

The Outcome of Ocular Prosthetic (Artificial Eye) Reconstruction

Peter Timothy Knowles

Thesis Submitted for Degree of
Master of Clinical Science

Adelaide Dental School
Faculty of Health and Medical Sciences
The University of Adelaide

July 2018

Table of Contents	Page No.
1. TITLE PAGE	
2. TABLE OF CONTENTS	Pg. 2
3. ABSTRACT	Pg. 5
4. THESIS DECLARATION	Pg. 6
5. ACKNOWLEDGEMENTS	Pg. 7
6. LIST OF TABLES	Pg. 8
6.9 Literature Review	
6.10 Results	
7. LIST OF FIGURES	Pg. 14
7.9 Literature Review	
7.10 Research Methodology	
7.11 Results	
8. INTRODUCTION	Pg. 20
9. LITERATURE REVIEW	Pg. 21
9.1 Introduction	
9.2 The Natural Eye – Orbital Anatomy	
9.3 The Natural Eye – Internal Anatomy	
9.4 Physiology of Vision	
9.5 Eye Loss	
9.6 Monocular Eyesight	

9.7 Ocular Prosthetic History

9.8 Ocular Prostheses

10. RESEARCH METHODOLOGY

Pg. 100

10.1 Study Group

10.2 Study Aim

10.3 Inclusions

10.4 Exclusions

10.5 Execution & Design

10.6 Null Hypotheses

10.7 Prosthesis Construction Methodology

11. RESULTS

Pg. 118

11.1 General Results

11.2 Psychological Results: Emotions at Time of Loss VAS Score Results

11.3 Period Between Eye Loss and First Prosthesis

11.4 Emotions After Receiving First Prosthesis

11.5 Emotions After Receiving Second Prosthesis

11.6 Emotions After Receiving Third Prosthesis

11.7 Emotions Now - With Prosthesis

11.8 Emotions Now - Without Prosthesis

11.9 Cosmetics Versus Function

11.10 Effect On Life

11.11 Feelings of Vision

11.12 Discharge

11.13 Sleeping

11.14 Eye Care

11.15 Getting Used to One Eye

11.16 Comparative Analysis

11.17 Null Hypotheses

12. DISCUSSION	Pg. 212
12.1 Introduction	
12.2 Research Methods	
12.3 General Findings	
12.4 Comparative Data Findings	
12.5 Null Hypothesis Findings	
12.6 Summary	
13. CONCLUSIONS	Pg. 244
13.1 Introduction	
13.2 Research Conclusions	
13.3 Further Research	
13.4 Summary	
14. APPENDICES	Pg. 248
14.1 Custom PMMA Ocular Prosthetics	
14.2 University of Adelaide Ethics Permission	
14.3 Visual Analogue Scale Glossary of Terms	
14.4 Research Questionnaire Used	
15. REFERENCE LIST	Pg. 265

3. ABSTRACT

Eye loss has been a feature of mankind's existence down through the ages, and whilst significant amounts of research have been undertaken to discuss monocular vision at an ophthalmic and optometric level, little or no research has been undertaken to discuss the benefits or otherwise of prosthetic reconstruction of the empty palpebral fissure. Most of this has been left at an artistic or anecdotal level.

To the author's knowledge, no research of this kind has been undertaken within Australia, and little or no research has been undertaken, to this extent, around the world. The overall aim of this research is to define the optimum benefit with the minimum risk for the different types of eye loss and ocular replacement.

This thesis attempts to research and document the reasons for eye loss and some of the more prevalent issues that arise as a result of wearing an artificial eye, whether they be negative or positive. A questionnaire was developed, to research and quantify various experiences of individual artificial eye wearers; their reasons for eye loss, the role the prosthetic eye played in their life, both prosthetically, socially and psychologically. Every attempt has been made to accurately represent the responses based upon feelings of a number of patients over a number of years. The point of commonality in this study is that all patients have had their artificial eyes made by a single ocular prosthetist.

It was found that eye loss was indiscriminate as to gender, age or ethnicity. The results showed that more people lost their right eye than those who lost their left, and over 50 age bracket lost their eye through disease more commonly. It was also hypothesized and confirmed that smokers lost their eye due to disease related issues more often than non-smokers. Prosthetic rehabilitation dramatically increased patients' sense of wellbeing, emotionally, psychologically and socially.

It is concluded that more than just being a cosmetic solution to what is otherwise a medical problem that an ocular prosthesis plays a more important, and vital, psychological role to those suffering eye loss.

4. THESIS DECLARATION

I certify that this work research material has no other material which has been accepted for any other award at any other university or tertiary institution. To the best of my knowledge and belief it contains no material which has been previously published or written by anyone else, unless appropriate referencing has been made in the written text.

I certify that this work will, in the future, not be used to submit for any other degree or diploma at any university or other tertiary organisation unless approval is given by The University of Adelaide.

I give consent for this thesis to be copied and deposited in the University Library, made available to other students or colleagues for loan or photocopying, subject to the provisions of the Copyright Act 1968.

The author acknowledges that copyright of published works contained within this thesis resides with the copyright holder(s) of those works.

I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

Signature: _____

Date: _____

5. ACKNOWLEDGEMENTS

I would first like to sincerely thank Emeritus Professor Alastair Goss, Oral and Maxillo-Facial Surgeon at The University of Adelaide/ Adelaide Dental Hospital, Royal Adelaide Hospital for his unwavering support and encouragement throughout the duration of the research and production of this thesis. He has always been both patient, encouraging and informative and for this I am very grateful. I appreciate and thank Professor Dinesh Selva, Ophthalmologist, for his encouraging me to undertake this research. I would also like to thank my daughter, Roseanna-Zoe Knowles, Ocularist/Ophthalmic Nurse, for her timely, punctual, consistent, enthusiastic and intelligent support. This thesis could not have been completed without her help, in organization, typing and formatting, and assisting in the research of the material needed. I wish her well in her Ophthalmic career.

Very profound gratitude to my wife Ruth and family for their support. Particularly Benjamin and Tobias for their statistical help in working the computer programs necessary to analyze the data.

I would like to thank the patients who were prepared to complete the questionnaire and share their feelings, in what for them is a traumatic and difficult experience, knowing that hopefully research of this nature now and in the future will benefit both them and the Ocularistry profession.

I would like to thank my staff at my private clinic, Adelaide Artificial Eye & Prosthesis Clinic, and also the staff and colleagues at the South Australian Health Services, particularly the Oral & Maxillo-Facial Department who have supported and encouraged me on this journey.

Thank you to Dr Evie Hutchinson, who was a graduate student, for her assistance in collating the results. To my colleague in New Zealand, Dr Keith Pine, thank you for his inspiration and unique research, as well as for his advice when I have contacted him. For the finalizing of formatting of this thesis I would like to thank Lorraine McMahan.

Peter Timothy Knowles

6. LIST OF TABLES

6. 9 LITERATURE REVIEW

9.5 Eye Loss

9.5-1 Table of Infections: Bacterial (Data gathered from University of Rochester Medical Centre (2016); Batterbury et al. (2009); Graham (2016); Callegan et al. (2002); Egan (2016); Miller (1990)).

9.5-2 Table of Infections: Viral (Data gathered from University of Rochester Medical Centre (2016); Batterbury et al. (2009); Egan (2016); Miller (1990)).

9.5-3 Table of Infections: Fungal (Data gathered from University of Rochester Medical Centre (2016); Batterbury et al. (2009); Klotz et al. (2000); Egan (2016); Miller (1990)).

9.5-4 Australian Medicare System Item Numbers, showing total numbers of eye removal procedures over a 4-year period (Australian Government, 2013).

6.10 RESULTS

11.1 General Results

11.1-1 Gender distribution of participants

11.1-2 Marital status of participants

11.1-3 Age groups of participants at time of survey

11.1-4 Referral source for participants

11.1-5 Occupation groups of patients

11.1-6 Full demographic data of all participants

11.1-7 Participant smoking status

11.1-8 History of Childhood Illness Experienced

11.1-9 Current chronic conditions suffered by participants

11.1-10 Overview of general health related data of participants

11.1-11 Age of participant at time of eye loss

11.1-12 Specific eye that participant lost

11.1-13 Reason for participant eye loss

11.1-14 Eye removal method

11.1-15 Varying socket colours of participants

11.2 Psychological Results: Emotions at Time of Loss VAS Score Results

11.2-1 Comparative feelings of patients at time of eye loss: anger vs contentment VAS score

11.2-2 Comparative feelings of patients at time of eye loss: sorrow vs excitement VAS score

11.2-3 Comparative feelings of patients at time of eye loss: denial vs acceptance VAS score

11.2-4 Comparative feelings of patients at time of eye loss: frustration vs relief VAS score

11.3 Period Between Eye Loss and First Prosthesis Care Process

11.3-1 Various options that participants viewed as possible improvements VAS score

11.3-2 Participants opinion on more time or less time impacting on coming to terms with their loss VAS score

11.3-3 Any complications experienced by participants prior to receiving their prosthesis

11.3-4 Participants discharge amounts prior to prosthesis wear

11.3-5 Participants who wore conformers post eye removal

11.3-6 The number of previous prostheses participants have had

11.3-7 Year that participant received first prosthesis

11.4 Emotions After Receiving First Prosthesis

11.4-1 Participants emotions when received first prosthesis: sad vs happy VAS score

11.4-2 Participants emotion when received first prosthesis: sorrow vs relief VAS Score

11.4-3 Participants emotion when received first prosthesis: dysfunctional vs healed VAS score

11.5 Emotions After Receiving Second Prosthesis

11.5-1 Year that participants received second prosthesis

11.5-2 Participants emotions when received second prosthesis: sad vs happy VAS score

11.5-3 Participants emotions when received second prosthesis: sorrow vs relief VAS score

11.5-4 Participants emotions when received second prosthesis: dysfunctional vs healed VAS score

11.6 Emotions After Receiving Third Prosthesis

11.6-1 Participants emotions when received third prosthesis: sad vs happy VAS score

11.6-2 Participants emotions when received third prosthesis: sorrow vs relief VAS score

11.6-3 Participants emotions when received third prosthesis: dysfunctional vs healed VAS score

11.7 Emotions Now - With Prosthesis

11.7-1 Participants emotions when received current prosthesis: sad vs happy VAS score

11.7-2 Participants emotions when received current prosthesis: sorrow vs relief VAS score

11.7-3 Participants emotions when received current prosthesis: dysfunctional vs healed VAS score

11.7-4 Participants emotions when received current prosthesis: unattractive vs attractive VAS score

11.7-5 Participants opinion on others' perception of their appearance

11.8 Emotions Now - Without Prosthesis

11.8-1 Participants emotion when not wearing prosthesis: unattractive vs attractive VAS score

11.8-2 Participants emotion when not wearing prosthesis: uncomfortable vs comfortable VAS score

11.8-3 Participants emotion when not wearing prosthesis: vulnerable vs secure VAS score

11.8-4 Participants emotion when not wearing prosthesis: not okay vs okay VAS score

11.8-5 Participants emotion when not wearing prosthesis: naked vs clothed VAS score

11.9 Cosmetics Versus Function

11.9-1 Participants opinion on whether the prosthesis is purely cosmetic

11.9-2 Participants opinion on whether the prosthesis contributes to their appearance VAS score

11.9-3 Participants opinion on whether the prosthesis contributes to their self-esteem VAS score

11.9-4 Participants opinion on whether the prosthesis contributes to their psychological health
VAS score

11.9-5 Participants opinion on whether the prosthesis contributes to their social acceptance VAS
score

11.9-6 Participants opinion on whether the prosthesis contributes to their functionality VAS score

11.9-7 Participants opinion on whether the prosthesis contributes to their balance VAS score

11.9-8 Participants opinion on whether the prosthesis contributes to their vision VAS score

11.9-9 Participants opinion on whether the prosthesis contributes to their emotional comfort VAS
score

11.9-10 Summary of participant's opinion on the prosthesis effecting cosmetics and function

11.10 Effect On Life

11.10-1 Participants feeling like a different person as a result of their situation of eye loss

11.10-2 Participants state others perception of prosthesis VAS scale

11.10-3 Participants state if others identify the eye as artificial VAS scale

11.10-4 Participants state the amount of emphasis they place on their appearance VAS scale

11.10-5 Participants identify areas for improvement in current prosthesis VAS scale

11.11 Feelings of Vision

11.11-1 Identification of whether the prosthesis assists to 'see' better

11.11-2 Identification of whether the participant can 'see' out of the prosthesis

11.11-3 Participants identify if the prosthesis makes them feel more balanced

11.12 Discharge

11.12-1 Participants discharge amount from current prosthesis

11.12-2 Participants identify main time of day for discharge

11.12-3 Participants identify discharge colour

11.12-4 Participants medication for discharge and outcomes

11.13 Sleeping

11.13-1 Whether participant's eyelid close at night

11.13-2 Participants who wear their prosthesis while sleeping compared to those who don't

11.14 Eye Care

11.14-1 How often participants remove their prosthesis

11.14-2 How often participants have their prosthesis professionally cleaned

11.14-3 How often participants experience dry eye

11.14-4 How often participants experience watery eye

11.15 Getting Used to One Eye

11.15-1 Participants identify hardest areas of initial adjustment

11.15-2 Participants identify easiest areas of initial adjustment

11.15-3 Participants identify how aware they are of the prosthesis VAS score

11.15-4 Participants identify how convenient the prosthesis is VAS score

11.15-5 Participants identify the physical comfort of the prosthesis VAS score

11.16 Comparative Analysis

11.16-1 Reason for loss compared with socket colour

11.16-2 Reason for loss compared with socket colour

11.16-3 Time of discharge compared with colour

11.16-4a) Discharge colour at all times compared to colour in the morning

11.16-4b) Discharge colour in the afternoon compared to discharge colour at night

11.16-5 Professional review period compared to discharge amount

11.16-6 Three-month review discharge amount compared to 6 Month review discharge amount

11.16-7 Professional review compared to discharge colour

11.16-8 Three monthly and 6 monthly reviews compared to discharge colour, milky or yellow

11.16-9 Participants age at eye loss compared with reason for loss

11.16-10 Reason for loss before and after 50 years of age

11.16-11 Reason for loss within first 10 years compared to next 40 years of age

11.16-12 Time taken to come to terms compared with age at loss

11.16-13 More or less time needed before and after 30 years

11.16.14 Date of eye loss in relation to the use of a conformer

11.16-15 The use of a conformer before 2000 and after 2001

11.17 Null Hypotheses

11.17-1 Null hypothesis: patients over 50 - disease

11.17-2 Null hypothesis: men – trauma

11.17-3 Null hypothesis: smokers – eye loss through disease

11.17-4 Null hypothesis: diabetic patients – dry eye problems

11.17-5 Null hypothesis: eye loss through disease – more discharge

11.17-6 Null hypothesis: men – more discharge

11.17-7 Null hypothesis: 3 monthly cleaning – discharge

11.17-8 Null hypothesis: men – more self-esteem increase with eye insitu

11.17-9 Null hypothesis: women – more vulnerable without eye insitu

11.17-10 Null hypothesis: women – more naked without prosthesis

11.17-11 Null hypothesis: women – more unattractive without eye insitu

7. LIST OF FIGURES

7.9 LITERATURE REVIEW

9.2 The Natural Eye – Orbital Anatomy

9.2-1 Right orbit anatomy (Head & Neck Cancer Guide, 2015)

9.2-2 Orbit angle and ocular orientation looking from superior to inferior (Based on Quizlet, 2014)

9.2-3 Effect of trauma on the globe (Batterbury et.al 2009, p. 77 Fig. 3)

9.2-4 The sinuses surrounding the orbit (WebMD, 2016)

9.2-5 Six extraocular muscles of right orbit: a) lateral view b) superior view c) frontal view (Saladin, 2015)

9.2-6 Cardinal directions of eye movements (Information from Cassel et al., 1998; Lim et al., 2001)

9.2-7 Table of eye movement, action and direction (Information from Batterbury et al., 2009; Lim et.al., 2001)

9.2-8 Table of six cardinal directions of eye movement (Information from Cassel et al., 1998; Lim et.al., 2001)

9.2-9 Sagittal eyelid anatomy and mechanism & 'grey line' (Batterbury et al. 2009, p. 20 Fig. 1)

9.2-10 Muscles and structure of the R) eyelid (Batterbury et al. 2009, p. 2). Fig. 2)

9.2-11 Tear production, action and drainage (PharmQD, 2011)

9.2-12 Conjunctiva orientation (Poen, 2011)

9.2-13 Healthy/inflamed Conjunctiva (WebMD, 2015)

9.2-14 Cornea and Sclera joined by Limbus (Wikipedia, 2014)

9.2-15 Layers of the Cornea (Hybrid Cornea, 2010)

9.3 The Natural Eye – Internal Anatomy

9.3-1 The Layers of the Lens (Delamare, 2006)

9.3-2 Lens action a) Lens Pulled Flat – Long Distance b) Lens Rounded – Short Distance (Lee, Wong & Yap, 2014)

9.3-3 The Uvea: Iris Ciliary Body & Choroid (Health Media Network, 2014)

9.3-4 a) Pupil constriction due to contraction of circular smooth muscles **b)** Pupil dilation due to contraction of radial smooth muscles (The Discovery Eye Foundation, 2016)

9.3-5 Aqueous production and flow (Blackrock Eye Care, 2010)

9.3-6 Scleral Venous Sinus/Canal of Schlemm & Aqueous Flow (Saladin, 2015)

9.3-7 Anatomy of the eyeball; vitreous body & orra serrata (Saladin, 2015)

9.3-8 The path of light to the retina (Pass My Exams, 2014)

9.3-9 The travel and comprehension of light (Flatworld Education, 2016)

9.3-10 Ophthalmoscopic view of the eye (Batterbury, 2009 Fig. 3)

9.3-11 Posterior anatomy of the eye; optic nerve and disc (Austin Community College District, 2008)

9.4 Physiology of Vision

9.4-1 Absorption, reflection and transmission of light (Urban Heat Island, 2015)

9.4-2 The visual pathway in the eye (ASU School of Life Sciences, 2016)

9.4-3 The visual pathway to the brain (OERPub)

9.5 Eye Loss

9.5-1 Cataract – opaque lens, dispersed light (Sarah Knows Eyes, 2016)

9.5-2 Retinal tear/detachment – retina separated from the choroid (Boyd, 2016)

9.5-3 Glaucoma damage to the optic nerve (Mahaveer Eye Hospital, 2016)

9.5-4 Retinopathy of prematurity (ROP) (Sasilik ve Goz Tembelligi, 2016)

9.5-5 Retinoblastoma – tumor in the retina (U.S National Library of Medicine, 2016)

9.5-6 Leukocoria of pupil – the light reflection off the tumour (Batterbury et al., 2009, p 68 Fig. 1)

9.5-7 a) Coloboma of iris (AAPOS, 2016); **b)** coloboma of eyelids (Science 2.0, 2016)

9.5-8 Microphthalmic left eye and normal functioning right eye (Tips Curing Disease, 2013)

9.5-9 Anophthalmic left eye (CDC, 2015)

9.5-10 Birmingham eye trauma terminology system (BETTS) (Scott, 2011)

9.5-11 Fungal Keratitis (American Academy of Ophthalmology, 2014)

9.5-12 Chemical burn to anterior segment of eye (Operational Medicine, 2015)

9.5-13 Difference between Evisceration, Enucleation & Exenteration - the limitations of removal are highlighted within the blue area (Head & Neck Cancer Guide, 2016)

9.6 Monocular Eyesight

9.6-1 Monocular visual field of left eye – lost visual field (Brady, 2009)

9.6-2 Elephant man – Joseph Merrick (Sheward, 2014)

9.6-3 Freddy Krueger from 'A Nightmare on Elm Street' (Wikia)

9.6-4 Scarface (The Herb Museum)

9.6-5 Moshe Dayan with patch over left eye (Wikipedia, 2016)

9.7 Ocular Prosthetic History

9.7-1 Ancient Egyptian eyes, initially for gods and statues (The College of Optometrists, 2014)

9.7-2 The 'Eye of Horus' (Horus)

9.7-3 The Young woman discovered in The Burnt City (Quigley's Cabinet, 2012)

9.7-4 The item discovered in the Burnt City determined as an artificial eye (Quigley's Cabinet, 2012)

9.7-5 Ambrose Pare revolutionary initial ocular prosthesis **a)** eklephara **b)** hypoblephara (Ilieva, 2015)

9.7-6 Portrait of James Smith exhibiting his work (The College of Optometrists, 2014)

9.7-7 The 3 'stock' eyes shapes (The College of Optometrists, 2014)

9.7-8 Rows of 'Stock' eyes to be tried for best fit (Artificial Eye Clinic, 2015)

9.7-9 Multiple acrylic prosthetic right eyes from one individual patient, worn over a period of many years (Knowles, R-ZR 2016a)

9.8 Ocular Prostheses

9.8-1 Ocularist depiction of own eye colour match hand painted on scleral shell (Knowles, R-ZR 2014b)

9.8-2 a) Patient wearing right haptic shell prosthetic eye **b)** the anterior **c)** the posterior (Knowles, R-ZR 2014a)

9.8-3 Components of the construction process of an acrylic ocular prosthesis, each eye being a different prosthesis **a)** the polished acrylic prosthesis made from the wax mold ready for a try-in **b)** veins and scleral colour added **c)** final process of the clear acrylic **d)** final polished product ready for wear (Knowles, R-ZR 2016b)

9.8-4 The model of homeostasis of prosthetic eye wear as established by Pine et. al (2013)

7. 10 RESEARCH METHODOLOGY

10.7 Prosthesis Construction Methodology

10.7-1 Socket inspection and assessment – deeper cavity superiorly with moderate inflammation

10.7-2 Socket inspection and assessment – globe implant texture apparent through tissue indicating ocular implant exposure

10.7-3 a) Impression trays of varying shapes and sizes to choose from **b)** Modifying impression based on each individual patient requirements

10.7-4 Impression material is mixed appropriately

10.7-5 a) Impression tray is placed in socket **b)** Syringe is used to infiltrate impression material into socket through anterior conduit

10.7-6 Impression is removed from socket once congealed

10.7-7 a) Impression is invested to create a plaster mould **b)** plaster mould is topped

10.7-8 Heated wax is poured into the mould cavity to create a prototype shape

10.7-9 Pre-made iris inserted (III. Iris Replication Process)

10.7-10 a) Prototype wax shape is modified **b)** and tried in according to specific patient requirements for best fit/comfort, including assessment of iris positioning

10.7-11 Patients iris and pupil are assessed for best size – taking into account the element of magnification that occurs in the process of making the eye

10.7-12 a) Iris is painted on the back of a corneal unit with pigment paints **b)** to match the natural eye

10.7-13 Iris is sealed with methylmethacrylate to the CCPIP, with boiling water to aid fast setting

10.7-14 The bottom of a two-part mould is made from the wax shape prototype in a flask from dental plaster

10.7-15 A separating medium is applied before filling the top of the two-part mould and joining

10.7-16 The two-part mould is opened and wax prototype removed with boiling water – leaving the iris disc in place anteriorly. Markers in the plaster indicate matching points

10.7-17 Scleral toned PMMA powder and monomer are mixed and left till a consistency of a gentle 'snap' is reached

10.7-18 Gelled PMMA mixture is then packed into two-part mould flask. Hydraulic press is used to ensure the mixture has flowed into any small crevice and removes any excess

10.7-19 Flask is inserted into heating water bath to be processed in accordance with processing times for this equipment

10.7-20 Mould is released, eye is trimmed and polished

10.7-21 a) Eye is tried into socket and assessed for fit and accuracy – then medial canthus marked **b)** Scleral acrylic is trimmed back to expose the iris and allow for scleral veins stains and characterisation to be added. Corneal/scleral juncture is trimmed 0.5mm of the greatest surface of facial radius/convexity

10.7-22 Iris tones and limbus are added, and then scleral tones and veins of cotton are applied

10.7-23 Prosthesis is positioned into the posterior of the mould

10.7-24 Prosthesis is removed from the mould

10.7-25 Prosthesis is finally polished with dry high gloss

10.7-26 Prosthesis is cleaned and sterilized

10.7-27 Prosthesis delivery and insertion

10.7-28 Patient wearing newly inserted right prosthesis

7.11. RESULTS

11.1 General Results

11.1-1 Red socket example from **Table 11.1-13** (Knowles PT, 2016a)

11.1-2 Pink socket example from **Table 11.1-13** (Knowles PT, 2016b)

11.1-3 White socket example from **Table 11.1-13** (Knowles PT, 2016c)

11.3 Period Between Eye Loss and First Prosthesis

11.3-1 Two types of conformers participants wore: Left – vented rigid PMMA conformer / Right – soft silicone (Knowles, PT 2016d)

11.7 Emotions Now - With Prosthesis

11.7-1 Right ocular prosthetic eye of patient who was happy with current prosthesis (Knowles PT, 2012)

7.8 Emotions Now - Without Prosthesis

7.8-1 Ocular prosthetic eye removed from right socket (Knowles PT, 2016)

8. INTRODUCTION

Eye loss has been a feature of mankind's existence down through the ages, and whilst research has been undertaken to discuss monocular vision at an ophthalmic and optometric level, little or no research has been undertaken to discuss the benefits or otherwise of prosthetic reconstruction of the empty palprebal fissure. Most of this has been left at an artistic or anecdotal level.

This thesis attempts to research and document the reasons for eye loss and some of the more prevalent issues that arise as a result of wearing an artificial eye, whether they be negative or positive. Every attempt has been made to accurately represent the responses based upon feelings of a number of patients over a number of years. Comments were made to the investigator in the clinic whilst treating patients, which prompted the desire to research further certain psychological and physical issues surrounding artificial eye wear. It seemed that more than just being a cosmetic solution to what is otherwise a medical problem the prosthetic eye played a more important, and perhaps vital, psychological role to the wearer.

A questionnaire was developed to research and quantify various experiences of individual artificial eye wearers; their reasons for eye loss, the role the prosthetic eye played in their life, both prosthetically, socially and psychologically. To the author's knowledge, no research of this generalized inclusion has been undertaken within Australia, and little research has been undertaken to this extent and scope around the world. The point of commonality in this study is that all patients have had their artificial eyes made by a single ocular prosthetist.

The overall aim of this research is to define the optimum benefit with the minimum risk for the different types of eye loss and ocular replacement. To characterise a consecutive sequence of patients who have suffered loss of an eye and who have then proceeded to rehabilitate with an ocular prosthesis. What are the similarities and differences that exist between eye loss from developmental anomaly, trauma, neoplasia or neurologic conditions? Determining the physical and psychological impact of eye loss and ocular prosthetic rehabilitation on the patient's life. Determine what complications may occur to patients who have suffered eye loss and ocular replacement. This would take into account the different causes of eye loss, the different types of ocular prosthesis construction and patient attitude toward their prosthesis.

9. LITERATURE REVIEW

9.1 INTRODUCTION

The eye – “the light of the body”, an expression of personality, and a “mirror of the soul” - has fascinated mankind since the dawn of its history. It is a naturally human desire to feel “normal” and accepted. Since humans have existed, eye loss has been a fact of life; however, little has been known about it or understood. Therefore, the endeavour to replace that loss with an entity to create feelings of normalcy and wholeness has always been present.

To understand the concept of fitting a surgically created orbital space with a prosthesis, one must first understand a brief outline of the anatomy and physiology of the natural eye, its components, functions, and purpose. The eye is very specific in its organisation and orientation, as such, creating a variety of possibilities relating to parts that can malfunction. Eye loss requires an individual to undertake major life re-adjustment, not only on a personal and social level, regaining self-confidence and pride; but also on a professional level, where talking face-to-face and personal interaction is a part of their community on a daily basis (Brady 2009). The final result of a patient wearing their new prosthesis, having previously lost their eye and subsequently their binocular vision, is a very mixed emotional event.

When reviewing the literature that discussed ocular prostheses/artificial eyes, it has been found that much of the research studies and published papers have focussed more specifically on the surgically implanted ‘orbital prosthesis’ to which the muscles are attached during evisceration or enucleation surgery, assisting in the creation of a socket space. This information was discerned as being primarily directed at the Ophthalmic Surgeons, and dealing with patient care and surgical concerns or issues. Prosthetic eye or artificial eye related literature is not well developed and has mostly been left at an anecdotal and artistic level, with much of the scientific information focussing more often on surgical techniques and procedures surrounding eye loss and emotional complications (Pine, Sloan, & Jacobs, 2012 (c); Pine, Sloan, Stewart, & Jacobs, 2011).

Extensive research and literature has been obtained relating to and discussing the effect that immediate post-operative monocular vision has on a person's vision and depth perception. A steady stream of information is also available through social media sites; however, it is important to receive and filter the information with critical thinking as the credibility of resources is not always guaranteed. Pine, Sloan, & Jacobs, (2012 (a)), found similarly that few published studies discussed the experiences and adaptations of patients to artificial eye wear over time and on an ongoing basis.

Despite the minimal literature available within this specific topic, the following factors were identified by Rasmussen (2008); complications most commonly found to be correlated with the wearing of an ocular prosthesis include hyper-secretion, lagophthalmos (inability for eyelids to close), enophthalmos (posterior displacement of eye within orbit), prostheses instability, and exophthalmos (protrusion of eyeball). It was established in the studies undertaken by Pine, Sloan, Stewart, & Jacobs (2011), that the one major concern for monocular or unilaterally anophthalmic patients was 'the health of the remaining eye'. With that being an understandable and justifiable worry for patients, Pine et al. (2011) found that the other concern relating to specific artificial eye wear included a vast array of discharge complications as well as aesthetic components relating to direction of gaze and symmetry.

9.2 THE NATURAL EYE – ORBITAL ANATOMY

The Orbit

The natural eye, also called ocular globe, is 24mm in diameter, with a whole network of mechanisms and layers that interrelate and effectively work together (Cassel, et. al 1998; Saladin, 2015). The ocular globe is part of a set, and these both require appropriate protection, provided by the orbits which are located in the anterior of the skull (**Fig. 9.2-1**). The orbits are shaped so that all sides of the eye are effectively protected by bone except for the front, which is where the image is obtained (Batterbury et al. 2009).

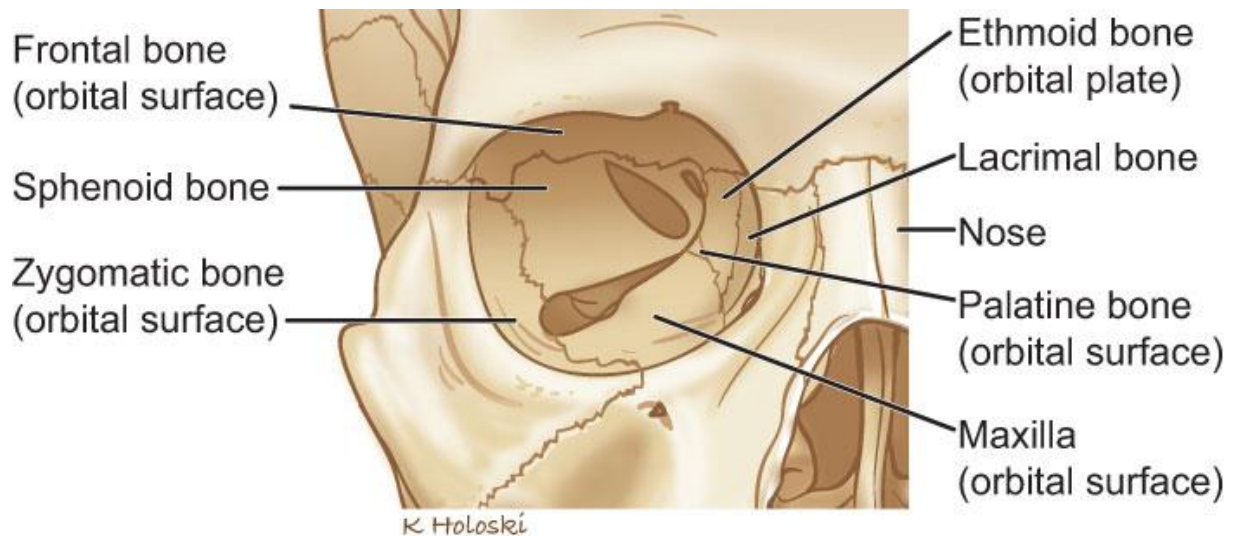


Fig. 9.2-1 Right orbit anatomy (Head & Neck Cancer Guide, 2015)

The medial (inner) walls are parallel to each other on either side of the nose and the lateral (outer) walls are at an angle of 45 degrees to each other (**Fig. 9.2-2**) (Batterbury et al. 2009; Cassel et al. 1998). This shape roughly resembles a pyramid, with the apex angled posteriorly and the base at the opening of the face (**Fig. 9.2-2**). The medial wall (nasal surface) and the floor of each orbit contain thinner bone than the other walls and roof which consist of heavy bone, on its outer edges. The junction of the anterior (front) and middle cranial fossae is located at the apex of the orbit (**Fig. 9.2-1; 9.2-2**). This orientation of bone structure ensures maximum protection for these very delicate occupants of the orbits.

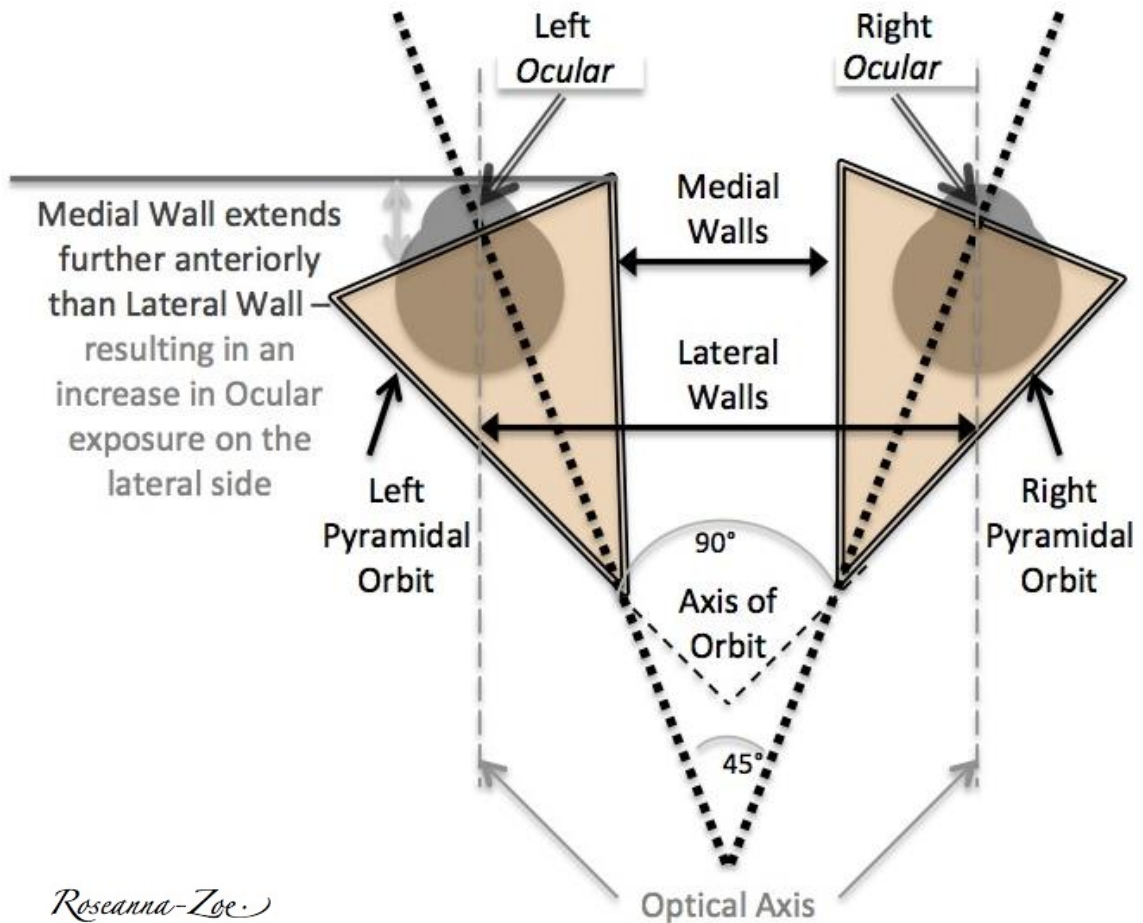


Fig. 9.2-2 Orbit angle and ocular orientation looking from superior to inferior
(Based on Quizlet, 2014)

Added to this protective structure, the orbit also contains a “facing” of fat, which cushions the eye. In the event of a forceful impact on the orbit, the eye is forced backwards and downwards into the orbit. The medial wall and floor of the orbit, consisting of a thinner bone, enable decompression through the fracturing of these bones, ideally minimizing damage to the eyeball (**Fig. 9.2-3**) (Batterbury et al. 2009; Cassel et al. 1998; Glasspool 1982; Parr 1982). Covering the base of the pyramid is a fibrous sheet of tissue, the orbital septum, which holds the eyeball and the rest of the orbital contents in place. Orbital contents include the eye, extraocular muscles (which move the eye), nerves, blood vessels and the protective fat mass (**Fig. 9.2-3**) (Batterbury et al. 2009; Cassel et al. 1998).

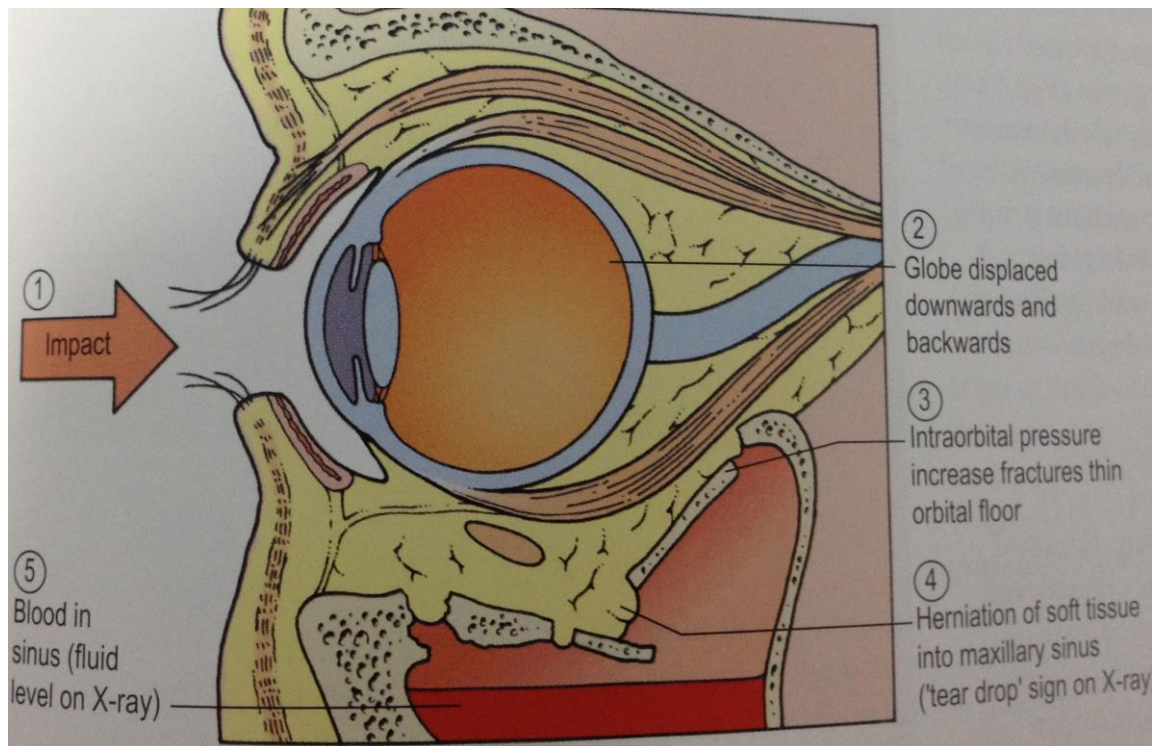


Fig. 9.2-3 Effect of trauma on the globe (Batterbury et al. 2009, p. 77, Fig. 3)

The maxillary sinuses lie below the orbits, the ethmoid sinuses lie medial to them, while the frontal sinuses and frontal lobes of the brain are located above the orbits. Due to the close proximity and direct connection (**Fig. 9.2-4**), infection in the maxillary or ethmoid sinus can easily transfer to the orbit creating multiple complications, which in extreme circumstances can include eye loss. Unlike other bones, the orbital bone, already exceptionally thin, is not susceptible to osteoporosis – it does not thin or weaken significantly with aging (Batterbury et al. 2009). In very elderly persons, the cushion of orbital fat occasionally atrophies, or shrinks, causing the eyes to sink noticeably back into the skull, or it may herniate forward into the eyelids, causing abnormal puffiness or 'bags' under the eyes (Batterbury et al. 2009; Cassel et al. 1998; Glasspool 1982; Parr 1982). The two eyes are joined together behind the orbit to maintain binocular vision without diplopia (Batterbury et al. 2009). Our field and quality of vision is improved by having two eyes – this will be further discussed in section 9.4.

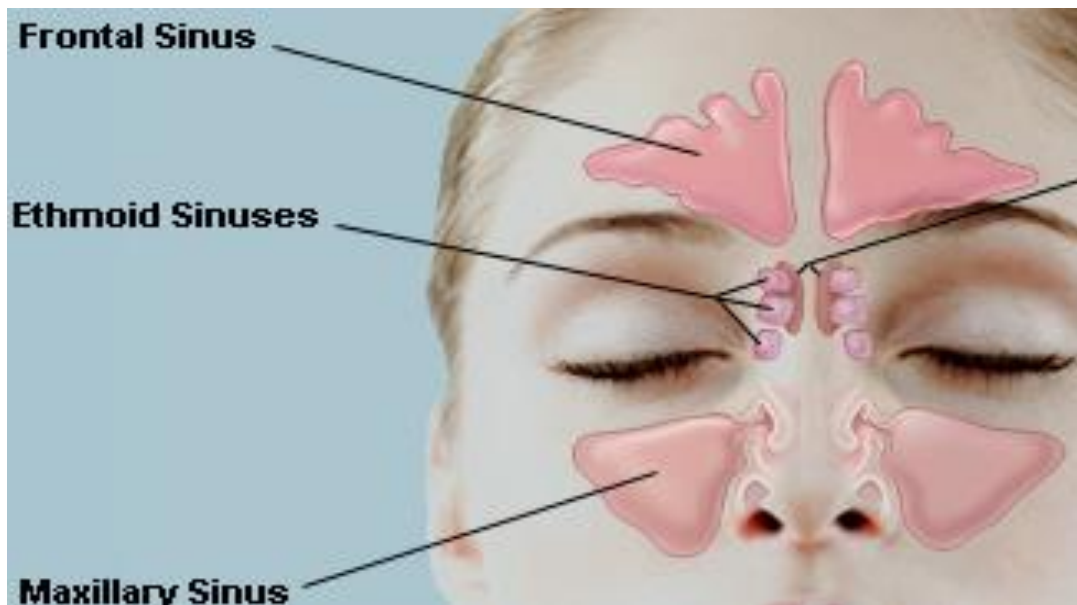


Fig. 9.2-4 The sinuses surrounding the orbit (WebMD, 2016)

Muscles & Eye Movement

The extra-ocular muscles, contributing to the orbital contents, are essential for eye movement (**Fig. 9.2-5**). To see specific things, our body and head can alter their positions to assist our eyes in getting a clear and direct desired view (Batterbury et al. 2009). In addition to this, our eyes can move independently of the rest of the body, by using these extra-ocular muscles located in each orbit (**Fig. 9.2-6**). However, although moving independently of the body within their own orbit, the eyes are designed to move in similar motion with each other (Batterbury et al. 2009, p. 6; Cassel et al. 1998; Glasspool 1982; Parr 1982). There are six main extra-ocular muscles fastened to the eye providing eye movement (**Fig. 9.2-5**) (Batterbury et al. 2009, p. 6): -

- Medial Rectus
- Lateral Rectus
- Superior Rectus
- Inferior Rectus
- Superior Oblique
- Inferior Oblique

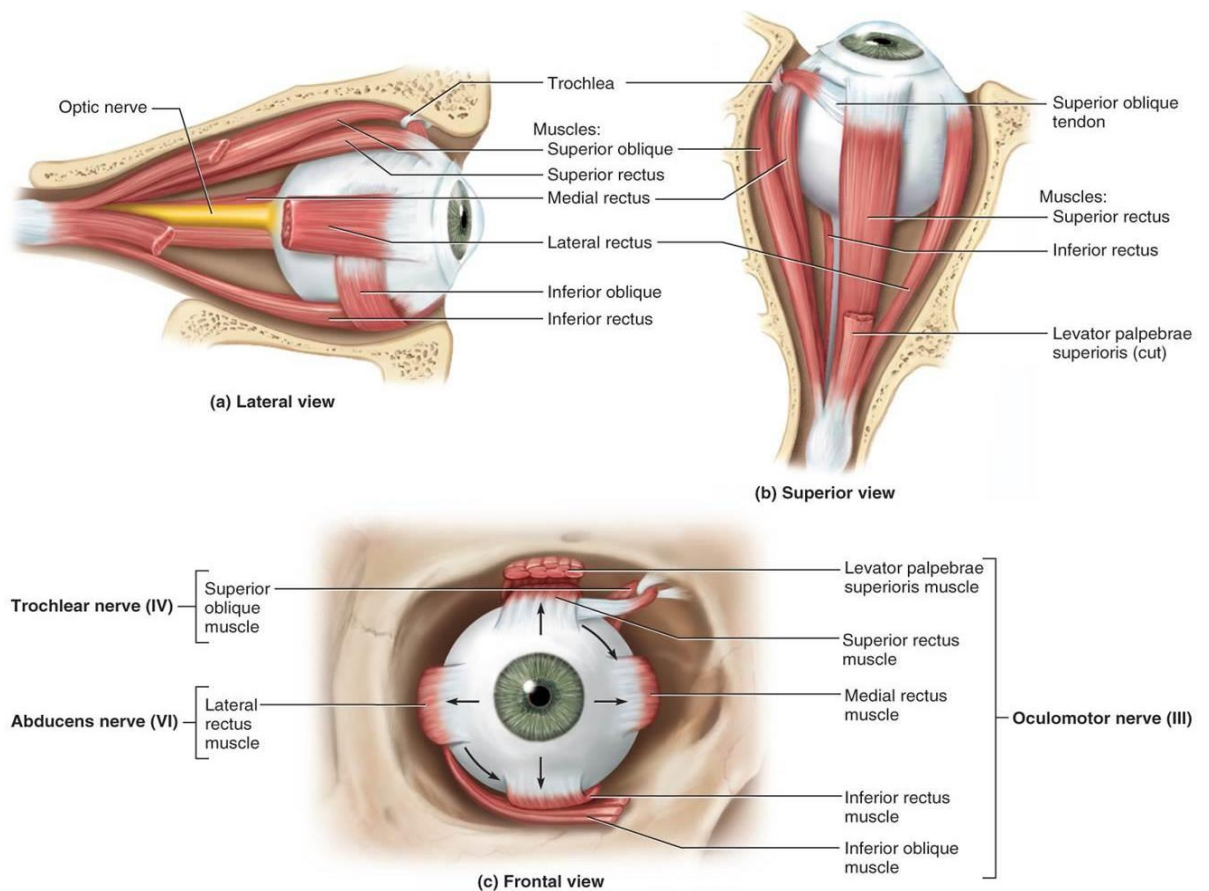


Fig. 9.2-5 Six extraocular muscles of right orbit: a) lateral view b) superior view c) frontal view (Saladin, 2015)

When the head is held vertically straight and the eyes are pointed straight ahead, the position of the eyes is called the 'primary position' (Cassel et al. 1998). The Medial Rectus and Lateral Rectus are responsible for horizontal (medial and lateral) movement, which is known as the adduction movement when medial (middle), and abduction movement when lateral (outer) (**Fig. 9.2-6; 9.2-7; 9.2-8**). The Superior Rectus, Inferior Rectus, Superior Oblique and Inferior Oblique provide upwards movement, elevation and downwards movement, depression, known generally as vertical movements (**Fig. 9.2-6; 9.2-7; 9.2-8**). These four muscles also provide torsional movement; inward twisting known as intorsion and outward twisting known as extorsion movements (**Fig. 9.2-6; 9.2-7; 9.2-8**). Because the eyes move in similar motion, when eye movement occurs all six muscles work together to ensure both eyes are focusing in the same direction. For each rotation, action & direction, the principal muscles are shown in **Fig. 9.2-7**, along with their general movement.

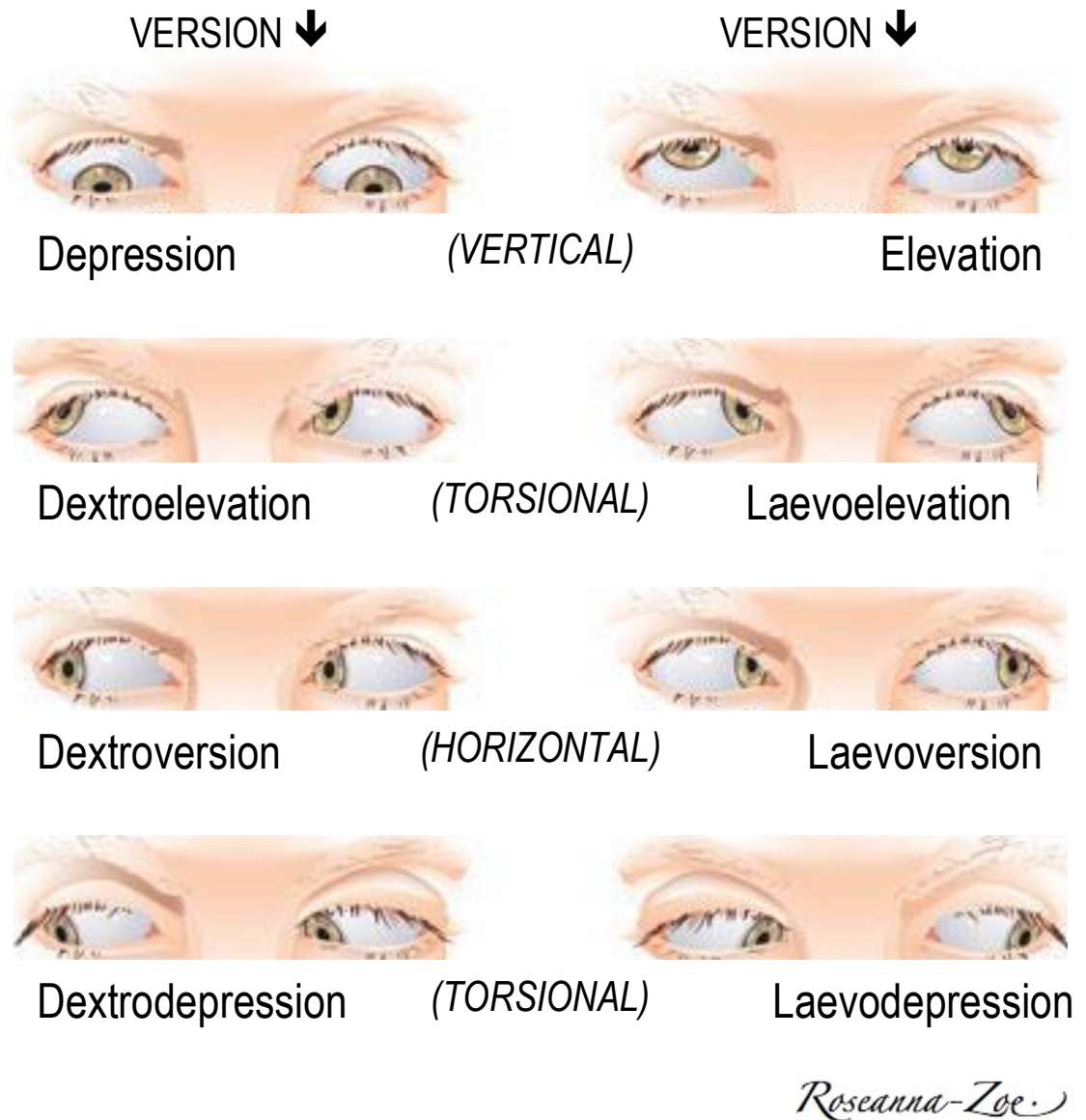


Fig. 9.2-6 Cardinal directions of eye movements (Based on Cassel et al. 1998; Lim et al. 2001)

The movement of both eyes coordinated together in the same direction is called conjugate movement or versions. When this happens, the corresponding muscles in the eyes work in pairs within each eye, and are sometimes called 'yoke muscles'. There are six cardinal directions of eye movement, and each version has a different name and different yoke muscles (Fig. 9.2-6; 9.2-8).

MUSCLE: MOVEMENT, ACTION, AND DIRECTION						
Muscles	Medial Rectus	Lateral Rectus	Superior Rectus	Inferior Rectus	Superior Oblique	Inferior Oblique
MOVEMENT						
Horizontal <i>Medial & Lateral</i>	✓	✓				
Vertical <i>Elevation & Depression</i>			✓	✓	✓	✓
Torsional <i>Intorsion & Extorsion</i>			✓	✓	✓	✓
ACTION/DIRECTION						
Adduction <i>Medial (middle of body)</i>	✓		✓	✓		
Abduction <i>Lateral (outer of body)</i>		✓			✓	✓
Elevation <i>Upward</i>			✓			✓
Depression <i>Downward</i>				✓	✓	
Intorsion <i>Inward Twisting</i>			✓		✓	
Extorsion <i>Outward Twisting</i>				✓		✓

Roseanna-Zoe

Fig. 9.2-7 Table of eye movement, action and direction (Information from Batterbury et al. 2009; Lim et al. 2001)

Version	Definition	Right Yoke Muscles	Left Yoke Muscles
Dextroversion	...to the right	Lateral Rectus	Medial Rectus
Dextroelevation	...up and to the right	Superior Rectus	Inferior Oblique
Dextrodepression	...down and to the right	Inferior Rectus	Superior Oblique
Laevoversion	...to the left	Medial Rectus	Lateral Rectus
Laevoelevation	...up and to the left	Inferior Oblique	Superior Rectus
Laevodepression	...down and to the left	Superior Oblique	Inferior Rectus

Roseanna-Zoe

Fig.9.2-8 Table of six cardinal directions of eye movement (Information from Cassel et al. 1998; Lim et al. 2001)

A malfunction with any of the six muscles of either eye will cause an effect on one or more of the six cardinal directions of eye movement. Depending on the muscle, malfunction will depend on the movement affected. When the eyes are not working simultaneously, blurry or double vision will occur (Batterbury et al. 2009; Cassel et al. 1998; Glasspool 1982; Lim et al. 2001; Parr 1982).

Eyelids

Eyelids fulfill two main functions: 1. Protection of the eyeball
2. Secretion, distribution and drainage of tears.

Cassel, Billig & Randall (1998, p. 3) artistically depict;

“Think of the eyelids as movable curtains on a stage - what we see of the eye is just the front surface that’s visible between the opened lids; backstage in the eye is just as important and interesting”.

The eyelids are covered on their inner aspect with a sheet of thin, slippery membrane called conjunctiva, which folds back and connects to the front surface of the eye. Over this lining, and giving the eyelid some rigid support structure and strength is a tough, fibrous plate of connective tissue called the tarsus; then come layers of muscle and skin (**Fig. 9.2-9**) (Batterbury et al. 2009; Cassel et al. 1998; Glasspool 1982; Lim et al. 2001; Parr 1982).

The space between the lids is termed the palpebral aperture or fissure (**Fig. 9.2-10**). The layers of an eyelid can be conveniently grouped into a posterior lamella (conjunctiva and tarsal plate) and an anterior lamella (orbicularis oculi muscle and skin) (**Fig. 9.2-10**). The orbicularis oculi muscle, called a sphincter muscle, is arranged as a ring of fibers around the palpebral aperture, and contraction of this causes the lids to close; the tarsal plate largely determines the shape of the eyelid (**Fig. 9.2-9; 9.2-10**). A thinner layer of fibrous tissue, called the orbital septum, connects the tarsus to the periosteum, the outermost layer of bone covering the orbit (Batterbury et al. 2009, p. 2). The orbital septum is a thin fence that keeps the previously mentioned layer of orbital fat confined inside the bony orbit. The two

lamellae are divided along the 'grey line', which is visible along the length of the lid margin between the lashes and the meibomian gland orifices (**Fig. 9.2-9**). These glands, which produce the oily lipid component of the tear film, are aligned vertically. The grey line is an important landmark in repairing lacerations of the lid margin and an eyelid related surgery such as ectropion / entropion. (Batterbury et al. 2009; Cassel et al. 1998; Lim et al. 2001).

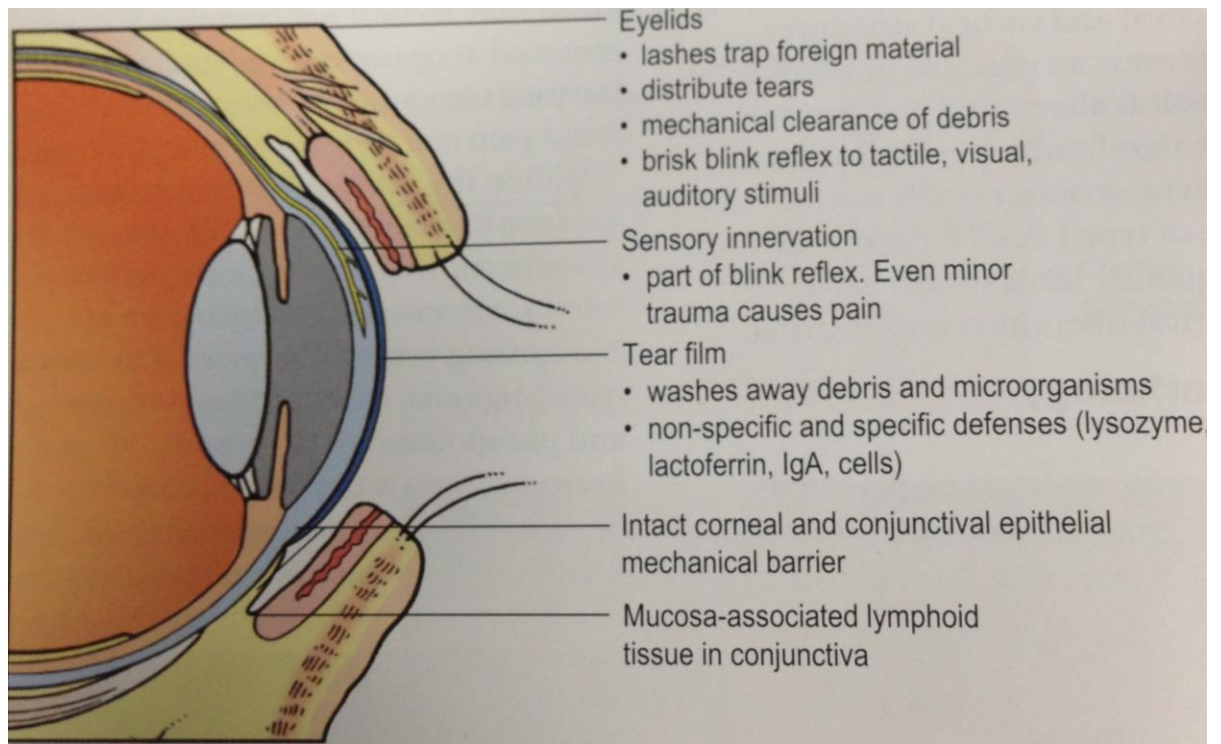


Fig. 9.2 -9 Sagittal eyelid anatomy and mechanism & 'grey line' (Batterbury et al. 2009, p.20, Fig. 1)

Opening of the lids is principally performed by the levator muscle in the upper lid, though there are some tenuous fibres which act to retract the lower lid (**Fig. 9.2-10**). The levator extends from an attachment at the orbital apex to attachments at the tarsal plate and skin (forming a skin crease) (**Fig. 9.2-10**). The lids are securely attached at either end to the bony orbital margin by the medial and lateral palpebral ligaments. Blinking distributes tears across the cornea, which maintains the smooth optical surface of the cornea and displaces debris (**Fig. 9.2-9**). A dust fragment or bright light stimulates the corneal reflex blinking, and during sleep the eyes are protected by a continuous eyelid closure. To function efficiently, the lids must be smooth and where they are in contact with the eye, they must close

completely and facilitate an adequate flow of tears for health of the cornea, this will be discussed later (Batterbury et al. 2009; Cassel et al. 1998; Glasspool 1982; Lim et al. 2001).

The skin of the eyelids is thin and only loosely attached to the underlying tissues, so that inflammation and bleeding may cause considerable swelling (Batterbury et al. 2009; Lim et al. 2001). As the skin of the eyelids age, just like the skin on the face or arms, it tends to lose its suppleness and begins to droop. The eyelids are supplied by an extensive network of blood vessels, which allows for excellent healing following trauma. As mentioned, the edges of the eyelids are home to ducts for the meibomian or tarsal glands that secrete an oily film. The eyelids are also the bases for the eyelashes which are delicate efficient filters that protect our eyes from dust and myriad other foreign objects (Fig. 9.2-11). Eyelashes have a protective aspect and tend to lessen in number as we get older, and interestingly, they become lighter, but rarely do they turn white with age.

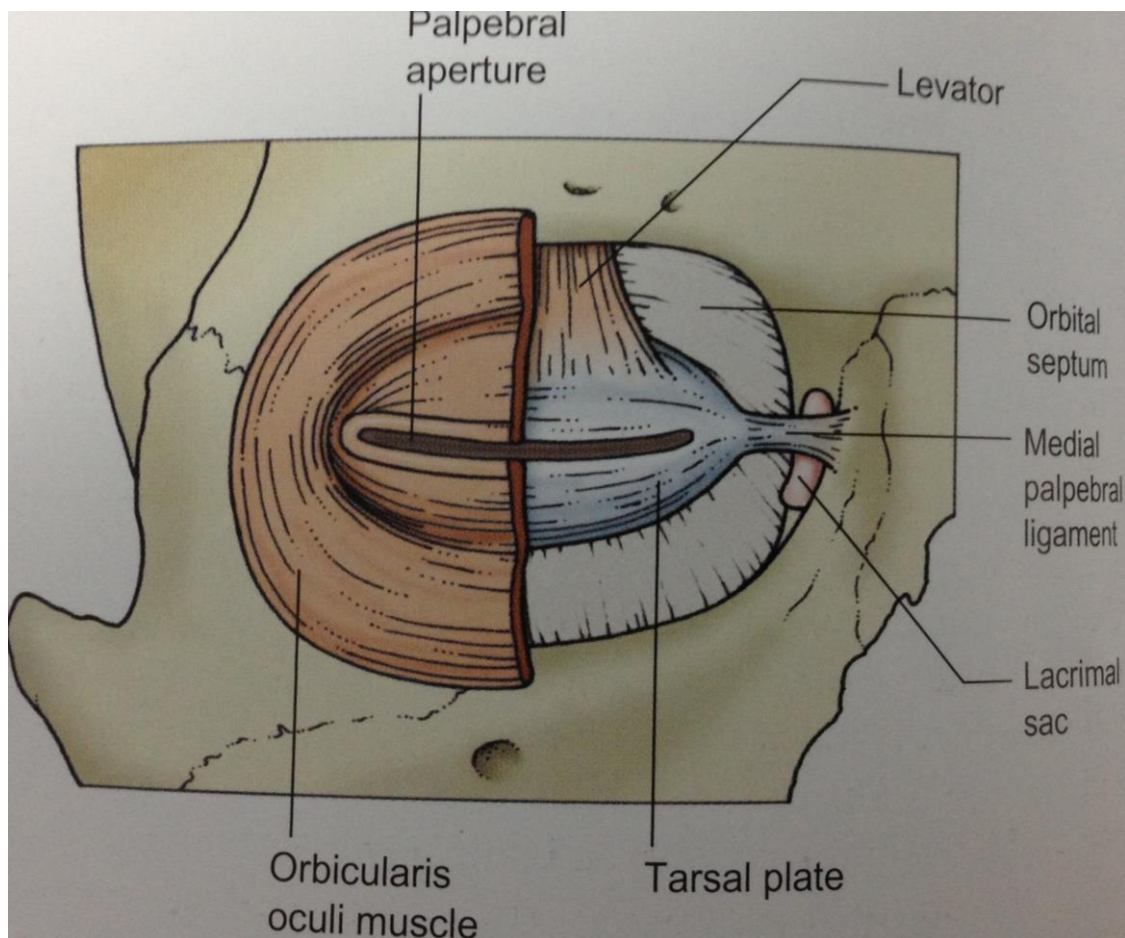
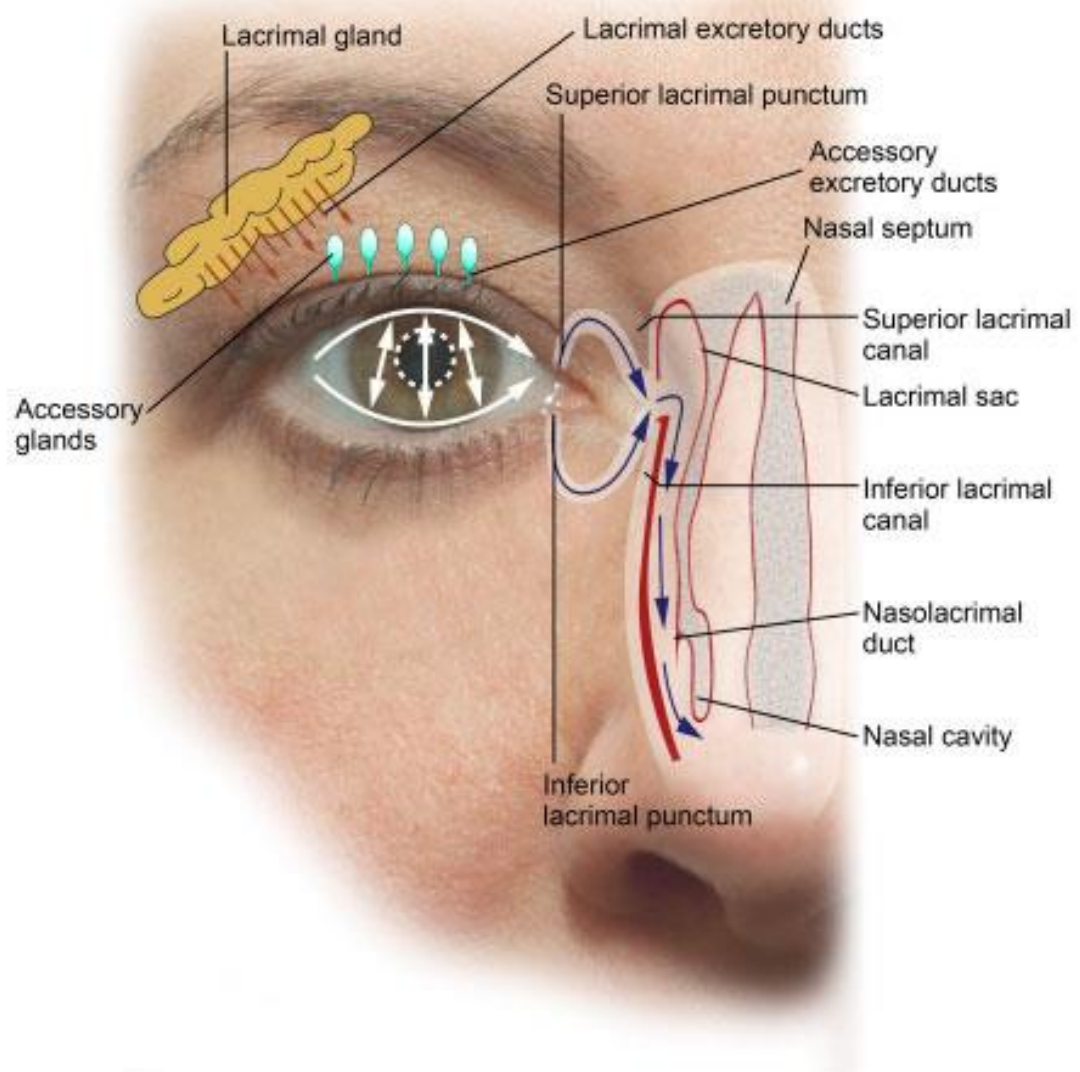


Fig. 9.2-10 Muscles and structure of the R) eyelid (Batterbury et al. 2009, p. 2, Fig. 2)

Tears

The presence of a normal precorneal tear film is important for cleansing and lubricating the eyes surface, for supply of oxygen and nutrients and even prevention of eye infections due to an antibacterial enzyme present in the tears (**Fig. 9.2-11**). The normal tear film pattern is derived from the lids, conjunctiva, and lacrimal glands. A normal blink reflex which is coordinated by the levator muscle, is required to allow regeneration and circulation of the tears (**Fig 9.2-11**).



© 2013 Opere CA & O'Brien K, SPAHP, Creighton University

Fig. 9.2-11 Tear production, action and drainage (PharmQD, 2011)

The stability of the tear film is dependent on the presence of three components together with a number of other factors. These are water to keep the epithelium hydrated, mucus secreted by the meibomian glands to bind the tear film to the corneal epithelium, and an outer lipid layer to reduce evaporation of the water. This outer lipid layer forms a monolayer on the surface of the tear layer. It contains waxy cholesterol esters, which are liquids at body temperature, which provide a surface tension property, therefore reducing evaporation (**Fig. 9.2-11**). Between this outer layer and the aqueous layer there is a mucus 'bonding' layer which is polarized, meaning it attaches to both layers either side by its differentiating ends, both hydrophobic and hydrophilic. This strong polar bonding holds the layers tightly onto each other, enabling maximum corneal epithelium 'wetting', ensuring the cornea remains constantly hydrated, the importance of which will be discussed later (**Fig. 9.2-11**).

The lacrimal gland which secretes most of the aqueous component of the tear film, lies in the superotemporal part of the anterior orbit (**Fig. 9.2-11**). Tears collect in a meniscus on the lower lid margin and are then spread medially across the ocular surfaces by blinking, and drain into the superior and inferior puncta at the nasal end of the eyelids (**Fig. 9.2-11**). Finally, tears pass down the nasolacrimal duct and posteriorly reach the nasopharyngeal cavity, which is the reason for the unpleasant taste that follows administration of certain eye drops (**Fig. 9.2-11**). At birth, the nasolacrimal duct may not be fully developed, causing a watery eye but in most cases, full canalization occurs within a year. Acquired obstruction of the nasolacrimal duct is a common cause of a watery eye in adults and can be flushed and cleared by an Ophthalmologist. Examples of this are facial fractures and pathology pressing on the nasolacrimal duct, which may lead to an acute infection of the sac, manifesting as a cellulitic swelling just below the medial palpebral ligament (**Fig. 9.2-11**).

There are two types of tears, the one discussed which are lubricating tears for the cornea, however there are another type of tears which act as a flushing mechanism, called 'crying tears'. An extra production of tears, 'crying tears' can happen in response to an external stimulant or irritant, designed to dilute and wash away anything that might harm the eye, however they are also produced when strong emotions are present, the reason for this being poorly understood (Batterbury et al. 2009).

Conjunctiva

The conjunctiva is a mucous membrane which lines the eyelids and covers the anterior eyeball up to the edge of the cornea. At the upper and lower reflections between eyeball and eyelid the conjunctiva forms two sacs, the superior and inferior fornices (**Fig. 9.2-12; 13**). The conjunctiva is tightly adherent to the lid, loosely attached to the eyeball and free in the fornices, allowing for free movement and any possible swelling (**Fig. 9.2-12**). The conjunctiva comprises an epithelium and an underlying stroma, and within the epithelium are goblet cells that secrete the mucin component of the tear film, discussed in the previous section. Conjunctival glands contribute to the secretion of the aqueous and lipid layers of the tear film. The conjunctiva facilitates free movement of the eyeball and provides a smooth surface as the lids blink against the cornea, and has an important role in the protection of the eye against microorganisms (**Fig. 9.2-13**).

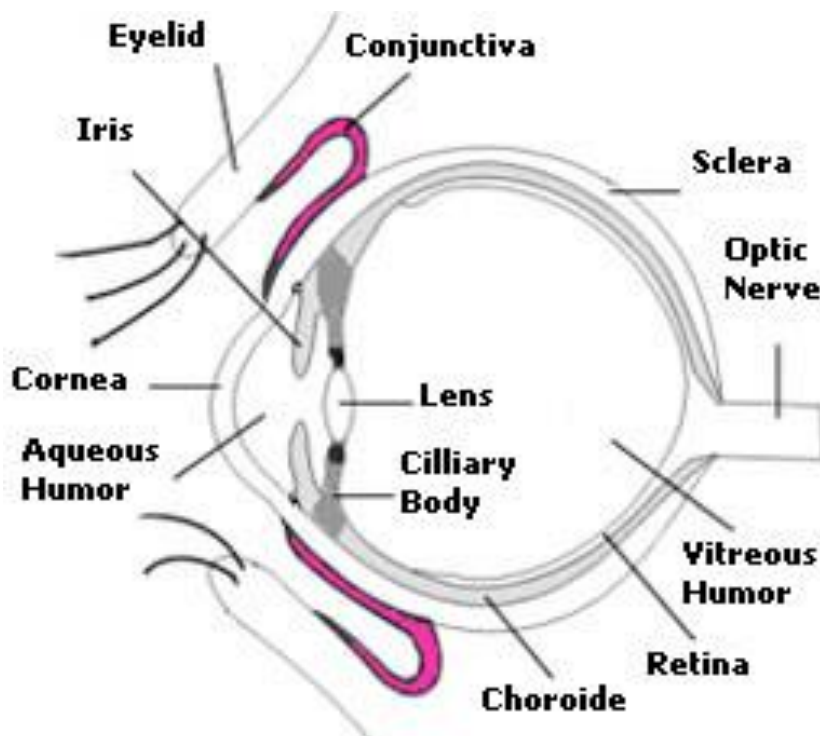
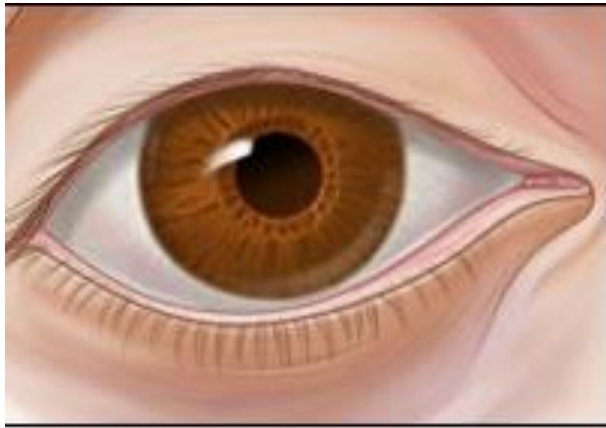
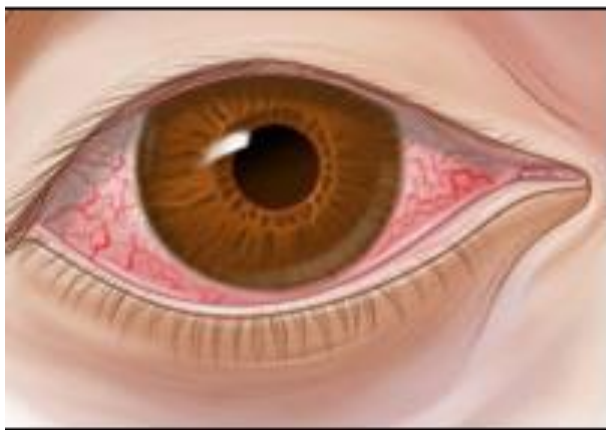


Fig. 9.2-12 Conjunctiva orientation (Poen, 2011)



Eye with healthy
conjunctiva



Inflamed
or irritated
conjunctiva

© Healthwise, Incorporated

Fig. 9.2-13 Healthy/inflamed Conjunctiva (WebMD, 2015)

Cornea & Sclera

Together, the cornea and sclera form a spherical shell, which makes up the outer wall of the eyeball, however, although they have this in common, their purpose and composition are vastly different (**Fig. 9.2-14**). The sclera is principally collagenous, avascular (apart from some vessels on its surface), relatively acellular, and is tough despite having a maximum thickness of 1mm, giving attachment to the extraocular muscles (Batterbury et al. 2009, p. 3). It is perforated posteriorly by the optic nerve, and by sensory and motor nerves and blood vessels to the eyeball. The cornea and sclera merge at the corneal edge, called the limbus (**Fig. 9.2-14**).

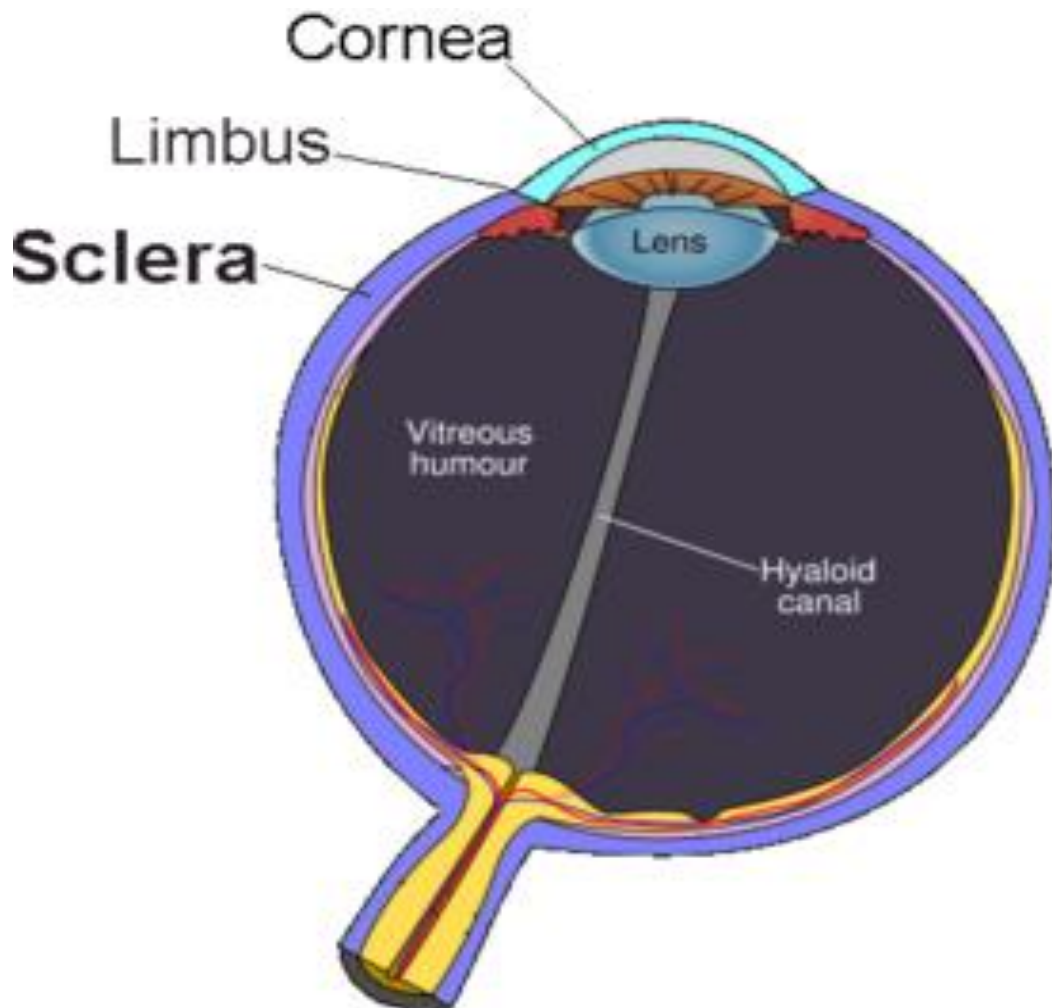


Fig. 9.2-14 Cornea and Sclera joined by Limbus (Wikipedia, 2014)

In contrast, the corneal structure is uniquely modified, being the only structure in the outer eye that transmits and refracts light, and is highly sensitive. The chief functions of the cornea are protection against invasion of microorganisms into the eye, and the transmission and focusing (refraction) of light (Batterbury et al. 2009, p. 3).

Cassel, Billig & Randall (1998, p. 7) state,

“The cornea is more than a window; it is a converging lens. As in a camera, it takes light rays and bends and focuses them to the back of the inside of the eye, the retina.”

The cornea consists of a stroma enfolded between a multilayered epithelium and an inner monolayer of endothelial cells, which never regenerate (**Fig. 9.2-15**). The center of the cornea is 500 micrometers

thick, increasing to 700 micrometers at the periphery, however it is very strong (Batterbury et al. 2009, p. 3). The stroma comprises 90% of the thickness, and it is a mixture of collagen and extracellular matrix. There are few cells and no blood vessels (**Fig. 9.2-15**).

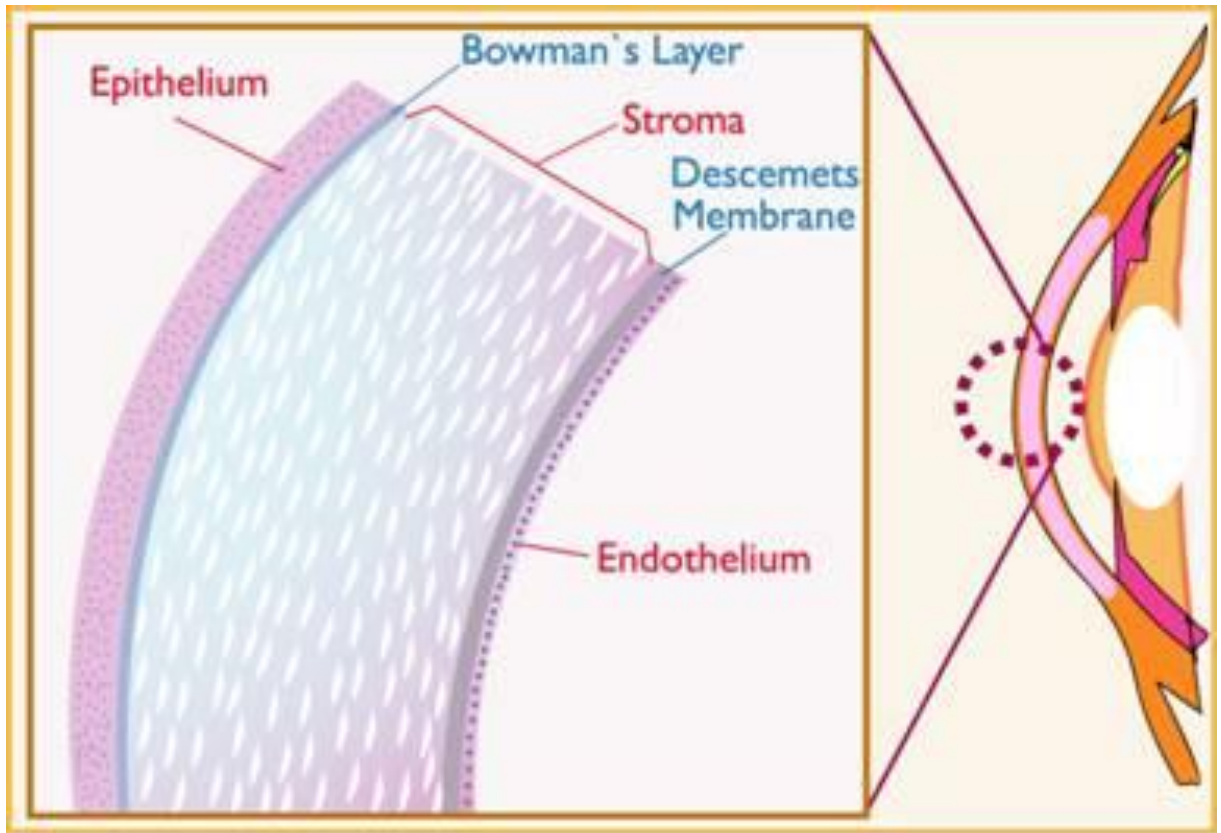


Fig. 9.2-15 Layers of the Cornea (Hybrid Cornea, 2010)

The corneal sensitivity is due to the nerve fibers from the ophthalmic division of the trigeminal nerve which are exposed when the corneal epithelium is lost, known as corneal ulceration, causing intense pain. Treatment and healing processes differ relating to the severity and type of ulceration.

The cornea is avascular, deriving its nutrition by diffusion sourced from blood vessels at the limbus, the aqueous humour and from the tear film (**Fig 9.2-11**). Limbal ischemia (lack of blood to the limbus) can lead to peripheral corneal thinning or 'melting', and prevention of oxygen diffusion from the tear film may result in ulceration, often seen in contact lens wearers. Refraction of light occurs because of the curved shape of the cornea and its greater refractive index compared with air (**Fig 9.2-15**). The cornea is transparent because of the specialized arrangement of the collagen fibrils within the stroma, which must

be kept in a state of relative dehydration, despite the 80% hydration of the cornea (**Fig. 9.2-15**). This state of relative dehydration balance is achieved by an energy/ATP-driven ion pump in the endothelium, as well as metabolic pumps, which pump in the direction of flow from stroma to anterior chamber (**Fig. 9.2-15**) (Batterbury et al. 2009, p. 3; Cassel et al. 1998; Glasspool 1982; Parr 1982, p. 4).

The epithelium undergoes constant turnover with basal cells replicating, migrating to the surface and then being shed and phagocytized. By contrast, endothelial cells do not divide or reproduce which is of great clinical significance, since there is a critical number of endothelial cells that the cornea will need to function. This is specifically important in relation to corneal transplants where there is a risk of losing multiple endothelial cells. When there is insufficient pump activity to maintain corneal dehydration the cornea swells and loses transparency, this is termed corneal decompensation or bullous keratopathy. Common causes of endothelial cell loss include normal ageing and intraocular surgery, including cataract surgery, and particularly during corneal transplants (Batterbury et al. 2009) (**Fig. 9.2-15**).

9.3 THE NATURAL EYE – INTERNAL ANATOMY

Lens

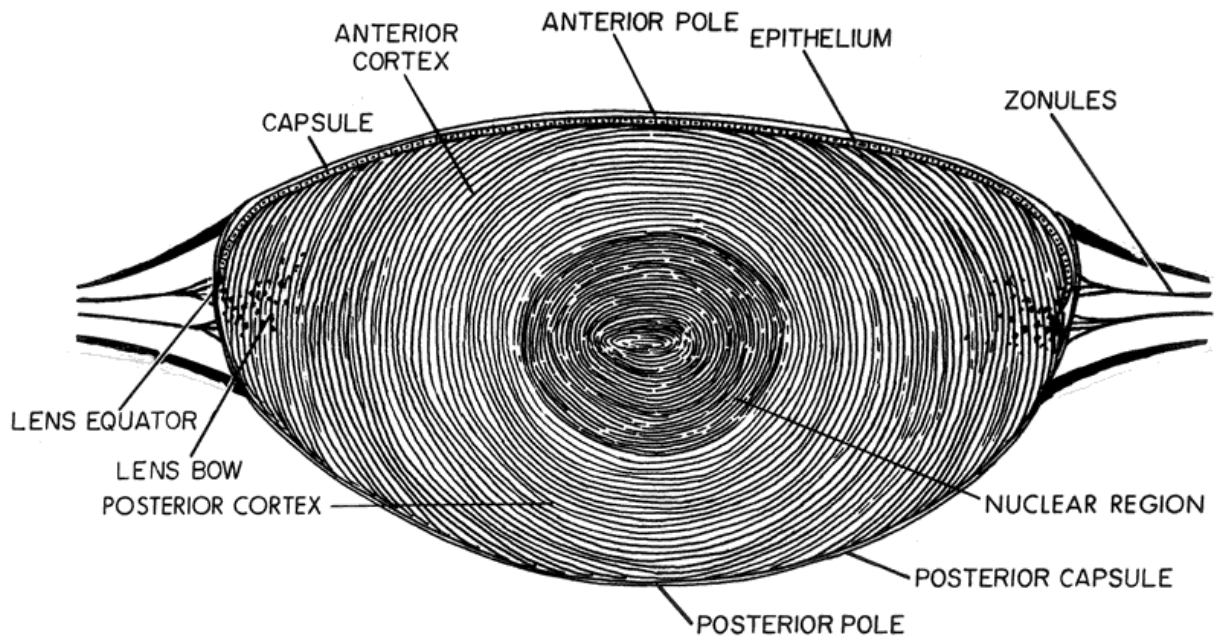


Fig 9.3-1 The Layers of the Lens (Delamare, 2006)

The discus-like lens comprises a mass of long cells known as fibres at the center of which is a hard nucleus and a softer cortex, bound by a capsule and held in place by the zonules (**Fig. 9.3-1; 9.3-2**).

The lens is elastic, which allows for the changing of shape to alter the focus of vision (**Fig. 9.3-1; 9.3-2**).

When light is focused onto the retina, the cornea, which has fixed focus power, does about three-quarters of the work, and the lens, which has variable focus power, does about one-quarter of the work.

The lens is transparent and colourless, however, with age it becomes less transparent and can develop a yellowish colouration. This can reduce the light reaching the retina and give the pupil a grey appearance. Any opacity of the lens is called a cataract, which clouds the vision. This can be removed through cataract surgery.

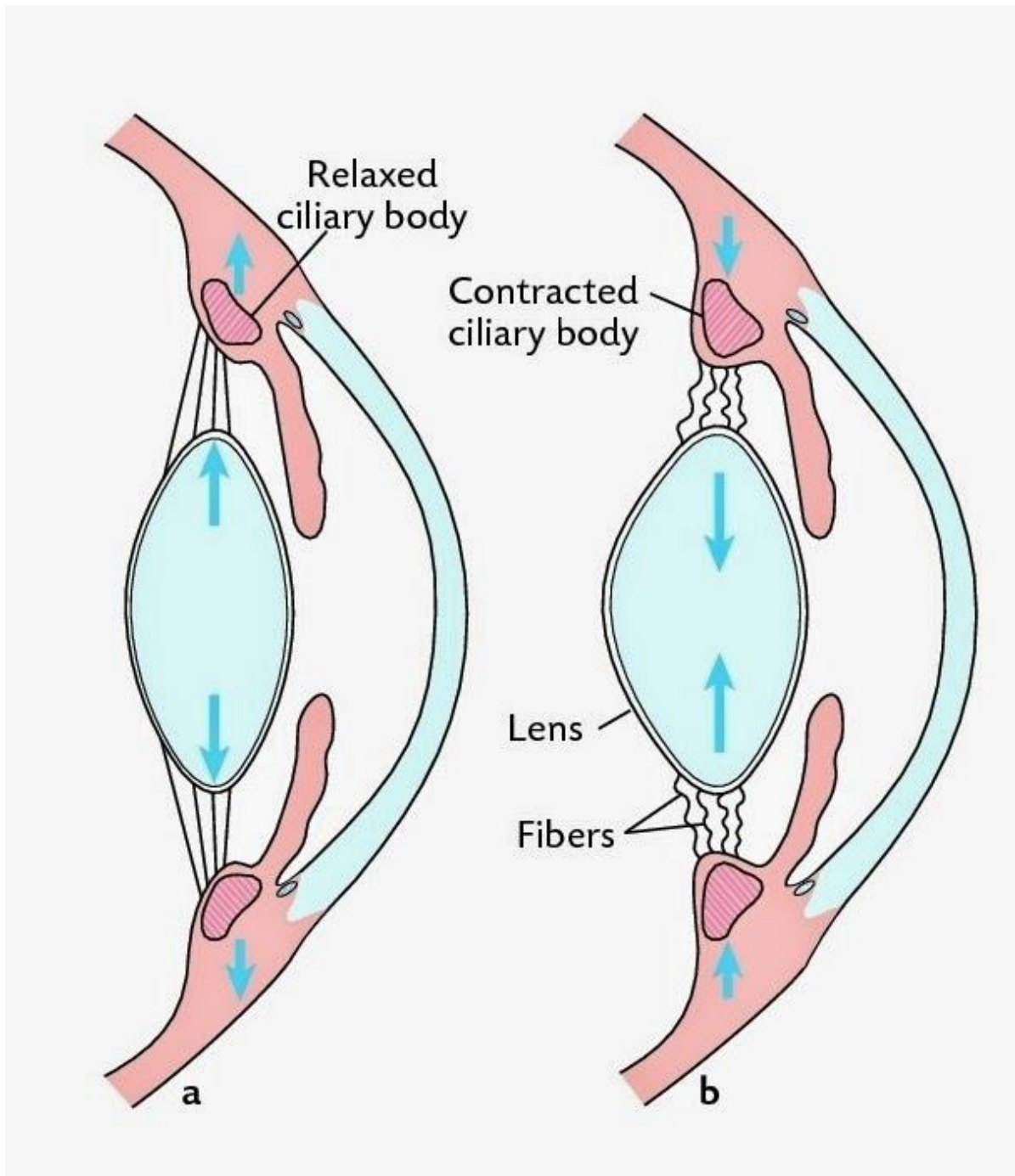


Fig. 9.3-2 Lens action a) Lens Pulled Flat – Long Distance b) Lens Rounded – Short Distance
(Lee, Wong & Yap, 2014)

When focusing long distance, the lens needs to be flat; to achieve this, the ciliary muscle is relaxed to allow the full tension of the zonules to be expressed (**Fig. 9.3-2 a**). The rounding of the lens is how short distance vision is achieved which occurs when the zonules are relaxed. This occurs when the ciliary muscle is contracted (**Fig. 9.3-2 b**). Accommodation is the action involving a muscle in the ciliary body contracting, relaxing the tension on the zonules, which then allows the lens to change from being

flattened to become more spherical (**Fig 9.3-2 b**). This action of accommodation diminishes with age, usually beginning from the age of 10, however, it is not usually noticed until around the age of 40 when smaller print isn't as easily read as they once were. This is due to the fact that with age, the elasticity of the lens decreases, and it no longer changes shape when the tension of the zonules changes.

Uvea

This includes the *iris* and *ciliary body* anteriorly and the *choroid* posteriorly (**Fig. 9.3-3**) (Batterbury et al. 2009, p. 4). The *iris*, essentially meaning rainbow derived from the Greek goddess of the rainbow, largely consists of connective tissue containing muscle fibres, blood vessels and pigment cells. At its center is an aperture, the pupil. The chief functions of the iris are to control light entry to the retina through its pigmentation, and to reduce intraocular light scatter by acting as curtains (Batterbury et al. 2009; Cassel et al. 1998). The amount of iris pigment determines eye colour; blue eyes have the least pigment and brown eyes the most. Pupil dilation allows increased light through and is caused by contraction of radial smooth muscle fibres innervated by the sympathetic nervous system (**Fig. 9.3-4b**). Pupil constriction, allowing less light through, occurs when a ring of smooth muscle fibres around the pupil contracts, innervated by the parasympathetic nervous system (**Fig 9.3-4a**).

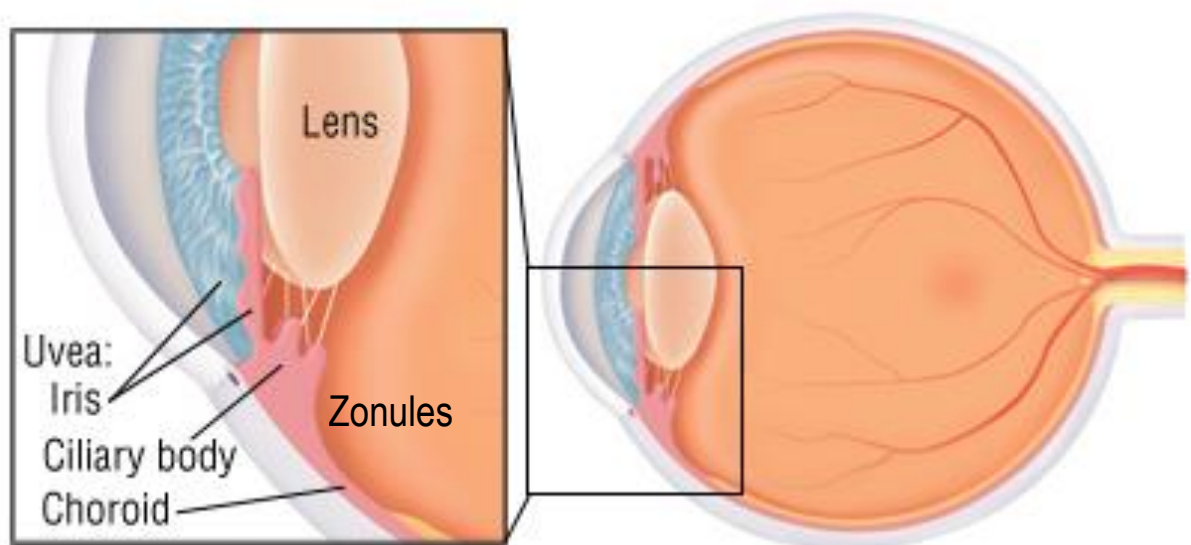


Fig. 9.3-3 Uvea: Iris, Ciliary Body and Choroid (Health Media Network, 2014)

The *ciliary body* is a specialized structure uniting the iris with the choroid (Fig. 9.3-3). It makes aqueous humour and anchors the lens to the ciliary body and choroid via the zonules (Fig. 9.3-3), through which lens convexity is modulated (see next section *Lens*). Anteriorly, the inner surface is folded into ciliary processes, which are the site of aqueous humour formation. Muscle fibres within the ciliary body contract, causing its inner circumference to reduce. This reduces the tension on the zonules, so that the natural elasticity of the lens causes it to become more convex to focus on near objects. This is called accommodation, and is controlled by parasympathetic fibres in the oculomotor nerve. Relaxation is passive, increasing tension on the zonules so that the lens is pulled flat for distance vision. The posterior part of the ciliary body merges into the retina (Batterbury et al. 2009, p. 4; Cassel et al. 1998; Glasspool 1982; Parr 1982, p. 7).

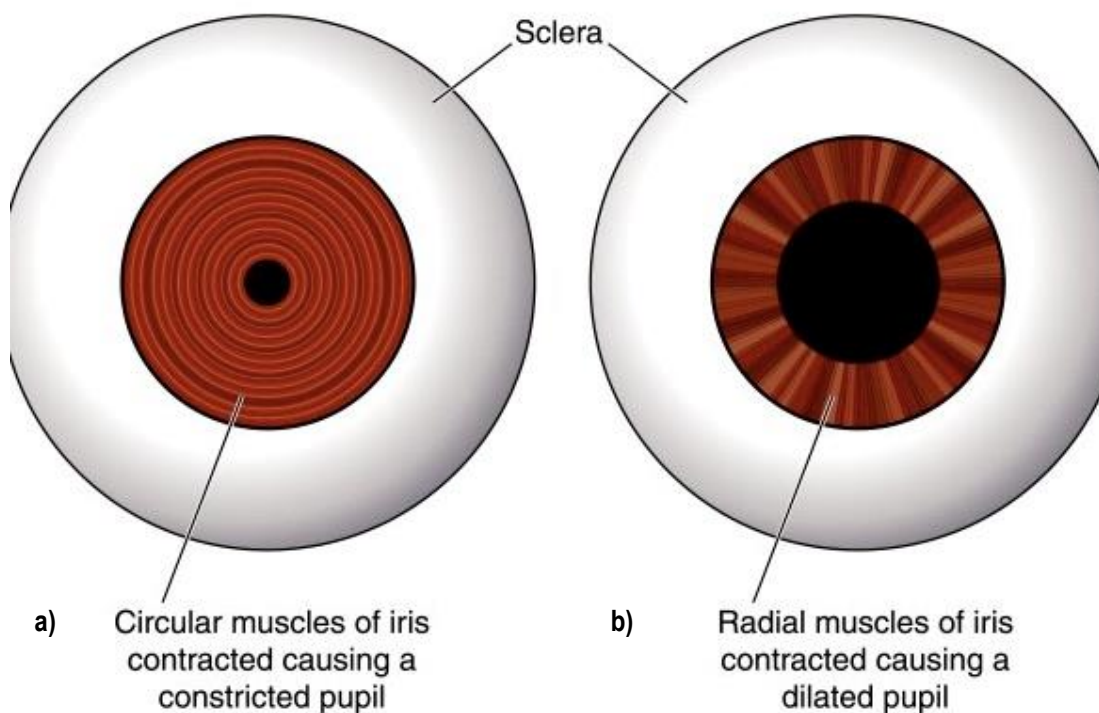


Fig. 9.3-4 a) Pupil constriction due to contraction of circular smooth muscles b) Pupil dilation due to contraction of radial smooth muscles (The Discovery Eye Foundation, 2016)

The *choroid*, is dark in colour consisting of blood vessels creating a vascular layer, connective tissue and pigment cells, and is incorporated between the retina and the sclera. The dark pigment of the choroid allows for absorption of scattered light, reducing reflection of light within the eye (Fig 9.3-3). It

creates an indirect blood supply to the retina facilitated by providing oxygen and nutrition to the outer retinal layers, which are devoid of blood vessels. The blood to the choroid comes from the ciliary arteries, which are branches of the ophthalmic artery. There is a potential space between the choroid and the sclera, which can become filled with blood or serous fluid (Batterbury et al. 2009; Cassel et al. 1998).

Aqueous Humour

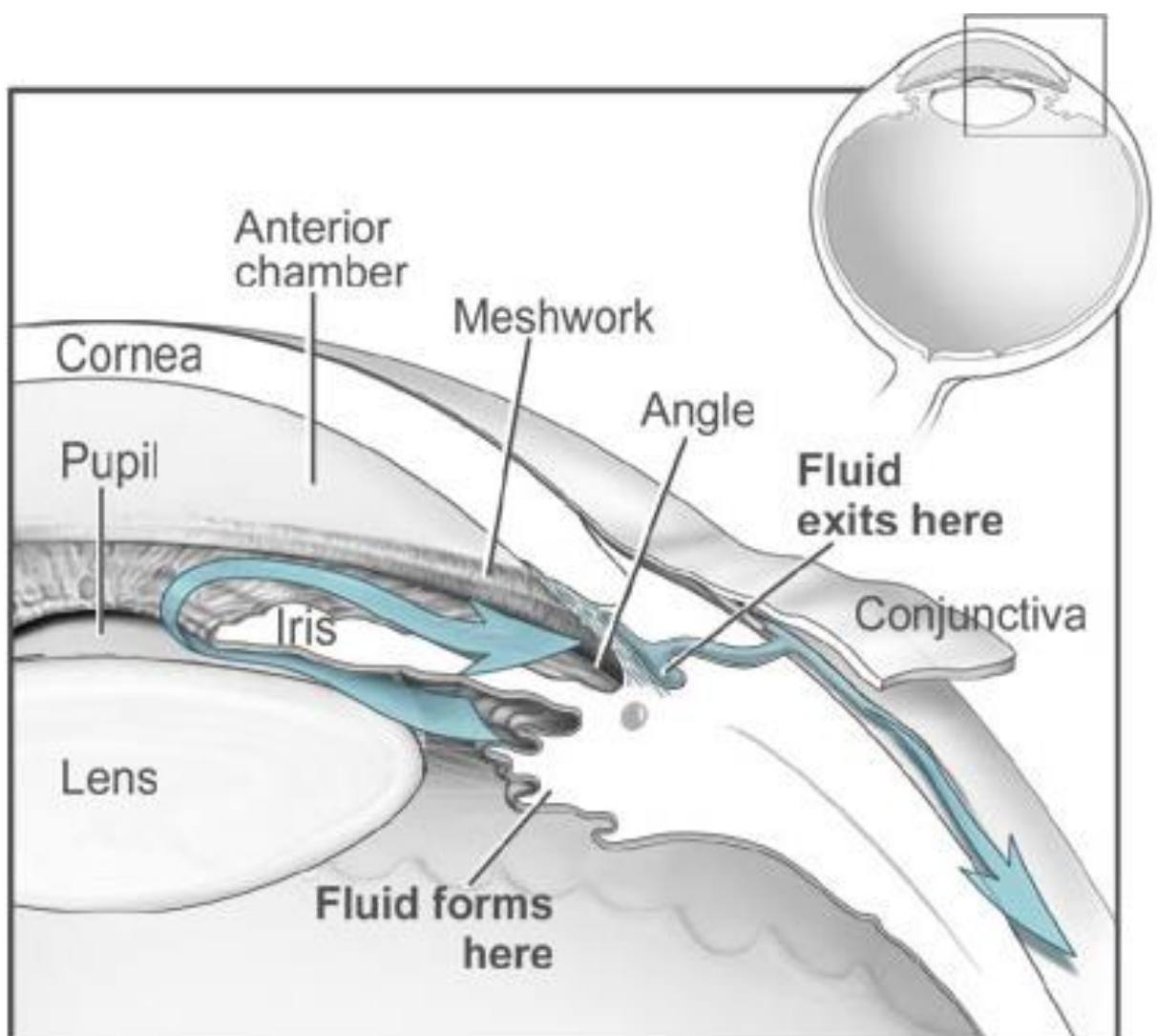


Fig. 9.3-5 Aqueous Production and Flow (Blackrock Eye Care, 2010)

Both the anterior and posterior chambers, which are connected by the pupil, are filled with aqueous humour (Fig. 9.3-5). The anterior chamber is the space between the cornea and the iris, and behind the iris and in front of the lens is the posterior chamber (Fig. 9.3-5; Fig. 9.3-6). The ciliary body forms aqueous humour by ultrafiltration and active secretion (Fig. 9.3-5). Its composition is strictly regulated to exclude large proteins and cells, but it does contain glucose, oxygen and amino acids for the cornea and lens.

Aqueous humor circulates from the posterior to the anterior chamber through the pupil, leaving the eye through the trabecular meshwork (Fig. 9.3-5; 6). This is a specialized tissue in the anterior chamber angle between the iris and the cornea - it resembles a sieve. From here aqueous humor drains into Schlemm's canal, which is an irregular channel that rings the circumference of the eye within the inner surface of the sclera at the limbus, formed by a 'gutter' in the sclera which is covered by the trabecular meshwork (Fig. 9.3-5). The scleral venous sinus, also called the Canal of Schlemm, and trabecular meshwork act as a filter through which aqueous humour passes, subsequently draining into the veins (Fig. 9.3-6) (Parr 1982, p. 6,7). Aqueous humour production and drainage are evenly and finely balanced to maintain appropriate intraocular pressure and ocular health (Batterbury et al. 2009,p.4,5).

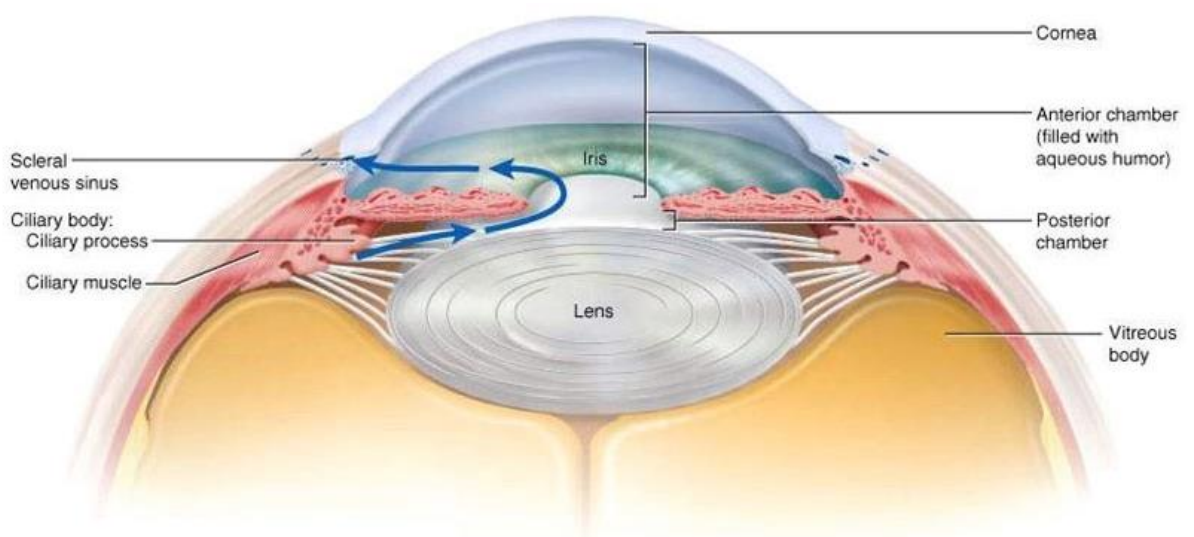


Fig. 9.3-6 Scleral Venous Sinus/Canal of Schlemm & Aqueous Flow (Saladin, 2015)

Vitreous

The vitreous body is 99% water but, vitally, also contains collagen fibrils and hyalouronan, which impart cohesion and a gel-like consistency. Behind the lens, this transparent avascular 'jelly' fills the posterior segment of the globe (**Fig. 9.3-7**). Aqueous can diffuse through the vitreous body, the composition of which is similar to that of the cornea. The vitreous is adherent to its surroundings at two main points at the limits of the retina; anteriorly at the ora serrata (the serrated junction between the retina and the ciliary body), and posteriorly at the optic disc (**Fig. 9.3-7**).

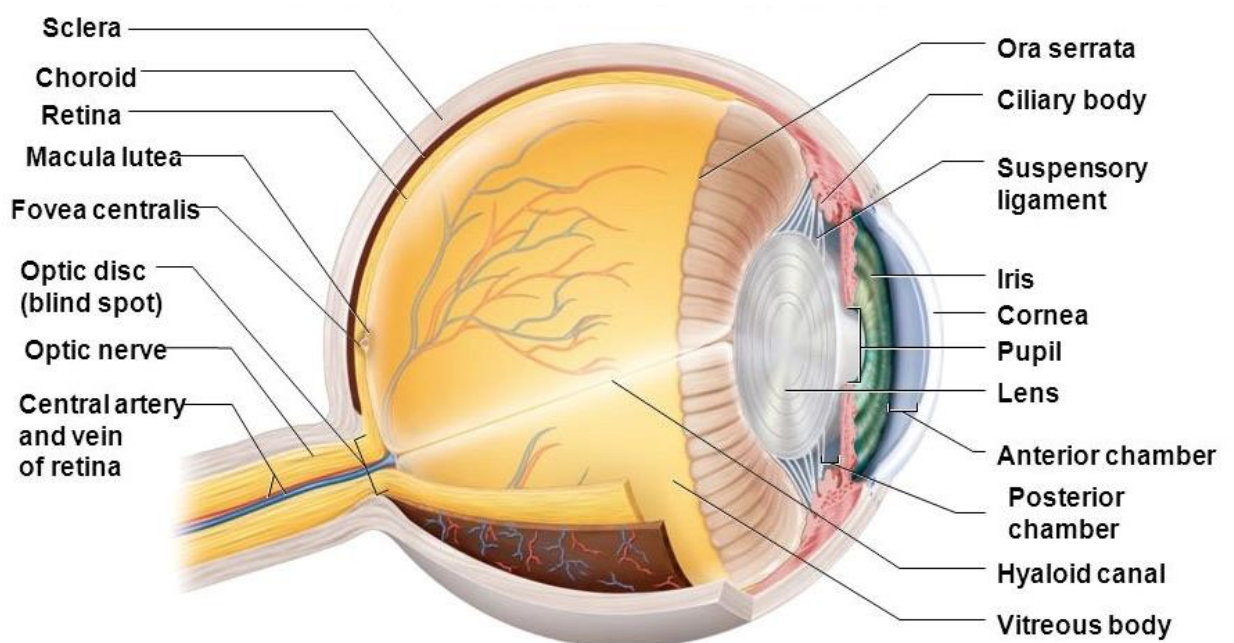


Fig. 9.3-7 Anatomy of the eyeball; vitreous body & orra serrata (Saladin, 2015)

With increasing age, the vitreous undergoes progressive degeneration, which involves the vitreous volume shrinking and separating posteriorly from the retina. The vitreous helps to cushion the eye during trauma and has a minor role as a metabolic sump, which is a collection point. Abnormal attachments of the vitreous to the retina can develop, which can lead to a retinal detachment if the vitreous volume shrinks and pulls away from the retina; this will leave a space, which fills with sub-retinal fluid.

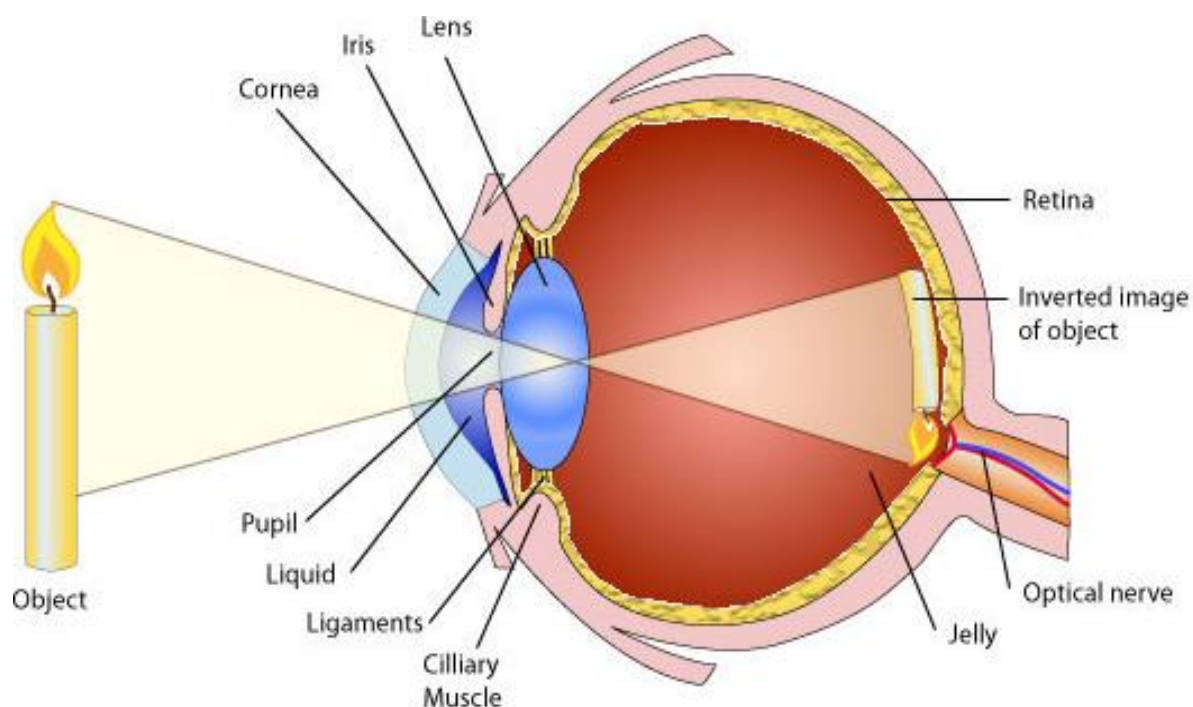
Retina

Fig. 9.3-8 The path of light to the retina (Pass My Exams, 2014)

Light passes through the tear film, cornea, pupil, lens and vitreous, shining onto the transparent back of the eye, the retina (**Fig. 9.3-8; 9; 10**). The retina converts light images received into nerve impulses by breaking down an image into multiple different components (**Fig. 9.3-9**). It is able to do this via the assistance of the photoreceptors, rods and cones, which receive these components of light energy, triggering a reaction. The bipolar cells receive the information from the reaction and transmit the information to the ganglion cells, which send signals to the brain via the optic nerve resulting in an image (**Fig. 9.3-8; 9**).

The ganglion cells, which have axons that run along the surface of the retina and enter the optic nerve, receive modified electrical signals passed on by the connector neurons (**Fig. 9.3-9**). The macula, located next to the optic nerve, which provides for central vision, includes a central specialized area called the fovea, generating high quality vision (**Fig. 9.3-9; 10**). Cones, depicted in **Fig. 9.3-9** as being yellow, are located in a high concentration at the macula and facilitate fine vision and color appreciation,

and have a one-to-one relationship with their ganglion cells (**Fig. 9.3-9; 10**) (Batterbury et al. 2009, p. 5). Rods, shown as blue, also concentrated in the macula area are distributed throughout the peripheral retina and respond to much lower levels of illumination, providing vision in low light levels including movement detection. However, the picture quality is 'grainy' as the rods do not have a one-to-one ratio with the ganglion cells therefore reducing their number (**Fig. 9.3-9; 10**). The rest of the retina is for peripheral vision (**Fig. 9.3-10**).

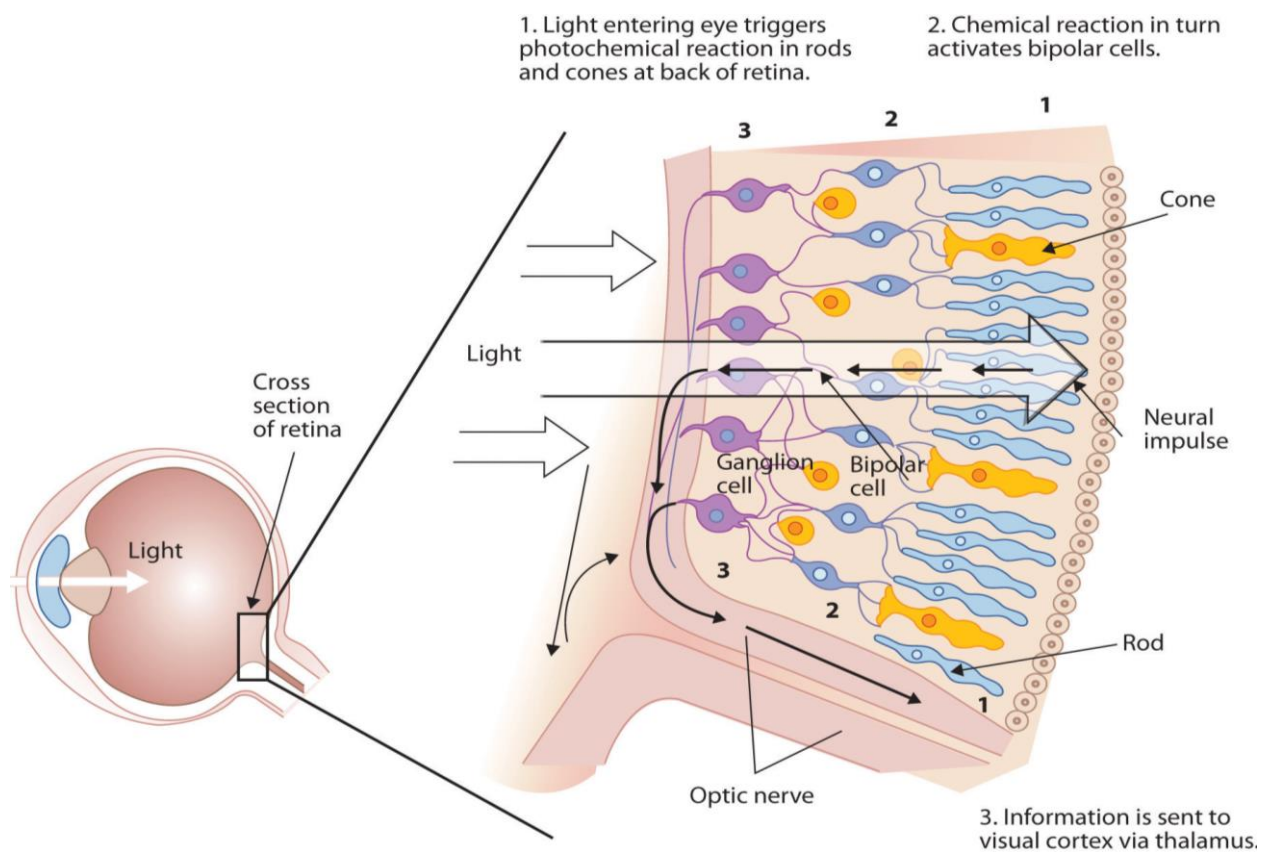


Fig. 9.3-9 The travel and comprehension of light (Flatworld Education, 2016)

The blood supply of the retina is derived from both the central retinal artery and vein and the choroid; both systems are required for normal function (**Fig. 9.3-10**). The retinal vessels enter and leave the eye through the optic nerve and run in the nerve fibre layer (**Fig. 9.3-8**). The retinal environment is isolated from any part of the systemic circulation by means of a blood-retinal barrier, which, if disrupted can lead

to retinal oedema and precipitation of lipid and protein. This causes a loss of transparency within the retina, and results in a loss of vision and an example of this is diabetic retinopathy.

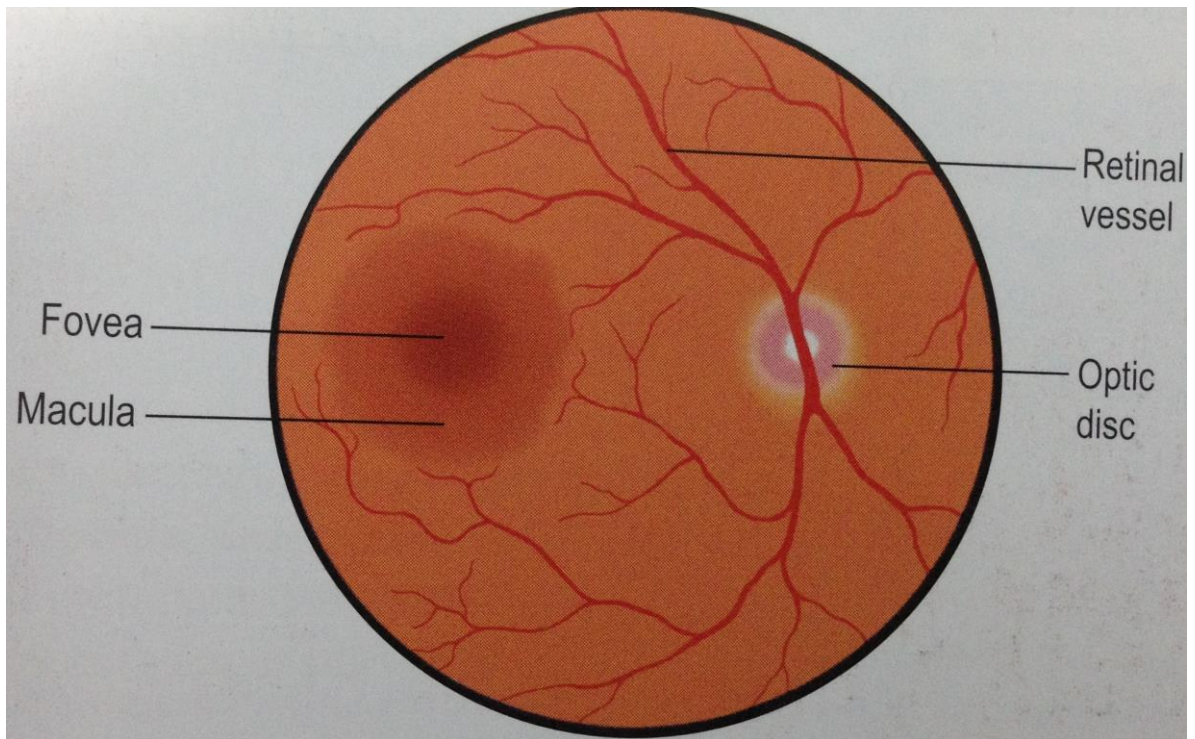


Fig. 9.3-10 Ophthalmoscopic view of the eye (Batterbury et al. 2009, p. 5, Fig. 3)

Optic Nerve

The optic nerve, located at the very back of the eye as an extension of the optic disc, behind the retina, is the 'cable' through which information is transferred to the brain to be interpreted. The optic nerve, consisting of over one million nerve fibres, is one of several pairs of cranial nerves and is also known as the second cranial nerve. It is responsible for transmitting the electrical impulses to the brain and similarly to those of the spinal cord, if severed, the ganglion axons are not able to regenerate.

In **Fig. 9.3-9** the ganglion cells are shown transmitting in the retinal nerve fibre layer, down the optic nerve at the optic disc (**Fig. 9.3-11**). The optic disk accounts for what is termed the 'blind spot', due to its lack of photoreceptors (**Fig. 9.3-11**). At the center of the optic disk is a pale central cavity called the optic cup. The pale appearance is on account of the contrasting redness from surrounding nerve fibres.

When there is a loss of these nerve fibres, the volume in the cup increases, which is an example of what occurs in glaucoma (**Fig. 9.3-11**).

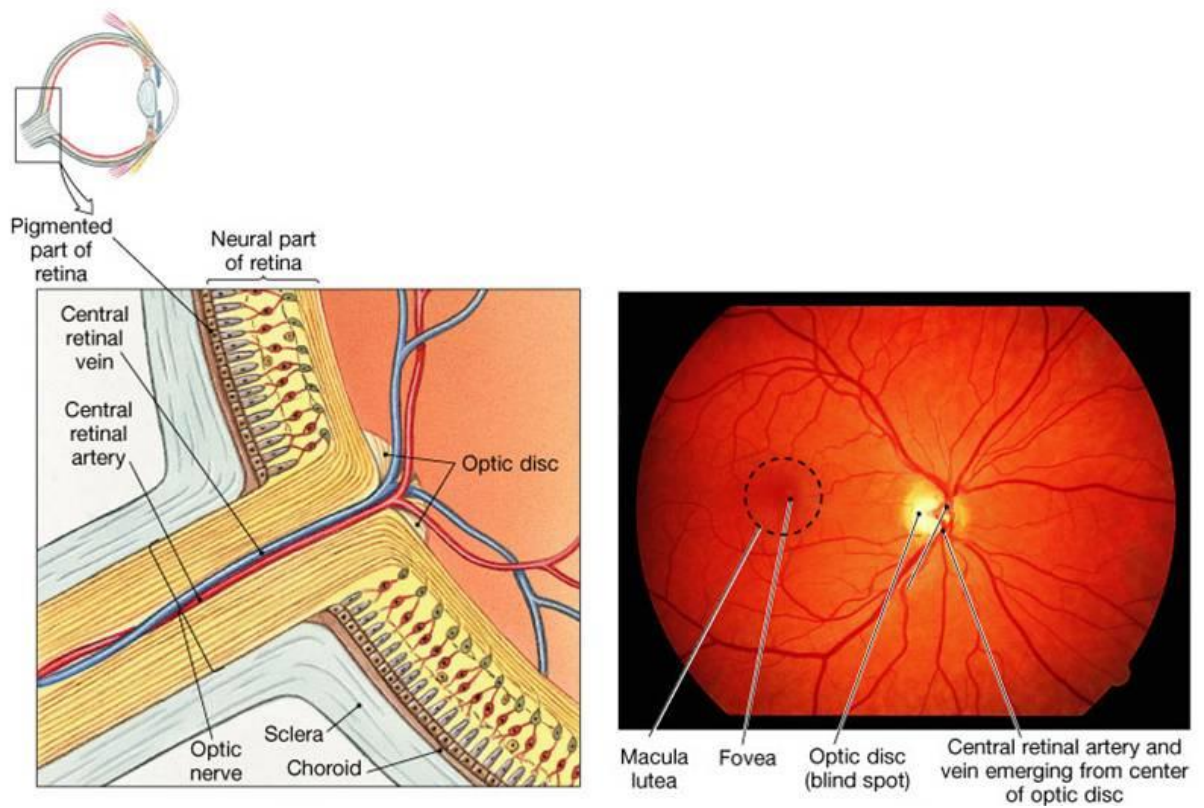


Fig. 9.3-11 Posterior anatomy of the eye; optic nerve and disc (Austin Community College District, 2008)

9.4 PHYSIOLOGY OF VISION

As light bounces around it is absorbed and reflected by different objects depending on their colour (**Fig. 9.4-1**). A black appearance is a result of the absorption of all the colours, and white is the reflection of all colours (**Fig. 9.4-1**). All colours that we see in between is a result of various colours being reflected and absorbed depending on their composition, which our eyes can then interpret through the rods and cones in the retina (**Fig. 9.4-2**).

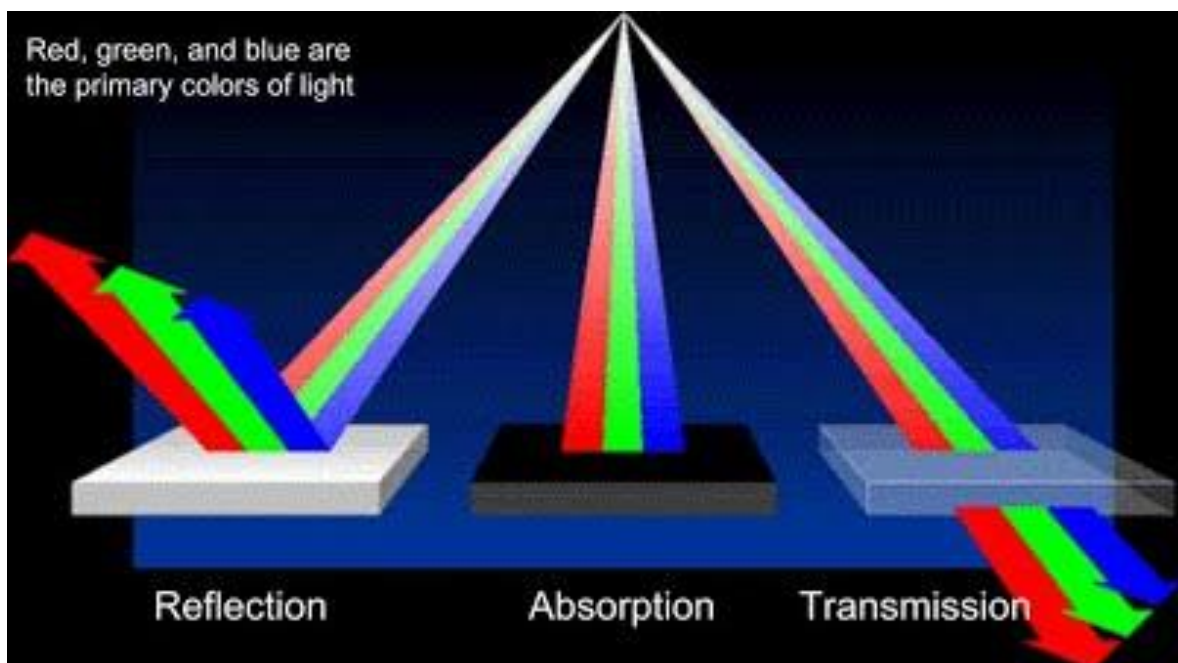


Fig. 9.4-1 Absorption, reflection and transmission of light (Urban Heat Island 2015)

The electromagnetic energy of light reaches the eye, and stimulates the rods and cones inside the eye (section 9.3) (**Fig. 9.4-2**). The cones are distributed throughout the retina, and different types of cones are responsible for picking up the varying colours being reflected and absorbed (**Fig. 9.4-2**). The specific physiology of the mechanism by which the cones determine differing colours can be simplified to say that the different cones are 'trained to be in tune' with the same wavelengths as the colours and can then transfer that knowledge to the brain (Saladin, 2015). Cones are concentrated at the macula to aid in fine vision, and have a single connection with a ganglion cell. The rods are for night and peripheral vision and multiple can share a ganglion cell, hence vision is not as good at night.

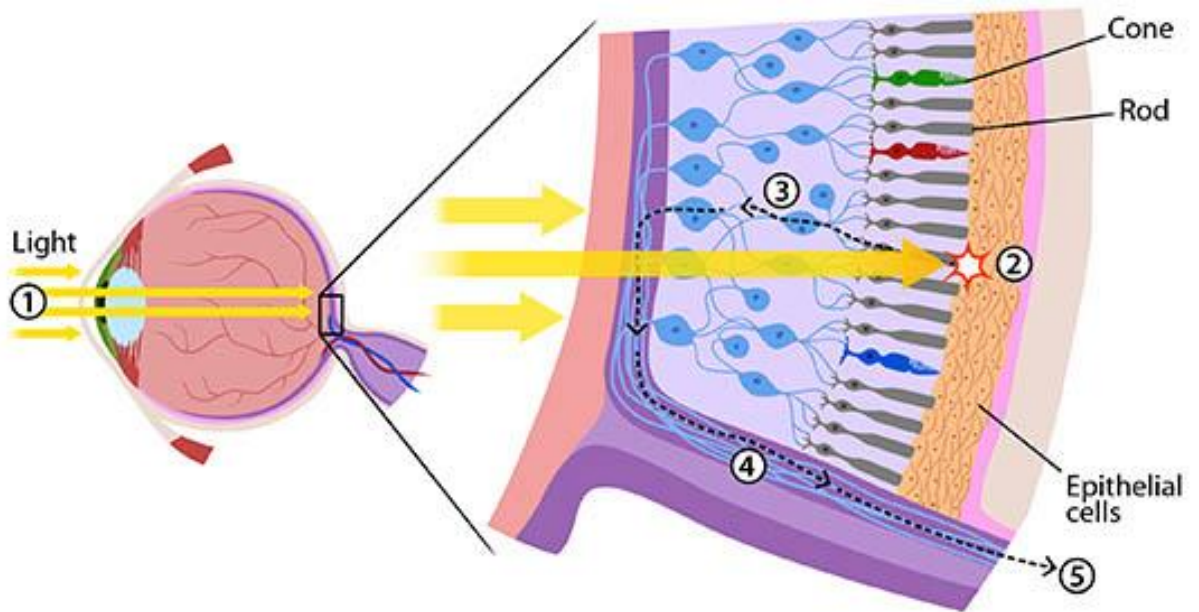


Fig. 9.4-2 Visual pathway in the eye (ASU School of Life Sciences, 2016)

The cornea and lens refract light, and focus it into an upside down and reversed image onto the retina (**Fig. 9.3-8; Fig. 9.4-2**). This image is processed by the ganglion cells in the retina, and converted into nerve impulses, which are passed down the optic nerve into the brain (**Fig. 9.3-11; Fig. 9.4-2**). The brain has the task of comprehending this image into something that makes sense and can be communicated and understood by the person. If the image in the retina is not clear, the brain will not have a full comprehension of the picture, and will result in a blurry image (**Fig. 9.4-2**). The accurate refraction of the cornea and lens are an important aspect in focussing the image onto the back of the retina, but refractive and focus errors are common. The size and the shape of the eyeball also effect whether the image is focussed onto the retina, and can mean the light is falling either too short, myopia, or too far, hyperopia. These are a diverse range of topics and although important to visual function and sight, will not be discussed in detail.

The eyes work in opposites; the right half of each eye's visual field goes to the left side of the brain and the left half of each eye's visual field translates to the right side of the brain (**Fig. 9.4-3**). The simple reason we see in three-dimensions is because our two eyes are separated, and each eye views the same object from a slightly different perspective (**Fig. 9.4-3**). Visual images can be disturbed due to

multiple reasons to do with the eye itself and surrounding muscles, but also due to the visual pathway process, where any defect along this pathway can cause a disturbance in a clear image perception.

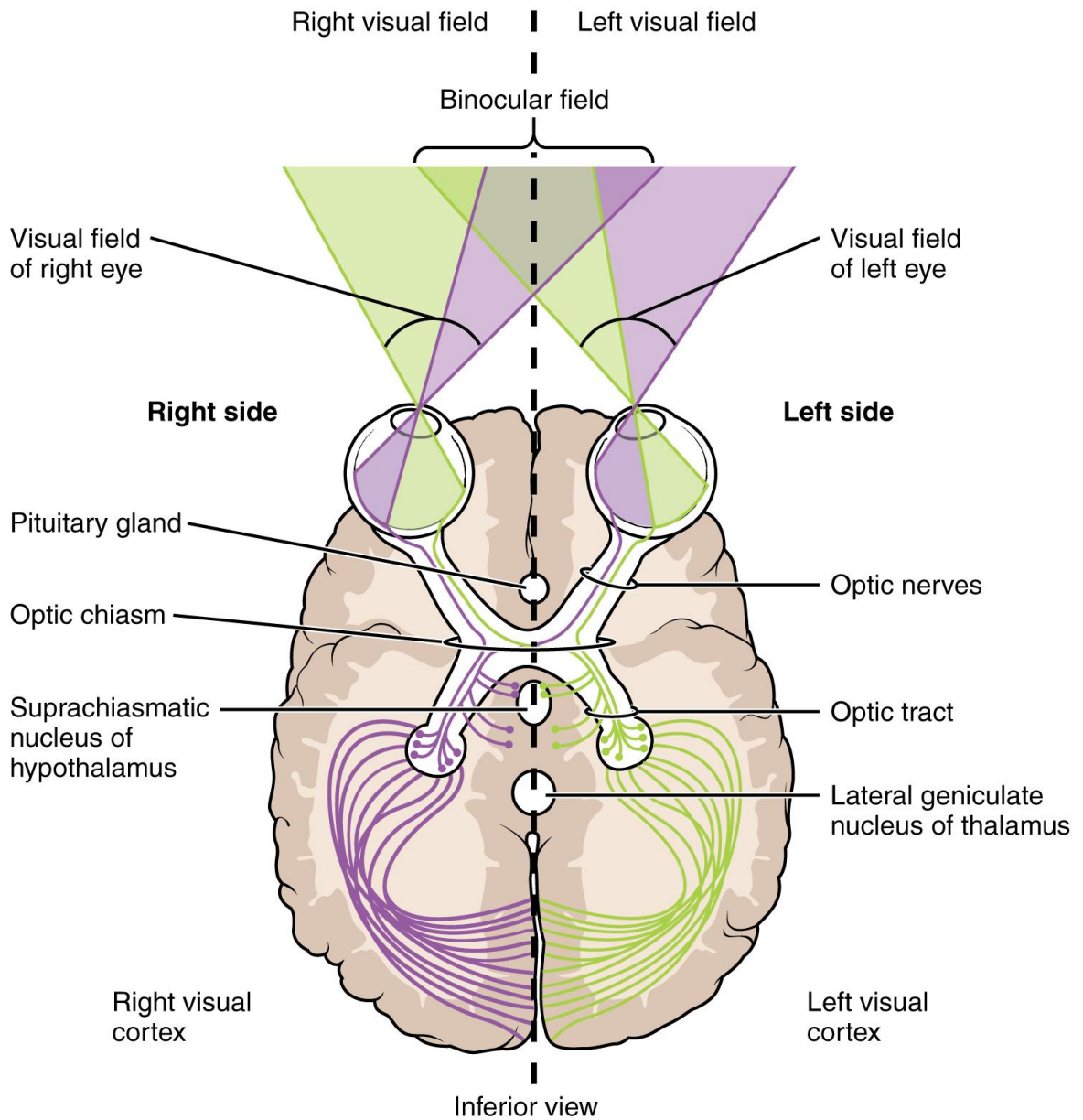


Fig. 9.4-3 Visual pathway to the brain (OERPub)

9.5 EYE LOSS

Blindness and eye loss, especially when bilateral, is a serious problem that affects a person's quality of life and imposes major socioeconomic and psychological impacts on patients and their relatives (Aghadoost, 2014). As previous sections have shown, the eye is very specific in its organisation and orientation, and as such, creates multiple possibilities of things that can malfunction. The complications and malfunctions are intricate and inter-relating, ranging from minor superficial complications, to complex whole body morbidity. As such, they require expert attention and treatment accordingly.

Eye loss defects and diseases

All reasons for eye loss can be broadly grouped and sub grouped into the following three main fields;

Developmental

- *Congenital*
 - *Environmental*
 - *Genetic*
 - *Both / unknown*
- *Acquired*
- *Genetic*

Inflammatory

- *Trauma*
- *Infection*
 - *Bacterial*
 - *Viral*
 - *Fungal*
- *Chemical*
- *Immunological*

Neoplastic

- *Benign*
- *Malignant*

The compiled list of pre-cursors for eye loss is a short summary of common complications that are seen as common past history for current artificial eye wearers and is not all-inclusive or descriptive of ocular complications.

Eye defects and diseases

Multiple eye defects can be caused by developmental, inflammatory or neoplastic defects, as well as independently being an age-related degenerative disease. Before defining the disease and eye defects listed in the previous table, a few common conditions will be defined.

Cataract - A condition in which the lens of the eye becomes cloudy and eventually opaque, diminishing vision (**Fig. 9.5-1**). Cataracts are commonly associated with aging but also may be precipitated by trauma and other causes. Cataract is treated by removal and replacement of the lens.

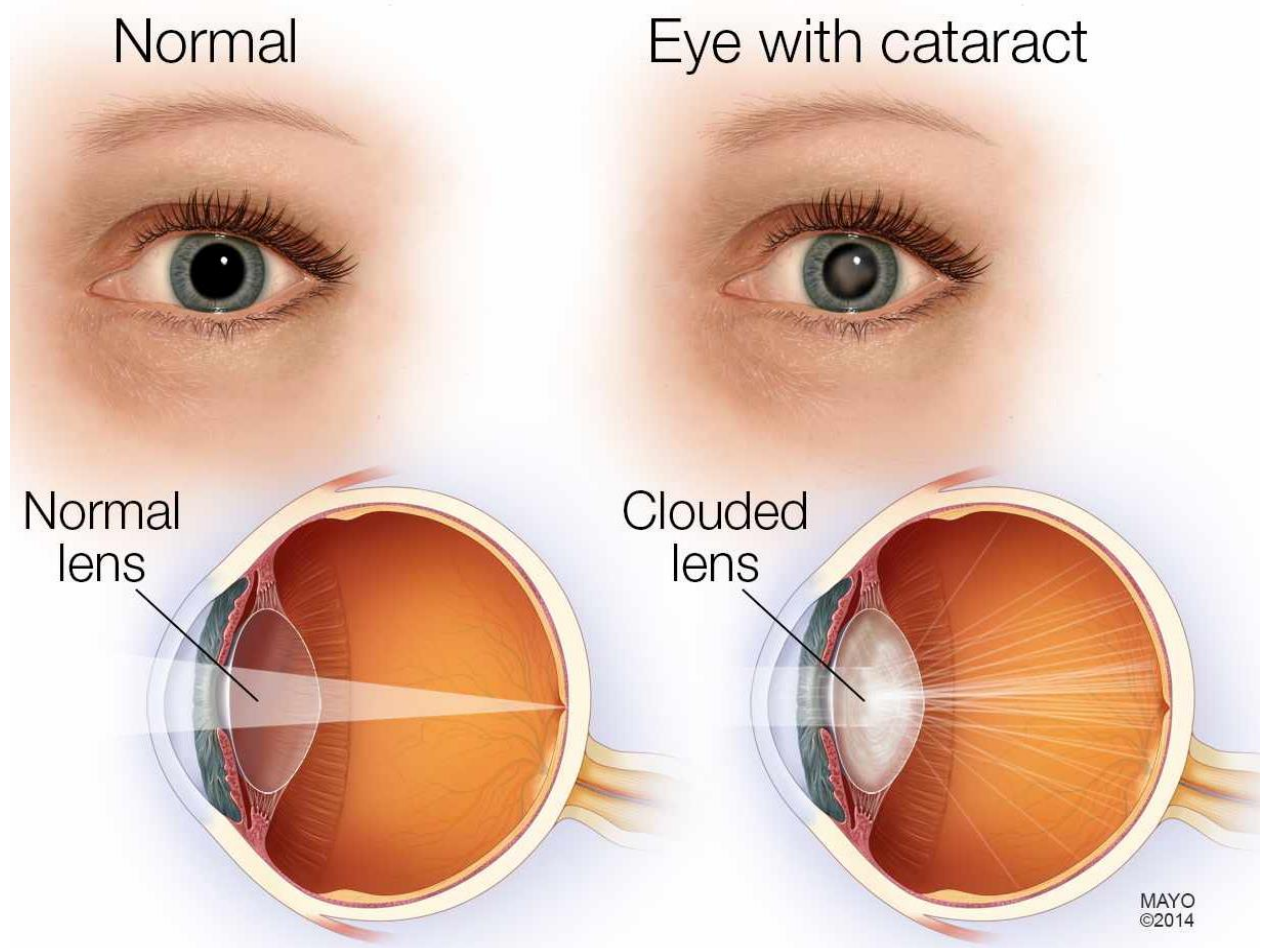


Fig. 9.5-1 Cataract – opaque lens, dispersed light (Sarah Knows Eyes, 2016)

Diabetic Retinopathy – As a leading cause of blindness in adults, this disease is caused by changes in

the blood vessels of the retina. The vessels either leak fluid or abnormal vessels grow on the surface of the retina. Often there are no symptoms or pain in the early stages. Early diagnosis and treatment can reduce the progression and prevent vision loss, which is irreversible once occurred (Batterbury et al. 2009, p. 52, 53).

Retinal Detachment - Separation of the thin vascular retina from its underlying tissue, the retinal pigment epithelium. This can occur with or without trauma (**Fig. 9.5-2**). Usually presents with peripheral vision loss, unless very advanced where central visual loss occurs. Treatment involves sealing the break and depends on situation and location of tear (Batterbury et al. 2009, p. 64, 65).

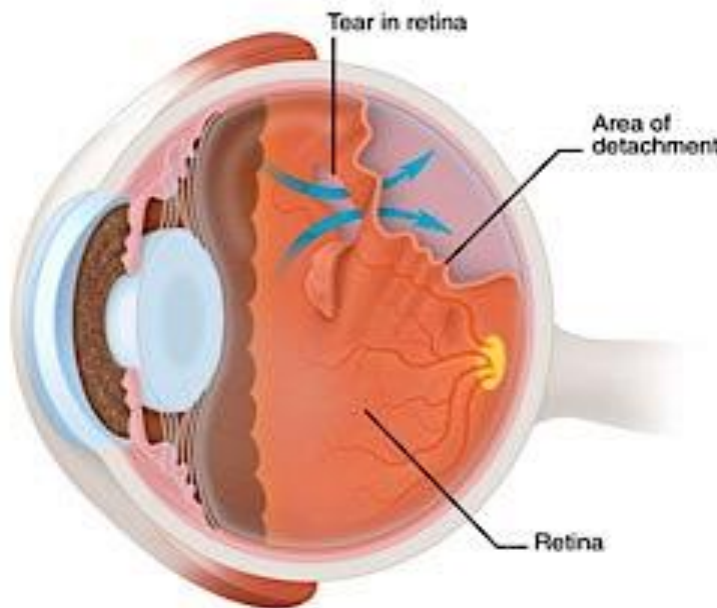


Fig. 9.5-2 Retinal tear/detachment – retina separated from the choroid (Boyd, 2016)

Glaucoma – manifests as increasing intra ocular pressure (**Fig. 9.5-3**). Glaucoma can occur either as open-angled glaucoma (primary open-angle and secondary open-angle), or closed-angled glaucoma (acute angle closure and chronic angle closure) (Batterbury et al. 2009, p. 42-45). This is caused by an outflow blockage of the natural delicately balanced inflow and outflow of aqueous humor within the eye. Open-angled glaucoma develops gradually and leads to slow and progressive damage to the optic nerve and visual loss with few or no symptoms and is more prevalent in Caucasians. Acute closed-angled glaucoma develops suddenly, and involves pain, sudden visual loss and congestion of the eye and is more common in the Chinese and Asian cultures due to differing eye shape. Treatments vary for

each type of glaucoma as well as for each individual patient. The eye will be removed as a last option in extreme circumstances when other various forms of treatments and interventions are not successful due the patient suffering from a painful blind eye and risk of sympathetic ophthalmitis.

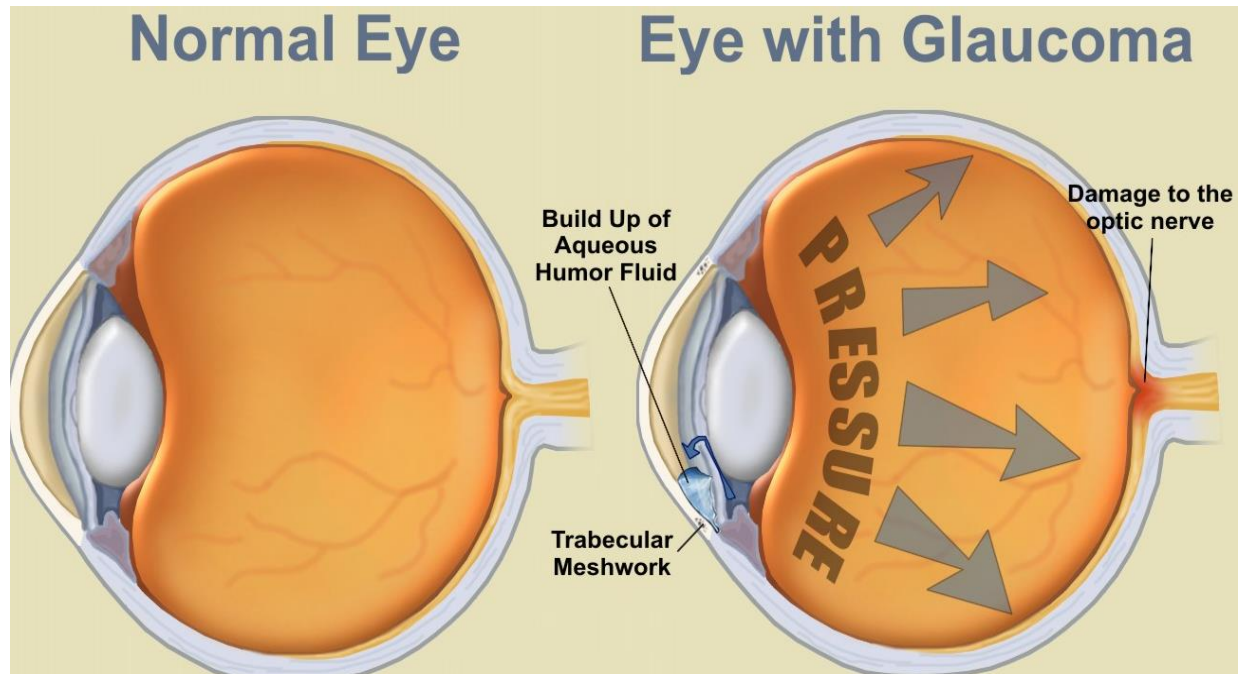


Fig. 9.5-3 Glaucoma damage to the optic nerve (Mahaveer Eye Hospital, 2016)

Vitreous Haemorrhage/ Detachment - Bleeding in the vitreous cavity in front of the retina with severe sudden visual loss which may be caused by either disease or injury. Haemorrhage can spontaneously resolve, can require laser treatment, or in the case of recurrence can require vitrectomy (Parr 1982, p. 20,21). The pulling away of the vitreous can also cause a Retinal detachment (Miller 1990, p. 210-211).

Sympathetic Ophthalmitis – this is a rare but potential inflammatory response of the uninjured eye following trauma. The injured eye is referred to as the ‘exciting eye’ and the undamaged eye as the ‘sympathizing eye’. The result of this inflammation can be blindness of the ‘sympathizing eye’. This reaction/response can develop from days to years following trauma. Treatments vary depending on cause, but include immunosuppressant’s, anti-inflammatories and in severe cases, eye removal (Batterbury et al. 2009, p. 46, 49, 79; Miller 1990, p. 290, 291).

Corneal Dystrophy - A type of eye disease with many forms, often hereditary, in which the cornea is altered on a cellular level, resulting in loss of its normal function. The cornea can become cloudy and inflamed, affecting vision and the health of the eye. Treatment is primarily the same for all types and focuses on the hydration of the eye with lubrication and environment (Cassel et al. 1998).

DEVELOPMENTAL EYE DEFECTS

Congenital

- ***Environmental***

Retinopathy Of Prematurity (ROP) - Congenital condition that affects children born prematurely where the retina is affected by blood vessels that grow abnormally, resulting in a retinal detachment (**Fig. 9.5-4**). ROP is a leading cause of visual impairment or blindness in children.

RETINOPATHY OF PREMATURITY

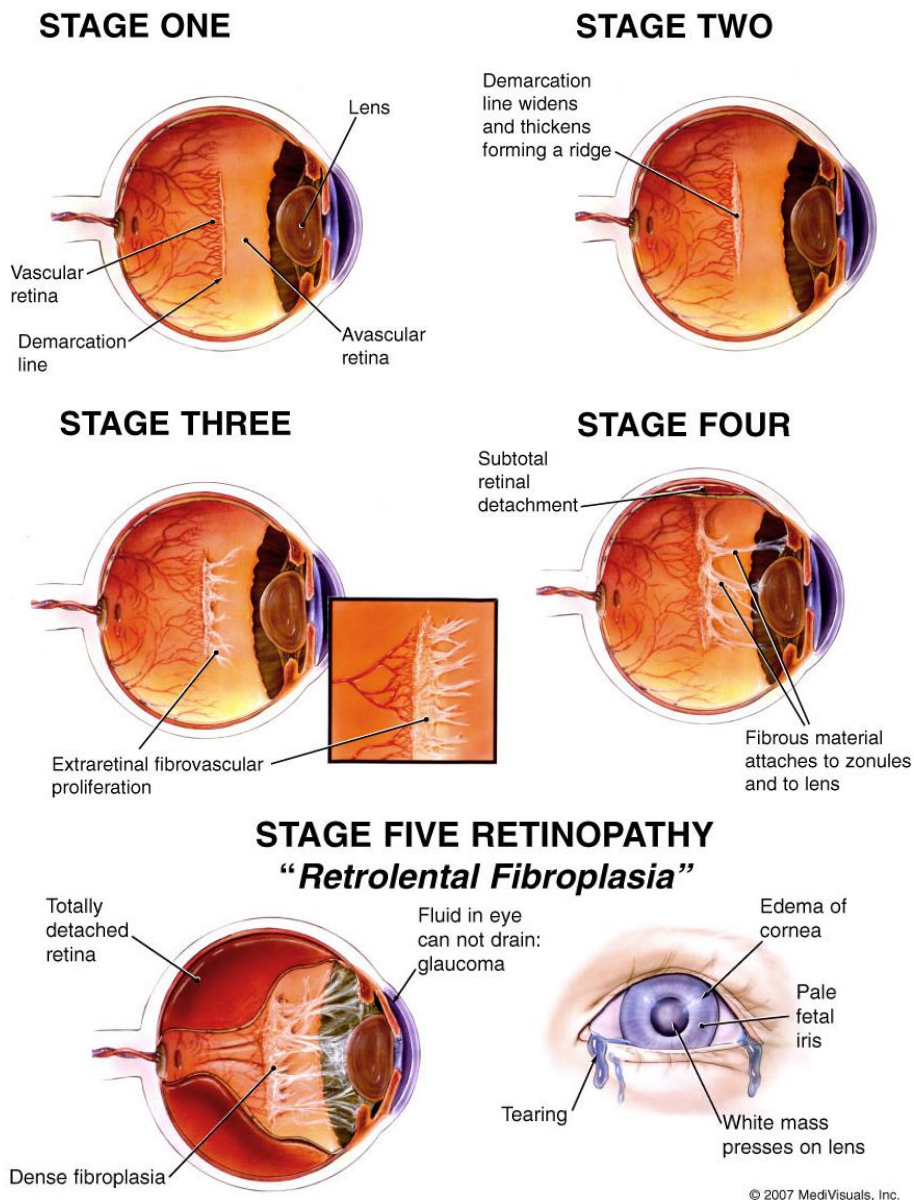


Fig. 9.5-4 Retinopathy of Prematurity (ROP) (Sasilik ve Goz Tembelligi, 2016)

Persistent Hyperplastic Primary Vitreous (PHPV) - Condition in which a vascularized membrane is present behind the lens. Complications can include Microphthalmia (**Fig. 9.5-8**), congenital cataracts, glaucoma, and retinal detachment. Often discovered by observation of a leukocoria (**Fig. 9.5-6**).

- **Genetic**

Retinoblastoma – A rare tumour that forms in the retina, either during gestation or within the first 5 years, being the most common intraocular malignancy of infancy and childhood (**Fig. 9.5-5**) (Miller 1990, p. 277). Over half of those diagnosed are unilateral, with most of these not being hereditary. Less

than half are bilateral, and are usually hereditary, causing a predisposition to other forms of cancer (Aerts et al. 2006). Although hard to diagnose, it is often characterised and discovered by a "flash of light" or leukocoria of the pupil while the unaffected eye flashes a normal red (Fig. 9.5-6). This is caused from light shining off the tumor and strabismus which impairs vision (Aerts et al. 2006; Miller 1990, p. 277) (Fig. 9-5.5). This flash was commonly caused by camera flashes, however this is changing with increasing technology and 'red eye' settings.

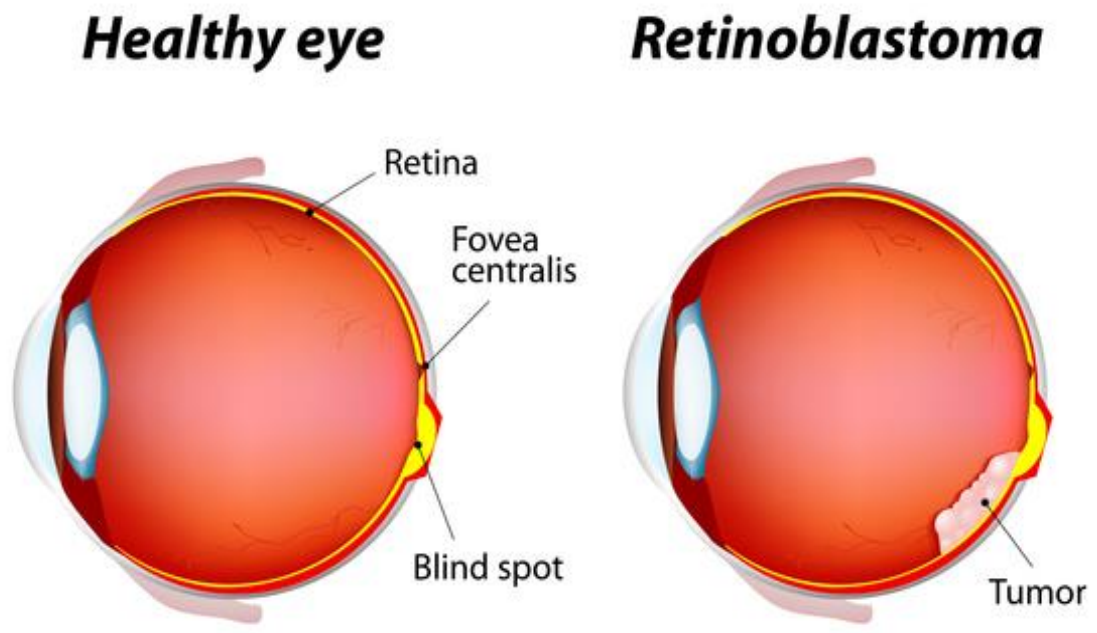


Fig. 9.5-5 Retinoblastoma – tumor in the retina (U.S National Library of Medicine, 2016)



Fig. 9.5-6 Leukocoria of pupil – the light reflection off the tumour (Batterbury et al. 2009, p. 68)

Coloboma - Congenital anomaly in which some of the structures of the eye are absent due to incomplete formation in utero. Structures that can be involved include the iris, ciliary body, retina, choroid and disc (Miller 1990, p. 92, 369). It is caused due to an incompleteness of the closure of the embryonic tissue. Occasionally this can indicate other significant developmental issues elsewhere in the body.

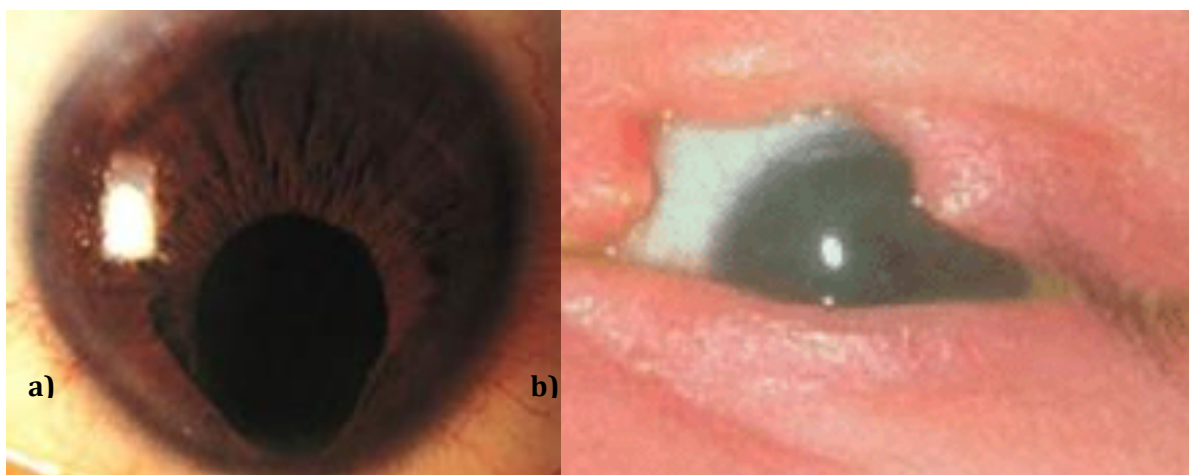


Fig. 9.5-7 a) Coloboma of iris (AAPOS, 2016); b) coloboma of eyelids (Science 2.0, 2016)

- ***Both / Unknown***

Microphthalmia – a structurally normal eye, however abnormally small. Microphthalmia may present in isolation or as part of a syndrome and have very complex aetiology with multiple causes identified, a highly prevalent cause being the gestational environment (Verma & FitzPatrick, 2007). As shown in **Fig. 9.5-8**, often includes lack of development in facial growth, in the area known as Pfeifer's diacephalic growth region and shown in the lack of symmetry in eyebrow height (El Essawy and Abdelbaky, 2016). Simple Microphthalmia is an isolated occurrence. Complex Microphthalmia describes the presentation along with a syndrome or other complications (Verma & FitzPatrick, 2007). Management features primarily consist of health of the fully developed eye and orbit socket space as well the use of prosthesis the stimulate growth of maxillary bones and achieve and maintain symmetry.



Fig. 9.5-8 Microphthalmic left eye and normal functioning right eye (Tips Curing Disease, 2013)

Anophthalmia –the absence of ocular tissue in the orbit, resulting specifically in the lack of any eyes or ocular structures (**Fig. 9.5-9**). As with Microphthalmia, Anophthalmia may present in isolation or as part of a syndrome and has very complex aetiology with multiple possible causes, including an increase in risk in maternal ages of over 40 (Verma & FitzPatrick, 2007; Miller 1990, p. 370). Management features primarily consist of health of the fully developed eye and orbit socket space as well the use of prostheses to stimulate growth of maxillary bones and achieve and maintain symmetry.



Fig. 9.5-9 Anophthalmic left eye (CDC, 2015)

Acquired

Coate's Disease - A progressive monocular condition of the retinal capillaries, characterised by a haemorrhage between the retina and choroid, often resulting in retinal detachments. Affects children under 10, predominantly males, who are otherwise apparently healthy. At final stages, enucleation of the effected eye may be indicated (Miller 1990, p. 231; The Jack McGovern Coates Disease Foundation 2014).

INFLAMMATORY EYE DEFECTS

Inflammation, based on historical observation, has been defined and characterized for centuries by a specific 5 cardinal signs including; redness, swelling, heat, pain and loss of function. With an increase in modern medicine, the depth of understanding behind these observations has also modernised (Punchard et al. 2004). As such the term 'inflammation' has been more specifically defined by Sanderson (1871, cited in Punchard et al. 2004) as: "...the succession of changes which occurs in a living tissue when it is injured provided that the injury is not of such a degree as to at once destroy its structure and vitality" and by Spector & Willoughby (1963 cited in Punchard et al. 2004) as "...the reaction to injury of the living microcirculation and related tissues".

Trauma

Although many anatomical protective mechanisms are in place (as discussed in 9.2 & 9.3), trauma to both the orbit and eyeball are common. Despite the major advances in ophthalmic surgery to improve outcomes, there are still a number of eyes that cannot be salvaged and potential vision loss either immediate or delayed can be a result of trauma (Meng & Yan, 2015). In view of this, one of the biggest risks arising from trauma is the occurrence of sympathetic ophthalmia whether post-injury, or post-surgical. Sympathetic ophthalmia is best defined as: "...a bilateral diffuse granulomatous intraocular inflammation that occurs in most cases within days or months after surgery or penetrating trauma to one eye" (Arevalo et al. 2012).

Sometimes the trauma will lead to a shrunken or disfigured globe that has lost function yet does not require removal of the eye, known as phthisis bulbi or aphakia. As the most common cause of eye loss, trauma can take many forms (Meng & Yan, 2015; Aghadoost 2014).

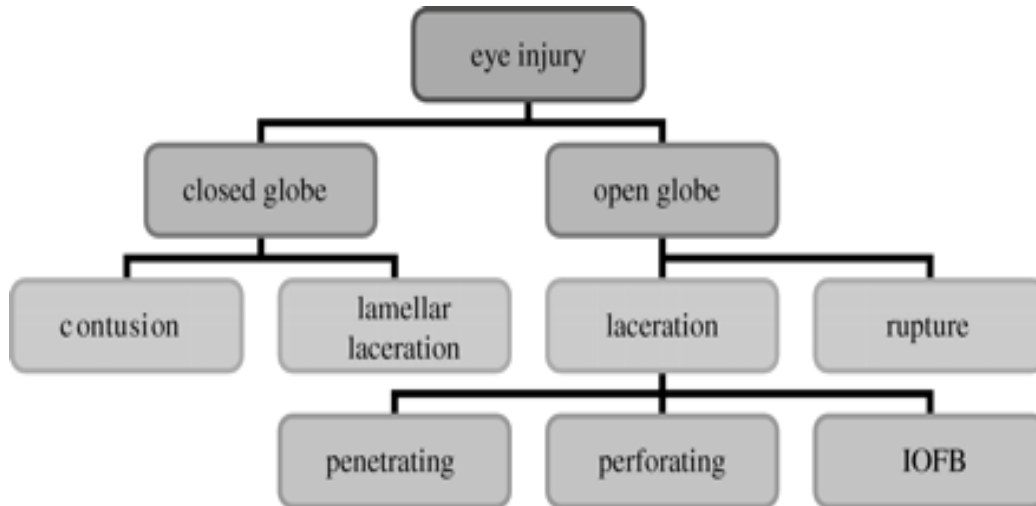


Fig 9.5-10 Birmingham eye trauma terminology system (BETTS) (Scott, 2011)

Fig 9.5-10 flowchart above depicts the differences/types of ocular injuries, and some of those listed are defined as follows.

Open globe injury: Defined as a full thickness wound of the eye wall, predominantly occurring in males (Meng & Yan 2015).

Ruptured Globe – caused by a blunt object or blunt force.

Penetrating Eye Injury – will have an entrance wound and/or an intraocular foreign body.

Perforating Eye Injury - causes an entrance and exit wound that enters in one location and exits another.

IOFB - Intraocular Foreign Body.

Painful Blind Eye - Condition in which eye has no light perception (NLP) and is causing pain. The most common, but least suspected, cause for the presence of pain is recurrent intraocular haemorrhage. Enucleation is indicated to alleviate pain and avoid risk of sympathetic ophthalmia occurring.

Infection

Tabbara et al. (2014) state: "Infections of the eye continue to cause serious ocular morbidity and loss of vision". Many types of infections causing inflammation can result in the loss of vision or the necessity for surgical removal of the eye to protect the other eye and the rest of the body from infection (**Table 9.5-1**). The infection-causing microorganism may be bacterial, viral and occasionally fungal. Tabbara et al. (2014) also add that we are on somewhat of a 'see-saw' in relation to infections due to the resilience of certain viruses and discovery of new ones, even though mass vaccinations and public health measures have reduced certain viruses. There is a call for ongoing learning to keep up with the new knowledge being discovered on this front, as Tabbara et al. (2014) confirm, "In the past two decades there have been a number of infectious diseases *defined*, and new pathogens have been discovered". Often the inflammation caused by the infection does irreparable damage to the eye (damage severity depends on location of infection), and leaves patients with painful blind eye, which can require removal in extreme cases for multiple reasons, including avoiding sympathetic ophthalmia.

Some common structures of the eye that are effected by infection, with complications involving ocular morbidity, although not always common, are listed on the following pages in their classifications:

<u>Ocular Presentation & Symptoms</u>	<u>Pathogen / Cause</u>	<u>Comments</u>
BACTERIAL:		
<p>Conjunctivitis: inflammation of the conjunctiva. Unilateral or bilateral severe inflammation, burning, itchiness, photophobia, sticky purulent discharge. Papillae present give a velvet appearance</p>	Neisseria Gonorrhoea (STD)	Severe inflammation- can penetrate through to cornea (Keratitis)
	Chlamydia trachomatis (STD)	Type A-C can lead to trachoma. Damages the cornea. 3 rd most common cause of blindness.
	Staphylococcus aureus/epidermis, Streptococcus pneumoniae	
	Haemophilus influenza	Similar to flu transmission- in infants and children
<p>Keratitis: inflammation of the cornea which can lead to scarring and opacity resulting in visual loss (can require corneal transplant). Extremely painful due to nerve concentration in cornea. A compromised corneal barrier leads to bacterial infection, this can be from other infections, trauma or contact lens wear. Often involves other eye structures, and can lead to endophthalmitis with a high risk of blindness.</p>	Staphylococcus aureus/epidermis, Streptococcus pneumoniae, Enterobacter, Pseudomonas aeruginosa	Presentation for all common organisms are similar, however identification is essential for appropriate individual treatment.
	Protozoan Acanthamoeba	Rare organism that is present in water. Very severe inflammation and pain, with no response to standard treatment. Associated with contact lens wear.
<p>Iritis/Anterior Uveitis: inflammation of the iris/anterior uvea. Aching pain, photophobia, watering, blurring and redness. Cornea develops deposits called keratic precipitates. Occurs bilaterally or unilaterally</p>	Herpes viruses (STD) – HSV, Herpes simplex keratitis (HSK), Trauma & sympathetic ophthalmitis, Psoriatic arthritis, Seronegative arthritides, Ankylosing spondylitis, Reiter’s syndrome, Inflammatory bowel disease,	Multiple ocular and systemic factors can cause iritis, with the treatment varying on cause. A range of conditions can indicate iritis where uveal inflammation is not the cause, but other ocular causes are the pathological process
	Syphilis (STD)	Granulomatous or non-granulomatous acute presentation can occur in congenital and acquired

<u>Ocular Presentation & Symptoms</u>	<u>Pathogen / Cause</u>	<u>Comments</u>
BACTERIAL continued:		
<p>Posterior Uveitis: inflammation of the choroid, posterior of the uveal tract. Floaters made up of vitreous opacities from debris and inflammatory cells, decreased vision and sometimes pain and redness are indicators. Can be part of a various systemic or multisystem diseases, with only a few of the most common listed.</p>	Toxoplasma gondii (Toxoplasmosis)	Most common cause for posterior inflammation, found in cat faeces with transmission either direct or through eating undercooked meat of infected livestock.
	Scarcoidosis	Tends to present with pain and redness in young adults
	Others multisystem diseases with ocular inclusions are: Syphilis, Toxocariasis (round worm), Tuberculosis	
<p>Blepharitis: inflammation of the eyelids with coats of scales and lashes stuck together</p>	Syphilis (STD), Staphylococcal,	Can lead to secondary conjunctivitis
<p>Endophthalmitis: inflammation of the internal eye</p>	Staphylococcus aureus, staphylococci, enterococci	Extremely serious infection that is a high risk of vision and/or eye loss. Bacteria enter via any trauma, including surgical or prior disease compromising the eye. An intraocular sample is required for diagnostic testing.
<p>Orbital Cellulitis: Unilateral inflammation and swelling of the whole orbit pain and edema</p>	Haemophilus influenza	Similar to flu transmission- in infants and children. Can lead to severe visual loss and intracranial inclusion if not treated aggressively enough
<p>Table 9.5-1 Table of Infections: Bacterial (Data gathered from University of Rochester Medical Centre (2016); Batterbury et al. (2009); Graham (2016); Callegan et al. (2002); Egan (2016); Miller (1990)).</p>		

<u>Ocular Presentation & Symptoms</u>	<u>Pathogen / Cause</u>	<u>Comments</u>
VIRAL:		
Conjunctivitis: inflammation of the conjunctiva. Unilateral progressing to bilateral inflammation burning, itchiness, watery discharge	Herpes Viruses (STD) – HSV, HZO,	Can occur in the course of systemic childhood viral infections.
Keratitis: inflammation of the cornea which can lead to scarring and opacity resulting in visual loss. Extremely painful due to nerve concentration in cornea	Herpes simplex virus (STD),	Infection may be primary or secondary, can cause dendritic type of corneal ulcer. Many patients suffer recurrences.
	Varicella-zoster virus = primary (chicken pox) – Herpes zoster ophthalmicus (HZO) = secondary (shingles)	Often accompanied by skin rash, typically on the forehead. Multiple other ocular structure inclusion.
Uveitis: inflammation of the uvea including acute pain, vesicular eruptions	Herpes Zoster Ophthalmicus (HZO)(STD),	
Blepharitis: inflammation of the eyelids/blephara. Acute pain, vesicular eruptions. Often associated with poor tear production.	Human Immunodeficiency Virus (HIV) (STD), Herpes Simplex Virus (HSV)(STD), Herpes Zoster Ophthalmicus (HZO)(STD),	
Endophthalmitis: inflammation of the posterior eye.	Herpes Zoster/Simplex	Very rarely caused by viruses
<p>Table 9.5-2 Table of Infections: Viral (Data gathered from University of Rochester Medical Centre (2016); Batterbury et al. (2009); Egan (2016); Miller (1990)).</p>		

<u>Ocular Presentation & Symptoms</u>	<u>Pathogen / Cause</u>	<u>Comments</u>
FUNGAL:		
Conjunctivitis: inflammation of the conjunctiva	Candida, Rhodotorula, Aspergillus	Can be a secondary infection from Blepharitis or even sinus infections. Shared-use cosmetics can be the source of multiple fungi.
Keratitis: inflammation of the cornea which can lead to scarring and opacity resulting in visual loss. Extremely painful due to nerve concentration in cornea (Fig. 9.5-11)	Candida	Abnormal or compromised corneal environments creates a higher risk factor, such as dry eye and contact lens wear.
	Most commonly following trauma or contact lens wearers	The trauma, caused by plants containing fungus, can be so slight that it is forgotten
Uveitis: inflammation of the posterior uvea including the choroid and ciliary body	Candidiasis	Can be local or multisystem disease opportunistically appearing in patients with immunosuppression and dysfunction, with compromised function.
Iritis/Anterior Uveitis: inflammation of the iris/anterior uvea. Aching pain, photophobia, watering, blurring and redness. Cornea develops deposits called keratic precipitates. Occurs bilaterally or unilaterally	Candidiasis	Tends to be related to predisposing factors such as In dwelling catheter (IDC) and immunosuppression.
Orbital Cellulitis: Unilateral inflammation and swelling of the whole orbit pain and edema	Secondary reaction to other systemic / multisystemic diseases	
Endophthalmitis: intraocular inflammation of the posterior eye	Candida, Aspergillus species	The two most common cause of fungal endophthalmitis. Endogenous, stemming from systemic causes.
	Fusarium, Candida, Aspergillus species	Although exogenous fungal endophthalmitis is more common, it is rare after cataract surgeries. These are the most likely fungi's to be involved.
<p>Table 9.5-3 Table of Infections: Fungal (Data gathered from University of Rochester Medical Centre (2016); Batterbury et al. (2009); Klotz et al. (2000); Egan (2016); Miller (1990)).</p>		



9.5-11 Fungal Keratitis (American Academy of Ophthalmology, 2014)

Chemical

Chemical burns in the eye take two forms; alkali burns and acid burns. Chemical burns require immediate attention and the neutralization of the specific chemical. A danger of large amounts of damage is lid adhesion to the eye, however the situation will depend on whether the burn is anteriorly or posteriorly. In severe cases the whole cornea can be destroyed, perforation takes place and the eye shrinks.

Alkali chemicals: eg. Ammonia - react very rapidly with the fats in the cell membrane (the protective barrier covering the eye's outer surface), which allows the chemical to damage the anterior segment including the cornea and also penetrate even further into the posterior eye.

Acid burns: don't generally reach the cornea, resulting in a lower chance of corneal scarring. Some acid burns are the result of assault, and also includes serious epithelia eyelid disfigurement.

Burns – hot water, steam, hot ashes, exploding powder, molten metal and many other possible sources can be the cause for damage to the eye.

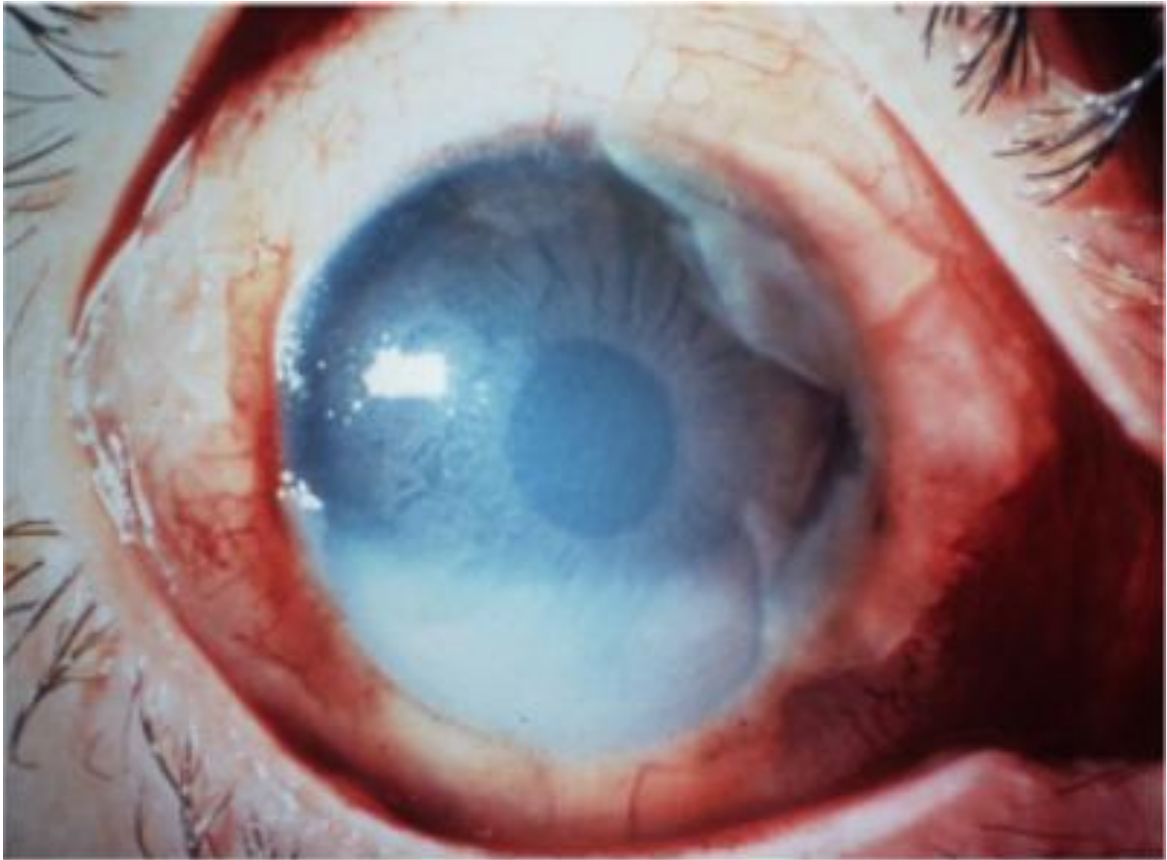


Fig 9.5-12 Chemical burn to anterior segment of eye (Operational Medicine, 2015)

NEOPLASTIC EYE DEFECTS

John Hopkins Medicine (2015) define a neoplasm as:

“... an abnormal new growth of cells. The cells in a neoplasm usually grow more rapidly than normal cells and will continue to grow if not treated. As they grow, neoplasms can impinge upon and damage adjacent structures. The term neoplasm can refer to benign (usually curable) or malignant (cancerous) growths.”

Neoplastic eye defects involve neoplasms within and around the eye, affecting the natural anatomy and physiology. A tumor is common non-specific definition of a mass of neoplasm, referred to either as a benign tumor or a malignant tumor (John Hopkins Medicine 2015).

The two are further defined below.

- *Benign tumors*: present as a localized lump and do not spread. Usually respond well to surgical

treatment. Some benign tumors can cause damage due to their size when left untreated, as such they are best removed when diagnosed (John Hopkins Medicine 2015).

- *Malignant tumors*: present as primary, cancerous tumour, and metastasize to other parts of the body, creating secondary tumours. This involves small detachments of the tumor traveling through the bloodstream or lymphatics and becoming trapped in small vessels, present in the liver, lungs, brain, kidney and lymphatic system, which is when it facilitates growth of a new secondary (John Hopkins Medicine 2015).

Tumours within the orbit, both benign and malignant, are of a great concern, not only due to the risk to the natural eye, but also due to the close proximity to the brain. Ocular tumours will most commonly be treated by surgical removal, but maybe irradiated.

Primary –

Ocular Melanoma - A type of malignant ocular cancer arising from the melanocytes found in the eye, and is the most common type of ocular cancer in adults. It is also known as uveal melanoma as can occur anywhere within the uvea (section 9.3), and is prevalent in people with lesser pigmentation, that is, fair skin and blue eyes. Melanoma tends to spread throughout the body via the blood stream, hence, there is a high risk of secondary tumours. Most commonly, liver metastases are a complication of ocular melanoma, as well as local metastases, or infiltration to the orbit, eyelids and surrounding tissues.

Retinoblastoma – (Previously discussed in *Congenital Eye Defects*, page 59-60)

Secondary –

Metastases of secondary tumors that can appear within the orbit, occur from the following primary locations; breast, lung, prostate or bowel. The most common secondary tumors metastasising to the eye are choroid metastases (**Fig. 9.3-1**), as the choroid is finely vascular.

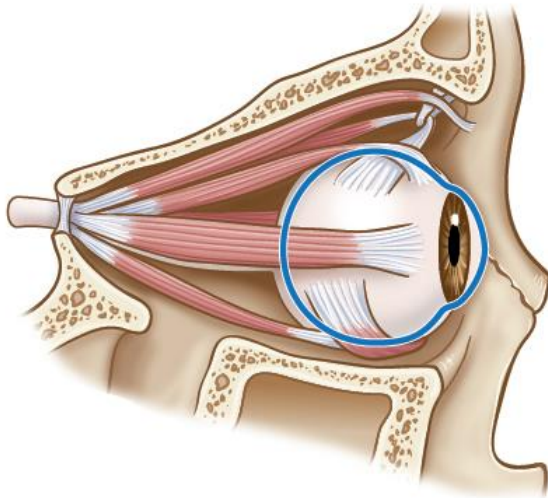
Typically, secondary tumors from anywhere in the body will metastasise from organs such as the liver and lungs, both of which have very fine filtration, where a metastasising tumour can easily lodge. This can also occur in the orbit.

Eye Removal Procedures

Removal of a diseased or injured eye is often necessary to save the non-affected eye from developing sympathetic ophthalmia. Eye removal has 3 different levels, each level increasing in amount of ocular content surgically removed.

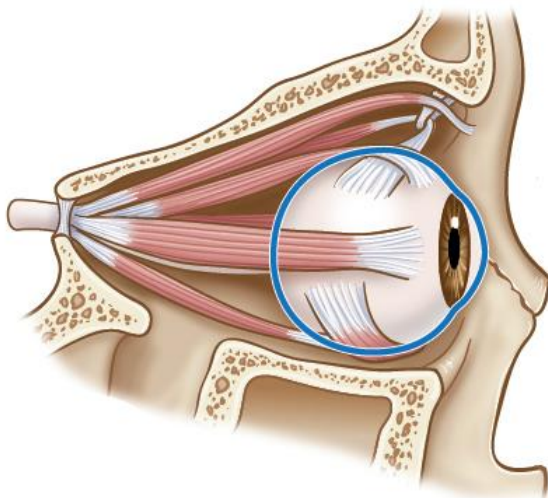
The 3 different surgical removals are *Evisceration* (Miller 1990, p. 311), *Enucleation* and *Exenteration*, (Fig. 9.5-13) and are defined as follows:

- *Evisceration*: the contents of the inner eye, the iris and cornea, are removed, but the sclera, or outer covering of the eye, remains with the extraocular muscles still attached. An orbital implant is placed inside the sclera to replace lost eye volume, and the sclera is stitched together over the implant opening.
- *Enucleation*: the entire eyeball is removed, leaving the remaining orbital contents intact; extraocular muscles are detached and usually reattached to an orbital implant and/or dermas fat graft.
- *Exenteration*: the entire contents of the eye socket are removed including the eyeball, fat, muscles and other adjacent structures of the eye. The eyelids may also be removed in cases of cutaneous cancers and unrelenting infection.



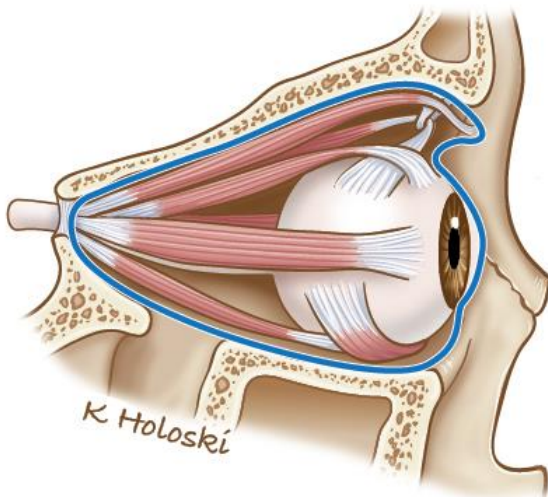
Evisceration:

The contents of the eye are removed, but the outer layer of the eyeball (sclera) is left intact.



Enucleation:

The entire eye, including the globe, is removed but the orbital contents are left in place.



Exenteration:

The contents of the eye socket are removed, including the muscles, lacrimal gland, optic nerve and various bones of the orbit.

Fig. 9.5-13 Difference between Evisceration, Enucleation & Exenteration - the limitations of removal are highlighted within the blue area (Head & Neck Cancer Guide, 2016)

Frequency of Procedures

Table 9.5-4 shows the past four years' statistics within the Australian Medicare System for the occurrence of specific eye removal procedures in private hospitals – the public hospitals use different descriptions. The table shows services as detailed by Medicare Item Numbers. There have been no substantial patterns of an increase or decrease in the number of surgeries over the four-year period, or a more prevalent gender likely to be requiring surgery. The key observation from these statistics is the incidence of Enucleation surgeries throughout the period of four years is significantly greater than that of Evisceration or Exenteration surgeries. However, it has already been established that Exenteration surgery is rare. The prevalence of Enucleation surgery has a direct relationship with the occurrence of specific reasons for this eye removal, such as tumors and accidents requiring an Enucleation. However, having said this it must be observed and stated that the public hospitals being larger and more equipped would be the major referral point for extreme and complex situations and surgeries.

Requested Medicare items processed from July 2014 to June 2017									
	State								
Services	NSW	VIC	QLD	SA	WA	TAS	ACT	NT	Total
Enucleation									
42506	29	13	14	2	3	6	1	2	70
42509	26	25	10	0	4	2	3	0	70
42510	22	44	44	14	9	7	2	0	142
									282
Evisceration									
42512	8	3	6	3	1	2	2	0	25
42515	33	13	15	4	17	2	1	0	85
									110
Exenteration									
42536	20	18	11	5	4	1	2	2	63
Total	138	116	100	28	38	20	11	4	455

Table 9.5-4 Australian Medicare System Item Numbers, showing total numbers of eye removal procedures over a 4-year period (Australian Government Department of Human Services, 2017)

9.6 MONOCULAR EYESIGHT

Eye loss, resulting in monocular vision, is often a major and traumatic event in an individual's life, contributed to by the reason for loss, healing period and prosthetic rehabilitation process. Eye loss requires a major re-adjustment from binocular to monocular vision for the subject (**Fig. 9.6-1**). Not only on a personal and social level, regaining self-confidence and pride, but also on a professional level where talking face-to-face and interacting is a part of their daily life. Basic necessities and activities will require some relearning due to things such as depth perception and spacial awareness being affected by their monocular vision (**Fig. 9.6-1**). Depth perception, although aided by, does not depend entirely on the presence of two eyes. Monocular visual clues such as proximity, shadows, perspective, overlap and parallax assist in the interpretation of an object. It usually takes some time to adapt to the sudden visual loss of sight of one eye (**Fig. 9.6-1**). The transition from binocular to monocular vision is probably the first and most challenging aspect of eye loss and the loss of what is often described by the patient as '3 dimension', referring to depth and visual field (Brady, 2009).

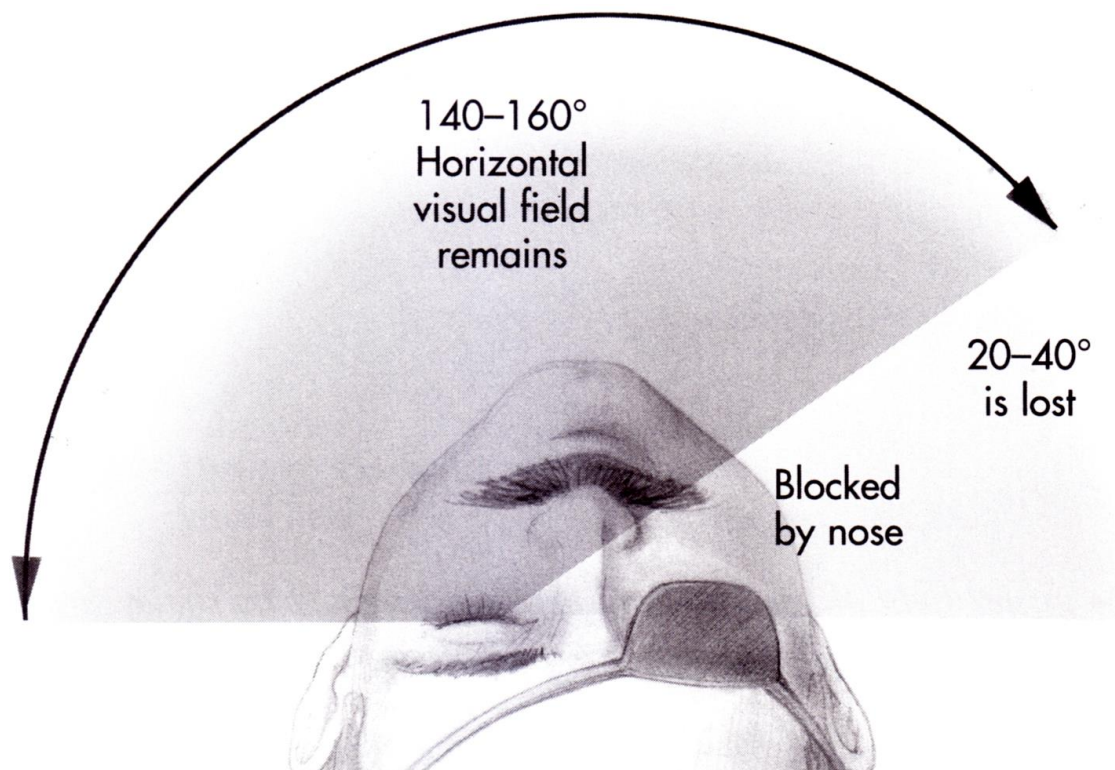


Fig. 9.6-1 Monocular visual field of left eye – lost visual field (Brady 2009, p.25)

Emotional/Psychological

Historically facial 'disfigurement' has caught the attention and macabre curiosity and fascination of people in what can only be described as insensitive and naïve. Krishna (2009), in an excerpt on psychosocial impact of disfigurement stated, "Among its myriad biological function, skin plays a key role in communication: it is the boundary between self and the environment, serving as the point of contact when meeting strangers". Anyone who has experienced any illness/disease resulting in a disfigurement will perfectly understand the social, personal and emotional barrier that it can cause. Eye loss is one of these disfigurements that cause extreme social awkwardness, as it is not a diagnosis you have the choice of sharing with someone. This social awkwardness is not only for the self-esteem of the individual, but can cause acute conversational difficulties, as eye contact is a polite and key aspect of socializing within any situation. Being on one's face, eye loss is not easily hidden, and those methods undertaken for disguise (sunglasses/eye patch (**Fig. 9.6-1**)) can still cause issues similar to those previously discussed.

These issues referred to are not limited to a social level, but can cause a severe amount of pressure for the individual to achieve social acceptance in other ways to make up for their disfigurement. This pressure has the ability to affect the individual on a professional and vocational level, as well as placing strains on personal relationships and daily activities.

From such well known 'celebrities' as Joseph (John) Merrick more commonly known as "Elephant Man" (**Fig. 9.6-2**), to the much acclaimed stage act, "Phantom of the Opera" by Andrew Lloyd Webber (AndrewLloydWebber.com), and Freddy Krueger from "A Nightmare on Elm Street" (**Fig. 9.6-3**) who the patients have, in the past, likened themselves to in a somewhat humorous yet at the same time tragic way. Disfigurement is more formally defined as a state in which ones' appearance is deeply and persistently harmed medically as from a disease, birth defect or wound (Krishna, 2009).

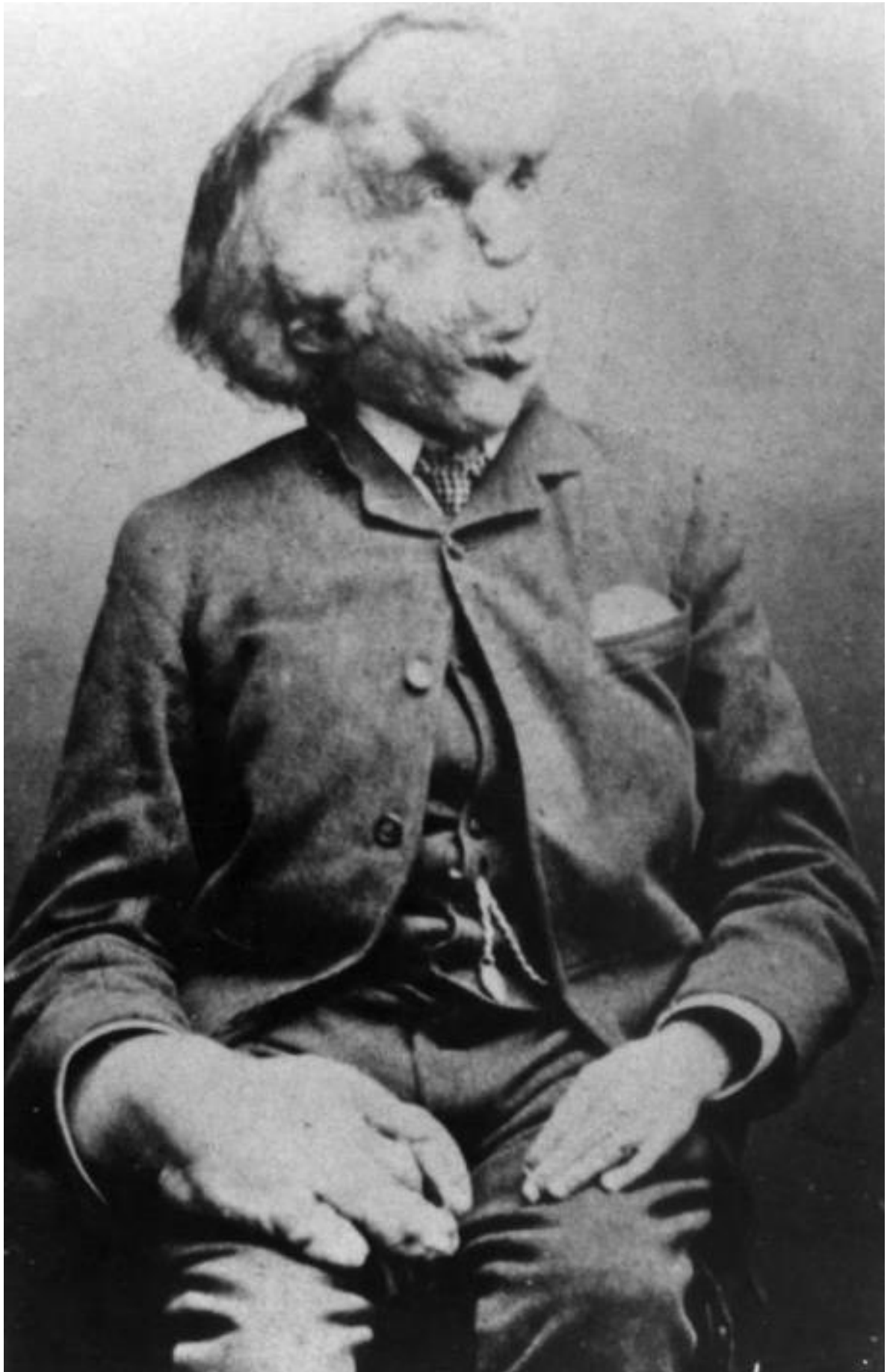


Fig. 9.6-2 Elephant man – Joseph Merrick (Sheward, 2014)



Fig. 9.6-3 Freddy Krueger from 'A Nightmare on Elm Street' (Wikia)



Fig. 9.6-4 Scarface (The Herb Museum)

Some have 'worn' their disfigurement as a badge of honour; such as the screenplay 'Scarface' 1932, based loosely on the rise and fall of Al Capone, and Moshe Dayan (Fig. 9.6.5), Israeli General and

subsequent Labour Government Defence Minister who wore a black patch as his 'trademark'. Despite the heroics associated with Dayan's eye loss, he said in his autobiography, 'Moshe Dayan: Story of My Life' (1992):

"I reflected with considerable misgivings on my future as a cripple without a skill, trade, or profession to provide for my family... ready to make any effort and stand any suffering, if only I could get rid of my black eye patch. The attention it drew was intolerable to me. I preferred to shut myself up at home, doing anything, rather than encounter the reactions of people wherever I went."



Fig. 9.6-5 Moshe Dayan with patch over left eye (Wikipedia, 2016)

Encountering negative situations relating to disfigurement may be a fact; education and reason is also factual, and these can work together to create a more positive experience and quality of life for suffering

individuals. The aim of a prosthetic eye is to maximise the natural appearance and minimise the individuals' disfigurement, which ultimately will reduce these previously mentioned issues surrounding disfigurement, within certain limits.

Gaspare Tagliacozzi (1545-1599), the father of modern plastic surgery, is known for this profound statement:

“We restore, rebuild, and make whole those parts which nature hath given, but which fortune has taken away. Not so much that it may delight the eye, but that it might buoy up the spirit, and help the mind of the afflicted”. (Mele, 2014)

9.7 OCULAR PROSTHETIC HISTORY

It is a naturally human desire to feel normal and be accepted. Since humans have existed, eye loss has been evident. Therefore, the endeavour to replace that loss with an entity to create feelings of normalcy has also been present. Artificial eyes can be found in history going back at least 2,500 years. Assuming that a form of surgery was designed and initiated prior to the need for an artificial eye, it is thought that the surgery goes back even further. This is quite rational considering Dyer (1980) reveals, that in 2600 BC the Chinese had gods devoted to their 'eye doctors'. Places such as Egypt and Mexico record the occurrence of artificial eyes; however, the worship of their gods in the form of statues was an essence to their culture, and potentially was referencing artificial eye fabrics relating to these statues (**Fig. 9.7-1**).



Fig. 9.7-1 Ancient Egyptian eyes, initially for gods and statues (The College of Optometrists, 2014)

The eye was a symbol of life within the ancient Egyptian world, with many gods and emblems involving the eye, including the 'Eye of Horus' (**Fig. 9.7-2**) which stood for power, protection, "filial" and virtue. Materials such as copper, brass, gold and clay, which have been found in Egyptian tombs, were used as artificial eyes. The Egyptian priests created artificial eyes that were attached to a cloth and worn over the head, and which sat over the lids like a patch.



Fig. 9.7-2 The 'Eye of Horus'(Horus)



Fig. 9.7-3 The Young woman discovered in The Burnt City (Quigley's Cabinet, 2012)

An artificial eye estimated at 4800 years old was discovered in 2006 by Iranian archaeologists in Burnt City, is said to have belonged to a woman around the age 25-30 upon her death (CAIS News, 2006) (Fig. 9.7-3; 4). The initial assessment of the material indicated that it was made from natural tar mixed with animal fat. Special effort was put into the details, even including small lines, less than half a millimetre, depicting the pupil and capillaries (Fig. 9.7-4). Due to long-term contact and materials, the artificial eye was estimated to have caused the formation of an abscess in the eyelid; this was supported by the finding of remaining eyelid tissues evident on the artificial eye.



Fig. 9.7-4 The item discovered in the Burnt City determined as an artificial eye (Quigley's Cabinet, 2012)

Anywhere we look in history relating to health, or more specifically, artificial eyes, it's apparent that the early surgeons did not fully understand the implications of an empty socket, or place a great deal of emphasis on hygiene of the socket. Any form of artificial eyes that may have been used for human purposes would have primarily been used for aesthetic appeal only.

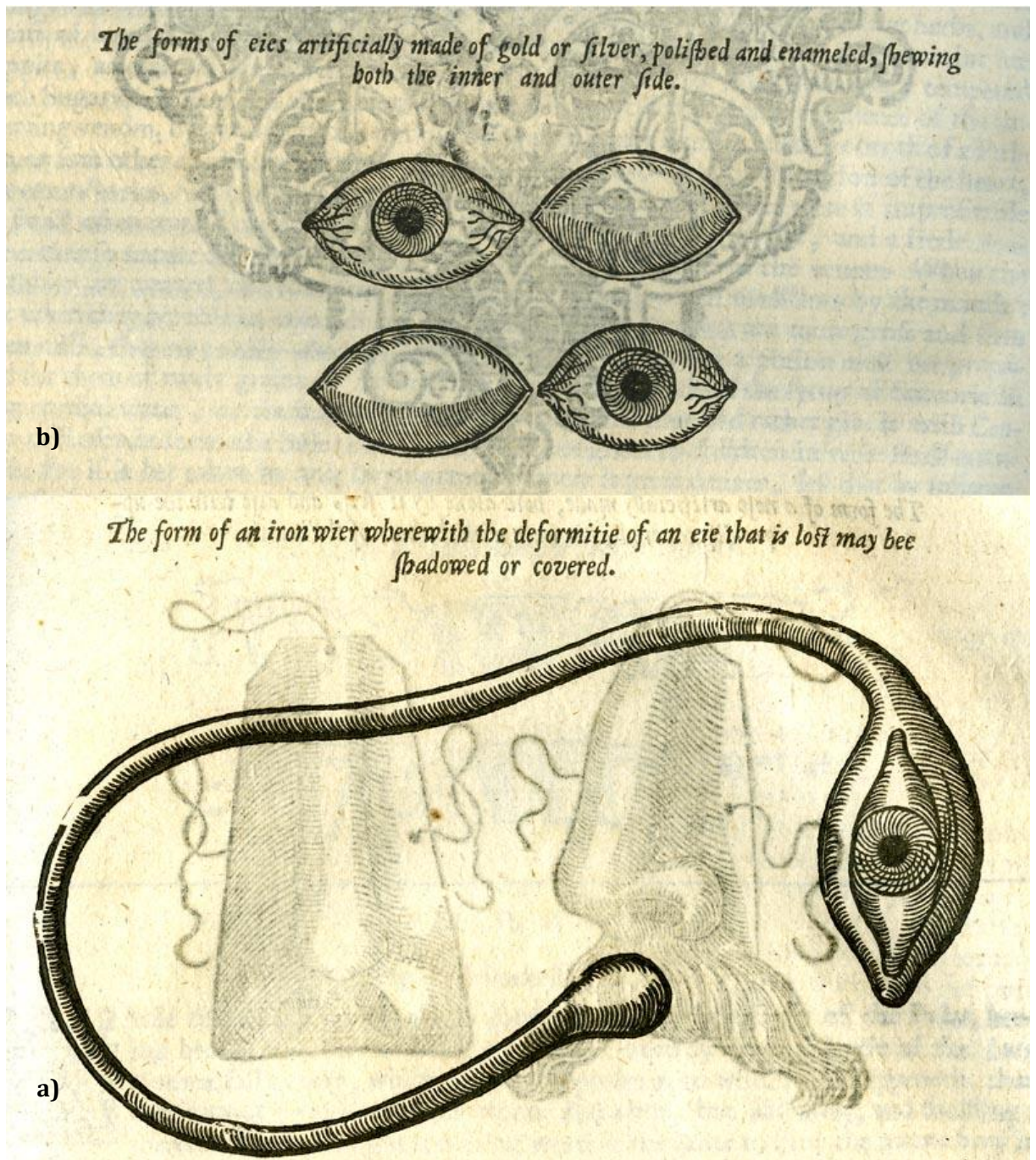


Fig. 9.7-5 Ambrose Pare revolutionary initial ocular prosthesis: a) eklephara b) hypoblephara (Ilieva, 2015)

As the knowledge of the medical field improved, so did knowledge relating to artificial eyes, and the implications of poor hygiene causing infections. Dyer (1980) aptly deduces that, “wherever in the world there was a civilization which utilized artificial eyes, the technique of construction and the basic physical forms were undeniably similar”.

The foundation of the concept basis used for artificial eyes today was built in 1561 by a French surgeon, Ambrose Pare. It was he who suggested the revolutionary idea of fitting the orbit of a human with a gold and coloured enamel artificial eye that sat beneath the eyelids. Initially he created two types of artificial eyes, the ‘ekblephara’, which was worn over the eyelid, secured around the head (**Fig. 9.7-5**); and the ‘hypoblephara’, which was a hemispherical shell, which sat over the existing eyeball (**Fig. 9.7-5**). Pare’s ‘hypoblephara’ eye did not become commonly popular till the 1800’s.

Throughout time, many ideas were generated which involved different methods and materials. Specifically, advances were made with glass, which became increasingly popular, however the exact time frame of their development for the human orbit is unknown. It’s suggested that they were present before the 16th century due a comment in William Shakespeare’s play ‘King Lear’ written in 1605 with a strong theme of blindness vs. sight. Sparknotes (2016) provides the original text:

“Get thee glass eyes,
And like a scurvy politician seem
To see the things thou dost not.”

Not surprisingly, Venice, with all its fame for glass making, holds records of secret methods for making glass eyes during the second half of the 16th century. In England, 1679, a William Boyce placed an advertisement in the ‘True Domestic Intelligence’ for artificial eyes made with glass; and again later in 1681 another advertisement in ‘Merlin’s Ephemeris’. He was succeeded by his son-in-law, James Smith in 1710 who is famous for an existing portrait, in which depicted he is holding an example of one of his products (**Fig. 9.7-6**). Throughout the 18th century, both metal, enamel and glass artificial eyes were

available; in 1752 it was observed by a surgeon of Nuremburg, Heister, that glass eyes were preferable to metal ones made by goldsmiths, since metal was not as bright and repelled tear fluid.



Fig. 9.7-6 Portrait of James Smith exhibiting his work (The College of Optometrists, 2014)

The growth of glass blowing in Germany was encouraged by Dr Friedrich Philipp Ritterich, who in 1852 wrote a book on his concern for his fellow man, from which we know that he fitted artificial eyes for 30 years. Paris was supplying ready-made stock prostheses, from which Ritterich would specifically choose for his patients. It wasn't until the 19th century that artificial eyes were glass blown specifically for individual patients. Germany became dominant in glass blown artificial eyes, and craftsmen began to travel the USA, demonstrating glass blowing throughout various cities. Around 1850, the Americans began making their own glass blown eyes, however German made were considered the very best.

Initially prostheses took a more shell like shape, initiated by Ambrose Pare, who designed this especially for patients with natural eyes existing within the orbit. This would have perpetuated issues such as constant infections, tear stagnation, growth deformity in children and quite obviously, severe discomfort. The health requirements and need for a full socket with materials directly in contact with the mucus membrane, and the concept of the individuality of socket size and shape was not always fully understood or realised.

The enucleation surgery became more common with improvements in anaesthesia and antisepsis. This meant that the shape of artificial eyes needed to change from the shell hemispherical shape that Ambrose Pare invented, to a fuller shape to fill out the socket.

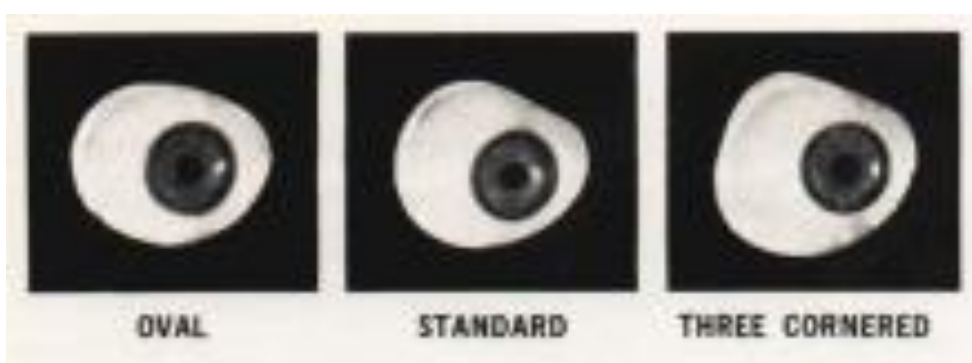


Fig. 9.7-7 The 3 stock eye shapes (The College of Optometrists, 2014)

Once the rationality of a full socket was expressed, it did not take long to be appreciated. 'Stock' eyes made of glass were invented and imported primarily from Germany (**Fig. 9.7-7; 8**). There were 3 main shapes that these 'stock' eyes consisted of; oval, standard or three cornered (**Fig. 9.7-7**). Every patient

would be generalised into one of these three shapes. ‘Eye-doctors’ would attempt to find the ‘best fit’ from cases upon cases of these pre-made glass prostheses (Fig. 9.7-8).



Fig. 9.7-8 Rows of ‘Stock’ eyes to be tried for best fit (Artificial Eye Clinic, 2015)

The conflicts in the World Wars affected the trade of glass from Germany, causing England and America to search for alternatives to glass. This resulted in the beginnings of acrylic eyes, made with a durable and permeable plastic, Poly Methyl-Methacrylate (PMMA). This material is the prevalent design in prosthetic eyes currently in the world, with a smaller percentage of glass eye makers in Europe still existing today. Although the specifics of construction technique differ from one Ocularist to another, a point of commonality is the preference for use of PMMA (Appendix 14.1).

The essence of providing the prosthetic eye is the patient, and encouraging them to live a full life despite this loss. Dyer (1980) sums up an Ocularists’ job into one sentence; “...it is vital that the prosthesis be comfortable at all times so the patient will be less self-conscious of their appearance”. The

importance of understanding the crude background which the process of making artificial eyes has come from cannot be emphasized enough. We must appreciate the quality of product we can give our patients today. Despite the process taking longer today, there is no question of the fact that the end results are far superior both in the prosthetic natural appearance, and hence how the patients themselves feel (**Fig. 9.7-9**).



Fig. 9.7-9 Multiple acrylic prosthetic right eyes from one individual patient, worn over a period of many years (Knowles, R-ZR 2016a)

9.8 OCULAR PROSTHESES

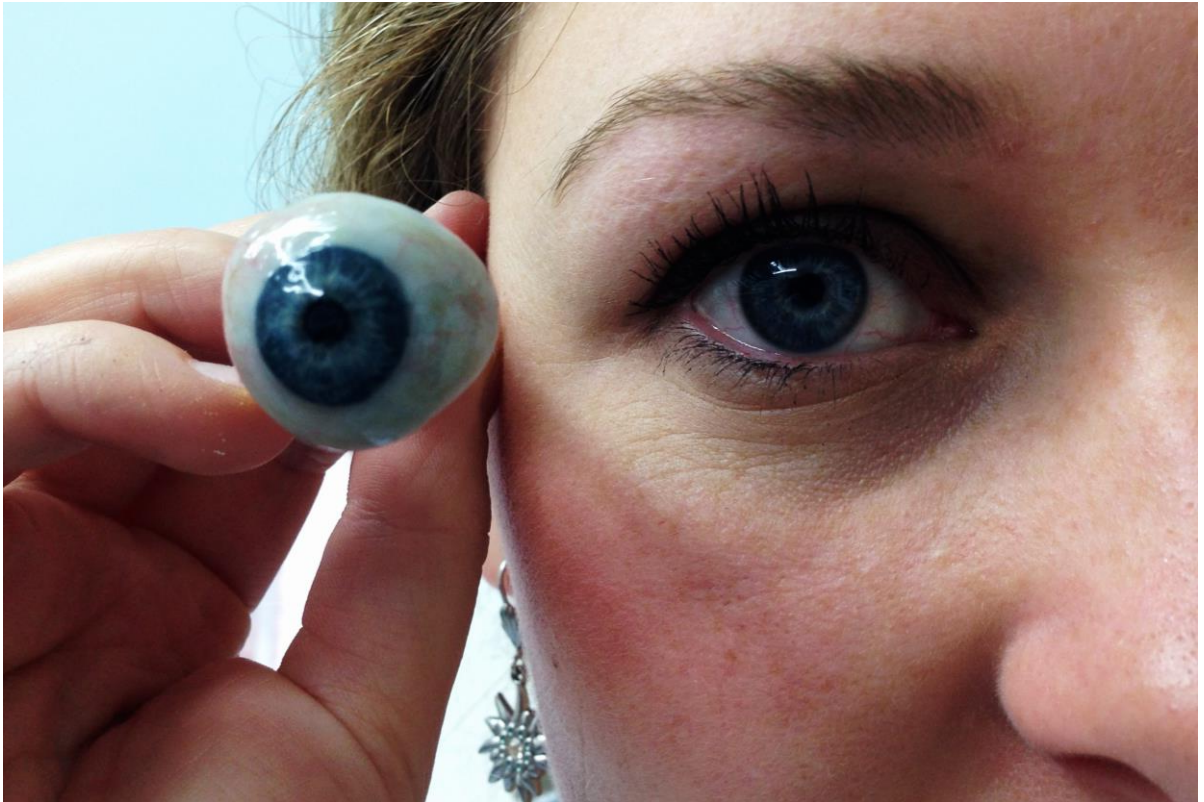


Fig. 9.8-1 Ocularist depiction of own eye colour match hand painted on scleral shell (Knowles, R-ZR 2014b)

“Artificial eyes are not for seeing, but are for being seen, being located ... in the middle of the face - the most visible part of the human body” (The College of Optometrists, 2014). The biocompatible acrylic prostheses made of poly methyl methacrylate (PMMA) is a hydrate-able passive material (as used with rigid contact lenses) and goes through a process in the eye socket known as syneresis and imbibition (the expulsion and absorption of moisture) which contributes to its biocompatibility and overall comfort. As a result, the palpebral fissure ‘sets up’ its own ecosystem or microenvironment (see section on homeostasis). The primary concern for monocular patients wearing a prosthesis, was found to be the health of the remaining eye (Pine, 2013) and more specifically, concerns relating to the artificial eye itself. These included common issues to do with discharge, such as watery eyes and discharge crusting, but also concerns relating to the eye itself including directional gaze, symmetry and similarity. The aim of a prosthetic eye is to maximise the natural appearance, which ultimately will reduce these previously mentioned issues surrounding disfigurement, within certain limits. Requoting Gaspare Tagliacozzi’s

(1545-1599) profound statement (Mele, 2014) highlights the essences of the psychological importance of this field:

“We restore, rebuild, and make whole those parts which nature hath given, but which fortune has taken away. Not so much that it may delight the eye, but that it might buoy up the spirit, and help the mind of the afflicted”.

Prostheses

Ocular Prostheses - An indication for an artificial eye / ocular prosthesis is generally surgical, with an ocular evisceration or enucleation, where the eye is, to differing extents, removed. Congenital malformations and diseases are also an indication for a prosthesis. An ocular prosthesis is fitted over an orbital implant that, depending on the type of surgery, is attached to the existing eye muscles and is designed to be worn full-time. A custom eye prosthesis made with an impression-fitting technique will have direct contact with the remnant tissues and associated muscles. As a result, most prostheses have a reasonable range of mobility. The exception can depend upon differing socket and eyelid shapes, and resultant shape of the prosthesis. Most patients whose surgery has been done by an experienced ophthalmologist would expect to have an ocular prosthesis with conversational or extended conversational eye movement. Conversational eye movement is when the prosthetic eye and natural eye of patient engages left eye, right eye, then drops to the mouth of third party, in what is described as, the triangle or envelope of conversational movement. Extended conversational eye movement is where eyes can move laterally and medially to include an individual either side of third party. At the most, it will generally be assumed the result of a lazy eye if the prosthesis does not have these apt conversational movements.

Prostheses should be replaced every 3-5 years to ensure good direct contact with the tissues in the socket, as the prosthesis degenerates, and the colour sometimes fades and anatomically the orbit changes, as the patient grows older. Children require progressively larger prostheses to be made more

frequently than 3-5 years. This is due to their rapid growth and the requirement for stimulation in the surrounding bony orbit area known as Pfeiffer's diacephalic growth region, and muscle growth within the orbit, to maintain symmetry with the opposing natural eye (El Essawy & Abdelbaky, 2016).

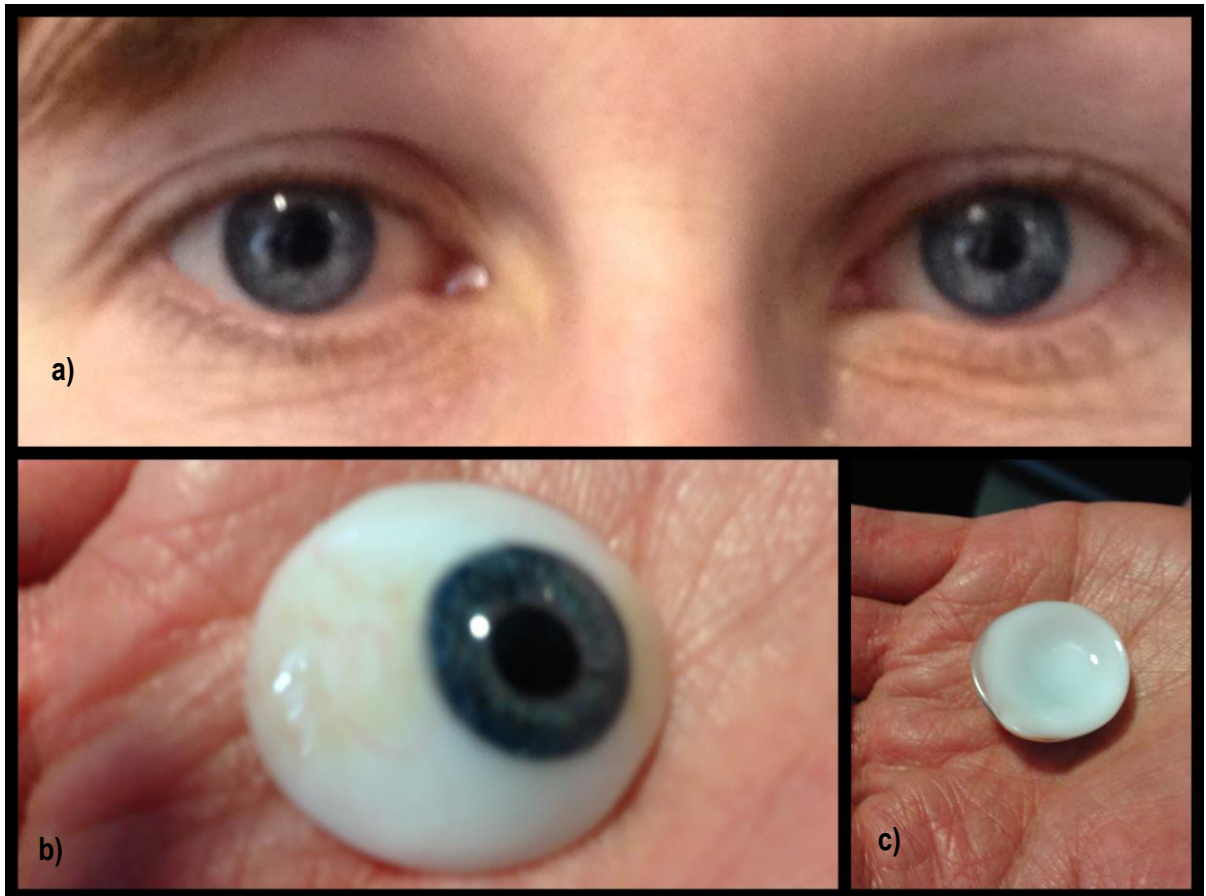


Fig. 9.8-2 a) Patient wearing right haptic shell prosthetic eye b) the anterior c) the posterior (Knowles, R-ZR 2014a)

Haptic Shell Prostheses - A haptic shell fits over the existing scleral surface of the eye and is peripherally borne to avoid any remaining corneal sensitivities and most commonly worn full-time (**Fig. 9.8-2**). Microphthalmia, a congenital malformation, and phthisical eye, the shrinking atrophy of the eye resulting from trauma, are all indications for a haptic (or scleral) shell. The motility of a haptic shell is typically better than the motility of an orbital prosthesis, but varies between the differing orbits shapes and sizes. Due to the natural contents of the eye still present, intensified sensitivity is relatively common in contrast to the typically reduced sensitivity of the socket without any ocular contents sitting on

mucosal tissue. As with ocular prostheses, the regularity of larger prostheses is more frequent in children due to their growth stimulation requirements.

Construction

The fabrication of ocular prosthesis is outlined in section 10.5, which also makes reference to **Appendix 14.1**. This includes the American Standard Operating Procedures outlined by the American Society of Ocularists (2015) and those methods used by the investigator (**Fig. 9.8-3**).



Fig. 9.8-3 Components of the construction process of an acrylic ocular prosthesis, each eye being a different prosthesis **a)** the polished acrylic prosthesis made from the wax mold ready for a try-in **b)** veins and scleral colour added **c)** final process of the clear acrylic **d)** final polished product ready for wear (Knowles, R-ZR 2016b)

Correct fabrication of a prosthesis is critical to its suitability as an object to be placed within the palpebral fissure and maintain contact with the delicate mucosal membrane tissue. The PMMA used in construction of most artificial eyes is the same gaseous permeable material as that used to construct

rigid contact lenses. Pine et al. (2013) reinforces the conclusion that all artificial eyes should be finished to an optical quality contact lens standard, as a minimum requirement. This is particularly important on the inter-palpebral surface of the prosthesis where it comes in contact with the eyelids, and would therefore aid in the free flowing action/motion of the lids and the lubricating and cleansing action of tears. It is also critical that product supplier directions for material curing and processing are strictly adhered to so that PMMA fused laminated globe can not only be biocompatible but polished to a surface lustre and smoothness, as would assist in tissue and lid movement and lubrication, with as minimal friction and tension as possible.

Maintenance

Once the acrylic (PMMA) prosthesis is placed in the empty eye socket, surface deposits begin to form, made up of proteins and other minerals adding to the biocompatibility. This initial protein deposit build-up process coincides with an amount of mucous discharge that can be both unpleasant and embarrassing for the patient. If left to dry, this can cause the lids to stick to the prosthetic surface and form a crust, which is not only unsightly but also uncomfortable on the socket and lids, often scratching and stinging the patient. Discharge regularity and amount is not widely understood but believed to be the dehydrated natural tears collecting rather than draining through the tear duct, as would be the normal process with a natural eye (see section **9.2 Tears**). Conflicting and various suggestions of mucous discharge reasons and treatments are offered by Ocularists worldwide, and are all clinic and patient specific (Pine, 2012).

Protein build-up is primarily blamed for discharge, whilst others say dust/dirt collection and / or continual handling and a dry environment also impact discharge. The author has clinically observed with cold and flu symptoms, hay fever and paediatric 'teething', discharge increases. Various Ocularist clinics suggest differing regimes for artificial eye maintenance and, it would seem, are based upon individual patient and environmental life style issues. Ongoing discharge and/or discharge amounts would be a potential

gauge for maintenance timing. The author, and others, have clinically observed that the less often the prosthesis is 'disturbed' by removal and manual cleaning, the better the socket health seemed. What is uncertain, is what comes first; the ongoing discharge resulting in the patient continually removing the prosthesis, or the patient continually removing the prosthesis because of the discharge. It would seem completely understandable however, that a discharging prosthetic eye with its attention drawing an unpleasant appearance and associated discomfort would be sufficient reason for a patient to remove and clean their prosthesis. Under 'normal' circumstances, where a patient and their eye socket are otherwise healthy, minimal removal and disturbance would be recommended and contribute to and allow natural tear flow and its accompanying lubricating and cleansing effect. However, if for whatever reason, eyelids do not occlude, this would tend to significantly complicate this process.

Studies have shown the indication that as a prosthesis is worn for longer periods over a longer term, the socket accommodates the artificial eye better. Pine et al. (2013) states: "Specific causes of mucoid discharge such as infections and environmental allergens are well understood, but non-specific causes are unknown and an evidence based protocol for managing non-specific discharge is lacking". It seems that the protein (biofilm) build-up, is at first, the medium for eye socket acceptance of the prosthesis, whilst in the same instance, contributing over time and with increased build-up, to causing irritation (discharging), inflammation, and can lead to infection and serious discomfort. Pine (2012) shows that a study of the anophthalmic population of New Zealand found evidence that 33% experienced discharge at least twice a day but no internationally accepted standardized treatment protocol has been developed to deal with it.

In addition to review, clean and polish regimes, the author and others, combine sterilization, lubricant and antibiotic and/or steroid ointment treatments as may be required. Pine, Sloan & Jacobs (2013) state:

"United Kingdom NHS (National Artificial Eye Service) advises via its website that, 'there are no set rules about this. If you have a lot of discharge from your socket you may need to clean it several times a day. For most people, once a day seems about right. It is up to you to decide, however we

recommend that the eye is removed for cleaning at least once every thirty days.' On the other hand LeGrand states that a 'properly designed, perfectly polished prosthesis is all that is required for total comfort with no excess secretions. Such a prosthesis need only be removed once each year for professional cleaning to remove natural deposits and restore its polished surface'- both claims cannot be completely right.

This shows conflicting opinions have existed based upon personal opinion and experience. It can also be concluded that the higher the level of surface polish the slower and lower the rate that biofilm forms. (Litwin, 2017; Pine, 2015))

Homeostasis

It has been found that the eye socket environment goes through various stages of change, affected by both the physical presence of a foreign object and the occasional intervention of eye removal and cleaning whether by the wearer and/or professional cleaning by an Ocularist. To disturb the prosthetic surface biofilm build-up is to unsettle the micro-environment of the palpebral fissure, and in turn affect the delicate and sensitive mucosal tissues which makes up the contacting socket.

Whilst the abrasive nature of excessive surface build-up is removed by polishing, the physiological acceptance and homeostasis of a 'cleaned' prosthesis may take some time to establish (**Fig. 9.8-4**). The physical stresses caused to the socket and surrounding tissues is considerable, with pulling, stretching, compressing and rubbing forces all applied during the process, as well as significant thermal changes involved in removal, cleaning and inserting.

Pine, Sloan & Jacobs (2013) states:

"The recovery time from the stresses of prosthesis removal and re-insertion appears to be rapid (perhaps only a few minutes). However, the establishment of stable physiological homeostasis may take longer because the conjunctival mucous substrate need to be re-distributed evenly around the prosthesis, foreign materials need to be encased and eliminated, and the balance between tear production and tear loss needs to be re-established. Once the disturbing effects of reinserting and removing the prosthesis have abated and surface coatings and deposits have been re-established to a minimum depth and coverage, a

stable physiological homeostasis is established within the socket. It is proposed that the physiological homeostasis in the micro-environment of the socket gradually becomes less benign. Over time some minor inflammation and discharge begins although it may not be enough to warrant attention by the wearer. However, once the balance has shifted, further perturbations lead to homeostasis breakdown. It's suggested that homeostasis may be established over a period that could extend for a month and that prosthetic eyes should be left undisturbed for at least this long. Beyond a month when stable homeostasis has been reached, the length of time before it starts to break down is likely to vary for individuals. The standard of surface polish on the prosthetic eye may influence the period of stable homeostasis. A proposed three phase model of prosthetic eye wear is presented as a basis for suggesting a personal cleaning regime to manage non-specific mucoid discharge associated with prosthetic eye wear."

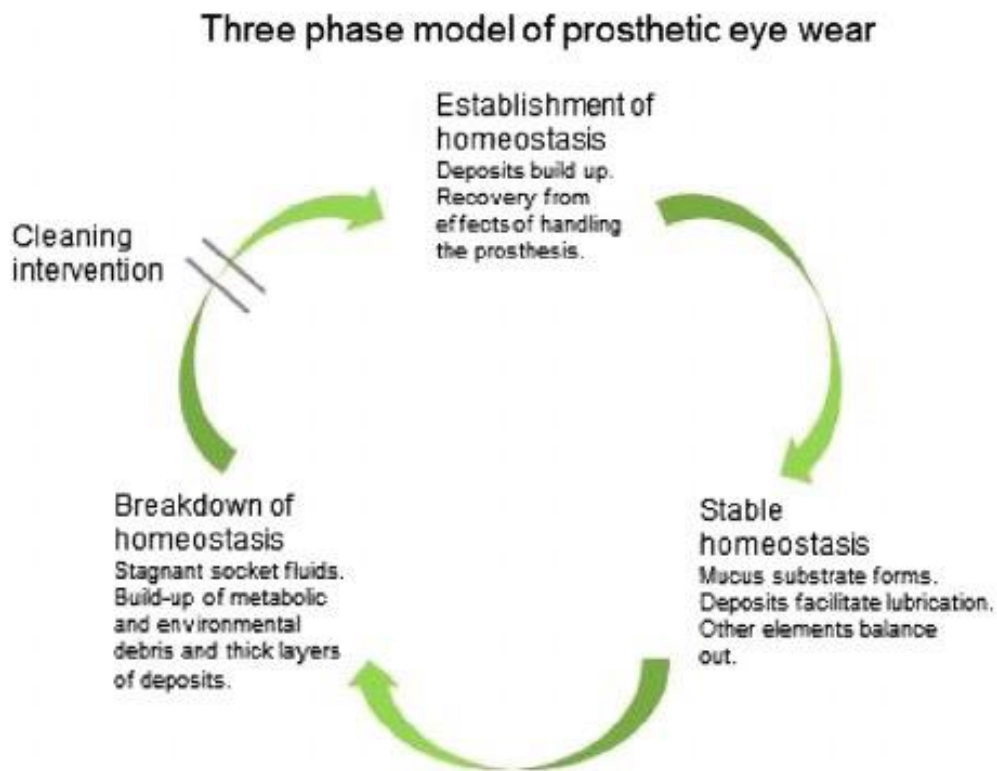


Fig. 9.8-4 The model of homeostasis of prosthetic eye wear as established by Pine, Sloan & Jacobs (2013)

Effective maintenance regimes are currently left up to individual Ocularist's discretion and opinion, and involves removal, cleansing and polishing of the prosthetic surface, to both remove any protein and debris build-up, and restore a brilliant lustre for both aesthetic and more importantly, physiological reasons.

10. RESEARCH METHODOLOGY

10.1 STUDY GROUP

The study group consists of consecutive cases of patients who received artificial eyes constructed by a single Ocularist working both publically in the Oral & Maxillofacial Surgery Unit of the Royal Adelaide Hospital and Adelaide Dental Hospital on referral from Ophthalmic Outpatients Department of the Royal Adelaide Hospital, and privately at rooms in North Adelaide on referral generally from private Ophthalmologists and general medical practitioners. All patients were primarily under the care of specialist ophthalmic surgeons and were referred for prostheses. Initially data was collected retrospectively and as the study progressed were collected prospectively.

10.2 STUDY AIM

The aim was to collect:

- 1) General demographic data; age, gender, occupation, public or private referral for treatment, and general medical status.
- 2) Specific eye data; which eye, time frames, reasons, type of prosthesis, and number of prostheses (if there had been multiple prostheses then the history of the most recent was used), management and complications associated with wearing the prosthesis.
- 3) Data on the psychological and social impact of eye loss on the patient. This included the patient either rating the impact using a visual analogue scale of 0-10 and/or on short structured interviews, different methods used based on varying circumstances.

10.3 INCLUSIONS

The inclusions criteria for the study participants were:

- 1) Consecutive adult patients treated by the single Ocularist for unilateral or bilateral natural eye replacement.

10.4 EXCLUSIONS

The exclusions criteria were:

- 1) Patients under the age of 18 at the time of study.
- 2) Patients who declined to give consent to be involved in the study.
- 3) Indigenous Australian patients.
- 4) Patients with serious socket complications.

10.5 EXECUTION & DESIGN

Data was collected on a questionnaire, a copy of which is attached in the appendix (Section 14.4). The initial version was trialled on a selected group of 12 patients. Patients were selected for this preliminary version on the grounds that they either had a professional health or academic background, or broadly covered a representative sample of the patients known to suffer eye loss.

The data was analysed using a Visual Analogue Scale (VAS) which is a psychometric response scale which can be used in questionnaires. It is a measurement instrument that endeavours to measure subjective characteristics or attitudes that are believed to range across a continuum of values and cannot easily be directly measured. When responding to a VAS item, respondents specify their level of agreement to a statement by indicating a position along a continuous line between two end points, eg. values between 1 to 10.

The current questionnaire was developed from feedback to the preliminary version. A computer program was developed, using Microsoft Access Database System, so that data collected could be entered and subsequently analysed.

The initial analysis covered the response of the group to the questionnaire. The first part (11.1) contained the demographics of the study group.

The second part (11.2 – 11.11) related to the emotional state and attitudes of the group at the time of their eye loss. Participants were asked to rate their emotions towards their eye loss and prosthetic replacement. The definitions for these emotions, as rated on a visual analogue scale, are defined by the investigator and accompanying the individual questions and answers in sections 11.2 – 11.11 inclusive.

The next focus was on the habits, functionality, adjustment and daily living for the participants with the prosthesis (11-12 – 11.15).

The study was conducted in accordance with the University of Adelaide Ethics Committee, permission number 111103, a copy of which is attached in the appendix (**Appendix 14.2**).

10.6 NULL HYPOTHESES

A series of null hypotheses were created based on the questions asked and are as follows:

1. Patients over the age of 50 are more inclined to lose an eye through disease than those under the age of 50
2. Men lose their eye to trauma disproportionately more than women
3. Smokers lose their eye to disease disproportionately more than non-smokers
4. Diabetic Patients experience more dry eye problems than non-diabetic
5. Those who lost their eye through disease experience more discharge than others
6. Men experience more discharge than women
7. Those who have their eye cleaned every 3 months experience less discharge
8. Men feel more self-esteem with their eye in than women
9. Women feel more vulnerable without their eye in than men
10. Women feel more naked than men without their prosthesis in
11. Women feel more unattractive than men feel without their prosthesis in.

10.7 PROSTHESIS CONSTRUCTION METHODOLOGY

As stated, the point of commonality for the results of this research was a single ocularist consistently using a method parallel with the 'Custom PMMA Ocular Prosthetics Standard Operating Procedures' (**Appendix 14.1**). This method for construction is used by the American Society of Ocularists and is adopted and endorsed by the Ocularists Association of Australia. The specific method used by the author is detailed and depicted below, accompanied by matching numbering as listed in in the 'Custom PMMA Ocular Prosthetics Standard Operating Procedures', listed in **Appendix 14.1**.

II. Fitting Model Formation Process

1. The eye socket is examined for anatomical features - globe or implant position and irregularities in conjunctival tissue. Abnormalities which must be addressed are identified (e.g. Fistulas; implant exposure, inflammation (**Fig. 10.7-1**), infection). Tissue colour/health and thickness are observed and any signs of 'thinning' over the implant radius are noted and acted upon (**Fig 10.7-2**).

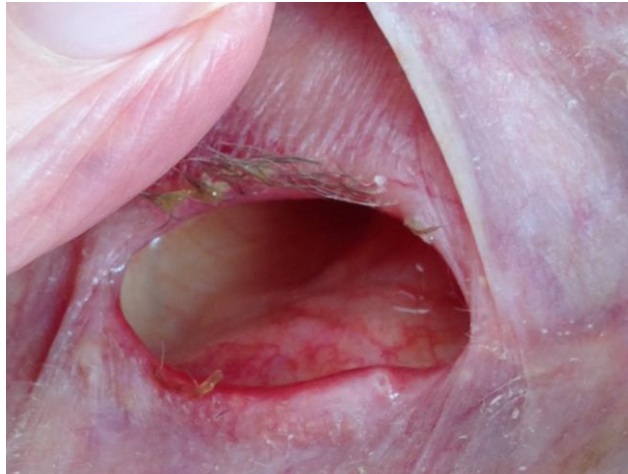


Fig. 10.7-1 Socket inspection and assessment – deeper cavity superiorly with moderate inflammation

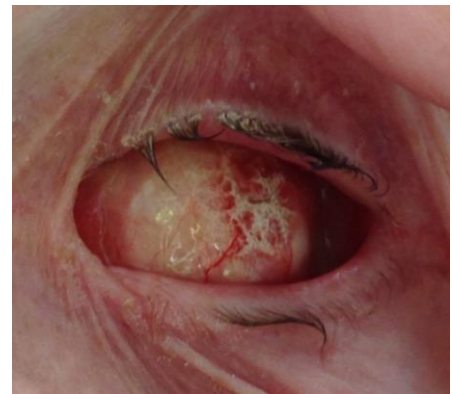


Fig. 10.7-2 Socket inspection and assessment – globe implant texture apparent through tissue indicating ocular implant exposure

2. An appropriate impression tray is selected and disinfected. Impression trays are made from PMMA. The tray or 'base shape' is chosen and/or modified, based on criteria of comfort, cosmesis, motility, and socket development (**Fig. 10.7-3**). Required volume and peripheral envelope is determined when selecting appropriate impression tray.

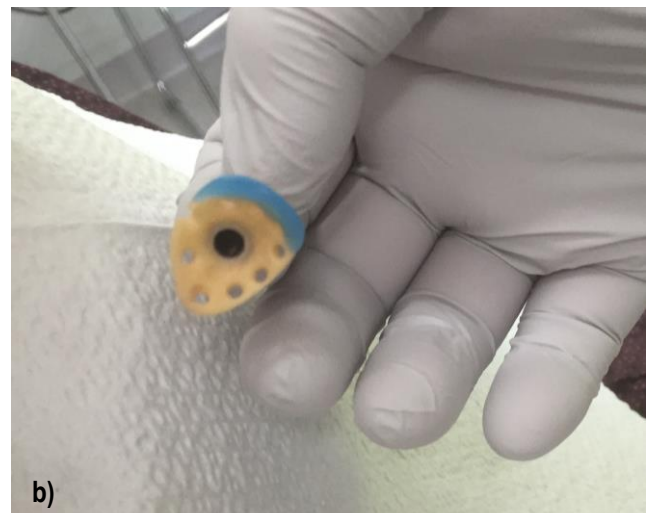


Fig. 10.7-3 a) Impression trays of varying shapes and sizes to choose from **b)** Modifying impression based on each individual patient requirements

3. Impression material is mixed in accordance with clinician's requirements (Fig 10.7-4). Tray is placed into socket and impression material is then introduced into the eye socket through the anterior conduit using a syringe (Fig. 10.7-5).



Fig. 10.7-4 Impression material is mixed appropriately



a)



b)

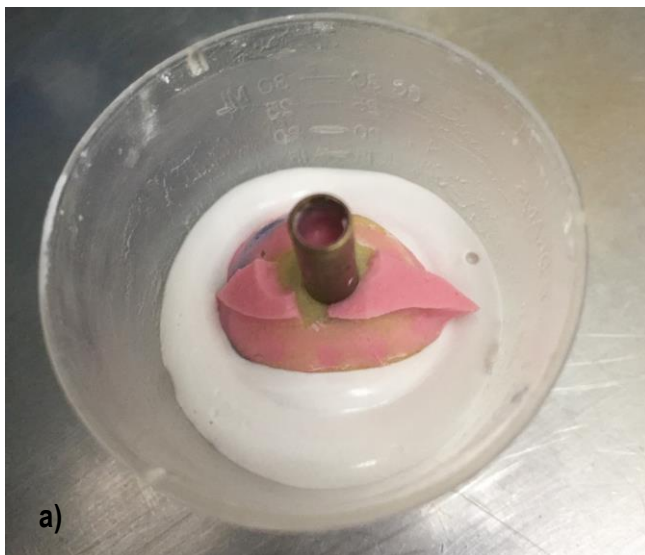
Fig. 10.7-5 a) Impression tray is placed in socket b) Syringe is used to infiltrate impression material into socket through anterior conduit

4. When the impression material has congealed or set, the tray and impression are removed.

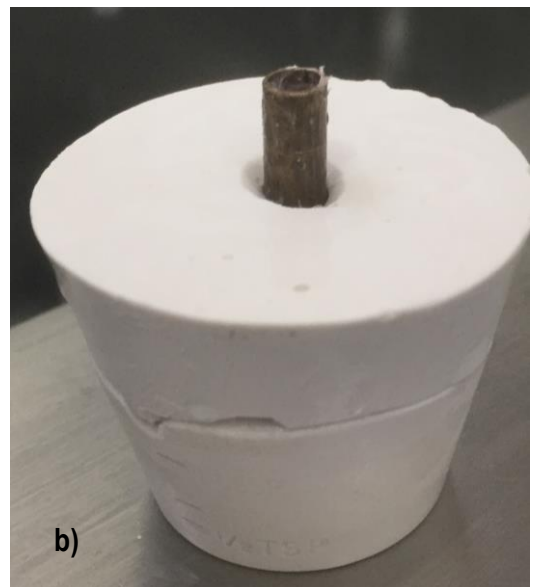


Fig. 10.7-6 Impression is removed from socket once congealed

5. The impression is then cast in a die-stone medium in preparation for replication (Fig 10.7-7). Heated dental inlay wax is then poured into the mould cavity, once the impression has been removed (Fig 10.7-8). (In this time where the author is waiting for die-stone to set, iris is constructed).



a)



b)

Fig. 10.7-7 a) Impression is invested to create a plaster mould b) plaster mould is topped



Fig. 10.7-8 Heated wax is poured into the mould cavity to create a prototype shape



Fig. 10.7-9 Pre-made iris inserted (*III. Iris Replication Process*)

6. Modifications of the impressed wax shaping are implemented determined by: patient comfort; the eye socket fornices; the eye socket irregularities and required volume replacement.
7. Anterior-posterior thickness and iris/pupil placement are determined as well as palpebral fissure symmetry, before the model is considered ready for investment in a mould and the fabrication process continued.

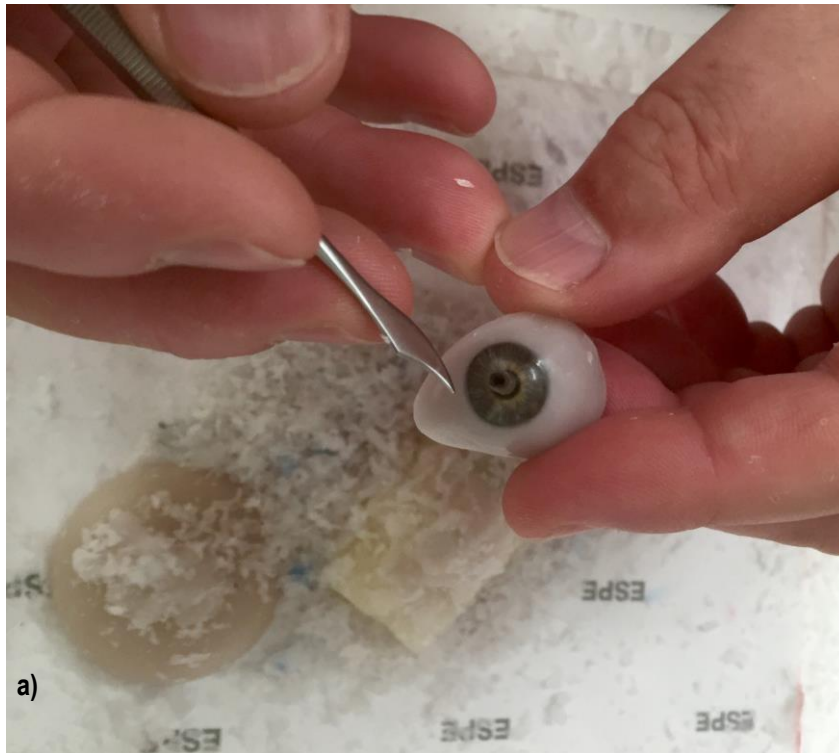


Fig. 10.7-10 a) Prototype wax shape is modified **b)** and tried in according to specific patient requirements for best fit/comfort, including assessment of iris positioning

III. Iris Replication Process

1. Patients natural iris and pupil are measured for correct iris size, taking into account pupil dilation and constriction in different light sources as a guide for the prosthetic match.



Fig. 10.7-11 Patients iris and pupil are assessed for best size – taking into account the element of magnification that occurs in the process of making the eye

2. The iris is painted using dry pigments dissolved in methylmethacrylate monomer on the posterior side of a flat or slightly concave CCPIP (**Appendix 14.1**), and then sealed.

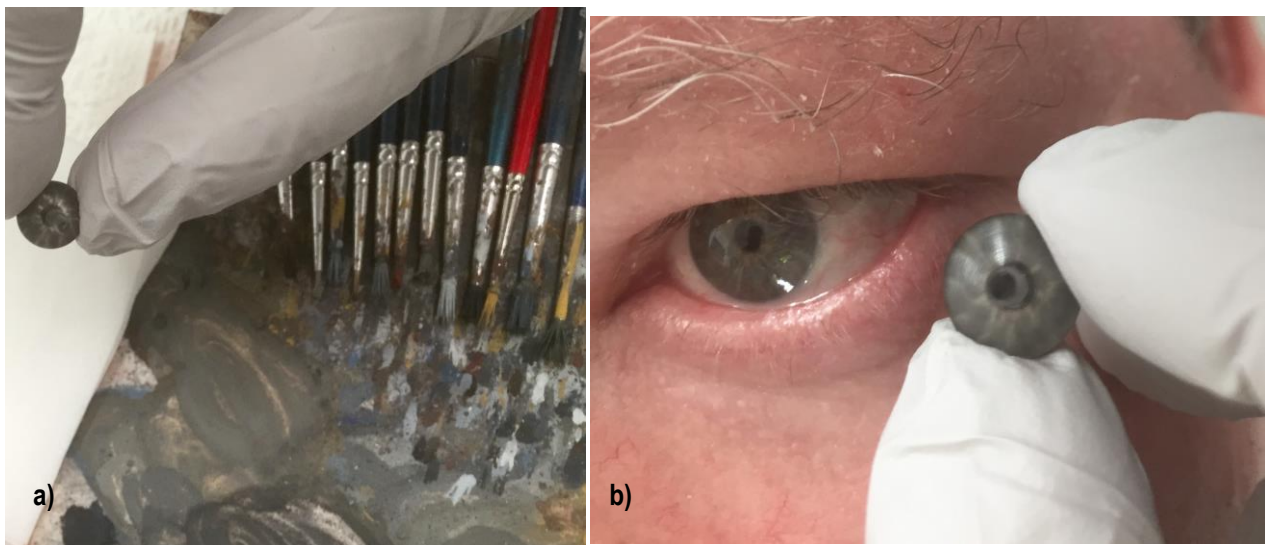


Fig. 10.7-12 a) Iris is painted on the back of a corneal unit with pigment paints **b)** to match the natural eye



Fig. 10.7-13 Iris is sealed with methymethacrylate to the CCPIP, with boiling water to aid fast setting

IV. Fabrication Process

1. A two-part mould is made of the prototype ocular prosthesis using dental white die-stone investment medium within a suitable flask, depending on the type of heating source used to cure the PMMA (Fig 10.7-14).



Fig. 10.7-14 The bottom of a two-part mould is made from the wax shape prototype in a flask from dental plaster



Fig. 10.7-15 A separating medium is applied before filling the top of the two-part mould and joining them

2. When both sections of the mould are hard, they are heated in near boiling water to soften the wax prototype. The flask is opened and the prototype model is removed, by pouring near boiling water to eliminate all wax debris (**Fig 10.7-16**).
3. The CCPIP used is checked to be in its predetermined location in the anterior section of the mould.
4. The mould is cleaned using a detergent agent, inspected and a separating solution is applied to each side of the mould (**Fig 10.7-15; 16**).

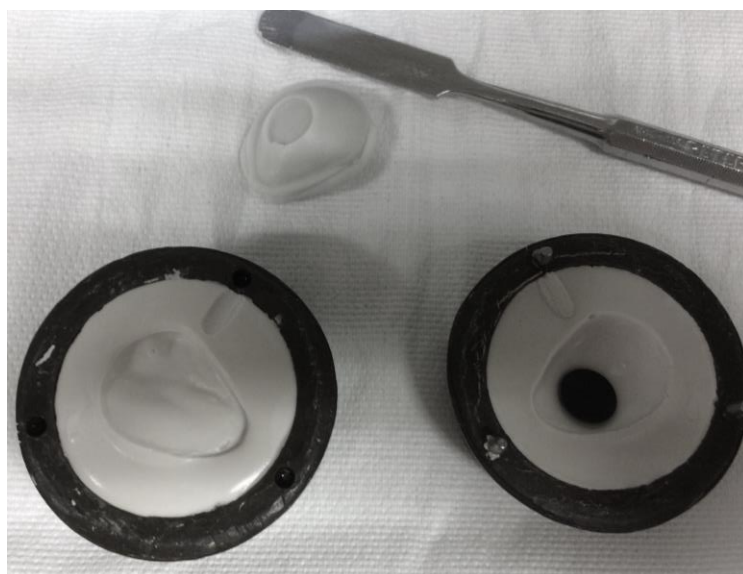


Fig. 10.7-16 The two-part mould is opened and wax prototype removed with boiling water – leaving the iris disc in place anteriorly. Markers in the plaster indicate matching points

5. Scleral toned PMMA regular curing polymer and monomer are mixed together in a suitable container, at the ratio specified by manufacturer.
6. The scleral-toned mixture is allowed to gel until it reaches an appropriate 'packable' consistency (i.e. does not stick to the hand).



Fig. 10.7-17 Scleral toned PMMA powder and monomer are mixed and left till a consistency of a gentle 'snap' is reached

7. The scleral toned mixture is packed into the anterior mould section to overflow and the posterior section is positioned to it, placed into a press, closed and tightened, using a hydraulic press.



Fig. 10.7-18 Gelled PMMA mixture is then packed into two-part mould flask. Hydraulic press is used to ensure the mixture has flowed into any small crevice and removes any excess

8. The packed eye flask is transferred to a spring clamp and the entire unit is then placed in a water bath and processed. Manufacturer's directions and curing times are always adhered to.



Fig. 10.7-19 Flask is inserted into heating water bath to be processed in accordance with processing times for this equipment

9. The packed and cured flask is released from press; the mould sections separated and prosthesis removed from the mould. The excess flashing ground away, iris exposed to proper diameter (if CCPIP is used), and scleral area is trimmed to allow for 'corneal acrylic' layer, veins, stains and other characterisation. Corneal / scleral junction is established, 0.5mm facial to greatest surface of peripheral convexity.

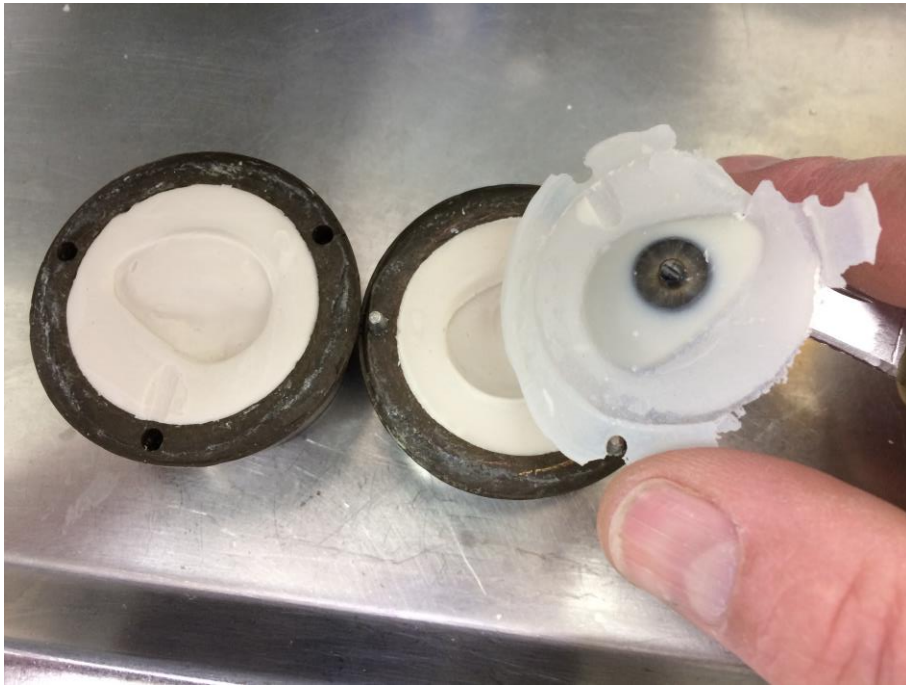


Fig. 10.7-20 Mould is released, eye is trimmed and polished

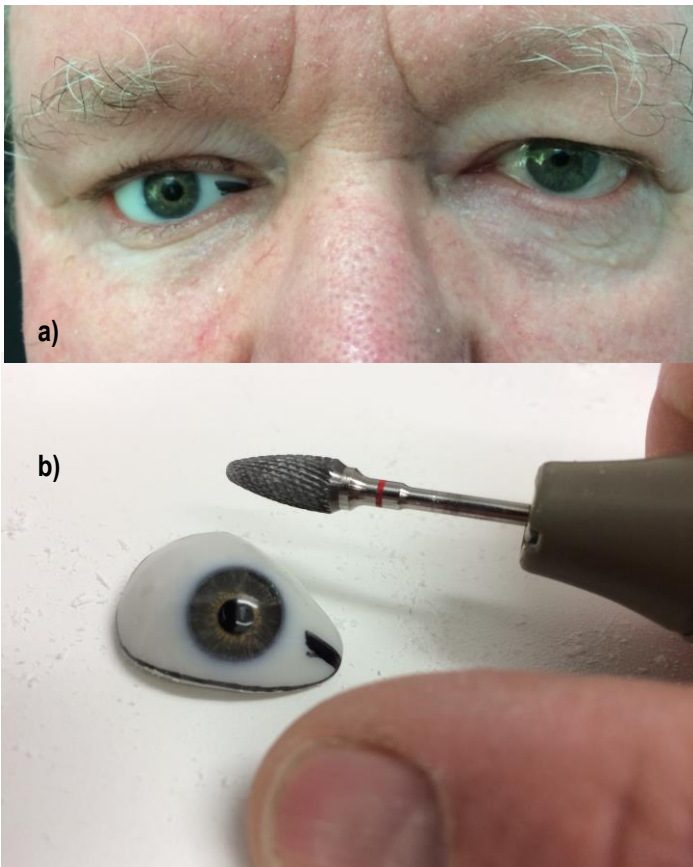


Fig. 10.7-21 a) Eye is tried into socket and assessed for fit and accuracy – then medial canthus marked
b) Scleral acrylic is trimmed back to expose the iris and allow for scleral veins stains and characterisation to be added. Corneal/scleral junction is trimmed 0.5mm of the greatest surface of facial radius/convexity

10. Iris features are enhanced, limbus 'softened', along with the scleral tones and veins. Veining material used is silk cotton of matching colours.



Fig. 10.7-22 Iris tones and limbus are added, and then scleral tones and veins of cotton are applied

11. The characterisation of the prosthesis is then allowed to dry. The mould is again inspected, repaired, cleaned of any debris and a separating medium is applied to both sections (**10.7-16**).
12. The prosthesis is positioned into the posterior section of the mould. Clear PMMA powder and monomer are mixed according to manufacturers specifications as in steps 5 and 6 (**Fig. 10.7-17**). The mixture is then placed on the anterior surface, the mould sections interfaced and closed in the press (**Fig. 10.7-18**).



Fig. 10.7-23 Prosthesis is positioned into the posterior of the mould

13. The flask is transferred to a spring clamp and the entire unit is placed into the curing unit and processed in the same manner as described in step 7 (**Fig. 10.7-19**).
14. The prosthesis is removed from the mould (**10.7-24**). Flashing and surface irregularities are trimmed away. It is first polished with gradually finer gradients of pumice polishing materials. Final dry high gloss is applied after inspection of all surfaces is complete (**10.7-25**). It is ensured that no visible defects are seen when examined with a loupe. The prosthesis is now ready for disinfection and delivery to the patient (**Fig. 10.7-26;27**). Minor surface reductions may be made during the delivery process, with subsequent repolishing of all surfaces, before final delivery of the prosthesis.



Fig. 10.7-24 Prosthesis is removed from the mould

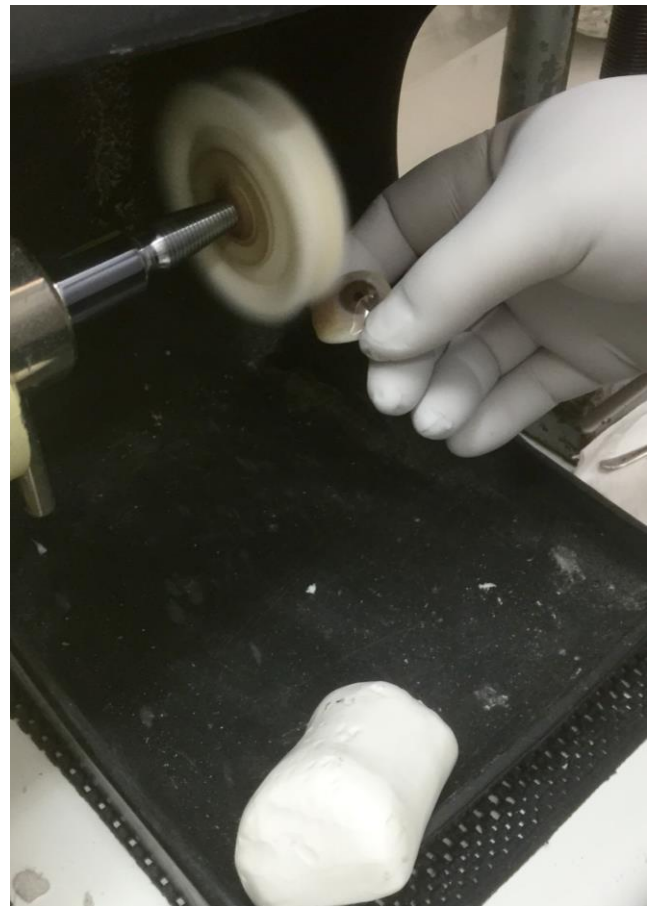


Fig. 10.7-25 Prosthesis is finally polished with dry high gloss



Fig. 10.7-26 Prosthesis is cleaned and sanitized



Fig. 10.7-27 Prosthesis delivery and insertion



Fig. 10.7-28 Patient wearing newly inserted right prosthesis

V. Materials

Type of product:	Dry pigments
PMMA Powder, white or tinted	Liquid separating agent
PMMA Powder, clear	Dental wax polish
MMA monomer	Dry final polish
Composite cornea-pupil-iris piece (button)	Alginate
PMMA iris discs/button (flat or curved)	Wax
Vinyl or acrylic iris discs	Die-stone plaster
PMMA monomer-polymer syrup	Pumice
Veining fibre- cotton	Disinfecting materials/compounds
Oil pigments	Contact lens wetting solution

11. RESULTS

Seventy-one patients were included in this study, although not all patients answered all of the questions.

Where there is incomplete information (with less than 71 patients answering), this is stated.

All patients completed the questionnaire during the process of having a new ocular prosthesis made for them. The new prostheses were all made from the same materials, and were made using a standardized process. The same ocularist provided all the prostheses.

At the time of study all participants were requiring a new prosthesis, or were already in the process of having a new prosthesis made.

11.1 GENERAL RESULTS

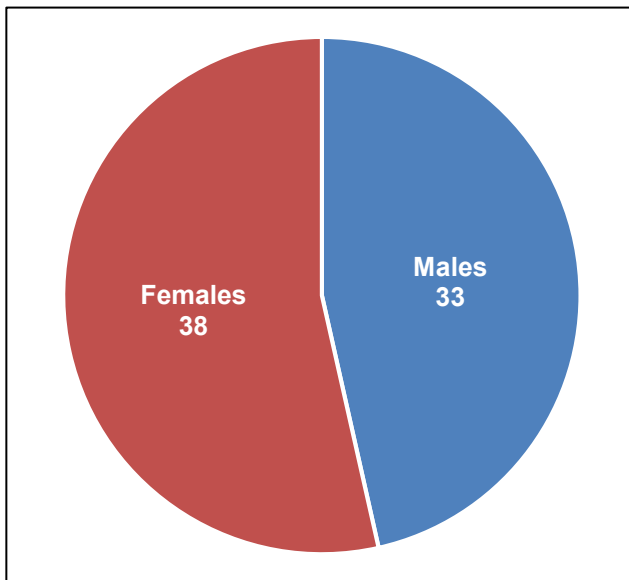


Table 11.1-1 Gender distribution of participants

There were 33 males (46.5%) and 38 females (53.5%) (**Table 11.1-1**) with most of the participants married/defacto, 52 (73%) and the remaining 27% described themselves as single, including unmarried or widowed (**Table 11.1-2**).

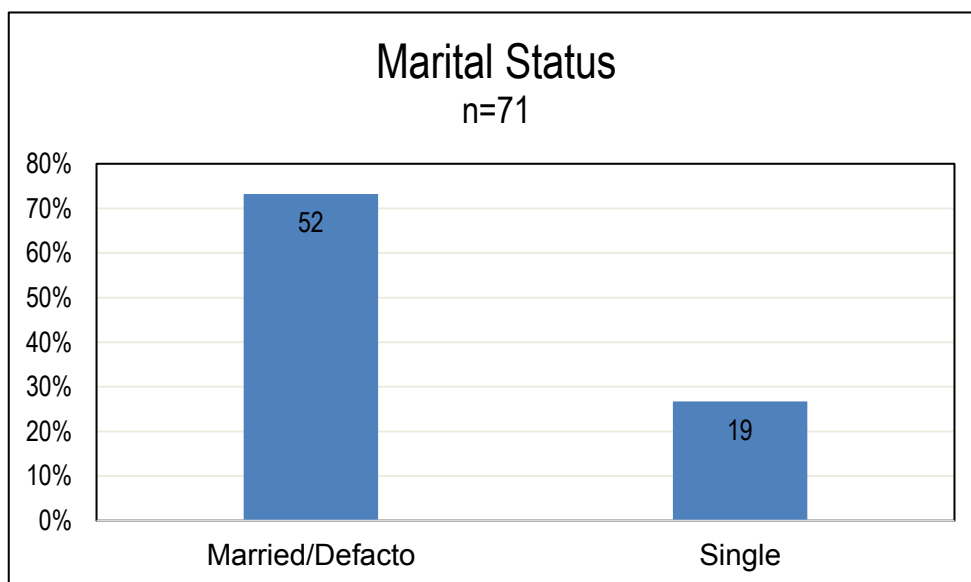


Table 11.1-2 Marital status of participants

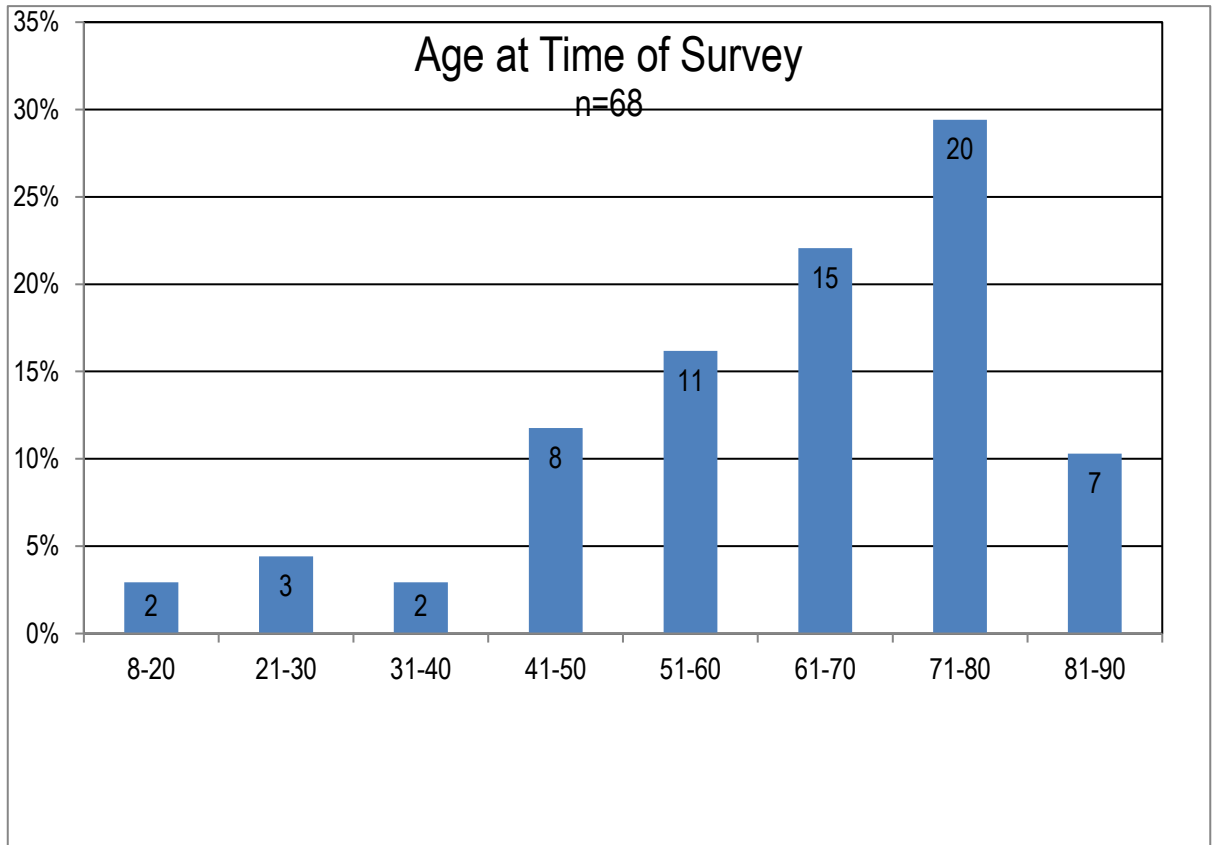


Table 11.1-3 Age groups of participants at time of survey

The largest group participating in the study was the 71-80-year-old bracket which made up 20 (29%) of the 68 who stated their age. The next largest group was the 61-70 year olds who made up 15 (22%). The 51-60-year-old age group made up 11 (16%), and 8 (12%) were in the 41-50 year old bracket. A total of 7 (10%) participants were between 81-90, and the remaining 7 (10%) participants were spread between 8 and 40 (**Table 11.1-3**).

At the time of the study, all participants were receiving care from a single Ocularist via either the private or public system. Those referred publicly received their prostheses at no personal cost, whilst those who were seen privately were required to cover the complete cost of their prosthesis – with few receiving assistance from private health cover. Those eligible for Public treatment is as defined by the SA Department of Health, usually relating to age, pensioner or employments status with no cost incurred. Those not eligible, or through personal choice were treated privately, where they are either fully self-funded or partially funded by private health insurer as part of extra’s cover or other insurance providers e.g. Work Cover.

Public referrals amounted to 29 of the 71 (40.8%) and Private referrals made up 42 of respondents (59.2%). (Table 11.1-4).

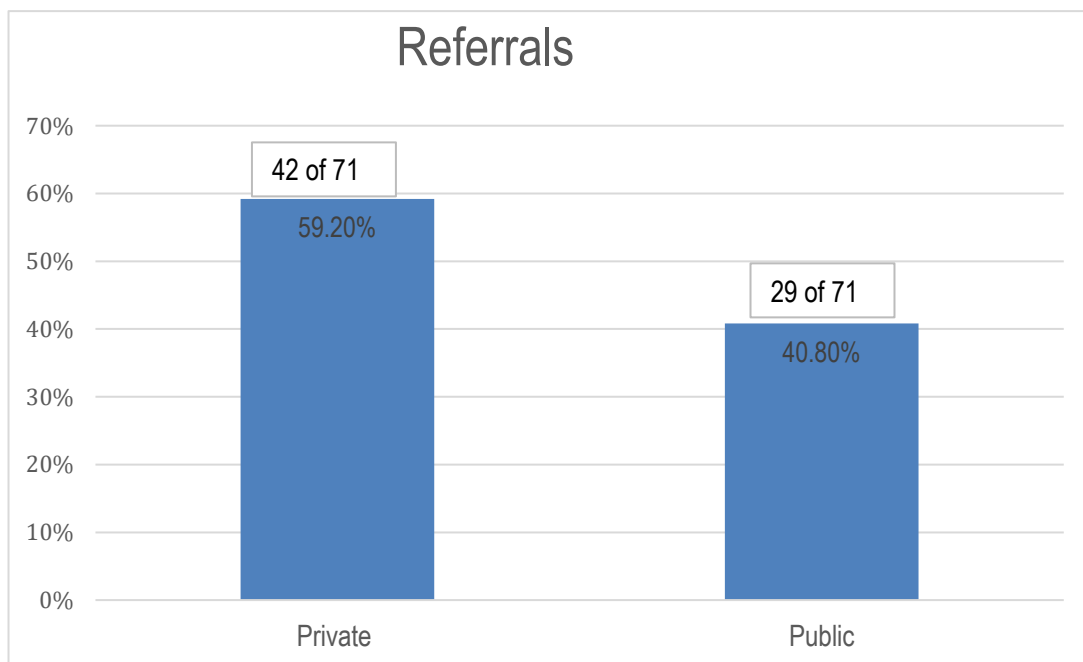


Table 11.1-4 Referral source for participants

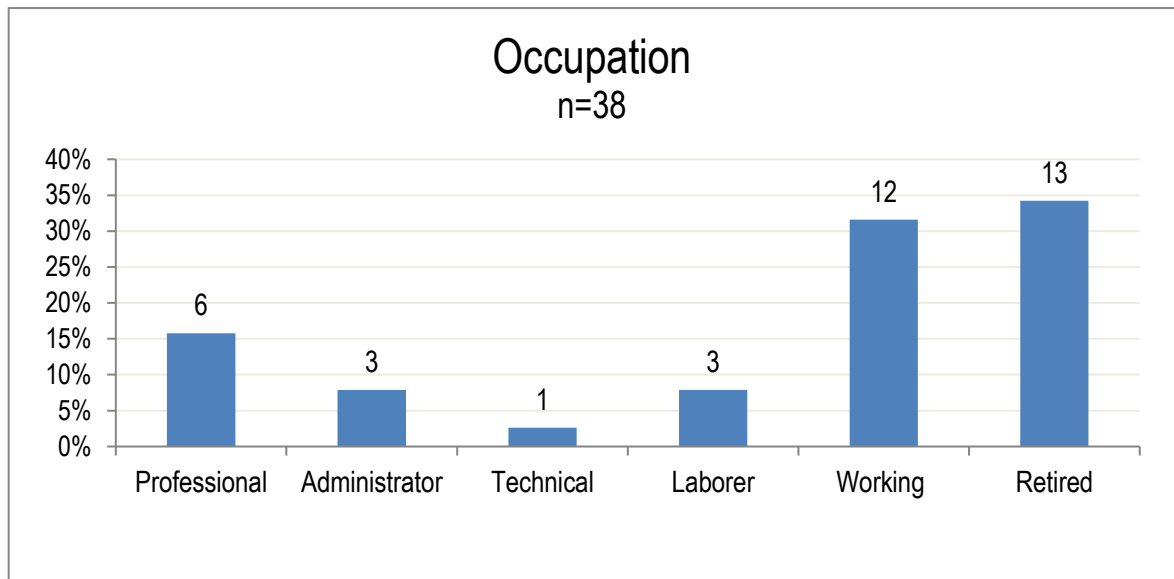


Table 11.1-5 Occupation groups of patients

Of the 38 respondents to the question regarding their occupation, 6 (15.8%) worked as a professional in their field, 3 (7.9%) worked in administration, 1 (2.6%) worked in a technical role, 3 (7.9%) worked as labourers, 12 (31.6%) selected 'Working' occupation, and 13 (34.2%) were retired (Table 11.1-5).

							Not Stated	TOTAL
GENDER	Male	Female					0	71
	33 (46.5%)	38 (53.5%)						
MARITAL STATUS	Married/DeFacto	Divorced	Single	Separated	Widowed		2	69
	52 (73%)	2	6	1	8			
OCCUPATION	Professional	Administrator	Technical	Laborer	Working	Retired	33	38
	6	3	1	3	12	13		
REFERRAL	Private	Public					9	62
	42 (59.2%)	29 (40.8%)						

Table 11.1-6 Full demographic data of all participants

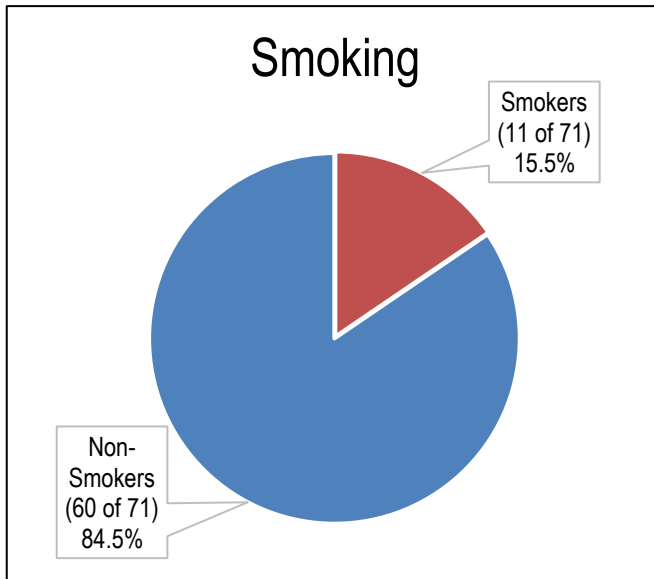


Table 11.1-7 Participant smoking status

Eleven were current **smokers** (15.5%) and 60 were not (84.5%) (**Table 11.1-7**).

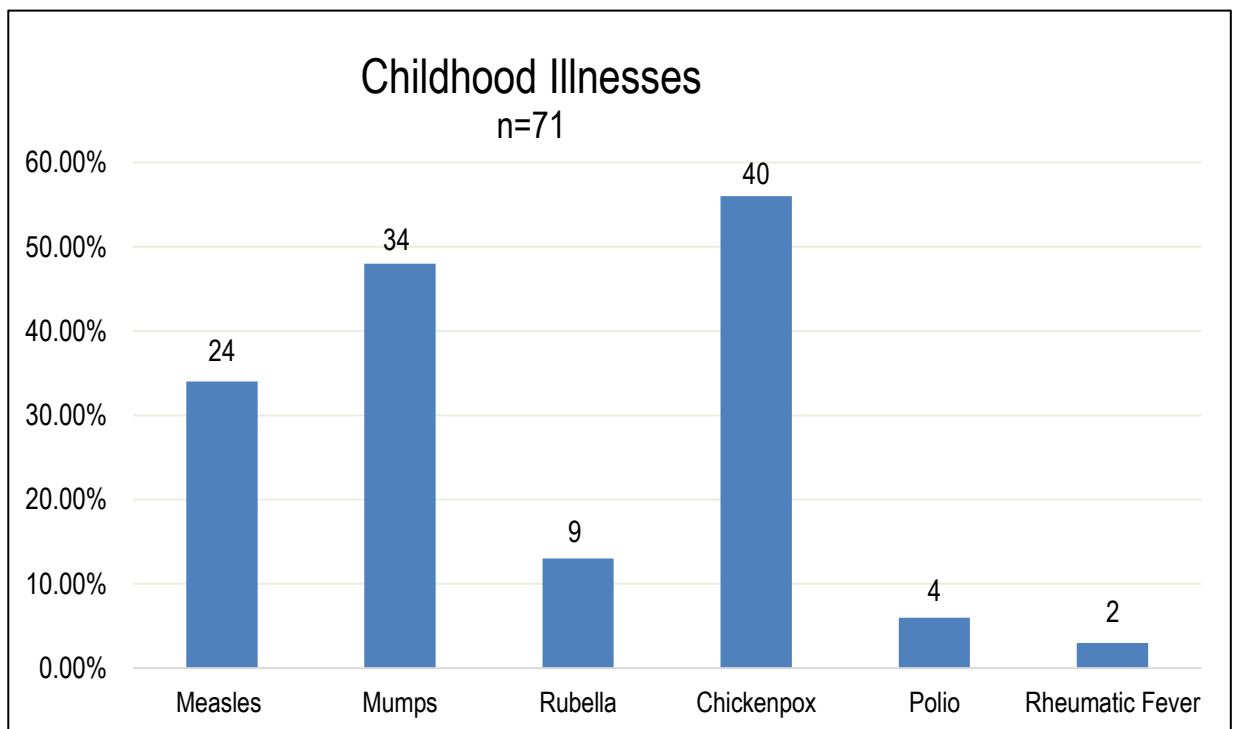


Table 11.1-8 History of Childhood Illness Experienced

Of the participants, 40 (56.3%) of the respondents contracted chickenpox as a child, 34 with mumps (47.9%). 24 (33.8%) suffered from measles, 9 (12.7%) had rubella, 4 polio (5.6%), and 2 (2.8%) rheumatic fever (**Table 11.1-8**).

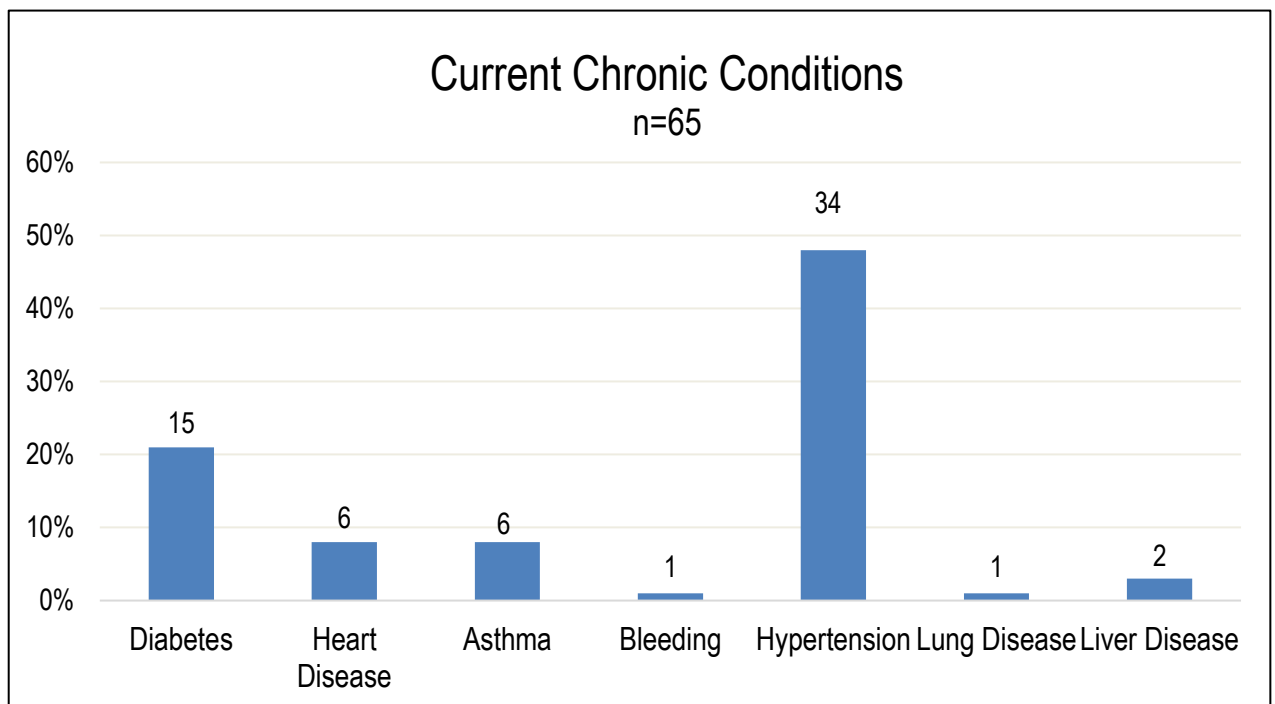


Table 11.1-9 Current chronic conditions suffered by participants

A total of 65 (91.5%) of the 71 participants suffered chronic health conditions (**Table 11.1-9**). A total of 34 (52.3%) experience ongoing chronic hypertension. 15 (23.1%) suffer from diabetes, 6 (9.2%) suffer from asthma, 6 (9.2%) suffer heart disease, 2 (3.1%) suffer from liver disease, 1 (1.5%) suffers from chronic bleeding disorders, and lung disease respectively.

<i>Table 2.</i>									<i>TOTAL WITH</i>
GENERAL MEDICAL	<i>Hospitalized</i> 67 (94.3%)	<i>Smoker</i> 11 (15.5%)							
CHRONIC ILLNESS	<i>Diabetes</i> 15	<i>Heart Disease</i> 6	<i>Asthma</i> 6	<i>Kidney Problems</i> 7	<i>Hypertension</i> 34	<i>Lung Disease</i> 1	<i>Liver Disease</i> 2	<i>Bleeding Disorders</i> 1	ANY CHRONIC ILLNESS 66 (92.9%)
CHILDHOOD ILLNESS	<i>Measles</i> 24	<i>Rubella</i> 9	<i>Rheumatic Fever</i> 2	<i>Mumps</i> 34	<i>Chickenpox</i> 40	<i>Polio</i> 4			ANY CHILDHOOD ILLNESS 53 (74.6%)
VACCINATIONS	<i>Tetanus</i> 43	<i>Hepatitis</i> 16	<i>Influenza</i> 37	<i>Pneumonia</i> 17	<i>Chickenpox</i> 15	<i>MMR</i> 19			ANY VACCINATIONS 55 (77.5%)

Table 7.1-10 Overview of general health related data of participants

Sixty-seven stated they had a history of **hospitalization** (94.3%) with 92.9% suffering **chronic illnesses**.

Three quarters (53 of 71) had **childhood illness** (74.6%)

Of the group, those **vaccinated** made up 55 of the 71 (77.5%).

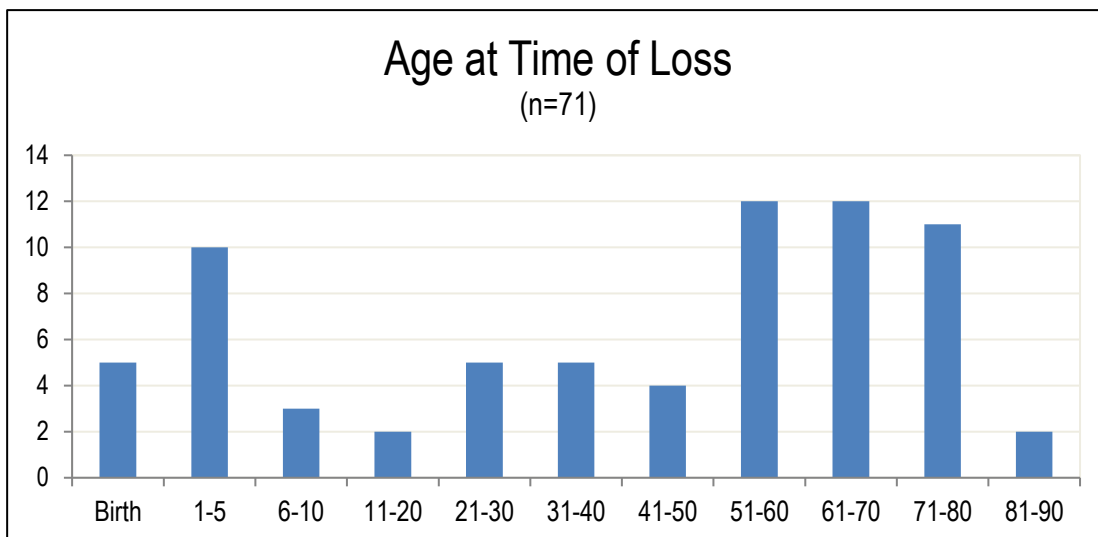


Table 11.1- 11 Age of participant at time of eye loss

The average age at time of eye loss was 43.1 years, with a wide range of age from 10 weeks to 87 years (**Table 11.1-11**).

The majority of eye loss occurs within the first ten years of life, with 18 participants (25.4%), and a spike in eye loss after fifty years making up 38 of the 71 cases (53.5%). Twelve of the 71 cases occurred between the age of 51-60 (16.9%); with the same number of cases (12) between the age of 61-70. Eleven of the 71 cases (15.5%) of eye loss occurred between the ages of 71-80; and the remaining 2 cases occurred after the age of 81.

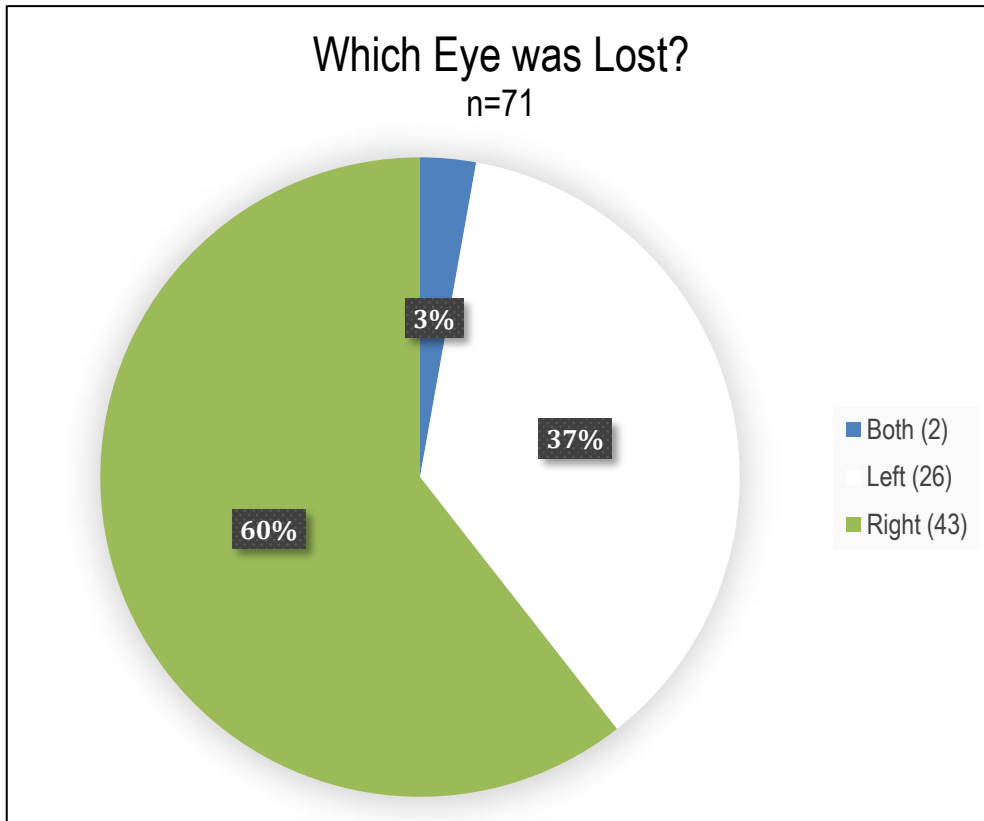


Table 11.1-12 Specific eye that participant lost

Of the participants, 43 (60%) had lost their right eye, whilst 26 (37%) had lost their left, 2 of the patients (3%) had lost both eyes (**Table 11.1-12**).

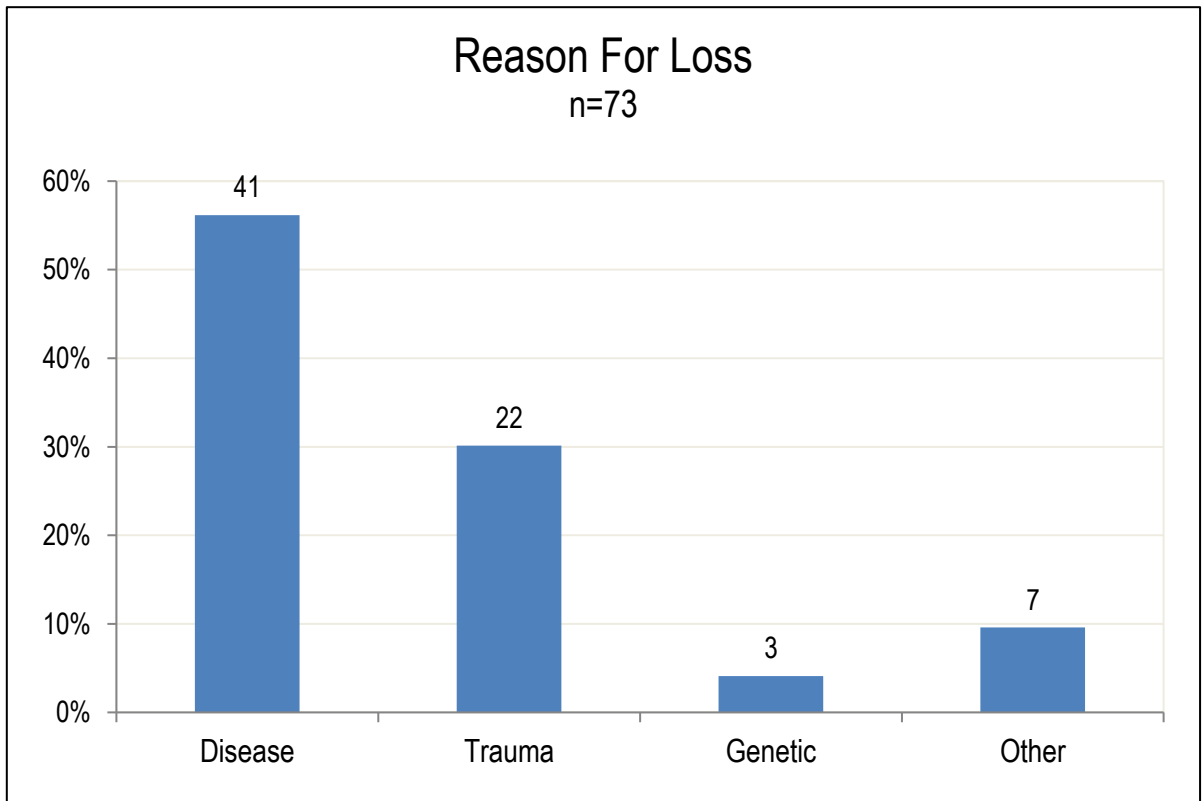


Table 11.1-13 Reason for participant eye loss

The number of eyes lost total 73, this is due to 2 of the respondents having lost both eyes (**Table 11.1-13**).

The most prevalent cause of eye loss amongst this group is disease, making up 41 (56.2%), followed by 22 from trauma (30.1%). Genetic reasons account for 2 of the cases (4.1%). Seven (9.6%) listed 'other' reasons, such as medical misadventure, or iatrogenic.

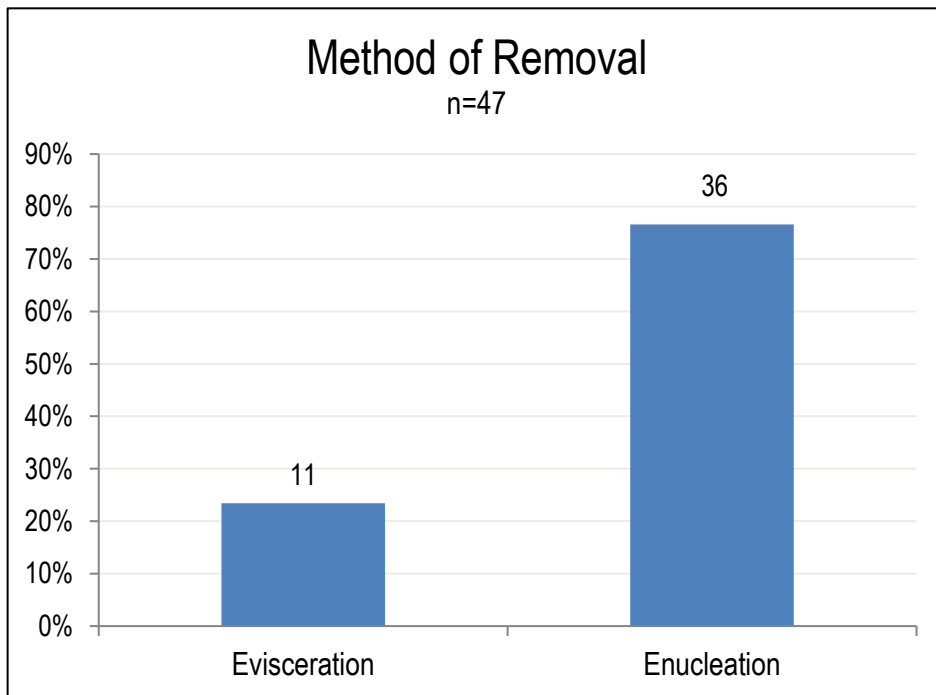


Table 11.1-14 Eye removal method

Only 47 of the 71 (66%) answered this question. It is possible that some patients did not understand the question, or know the answer, therefore did not answer (**Table 11.1-14**). Of those who answered, 36 (76.6%) had their natural eye enucleated, whilst 11 (23.4%) had their natural eye eviscerated.

The majority (58.5%) of the sockets are pink/healthy this number accounts for 31 of the 53 who answered this question (Table 11.1-15; Fig. 11.1-2). A total of 16 (30.2%) had red/irritated sockets (Fig. 11.1-1), and a group of 6 (11.3%) had a white/scarred socket (Fig. 11.1-3).

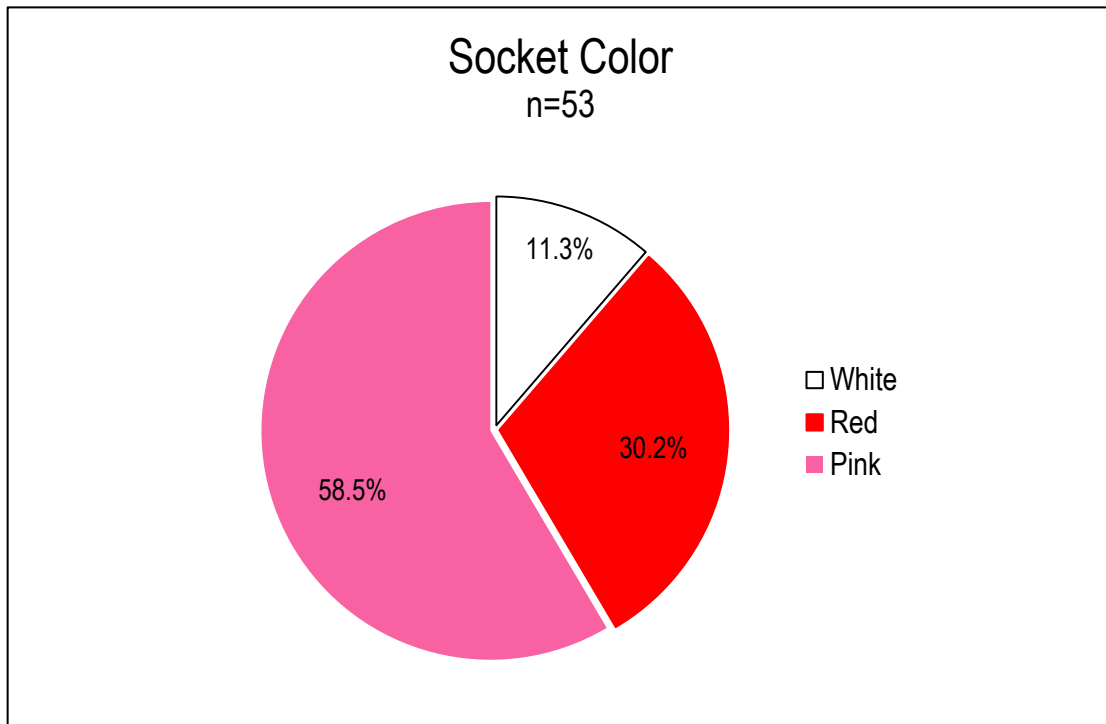


Table 11.1-15 Varying socket colours of participants



Fig. 11.1-1 Red socket example from **Table 11.1-13** (Knowles PT, 2016a)



Fig. 11.1-2 Pink socket example from **Table 11.1-13** (Knowles P, 2016b)



Fig. 11.1-3 White socket example from Table 11.1-13 (Knowles P, 2016c)

11.2 PSYCHOLOGICAL RESULTS: EMOTIONS AT TIME OF LOSS VAS SCORE RESULTS

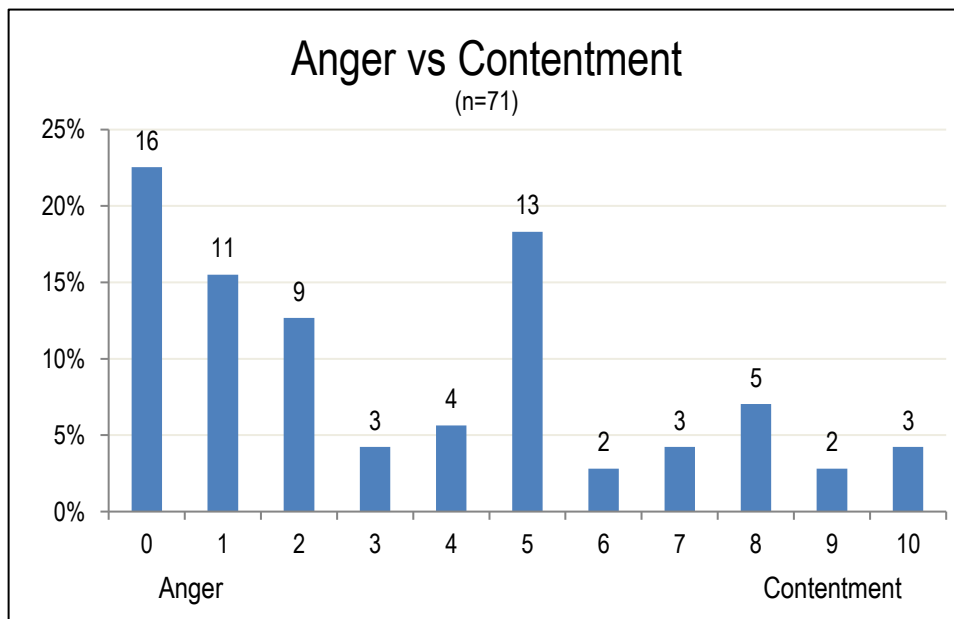


Table 11.2-1 Comparative feelings of patients at time of eye loss: anger vs contentment VAS score

Just over half of applicants 36 (50.7%) experienced extreme feelings of anger (0-2) whilst 13 (18.3%) were ambivalent, possibly due to their young age at the time of loss (Table 11.2-1).

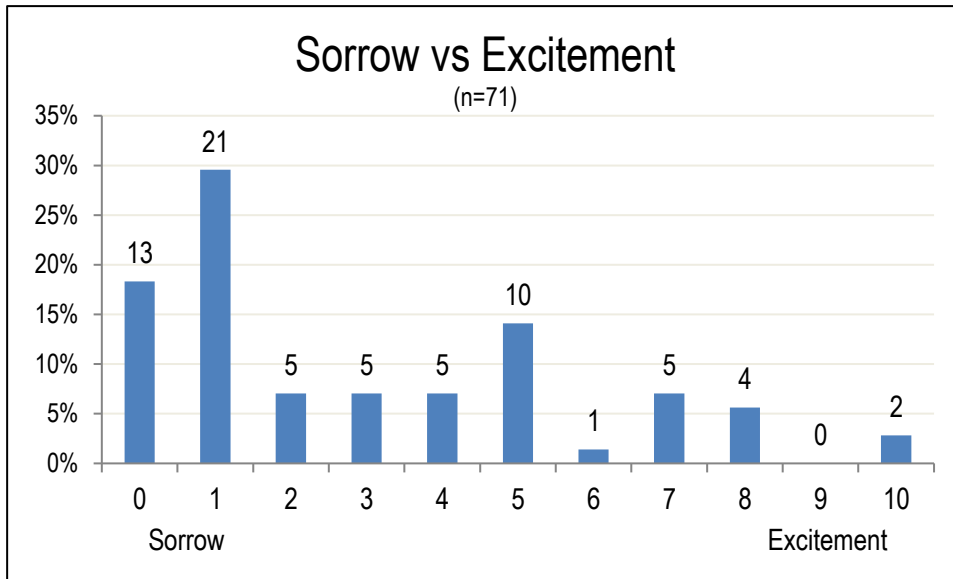


Table 11.2-2 Comparative feelings of patients at time of eye loss: sorrow vs excitement VAS score

Thirty-nine participants (54.9%) experienced extreme sorrow with 10 (14%) do not recall, or did not experience an emotion either way (**Table 11.2-2**).

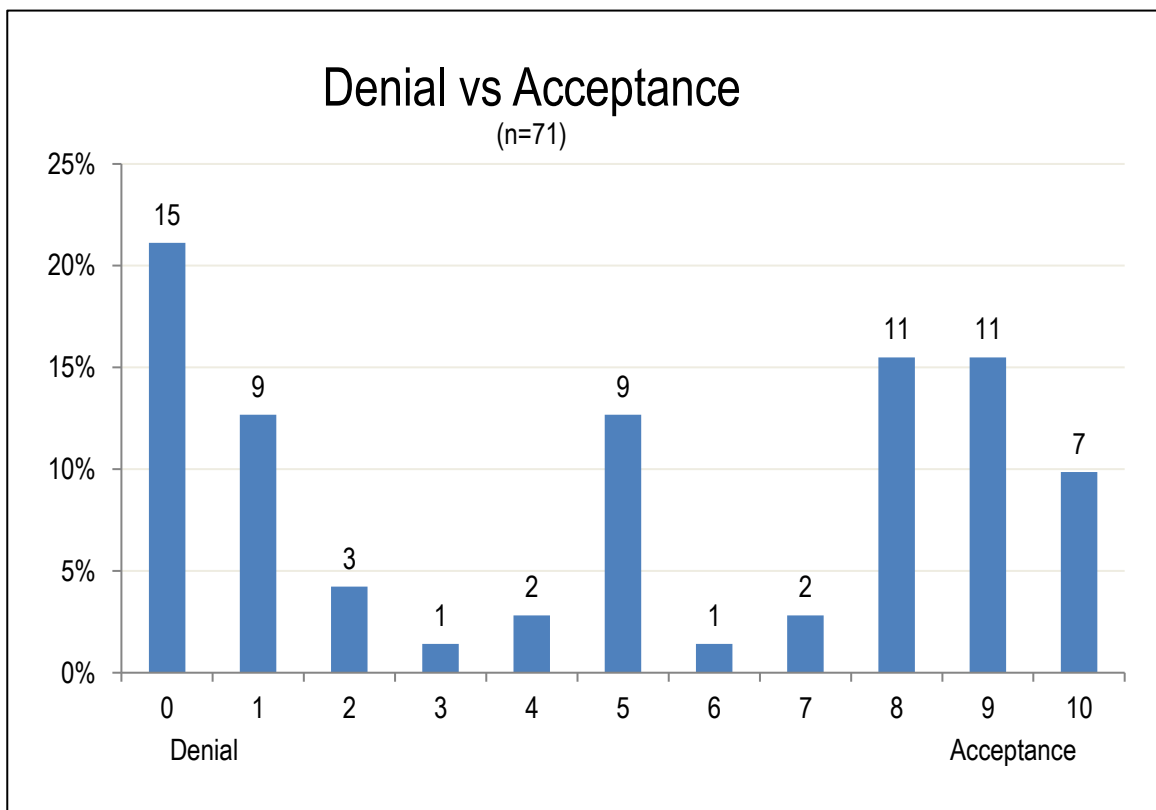


Table 11.2-3 Comparative feelings of patients at time of eye loss: denial vs acceptance VAS score

Twenty-seven of the participants (38%) report experiencing extreme denial, whilst 29 (40.8%) reported feeling a very high level of acceptance (**Table 11.2-3**). A similar number (9 participants or 12.7%) again reported either not recalling their emotions, or not feeling an emotion strongly either way.

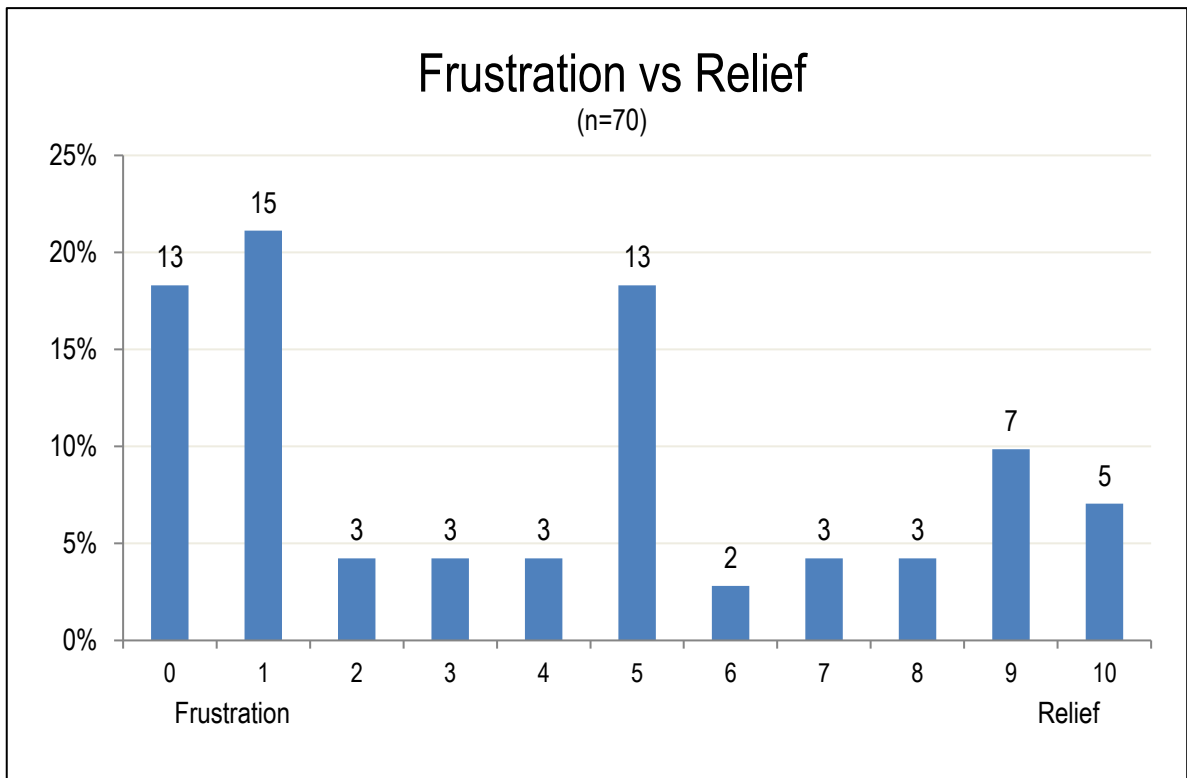


Table 11.2-4 Comparative feelings of patients at time of eye loss: frustration vs relief VAS score

Of the participants, 31 (44.3%) reported feeling extreme frustration, whilst only 15 (21.4%) experienced a high level of relief, a similar number of 13 participants (18.6%) reported feeling neither emotion strongly (Table 11.2-4).

11.3 PERIOD BETWEEN EYE LOSS AND FIRST PROSTHESIS CARE PROCESS

The majority (60 participants – 85.9%) did not feel their care process could have been any better as only 11 (14.1%) desired better care (Table 11.3-1). Of the participants, 21 (29.6%) would have liked better education regarding the process, and 29 (40.8%) would have liked access to communicate with others who had also experienced loss of an eye. Some 15 of the participants (21.1%) thought counselling could have improved their experience, with another 16 (22.5%) saying that a support group could have helped.

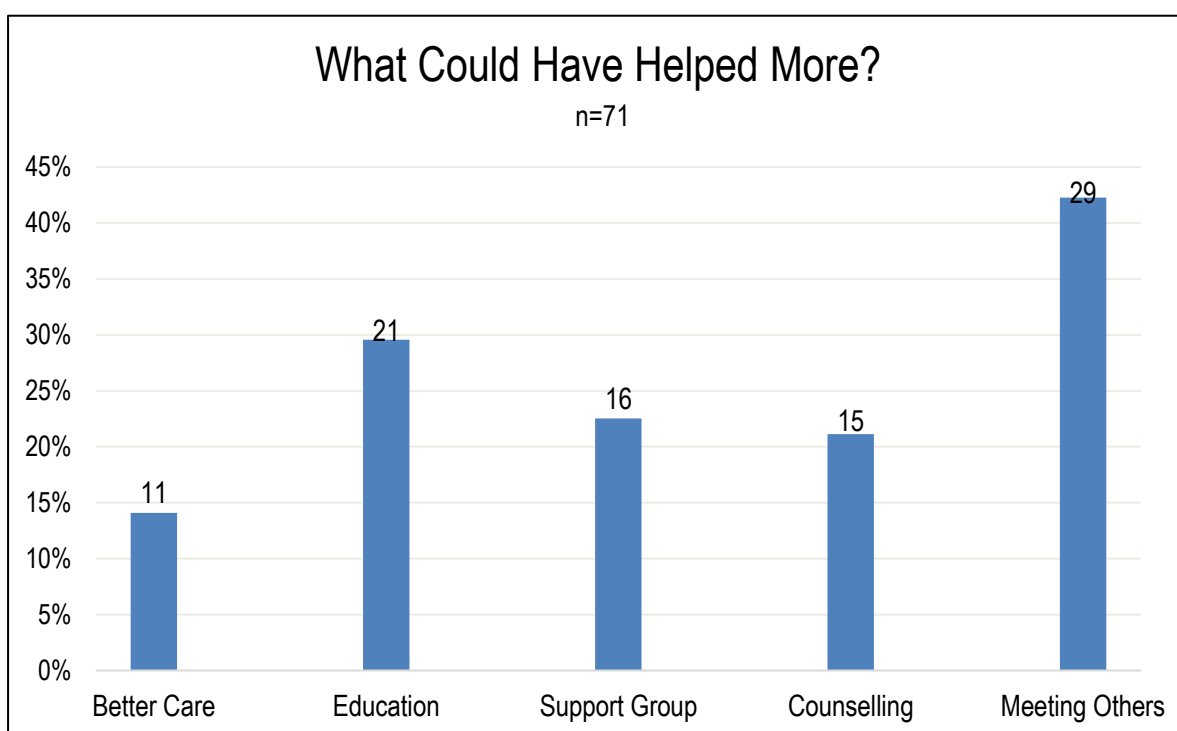


Table 11.3-1 Various options that participants viewed as possible improvements VAS score

Regarding initial eye loss, the majority of patients would have liked more time to come to terms with losing their eye (Table 11.3-2). For 10% more or less time would not have had an impact, and another 10% would have liked less time to have thought about their eye loss.

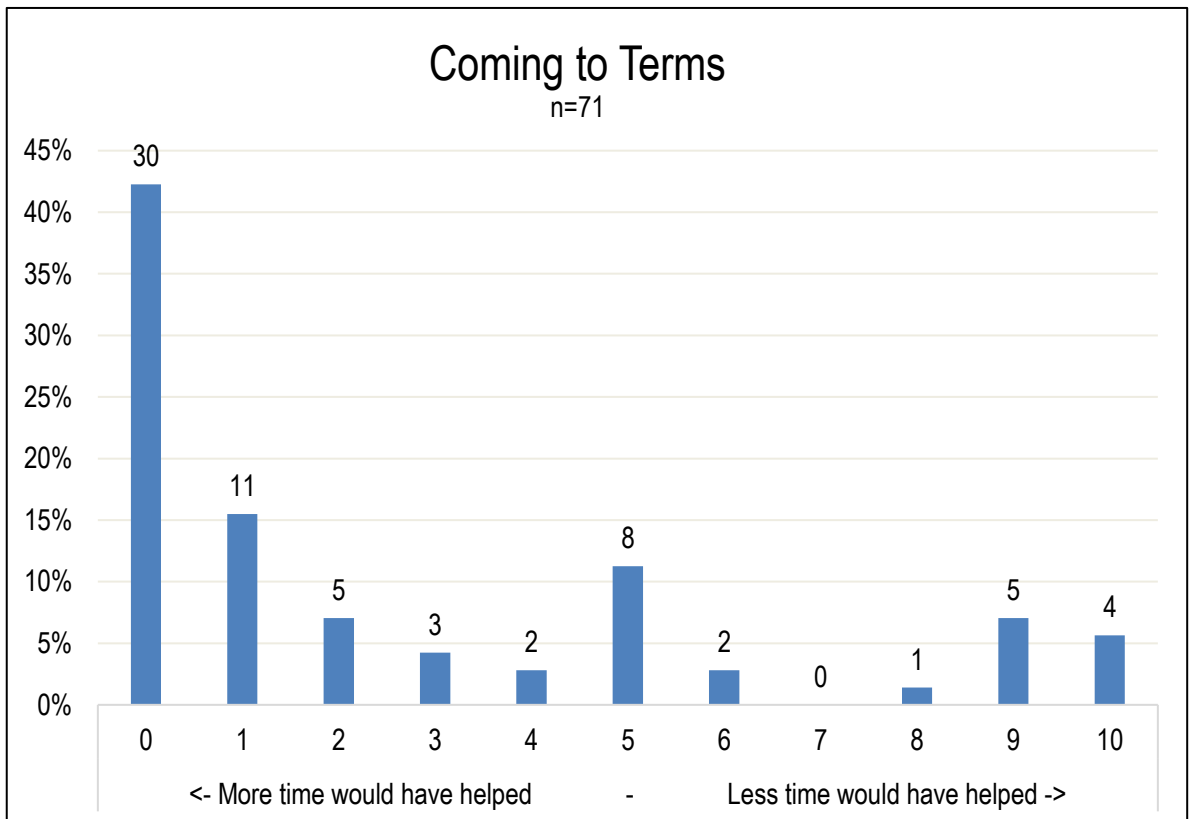


Table 11.3-2 Participants opinion on more time or less time impacting on coming to terms with their loss VAS score

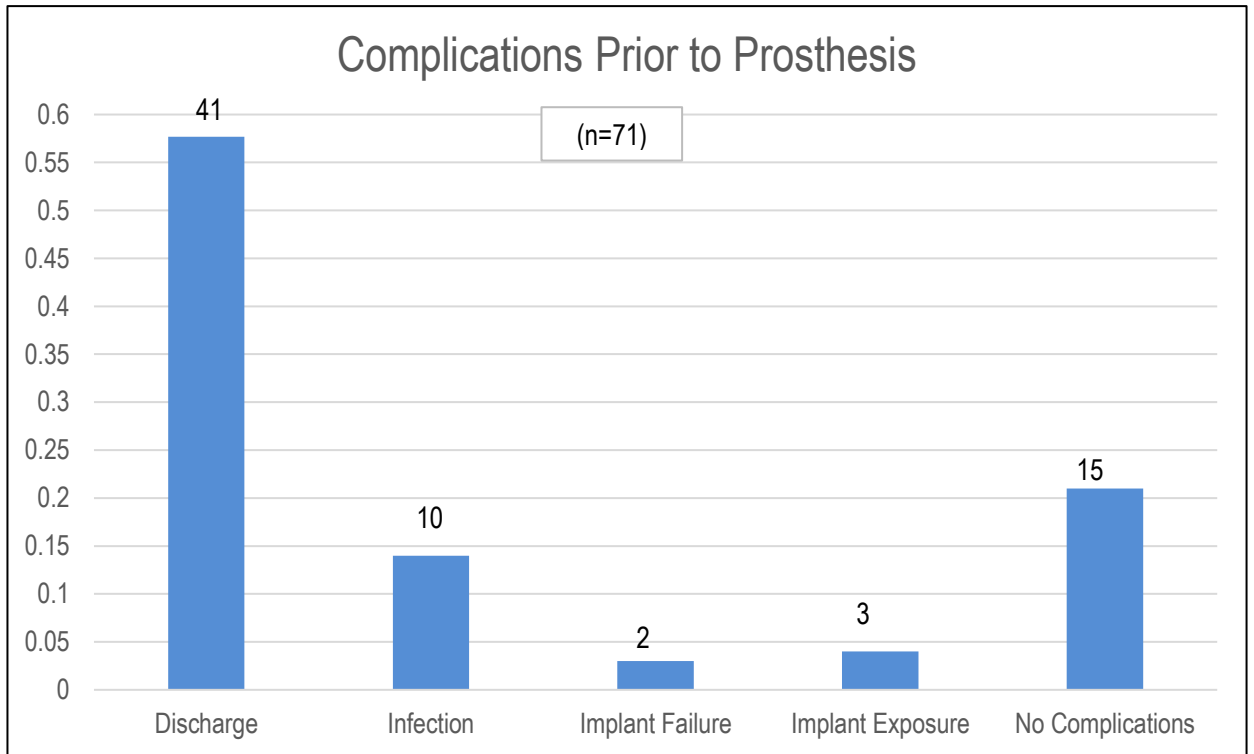


Table 11.3-3 Any complications experienced by participants prior to receiving their prosthesis

Fifteen (21.1%) reported no complications, 41 (57.7%) of the patients reported having discharge from the socket prior to their first prosthesis.

Of the group reporting complications, 14% (10 patients) suffered infection, 3% (2 patients) implant failure, and 4% (3 patients) implant exposure.

The complications consisted mainly of infection. All patients whose implants ended in failure or exposure, also suffered from infection.

Over half (41 or 57.7%) of all patients surveyed reported having discharge from their socket post eye removal, and before receiving a prosthesis (Table 11.3-4). When asked the amount of discharge, some reported different quantities at different times of the day – for this reason the sum of results totalled 46.

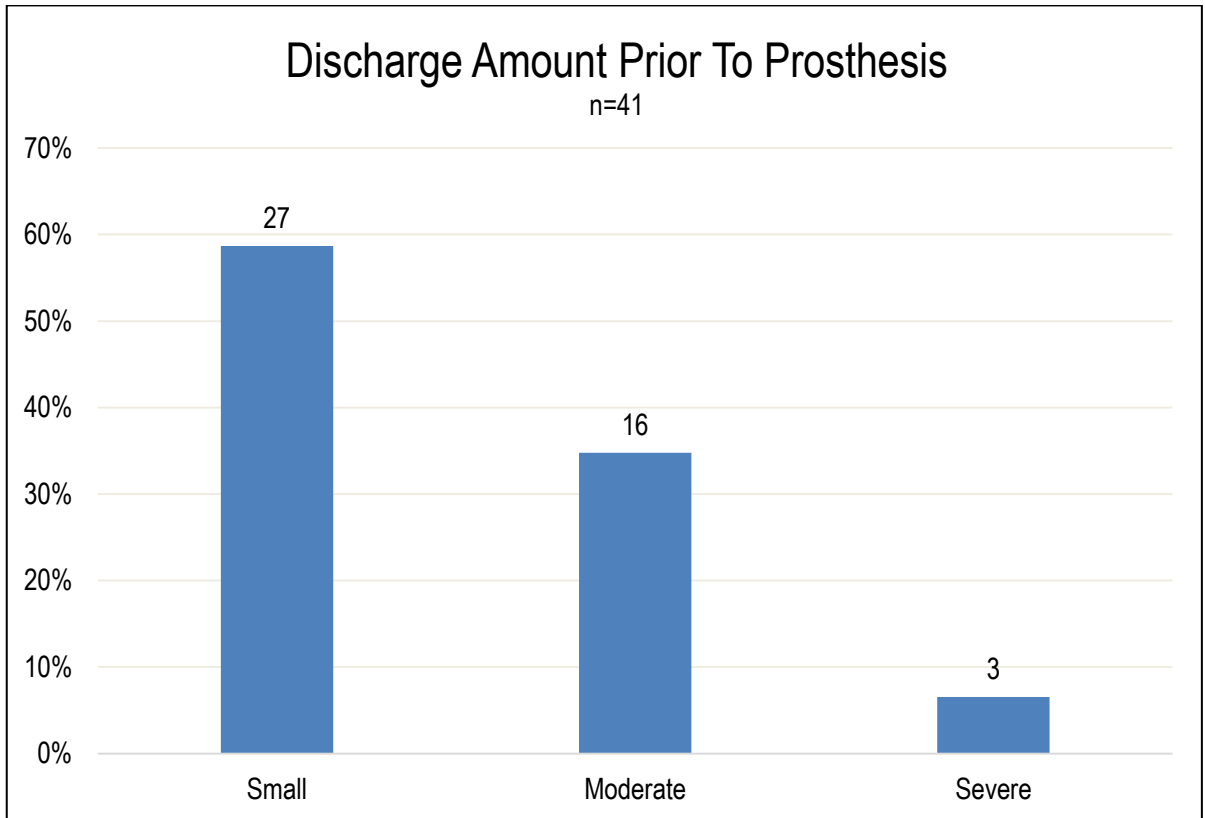


Table 11.3-4 Participants discharge amounts prior to prosthesis wear

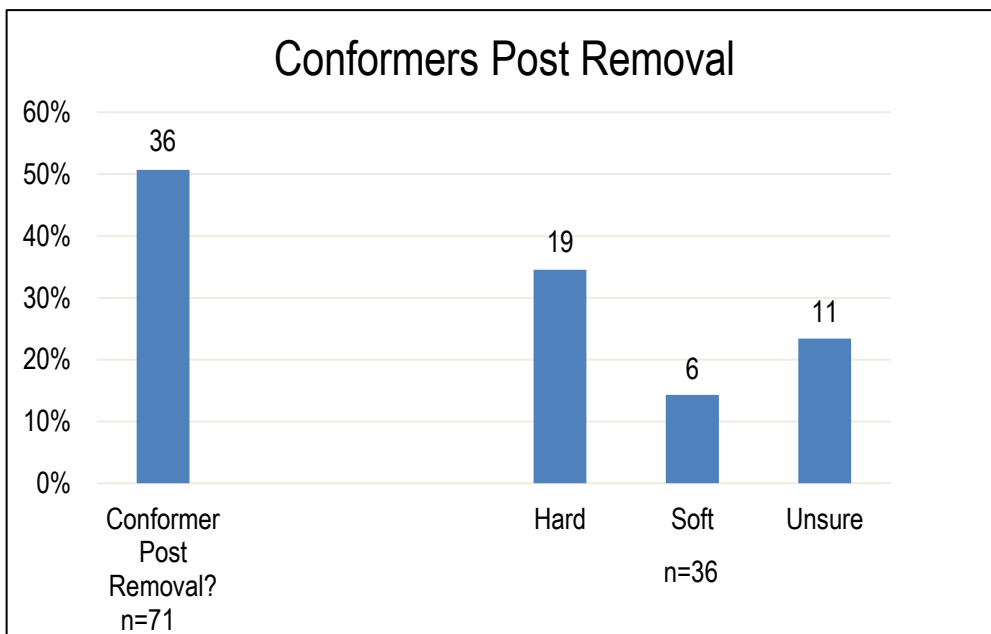


Table 11.3-5 Participants who wore conformers post eye removal

A conformer is an oval shaped disk that is often placed in the socket post eye removal to encourage healthy healing of the socket (**Fig. 11.3-1**). They can be soft, made of silicone or hard, made of acrylic. A conformer helps maintain the size of the socket by preventing the socket fusing in areas during the healing process. A healthy, naturally sized socket makes for a more comfortable fit, and a more aesthetically pleasing prosthesis.

Thirty-six patients (50.7%) received a conformer post eye removal (**Table 11.3-5**). Of these 19 (52.8% of the 36) received a hard conformer, 6 (16.7% of the 36) received a soft conformer, 11 (30.6% of the 36) were unsure what type of conformer they received.



Fig. 11.3-1 Two types of conformers participants wore: Left – Vented rigid PMMA conformer; Right – soft silicone (Knowles, P 2016d)

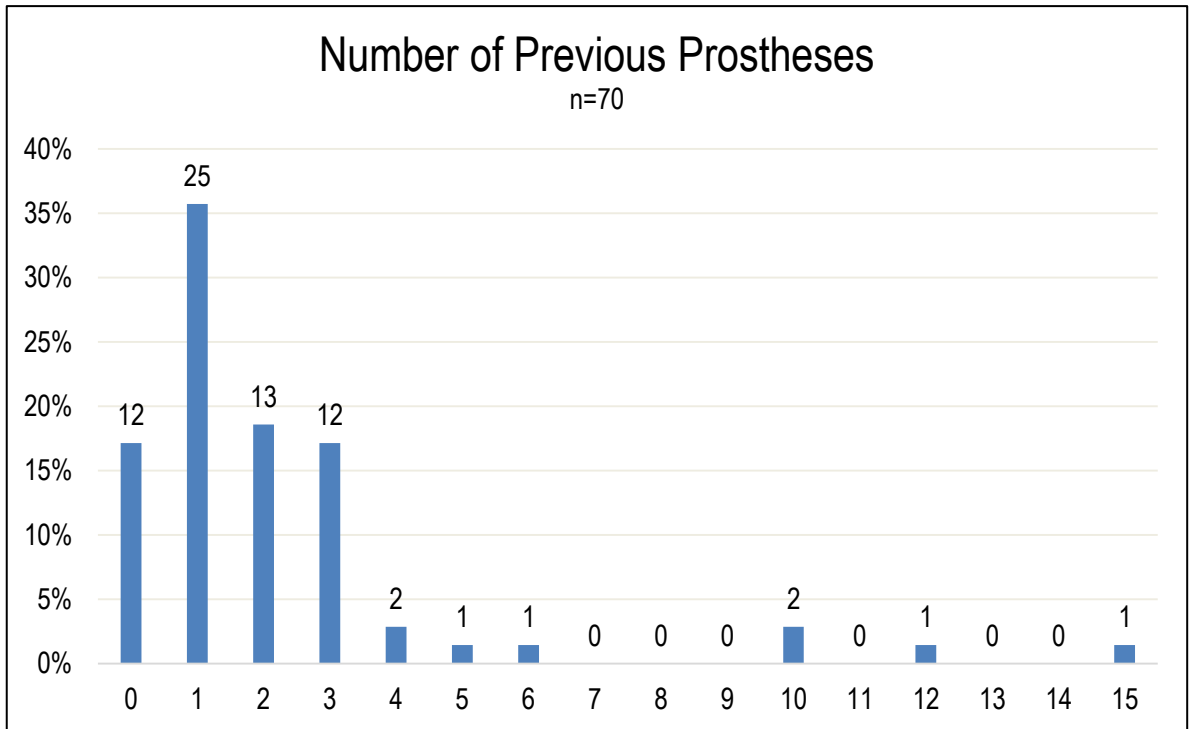


Table 11.3-6 The number of previous prostheses participants have had

A total of 12 (17.1%) had not received a prosthesis, due to this survey being completed during the process of making their first prosthesis (**Table 11.3-6**). The most common number was 1 previous prosthesis; with next highest being 13 having previously had 2 prostheses and 12 patients previously receiving 3 prostheses. A total of 2 patients had a previous 4 prostheses, and only 1 had both 5 or 6 prostheses. Two participants had 10, and just 1 for both 12 and 15 prostheses.

The total number of prostheses for all patients was 141.

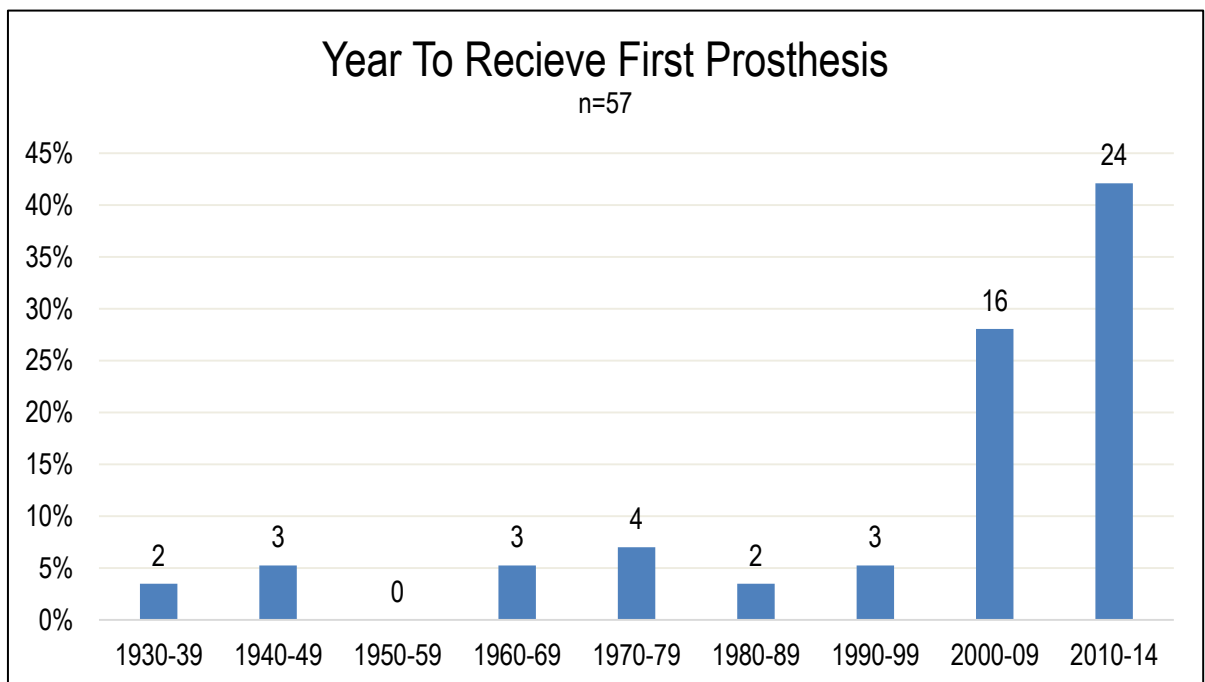


Table 11.3-7 Year that participant received first prosthesis

Of the 57 to respond to this question, 24 (42.1%) received or were receiving their first prosthesis between 2010 and 2014 (**Table 11.3-7**). Another 16 (28.1%) received their first prosthesis between 2000 and 2009; 3 (5.3%) between 1990 and 1999. The remaining 14 (24.6%) received their first prosthesis between the years of 1930 and 1989.

11.4 EMOTIONS AFTER RECEIVING FIRST PROSTHESIS

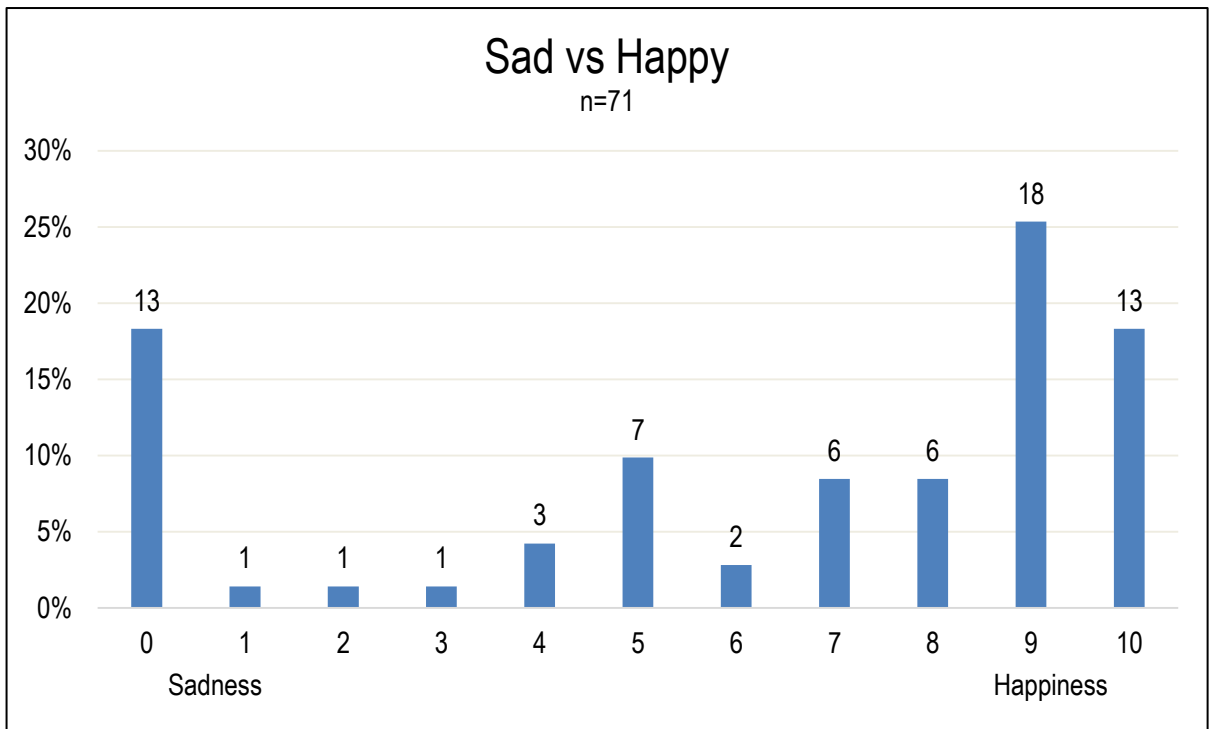


Table 11.4-1 Participants emotion when received first prosthesis: sad vs happy VAS score

All participants responded to this question, **Table 11.4-1** shows that 37 (52.1%) reported feelings of extreme happiness. A total of 15 (21.1%) reported emotions of extreme sadness. The remaining 19 (26.8%) had a mixture of emotion between sadness and happiness.

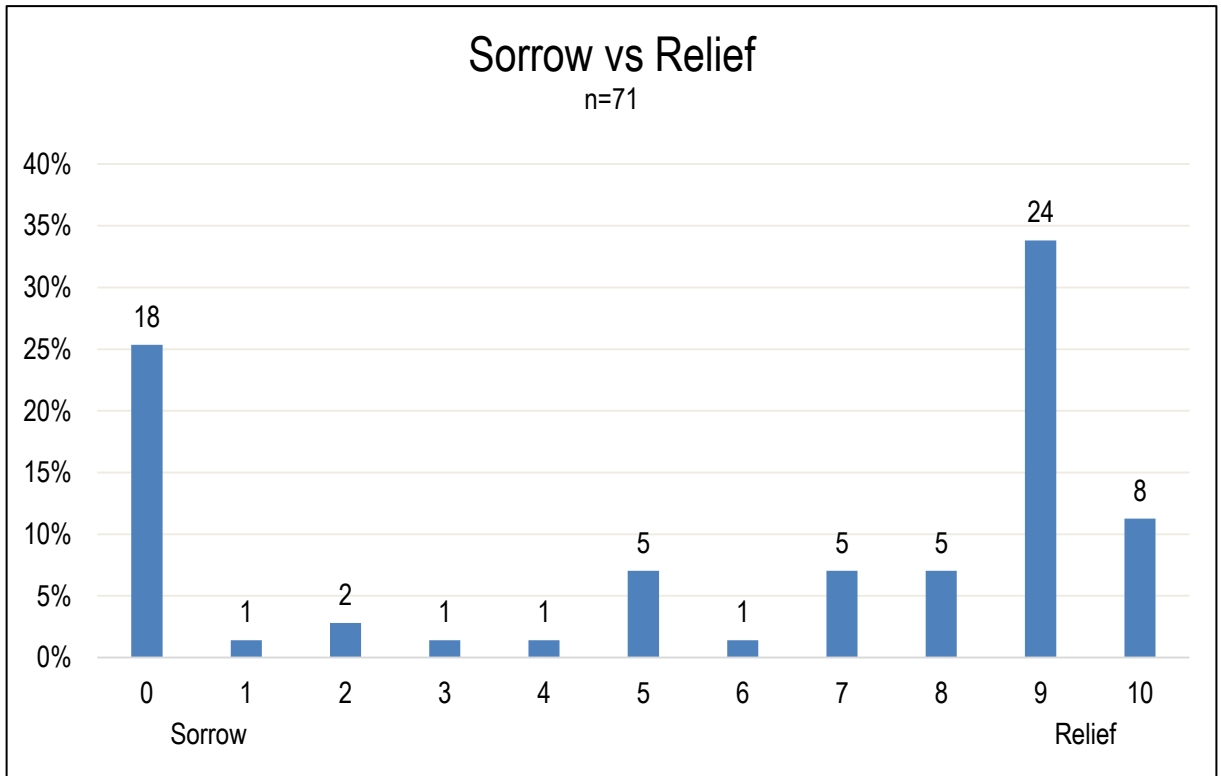


Table 11.4-2 Participants emotion when received first prosthesis: sorrow vs relief VAS score

All participants responded to this question **Table 11.4-2**, 21 (29.6%) reported extreme feelings of sorrow, whilst 37 (52.1%) reported extreme emotions of relief. The remaining 13 (18.3%) felt emotions in between the extremes of complete relief, or utter sorrow.

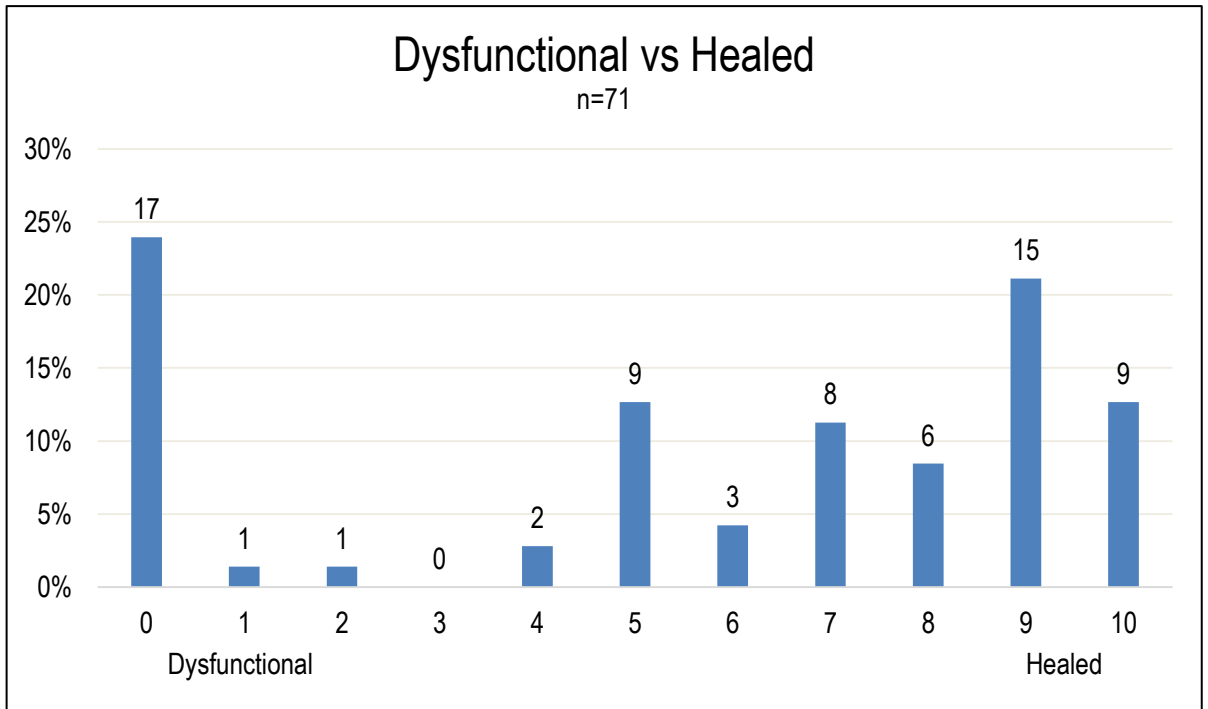


Table 11.4-3 Participants emotion when received first prosthesis: dysfunctional vs healed VAS score

All participants responded, 19 (26.8%) reported feeling extremely dysfunctional. Thirty (42.3%) reported feeling 'healed'. A total of 22 (30.1%) reported feeling somewhere in between dysfunctional and 'healed', but the majority of this middle group trended slightly towards the 'healed' side of the visual analogue scale of emotion (**Table 11.4-3**).

11.5 EMOTIONS AFTER RECEIVING SECOND PROSTHESIS

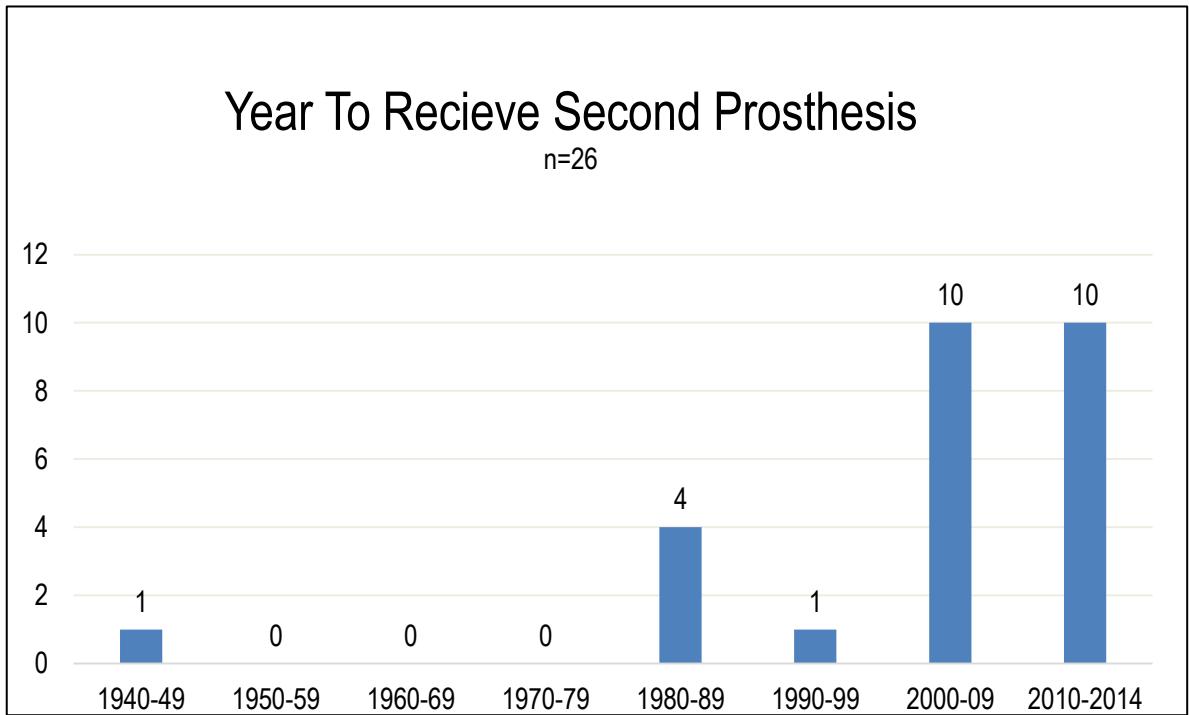


Table 11.5-1 Year that participants received second prosthesis

A total of 26 recalled the year they received their second prosthesis **Table 11.5-1**. Of this group, 10 (38.5%) received it between 2010-14, and another 10 (38.5%) between 2000-09. Only 1 (3.8%) received theirs between 1940-49, and the remaining 5 (19.2%) received their second prosthesis between 1980-1999.

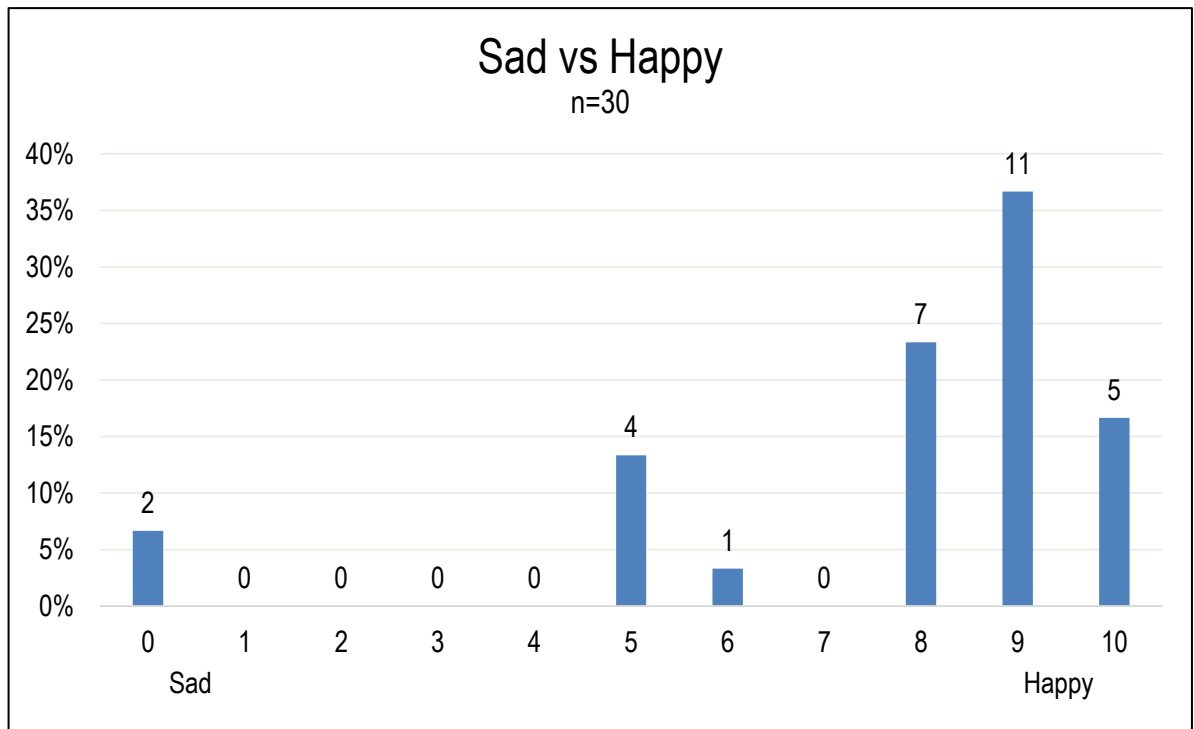


Table 11.5-2 Participants emotions when received second prosthesis: sad vs happy VAS score

Although only 26 recalled the year of receiving their second prosthesis (**Table 11.5-1**), a total of 30 responded regarding their emotions at the time of receiving their second prosthesis (**Table 11.5-2**). After receiving their second prosthesis, 23 (76.7%) of patients reported feeling extremely happy, whilst only 2 (6.7%) reported ongoing feelings of great sadness. A total of 5 (16.7%) continued not to feel strongly either way.

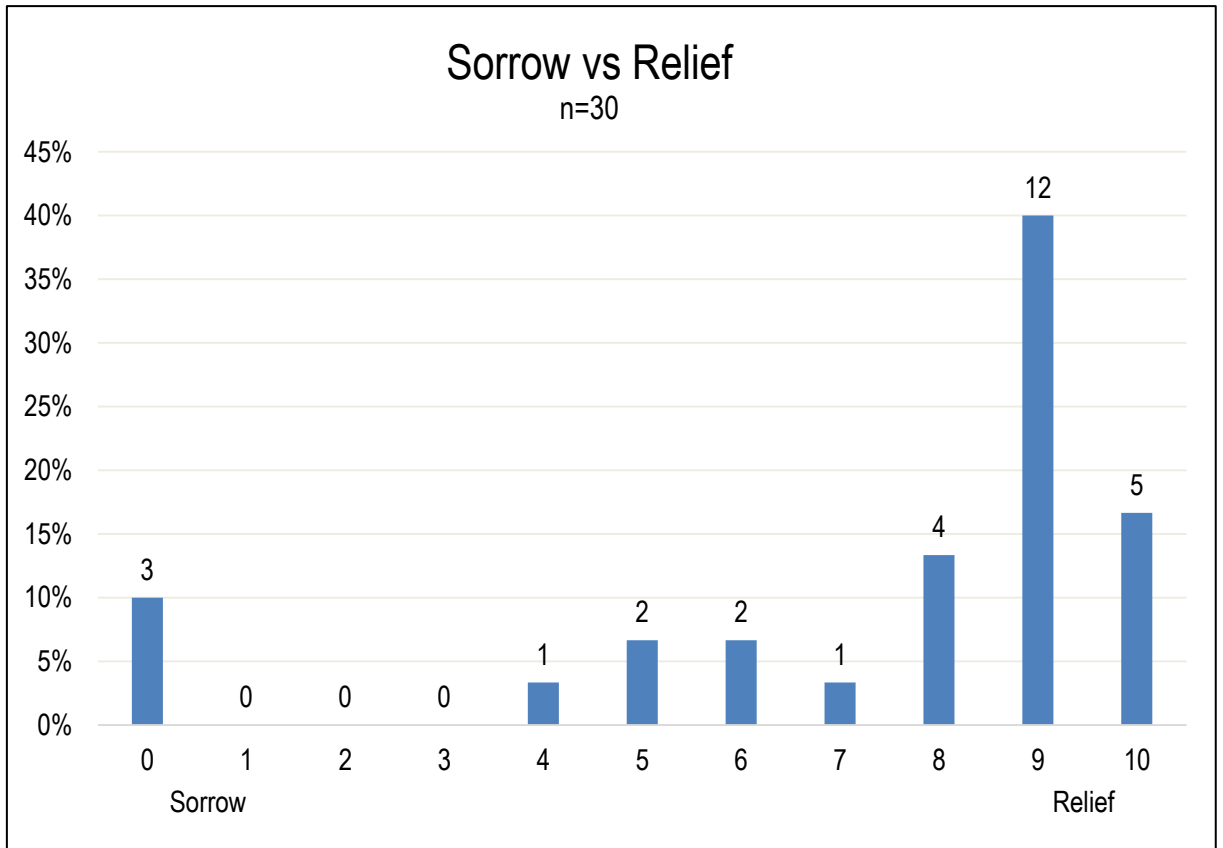


Table 11.5-3 Participants emotions when received second prosthesis: sorrow vs relief VAS score

Of the 30 participants who answered this section (**Table 11.5-3**), 21 (70%) felt an immense feeling of relief after receiving their second prosthesis. A total of 3 (10%) had ongoing feelings of deep sorrow, whilst 6 (20%) felt somewhere in between these emotions, with a slight trend towards relief.

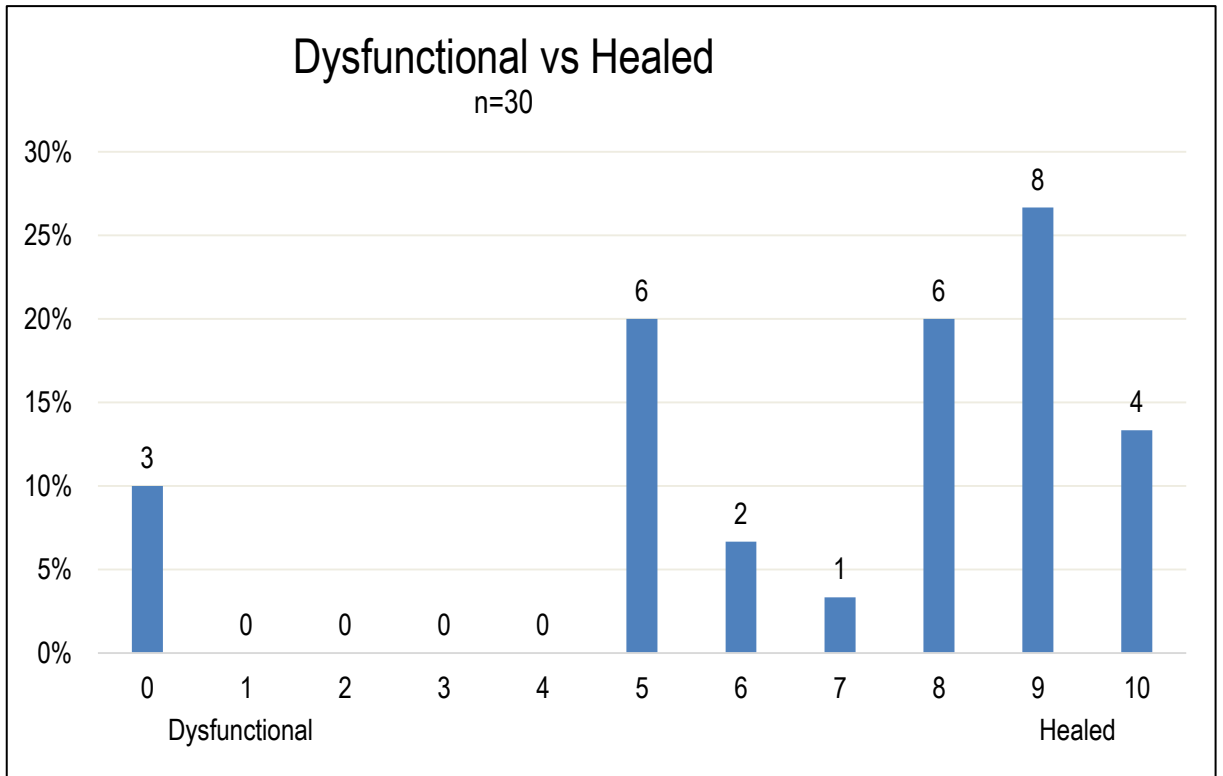


Table 11.5-4 Participants emotions when received second prosthesis: dysfunctional vs healed VAS score

Of the same group of 30, a total of 18 (60%) reported feeling 'healed'; whilst a group of 3 (10%) felt dysfunctional. The remaining 9 (30%) reported feeling somewhere in between these emotions, but tending towards feeling 'healed' (**Table 11.5-4**).

11.6 EMOTIONS AFTER RECEIVING THIRD PROSTHESIS

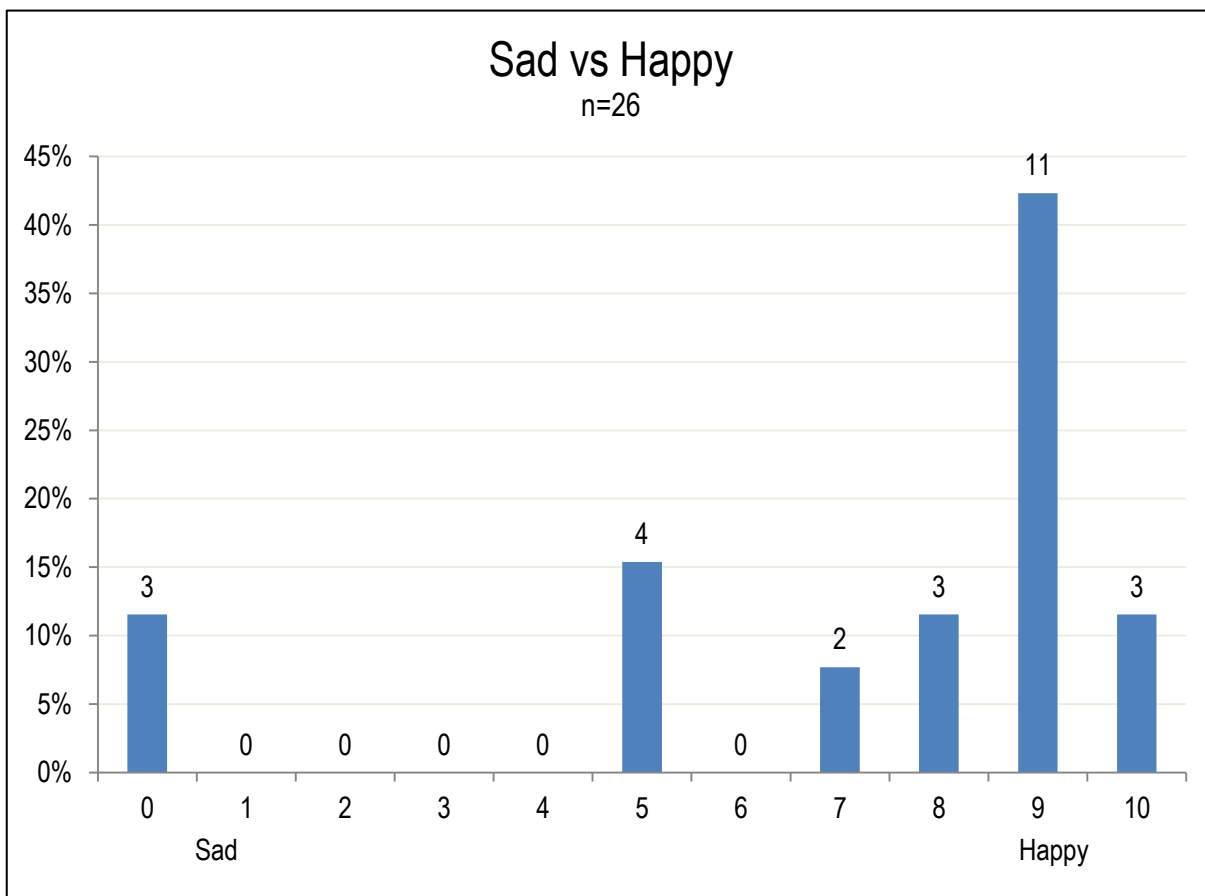


Table 11.6-1 Participants emotions when received third prosthesis: sad vs happy VAS scale

Twenty-six patients responded to having received a third prosthesis. Of the 26 patients who responded to this part of the questionnaire, 17 (65.4%) felt extremely happy after their 3rd prosthesis (**Table 11.6-1**). A total of 3 (11.5%) had ongoing extreme sadness; and 6 (23.1%) felt somewhere in between, with a slight trend towards happiness.

It is not possible to determine if only 30 of the participants had previously had two prostheses, or whether only 26 had previously had three. The number of results presented, are the number of participants who provided feedback on previous prostheses.

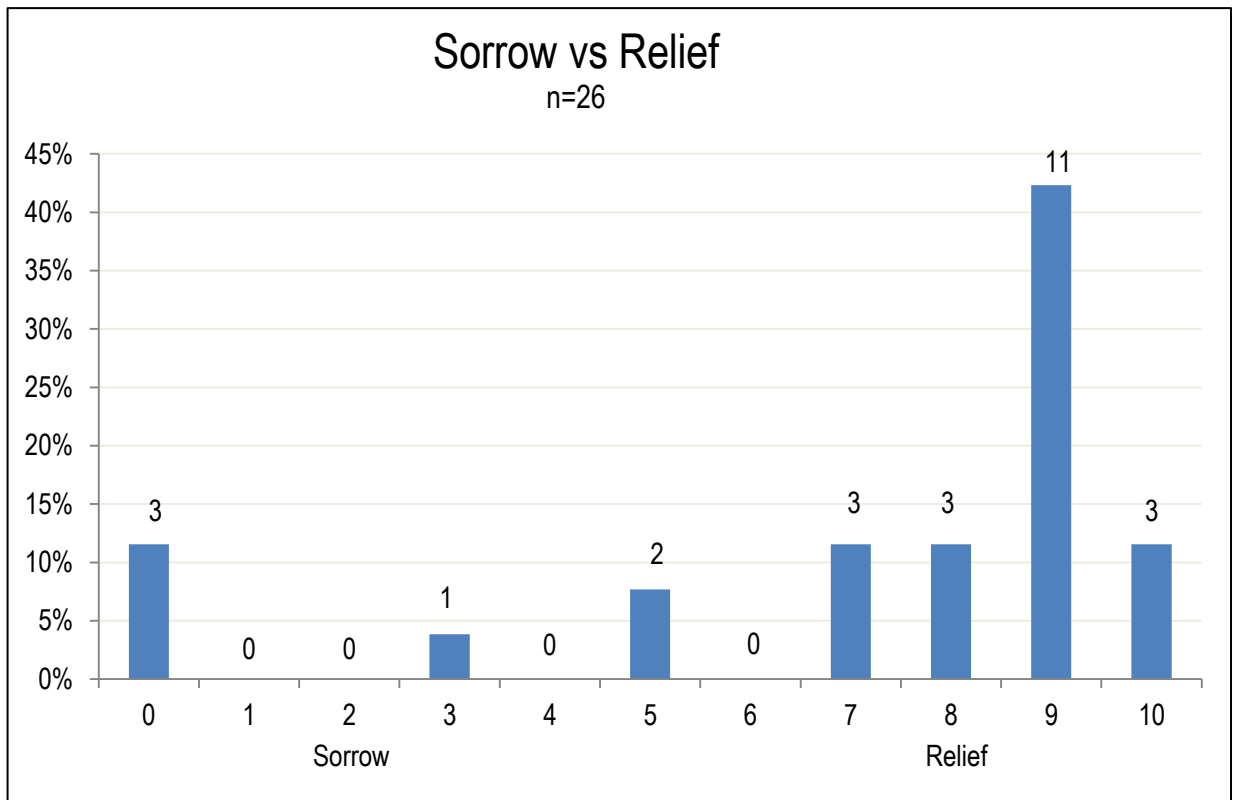


Table 11.6-2 Participants emotions when received third prosthesis: sorrow vs relief VAS scale

A total of 17 (65.4%) felt extremely relieved after receiving their third prosthesis (**Table 11.6-2**). In total, 3 (11.5%) had ongoing emotions of extreme sorrow; 6 (23.1%) were spread somewhere in between the two emotions.

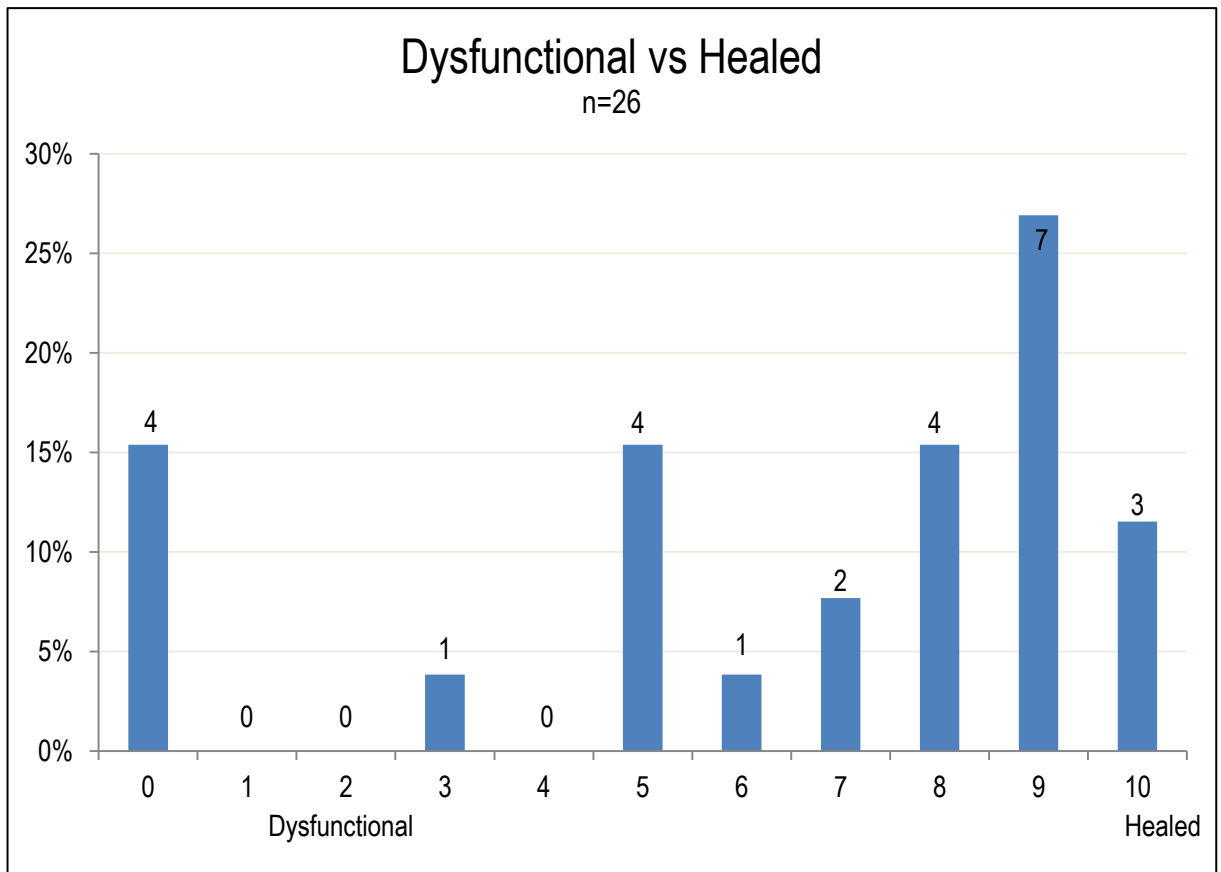


Table 11.6-3 Participants emotions when received third prosthesis: dysfunctional vs healed VAS scale

A total of 14 (53.8%) felt strongly that they were 'healed', whilst 4 (15.4%) felt completely dysfunctional (Table 11.6-3). The remaining 8 (30.8%) felt neither emotion strongly.

11.7 EMOTIONS NOW - WITH PROSTHESIS

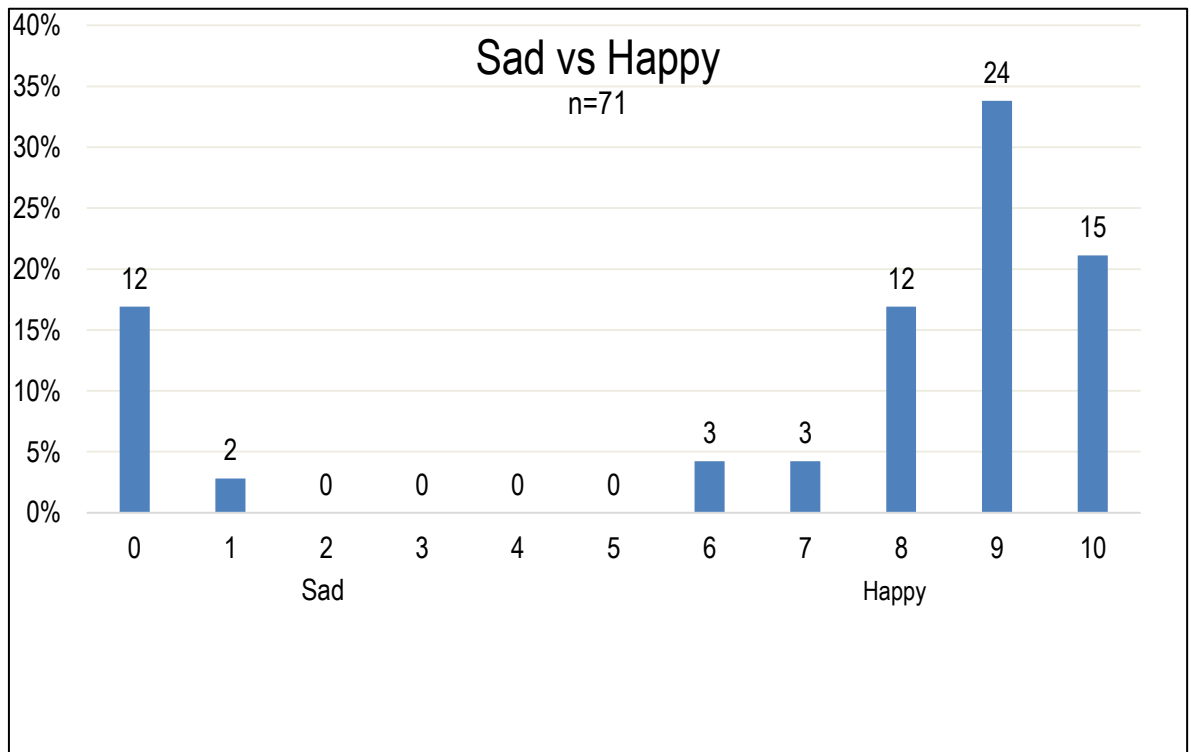


Table 11.7-1 Participants emotions when received current prosthesis: sad vs happy VAS scale

A total of 51 (71.8%) of the 71 patients surveyed reported feeling extremely happy about their current prosthesis. Those reporting feeling great sadness numbered 14 (19.7%), and the remaining 6 (8.4%) felt generally happy about their prosthesis.

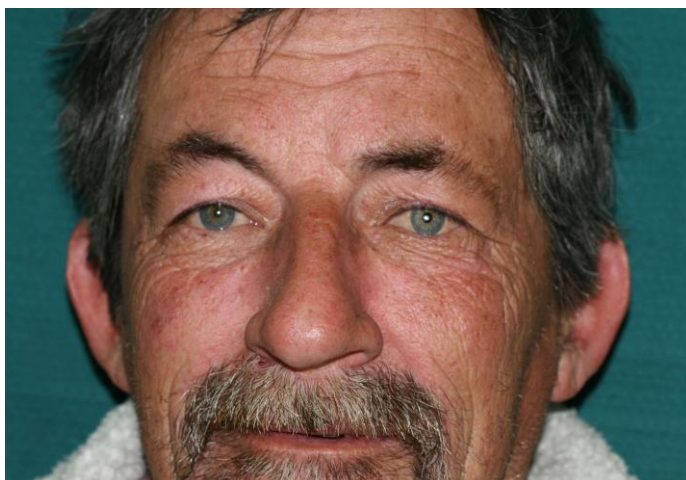


Fig. 11.7-1 Right ocular prosthetic eye of patient who was happy with current prosthesis (Knowles, PT 2012)

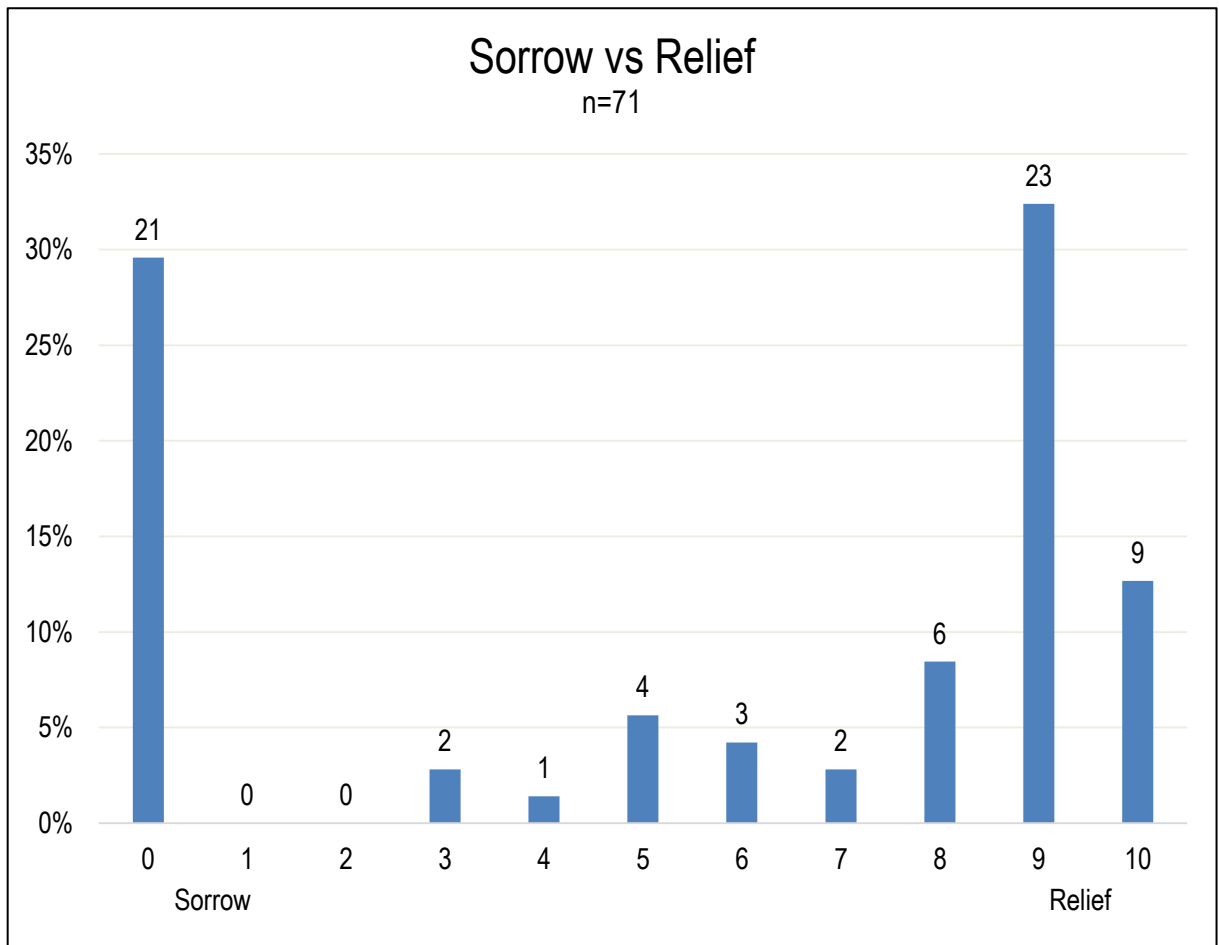


Table 11.7-2 Participants emotions when received current prosthesis: sorrow vs relief VAS score

Table 11.7-2 shows that a total of 21 (29.6%) felt deep sorrow, whilst 38 (53.5%) reported feeling extreme relief. The remaining 12 (16.9%) report feeling somewhere in between the two extremes, but trending towards relief.

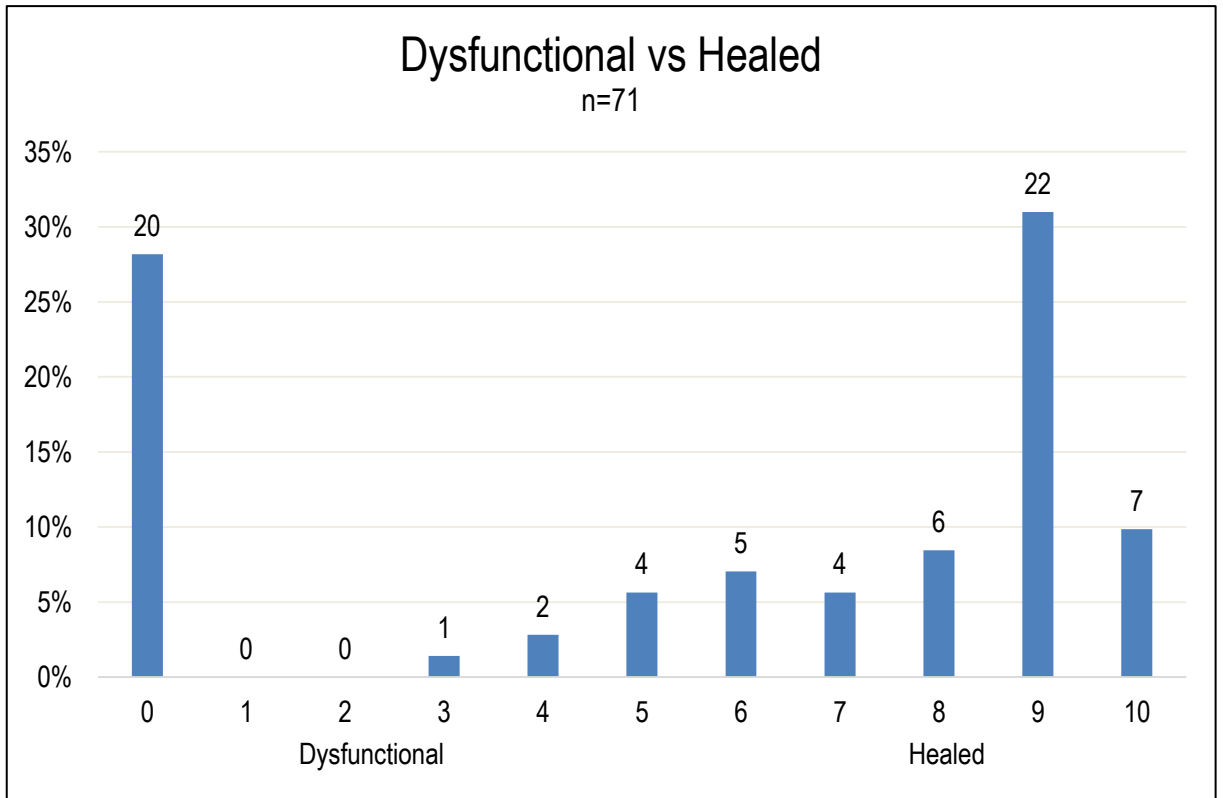


Table 11.7-3 Participants emotions when received current prosthesis: dysfunctional vs healed VAS score

Of the 71 patients, 35 (49.3%) reported that they felt a strong emotion of being 'healed'; whilst 20 (28.2%) felt very dysfunctional. The remaining 16 (22.5%) trended towards feelings of being 'healed' (**Table 11.7-3**).

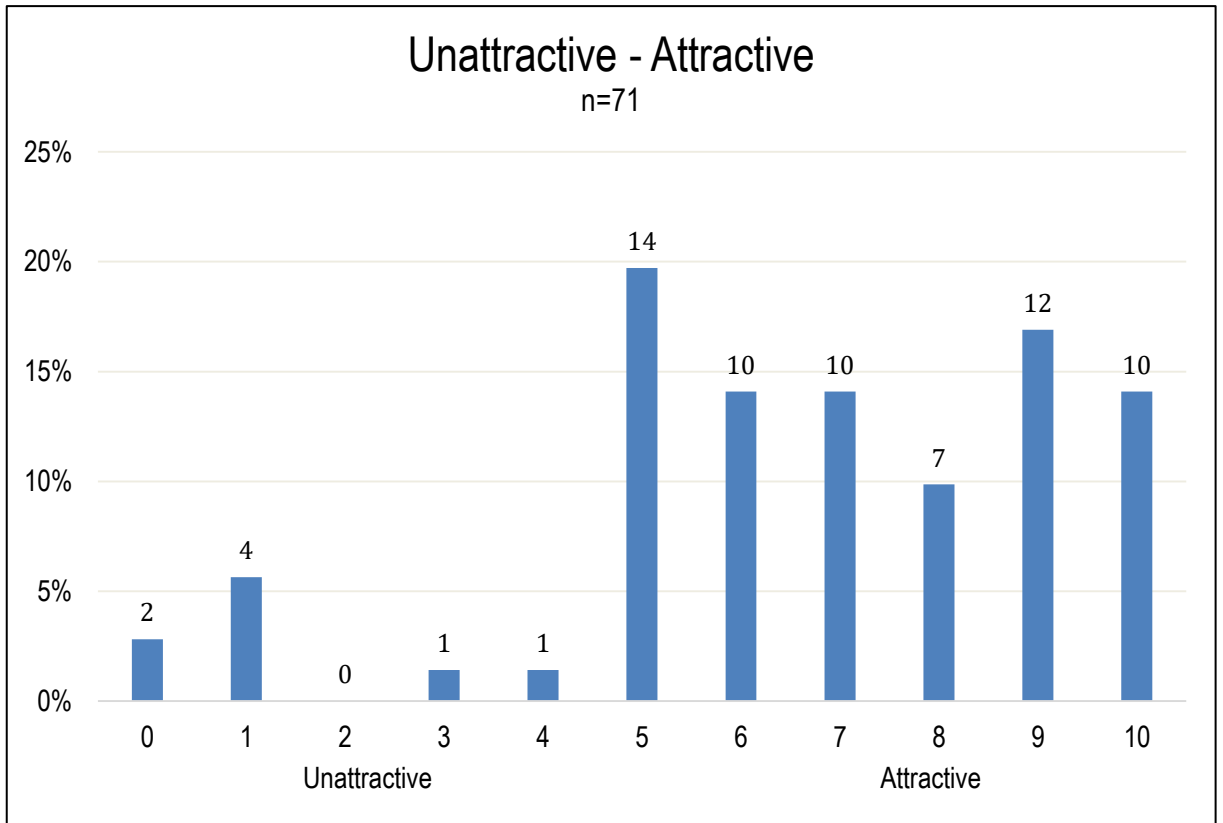


Table 11.7-4 Participants emotions when received current prosthesis: unattractive vs attractive VAS score

Of the 71 respondents, 29 (40.8%) felt they look extremely attractive with their prosthesis (**Table 11.7-4**). Another 6 (8.5%) felt extremely unattractive, 14 (19.7%) feel no difference regarding their appearance with the prosthesis in, and the remaining 27 (38.0%) felt an improvement in their appearance whilst wearing their prosthesis.

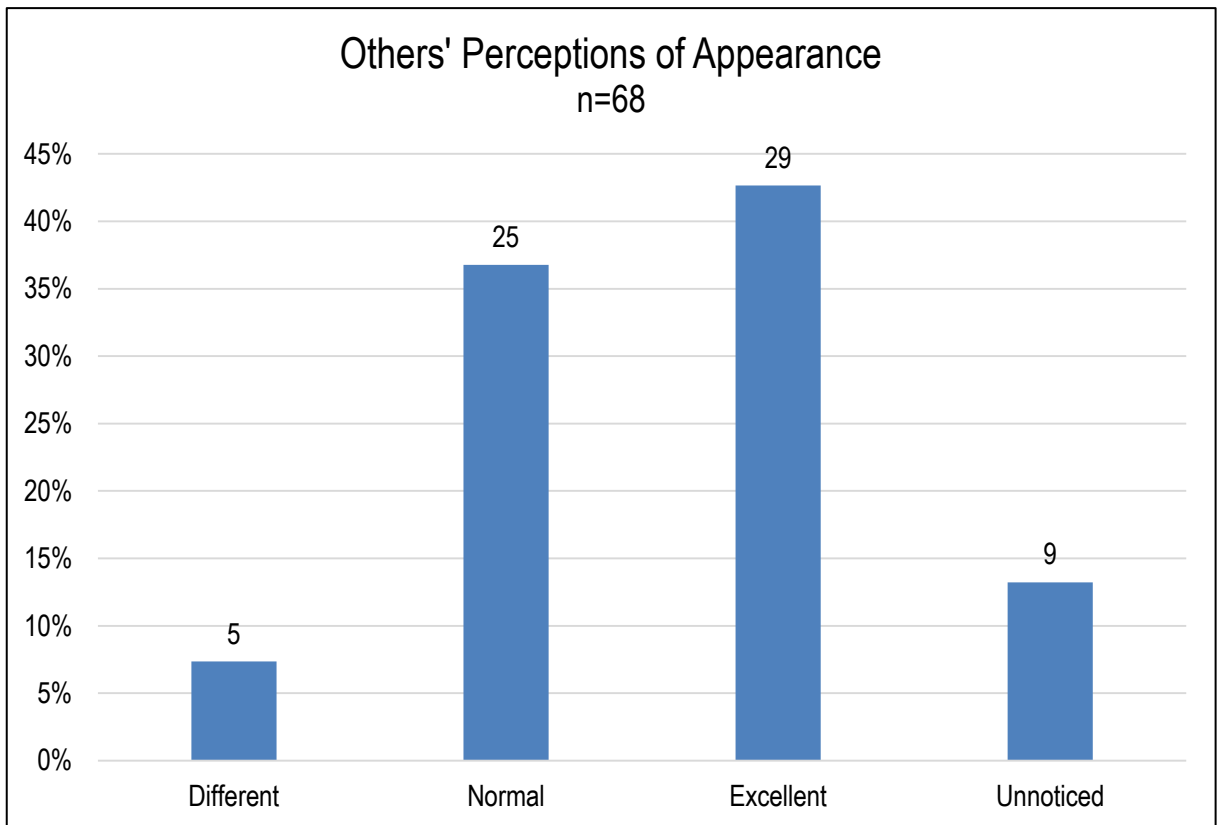


Table 11.7-5 Participants opinion on others' perception of their appearance

A total of 68 respondents answered this question (**Table 11-7-5**), with 25 (36.8%) feeling that others described them as looking 'normal'. A total of 5 (7.4%) state others see them as looking different, whilst 29 (42.6%) say others describe them as looking excellent. The remaining 9 (13.2%) say that others do not notice the way their eye looks.

11.8 EMOTIONS NOW - WITHOUT PROSTHESIS

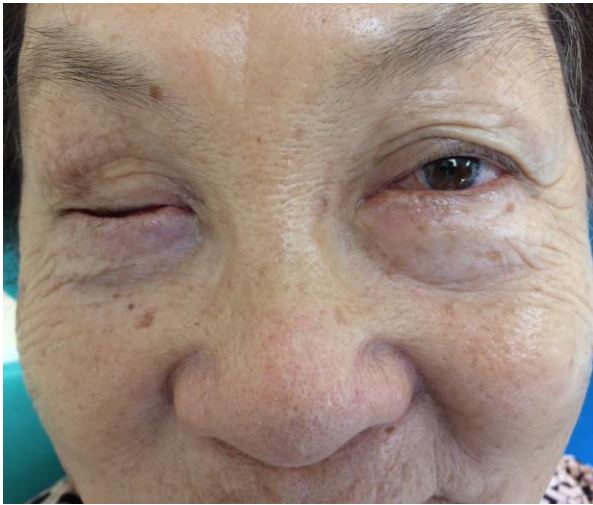


Fig. 11.8-1 Right socket of patient without ocular prosthesis insitu (Knowles, PT, 2016e)

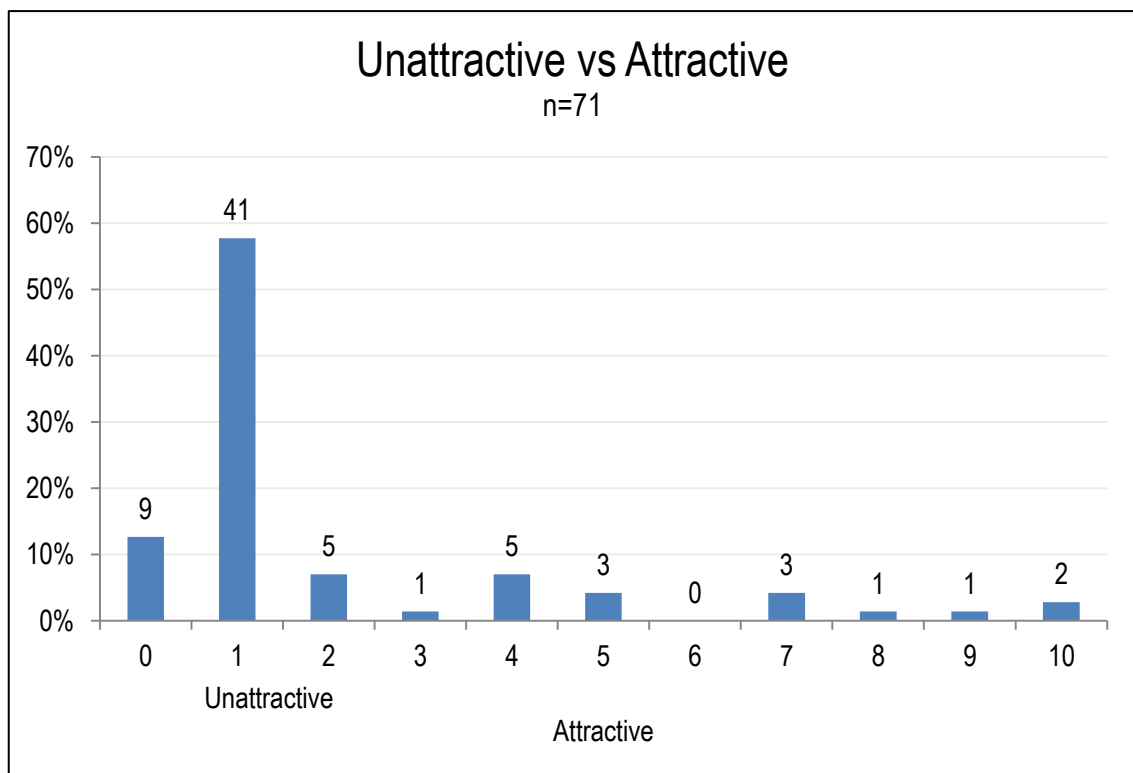


Table 11.8-1 Participants emotion when not wearing prosthesis: unattractive vs attractive VAS score

A vast majority of 55 (77.5%) reported feeling extremely unattractive without their prosthesis in, whilst only 4 (5.6%) report feeling very attractive without it. For the 12 (16.9%) remaining, the majority report feeling generally unattractive (Table 11.8-1).

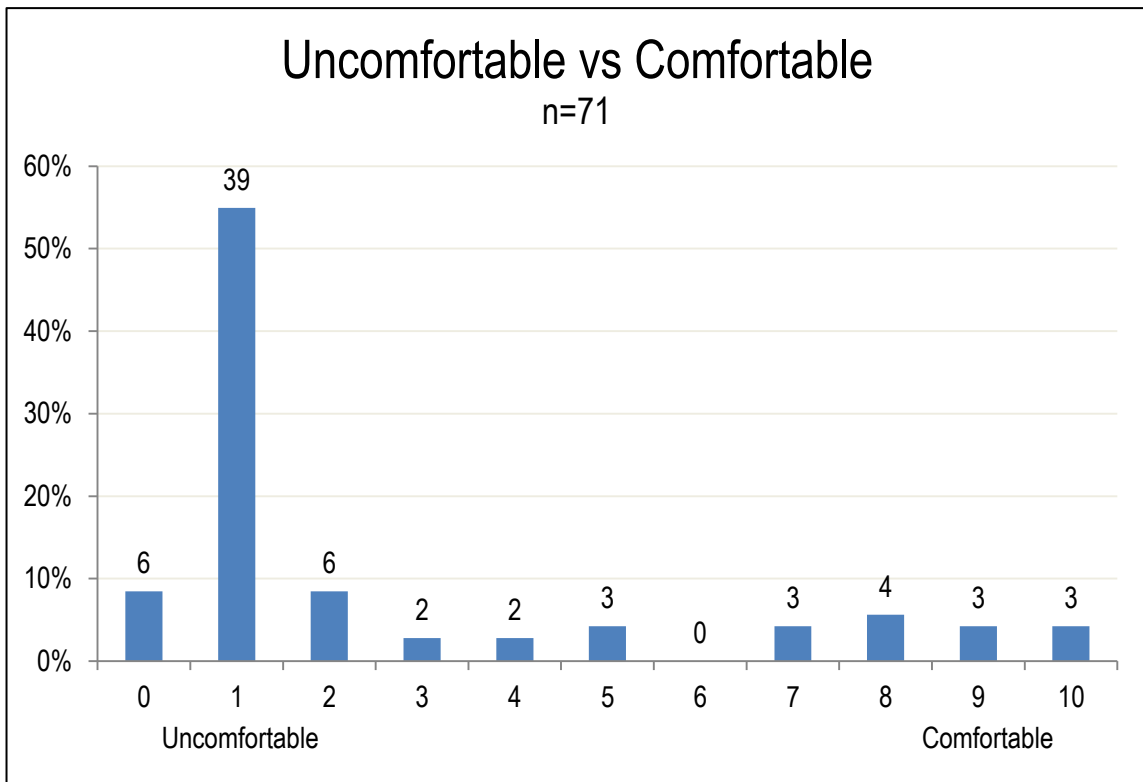


Table 11.8-2 Participants emotion when not wearing prosthesis: uncomfortable vs comfortable VAS score

Of the 71 patients who responded to this question (**Table 11.8-2**), 51 (71.8%) reported feeling extremely uncomfortable without their prosthesis in. Only 10 (14.1%) report feeling very comfortable; and the majority of the 10 (14.1%) remaining reported feeling generally uncomfortable without their prosthesis.

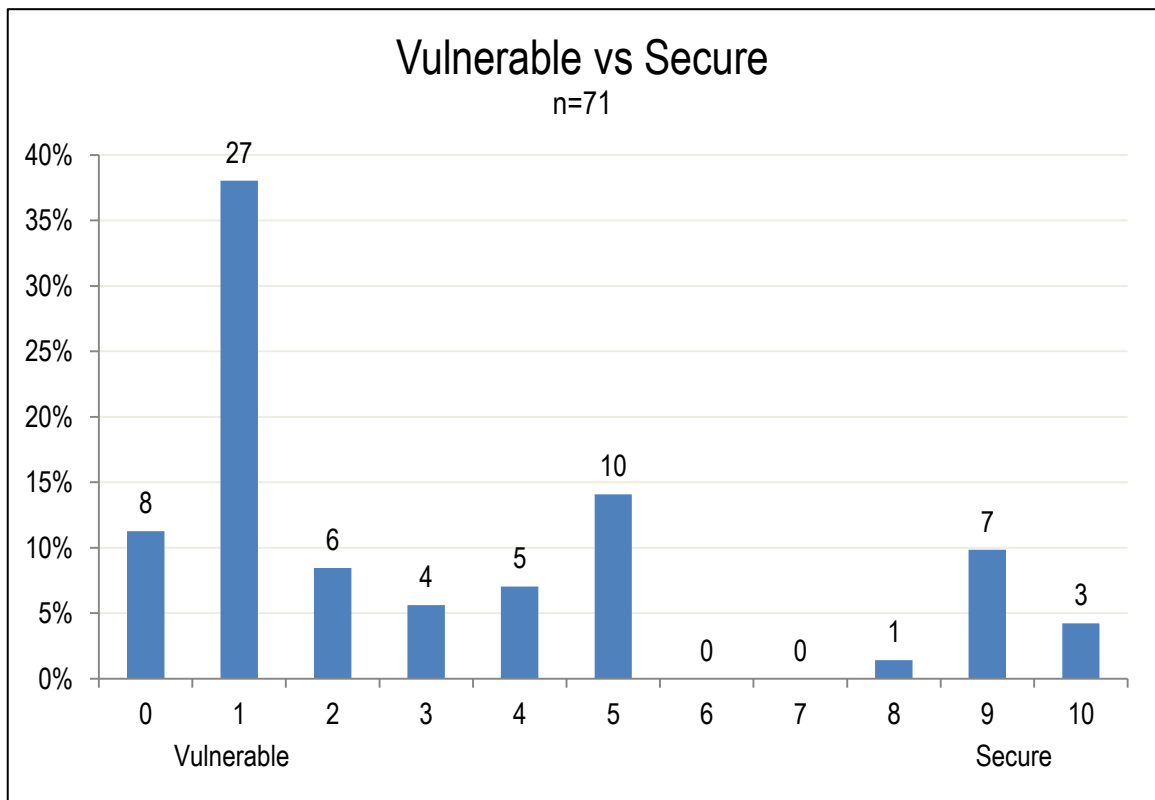


Table 11.8-3 Participants emotion when not wearing prosthesis: vulnerable vs secure VAS score

The majority of 41 (57.7%) of participants reported feeling extremely insecure whilst not wearing their prosthesis (**Table 11.8-3**). Only 11 (15.5%) reported feeling very secure. A group of 10 (14.1%) reported feeling indifferent, whilst the remaining 15 (21.1%) say they feel a little insecure without their prosthesis.

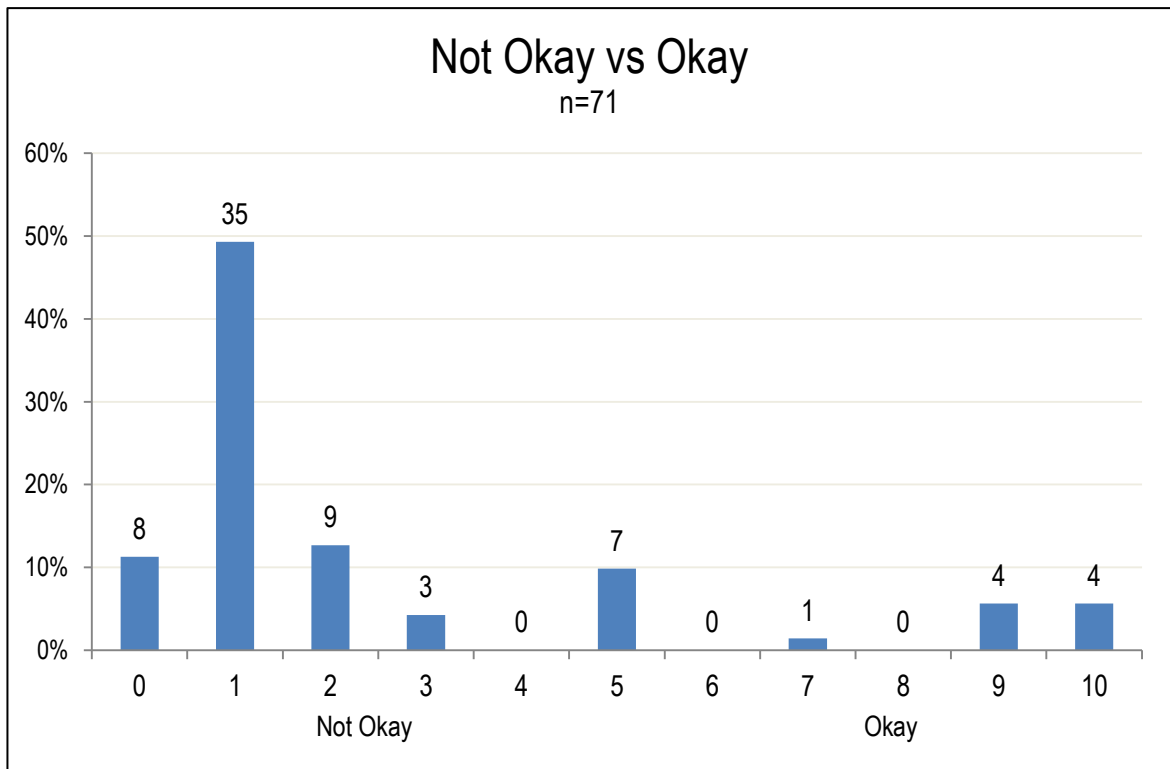


Table 11.8-4 Participants emotion when not wearing prosthesis: not okay vs okay VAS score

Of the 71 patients, 52 (73.2%) felt like they were 'not okay' without their prosthesis, and only 8 (11.3%) felt 'okay'. Seven (9.9%) said they did not feel strongly either way; and of the remaining 4 (5.6%), the majority did not feel overly okay about not wearing their prosthesis (**Table 11.8-4**).

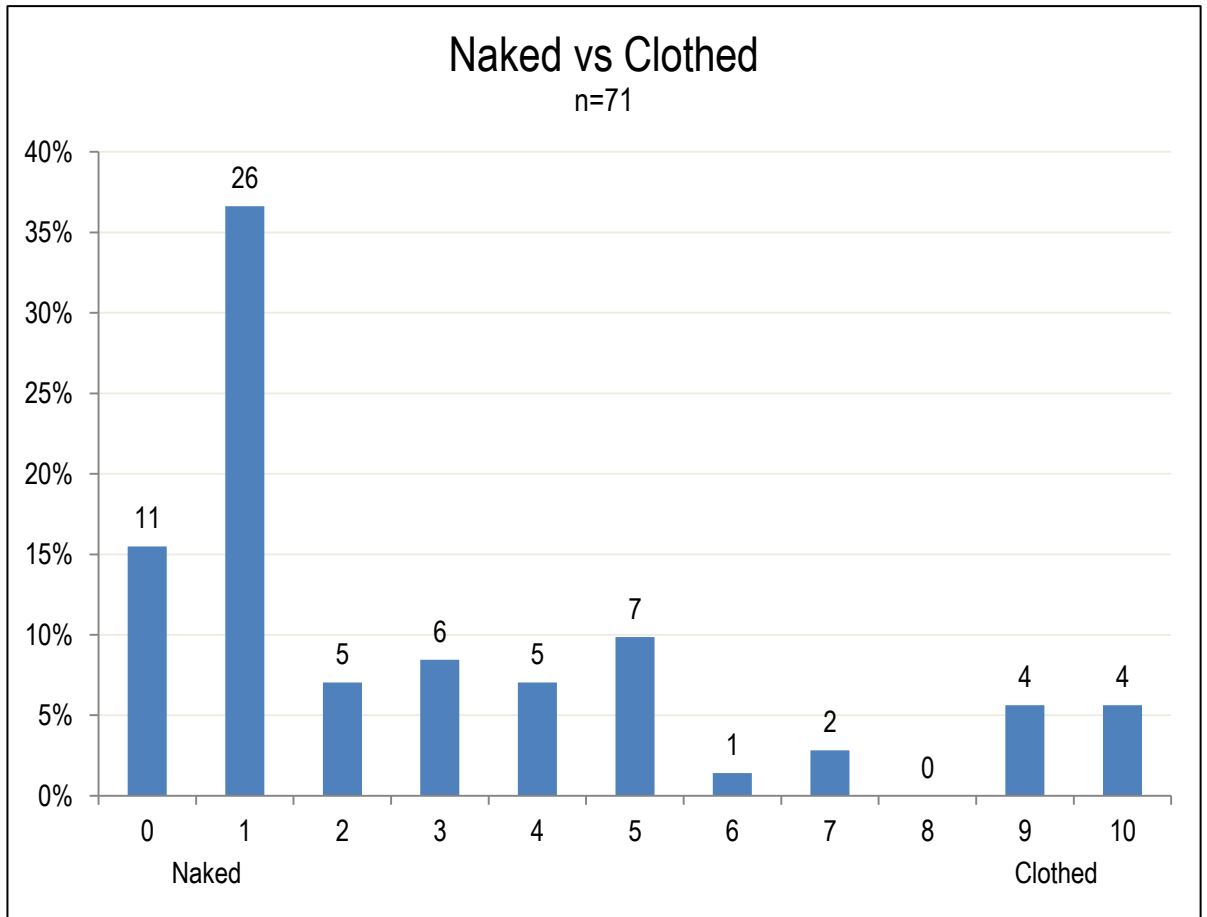


Table 11.8-5 Participants emotion when not wearing prosthesis: naked vs clothed VAS score

In total, 42 (59.2%) felt completely 'naked' without their prosthesis, and only 8 (11.3%) felt fully 'clothed' without it (**Table 11.8-5**). The majority of the other 21 (29.6%) tended towards feeling naked, or not completely clothed.

11.9 COSMETICS VERSUS FUNCTION

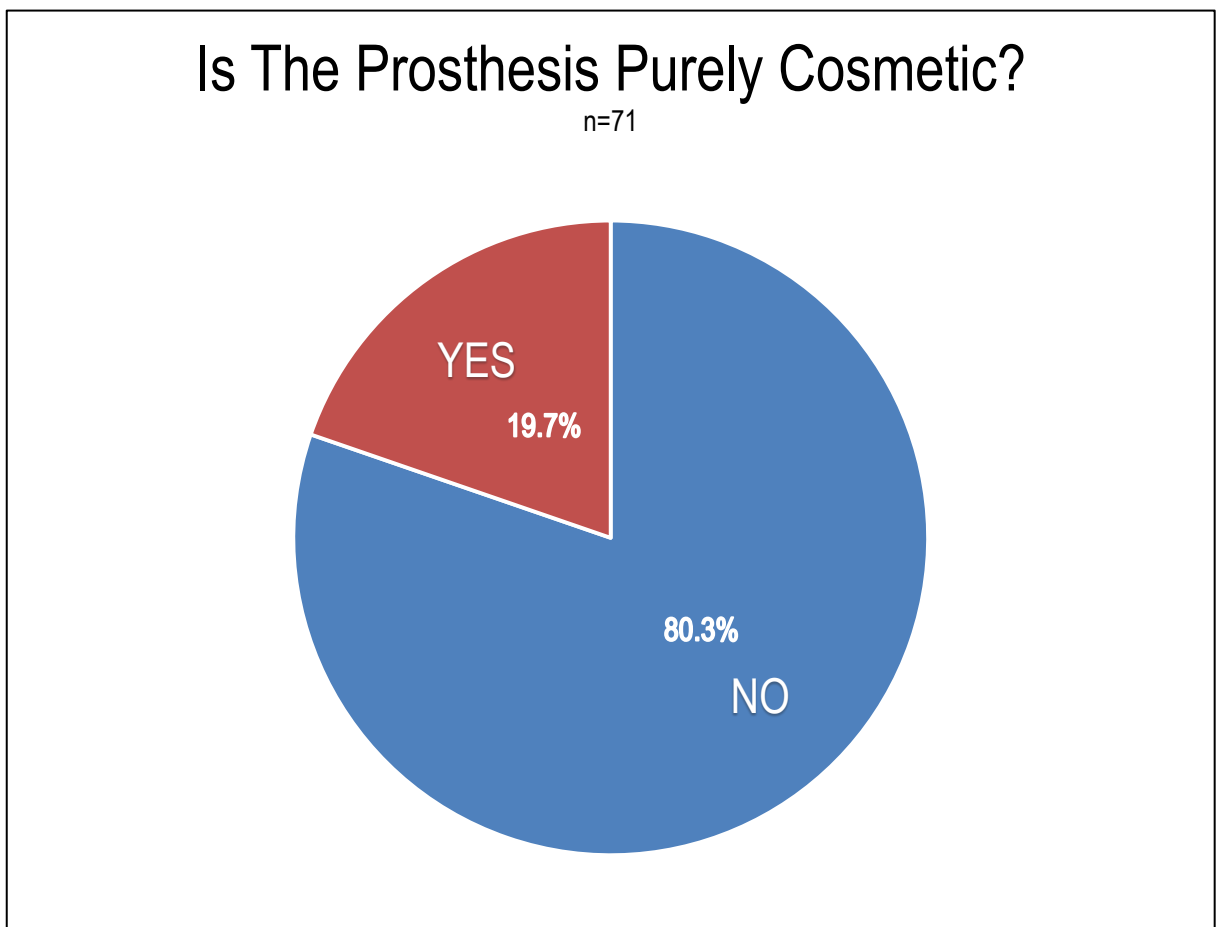


Table 11.9-1 Participants opinion on whether the prosthesis is purely cosmetic

A total of 59 (80.3%) out of the 71 patients who responded to this question stated that they did not believe their prosthesis was purely of cosmetic/aesthetic value to them (**Table 11.9-1**). Only 12 (19.7%) saw it as purely of a 'looks based' benefit to them. The following results reflect the additional value those who responded 'no' place on their prosthesis.

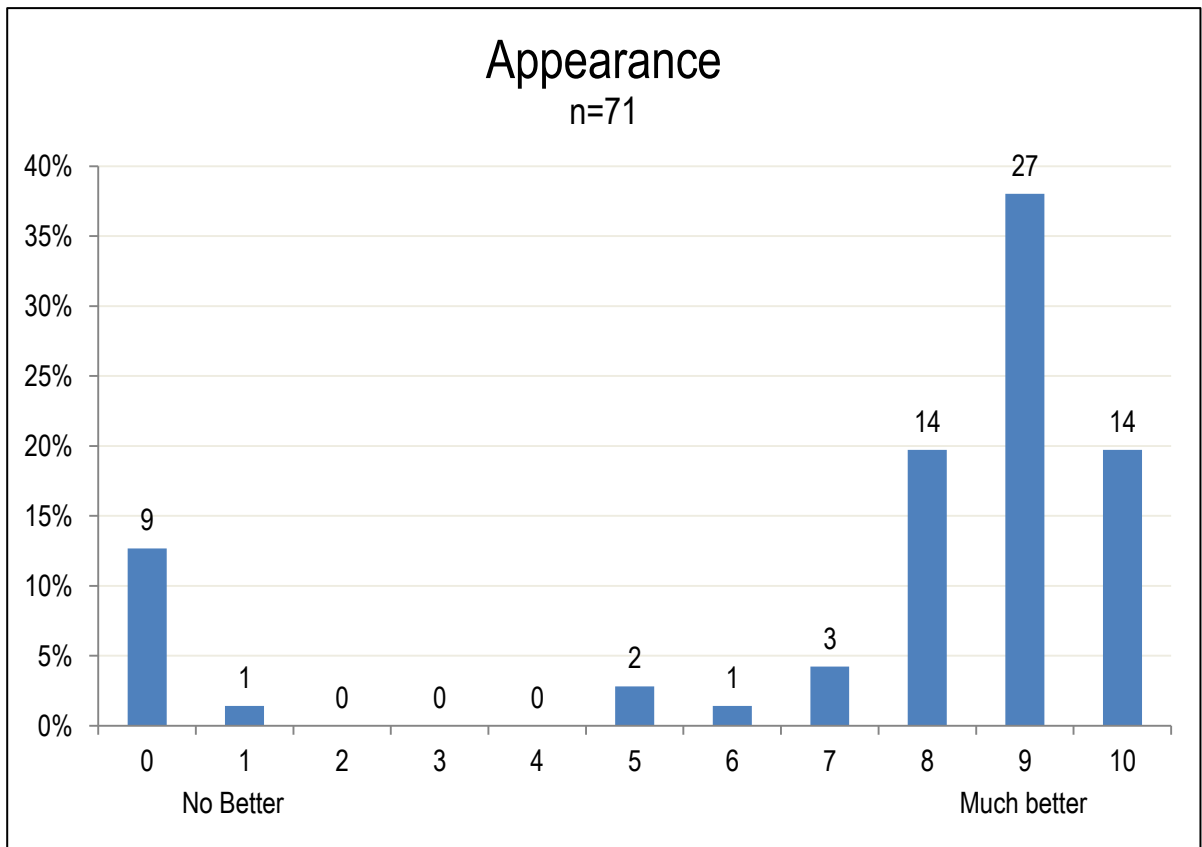


Table 11.9-2 Participants opinion on whether the prosthesis contributes to their appearance VAS score

When asked whether their prosthesis contributed to their appearance, 55 (77.5%) responded that they believed it made them look much better. Only 10 (14.2%) responded that it did not make their appearance any better. The remaining 6 (8.5%) responded that their prostheses made them look better (**Table 11.9-2**).

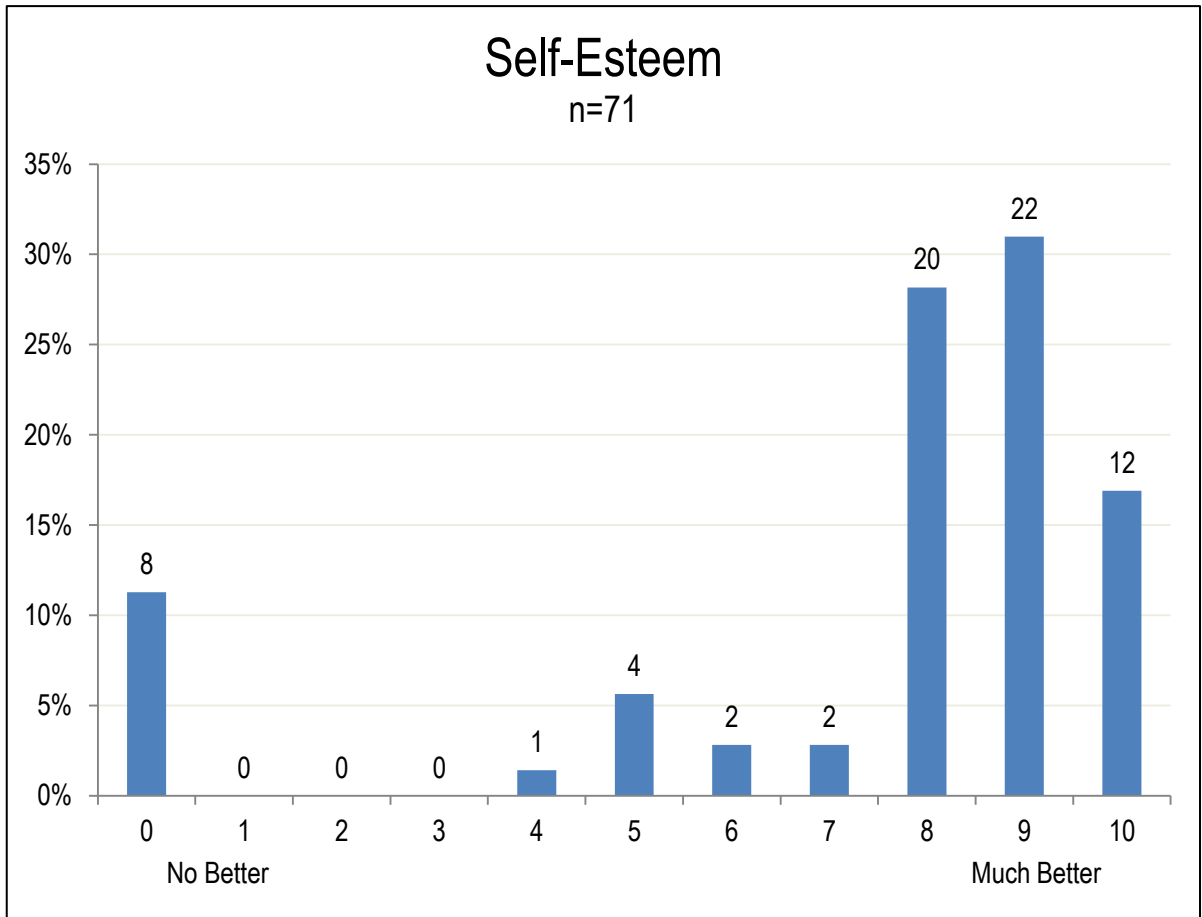


Table 11.9-3 Participants opinion on whether the prosthesis contributes to their self-esteem VAS score

A vast majority of 54 (76.1%) of respondents stated that their prostheses contributed greatly to their self-esteem (**Table 11.9-3**), whereas only 8 (11.3%) said it did not contribute at all. The remaining 9 (12.7%) responded that their prosthesis contributed to their self-esteem in some way.

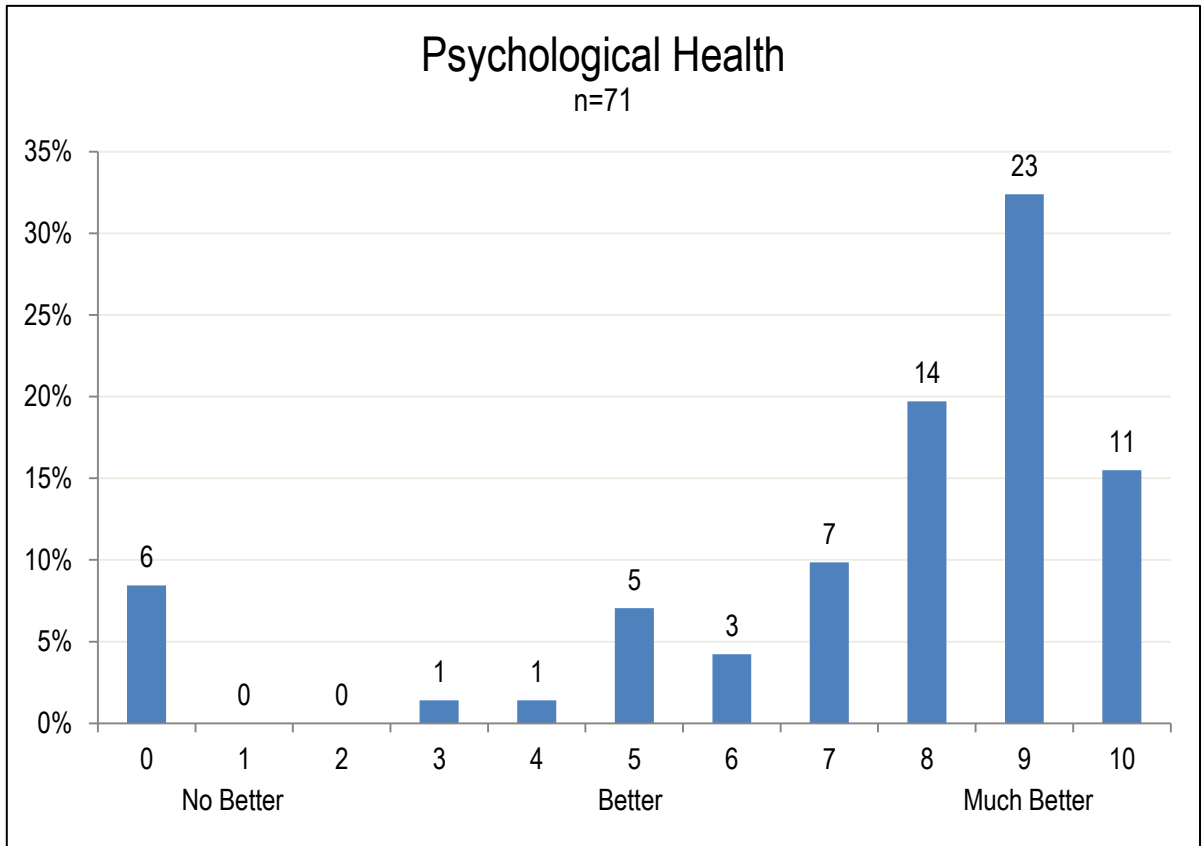


Table 11.9-4 Participants opinion on whether the prosthesis contributes to their psychological health VAS score

A total of 48 (67.6%) responded that their prosthesis contributed to their psychological health in a major way (**Table 11.9-4**). Whilst only 6 (8.5%) said it did not contribute in any way. The remaining 17 (23.9%) said that their prosthesis contributed to their psychological health in some way.

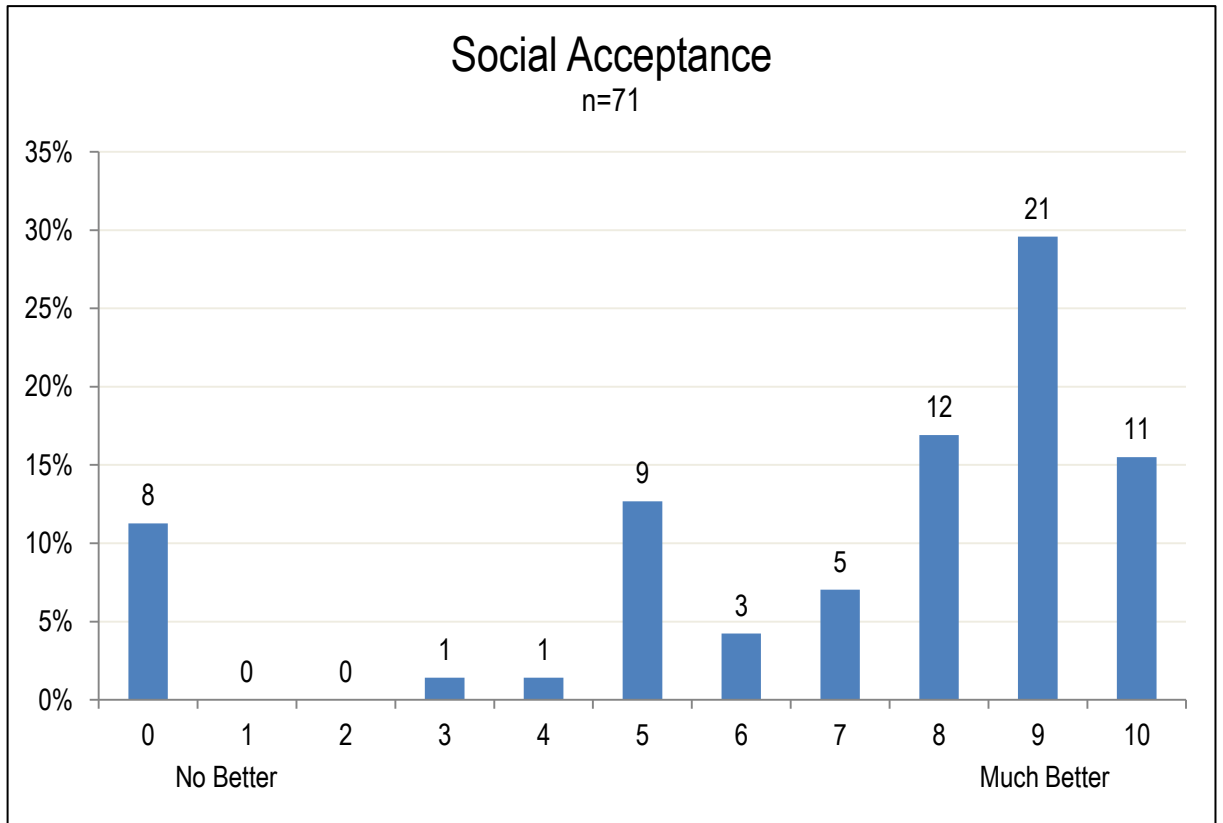


Table 11.9-5 Participants opinion on whether the prosthesis contributes to their social acceptance VAS score

A total of 43 (60.6%) stated that their prosthesis made them feel much better about social acceptance, whilst only 8 (11.3%) responded that they did not feel it contributed towards their social acceptance in any way. The majority of the remaining 19 (26.8%) responded that it made them feel that their social acceptance had improved (**Table 11.9-5**).

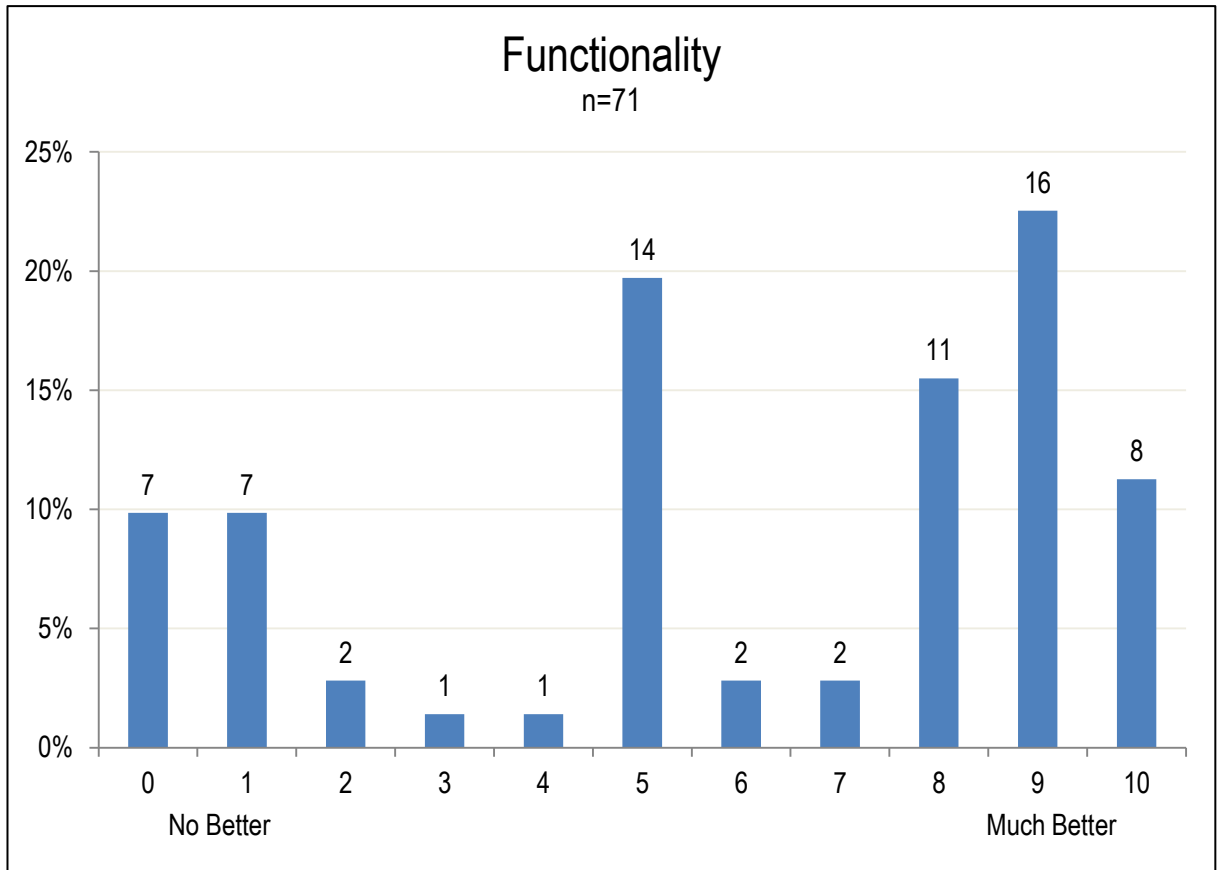


Table 11.9-6 Participants opinion on whether the prosthesis contributes to their functionality VAS score

A total of 35 (49.3%) responded that their prosthesis improved their functionality in a major way (**Table 11.9-6**). A group of 16 (22.5%) said it did not improve their functionality at all. The majority of the remaining 20 (28.2%) said that their prosthesis contributed to their functionality in some way.

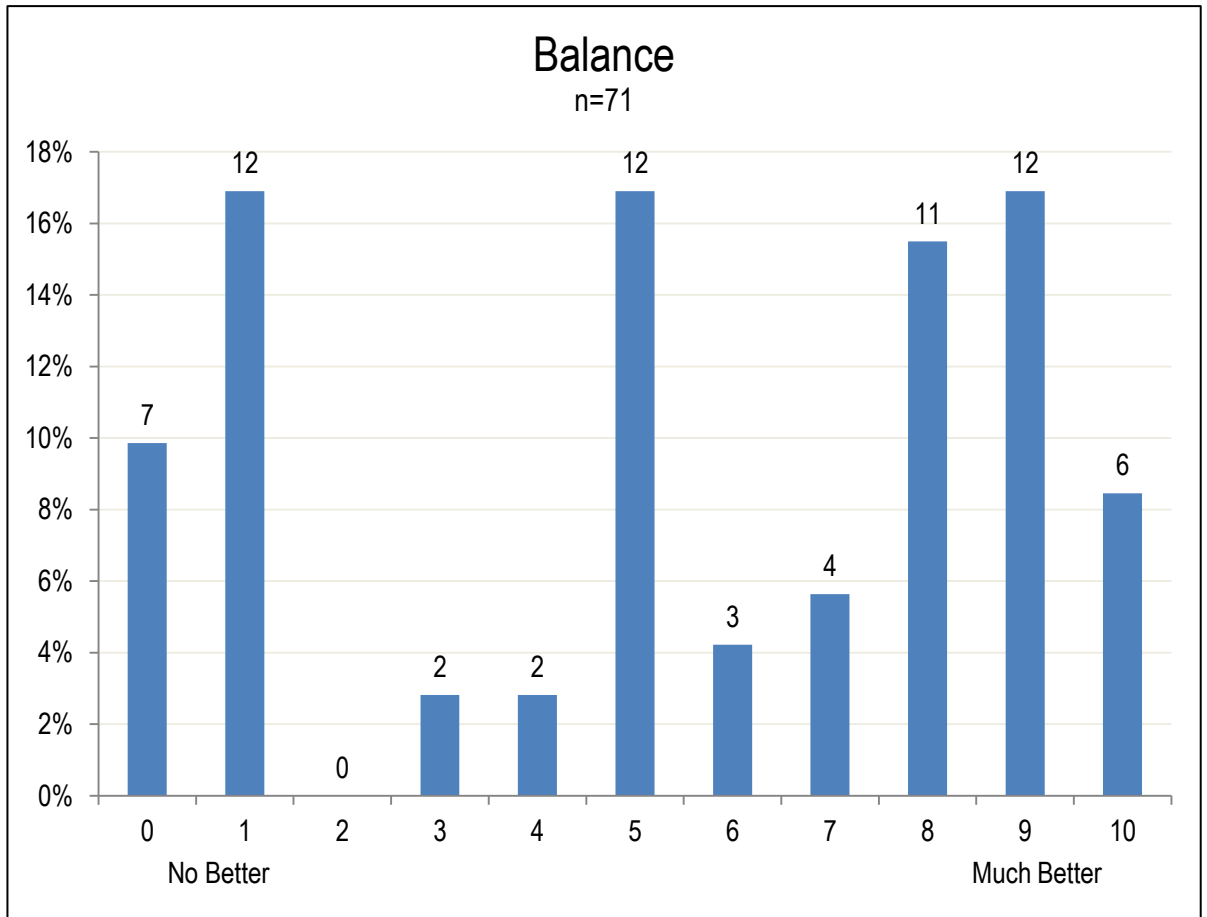


Table 11.9-7 Participants opinion on whether the prosthesis contributes to their balance VAS score

A total of 29 (40.8%) of respondents answered that their prosthesis made their balance ‘much better’, and another 19 (26.8%) said that the prosthesis made their balance ‘no better’. The majority of the remaining 23 (32.4%) answered that their prosthesis contributed in some way to their balance (**Table 11.9-7**).

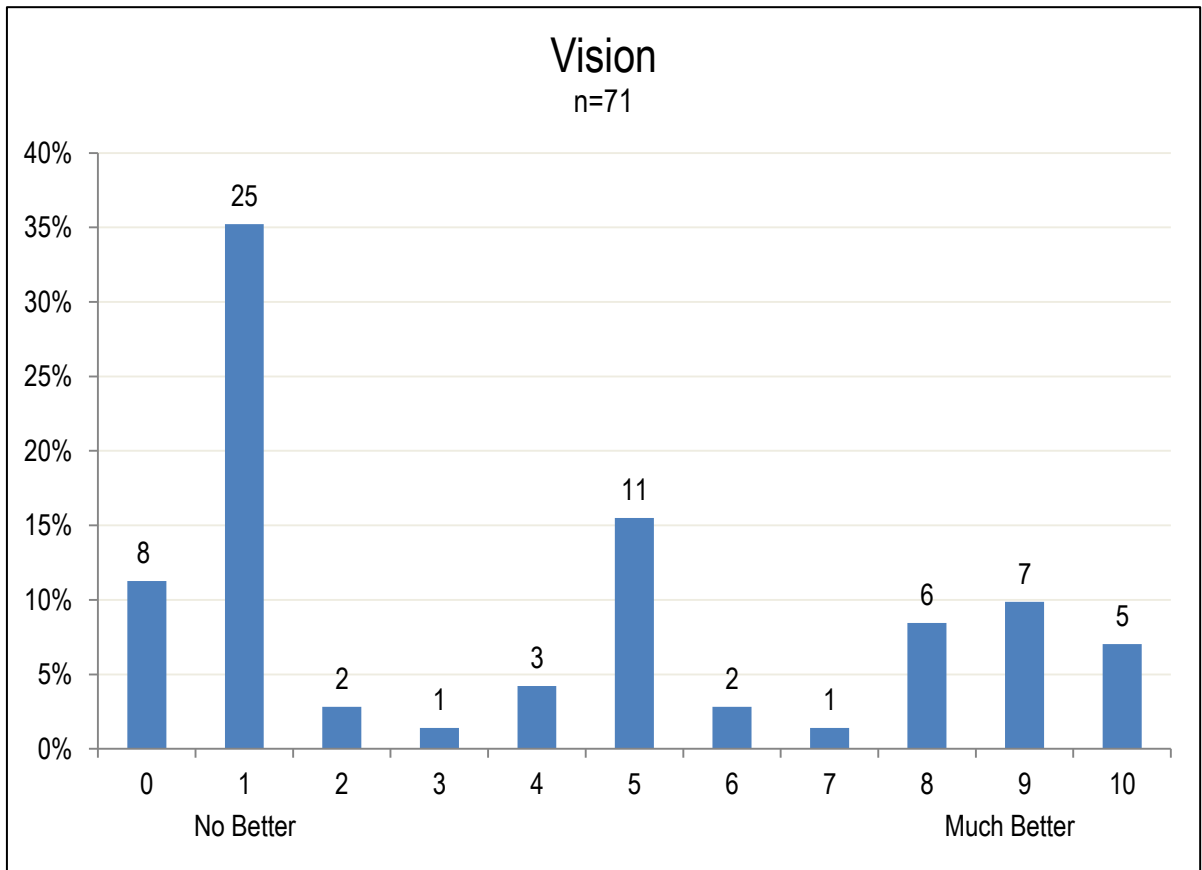


Table 11.9-8 Participants opinion on whether the prosthesis contributes to their vision VAS score

A total of 35 (49.3%) respondents answered that their prosthesis did not contribute in any way to their vision, whilst 18 (25.4%) answered that it made their vision 'much better' (11.9-8). Another group of 18 (25.4%) answered that their prosthesis improved their vision in some way.

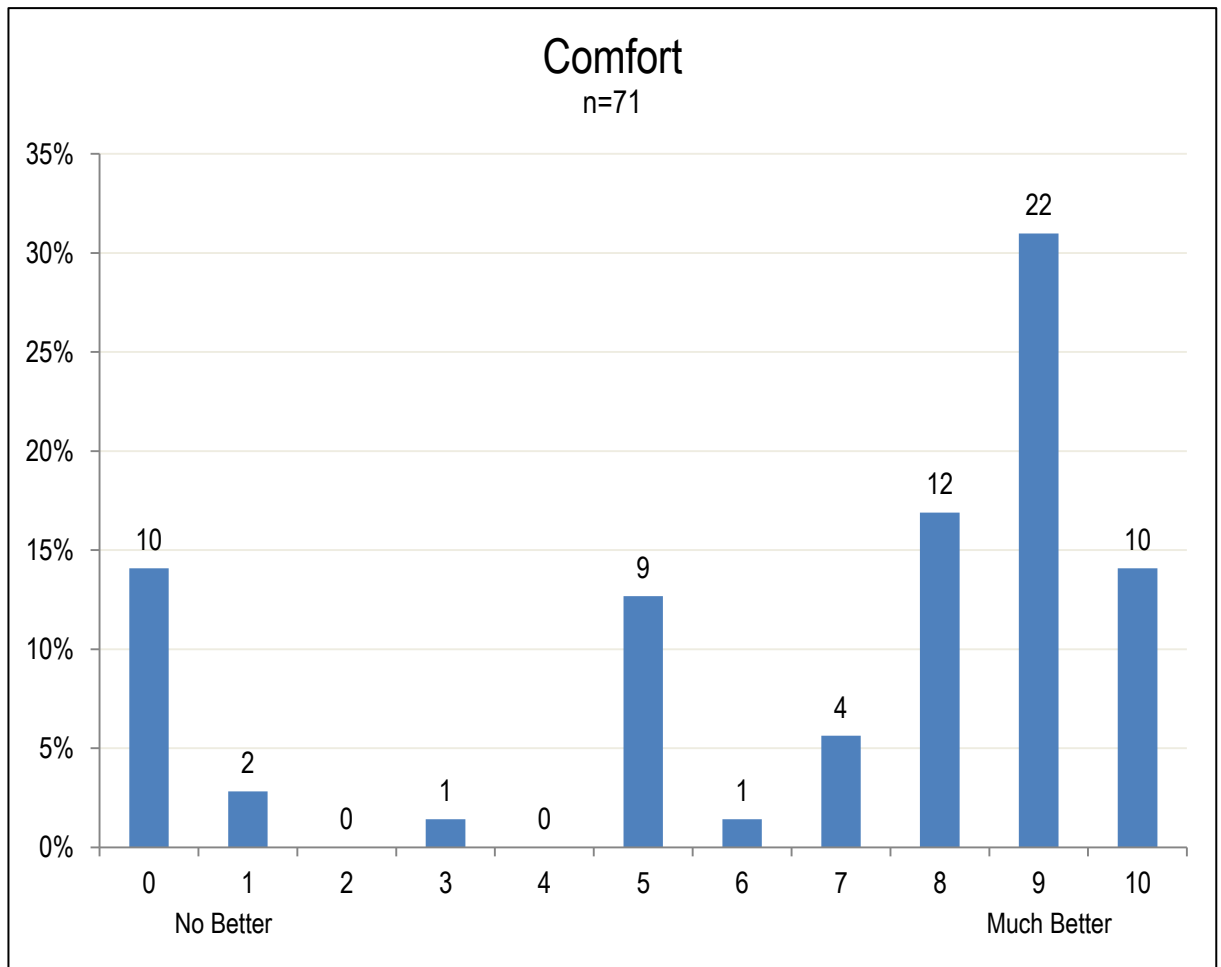
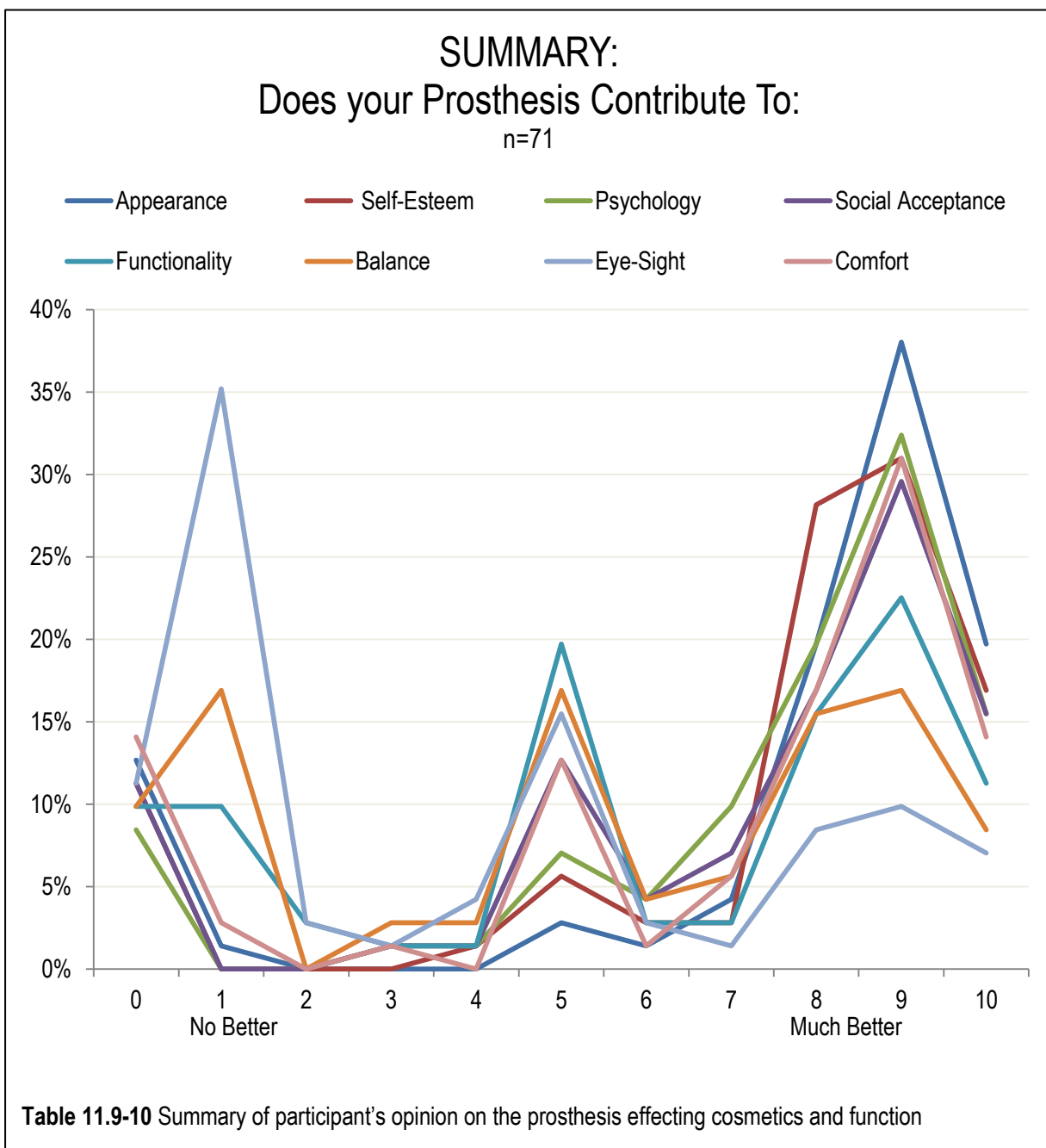


Table 11.9-9 Participants opinion on whether the prosthesis contributes to their comfort VAS score

A majority of 44 (62.0%) responded that their prosthesis made them feel much more comfortable (**Table 11.9-9**). A minority of 12 (16.9%) responded that their prostheses did not contribute to their comfort in any way. The remaining group of 15 (21.1%) answered that their prosthesis made them feel a little more comfortable.



There is a strong trend in the respondent's answers (Table 11.9-10). In the majority of categories, the respondents answer that their prosthesis makes them feel 'much better', or better in some way. There is also a very similar number of respondents across almost all areas who answer that their prostheses makes them feel 'no better'.

11.10 EFFECT ON LIFE

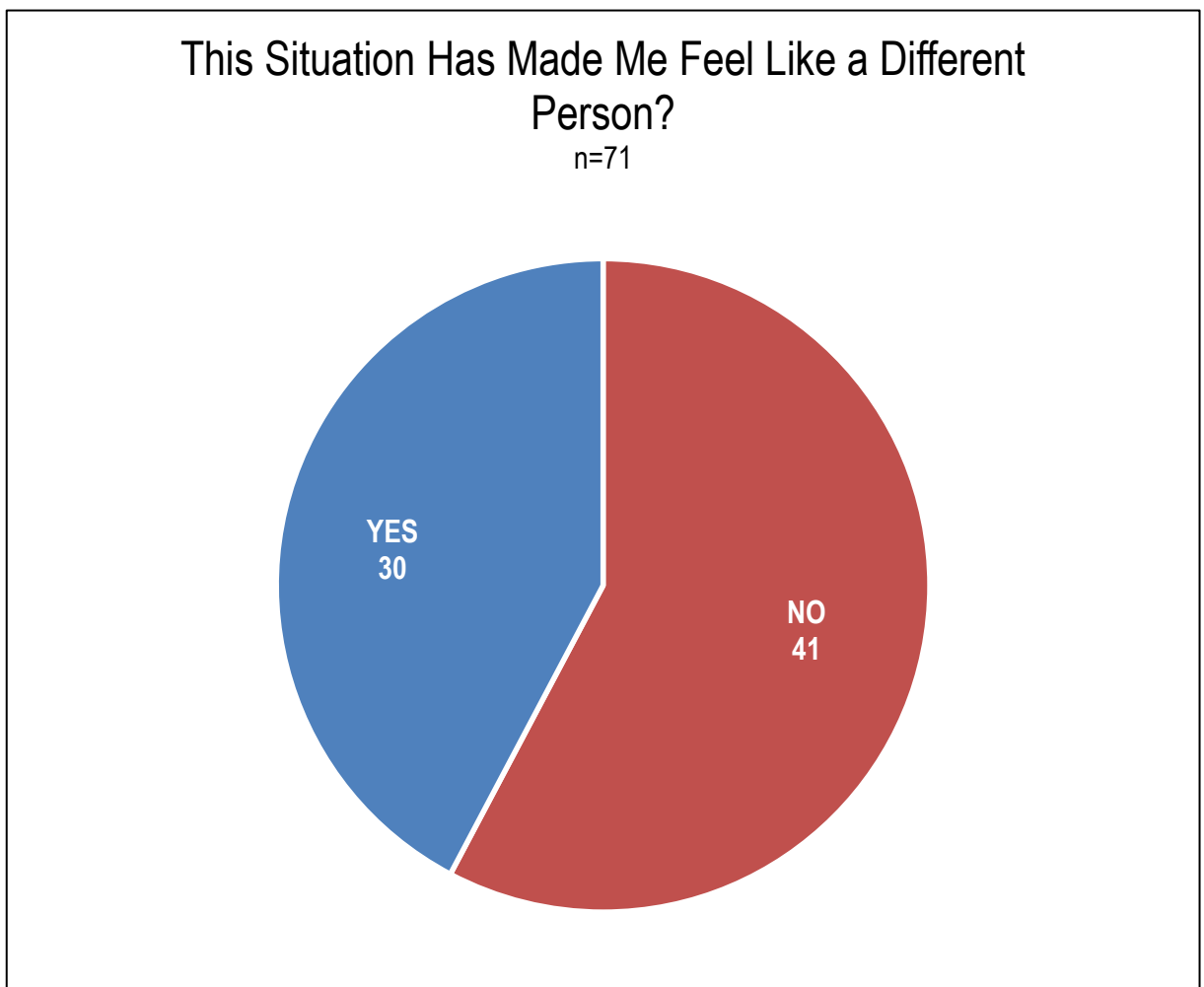


Table 11.10-1 Participants feeling like a different person as a result of their situation of eye loss

Of the 71 respondents, 30 (42.3%) answered that their ordeal of losing an eye, and having to go through prosthetic rehabilitation made them feel like a different person to who they were before (**Table 11.10-1**). The other 41 (57.7%) responded that their situation did not make them feel as though they had changed.

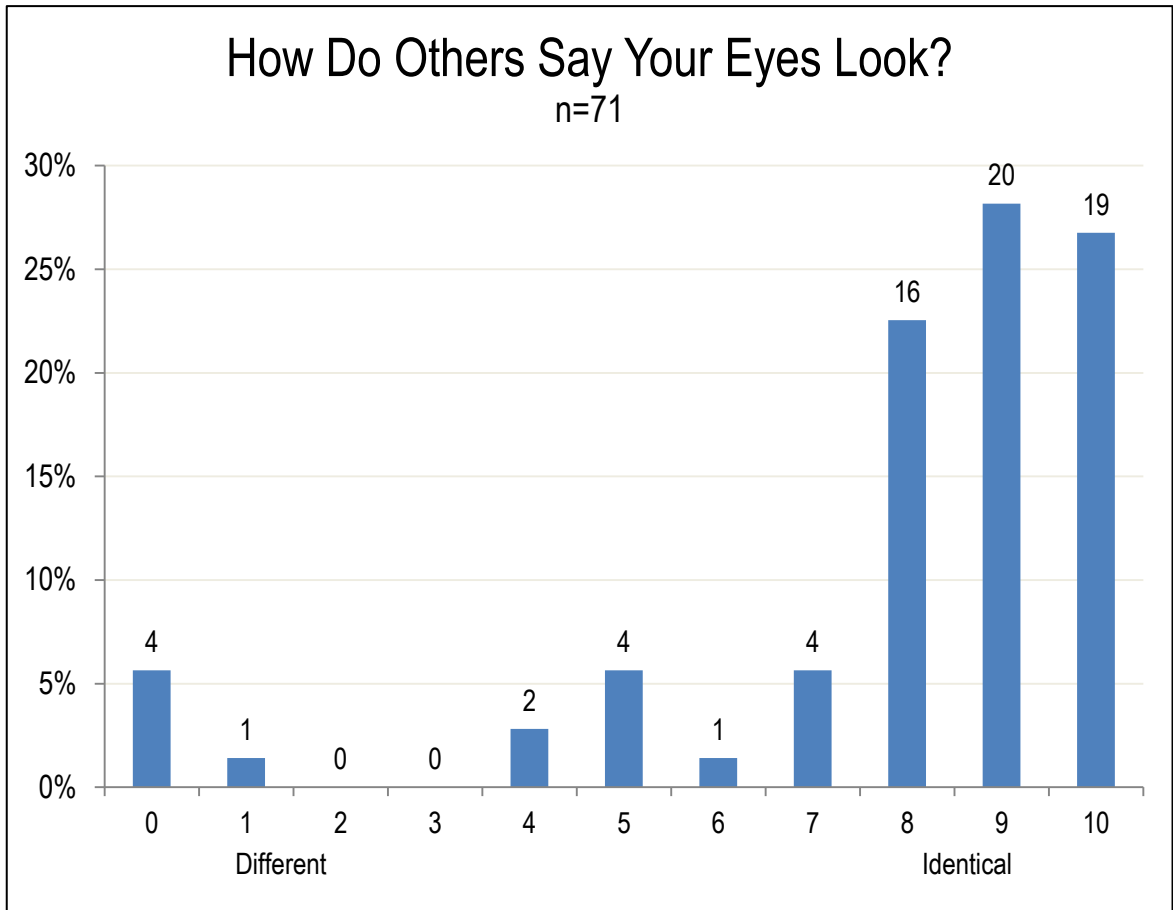


Table 11.10-2 Participants state others perception of prosthesis VAS scale

The vast majority of respondents numbered at 55 (77.5%) answered that others says their eyes look identical (**Table 11.10-2**). A small minority of 5 (7.0%) stated that others say their eyes look different. The remaining 11 (15.5%) answered that others say their eyes look similar.

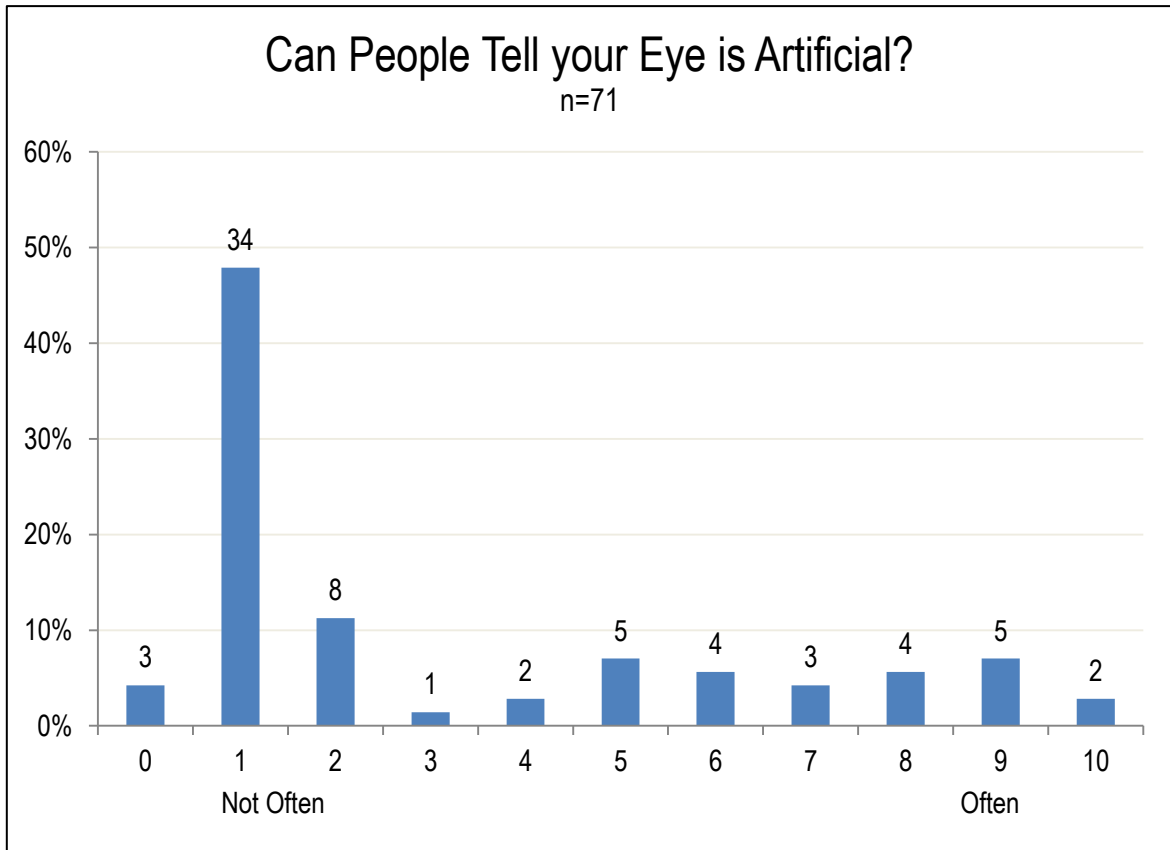


Table 11.10-3 Participants state if others identify the eye as artificial VAS scale

Of the 71 respondents, 45 (63.4%) answered that it is not often that people can tell their eye is artificial (**Table 11.10-3**). Only 11(15.5%) answered that people can often tell their eye is artificial. The remaining 15 (21.1%) answered that people can sometimes tell that their eye is artificial (**Fig. 7.8-1**).

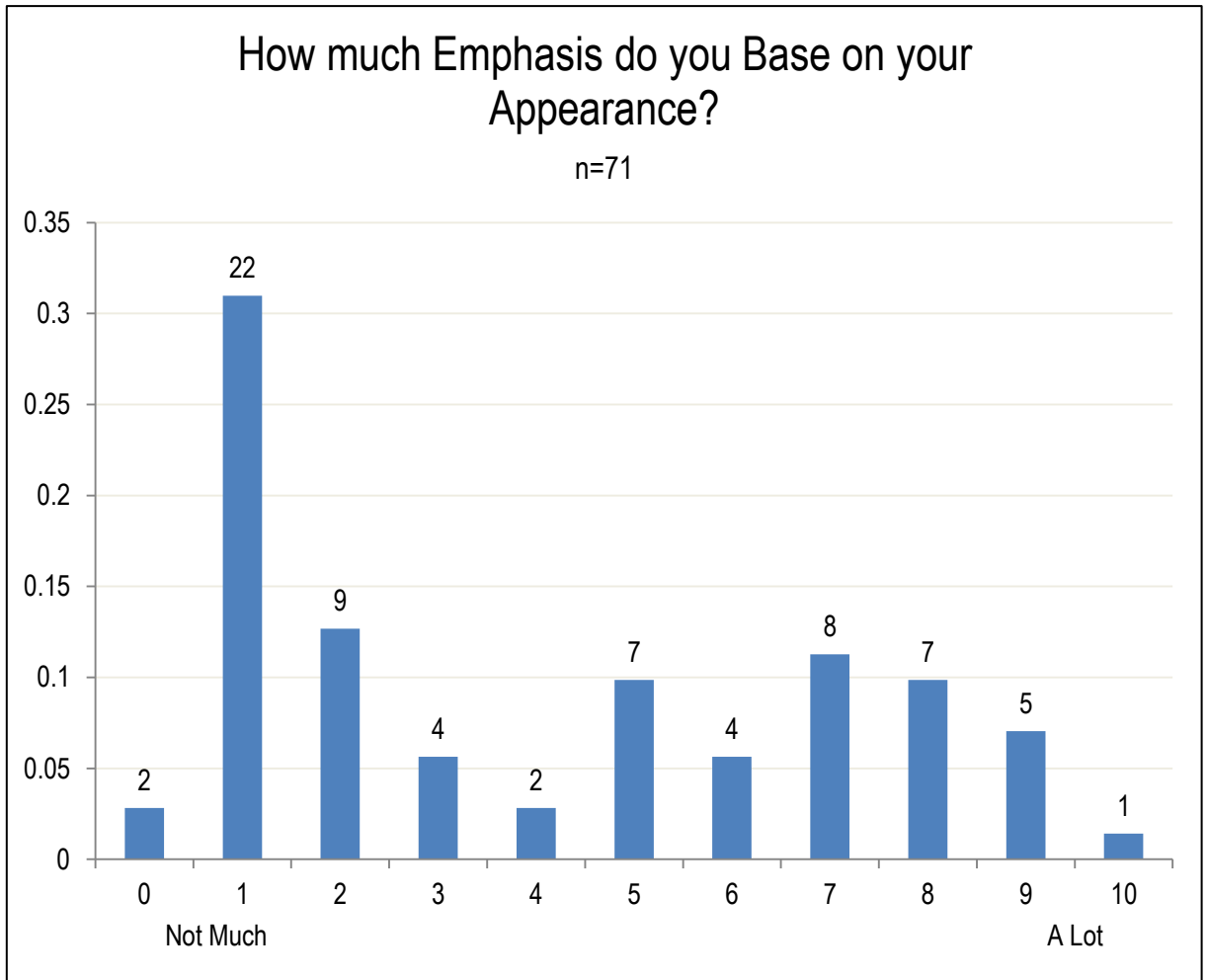
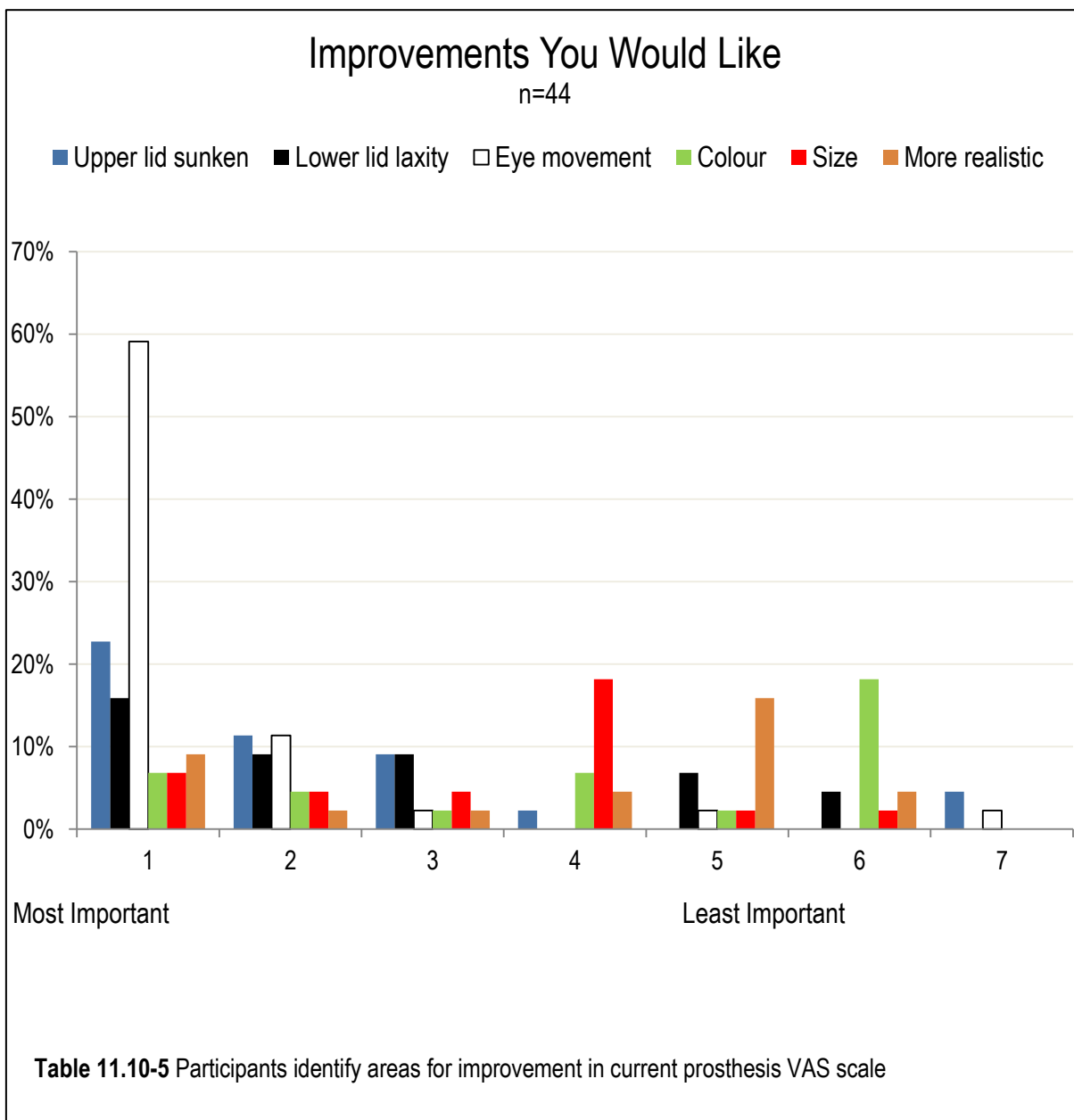


Table 11.10-4 Participants state the amount of emphasis they place on their appearance VAS scale

A total of 33 (46.5%) respondents answered that they do not base much emphasis at all on their appearance, whilst 13 (18.3%) answered that they base a lot of emphasis on the way they look (**Table 11.10-4**). The remaining 25 (35.2%) were spread in between each answer, with a small trend towards putting some emphasis on the way they look.



Of the 71 respondents, 44 (62.0%) listed improvements to their prosthesis that could make it more natural (Table 11.10-5). Of these 44, 26 (59.1%) listed increased prosthesis movement as the most important improvement that could be made. Some respondents rated more than one improvement as '1' or, most important, meaning that the 'number of respondents', who rated improvements '1' or, most important, is more than 100%.

The second most important improvement that this group identified was improvements involving sunken upper eyelids, 10 respondents (22.7%) listed this as '1' or, most important.

The lower lid laxity was the next 'most important' improvement that could be made, a total of 7 (15.9%) respondents listed this as '1' on their VAS scale.

A total of 4 (9.1%) listed that the most important improvement for them would be a more realistic prosthesis.

Two groups of 3 respondents (6.8%) listed their most important improvement as 'colour improvements', and 'size adjustments', respectively.

11.11 FEELINGS OF VISION

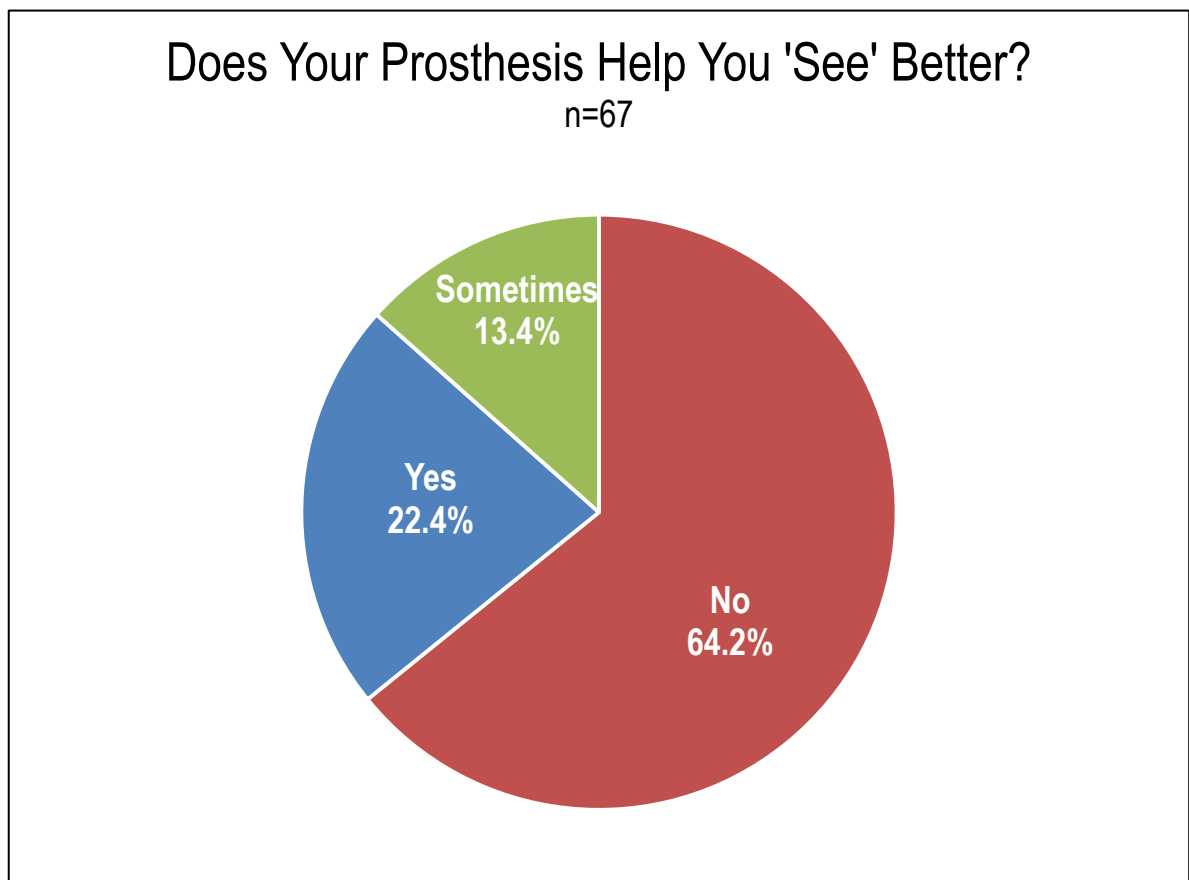


Table 11.11-1 Identification of whether the prosthesis assists to 'see' better (also see **Table 11.9-8**)

A majority of 43 (64.2%) answered that they cannot 'see' any better with their prosthesis, whilst 15 (22.4%) say they can, and 9 (13.4%) say that sometimes it helps them 'see' better (**Table 11.11-1; Table 11.9-8**). This question is aimed to assess the perception of improved vision as a number of patients had stated in a clinical context that their prosthetic eye made them feel that they could see better. Some felt it was because their remaining natural eye 'relaxed' and felt under less stress.

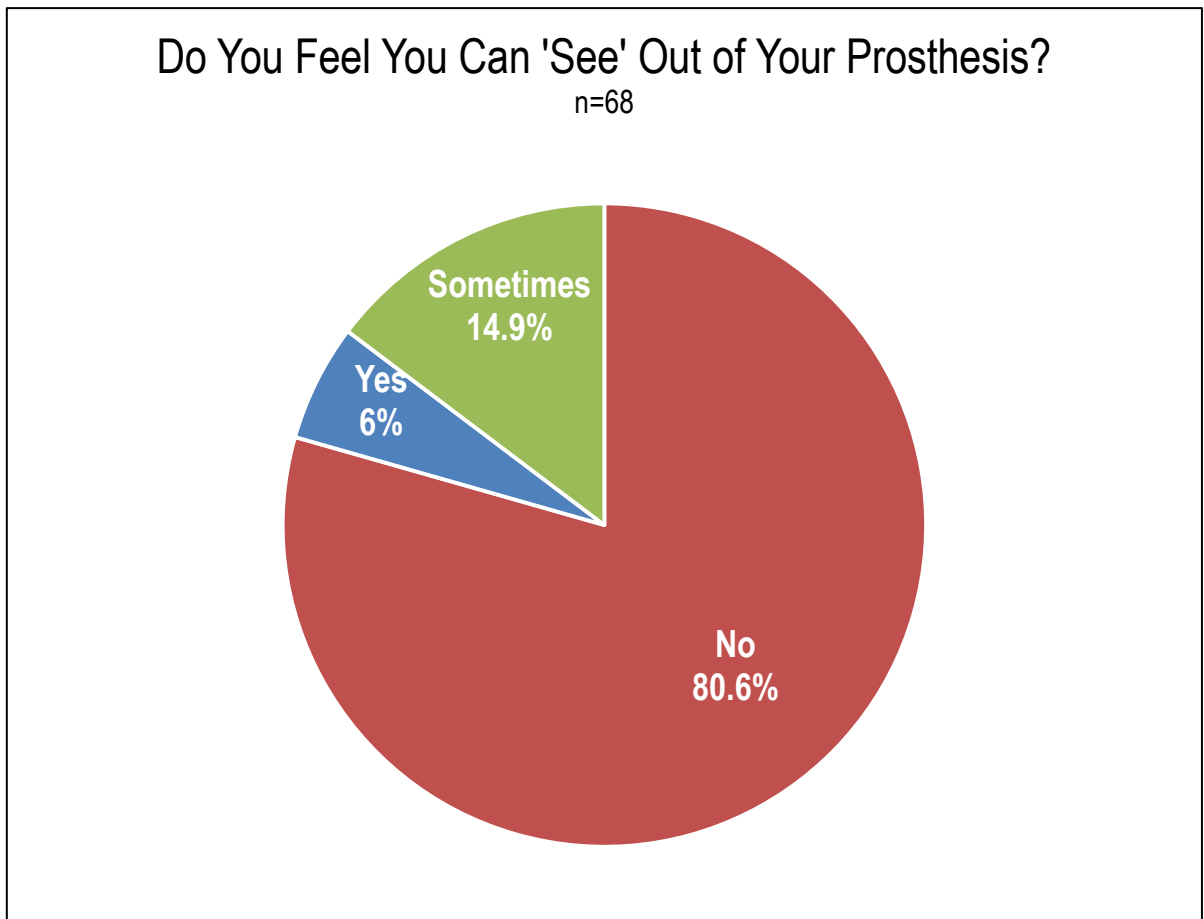


Table 11.11-2 Identification of whether the participant can 'see' out of the prosthesis

A total of 54 (80.6%) answered that they cannot 'see' out of their prosthesis, however 4 (6.0%) answered they feel they can see out of their prosthesis (**Table 11.11-2**). Another group of 10 (14.9%) answered that sometimes they feel like they can 'see' out of their prosthesis. This question was asked due to patient comments in a clinical context that 'although it may sound strange' they felt they could 'see through' or 'out of' their prosthetic eye. This could be attributed to the widely debated theory of 'morphic resonance', which suggests a habit gained from memory of previously similar systems rather than laws of nature (Sheldrake, 2016).

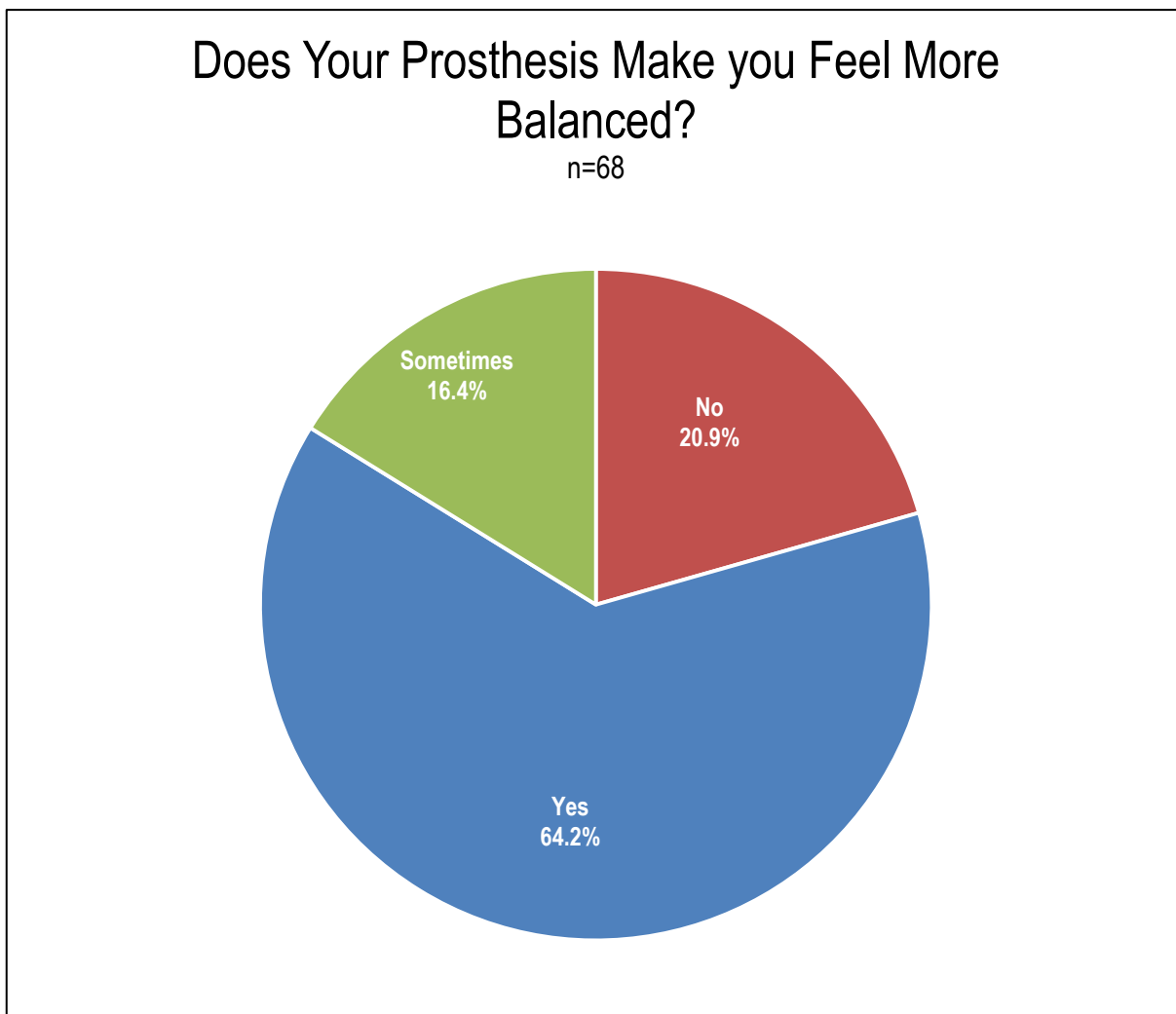


Table 11.11-3 Participants identify if the prosthesis makes them feel more balanced

A majority of 43 (64.2%) state that wearing their prosthesis makes them feel more balanced (**Table 11.11-3**). A group of 14 (20.9%) answered that it does not help their balance, and another group of 11 (16.4%) answered that wearing their prosthesis sometimes helps with their balance. This term 'balance' was used due to a number of patients in the clinical context describing a sensation of balance whilst wearing their prosthesis and by contrast feeling unbalanced without. This could be defined as both residual symmetry and morphic resonance.

11.12 DISCHARGE

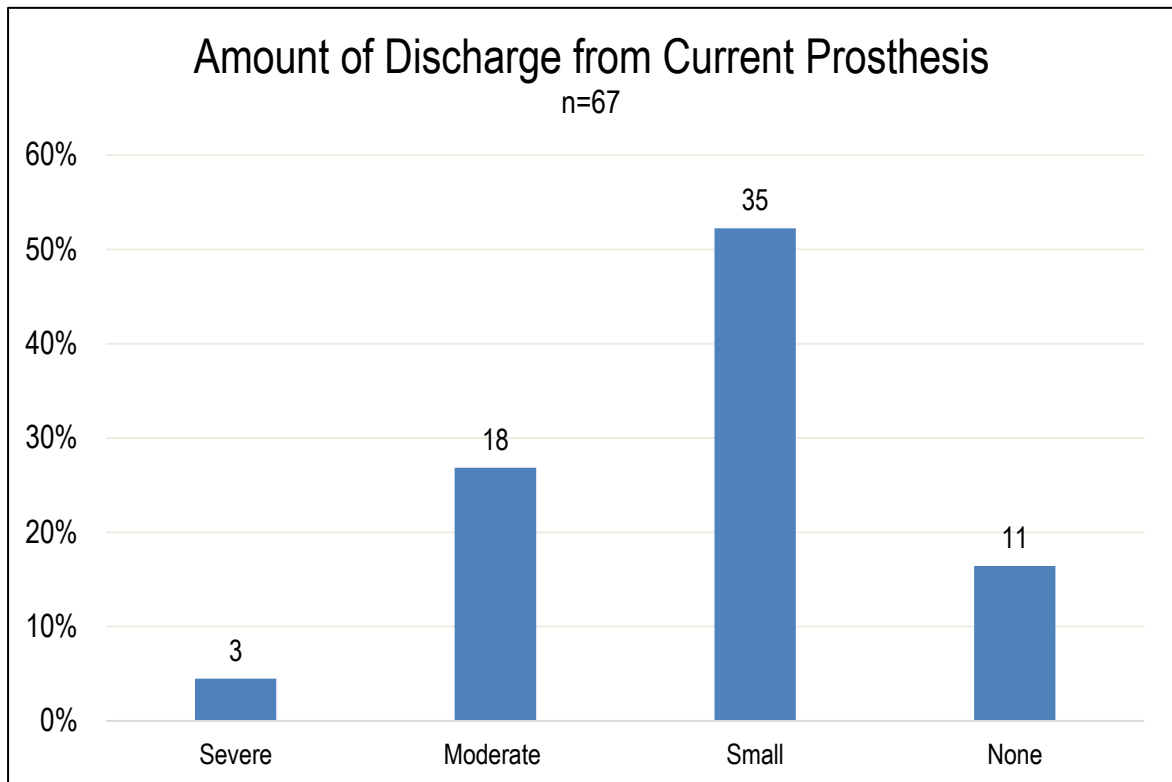


Table 11.12-1 Participants discharge amount from current prosthesis

In the group of 67 that answered, a group of 35 (52.2%) answered that they get a small amount of discharge with their current prosthesis (**Table 11.12-1**). A group of 18 (26.9%) answered that they experience a moderate amount of discharge. A group of 11 (16.4%) experience no discharge at all, whilst 3 (4.5%) of the respondents answered that they experience severe discharge with their current prosthesis.

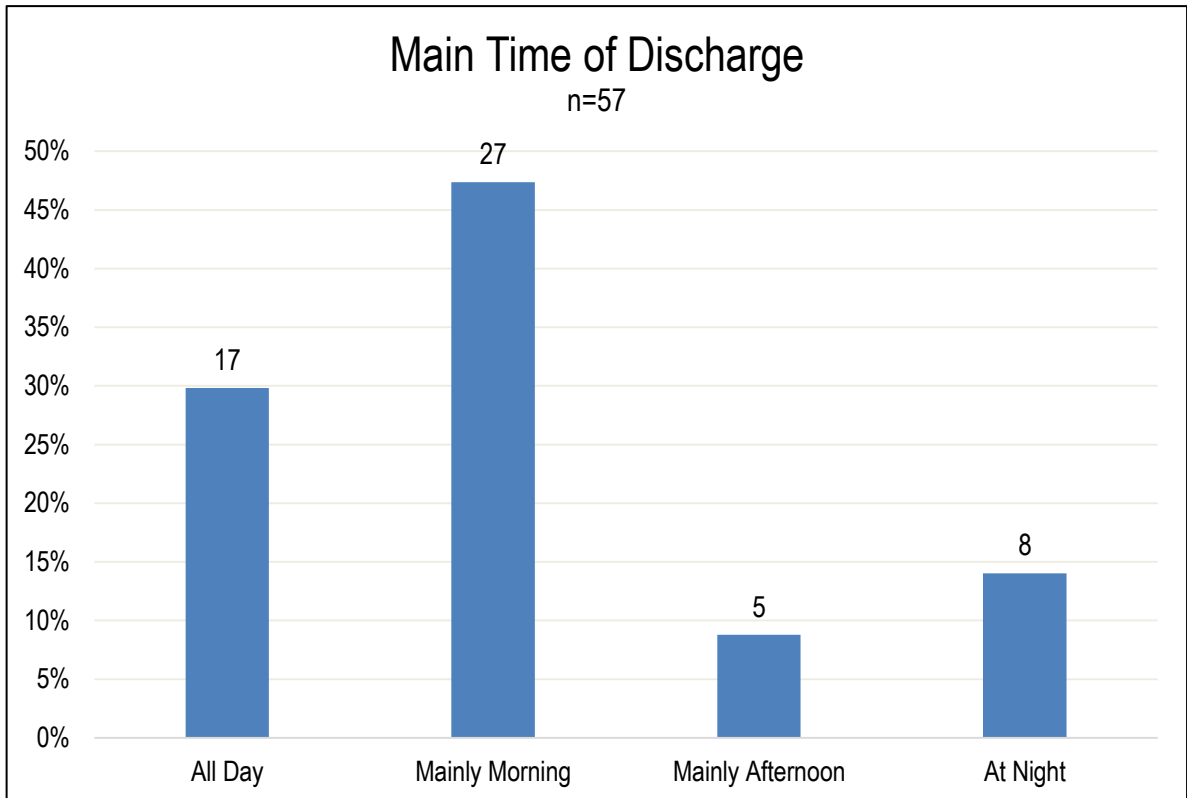


Table 11.12-2 Participants identify main time of day for discharge

A total of 27 (47.4%) of the group of 57 respondents to this question answered that their discharge occurs mainly in the morning (**Table 11.12-2**). A group of 17 (29.8%) answered that they experience discharge all day. A group of 8 (14.0%) experience discharge at night, whilst only 5 (8.8%) mainly experience discharge in the afternoon.

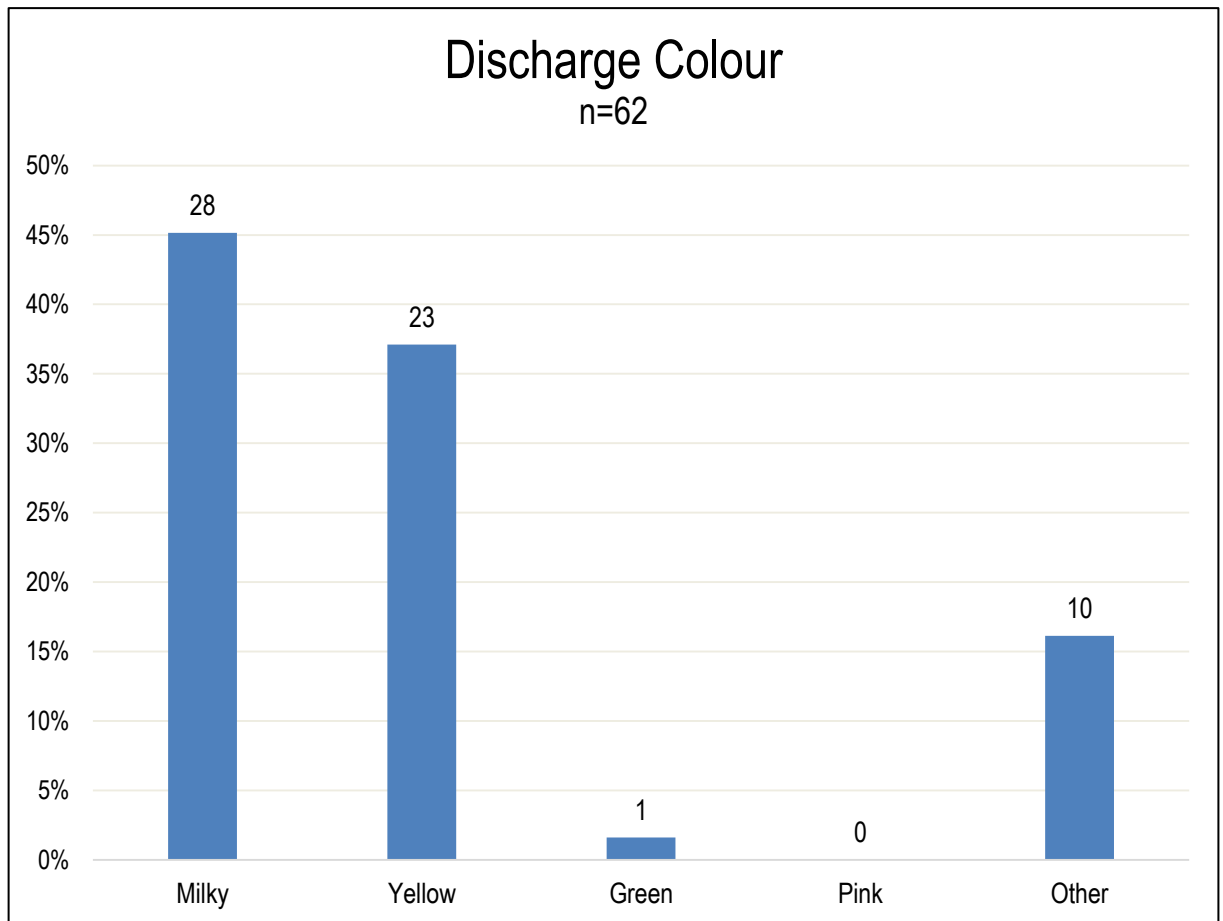


Table 11.12-3 Participants identify discharge colour

Whilst only 56 reported experiencing discharge; there is discrepancy as there are 62 responses as to the colour of the discharge experienced (**Table 11.12-3**). A majority of 28 (45.2%) respondents experiencing discharge are experiencing 'milky' discharge. Another group of 23 (37.1%) reported that they experience yellow discharge. A total of 10 (16.1%) reported that they experience another colour, such as clear or sandy. Only 1 (1.6%) in the group reported experiencing green discharge.

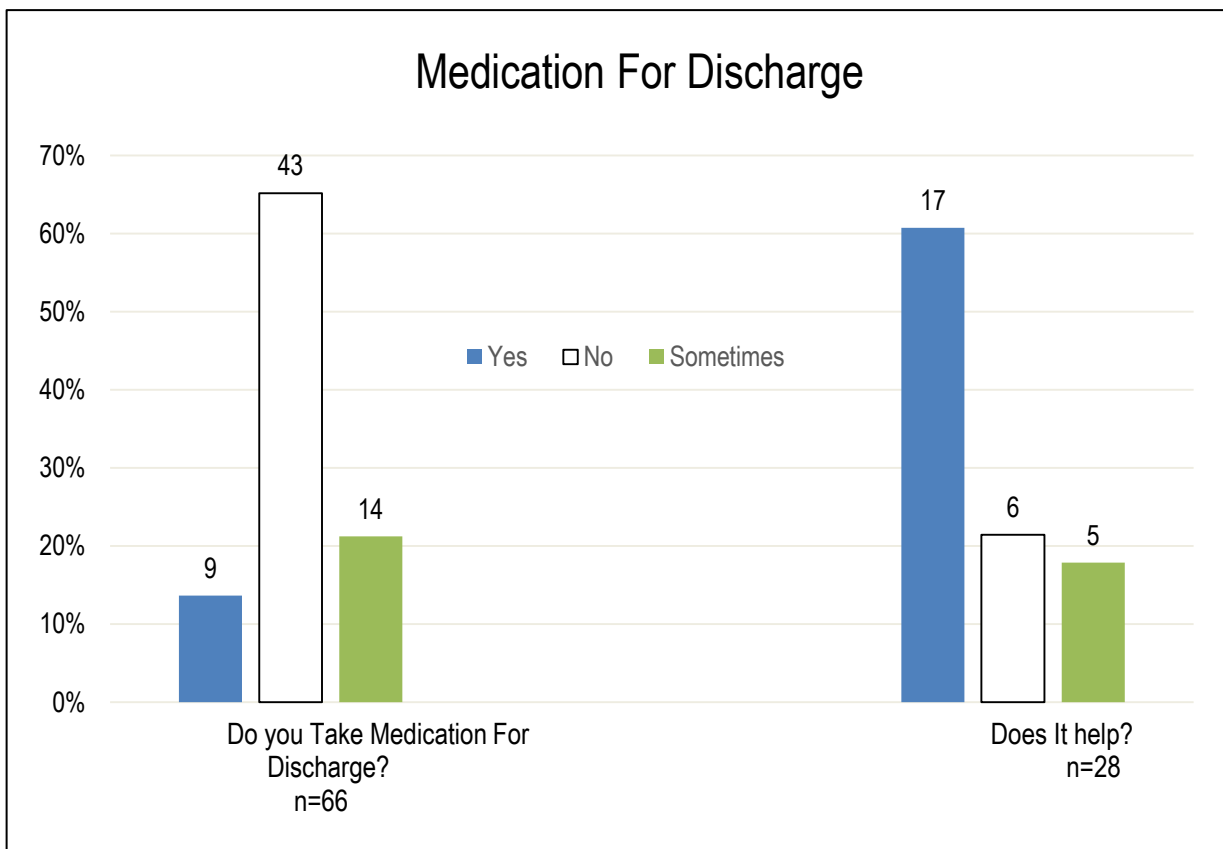


Table 11.12-4 Participants medication for discharge and outcomes

A majority of 43 (65.2%) respondents do not take medication for the discharge they experience, whilst 9 (13.6%) do, and 14 (21.2%) sometimes do (**Table 11.12-4**).

A total of 28 respondents commented on whether medication helps for discharge, 17 (60.7%) of this group answered that medication does help with discharge. A total of 6 (21.4%) said that medication does not help for discharge, and 5 (17.9%) answered that medication sometimes helps to treat their discharge.

A total of 23 responded that they did, or sometimes take medication for discharge, however 28 commented on whether medication for discharge helps. This may be due to some participants no longer taking medication, because their discharge has stopped, or they do not benefit from the medication, so have ceased from taking it. The type of medication used was irrelevant for this question, with each patient receiving individual recommendations from their health professionals. Usually medication would involve a topical antibiotic as an ointment or some various lubricant.

11.13 SLEEPING

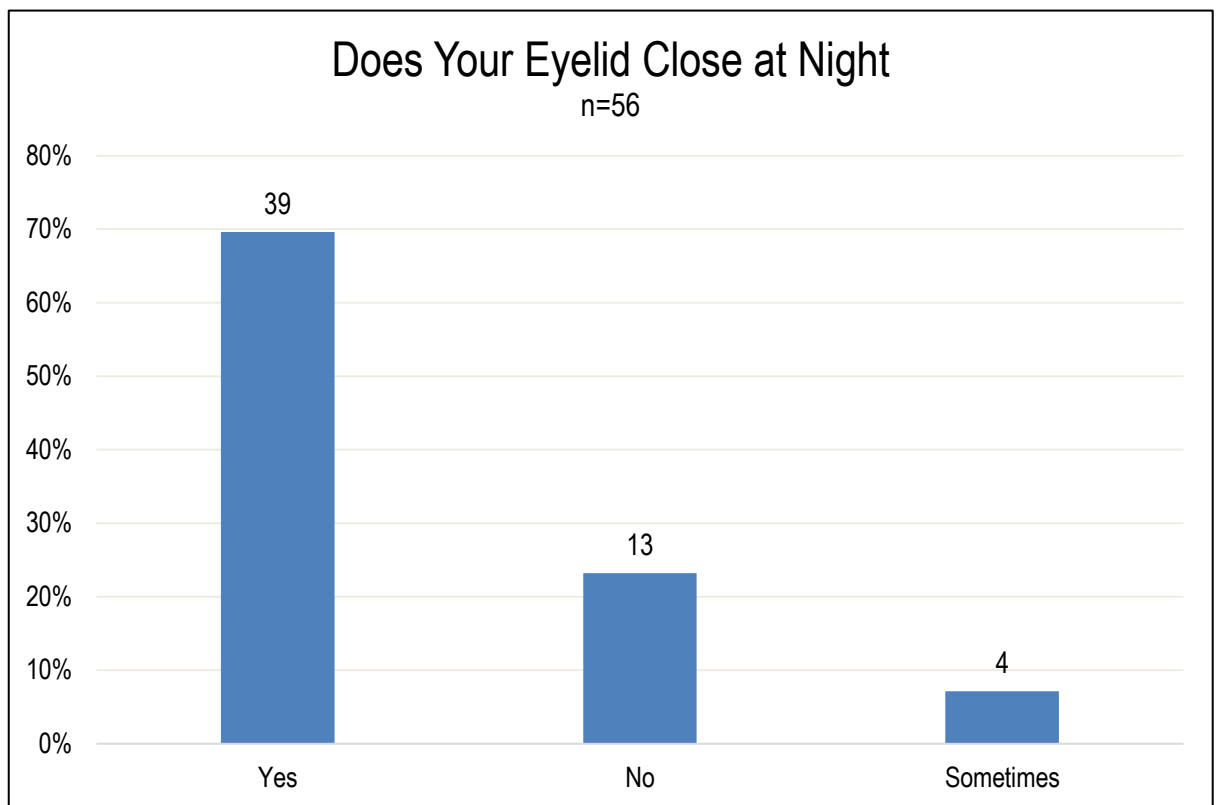


Table 11.13-1 Whether participants' eyelid close at night

Out of the 71 participants, 56 participants responded. A group of 39 (69.6%) of respondents answered that their eyelid closes over the prosthesis at night (**Table 11.13-1**). A total of 13 (23.2%) answered that their eyelid does not close over the prosthesis. A minority of 4 (7.1%) answered that their eyelid sometimes, but not always closes over the prosthesis at night.

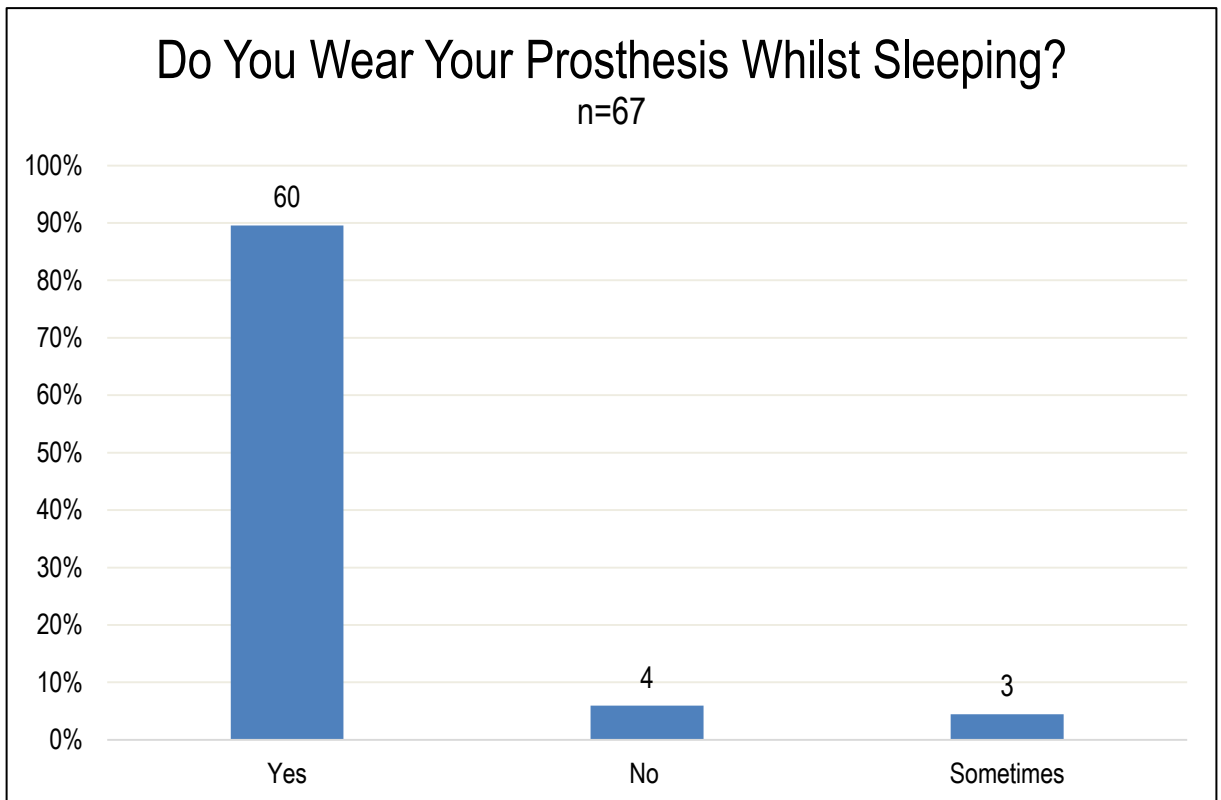


Table 11.13-2 Participants who wear their prosthesis while sleeping compared to those who don't

A majority of 60 (89.6%) respondents reported that they wear their prosthesis whilst sleeping. A small group of 4 (6.0%) answered that they do not wear their prosthesis whilst sleeping, and a minority of 3 (4.5%) sometimes wear their prosthesis whilst sleeping. The total of respondents was 67 of the 71 participants.

11.14 EYE CARE

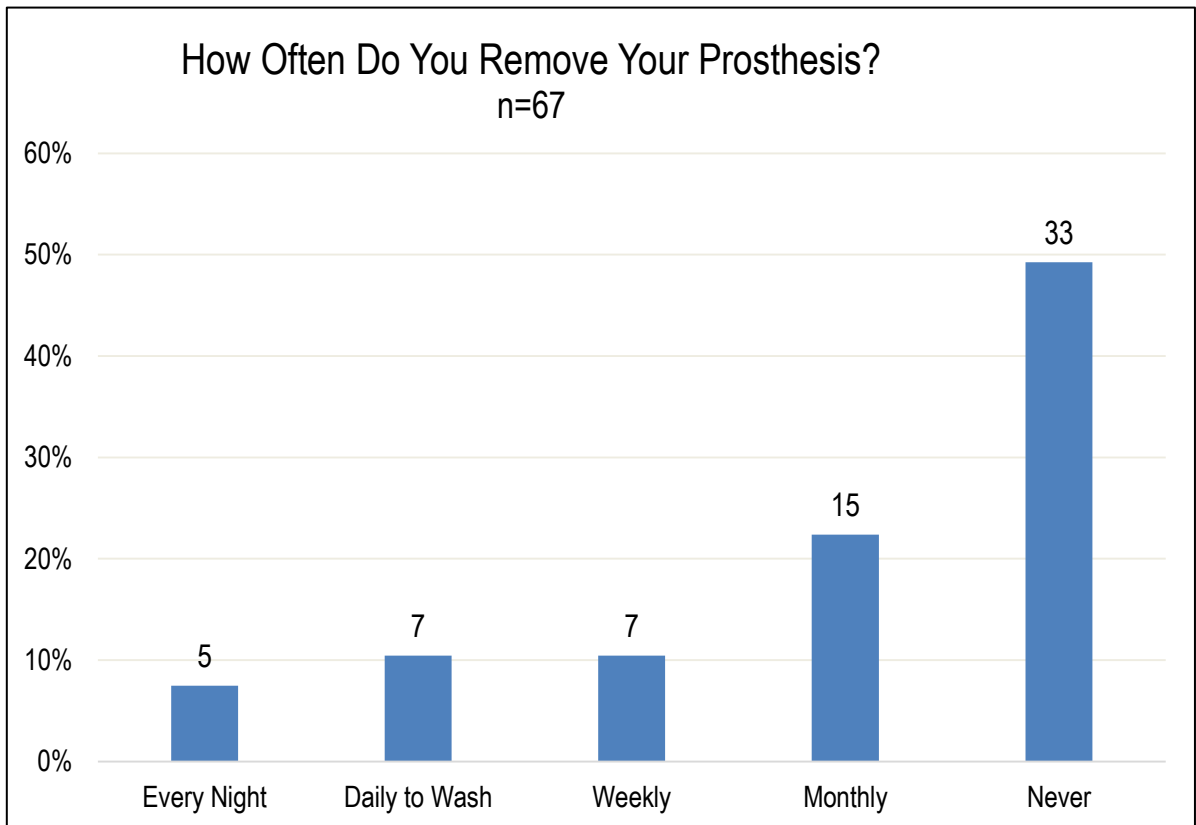


Table 11.14-1 How often participants remove their prosthesis

A total of 33 (49.3%) of the 67 respondents to this question answered that they never remove their prosthesis (**Table 11.14-1**). A group of 15 (22.4%) remove theirs monthly; 7 (10.4%) remove theirs weekly; another 7 (10.4%) remove theirs daily for washing, and a small group of 5 (7.5%) remove theirs every night to sleep.

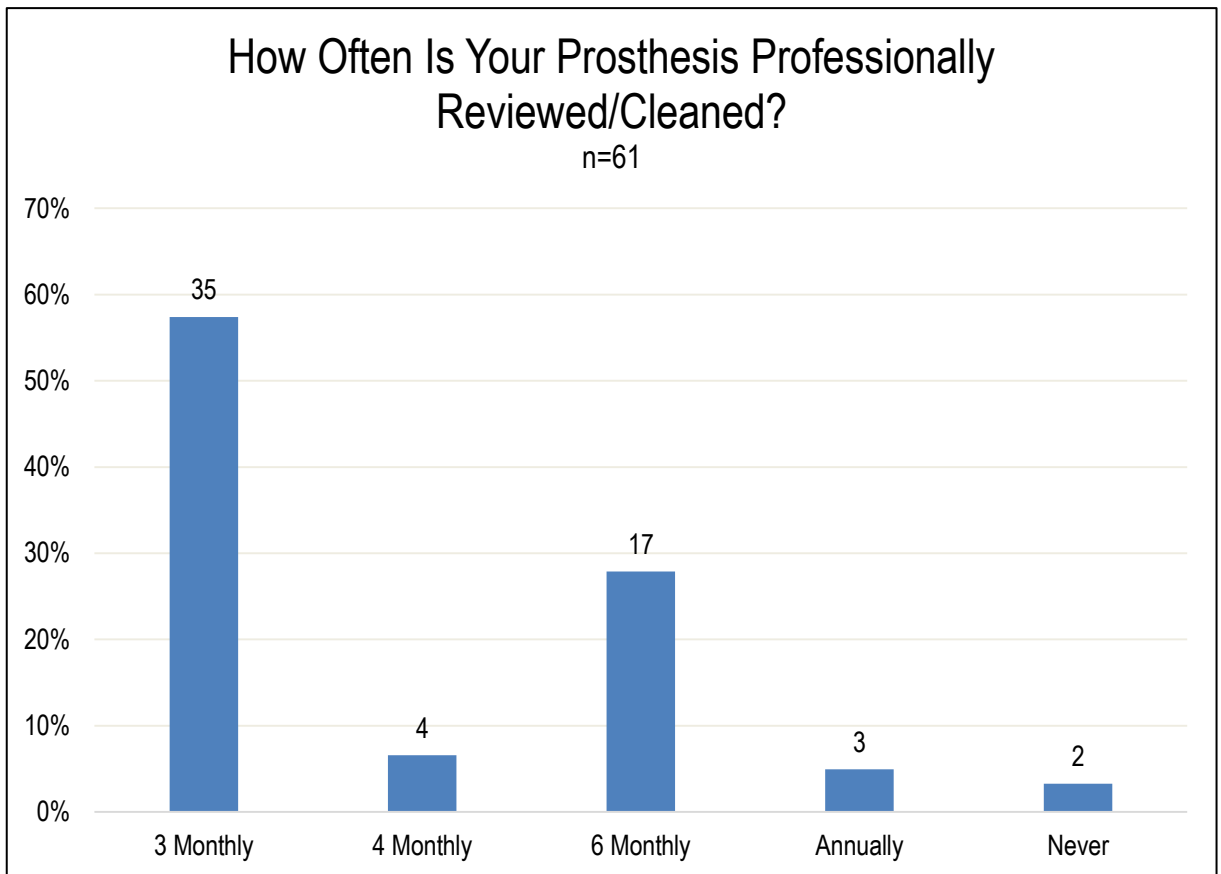


Table 11.14-2 How often participants have their prosthesis professionally cleaned

A group of 35 (57.4%) have their prosthesis professionally reviewed and cleaned every 3 months, whilst 17 (27.9%) answered that they have theirs reviewed/cleaned every 6 months (Table 11.14-2). A group of 4 (6.6%) have their reviewed/cleaned professionally every 4 months, with another group of 3 (4.9%) undertake this annually. A minority of 2 (3.3%) reported that they never have their prosthesis professionally reviewed/cleaned.

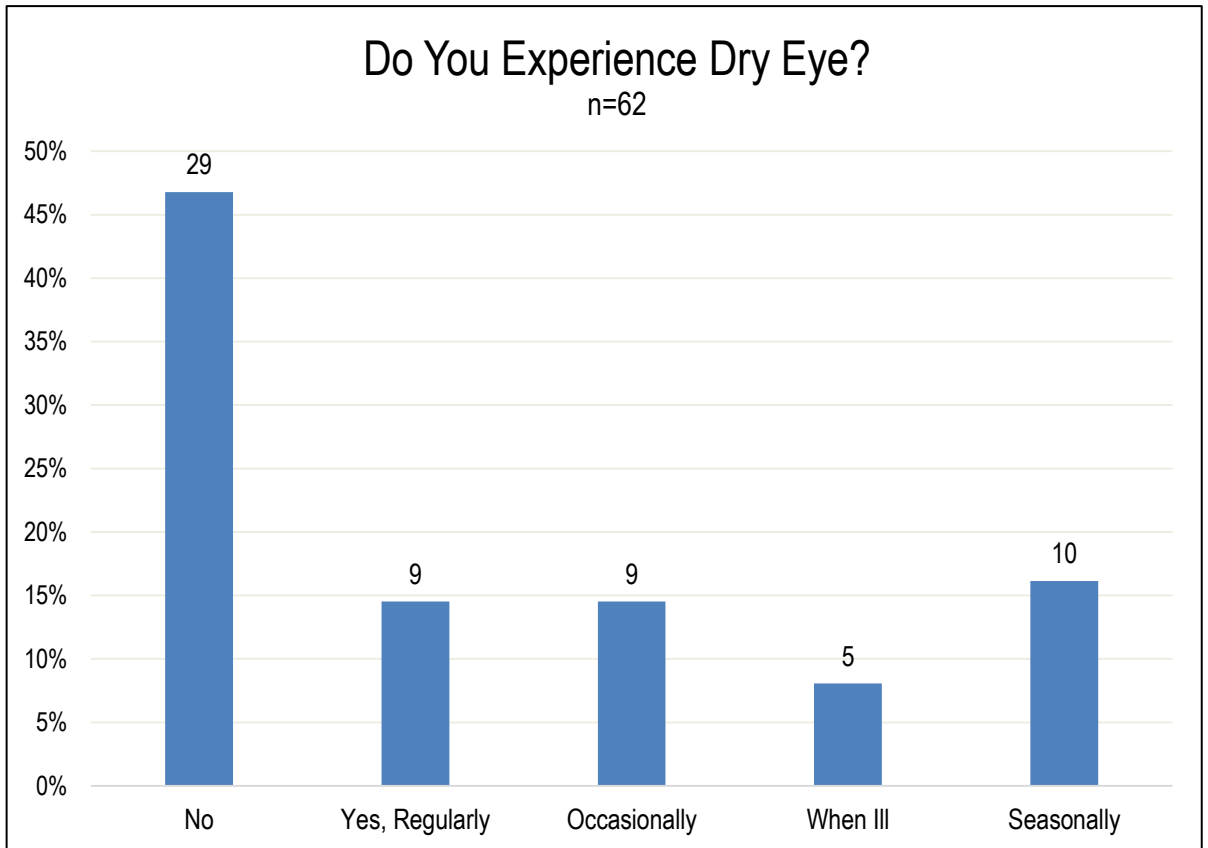


Table 11.14-3 How often participants experience dry eye

Almost half – 29 (46.8%) – of respondents answered that they do not experience dry eye (**Table 11.14-3**). A group of 9 (14.5%) answered that they regularly suffer from a dry eye, another 9 (14.5%) answered that they occasionally do. A total of 5 (8.1%) answered that they suffer from dry eye when they are unwell, and 10 (16.1%) experience dry eye seasonally.

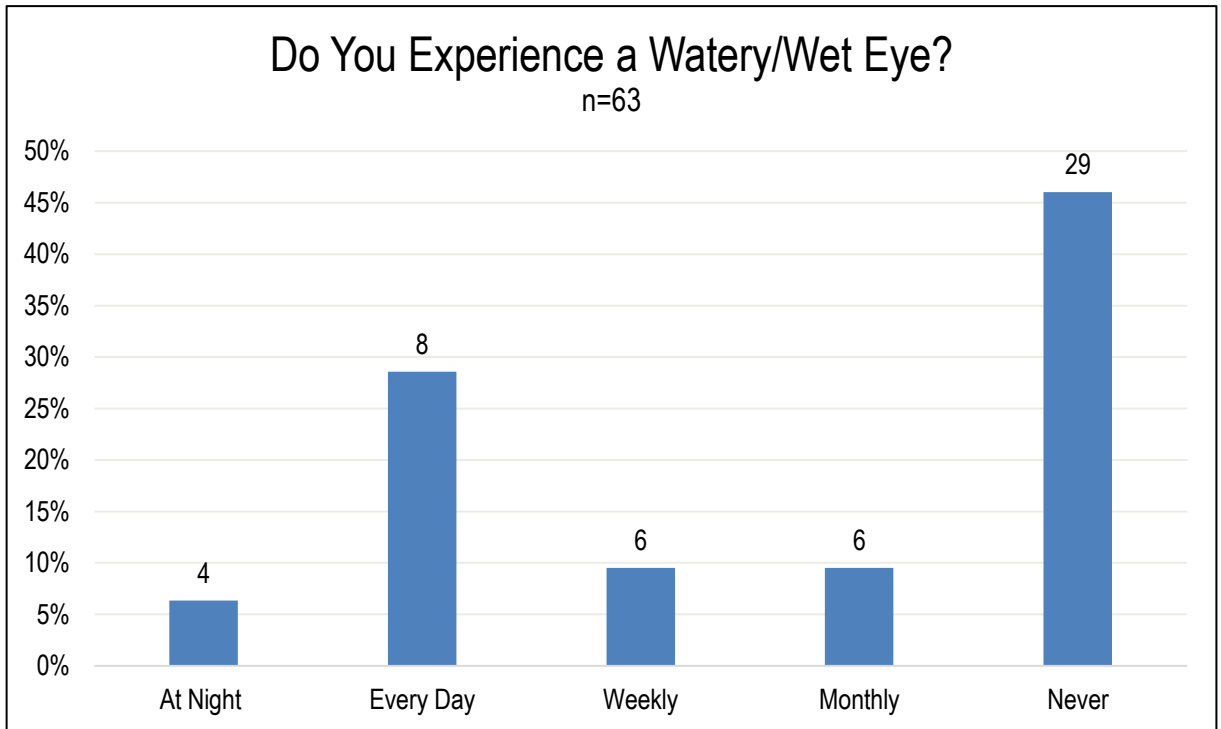


Table 11.14-4 How often participants experience watery eye

A total of 29 (46.0%) of the 63 respondents answered that they never experience wet/watery eye (**Table 11.14-4**). A group of 8 (12.7%) suffer it on a daily basis, whilst 6 (9.5%) experience it weekly, and another 6 (9.5%) suffer it monthly. A minority of 4 (6.3%) answered that they suffer watery/wet eye at night.

11.15 GETTING USED TO ONE EYE

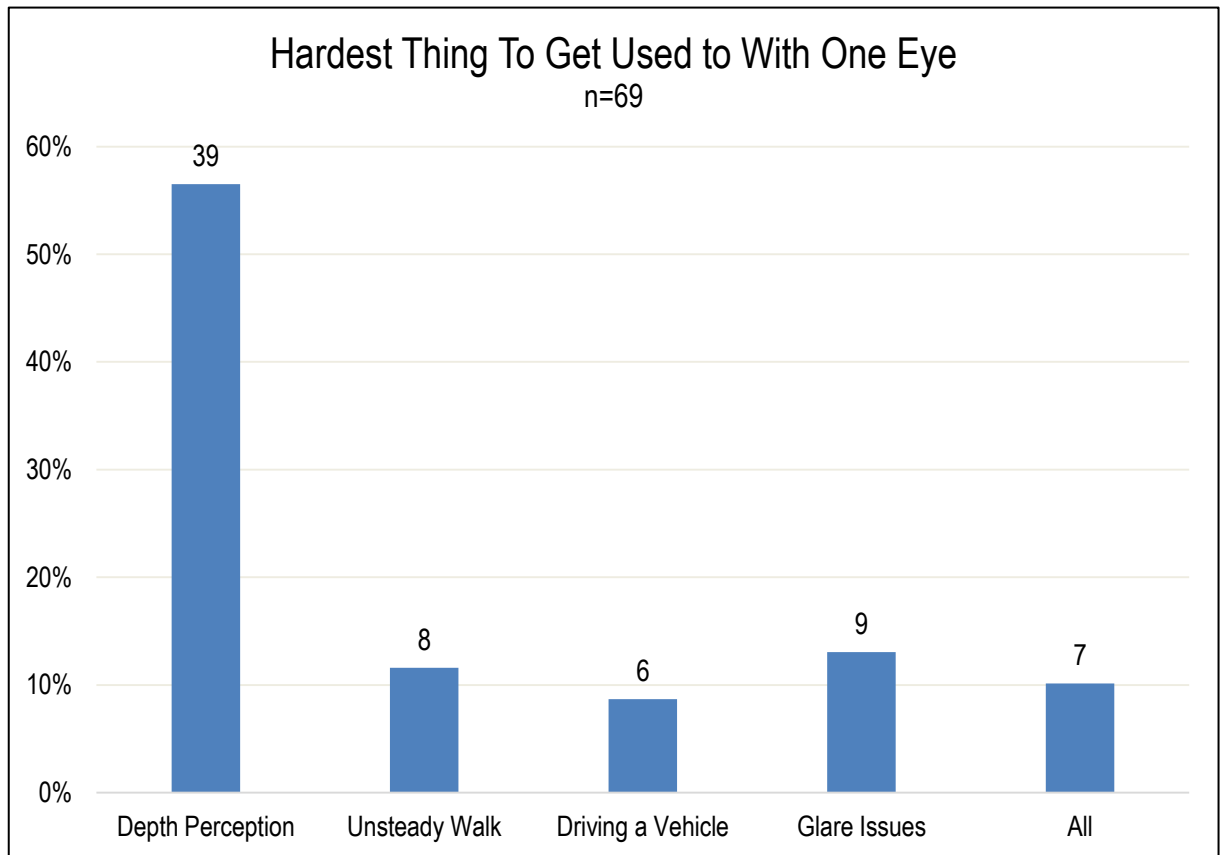


Table 11.15-1 Participants identify hardest areas of initial adjustment

When asked what the hardest thing to get used to doing with one eye, 69 participants responded out of the 71 total. Thirty-nine (56.5%) of respondents said it was depth perception was the hardest adjustment (**Table 11.15-1**). A group of 9 (13.0%) answered glare issues, whilst another 8 (11.6%) answered that an unsteady walk (misjudging where to put their feet) was the hardest. A total of 6 (8.7%) answered that driving a vehicle was the hardest thing to get used to, whilst a group of 7 (10.1%) said that everything was very difficult to get used to. This question was asked in the light that any change requires time for adjustment over a period of time.

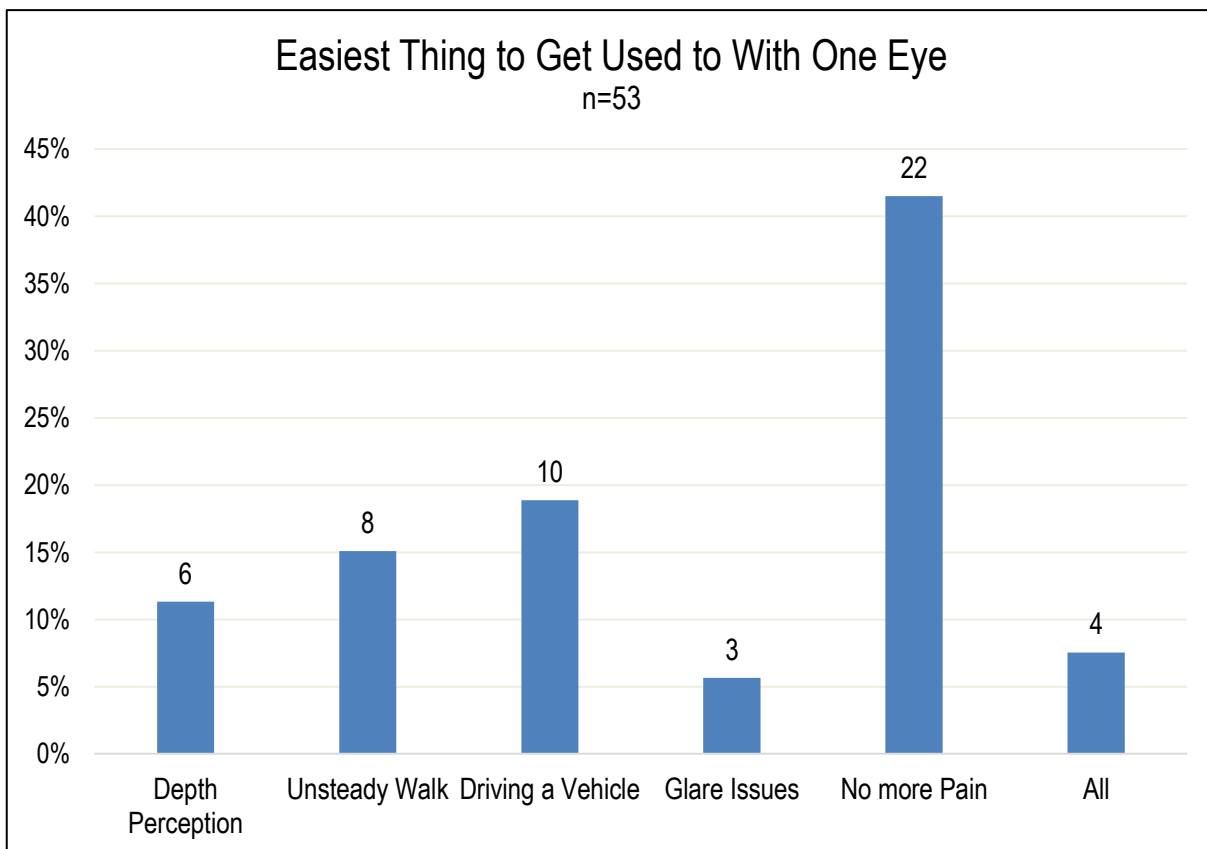


Table 11.15-2 Participants identify easiest areas of initial adjustment

Even less participants responded to the easiest thing to get used to, 53 (**Table 11.15-2**) following the previous question of the hardest thing to get used to (**Table 11.15-1**). A group of 22 (41.5%) of respondents answered that ‘no more pain’ was the easiest thing to get used to once they had lost their eye. A total of 10 (18.9%) answered that driving a vehicle was the easiest, whilst 8 (15.1%) answered that walking was the easiest. A group of 6 (11.3%) said they found depth perception the easiest to get used to, whilst 3 (5.7%) found glare the easiest to deal with, and 4 (7.5%) answered that everything was very easy to get used to with one eye.

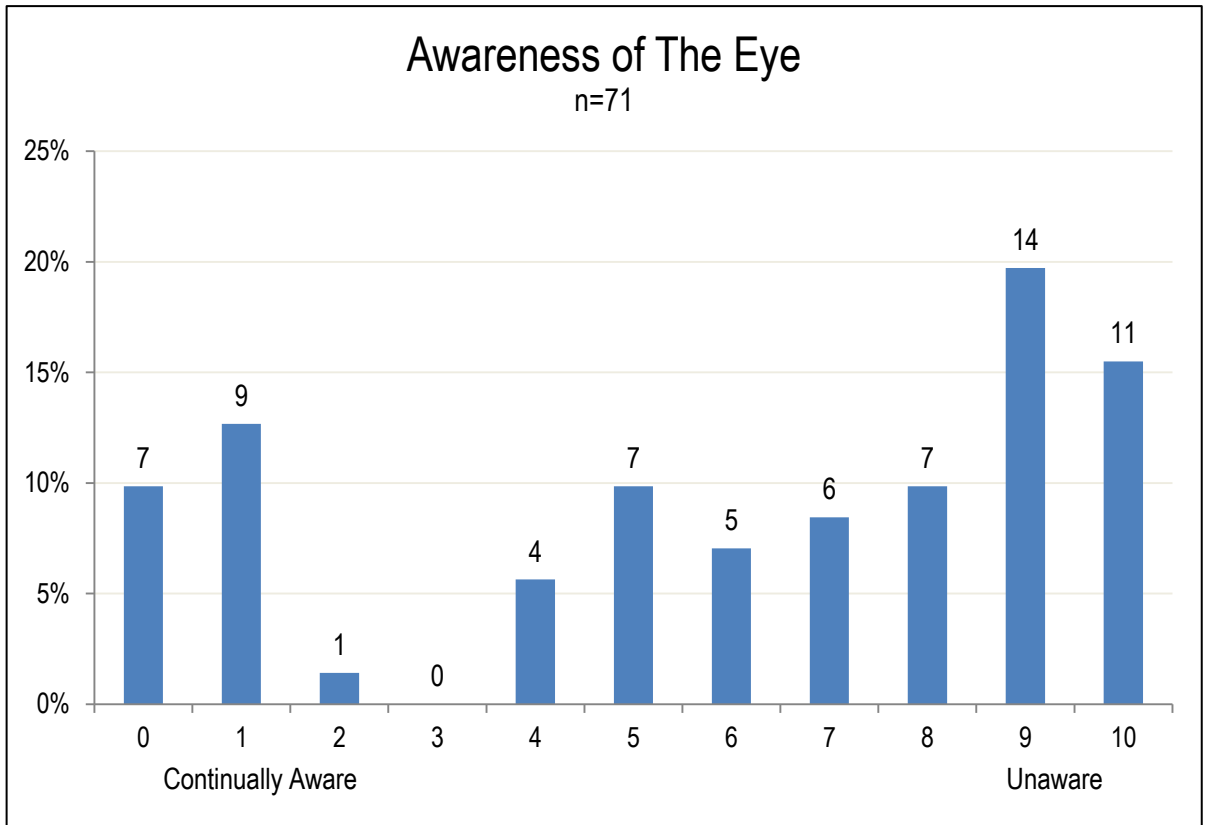


Table 11.15-3 Participants identify how aware they are of the prosthesis VAS scale

All participants responded to this question (**Table 11.15-3**), with a group of 32 (45.1%) reported that they are completely unaware of their prosthesis when they are wearing it, and 17 (23.9%) reporting that they are constantly aware of it. The majority of the remaining 22 (31.0%) respondents reported that they are reasonably unaware of their prosthesis.

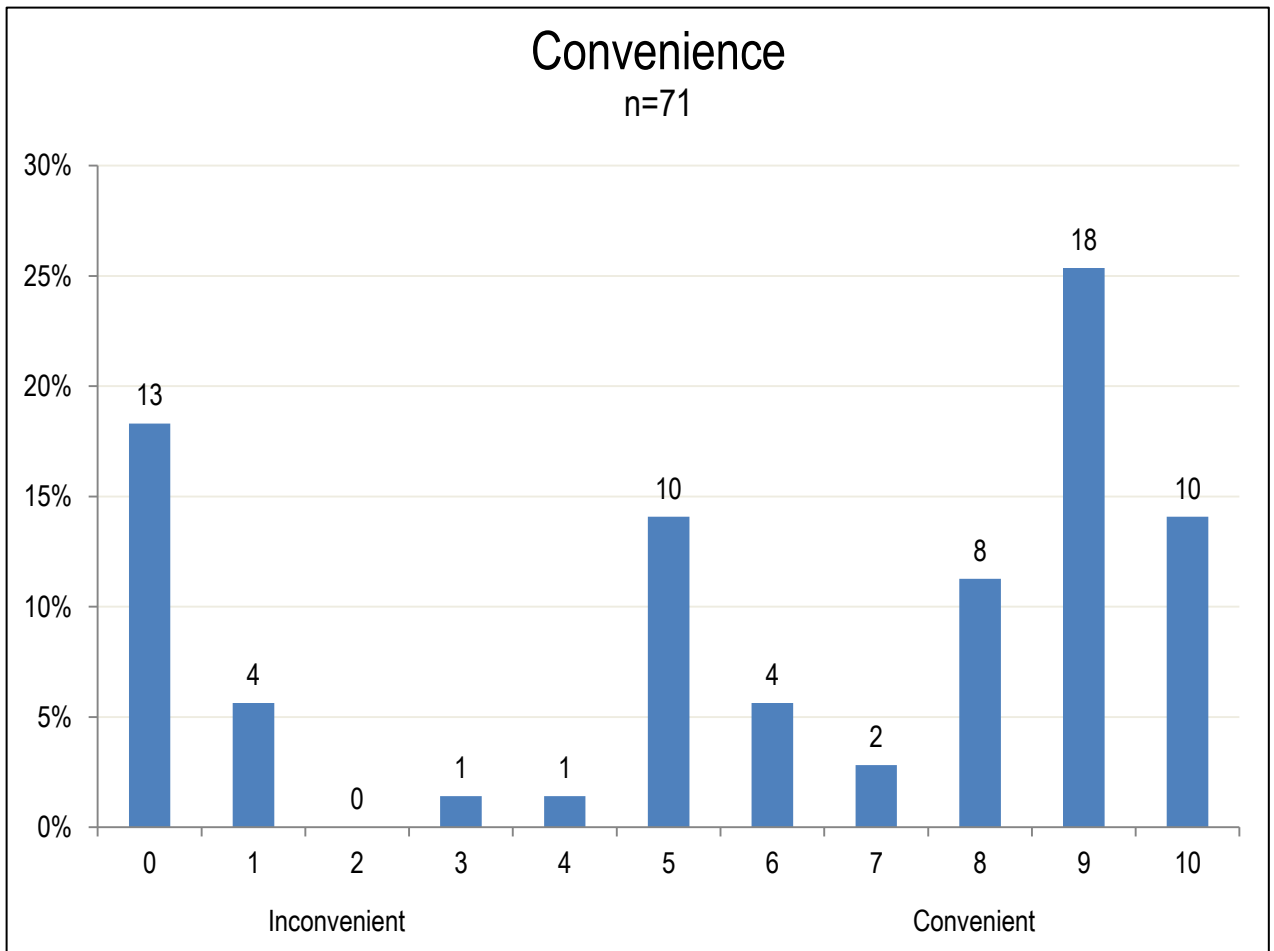


Table 11.15-4 Participants identify how convenient the prosthesis is VAS scale

A total of all participants answered, with 36 (50.7%) reporting that they find that it is convenient wearing their prosthesis (**Table 11.15-4**). A group of 17 (23.9%) answered that it is very inconvenient. The remaining 18 (25.4%) report they don't feel strongly either way.

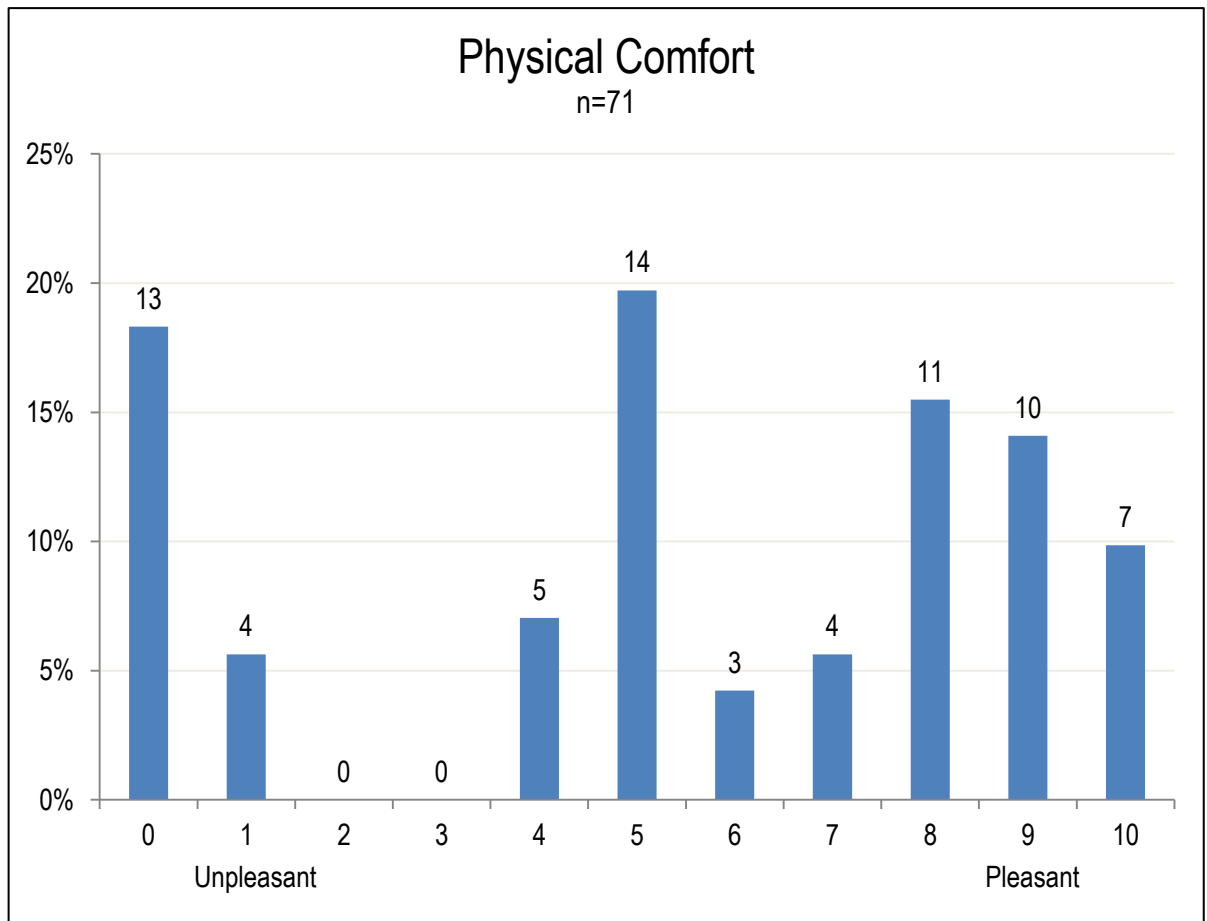


Table 11.15-5 Participants identify the physical comfort of the prosthesis VAS scale

A total of 28 (39.4%) out of the 71 total participants find that wearing their prosthesis is a very pleasant experience, whilst a group of 17 (23.9%) find it extremely unpleasant (**Table 11.15-5**). A group of 26 (36.6%) do not feel strongly either way, but tend towards it being more pleasant than unpleasant.

11.16 COMPARATIVE ANALYSIS

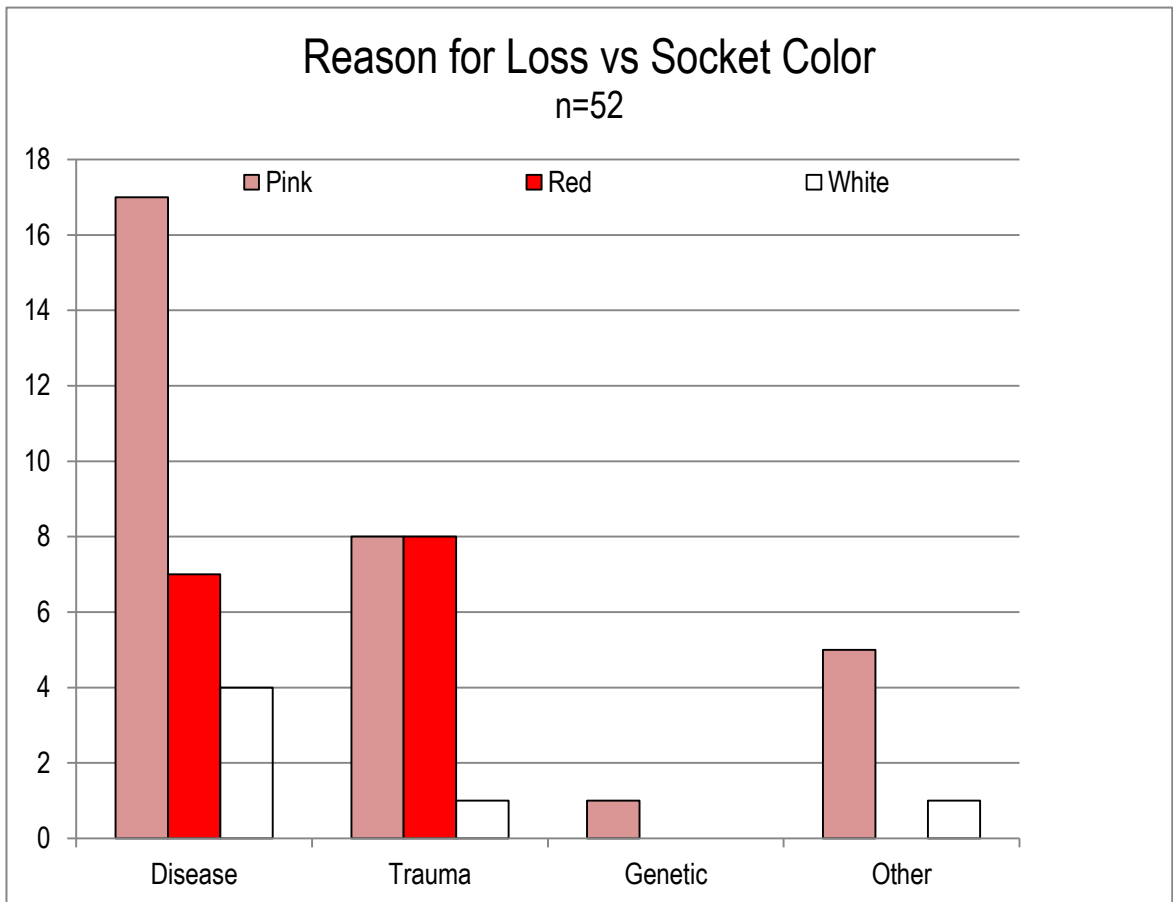


Table 11.16-1 Reason for loss compared with socket colour

<i>Total 45</i>	Disease	Trauma
Pink	17 (37.8%)	8 (17.8%)
Red	7 (15.6%)	8 (17.8%)
White	4 (8.9%)	1 (2.2%)

Table 11.16-2 Reason for loss compared with socket colour

Socket colour is often used as a sign of socket health. A pink socket infers that the socket is healthy, red indicates potential irritation, infection, or damage, and white is usually a sign of skin grafting or the presence of scar tissue, but is not inflamed.

The ratio of pink (healthy) to red (potentially compromised) is interesting to compare between the group who lost due to disease, and those who lost due to trauma. Healthy compared to compromised for those who lost due to disease is more than 2:1, whereas it is exactly 1:1 for those who lost due to trauma.

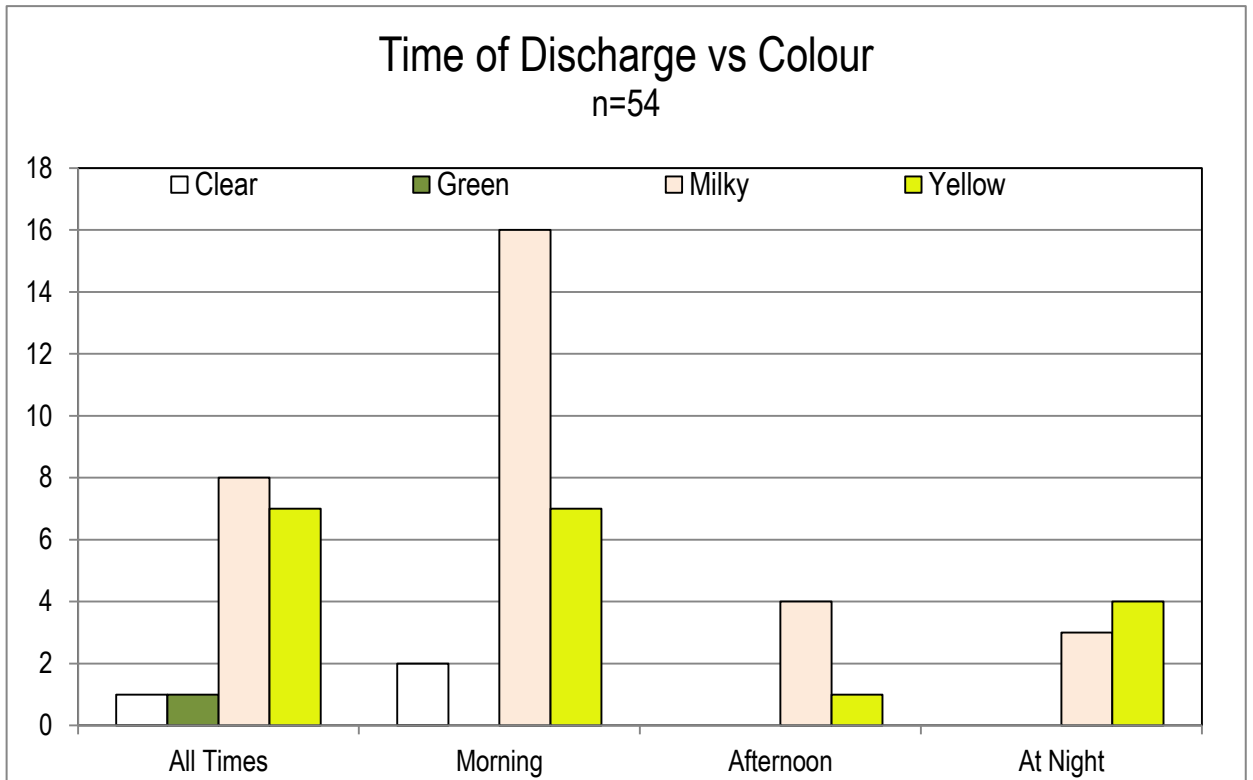


Table 11.16-3 Time of discharge compared with colour

N=42	All Times	Morning
Milky	8	16
Yellow	7	7
Green	1	0
Clear	1	2

Table 11.16-4a Discharge colour at all times compared to colour in the morning

N=12	Afternoon	Night
Milky	4	3
Yellow	1	4

Table 11.16-4b Discharge colour in the afternoon compared to discharge colour at night

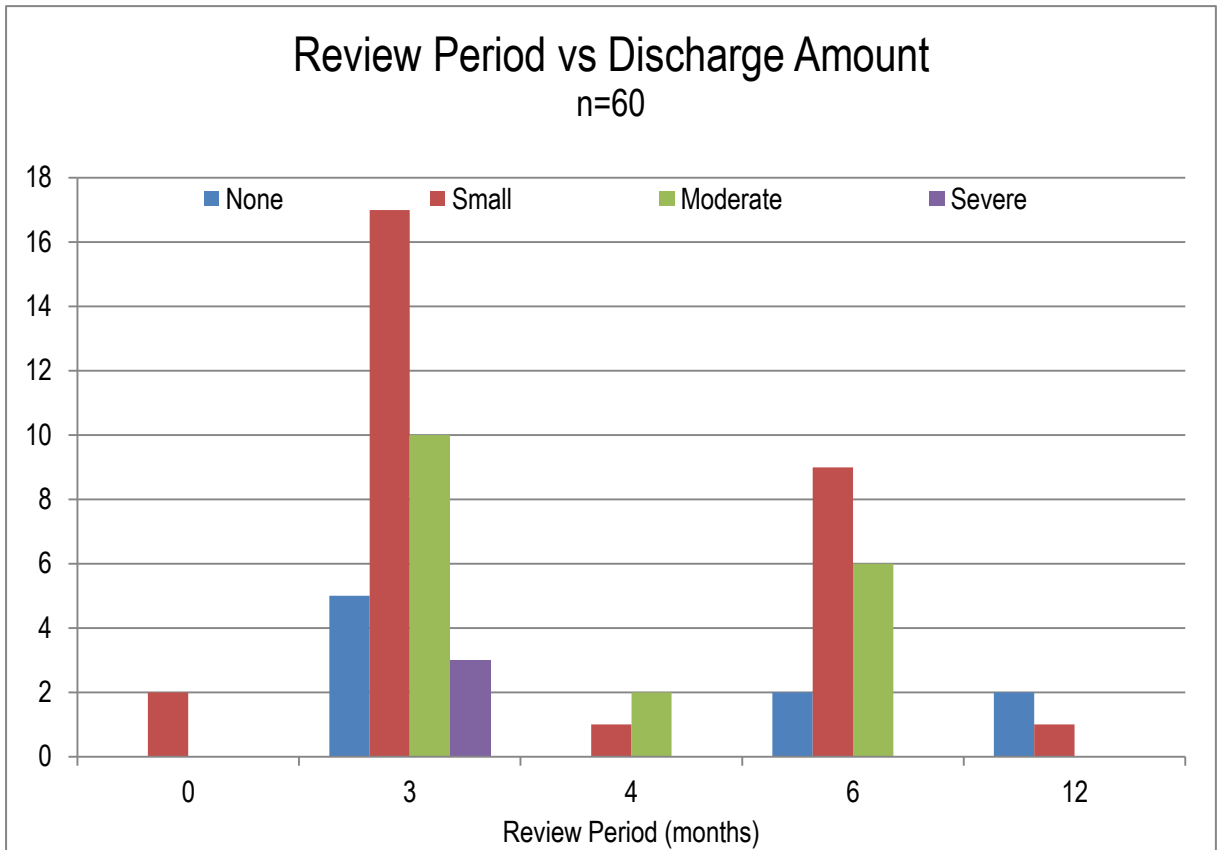


Table 11.16-5 Professional review period compared to discharge amount

	Small	Moderate
3 Monthly	17	10
6 Monthly	9	6

Table 11.16-6 3 Month review discharge amount compared to 6 Month review discharge amount

Where there is a 0, it indicates that the patient does not attend review appointments.

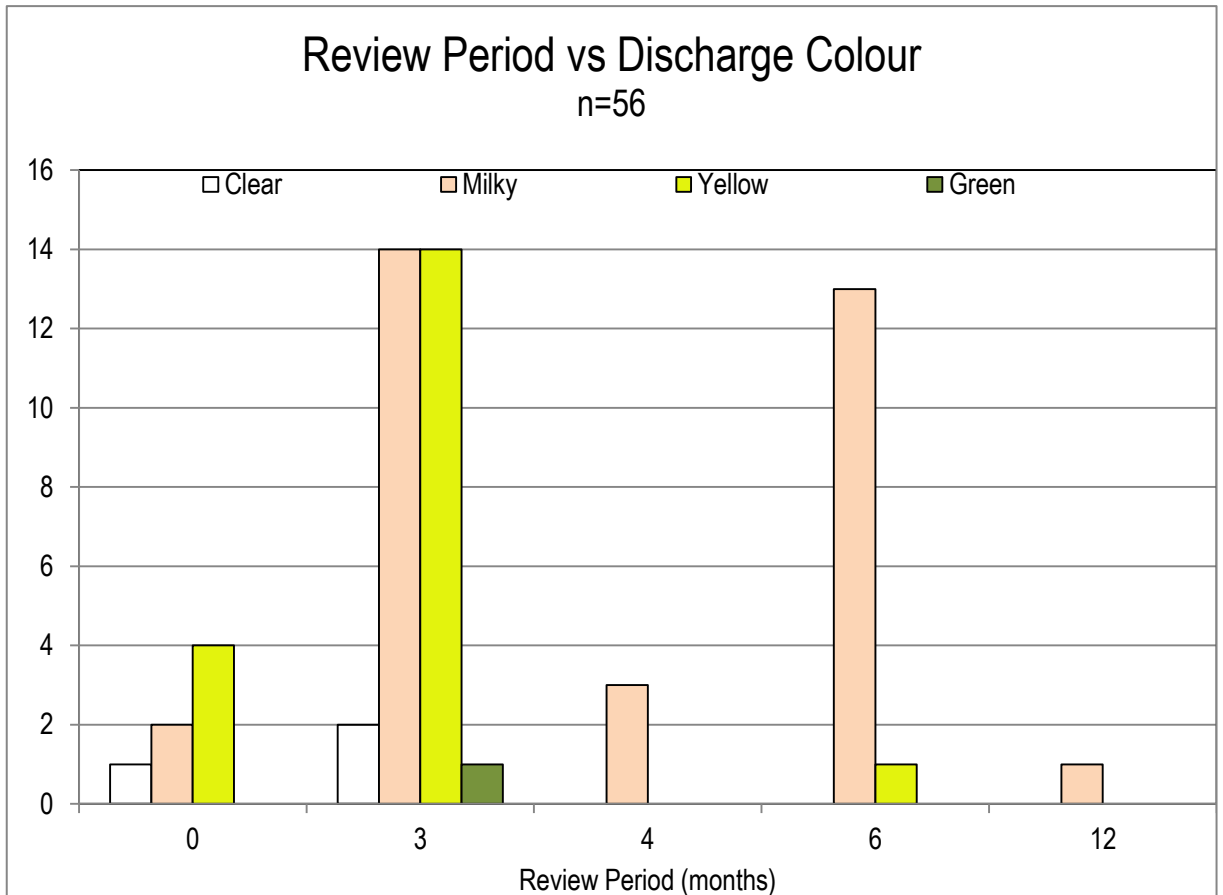


Table 11.16-7 Professional review compared to discharge colour

	Milky	Yellow
3 Monthly	14	14
6 Monthly	13	1

Table 11.16-8 3 monthly and 6 monthly compared to discharge colour, milky or yellow

Discharge colour can indicate whether a patient is experiencing something simple such as 'dry eye' (clear) to severe infection (green). Milky discharge indicates ongoing irritation, whereas yellow indicates mild infection. Again, 0 indicates that the patient does not attend reviews. This comparative chart suggests that those being reviewed most frequently are those with the more severe discharge, and those scheduled at wider intervals are those who experience less severe discharge.

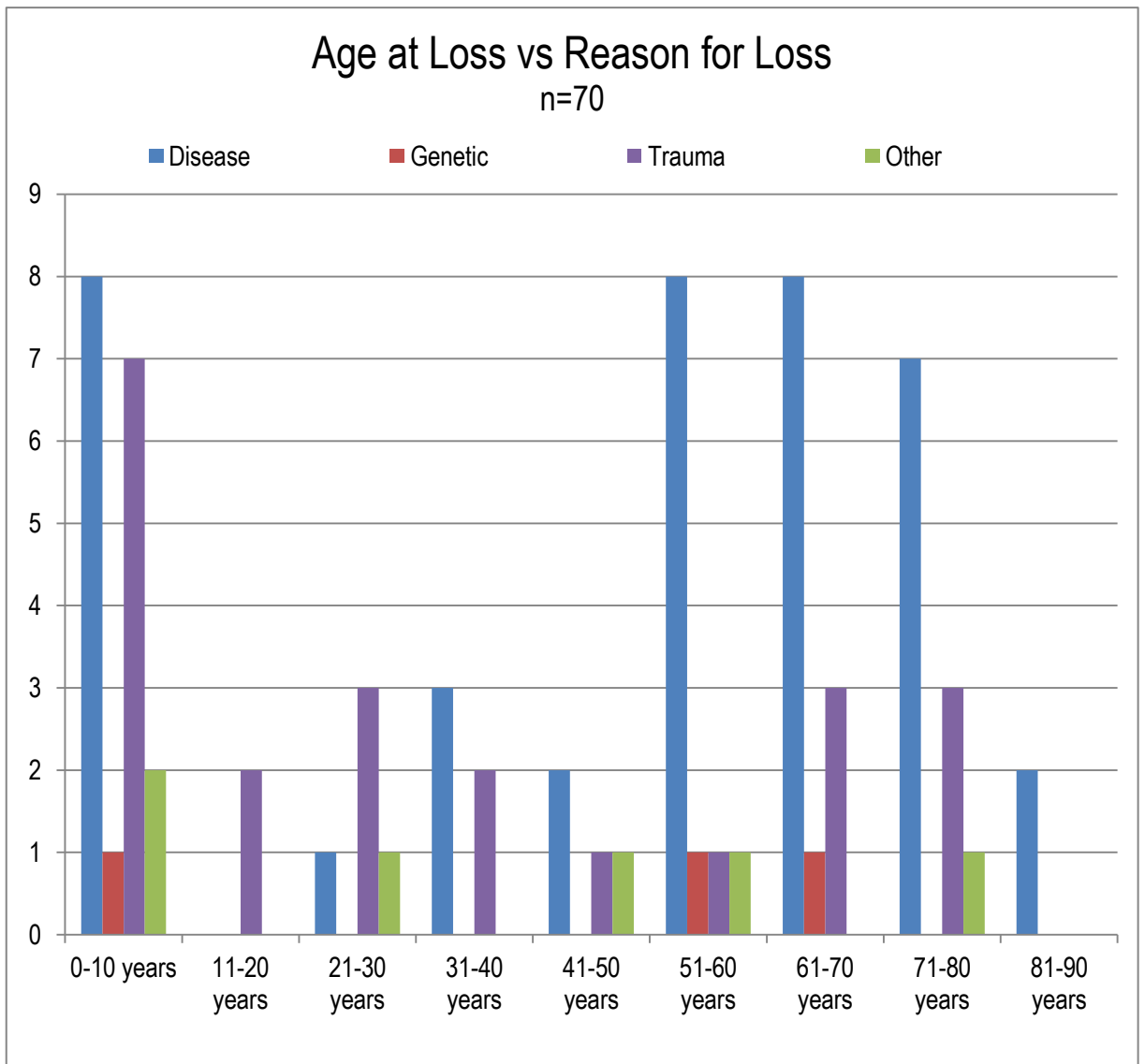


Table 11.16-9 Participants age at eye loss compared with reason for loss

	Disease	Trauma
0-50 Years	14	15
+ 51 Years	25	7

Table 11.16-10 Reason for loss before and after 50 years of age

	Disease	Trauma
0-10 Years	8	7
11-50 Years	6	8

Table 11.16-11 Reason for loss within first 10 years compared to next 40 years of age

This comparative analysis can give insight into lifestyle factors that may/may not affect the causation of eye loss. Most obviously is the incidence of disease peaking in the early and later years of life. There seems to be a relationship between the incidence of trauma, and disease related loss, up until 50 years where disease becomes a leading cause.

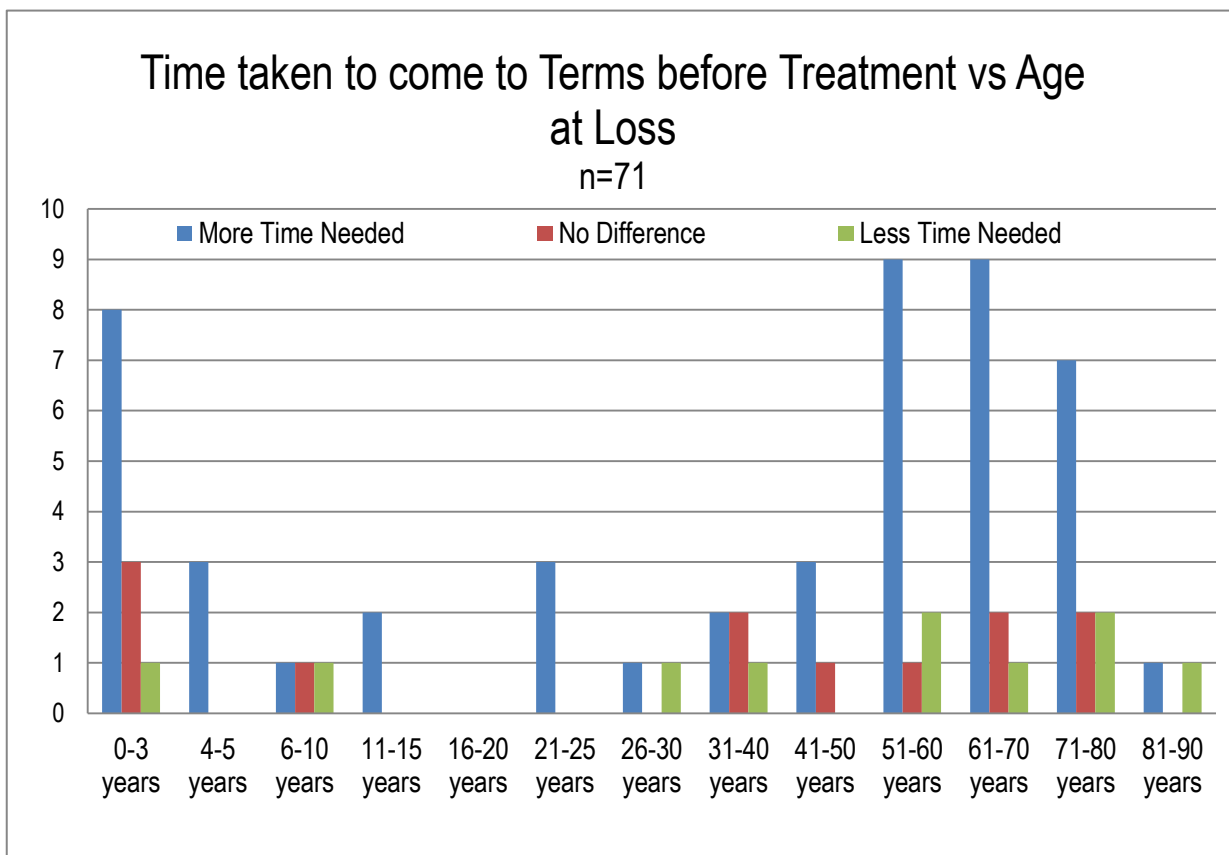


Table 11.16-12 Time taken to come to terms compared with age at loss

	More Time Needed	Less Time Needed
0-30 Years	18	3
31+ Years	31	7

Table 11.16-13 More or less time needed before and after 30 years

The results show most would have liked more time to come to terms with what was happening before being treated. The number who would have liked less time seems to remain consistent, regardless of how many from that age bracket had experienced loss. There is not enough data to make a comparison whether this is an age related predicament or not.

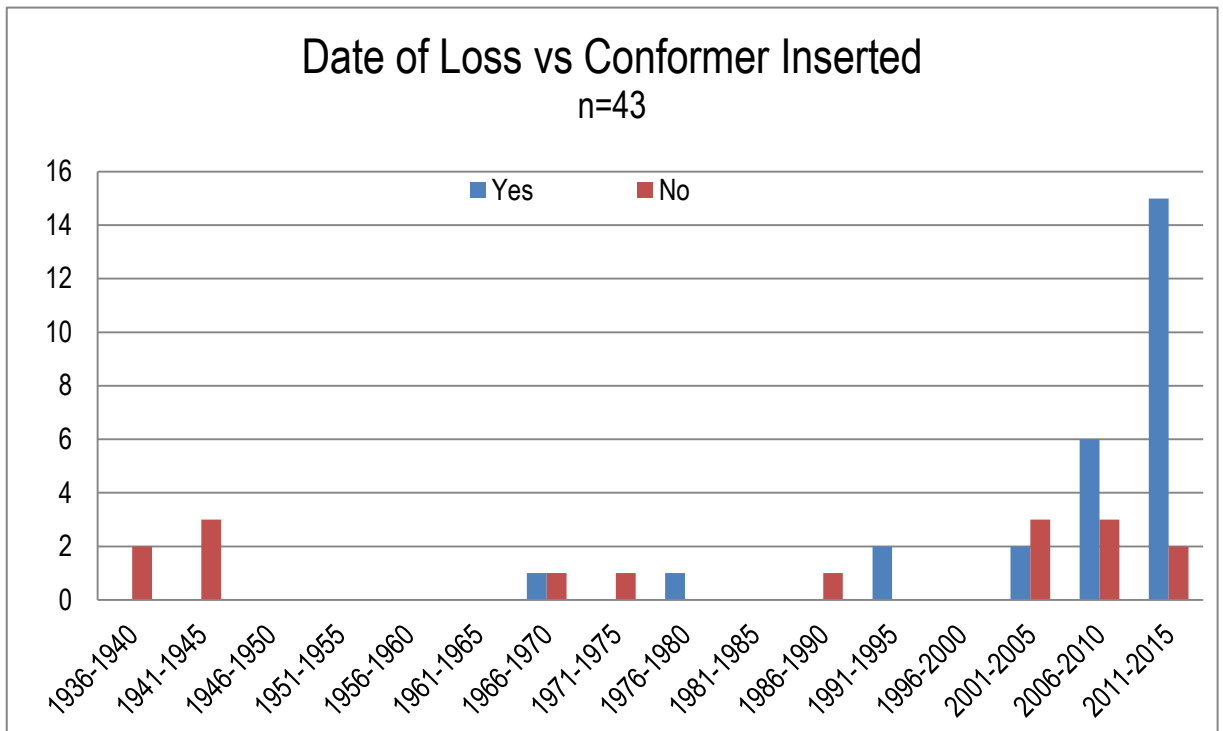


Table 11.16.14 Date of eye loss in relation to the use of a conformer

	Conformer	No Conformer
Before 2000	4	8
2001 Onwards	23	8

Table 11.16-15 The use of a conformer before 2000 and after 2001

Of the 43 who remembered and reported whether they had a conformer post eye removal or not, 36 reported that they did receive one. The majority of those receiving conformers, did so after the year 2001. Prior this in the years between 1966 and 1999, conformers were used 57% of the time (4 out of 7 cases). The quantity of data is probably insufficient to draw any conclusive thoughts from this. Prior to 1966, in the case of 5 patients who recalled whether they received a conformer or not, none of the cases received a conformer prior to receiving a prosthesis.

11.17 NULL HYPOTHESES

Null Hypothesis	Patients over the age of 50 at time more inclined to lose through disease than those under 50		
Actual	Disease	Other	
Over 60	27	13	40
Under 60	12	18	30
	39	31	70

Expected	Disease	Other	
Over 60	22.29	17.71	40
Under 60	16.71	13.29	30
	39	31	70

<i>Is P Less than 0.05</i>	0.021892072	Supported
----------------------------	--------------------	-----------

Table 11.17-1 Null hypothesis: patients over 50 - disease

The Hypothesis that Patients over the age of 50 at time more inclined to lose through disease than those under 50 is supported.

Null Hypothesis	Men lose their eye to trauma disproportionately more than women		
Actual	Other	Trauma	
Male	19	17	36
Female	26	8	34
	45	25	70

Expected	Other	Trauma	
Male	23.14	12.86	36
Female	21.86	12.14	34
	45	25	70

<i>IS P Less than 0.05</i>	0.038671593	Supported
----------------------------	--------------------	-----------

Table 11.17-2 Null hypothesis: men - trauma

The hypothesis that men lose their eye to trauma disproportionately more than women is supported.

Null Hypothesis	Smokers lose their eye to disease disproportionately more than non-smokers		
Actual	Disease	Other	
Smoker	11	5	16
Non-smoker	21	33	54
	32	38	70

Expected	Disease	Other	
Smoker	7.31	8.69	16
Non-smoker	24.69	29.31	54
	32	38	70

Is P Less than 0.05	0.035209955	Supported
----------------------------	--------------------	-----------

Table 11.17-3 Null hypothesis: smokers – eye loss through disease

The Hypothesis that Smokers lose their eye to disease disproportionately more than non-smokers is supported.

Null Hypothesis	Diabetic Patients experience more dry eye problems than non-diabetic		
Actual	Dry Eye (no)	Dry Eye (yes/sometimes)	
Diabetic	10	9	19
Non-Diabetic	22	29	51
	32	38	70

Expected	Dry Eye (no)	Dry Eye (yes/sometimes)	
Diabetic	8.69	10.31	19
Non-Diabetic	23.31	27.69	51
	32	38	70

IS P Less than 0.05	0.478261728	Not Supported
----------------------------	--------------------	---------------

Table 11.17-4 Null hypothesis: diabetic patients – dry eye problems

The Hypothesis that Diabetic Patients experience more dry eye problems than non-diabetic is not supported.

Null Hypothesis	Those who lost their eye through disease experience more discharge than others		
Actual	1-2	3-4	
Disease	30	9	39
Other	20	11	31
	50	20	70

Expected	1-2	3-4	
Disease	27.86	11.14	39
Other	22.14	8.86	31
	50	20	70

<i>Is P Less than 0.05</i>	0.253715245	Unsupported
----------------------------	--------------------	-------------

Table 11.17-5 Null hypothesis: eye loss through disease – more discharge

The hypothesis that those who lost their eye through disease experience more discharge than others is not supported

Null Hypothesis	Men experience more discharge than women		
Actual	1-2	3-4	
Male	22	10	32
Female	24	11	35
	46	21	67

Expected	1-2	3-4	
Male	21.97	10.03	32
Female	24.03	10.97	35
	46	21	67

<i>Is P Less than 0.05</i>	0.987442825	Unsupported
----------------------------	--------------------	-------------

Table 11.17-6 Null hypothesis: men – more discharge

The hypothesis that men experience more discharge than women is not supported.

Hypothesis	Those who have their eye cleaned every 3 months experience less discharge		
	1-2	3-4	
Actual			
Every 3 Months	22	13	35
Greater	18	8	26
	40	21	61

Expected	1-2	3-4	
Every 3 Months	22.95	12.05	35
Greater	17.05	8.95	26
	40	21	61

Is P Less than 0.05	0.604372703	Unsupported
----------------------------	--------------------	-------------

Table 11.17-7 Null hypothesis: 3 monthly cleaning – discharge

The hypothesis that those who have their eye cleaned every 3 months experience less discharge is not supported.

Null Hypothesis	Men feel more self-esteem with their eye in than women		
	0-5	6-10	
Actual			
Male	5	28	33
Female	8	30	38
	13	58	71

Expected	0-5	6-10	
Male	6.04	26.96	33
Female	6.96	31.04	38
	13	58	71

Is P Less than 0.05	0.521361156	Unsupported
----------------------------	--------------------	-------------

Null Hypothesis	Women feel more vulnerable without their eye in than men		
Actual	0-5	6-10	
Male	29	4	33
Female	31	7	38
	60	11	71

Expected	0-5	6-10	
Male	27.89	5.11	33
Female	32.11	5.89	38
	60	11	71

<i>Is P Less than 0.05</i>	0.464349151	Unsupported
----------------------------	--------------------	-------------

Table 11.17-9 Null hypothesis: women – more vulnerable without eye insitu

The hypothesis that women feel more vulnerable without their eye in than men is not supported.

Null Hypothesis	Women feel more naked than men without their prosthesis in		
Actual	0-5	6-10	
Male	28	5	33
Female	32	6	38
	60	11	71

Expected	0-5	6-10	
Male	27.89	5.11	33
Female	32.11	5.89	38
	60	11	71

<i>Is P Less than 0.05</i>	0.940933501	Unsupported
----------------------------	--------------------	-------------

Table 11.17-10 Null hypothesis: women – more naked without prosthesis

The hypothesis that women feel more naked than men without their prosthesis in is not supported.

Null Hypothesis	Women feel more unattractive than men feel without their eye in			
	Actual	0-5	6-10	
Male		31	2	33
Female		33	5	38
		64	7	71

Expected	0-5	6-10	
Male	29.75	3.25	33
Female	34.25	3.75	38
	64	7	71

Is P Less than 0.05	0.317052649	Unsupported
----------------------------	--------------------	-------------

Table 11.17-11 Null hypothesis: women – more unattractive without eye insitu

The hypothesis that women feel more unattractive than men feel without their eye in is not supported.

12. DISCUSSION

12.1 INTRODUCTION

This thesis presents for the first time the demographics and emotional responses and opinions of a consecutive series of patients treated by a single Ocularist within Australia. As there is only a limited literature and published studies available describing artificial eye wear, with most of the literature being on eye loss, the benefit of prosthetic rehabilitation was of prime concern to this study.

The sole exception to this deficiency in the literature has been the work of Dr Keith Pine, PhD (Optom) New Zealand, (NZ Prosthetic Eye Service n.d.) who has researched and published extensively in the area (Pine, Sloan & Jacobs 2013; Pine, Sloan & Jacobs 2012a; Pine, Sloan & Jacobs 2012b; Pine, Sloan & Jacobs 2012c; Pine, Sloan, KyuYeon, Swift & Jacobs 2013; Pine, Sloan, Stewart & Jacobs 2012; Pine, Sloan, Stewart & Jacobs 2011; Pine, Sloan, Stewart & Jacobs 2013). His inspiration and guidance is acknowledged.

A desire was to formulate a questionnaire that would glean information from patients that best described their experiences of artificial eye rehabilitation after eye loss, in a physiological, medical and psychological way. The questionnaire was designed to answer a number of clinically observed issues, and also patient stated concerns or issues, that may or may not have an impact on a patient's acceptance of their prosthesis and or help them physically, socially, psychologically and emotionally.

Limited literature and published studies describing artificial eye wear, and relating concerns has been published and as such the ambition was to formulate information gleaned from patients in a way that best described their experiences both physically, psychologically and medically.

12.2 RESEARCH METHODS

Patients who were participant candidates for the questionnaire were requested to sign a consent form prior to the completion of the questionnaire (**Appendix 14.2**) The information was gleaned by the patients

completing questionnaires, their experience and psychological state, and were also given an opportunity to tell their own story, in their own words, 'my eye, my story'. The questionnaire would de-identify the patient allowing them to state their concerns and/or other issues they may have, without fear of offence and ensuring confidentiality.

The data questionnaire was completed by two groups of people primarily; those who had recently lost their eye, prospective view, and those who had lost their eye a long time ago, retrospective view. The questionnaires were designed to answer a number of questions, which would enable arrangement of the participants into particular groups. General demographic, health and daily routine details were asked followed by more specific ocular related questions giving a thorough picture of patient background and past treatments.

The question was asked how many artificial eyes the patient had worn, and the opportunity was given for the patient to describe their feelings at the time the prosthesis was placed. The questionnaire allowed for three prostheses and patients were told the 3rd would be considered the most recent one. The issue of commonality would be resolved in that their third prosthesis was made by the author of this thesis, hence the same standard operating procedures would be used to have made the prostheses. Therefore, an accurate comparison could be drawn between individual patients wearing what would otherwise be identical prostheses as far as material and methods used to construct the artificial eye.

Questions regarding the patient's feeling when wearing their artificial eye, and then a number of questions were asked with regard to the patients' attitude or feelings if they were without their prosthesis. Emotional and psychological data were demonstrated by using visual analogue scales ranging from 0 – 10 was used to determine emotions related to physical and psychological factors, with a line that could be used at millimetre intervals for a patient to mark at which point an exact figure in percentage could be used to determine their feelings regarding a particular question. This process enabled the quantifying in numerical value of an emotion as a means of description.

A number of opportunities were given there to determine exactly how patients may feel without a prosthesis. The questions were then asked with regard to other people's comments regarding the patient's artificial eye; whether people commented, whether they could tell, and then whether the patients actually cared about those people's opinions. Questions were asked to determine what the patients thought could be better about their prostheses, other than sight.

Being as it is that a number of patients have stated at the time of fitting an artificial eye that they sometimes feel they can see out of it or see better with it in, a number of questions were asked relating to whether they feel they can see better or if they feel more balanced with their prosthesis in.

Various questions were asked with regard to their eye care and maintenance relating to the way the patient lives with their eye; frequency of removal, amount of discharge, regularity of professional maintenance, amount of discomfort (dry eye), and any medications used for their eye. The question is then asked, what is the hardest/easiest things to adjust to with one eye, and how would they best describe their experience of wearing an artificial eye.

Given that the questionnaire contained 90 questions, the patient was also given an opportunity to rate how they felt about the questionnaire and their participation. Whether the questionnaire actually opened old wounds or if they found it helpful, if they did/didn't enjoy answering, if it was/wasn't emotionally challenging, whether or not the questions were relevant and any other comments they could make with regards to wearing an artificial eye. Lastly we gave the patients an opportunity to tell their story with some prompts to help them start. For example, how old they were when they lost their eye, what they remembered most, what it was like growing up, and/or getting back to school/work, family reactions, and words of advice.

Patients participating in the study would be wearing an artificial eye made by the author, regardless of the duration of prosthesis wear. There was no differentiation between race, culture, gender, religion, age, between public or private patients, or between differences in reasons for eye loss.

Exclusions from the study were children, due to potential difficulties in communication and comprehension and consideration was given to ability to consent to participate. Patients with exenterated sockets, and wearing orbital prostheses were excluded, interestingly there were no Aboriginal or Torres Straight Islanders included in this study. This was not originally intentional, but due to lack of participants and afterthoughts of communication and cultural liaison difficulties it was added as listed as an exclusion.

Twelve initial questionnaires were formulated and were handed to a number of patients to give feedback. The 12 patients chosen were chosen because of their academic background. These included a PhD graduate in education, a PhD student of registered nursing, and a Masters student based in research on men's health issues. Each of these patients also wore artificial eyes themselves and so had a vested interest in the research as well as their academic background. The other nine questionnaires were given to five male and four female patients for their feedback. Other questionnaires were also handed to professional colleagues who gave feedback regarding the format and direction of the questioning. Some questions were deemed to be too specific, others to be not specific enough, and some questions were changed to avoid push polling, hence some of the questions were reworded.

The visual analogue scales were added initially as a result of this feedback, to allow for an objective numerical value to be assigned to a subjective feeling. A total of 76 questionnaires were handed out, and a total of 74 were returned. 3 were returned unanswered leaving a total of 71 questionnaires to be used for data analysis. These 3 unanswered questionnaires returned were because the patients felt that the stress and emotion involved in covering this information and revisiting their eye loss was too great and too difficult for them to deal with. Upon the return of their unanswered questionnaire, one 91-year-old patient said, "Peter I'm sure you'll understand, the wound is too deep still", and this particular patient lost their eye when they were 3 years old.

12.3 GENERAL FINDINGS

Table 11.1-1 Gender distribution of participants

It was evident that eye loss was non discriminant and non-gender specific (**Table 11.1-1**) in that the 71 patients that were researched, 38 were female and 33 were male.

Table 11.1-3 Age groups of participants at time of survey

However, when we look at the age group in **Table 11.1-3** of the participants at the time of the survey, the largest group of the study were in the bracket 71 – 80, and clearly the largest group of eye loss and questionnaire participants were over 50 at the time of survey and at time of eye loss.

Table 11.1-4 Referral source for participants

As patients were treated from both private and public referral, the two groups amounted to 59% of private and 40% being public (**Table 11.1-4**). The reason for this is that the privately referred patients paid for their prosthesis, however the publically referred patients received their prosthesis for free, at no expense or cost to them. It has been suggested that the reason for that is, that it is generally understood that when a person pays for something, it is appreciated more than when they get it for free. However, later it was shown to not be the case as all patients seemed equally as appreciative and overall happy with their prosthesis, whether paid for by themselves, or received for free through the public system.

Table 11.1-5 Occupation groups of patients

As stated, most patients were over the age of 50, hence the large proportion of the patients responding to the questionnaire were retired (34%) and they made up the largest group.

Table 11.1-7 Participant smoking status

One of the interesting findings that we will speak about later in the hypothesis section was those that smoked of the list that were questioned. The stipulation needs to be expressed that the non-smokers were also made up of some who had given up smoking as a result of losing their eye, shortly before or shortly

after (Table 11.1-7). This needs to be stated as a result because reason for eye loss and disease vs smoking related data, which we're looking at later in our null hypothesis.

Table 11.1-8 *History of childhood illness experienced*

Table 11.1-9 *Current chronic conditions suffered by participants*

Childhood illness did not seem to have any relevance as reason for eye loss, but it was interesting that a number of patients experienced hypertension and others diabetes, therefore we investigated if diabetes played a role (Table 11.1-8;9).

Table 11.1- 11 *Age of participant at time of eye loss*

What we did find as very interesting was the age of patients at time of eye loss (Table 11.1-11), with the majority of loss occurring initially within the first 5 years of life, with a number of the patients losing it under the age of 10, but predominantly eye loss was in the over 50 age group.

Table 11.1-12 *Specific eye that participant lost*

Sixty percent of eye loss was the right eye, and 37% of eyes lost were left eye (Table 11.1-12). A potential reason for this could be that majority of people would have their right eye as their dominant eye, and therefore their right eye is closer to what they are doing in trauma related cases. Coincidentally, in Australia we drive on the left, with the sun coming through on the right side, with an increase in sunlight exposure being a possible cause for loss by disease.

Table 11.1-13 *Reason for participant eye loss*

Table 11.16-11 *Reason for loss within first 10 years compared to next 40 years of age*

When we looked at age of participant at time loss and compared it with the reason for eye loss, comparison were found with increase of eye loss due to disease (Table 11.1-13; Table 11.16-11). It is interesting to note that the majority of eye loss is due to disease, followed by trauma (Table 11.1-13). This is due to participant age being predominantly over 50, and disease being more prevalent in 50 year olds, which is consistent with what we had expected.

Table 11.1-14 *Eye removal method*

Following on from previous comments, when the condition is disease related, enucleation is often the preferred and necessary form of eye removal (**Table 11.1-14**). This is particularly true in the situation of disease such as ocular melanomas, where the preferred and safer option is to enucleate or eviscerate to lessen or reduce the risk of sympathetic ophthalmitis.

Table 11.1-15 *Varying socket colours of participants*

Table 11.1-15 shows the indications of the health of the socket being determined by the colour of the socket subjectively reported by participants. Sixty percent of participants experience a pink socket, a very normal healthy vascularization. Others reported a white socket, which is generally due to thinned mucosal tissue over what might be an implant, therefore showing white. The red would generally indicate inflammation with those who suffer more discharge, irritation, sensitivity or indicate ongoing infections. These results are consistent with clinical findings.

Emotions

The emotional aspect of eye loss is of great interest to the author and often overlooked in the treatment of the patient at times. The reason for eye loss is focussed at a medical/surgical level, rather than remembering that attached to the eye being removed is a human-being with emotions, feelings, concerns and definitely the 'unknown' of life after eye loss.

Table 11.2-3 *Comparative feelings of patients at time of eye loss: denial vs acceptance VAS score*

So, it was not with any surprise that when the questions of emotions at time of eye loss regarding anger, sorrow, denial and frustration were asked, a great proportion of the patients (over half) were angry with the feeling of eye loss. Over 55% were upset and others experienced a sense of denial or disbelief. However, many of them ended up accepting the inevitable and when talking to patients, that is often due to the fact that the option of 'my eye or my life' as it has been expressed, is the ultimate resigned position the patients

find themselves in. This is particularly in the context of ocular melanomas and other life threatening ocular diseases.

Table 11.2-4 *Comparative feelings of patients at time of eye loss: frustration vs relief VAS score*

Those feeling frustration are often those that express the 'why me' combined with the inevitability in their mind of eye loss; 'perhaps if I'd done something different?', 'perhaps if I hadn't gone here', particularly in the situations of trauma. Patients often feel that they could have done or should have done something different to avoid eye loss, and therefore live with that blame on their minds that they could have avoided it if they had done something different.

Table 11.2-2 *Comparative feelings of patients at time of eye loss: sorrow vs excitement VAS score*

Those that felt relief were often those that were having their eye removed through a painful or seriously diseased eye, and therefore they were far more likely to accept and be content and excited about the concept as well as feeling a sense of relief.

Table 11.3-1 *Various options that participants viewed as possible improvements VAS score*

Patients often express the desire to have met someone else who had suffered eye loss, or be counselled. Particularly in South Australia, where the author practices, a number of patients have expressed a desire to be given information that could help them through. A very large percentage expressed the desire to meet someone else who had lost an eye and perhaps be given greater counselling, support group or some form of education. This is an area that the author feels should be looked at in the future. This again reinforces the great feelings of emotions, therapeutic benefit in meeting others and the education indicating that patients were fearful and apprehensive of the unknown aspects of eye loss and hence education would dispel that. Meeting others would obviously be a part of the education process, allowing feelings and experiences to be shared and empathised with, which again is something that patients in the situation of eye loss feel strongly about.

Table 11.3-2 *Participants opinion on more time or less time impacting on coming to terms with their loss*
VAS score

A number of patients state that more time would have helped (**Table 11.3-2**), which indicates that often eye loss is very sudden, and hence patients are left reeling and not having a clue what is really going on, and struggling to come to terms with such a traumatic prospect.

Table 11.3-3 *Any complications experienced by participants prior to receiving their prosthesis*

Table 11.3-4 *Participants discharge amounts prior to prosthesis wear*

The main complication was discharge, followed by other ongoing complications. The discharge amounts (**Table 11.3-4**) are often more prior to the prosthesis being fitted due to the socket itself being larger and the surgical conformer being smaller and therefore causing irritation through free-play within the socket.

The results are showing that only a small amount of discharge was evident prior to prosthesis inserted, which differs from clinical experience, with a possible reason for this including most patients before surgery and prior to the prosthesis being worn are often on some form of antibiotic treatment, whether topical or systemic to avoid infections occurring. This matter was not explored in the questionnaire, but which would tend to reduce discharge amount generally at the time of first eye construction.

Table 11.3-5 *Participants who wore conformers post eye removal*

The hard conformers are the preferred form of conformer, and the majority of patients wore the hard conformers. Often patients are unaware what the conformer is, hence a large number of 11 were unsure if they had one in there at all. Also confusion arises between the surgically inserted implant and the conformer, which patients often describe as an implant which is often removed. In the author's experience, the soft silicone implants tend to generate more discharge, hence the preference would be for hard, non-vented as being more suitable and comfortable and causing less irritation.

Table 11.3-6 *The number of previous prostheses participants have had*

Table 11.3-7 *Year that participant received first prosthesis*

The number of patients who had received previous prostheses, there are 12 who listed themselves as not having had a previous prosthesis as their prosthesis was being completed whilst the questionnaire was being filled out, and they received their first prosthesis in the process. The majority of the participants had only received one previous prosthesis being 37, the other smaller amounts had received 2, 3 or more.

Table 11.4-1 *Participants emotion when received first prosthesis: sad vs happy VAS score*

Table 11.4-2 *Participants emotion when received first prosthesis: sorrow vs relief VAS score*

Table 11.4-3 *Participants emotion when received first prosthesis: dysfunctional vs healed VAS score*

These tables show us that there is an overwhelming sense of relief and healing at the time of going from post eye loss having nothing in the socket, and then having a prosthesis placed, creating an overwhelming sense of happiness, relief and progressing towards healing. Most of the patients were on that side, but it is interesting to note that there is also a very strong sense of emotion, almost reopening old wounds with sadness, sorrow and dysfunctionality being a large percentage of the patients' feelings, in that whilst they had their artificial eye put in, it reinforced that fact that they had lost an eye and sight and therefore did not feel themselves. It is interesting to note that when looking further on in time at patients who had received more than one prosthesis, their level of acceptance had increased over time such that those who had receive their second prosthesis had overall higher percentages of feelings of happiness far greater and the percentage of those unhappy reducing significantly.

Table 11.6-1 *Participants emotions when received third prosthesis: sad vs happy VAS scale*

Table 11.6-2 *Participants emotions when received third prosthesis: sorrow vs relief VAS scale*

Table 11.6-3 *Participants emotions when received third prosthesis: dysfunctional vs healed VAS scale*

Again the same is seen that patients over time are feeling a lot more accepting, relieved, happy, and functional compared to those who at the early stage of eye loss and coming to terms with that, are feeling emotionally tender.

Table 11.7-1 *Participants emotions when received current prosthesis: sad vs happy VAS scale*

The comparisons were then made across the board with all the patients wearing their current prosthesis. For those who had more, their third prosthesis for the sake of the questionnaire was their most recent, which then included all patients. those that had their first and only one, as well as those who had multiple. As such, an overwhelming proportion of patients were very happy, but interestingly those who more recently received their first prosthesis were struggling and feeling a sense of sadness at their eye loss.

Table 11.7-2 *Participants emotions when received current prosthesis: sorrow vs relief VAS score*

It's interesting that whilst there is a strong feeling of those feeling relief, 21 of the respondents were still feeling strong feelings of sadness, which is seen with the same number feeling dysfunctional, which correlates with the American literature that shows eye loss is equated with death (American Medical Association, 2001).

Table 11.7-3 *Participants emotions when received current prosthesis: dysfunctional vs healed VAS score*

As previously stated with reference to **Table 11.7-2**, sorrow vs relief and dysfunction vs healed, we refer to the American Medical Association (2001) statement, "the loss of an eye is a catastrophic event, and in medico-legal disability terms is equated with death", and for this reason, different people cope differently and feel differently with the loss of the eye, and the subsequent ocular prosthetic rehabilitation.

Table 11.7-4 *Participants emotions when received current prosthesis: unattractive vs attractive VAS score*

When asked about their emotions with regard to their feelings of attractive and unattractive (obviously a subjective question) as some people feel even with two natural eyes that they are unattractive. Taking this into account, a number, the vast majority of patients overwhelmingly felt more attractive with their artificial eye in; some were somewhat ambivalent but this tends to be the case that they feel neither unattractive or attractive normally, however with the artificial eye in the overwhelming feeling was that an improvement in appearance occurred, hence the artificial eye plays a vital role with peoples' feelings about themselves.

Table 11.7-5 *Participants opinion on others' perception of their appearance*

When considering the opinion of others, again was somewhat of a subjective question in that it varies as to the value and credit on others opinion of them, whereas others do not really care. Taking this into account, the feedback is overwhelmingly positive so far as artificial eye wearers concern, with 29 of the respondents saying that they look excellent, others that they looked normal or the same. Taking that into account, being unnoticed, so as far as the author is concerned feedback of an excellent nature means the patient has made it known that they wear an artificial eye, and the feedback is that they look excellent, others have shown and they say it looks the same or normal. The fact that it's unnoticed is also positive feedback in that people haven't been able to tell that there is a prosthesis there, with only 5 in fact having people say that they are in fact different and these are often people that are super sensitive and are detail orientated. The issue of attractiveness can be examined by the like of Abnormal Illness Behaviour Questionnaire (Pilowsky, 1993; Kirmayer & Looper, 2006) and Body Image Assessment (Cash & Labarge, 1996). This is a fruitful area of further research.

Table 11.8-1 *Participants emotion when not wearing prosthesis: unattractive vs attractive VAS score***Table 11.8-2** *Participants emotion when not wearing prosthesis: uncomfortable vs comfortable VAS score*

The whole feeling of the patients without a prosthesis is showing an overwhelmingly tendency towards unattractive, with the vast majority feeling unattractive without their prosthesis. Again this shows the vital role that an artificial eye plays in the overall sense of wellbeing. When making the prosthesis Ocularists must take into account the psychological, physiological and biological functions of the artificial eye. Such that while we can make an eye that might look aesthetically pleasing and symmetrical to the opposing natural eye, it may not be comfortable for the patient to wear and as such a number of factors need to be taken into consideration when making a prosthesis. Some factors include, that it not only looks good, but feels good and functions well within the ocular pulperable fissure and the surrounding anatomy, integrating into the surrounding tissues as previously discussed in Research Methodology 10.7. Of the 71 participants,

again the feeling of the prosthesis when not in was uncomfortable, such that when putting an artificial eye in initially the patients often state that it feels uncomfortable or unusual, comments like it feels 'full, big, heavy', are often made by the patient. Within the first month, generally the patients accept the prosthesis and state that very quickly they are unaware of it's presence. Then when removed for cleaning or other reasons they feel uncomfortable both physically and psychologically, often commenting on the sense of dryness or cold breeze, stinging or other factors making it feel uncomfortable.

Table 11.8-3 *Participants emotion when not wearing prosthesis: vulnerable vs secure VAS score*

The question of vulnerable vs. secure was asked based on a number of patients expressing vulnerability and 'not feeling right' without their prosthesis in. Again an overwhelming number of participants felt vulnerable and insecure without their artificial eye in, which seems to be due to the fact that it reminds them of their eye loss and again perhaps their reason for eye loss, whether it was traumatic or disease. A number of patients struggle with the ongoing issues of disease and particularly with cancers and the possibility of recurrence. The eye being removed reminds them of the possibility of the recurrence of the cancer and hence makes them feel vulnerable.

Table 11.8-4 *Participants emotion when not wearing prosthesis: not okay vs okay VAS score*

The question 'not okay' again an overwhelming number of patients felt 'not okay' without their artificial eye in, and strongly felt therefore its benefit of wellbeing and wholeness.

Table 11.8-5 *Participants emotion when not wearing prosthesis: naked vs clothed VAS score*

A somewhat unusual question was asked of naked vs clothed and this is because a number of patients, particularly female, said that without their eye in they felt naked, and the statement was made, 'I would rather be caught naked than without my eye in', being that it is far more natural to be found unclothed than it would be to be without an eye. Later in our discussion we look at whether it's just female or male that felt nakedness, however clinically it was usually females that made this statement. And so the concept of the artificial eye 'clothing the socket' is an interesting statement. Whilst naked without the eye in they felt clothed

with it in, so it clothes the nakedness of the socket. When taking into account the human feeling of being found in a social environment naked or unaware, the emotions connected with that and the feelings of shame, this is quite a powerful factor that should be taken into account when Ocularists are treating patients, and clinicians are reviewing patients who are wearing a prosthesis. Often it has been said that perhaps a patient doesn't need a prosthesis, however when looking at questions like this, it would be strongly advised to the contrary.

Table 11.9-1 *Participants opinion on whether the prosthesis is purely cosmetic*

The question was asked is the prosthesis purely cosmetic, and the response was overwhelmingly 'No'. However, in discussion with patients it seems that this question was perhaps misunderstood. The numbers that said that the prosthesis is not purely cosmetic the answer was not particularly clear with a number when the questions were clarified. Therefore, the statistic I believe would be more participants feeling that the prosthesis plays a far greater role than merely cosmetic. The Australian Government and other Australian Health departments deem artificial eyes to be a cosmetic thing only, but we believe that this research shows the role of the artificial eye is far above 'merely cosmetic' and patient feedback supports this.

Table 11.9-2 *Participants opinion on whether the prosthesis contributes to their appearance VAS score*

Table 11.9-3 *Participants opinion on whether the prosthesis contributes to their self-esteem VAS score*

Table 11.9-4 *Participants opinion on whether the prosthesis contributes to their psychological health VAS score*

Table 11.9-5 *Participants opinion on whether the prosthesis contributes to their social acceptance VAS score*

However, of course the overwhelming feeling of the patients when asked about whether the prosthesis contributes to their appearance, overwhelmingly patients said that they appear much better with the eye in, which would correlate to the **Table 11.9-3**. This stands to reason that if they feel much better about their

appearance then clearly they feel much better about their self-esteem as is borne out with the 76% of the respondents saying that their prosthesis contributed greatly to their self-esteem. Taking that further, their psychological health, an overwhelming response of nearly 70% said that their psychological health was much better with the wearing of the prosthesis. This is largely borne out in **Table 11.9-5**, where patients felt that socially they are more acceptable with their prosthesis in, having stated that the prosthesis is excellent and unnoticeable, symmetrical, natural. On the contrast it is stated by patients that when they went out prior to their prosthesis being made, comments were made, those that wore a patch were the butt and ridicule of pirate jokes and so on, hence to wear the prosthesis was to certainly improve their social acceptance.

Table 11.9-6 *Participants opinion on whether the prosthesis contributes to their functionality VAS score*

Questions regarding functionality was listed on the basis that the statement was frequently made to the author by patients awaiting their first prosthesis, who said 'I feel like I am unable to function properly, but I know that when I receive my artificial eye, I'll feel whole again'. As such, functionality was somewhat of a generalised question as far as the respondents were concerned. Patients felt that they could function physically better with the prosthesis in, others felt that they could function socially. So this question still carries a degree of relevance in that most patients felt more functional with the artificial eye in. However, others felt that it inhibited their functioning, and that was generally verbal feedback due to the fact that their eye discharged or they were continually aware of it and the need to take care of it.

Table 11.9-7 *Participants opinion on whether the prosthesis contributes to their balance VAS score*

The association between balance and vision physiologically is well accepted (Aartolahti, Häkkinen, Lönnroos, Kautiainen, Sulkava & Hartikainen 2013). If you close your eyes your balance is less than with your eyes open. A number of patients felt that the artificial eye gave them a sense of balance and this is not just an aesthetic response. The reason for this question as stated, was that patients felt unbalance with one natural eye and a natural eye missing. The term morphic resonance has been used for this, and whilst a controversial area of science, may carry some merit in this area in regard to the socket feeling full.

Although still a foreign body, however nevertheless the artificial eye gives the patient a sense of the void of the empty socket being filled. This then sends messages whether real or imagined to the patient, giving them a sense of physical, psychological and at times visual balance. Other patients tend to look rather analytically at things, and when asked about this question said 'it doesn't help my balance at all because my eyes don't help my balance in that way and therefore with or without my eye in my balance is the same'.

Table 11.9-8 *Participants opinion on whether the prosthesis contributes to their vision VAS score*

The question with regard to vision was put in two different ways – did it help their vision, and this again is borne out later in the questioning as whether you can see with or better with the prosthesis. A number of patients felt their vision was better in the remaining natural eye when the artificial eye was in because it gave them a sense of balance. Other comments have been made with regard to the eyelids being opened the same. Patients felt that in some way if the eye socket is left empty the eyelids of course collapse by lack of volume, and they felt that their natural opposing eye went out in some form of sympathy with the empty socket and kept trying to close as well. Whether this is a real or imagined phenomenon, nevertheless it needs to be taken into account that a number of patients felt that their vision was improved because they felt their natural eye could open and relax more when the artificial eye was in. It has been clinically observed by the author that when removing artificial eyes for polishing and cleaning and ongoing maintenance, that quite often the patient will experience a watering and welling up of tears in the opposing natural eye almost as an involuntary response to the artificial eye being removed. This watering eye blurs their vision and hence with the prosthesis back in, the natural eye could relax, resulting in less tear production, and improved vision. Whether this was a psychological or physical response, nevertheless it is a real experience patients have to endure. The issue of real versus imagined is an artificial concept. All perception is essentially controlled by the brain (Saladin 2015).

Table 11.9-9 *Participants opinion on whether the prosthesis contributes to their comfort VAS score*

Again clinically observed by the author, a number of patients say that it's very uncomfortable with the eye out, and again initially this is not the case, most patients find that with the prosthesis initially being placed, they are aware of it and feel uncomfortable. Ongoing physical comfort is achieved with the prosthesis being in situ and developing its own micro-environment or akin to the natural environment. The process of homeostasis is undertaken and so patients feel far more comfortable with the void being filled and micro-environment being achieved.

Table 11.9-10 *Summary of participant's opinion on the prosthesis effecting cosmetics and function*

There was an overwhelming trend toward an improvement in appearance, self-esteem, psychologically, socially, functionally, balance and comfort. With others, obviously their eyesight is not really any better objectively as a result, but nevertheless visually an overwhelming sense of improvement is seen across the questions with regard to artificial eye wear and patient's feelings towards it. This again reinforces the fact that an artificial eye plays a far more vital role than merely cosmesis.

The effect of eye loss on a patient's life is many and varied, and often directly in proportion relating to their reason for eye loss, such that a patient who lost their eye due to trauma is often less accepting and takes longer to come to terms with it than a patient who had had their eye removed due to a painful eye or serious life threatening diseases. Thus they were happy and relieved to have the natural eye removed and a prosthesis placed.

Table 11.10-1 *Participants feeling like a different person as a result of their situation of eye loss*

A number of patients have stated over time that having their eye removed makes them feel a different person and in that sense the question was asked with regard to the impact that a natural eye loss has on a patient. No specific details were necessarily asked in relation to what way they were different but through clinical observation the author has received information from the patients that a number of patients feel more anger, more frustration, less patient as a person in general, so it has adversely affected them. Others

have stated that they feel like a different person for the positive, that they feel privileged to be alive, that eye loss has made them more compassionate towards others and as such in some way in their mind, they feel that the eye loss has helped them. Whilst of course not being something they enjoyed, nevertheless they feel that the outcome has been a positive thing from an initially negative situation. The greater majority of patients said that in no way have they changed from the experience, that they are the same person, despite the fact that they've lost their eye, nevertheless the questioning received interesting results and should be taken into account when treating patients for an artificial eye.

Table 11.10-2 Participants state others perception of prosthesis VAS scale

Humans tend to look intuitively rather than analytically at each other. Clinical observations have been that children who tend to look more analytically will observe that something is different about an artificial eye to the natural eye and will comment, whereas adults in a social context cannot tell. Many patients have also stated that when going for medical treatment both their local doctor, clinical nurse and even ophthalmologist have not been aware of the fact that it is a natural eye and an artificial eye that they are looking at, such is the natural appearance that can be achieved. This feedback which is overwhelmingly in favour of their eyes looking identical is very positive and encouraging feedback for patients, who take heart and feel a lot more positive about wearing an artificial eye and therefore its benefit. The author has a statement which he says to patients, "I like my work to be seen but not noticed", and as such, this is the endeavour of any camouflage prosthetic when natural loss has occurred.

Table 11.10-3 Participants state if others identify the eye as artificial VAS scale

Often the response from patients which is a positive one, is that any difference in appearance that is noted by the public is often described as a lazy eye. This is not only due to a slight difference in aperture for anatomical differences, but also due to slight differences in movement. Whilst getting movement, it's never quite as staccato or extreme as natural movement would be. But respondents also said that often people cannot tell that their eye is artificial. To further comment regarding lazy eye, patients often are not inclined

to open the eyelids as much as there is no visual stimulus and sight in the defect side, which is a possible contribution.

Table 11.10-4 *Participants state the amount of emphasis they place on their appearance VAS scale*

The reason for this is that often patients are very concerned about how they are accepted by others. This is somewhat of a subjective question and some patients answered in a way they felt it should be answered which was, 'I don't really care about how people think I look, but everyone likes to be liked and look their best'. This question may not carry a lot of relevance in that the author feels it was perhaps not answered as honestly as people actually feel.

Table 11.10-5 *Participants identify areas for improvement in current prosthesis VAS scale*

Improvements people would like generally related to sunken upper lid and things like movement and often due to anatomical issues with regard to lid laxity, volume and/or trauma to the eyelids causing the eye loss. Often total symmetry cannot be achieved, and an artificial eye will in some way always be artificial. Improvements that patients wanted to make their eye more natural, most patients said that they would like to get better movement. This is something that has surgically been worked on with implant surgery or motility pegs, which the author has found not to improve movement by much. Lower lid laxity was of a concern, and post enucleation socket syndrome often caused from the weight of the artificial eye. The lower lid becomes ectropic and as such loses its tension and therefore the stability of the eye. Surgical procedures such as lateral canthal sling procedures or permanent tarsorrhaphy can aid in the tightening of the lower lid. Of course therefore both the aesthetics and function, including movement of the prosthesis, and should be considered and discussed with the patient made aware of what is available to them by Ocularists when reviewing patients and in consultations with Ophthalmologist and Oculoplastic surgeons.

Table 11.11-1 *Identification of whether the prosthesis assists to 'see' better (also see Table 11.9-8)*

Table 11.11-2 *Identification of whether the participant can 'see' out of the prosthesis*

This question has been described by colleagues and some of the participants as a bizarre question. However, the question stated was given because a number of patients have said that when the prosthesis is placed, they feel they can see better, and at times can 'see out' of their prosthesis. Sense of balance (**Table 11.9-7**) is understood perhaps, but the 'seeing better' and 'seeing out of' were perhaps a little more complicated in their reasoning (**Table 11.11-1;2**). The author feels that if there are scientific reasons for this they are out of his area of understanding and expertise. However, a large proportion also the majority of 64.2% said it did not help them see better, 22.4% said yes it does, and 13.4% said sometimes it helps them see better. This is perhaps because their remaining natural eye is able to relax and feel less stressed, as stated in the questions relating to balance and artificial eye wear (**Table 11.9-7**). Perhaps morphic resonance, a message is sent physiologically to the patients' brain saying the area is filled, and this makes them 'feel better'. The feedback from the patient was they felt their natural eye could relax and open up more as was discussed in **Table 11.11-2**, and perhaps allow for an increase in field of vision. A much smaller percentage of patients answered yes (6%) or sometimes (14.9%) and this is perhaps again a mental sensation. Hence the question was 'Do you *feel* you can see out of your prosthesis?' (**Table 11.11-2**), as a number of patients felt they were getting information peripherally on their blind side. The reasons for these feelings could be a point for further discussion, nevertheless again this indicates that the artificial eye so far as the patients wearing them are concerned, plays a more vital role to their daily life and overall sense of wellbeing.

Table 11.11-3 *Participants identify if the prosthesis makes them feel more balanced*

The question was also asked, 'does your prosthesis make you feel more balanced' (**Table 11.11-3**) and as such a number of patients felt more balanced not just in appearance, but a number have said that without the prosthesis in they feel lopsided, and this does affect how they walk and how they feel they look and overall sensations that they received from the eye loss side of their face. When the prosthesis is placed they feel more balanced, an overwhelming amount of patients said yes (64.2%) or sometimes (16.4%) such that the prosthesis gives a patient a sensation of symmetry which in some instances as patients have

described, helps them hold their head straight. Others say it helps them feel they are walking straight, standing straight and others have described it as perhaps a weight related feeling of the eye socket being full and the eyelids carrying/supporting the prosthesis, which makes them feel more balanced. This is not merely a feeling of facial symmetry, but a physical feeling of balance. Again, the controversial area of morphic resonance could perhaps be an explanation for this.

Table 11.12-1 *Participants discharge amount from current prosthesis*

As colleague Ocularists will observe, and have discussed on many occasions with supporting research (Pine, Sloan, Stewart & Jacobs 2012), discharge from the prosthetic eye socket is a matter of concern amongst many patients. Hence the question relating to amount of discharge was produced. It would be described as normal to experience a small amount of discharge from the socket which is believed to be caused by the dehydration of naturally occurring lubricating tears, which are unable to find their way down the tear duct as would be the case in a natural eye environment. Most patients experience a small amount, rarely patients experience none. However 16.4% felt they experienced none. The causes of discharge have also been anecdotally described by many Ocularists as being through protein build up, biofilms, poorly fitting prostheses, and poorly chemically cured prostheses will cause discharge due to hypersensitivity or allergic reactions to the uncured PMMA. However, when all processes are followed, patients can still experience discharge. This can be because of environmental, lifestyle and possible other health issues, with regards to immunocompromised or other health conditions which means the eye socket responds in similar ways to sinus infections and paediatric teething and other ENT medical conditions, where the author has noted increased levels of discharge.

Table 11.12-2 *Participants identify main time of day for discharge*

Table 11.12-3 *Participants identify discharge colour*

Discharge amount seemed to indicate the level of bacteria or otherwise infections. A milky discharge is a normally occurring feature, and tends to be the smaller amount, however yellow tinged with green usually

indicated a conjunctivitis infection, which patients may get more easily, it would seem, than patients' with a natural eye. Others experience clear discharge which is described as 'other' in the table, and tend to be waterier than jelly-like discharge. Most patients experience this on a daily basis and find it occurs in the morning mainly after a night's sleep and clean it away and get on with their day. However, others experience it all day and it becomes a nuisance and occupies much of their thought, in having to check in the mirror to see if there is discharge present, and are embarrassed if someone comments on the discharge collecting in their eye. This is the downside to wearing an artificial eye and most patients at some point will experience this, or do experience it on a regular basis. Hence the author suggests a regular cleaning routine and regime.

Table 11.12-4 *Participants medication for discharge and outcomes*

Occasionally if the discharge is discoloured, yellow, green or other, perhaps a swab can be taken to check if any abnormal bacterial flora is present and an antibiotic medication, either topical or systemic, could be prescribed (**Table 11.12-4**). Generally, this resolves both the amount and the colour of the discharge as the infection is cleared. Usually also the socket colouration is improved from a darker red, to a paler red, or more pinky colour an indication of a healthy eye socket. Many patients that experience discharge often do so for quite a while without taking any action until visiting an Ocularist, and often General Medical Practitioners are not familiar with an artificial eye scenario and as such do not treat the condition properly. In the author's experience, chloramphenicol antibiotic eye ointment applied to the posterior aspect of the prosthesis for 14 days usually reduces discharge dramatically and the infection resolves. However, recently a number of patients have had their discharge swabbed and antibiotic resistant bacteria have been found, with often an inflamed socket with profuse discharge occurring. When treated, this may take some time. The author also in some circumstances, due to the permeability of the PMMA prosthesis, will sterilize the prosthesis by re-investing it in a flask (Section 10.7) and placing under minimal pressure and will re-cure the prosthesis. This has been done historically by Ocularists acting anecdotally due to the belief that perhaps there was free Methyl-Methacrylate monomer residually held in the prosthesis, and this was causing the

reaction, which was misdiagnosed as an allergic reaction to the monomer. This has helped the situation, but the author believes it is because bacteria has been harboured in the prosthesis. It had been observed also that patients who have older prostheses that harbour moisture and therefore trap bacteria. When treated with antibiotics, receive symptomatic relieve for a few months, after which the infection reoccurs. The author believes is due to absorbed bacteria seeping out of the prosthesis and re-presenting in the socket. Hence the need either for a new prosthesis to be made if older than 5 years, or sterilization treatment in the flask. The author has found that often hydrocortisone ointment treatment and antibiotic ointment used in alternate days for 1 month, that both the inflammation and the infection are significantly reduced, if not eliminated. There seems to be in the author's opinion, a correlation between inflammation and infection, but as to which one comes first is the question, or do both situations occur in different patients at different times. However, in the authors opinion, a poorly fitting prosthesis will cause irritation which then leads to inflammation, which then often triggers infection. Hence the need for a well-fitting, properly cured and well maintained artificial eye prosthesis, conforming to the surrounding anatomy and for the overall homeostasis and well-being of the patient. This is an area that seems to not be fully understood by many Ocularists worldwide, and could be an area for further study.

Table 11.13-1 Whether participants' eyelid close at night

A number of patients due to anatomical reasons and related trauma, experience poor eyelid competence, and as such when sleeping with the prosthesis in, a dry patch forms, causing the upper lid particularly to adhere to the dry acrylic surface. This can also coincide with a dry film of tear which then becomes both irritating and abrasive when the patient blinks. This will also cause an inflammatory response and can lead to an infection. In situations where a patient's eyelids does not close when sleeping, normally what happens is that when the patient blinks the eyelids do not occlude either, hence a full surface wipe of the prosthesis, similar to windscreen wipers on a motor vehicle, does not occur. This also allows dry patches to form and is another potential area of concern and irritation for the patient. The author usually suggests eye lubricant ointments consisting predominantly of paraphen to be put on the surface to act as both a barrier layer to

avoid sediment and biofilms forming, and to act as a lubricant and soothing agent. The eye ointments with antibacterial components the author believes to have a three-fold benefit over and above drops. The ingredient acts as both a soothing agent and lubricant. It lasts longer and rather than dehydrating and leaving debris behind, it dissipates and can soothe the socket. The antibiotic also stays around longer and therefore acts more effectively than drops would otherwise do when applied to the posterior surface of the prosthesis in direct contact with the socket tissues. So far as the eyelids closing is concerned, surgery can be performed, however this can often result in the patient experiencing ptosis of the upper lid and hence the appearance of a lazy eye. The outcome of any surgery needs to be discussed with the patient, Ocularist and operating Surgeon collaboratively to ensure that both the aesthetics and function are being taken into account. However, the author believes that if ointment is used this can alleviate significantly the symptoms caused by the lack of eyelid occlusion.

Table 11.13-2 *Participants who wear their prosthesis while sleeping compared to those who don't*

Most patients are encouraged to wear their prosthesis all the time, but historically with glass eyes, patients would remove them at night and sleep without them in (**Table 11.13-2**). On rare occasions this may be necessary, particularly at times when patient's eyelids do not close and if pharmaceutical products do not relieve the symptoms. The last resort would be to remove the prosthesis at night, to leave it hydrated in a rigid contact lens or other similar saline solution and replace in the morning, perhaps with eye lubricant ointment. Otherwise in a normal eye socket where all functions are healthy and full eyelid closure occurs, patients that wear their eye when sleeping, experience a much better homeostasis cycle (**Fig. 9.8-4**) and easier ongoing life with their eye.

Table 11.14-1 *How often participants remove their prosthesis*

A number of patients would leave their prosthesis in for extended periods of time (**Table 11.14-1**) and in the questionnaire, close to 50% of respondents never removed their prosthesis other than coming to the Ocularist clinic for ongoing maintenance. At which point it is removed, cleaned and replaced, and thus the

patient will never handle their prosthesis. Others removed monthly to clean and wash and check their socket for foreign bodies such as eyelashes or dust/dirt. The patients that handle their eyes regularly historically are ones who had worn a glass eye and were told to remove daily to clean and are therefore in the habit of doing so. A habit which is hard to break. It is the author's belief that a prosthesis left in the eye socket will create its own micro-environment and follow the homeostasis cycle (Fig. 9.8-4). It is less invasive on a patients' life, in that they can get on with their life with little thought or concern for their prosthesis if maintained regularly by the Ocularist. However, those that handle their prosthesis, the author believes, are perhaps more prone to contracting an infection by the continual introduction of the prosthesis on a regular basis.

Table 11.14-2 *How often participants have their prosthesis professionally cleaned*

More than 50% of the respondents did have their prosthesis reviewed/cleaned on a 3-4 monthly basis; others are 6 monthly, and this is usually due to availability or country living. The authors preference is for the patient to have their prosthesis reviewed at least twice a year, whilst other patients are non-compliant, but sometimes overlook the need and will only appear or request a review when their symptoms of discharge, infection, irritation or discomfort increase to a level that they cannot tolerate anymore. Then they present in clinic, at which point the Ocularist is able to educate and explain the issues surrounding artificial eye wear, and the need for professional and ongoing maintenance.

Table 11.14-3 *How often participants experience dry eye*

Historically the author has observed that patients have complained of dry eye, however the respondents to this questionnaire largely do not experience this. A number of patients describe reverse cycle air-conditioning as being a cause of dry eye, particularly in office environments and airplane travel where the air is recycled and non-hydrated. Other patients experience dry eye seasonally, often due to hay fever symptoms, or occasionally when ill. Those who do complain of dry eye often describe it as a burning or

stinging sensation accompanied by itchiness. The author has found that application of an ocular lubricant will alleviate these symptoms and reduce discomfort.

Table 11.14-4 *How often participants experience watery eye*

Those complaining of watery eye which is occasional, generally describe it as being caused by tiredness or having some other respiratory or ear/nose/throat infection, also often associated for some with hay fever symptoms. The author has also found the solution for watery eye to be similar to that of dry eye, namely using an eye lubricant ointment. This reduces the friction sensation and soothes, and therefore does not engage the tear gland overly, so both the solutions for dry and watery eye the author has found to be similar.

Table 11.15-1 *Participants identify hardest areas of initial adjustment*

Depth perception is overwhelmingly the most difficult thing to adjust to, whilst other patients have found that they walked unsteadily. However, this was due to their lack of depth perception as was driving a vehicle. Others stated that all of them were difficult, and this is generally accommodated for over time and books have been written (Brady 2009). The author would direct his patients to either purchase or borrow books which relay tips as how to accommodate their loss of depth perception due to the loss of one eye (Brady 2009).

Table 11.15-2 *Participants identify easiest areas of initial adjustment*

Interestingly those who had their eye removed through painful eye found the easiest thing to get used to was no more pain. Obviously pain is a debilitating a stressful thing, and the removal of an eye due to that generally patients receive immediate relief, and as such, having their eye removed is understandably a more pleasant state.

Table 11.15-3 *Participants identify how aware they are of the prosthesis VAS scale*

Most patients describe wearing their artificial eye as something they are aware of but it does not play on their mind on a daily basis. From time to time they are reminded of it either by virtue of a small amount of discharge or by bumping into someone on their blind side. When asked about their awareness of their

artificial eye, most patients wear it without physically being aware of it from a feelings or sensation point of view. However, they are reminded of it when doing tasks that would otherwise be easier with two eyes, that accommodation is needed to be made for the monocular vision. Most of the patients are not overly aware, however some are continually aware, and that is generally due to levels of discharge that play on their mind, and they feel the need to clean away a number of times a day.

Table 11.15-4 *Participants identify how convenient the prosthesis is VAS scale*

Most patients described the wearing of the artificial eye as a convenient thing (**Table 11.15-4**), it doesn't overly effect their lifestyle and as such can get on with their normal routine. Ten of the respondents were ambivalent in that they had no real feeling about it, and others said it was a "pain in the neck" to wear an artificial eye because of the issues surrounding it, and the need for regular and ongoing maintenance.

12.4 COMPARATIVE DATA FINDINGS

Table 11.16-1 *Reason for loss compared with socket colour*

While this may provide a small amount of evidence to suggest that those who lose their eye due to trauma being more susceptible to having ongoing complications, there are other factors that would need to be looked into. This would include looking at the amount of time that socket has had to heal after eye removal. The comparison of the colour of discharge to the time of discharge may be informative, as it may suggest the reason many are experiencing discharge (**Table 11.16-3**). Most interestingly is that 16 (30%) of those who responded to both questions used to make the comparison, experienced milky discharge in the morning. This may simply be the result of the prosthesis drying, and causing mild irritation to the socket overnight, resulting in the discharge. However, it is common for people with two natural seeing eyes to experience a small amount of discharge from their eye in the morning as tears have collected throughout the night through eye aqueous, tear film and movement.

Table 11.16-5 *Professional review period compared to discharge amount*

Interestingly in **Table 11.16-5**, those who had their eye reviewed regularly still experience a significant amount of discharge, and what is unsure is whether patients came and got their eye reviewed because of the discharge or whether the polishing and review caused the discharge. The author believes that those who experience ongoing discharge find a significant increase in bio-film and as Pine, Sloan & Jacobs (2012b) found, the rate of deposit build-up was increased where the prosthesis was not professionally polished, which therefore shows the need for the regular review and professional cleaning. Those who experience limited discharge therefore tend to experience less amount of bio-film build-up on the surface and therefore tend to need their eye reviewed less. The author believes that the bio-film build-up perhaps correlates to the alkalinity or acidity of the natural tears the patient produces; a more alkaline tear would tend to build up more bio-film and protein deposits, whereas more acidic tears would tend to dissolve these and less build-up would occur. However, to his knowledge, no study has been done on the chemical environment of the eye socket, and further study could be done to see whether this in fact is the case. Comparing the time between review periods with the discharge amount is interesting as it may highlight two perspectives; one perspective may be that more frequent reviews may be irritating, and contributing to higher amounts of discharge. The alternative perspective may be that those experiencing higher amounts of discharge are being seen and reviewed at intervals appropriate to their needs.

Table 11.16-7; 11.16-8 *Professional review and frequency compared to discharge colour*

Professional review compared to discharge colour would seem to show that those who experience the most amount of discharge and also therefore experience differing colours of discharge, would either by clinical advice or by their own volition, have their prosthesis reviewed relatively often so as to maintain health, comfort and aesthetics. This table suggests that those being reviewed most frequently are those with the more severe discharge, and those scheduled at wider intervals are those who experience less severe discharge. This data fits with general care plans, and is appropriate.

Table 11.16-9 *Participants age at eye loss compared with reason for loss*

This table shows that a significant amount of people who lost their eye were over 50 as discussed, and of that, a large proportion lost it through disease. So clearly the incidence of disease peaks in the earlier and later years of life. There seems to be a relationship between the incidence of trauma and disease related loss up until 50, then disease becomes the leading cause.

Table 11.16-12 *Time taken to come to terms compared with age at loss*

The interpretation of this data is that most would have liked more time to come to terms with what was happening, before being treated. The number who would have liked less time seems to remain consistent, regardless of how many from that age bracket had experienced loss. There is not enough data to make a comparison whether this is an age related predicament or not. Most interestingly, is the 9 cases between the ages of 0 and 3 who have given feedback. One may expect the age group to have selected 'no difference' based on memory, or childhood innocence. However, 9 respondents have felt strongly enough about their memories of the experience to respond either way. This may provide evidence to help demonstrate the level of the psychological impact of eye loss occurs even as a very young child. As previously stated one 91-year-old patient who lost her eye when aged 3 years old was still too traumatised by the experience to be able to answer the research questionnaire. Some of this may also stem from childhood experiences as a result of eye loss including bullying and teasing.

12.5 NULL HYPOTHESES FINDINGS

Table 11.17-1 *Null hypothesis: patients over 50 - disease*

This shows the null hypothesis that patients over the age of 50 at the time of eye loss are more inclined to have lost their eye through disease than those under 50. This is supported as most of the patients over 50 who lost their eye disproportionately lost their eye through disease. This means that as we age we are more susceptible to disease and therefore the risks of eye disease are included in that.

Table 11.17-2 *Null hypothesis: men - trauma*

As Pine, Sloan & Jacobs (2012a) observed, men generally lose their eye to trauma disproportionately more than women (**Table 11.17-2**). This is supported due to historically lifestyle and vocational issues, with men doing more manual labour and jobs at risk of eye injury. There are also issues of eye safety which were not enforced historically, but more recently it has been enforced. However, a number of patients also lost their eye through non-work related trauma, for example, pub brawls, glassing, assault and other recreational activities tending toward that direction.

Table 11.17-3 *Null hypothesis: smokers – eye loss through disease*

The hypothesis was that smokers would lose their eye to disease disproportionately more than non-smokers and this was supported. There were a number listed as non-smokers in the original questionnaire, who when verbally questioned had given up smoking as a result of their eye loss or shortly before because of their eye related condition. In this study they were deemed to have been smokers. As such, smokers did disproportionately lose their eye, supporting scientific and publicised evidence on cigarette packets that smoking can harm your eyesight, hence education is needed for people who smoke to quit.

Table 11.17-4 *Null hypothesis: diabetic patients – dry eye problems*

It was thought that perhaps diabetic patients experience more dry eye problems than non-diabetic patients due to other associated health issues with diabetes. However, it would seem that there was not necessarily a correlation between patients suffering diabetes and experiencing dry eye.

Table 11.17-5 *Null hypothesis: eye loss through disease – more discharge*

The hypothesis that patients who lost their eye through disease experience more discharge based on the fact that they had a history of a disease that effected their eye and perhaps there was some ongoing medical legacy left as a result. Again, this was unsupported such that no correlation between a reason for eye loss and discharge or dryness is supported.

Table 11.17-6 *Null hypothesis: men – more discharge*

The hypothesis due to lifestyle issues that perhaps men who we saw lost their eye through trauma more prevalently than women and subsequently also experience more discharge than women. This was not supported, meaning that men and women experience the same homeostasis and micro-environment issues with artificial eye wear. Eye condition issues are not gender specific.

Table 11.17-8 *Null hypothesis: men – more self-esteem increase with eye insitu*

The hypothesis suggested that men felt more self-esteem when wearing an artificial eye than women necessarily would (**Table 11.17-8**), but again the feeling of self-esteem hypothesis is not supported, it is not gender related.

Table 11.17-9 *Null hypothesis: women – more vulnerable without eye insitu*

This hypothesis was not supported, and vulnerability without a prosthesis is not gender specific, despite the fact that women were the ones that the author heard say they felt naked without their prosthesis in.

Table 11.17-10 *Null hypothesis: women – more naked without prosthesis*

Both these feelings of vulnerability and nakedness are experienced by both men and women (**Table 11.17-10**). As such this confirms to the author that the emotional, psychological, and social issues of eye loss and subsequent artificial eye wear effects both genders in the same way.

Table 11.17-11 *Null hypothesis: women – more unattractive without eye insitu*

Again, when relating to cosmesis, the hypothesis was that women would feel more unattractive than men without their prosthesis in. This was unsupported and again non gender related in that both men and women felt unattractive without a prosthesis in. Hence, the vital role that prosthetic rehabilitation plays for people who have suffered eye loss.

None of the hypothesis relating to a gender and psychological relationship were supported, indicating that at an emotional level everyone is entirely individual and required treatment as such.

12.6 SUMMARY

The research findings have conclusively shown that artificial eye wear is far more than merely a cosmetic experience for those who have suffered eye loss. It has shown that ongoing care, both emotionally and medically is needed for those who wear artificial eyes, certainly in the initial stages of eye loss and prosthetic rehabilitation, where both education, support and care is needed for the patient.

13. CONCLUSION

13.1 INTRODUCTION

This study details the demographic and experience of a consecutive group of patients experiencing eye loss through trauma, disease or congenital causes. Each patient has then undergone ocular prosthetic rehabilitation, being treated by a singular Ocularist, following Standard Operating Procedures (Appendix 14.1) outlined by the American Society of Ocularists (2015), and adopted by the Ocularist Association of Australia. As such, this study is unique within Australia and within the world.

13.2 RESEARCH CONCLUSIONS

It was found that eye loss, as stated by the American Medical Association (2001), is traumatic for most patients and affects them as would a death. As stated by many a patient, the loss of their eye was like losing a very close friend. Patients identified that areas that could have improved through their experiencing of this trauma would have been meeting with others, better education, support groups and counselling services. The psychological, social and physiological benefit of prosthetic eye wear was established, with patients feeling a greater sense of social acceptance, improvement in appearance, self-esteem and overall well-being. Balance and even eyesight at times were said to have been improved.

Overall socket health was considered, and it was felt that patients benefit from a regular ongoing maintenance regime, for both functional, comfort, and homeostasis reasons. It was found that initial eye loss and prosthetic rehabilitation patients were still experiencing trauma many years later. However, as time progressed acceptance levels increased and the overall feeling of wellbeing increased, and the patients artificial eye wear contributed to this.

It was shown that eye loss is non-gender specific and indiscriminate, however over the age of 50 men and women lost their eye through disease significantly more commonly than those under 50. Trauma was clearly seen as an issue surrounding males, both occupational injuries and through social and recreational trauma.

Overwhelmingly, most patients felt that their prosthetic eye contributed to them more than mere cosmesis, providing significant improvement in their appearance, self-esteem, psychological health, social interactions, eyesight, comfort and balance.

A number of propositions were put forward.

One, that patients over the age of 50 at the time were more inclined to lose their eye through disease than those under 50, which was supported.

Two, that men lose their eye through trauma disproportionately more than women, which also was supported.

Three, that smokers would more likely lose their eye through disease more than non-smokers, also being supported.

The propositions that diabetics experience more dry eye than non-diabetics, those who lost their eye through disease experience more discharge, that men experience more discharge than women, were not supported.

Those who have their eye cleaned every 3 three months experience less discharge, was not supported.

Men experience more improvement in self-esteem when wearing their prosthesis, women feeling more vulnerable, women feeling more naked, and women feeling more unattractive without their prosthetic eye in, were hypotheses not supported. This showed that both men and women experience the same social, physiological and psychological issues surrounding eye loss and prosthetic rehabilitation as each other.

13.3 FURTHER RESEARCH

Children and adolescents were excluded as candidates from the questionnaire as the results would primarily come from the parents. This would involve and create further research topics such as parents' views and feelings upon the eye loss and artificial eye wear of their child. This is an area of research that was not included in this current research topic. It is understood that this will affect data results in relation to

childhood illness as causes for eye loss, and discharge amounts. Also excluded, only through lack of opportunity, was Indigenous Australians, for which further research could be beneficial. It was found that eye loss and rehabilitation with an artificial eye and artificial eye wearers are highly emotive and sensitive issue for those involved. This should be taken into account, and further studies could be undertaken by psychologists and others involved in this area to help future treatment. Bio-film deposits and their relationships to tear pH levels could be a further area of beneficial research. As many patients reported an improvement in balance and at times, eyesight, further study could be considered to understand this more fully in the controversial area of morphic resonance, which may in fact be playing a part whilst not a proven science.

13.4 SUMMARY

This study, whilst being undertaken by a single Ocularist over a number of years providing artificial eyes for both men and women who have lost their eyes through trauma, disease and congenital reasons, has proven that contrary to both public and medical consensus, an artificial eye contributes not merely to cosmesis but the overall wellbeing and quality of life for the individual who has lost their eye. It was seen clearly that further effort should be put toward support groups, education and counselling for those that have lost their eyes, as they felt that this was needed to aid them through the sorrow, emotion and trauma of eye loss and subsequent rehabilitation was seen to contribute to the psychological and lifestyle health of the patients wearing a prosthetic eye.

As such the need for prosthetic rehabilitation and knowledge and education of the associated issues surrounding it should be taken seriously. Patients, their support team and family should be handled very carefully, taking into consideration the trauma they are experiencing whether their eye loss be through trauma, disease or congenital causes.

The overall message from this thesis would indicate that the small professional area of Ocularistry, both here in Australia and worldwide, plays a vital role in the life of a small percentage of people who have lost their eyes. More than a cosmetic role, it plays a vital role for them and their families and as such this study has shown the importance of the Ocularist profession, and the need for further education, research and training, and support for both the profession and through that, most importantly the patient.

14. APENDICES

14.1 CUSTOM PMMA OCULAR PROSTHETICS STANDARD OPERATING PROCEDURES

American Society of Ocularists

CUSTOM PMMA OCULAR PROSTHETICS STANDARD OPERATING PROCEDURES

(Adopted & Endorsed By The Ocularists Association Of Australia)

I. METHODOLOGY

Most contemporary Ocularists utilize one or several combined fitting-fabrication techniques; ie., the fabrication process is actually begun as a part of the initial fitting procedure and continues until the ocular prosthesis is considered fabricated and adequately inserted in the patients' eye socket. One ocularist usually does all of the fitting-fabrication procedures; however, two or more ocularist may work as a team on one patient until all of the procedures are completed.

Except as a temporary prosthesis, there are no pre-fabricated or 'stock' eye prostheses fabricated or provided to any individual or dispenser, in keeping with the rules mandated by the American Society of Ocularists (and adopted by Ocularists Association of Australia).

Within each Ocularist's office, fitting/fabricating each product requires virtually identical materials, but slightly varied processing time, depending upon whether they are cast in opaque and clear PMMA (see A; B; C3-5; D; F). the following types of products are identified separately, since they require varied fitting techniques and/or single or multiple curing processes.

- A.** An ocular prosthesis for an enucleated eye socket with, or without, and implant (implant surgically placed by an ophthalmic surgeon). Device requires multiple curing processes.
- B.** A scleral shell ocular prosthesis for a phthisical, eviscerated, microphthalmic or blind, disfigured globe. Device requires single or multiple curing processes.
- C.** Custom made conformers for:
 - 1. Post-surgical eye sockets; single cure process;
 - 2. shield for eyelid surgery; single cure process;
 - 3. Contracted eye socket expansion; single or multiple cure process;
 - 4. Congenital microphthalmos socket and/or eyelid expansion; single or multiple cure process;
 - 5. Congenital anophthalmos socket and /or eyelid expansion; single or multiple cure process;
 - 6. Template for prosthesis – to – implant motility – coupling device placement procedure; single cure process.
- D.** Enlargement (augmentation) of an ocular prosthesis; single or multiple cure process.

- E. Reduction of an ocular prosthesis; no curing process involved.
Modification of prosthesis for motility-coupling device(s); single or multiple cure process.

II. FITTING MODEL FORMATION PROCESS

The following enumerates the formation sequence of an individual fitting model (prototype).

1. The eye socket is inspected for globe or implant position and irregularities in conjunctival tissue. Abnormalities which must be addressed are identified (e.g. Fistulas)
2. An appropriate impression tray is selected and disinfected. Impression trays are made from PMMA, polybutyrate and/or dental wax. The tray or 'base shape' is chosen and/or modified, based on criteria of comfort, cosmesis, motility, and socket development.
3. Impression material is mixed in accordance with manufacturer's instructions.
 - a) Impression material is placed in tray and tray-impression-material composite is placed in socket or over existing globe.

OR

- b) Tray is placed into socket and impression material is then introduced into the eye socket behind the tray using a syringe.
4. When the impression material has congealed or set, the tray and impression are removed.
5.
 - a) The impression is then invested in an investment medium in preparation for replication. Heated dental inlay wax is then poured into the mould cavity, once the impression has been removed.

OR

- b) Replication can be made in PMMA by either
 - i. Casting of clear or opaque white PMMA-MMA dough within the investment medium, following procedure set out in section IV, subsection 5-7, or;
 - ii. Forming of clear acrylic sheet pressed or vacuum, formed over a dental investment medium positive of the impressed globe/implant.
6. Modifications of the impressed shape are implemented relative to:
 - a) Patient comfort;
 - b) The eye socket fornices;
 - c) The eye socket irregularities.
7. Anterior-posterior thickness and iris location are determined (with either a composite cornea-pupil-iris-piece (CCPIP) or a composite cornea-iris-limbus-piece (CCILP) (see section III, Subsection 2, Part V for definition) as well as palpebral fissure symmetry, before the model is considered ready for investment in a mould and the fabrication process continued.

III. IRIS REPLICATION PROCESS

1. Patients iris is measured for correct iris size.
2. The following represents seven alternative choices depending upon eye socket/fitting circumstances and ocularist's preferences (one of the following):
 - i) The iris is painted on a vinyl or PMMA disk
 - a. Clear PMMA-MMA dough is then cured onto the painted surface.

OR

 - b. A cornea button is glued onto the painted surface with monomer-polymer solution.
 - ii) The iris is painted on the posterior side of a flat or slightly concave CCPIP.
 - iii) The iris is painted on a thin sheet of aluminium or tin foil, which has been placed over the convex side of a steel die. When painting is complete, clear PMMA-MMA dough is capped over the iris, the die is closed within a press and the piece is cured for a predetermined period of time in an approved "curing unit" (see Section IV, subsection 7).
 - iv) The iris is painted on a slightly convex anterior surface of the prosthesis, in the appropriate location.
 - v) The iris is painted on a PMMA button. The 'bonnet' of white PMMA is added over the top of the iris button and clear PMMA-MMA dough is pressed inside the bonnet/button assembly. Bonnet/button/dough assembly is then placed in a springless clamp and cured. This creates the CCILP which, when cured, has its anterior surface cut on a modified contact lens lathe.
 - vi) A solid-colour corneal lens is invested in the shape and cured. Then, after relieving surface material down to allow for final clear cap and proper iris size, the iris is painted on the surface, including veins and scleral tones.
 - vii) A flat or curved black MMA disc is painted. A flat or curved clear corneal button with or without pupil is glued onto the painted surface with monomer-polymer syrup ('monopoly'). To prevent the curved black PMMA disk from collapsing, during gluing operations, the curved disk is placed over an appropriate curved backing device.

IV. FABRICATION PROCESS

Note: Ocularists currently use the same basic process employed by the U.S Army and Navy Dental Corps, at VA hospital circa 1942, with the following exceptions:

1. Other separating media may be used in place of tin foil;
2. Polyethylene, stainless steel glass cups, or other suitable container may be used instead of glass jars for mixing PMMS powder with monomer;
3. The microwave oven, hydraulic press with heated platens and heated glycerine bath now exists as curing options;

Note: All PMMA & MMA materials must be heat curable or exothermic polymerized (i.e. no auto polymerizing materials allowed in eye socket).

The actual steps adhered to by American society of Ocularists (and Ocularists Association of Australia) in fabricating the prosthesis are as follows (modify to individual lab):

1. A mould is made of the prototype ocular prosthesis using dental investment medium within a suitable flask, depending on the type of heating source used to cure the PMMA.
2. When both section of the mould are hard, the flask is opened and the prototype model is removed.
3.
 - a) if a CCPIP is used, then it is placed into its predetermined location in the anterior section of the mould.

OR

- b) If a CCPIP is NOT used, a curved-back CCPIP may be used if the prosthesis is too thin for a flat CCPIP, or if the prosthesis is to be made as an extremely thin scleral shell, the CCPIP may be eliminated.

OR

- c) If CCILP is used, the 'trial' CCILP is removed and a custom CCILP is permanently attached to the acrylic shape. The anterior of the acrylic blank is reduced to allow room for the addition of the veins and scleral tinting.
4. Either half of the mould may be enlarged slightly by grinding and/or scraping or a shim material may be placed between the mould halves. The mould is cleaned, inspected and a separating medium is applied to each side of the mould.

Note: if using a CCILP, go to section 10

5. Scleral toned PMMA powder and monomer are mixed together in a suitable container, at a ratio of three (3) parts of powder to one (1) part monomer by volume 3:1.
6. The scleral-toned mixture is allowed to gel until it reached a consistency ranging from 'dry' (i.e. does not stick to the hand) to resembling 'snappable' taffy. To accelerate gelation, the mixture may be warmed pre-or-post-mixing of the MMA with the PMMA powder.
7. The gelled scleral toned mixture is packed into the anterior mould section to overflow and the posterior section is interfaced with it, placed into a press, closed and tightened.
8. The entire unit is then placed in an (choose a, b, or c)
 - a) Water bath and processed in accordance with Specification 12 of the American Dental Association (Spec 12, hereafter). If using materials requiring different processing times, manufacturer's directions and curing times are to be adhered to.

Note: Spec 12 specifies a flasking clamp without SPRINGS. For spec 12, these are the procedures and minimum processing times:

“...the flasked specimen held in a flask clamp without springs, shall be submerged in water at 73C (+1-1C) for one and a half hours and then immersed in boiling water for one half hour.

When the heating schedule has been completed, the flask in the clamp shall be cooled in air at 23C (+/- 10C) for 30 minutes and then immersed in water at 23C (+/-10C) for 15 minutes.”

- b) Microwave oven (times and power levels will vary depending on the output rating or wattage and the ballast mass placed in the microwave oven). The specific power of the microwave oven, its model number, brand name, as well as levels, curing time and ballast mass shall be indicated on the Medical Device History Record.
- c) Alternate source of polymerization propagation. The chosen method's times and temperatures shall be adhered to, and all permanent information shall be indicated on the Medical Device History Record.

Note: all sources of polymerization propagation are considered 'curing units'.

- 9. Mould is released from press, mould sections separated and prosthesis removed from the mould, excess flashing ground away, iris exposed to proper diameter (if CCPIP is used), and scleral area is readied for painting and veining.
- 10. Iris tones enhanced, or applied to any anterior surface (if fashioning extremely thin prosthesis), along with the scleral tones and veins. Veining material may be made of *nylon, polyester, cotton, silk, or pencil crayon*. Artwork on prosthesis is then allowed to dry. The mould is again inspected, repaired, cleaned and a separating medium is applied to both sections.
- 11. The prosthesis is placed into the posterior section of the mould. Clear PMMA powder and monomer are mixed in the same 3:1 ratio and gelled as in steps 5 and 6. The mixture is then placed on the anterior surface, the mould sections interfaced and closed in the press. 'Trial Packing' with a polyethylene sheet between anterior surface of prosthesis and MMA-PMMA mixture may be used here, with excess flashing *removed prior to final packing*. The flask-press unit is placed into the curing unit and processed in the same manner as described in step 7.
- 12. The prosthesis is released from the mould. Flashing and surface irregularities are ground away. It is first polished with gradually finer gradients of polishing materials. Final wet and/or dry high gloss is applied after inspection of all surfaces is complete. There should be no visible defects when examined with a loupe. The prosthesis is now ready for disinfection and delivery to the patient. Minor surface reductions may be made during the delivery process, with subsequent repolishing of all surfaces, before final delivery of the prosthesis.

V. Materials

Type of product:

PMMA Powder, white or tinted

PMMA Powder, clear

MMA monomer

Composite cornea-pupil-iris piece (button)

PMMA iris discs/button (flat or curved)

Vinyl or acrylic iris discs

PMMA monomer-polymer syrup

Veining fibre

Oil pigments

Dry pigments

Tattoo pigments

Liquid separating agent

Metallic foil

Dental wax polish

Liquid (water based) polish

Dry final polish

Alginate

Wax

Dental stone or other suitable investment medium

Pumice

Disinfecting materials/compounds

Contact lens wetting solution

VI. Supporting Documentation

'Guide to Dental Materials and Devices, sixth edition (1972-73): page 203

- a. Dupont Material Safety Data Sheet Methylmethacrylate Monomer, Inhibited
- b. Dupont Material Safety Data Sheet – "Lucite" 6751 Acrylic Resin
- c. Dupont Material Safety Data Sheet "Ti-Pure" R-103
- d. Johnson, Walter, "How Pressure Affects Polymerization"
- e. Durette, Jean-Francois, "Microwave Curing of Ocular Prosthesis"

14.2 UNIVERSITY OF ADELAIDE ETHICAL PERMISSION



Government of South Australia
SA Health

2 November 2011

Mr Peter Knowles
Senior Oral and Maxillofacial Body Prosthetist
Oral and Maxillofacial Surgery Unit
Eye Department
ROYAL ADELAIDE HOSPITAL

Central Adelaide Local Health Network
ROYAL ADELAIDE HOSPITAL
North Terrace
Adelaide SA 5000
Tel: +61 8 8222 4000
Fax: +61 8 8222 5939
ABN 80 230 154 545
www.rah.sa.gov.au

Research Ethics Committee
Level 3, Hanson Institute
Tel: (08) 8222 4139
Fax: (08) 8222 3035
Email: Heather.O'Dea@health.sa.gov.au

Dear Mr Knowles,

Re: "The outcome of ocular prosthetic (artificial eye) reconstruction."
RAH PROTOCOL NO: 111103.

I am pleased to advise that Research Ethics Committee APPROVAL is granted to the above project on the above date. The following have been reviewed and approved:

- **Protocol, Version 2, April 2011**
- **Participant Information Sheet & Consent Form, Version 2, April 2011**
- **Health Survey**
 - **I.B.Q**
 - **S.I. Questionnaire**
- **Research Questionnaire**

Please quote the RAH Protocol Number allocated to your study on all future correspondence. Research Ethics Committee deliberations are guided by the NHMRC National Statement on Ethical Conduct in Human Research 2007.

GENERAL TERMS AND CONDITIONS OF ETHICAL APPROVAL:

- Adequate record-keeping is important. If the project involves signed consent, you should retain the completed consent forms which relate to this project and a list of all those participating in the project, to enable contact with them in the future if necessary. The duration of record retention for all clinical research data is 15 years.
- You must notify the Research Ethics Committee of any events which might warrant review of the approval or which warrant new information being presented to research participants, including:
 - (a) serious or unexpected adverse events which warrant protocol change or notification to research participants,
 - (b) changes to the protocol,
 - (c) premature termination of the study,
 - (d) a study completion report within 3 months of the project completion.
- The Committee must be notified within 72 hours of any serious adverse event occurring at this site.
- Approval is **ongoing**, subject to satisfactory annual review. Investigators are responsible for providing an annual review to the RAH REC Executive Officer each anniversary of the final approval date using the Annual Review Form available at: <http://www.rah.sa.gov.au/rec/index.php> The REC must be advised with a report or in writing when this study is complete so that the file can be closed.

Yours sincerely,

 **A/Prof B Chatterton**
DEPUTY CHAIRMAN
RESEARCH ETHICS COMMITTEE

14.3 VISUAL ANALOGUE SCALE GLOSSARY OF TERMS

All definitions sourced from English Oxford Living Dictionaries (2017)

ACCEPTANCE – believe to be valid or correct, resign oneself to

ANGRY – outraged, wrathful, indignant, irritated, annoyed

APPEARANCE – the way that someone looks or seems

ATTRACTIVE – pleasing in appearance

BALANCE – to be in a steady position – a situation where elements are in the correct proportions

CLOTHED – body covered, dressed

CONTENT – satisfied with what you have, gratified, at ease, peace, satisfied

CONVENIENT – involving little trouble or effort

DENIAL – refusing to accept something unpleasant

DISFUNCTIONAL – not operating normally

DISCONTENT – dissatisfied, disgruntled, unhappy

EXCITED – enthusiastic or eager, anticipation

FRUSTRATED – disheartened, dispirited, depressed

FUNCTIONALITY – working order, practical and useful

HAPPY – pleased, contented, fortunate, in good spirit

HEALED - make or become healthy again

INCONVENIENT - causing trouble or difficulty

NAKED – without clothes, without covering

NOT OKAY – opposite of okay

OKAY – all right

PLEASANT – enjoyable, likeable

RELIEF / RELIEVED – a feeling of relaxation after anxiety

SAD – despondent, glum, depressed, miserable

SECURE – safe, confident

SOCIAL ACCEPTANCE – received by society

SORROW – deep distress caused by loss or disappointment, grief

UNATTRACTIVE – opposite of attractive

UNCOMFORTABLE – opposite of comfortable

UNPLEASANT – causing distaste or distress

VULNERABLE – exposed to being attacked – defenceless, unprotected

14.4 RESEARCH QUESTIONNAIRE USED

Number:	
Date:	
Dates Revised:	

RESEARCH QUESTIONNAIRE

All questions contained in this questionnaire are strictly confidential and will be kept on a secure stand alone research computer with access limited to the investigators.

1, Name (Last, First, M.I.):		<input type="checkbox"/> M <input type="checkbox"/> F	2, DOB: _/ _/ _ _ _ _ (dd/mm/yyyy)
3, <input type="checkbox"/> Would you be able to be contacted for further info? Contact info - Phone/Mobile:		4, Email:	
5, Postal Address:		6, City:	
7, State:		8, Post Codes (required)	
9, Name of medical doctor:			
10, Address:			
11, Marital status: <input type="checkbox"/> Single <input type="checkbox"/> Partnered <input type="checkbox"/> Married <input type="checkbox"/> Separated <input type="checkbox"/> Divorced <input type="checkbox"/> Widowed			
12, Occupation:	<input type="checkbox"/> Professional	<input type="checkbox"/> Administration	<input type="checkbox"/> Other (specify):
	<input type="checkbox"/> Technical	<input type="checkbox"/> Laborer	

PERSONAL MEDICAL/HEALTH HISTORY

13, Childhood illness:	(a) Measles <input type="checkbox"/> Yes <input type="checkbox"/> No	(d) Mumps <input type="checkbox"/> Yes <input type="checkbox"/> No
	(b) Rubella <input type="checkbox"/> Yes <input type="checkbox"/> No	(e) Chickenpox <input type="checkbox"/> Yes <input type="checkbox"/> No
	(c) Rheumatic Fever <input type="checkbox"/> Yes <input type="checkbox"/> No	(f) Polio <input type="checkbox"/> Yes <input type="checkbox"/> No
14, Immunizations and dates:	(a) <input type="checkbox"/> Tetanus	(d) <input type="checkbox"/> Pneumonia
	(b) <input type="checkbox"/> Hepatitis	(e) <input type="checkbox"/> Chickenpox
	(c) <input type="checkbox"/> Influenza	(f) <input type="checkbox"/> MMR Measles, Mumps, Rubella
15, Have you ever stayed in a hospital or had an operation: <input type="checkbox"/> Yes <input type="checkbox"/> No		
16, Do you have any allergies: <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, specify:		
17, Do you have diabetes: <input type="checkbox"/> Yes <input type="checkbox"/> No		

Have you ever had:			
18, Any type of heart disease	<input type="checkbox"/> Yes <input type="checkbox"/> No	26, High Blood Pressure	<input type="checkbox"/> Yes <input type="checkbox"/> No
19, Rheumatic fever	<input type="checkbox"/> Yes <input type="checkbox"/> No	27, Tuberculosis	<input type="checkbox"/> Yes <input type="checkbox"/> No
20, Asthma	<input type="checkbox"/> Yes <input type="checkbox"/> No	28, Lung Disease	<input type="checkbox"/> Yes <input type="checkbox"/> No
21, Hepatitis	<input type="checkbox"/> Yes <input type="checkbox"/> No	29, Any Liver Disease	<input type="checkbox"/> Yes <input type="checkbox"/> No
22, Kidney Problems	<input type="checkbox"/> Yes <input type="checkbox"/> No	30, Infectious Disease	<input type="checkbox"/> Yes <input type="checkbox"/> No
23, Bleeding Problems	<input type="checkbox"/> Yes <input type="checkbox"/> No	31, Blood Disorder	<input type="checkbox"/> Yes <input type="checkbox"/> No
24, An HIV Test	<input type="checkbox"/> Yes <input type="checkbox"/> No	32, Medications currently taking:	
25, Are you Pregnant:	<input type="checkbox"/> Yes <input type="checkbox"/> No		
33, List any medical problems that other doctors have diagnosed			
IMPLANT INFORMATION			
34, Date of eye loss: __/__/____ (dd/mm/yyyy) <i>If unsure then year only.</i>		35, Age at time of eye loss: __ <i>If unsure then approximate.</i>	
36, Which eye was lost: <input type="checkbox"/> Left <input type="checkbox"/> Right <input type="checkbox"/> Both			
37, Reason for eye loss: <input type="checkbox"/> Trauma <input type="checkbox"/> Disease <input type="checkbox"/> Genetic <input type="checkbox"/> Other			
Please Specify:			
38, Procedures:	Evisceration <input type="checkbox"/> Yes <input type="checkbox"/> No		
	Enucleation <input type="checkbox"/> Yes <input type="checkbox"/> No		
	<input type="checkbox"/> Other (specify):		
39, Current Implant:	<input type="checkbox"/> Yes <input type="checkbox"/> No	40, Implant: (Type)	(Size)
41, Immediate Implant: (Type)	(Size)	42, Delay Implant: (Type)	(Size)
43, R # Therapy:	<input type="checkbox"/> Yes <input type="checkbox"/> No		
44, Describe socket colour:	<input type="checkbox"/> Dark Red	<input type="checkbox"/> Red	<input type="checkbox"/> Pink <input type="checkbox"/> White <input type="checkbox"/> Other:
45, Feelings at the time of eye loss: (Place an x on the line where you feel is appropriate)			
(a) (Angry)	0 - - - - 5	- - - -	110 (Content)
(b) (Sorrow)	0 - - - - 5	- - - -	110 (Excited)
(c) (Denial)	0 - - - - 5	- - - -	110 (Acceptance)
(d) (Frustrated)	0 - - - - 5	- - - -	110 (Relief)
<input type="checkbox"/> Other (specify):	0 - - - - 5	- - - -	110
46, What could have made the process better:			
(a) (Less time to come to terms)	0 - - - - 5	- - - -	110 (More time to come to terms)
(b) Better care <input type="checkbox"/> Yes <input type="checkbox"/> No	(c) Education <input type="checkbox"/> Yes <input type="checkbox"/> No	(f) Talk to other eye loss patients <input type="checkbox"/> Yes <input type="checkbox"/> No	(g) Other (specify):
(d) Support Group <input type="checkbox"/> Yes <input type="checkbox"/> No	(e) Counseling <input type="checkbox"/> Yes <input type="checkbox"/> No		
47, Did you have any problems with your first prosthetic eye: <input type="checkbox"/> Yes <input type="checkbox"/> No			

48, Please note any initial complications you may have encountered:			
(a) Discharge <input type="checkbox"/> Yes <input type="checkbox"/> No	(b) Infection <input type="checkbox"/> Yes <input type="checkbox"/> No	(c) Implant failure <input type="checkbox"/> Yes <input type="checkbox"/> No	
(d) Implant exposure <input type="checkbox"/> Yes <input type="checkbox"/> No	(e) Other (specify):		

49, Conformer worn post-surgical? <input type="checkbox"/> Yes <input type="checkbox"/> No	50, Conformer: <input type="checkbox"/> Hard <input type="checkbox"/> Soft <input type="checkbox"/> Unsure
---	---

51, Discharge amount prior to artificial eye being made:			
<input type="checkbox"/> Severe	<input type="checkbox"/> Moderate	<input type="checkbox"/> Small	<input type="checkbox"/> None

52, How many artificial eyes have you worn? ___			
53, Where was the first artificial eye made:			
54, Year the first artificial eye made: ----			
55, How did you feel when your 1st prosthesis was made: (Place an x on the line where you feel is appropriate)			
(a) (Sad)	0 - - - - 5 - - - - 110	(Happy)	
(b) (Sorrow)	0 - - - - 5 - - - - 110	(Relieved)	
(c) (Dysfunctional)	0 - - - - 5 - - - - 110	(Healed)	
(d) <input type="checkbox"/> Other (specify):	0 - - - - 5 - - - - 110		

56, Where was the second artificial eye made:			
57, Year the second artificial eye made: ----			
58, How did you feel when your second prosthesis was made: (Place an x on the line where you feel is appropriate)			
(a) (Sad)	0 - - - - 5 - - - - 110	(Happy)	
(b) (Sorrow)	0 - - - - 5 - - - - 110	(Relieved)	
(c) (Dysfunctional)	0 - - - - 5 - - - - 110	(Healed)	
(d) <input type="checkbox"/> Other (specify):	0 - - - - 5 - - - - 110		

59, Where was the third artificial eye made:			
60, Year the third artificial eye made: ----			
61, How did you feel when your third prosthesis was made: (Place an x on the line where you feel is appropriate)			
(a) (Sad)	0 - - - - 5 - - - - 110	(Happy)	
(b) (Sorrow)	0 - - - - 5 - - - - 110	(Relieved)	
(c) (Dysfunctional)	0 - - - - 5 - - - - 110	(Healed)	
(d) <input type="checkbox"/> Other (specify):	0 - - - - 5 - - - - 110		

62, How do you feel now about your prosthesis? (Place an x on the line where you feel is appropriate)			
(a) (Sad)	0 - - - - 5 - - - - 110	(Happy)	
(b) (Sorrow)	0 - - - - 5 - - - - 110	(Relieved)	
(c) (Dysfunctional)	0 - - - - 5 - - - - 110	(Healed)	
(d) <input type="checkbox"/> Other (specify):	0 - - - - 5 - - - - 110		

63, How do you feel you look with your prosthesis in? <i>(Place an x on the line where you feel is appropriate)</i>			
(Unattractive)	0	1 - - - - 5 - - - -	10 (Attractive)
64, How old is the current artificial eye: _____			
65, How do others say you look generally?			
<input type="checkbox"/> Normal	<input type="checkbox"/> Different	<input type="checkbox"/> Excellent	<input type="checkbox"/> No comment
<input type="checkbox"/> Other <i>(specify):</i>			
66, Describe the feeling without the prosthesis in? <i>(Place an x on the line where you feel is appropriate)</i>			
(a) (Unattractive)	0	1 - - - - 5 - - - -	10 (Attractive)
(b) (Uncomfortable)	0	1 - - - - 5 - - - -	10 (Comfortable)
(c) (Vulnerable)	0	1 - - - - 5 - - - -	10 (Secure)
(d) (Not Okay)	0	1 - - - - 5 - - - -	10 (Okay)
(e) (Naked)	0	1 - - - - 5 - - - -	10 (Clothed)
(f) (Discontent)	0	1 - - - - 5 - - - -	10 (Content)
(g) Other <i>(specify):</i>	0	1 - - - - 5 - - - -	10
67, Do you feel that your artificial eye is only cosmetic? <input type="checkbox"/> Yes <input type="checkbox"/> No			
68, Does your artificial eye contribute to <i>(Place an x on the line where you feel is appropriate)</i>			
(a) Appearance:	(No Better)	0	1 - - - - 5 - - - - 10 (Much Better)
(b) Self-Esteem (I feel better about myself):	(No Better)	0	1 - - - - 5 - - - - 10 (Much Better)
(c) Psychological (I feel better within myself):	(No Better)	0	1 - - - - 5 - - - - 10 (Much Better)
(d) Social Acceptance:	(No Better)	0	1 - - - - 5 - - - - 10 (Much Better)
(e) Functionality:	(No Better)	0	1 - - - - 5 - - - - 10 (Much Better)
(f) Balance:	(No Better)	0	1 - - - - 5 - - - - 10 (Much Better)
(g) Eye-sight:	(No Better)	0	1 - - - - 5 - - - - 10 (Much Better)
(h) Comfort:	(No Better)	0	1 - - - - 5 - - - - 10 (Much Better)
69, Do feel you are a different person having experienced eye loss and prosthetic replacement? <input type="checkbox"/> Yes <input type="checkbox"/> No			
<i>If yes then please specify eg : more/less patient, more/less understanding, more/less content etc</i>			

70, How do others generally say your eyes look?										
(Different)	0	1	-	-	-	-	5	-	-	10 (Identical)
71, In your opinion can people often tell that your eye is artificial										
(Not often)	0	1	-	-	-	-	5	-	-	10 (Often)
72, How much emphasis do you place on the opinion of others as to your appearance?										
(No emphasis)	0	1	-	-	-	-	5	-	-	10 (Lots of emphasis)

73, If there could be things better (other than sight) about your artificial eye what would they be? (Tick to indicate yes).			
<input type="checkbox"/> Upper lid sunken	<input type="checkbox"/> Lower lid laxity	<input type="checkbox"/> Eye movement	<input type="checkbox"/> Colour
<input type="checkbox"/> Size	<input type="checkbox"/> More realistic	<input type="checkbox"/> Other (specify):	
74, Do you feel that you can "see better" with your prosthesis in?			
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Sometimes	
75, Do you feel that you can "see out" of your prosthesis?			
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Sometimes	
76, Do you feel more "balanced" with your prosthesis in?			
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Sometimes	

EYE CARE AND MAINTANENCE (regarding your current eye)

77, Describe discharge amount:				
<input type="checkbox"/> Severe	<input type="checkbox"/> Moderate	<input type="checkbox"/> Small	<input type="checkbox"/> None	
78, Describe discharge timing:				
<input type="checkbox"/> All Day	<input type="checkbox"/> Mainly morning	<input type="checkbox"/> Mainly Afternoon	<input type="checkbox"/> At Night	
79, Describe discharge colour:				
<input type="checkbox"/> Milky	<input type="checkbox"/> Yellow	<input type="checkbox"/> Green	<input type="checkbox"/> Pink	<input type="checkbox"/> Other:
80, Does your lid close completely when sleeping:				
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Sometimes		
81, Do you wear your prosthesis while sleeping:				
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Sometimes		
82, How often do you remove your prosthesis:				
<input type="checkbox"/> Every night	<input type="checkbox"/> Daily to wash	<input type="checkbox"/> Weekly	<input type="checkbox"/> Monthly	<input type="checkbox"/> Never
83, How often do you have your artificial eye professionally reviewed/cleaned:				
<input type="checkbox"/> Every 3 months	<input type="checkbox"/> Every 6 months	<input type="checkbox"/> Yearly	<input type="checkbox"/> Never	<input type="checkbox"/> Other:
84, Do you experience dry eye?				
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Sometimes		
If sometimes please specify:				
<input type="checkbox"/> Seasonal	<input type="checkbox"/> Health related (eg. Cold/fever)	<input type="checkbox"/> Menstrual	<input type="checkbox"/> Unknown	
85, Do you take medication/ointment for discharge?				
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Sometimes		
86, Does this medication help?				
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Sometimes		

87, Do you experience wet watery eye?				
<input type="checkbox"/> At night	<input type="checkbox"/> Every day	<input type="checkbox"/> Weekly	<input type="checkbox"/> Monthly	<input type="checkbox"/> Never

LEARNING ABOUT YOUR EYE

88, What was the hardest thing to get used to with sight in one eye?			
<input type="checkbox"/> Depth perception	<input type="checkbox"/> Unsteady walk	<input type="checkbox"/> Driving a vehicle	<input type="checkbox"/> Glare issues
<input type="checkbox"/> All		<input type="checkbox"/> Other (specify):	

89, What was the easiest thing to get used to when your eye was lost?			
<input type="checkbox"/> Depth perception	<input type="checkbox"/> Unsteady walk	<input type="checkbox"/> Diving a vehicle	<input type="checkbox"/> Glare issues
<input type="checkbox"/> No more pain	<input type="checkbox"/> All	<input type="checkbox"/> Other (specify):	

90, How would you describe your experience of artificial eye wearing? (Place an x on the line where you feel is appropriate)														
(a)	(Inconvenient)	0		-	-	-	-	5	-	-	-	-	10	(Convenient)
(b)	(Unpleasant)	0		-	-	-	-	5	-	-	-	-	10	(Pleasant)
(c)	(Continually Aware)	0		-	-	-	-	5	-	-	-	-	10	(Not Aware)
(d)	<input type="checkbox"/> Other (specify):	0		-	-	-	-	5	-	-	-	-	10	

91, How did answering the questions in this survey and revisiting your experience make you feel personally?														
(a)	(Opened old wounds)	0		-	-	-	-	5	-	-	-	-	10	(Healing)
(b)	(Unhelpful)	0		-	-	-	-	5	-	-	-	-	10	(Helpful)
(c)	(Didn't like answering)	0		-	-	-	-	5	-	-	-	-	10	(Good to contribute)
(d)	(Emotionally Challenging)	0		-	-	-	-	5	-	-	-	-	10	(Emotionally Helpful)
(e)	(Questions seemed irrelevant)	0		-	-	-	-	5	-	-	-	-	10	(Listened to)
(f)	<input type="checkbox"/> Other (specify):	0		-	-	-	-	5	-	-	-	-	10	

92, Any other comments regarding this survey or associated details:													

15. REFERENCE LIST (*Harvard Referencing Guide*)

1. AAPOS, 2016 'Coloboma', image, *American Association for Pediatric Ophthalmology and Strabismus*, viewed 9 August 2016, <<https://www.aapos.org/terms/conditions/35>>.
2. Aartolahti, E Häkkinen, A Lönnroos, E Kautiainen, H Sulkava, R & Hartikainen, S 2013, 'Relationship between functional vision and balance and mobility performance in community-dwelling older adults', *Aging Clinical and Experimental Research*, vol. 25, pp. 545-552.
3. Aerts, I Lumbroso-Le Rouic, L Gauthier-Villars, M Brisse, H Doz, F & Desjardins, L 2006, 'Retinoblastoma', *Orphanet Journal of Rare Diseases; BioMed Central*, vol. 1, no. 31, viewed 14 April 16, < <http://ojrd.biomedcentral.com/articles/10.1186/1750-1172-1-31>>.
4. Aghadoost, D 2014, 'Ocular trauma: an overview', *Archives Of Trauma Research*, viewed 14 April 16, < http://archtrauma.com/?page=article&article_id=21639>.
5. American Academy of Ophthalmology 2014, 'Fungal keratitis – middle east/ north Africa', image, *American Academy of Ophthalmology*, viewed 9 August 2016, < <http://www.aao.org/topic-detail/fungal-keratitis--middle-eastnorth-africa>>.
6. American Society of Ocularists 2015, *American Society of Ocularists*, viewed 25 August 2016, <<http://www.ocularist.org/>>.
7. American Medical Association 2001, *AMA Guides Fifth*, USA, American Medical Association.
8. AndrewLloydWebber.com, *The Phantom of the Opera*, viewed 11 August 2016, <<http://www.andrewlloydwebber.com/shows/?show=The%20Phantom%20of%20the%20Oper>>.
9. Arevalo, JF Garcia, RA Al-Dhibi, HA Sanchez, JG & Suarez-Tata, L 2012, 'Update on sympathetic ophthalmia', *Middle East African Journal of Ophthalmology*, vol. 1, pp. 13-21.
10. Artificial Eye Clinic 2015, *History of Artificial Eyes*, image, viewed 12 August 2016, < <http://wordpress.artificialeyeclinic.com/history/> >.
11. ASU School of Life Sciences 2016, 'Seeing colour: rods and cones of the human eye', image, *Arizona State University*, viewed 5 August 2016, < <https://askabiologist.asu.edu/rods-and-cones>>.

12. Austin Community College District 2008, 'Peripheral Nervous System-Afferent (Special Senses)', image, *Austin Community College District*, viewed 5 August 2016, <<http://www.austincc.edu/apreview/PhysText/PNSafferentpt2.html>>.
13. Australian Government Department of Human Services 2017, 'Medicare Benefits Scheme: Medicare Item Reports', *Medicare Australia Statistics*, viewed 8 September 2017, <www.medicarestatistics.humanservices.gov.au>.
14. Australian Government Department of Health n.d., 'Medicare', *Australian Government Department of Health*, viewed 13th October 2017, <http://www.health.gov.au/internet/otd/publishing.nsf/Content/medicare>>.
15. Batterbury, M Bowling, B & Murphy, C 2009, *Ophthalmology an illustrated colour text*, 3rd edn, Churchill Livingstone Elsevier, Edinburgh.
16. Blackrock Eye Care 2010, 'General eye care: glaucoma', image, *Blackrock Eye Care*, viewed 29 August 2014, <<http://www.blackrockeyecare.com>>.
17. Boyd, K 2016, 'Retinal detachment: torn or detached retina causes', image, *American Academy of Ophthalmology*, viewed 9 August 2016, <<http://www.aao.org>>.
18. Brady, FB 2009, *A singular view: the art of seeing with one eye*, image, 7th edn, Michael O. Hughes, Virginia, USA.
19. CAIS News, 2006 '4800-Year-Old Artificial Eyeball Discovered in Burnt City', *Archeological & cultural news of the Iranian world*, viewed 11 December 2014, <<http://www.cais-soas.com>>.
20. Callegan, MC Engelbert, M Parke, DW Jett, BD & Gilmore, MS 2002, 'Bacterial Endophthalmitis: Epidemiology, Therapeutics, and Bacterium-Host Interactions', *Clinical microbiology reviews*, vol. 15, pp. 111-124, viewed 10 October 2016, <<http://cmr.asm.org/content/15/1/111.full>>.
21. Cash, TF & Labarge, AS, 1996, 'Development of the Appearance Schemas Inventory: A new cognitive body-image assessment', *Cognitive Therapy and Research*, vol. 20, pp. 37-50.

22. Cassel, GH Billig, MD & Randall, HG 1998, *The eye book*, The John Hopkins University Press, London.
23. CDC 2015, 'Facts about anophthalmia/microphthalmia', image, *Centres for Disease Control and Prevention*, viewed 9 August 2016, <<http://www.cdc.gov>>.
24. Dayan, M 1992. *Moshe Dayan: Story of My Life*, Da Capo.
25. Delamere, NA 2006, 'The Lens', image, *Duane's Ophthalmology*, viewed 6 October 2016, <<http://www.oculist.net/downaton502/prof/ebook/duanes/pages/v8/v8c010.html>>.
26. Dyer, NA 1980, 'The artificial eye', *Australian Journal of Ophthalmology*, vol. 8, no.4, pp. 325-327.
27. Egan, DJ 2016, 'Endophthalmitis', *Medscape*, viewed 10 October 2016, <<http://emedicine.medscape.com/article/799431-overview>>.
28. El Essawy, RA & Abdelbaky, SH 2016, 'Successful conjunctival socket expansion in anophthalmic patients until the age of 2 years: an outpatient procedure', *Clin Ophthalmol*, vol. 10, pp. 1743-8.
29. English Oxford Living Dictionaries 2017, *Oxford University Press*, viewed 26 January 2017 <<https://en.oxforddictionaries.com>>.
30. Flatworld Education 2016, 'Introduction to psychology; seeing', image, *Flatworld Knowledge*, viewed 18 July 2016, <http://catalog.flatworldknowledge.com/bookhub/127?e=stangor-ch04_s02>.
31. Glasspool, MG 1982, *Atlas of ophthalmology*, University Park Press, Baltimore.
32. Graham RH 2016, 'Bacterial Endophthalmitis', *Medscape*, viewed 10 October 2016, <<http://emedicine.medscape.com/article/1201134-overview>>.

33. Head & Neck Cancer Guide 2015, *Cancer Basics; Explore Cancer Types; Orbital Tumours*, image, viewed 9 September 2015, <<http://www.headandnmcgeckcancerguide.org/teens/cancer-basics/explore-cancer-types/orbital-tumors/>>.
34. Head & Neck Cancer Guide 2016, *Evisceration, enucleation & exenteration*, image, Head & Neck Cancer Guide, viewed 10 August 2016, <<http://www.headandneckcancerguide.org/adults/cancer-diagnosis-treatments/surgery-and-rehabilitation/cancer-removal-surgeries/evisceration-enucleation-and-exenteration/>>.
35. Health Media Network 2014, 'Uveitis', image, *Patient Education Centre*, viewed 28 November, 2014, <<http://www.patienteducationcenter.org/articles/uveitis/>>.
36. *Horus*, image, viewed 11 August 2016, < <http://www.crystalinks.com/horus.html>>.
37. Hybrid Cornea 2010, 'The Cornea', *Hybrid Cornea*, viewed 28 November, 2014, <<http://www.hybridcornea.org/aboutcornea.htm>>.
38. Ilieva, P 2015, 'Upcoming Lecture & Exhibit: History, Science and Art of Ocular Prosthetics', image, *Brought to Light*, viewed 11 August 2016, <<https://blogs.library.ucsf.edu/broughttolight/2015/04/24/1751/>>.
39. John Hopkins Medicine 2014, *Wilmer eye institute at John Hopkins*, viewed 1 September 2014, < www.hopkinsmedicine.org>.
40. John Hopkins Medicine 2015, 'What are tumors', *John Hopkins University*, viewed 13 September 2015, <<http://pathology.jhu.edu/pc/BasicTypes1.php?area=ba>>.
41. Kirmayer, LJ & Looper, KJ 2006, 'Abnormal illness behaviour: physiological, psychological and social dimensions of coping with distress', *Curr Opin Psychiatry*, vol. 19, pp. 54-60.
42. Klotz, SP Penn, CC Negvesky, GJ & Butrus, SI 2000, 'Fungal and Parasitic Infections of the Eye', *Clinical Microbiology Reviews*, vol. 13, pp. 662-685.
43. Knowles, PT 2012, *Patient Wearing Ocular Prosthesis in Right Socket*, image, Adelaide, Australia.

44. Knowles, PT 2016a, *Example of Red Socket*, image, Adelaide, Australia.
45. Knowles, PT 2016b, *Example of Pink Socket*, image, Adelaide, Australia.
46. Knowles, PT 2016c, *Example of White Socket*, image, Adelaide, Australia.
47. Knowles, PT 2016d, *Example of the two types of conformers worn*, image, Adelaide, Australia.
48. Knowles, PT 2016e, *Right Socket Of Patient Without Ocular Prosthesis Insitu*, image, Adelaide, Australia.
49. Knowles, R-ZR 2014a, *Patient Presentation of Haptic Shell Prosthetic Eye*, image, Nottingham, United Kingdom.
50. Knowles, R-ZR 2014b, *Ocularist Depiction of Own Eye*, image, Nottingham, United Kingdom.
51. Knowles, R-ZR 2016a, *Multiple Acrylic Prosthetic Right Eyes from One Individual Patient*, image, Adelaide, Australia.
52. Knowles, R-ZR 2016b, *Components of the Construction Process of an Acrylic Ocular Prosthesis*, image, Adelaide, Australia.
53. Krishna, S 2009, 'Disfigurement: psychosocial impact and coping', *The Open Dermatology Journal*, vol. 3, pp. 54-57.
54. Lee, SH Wong, M & Yap, S 2014, 'Eye opener: physiology – image formation', image, *Rods and Cones*, viewed 28 November 2014, <<http://rodsncones.blogspot.com.au/2014/05/physiology-image-formation.html>>.
55. Lim, ASM Constable, I & Wong, TY 2001, *Colour atlas of ophthalmology*, 4th edn, World Scientific, Singapore.
56. Litwin, AS, Worrell, E, Roos, JCP, Edwards, B, Malhotra, R 2017, Can We Improve the Tolerance of an Ocular Prosthesis by Enhancing Its Surface Finish? *Ophthal Plast Reconstr Surg*. DOI:10.1097/IOP.0000000000000891.

57. Mahaveer Eye Hospital 2016 'Glaucoma and glaucoma treatment', image, *Mahaveer Super Specialty Eye Hospital & Laser Centre*, viewed 9 August 2016, <<http://www.mahaveereyehospital.com/glaucoma-and-glaucoma-treatment-in-pune/>>.
58. Mele, JA 2014, 'The Latest Cosmetic Plastic Surgery News for the San Francisco Bay Area', viewed 12 December 2014, <<http://www.sanfranciscoplasticsurgeryblog.com/rhinoplasty-nasal-surgery-san-francisco-bay-area-cosmetic-nose-job-part-3-of-4/>>.
59. Meng, Y & Yan, H 2015, 'Prognostic factors for open globe injuries and correlation of ocular trauma score in Tianjin, China', *Journal of Ophthalmology*, vol. 2015, Hindawi.
60. Miller, SJH 1990, *Parsons' diseases of the eye*, 18th edn, Churchill Livingstone, Edinburgh.
61. NZ Prosthetic Eye Service n.d., 'About Keith Pine', *New Zealand Prosthetic Eye Service*, viewed 13th October 2017, <<http://www.prosthetic-eyes.co.nz>>.
62. OERPub, 'Central Processing', image, *OERPub*, viewed 5 August 2016, <<http://oerpub.github.io/epubjs-demo-book/content/m46557.xhtml>>.
63. Operational Medicine 2015, 'Burns of the eye (anterior segment, or front portion)', image, *Operational Medicine 2001: Healthcare in Military Settings*, viewed 9 August 2016, <<http://www.brooksidepress.org/Products/OperationalMedicine/DATA/operationalmed/SickCall/Eye/BurnsoftheEye.htm>>.
64. Parr, J 1982, *Introduction to Ophthalmology*, 2nd edn., Oxford University Press, Oxford.
65. Pass My Exams 2014, 'Use of lenses for correcting vision', image, *Pass My Exams*, viewed 1 December 2014, <<http://www.passmyexams.co.uk/GCSE/physics/use-of-lenses-for-correcting-vision-eyesight.html>>.
66. PharmQD 2011, 'Management of dry eye disease for optometrists', image, viewed 6 October 2016, <<https://www.pharmqd.com/node/124388/lesson>>.
67. Pilowsky, I 1993, 'Dimensions of illness behaviour as measured by the illness behaviour questionnaire: A replication study', *Journal of Psychosomatic Research*, vol. 37, pp. 53-62.

68. Pine, KR, Sloan, B & Jacobs, RJ 2013, 'A proposed model of the response of the anophthalmic socket to prosthetic eye wear and its application to the management of mucoid discharge', *Medical Hypotheses*, vol. 81, no. 2, pp. 300-305.
69. Pine, KR Sloan, B & Jacobs, RJ 2012a, 'Biosocial profile of New Zealand prosthetic eye wearers', *Journal Of The New Zealand Medical Association*, vol. 125, no. 1363, pp. 29-38.
70. Pine, KR Sloan, B & Jacobs, RJ 2012b, 'Deposit buildup on prosthetic eyes and implications for conjunctival inflammation and mucoid discharge', *Clinical Ophthalmology*, vol. 6, pp. 1755-1762.
71. Pine, KR Sloan, B & Jacobs, RJ 2012c, 'The development of measurement tools for prosthetic eye research', *Clinical and Experimental Optometry*, vol. 96, no. 1, pp. 32-38.
72. Pine, KR Sloan, B & Jacobs, RJ 2015. DOI:10.1007/978-3-319-19057-0.
73. Pine, KR Sloan, B KyuYeon, IH Swift, S & Jacobs, RJ 2013, 'Deposit buildup on prosthetic eye material (in vitro) and its effect on surface wettability', *Clinical Ophthalmology*, no. 7, pp. 313-319.
74. Pine, KR Sloan, B Stewart, J & Jacobs, RH 2012, 'A survey of prosthetic eye wearers to investigate mucoid discharge', *Clinical Ophthalmology*, no. 6, pp. 707-713.
75. Pine, KR Sloan, B Stewart, J & Jacobs, RJ 2011, 'Concerns of anophthalmic patients wearing artificial eyes', *Clinical & Experimental Ophthalmology*, vol. 39, no. 1, pp. 47-52.
76. Pine, KR Sloan, B Stewart, J & Jacobs, RJ 2013, 'The response of the anophthalmic socket to prosthetic eye wear', *Clinical and Experimental Optometry*, vol. 96, no. 4, pp. 388-393.
77. Poen 2011, 'Information for patients; what is eye allergy?', image, *Poen*, viewed 10 September 2014, <<http://www.poen.net.ar/en/information-for-patients/>>.
78. Punchard, N Whelan, C & Adcock, I 2004, 'The journal of inflammation', *BioMed Central*, vol. 1, no. 1, viewed 7 April 2016, <<http://journal-inflammation.biomedcentral.com/articles/10.1186/1476-9255-1-1>>.

79. Quigley's Cabinet 2012, *Earliest artificial eye*, image, viewed 11 August 2016, <<http://quigleyscabinet.blogspot.com.au/2012/02/earliest-artificial-eye.html>>.
80. Quizlet 2014, 'Neuro: Cranial Nerves, Skull and Head Circulation', *Quizlet*, image, viewed 15 December 2014, <<http://quizlet.com/25431104/neuro-cranial-nerves-skull-and-head-circulation-flash-cards>>.
81. Rasmussen ML 2008, 'Complications from eye prosthesis', *Ugeskr Laeger*, vol. 107, pp. 2456-2458.
82. Saladin, KS 2015, 'Anatomy and physiology: the unity of form and function', image, 7th edn, New York, USA, McGraw-Hill Education.
83. Sanderson, J 1871, 'A system of surgery', *London Longmans: Green and Co*, 2nd edn,. Cited in Punchard, N Whelan, C & Adcock, I 2004, 'The journal of inflammation', *BioMed Central*, vol. 1, no. 1, viewed 7 April 2016, <<http://journal-inflammation.biomedcentral.com/articles/10.1186/1476-9255-1-1>>.
84. Sarah Knows Eyes 2016, 'Cataracts - the (relatively unscary) modern way' image, *Sarah Knows Eyes*, viewed 9 August 2016, <<http://www.sarahknowseyes.com/158-cataracts-the-relatively-unscary-modern-way>>.
85. Sasilik ve Goz Tembelligi 2016, 'Retinopathy of Prematurity (ROP)' image, *Sasilik ve Goz Tembelligi*, viewed 9 August 2016, <<http://www.sasilik.com.tr/en/makaleler/9-retinopathy-of-prematurity->>>.
86. Science 2.0 2016, 'Coloboma: humans with "cat eyes"', image, *Science 2.0 Join The Revolution*, viewed 9 August 2016, <http://www.science20.com/science_motherhood/coloboma_humans_cat_eyes>.
87. Scott, R 2011, 'The injured eye', image, *The Royal Society*, vol 366, pp. 251-260, viewed 14 April 2016, <<http://rstb.royalsocietypublishing.org/content/366/1562/251>>.

88. Sheward, D 2014, 'The 'real' elephant man: a look at the life of Joseph Merrick', image, *Bio*, viewed 10 August 2016, < <http://www.biography.com/news/elephant-man-joseph-merrick-biography>>.
89. Sparknotes 2016, 'No Fear Shakespeare: King Lear: Act 4 Scene 6 Page 7', *Sparknotes*, viewed 26 January 2017, <<http://www.sparknotes.com/shakespeare>>.
90. Spector, W & Willoughby, D 1963, 'The inflammatory response', *Bacteriological Reviews*, vol.27, pp. 117-149. Cited in Punchard, N Whelan, C & Adcock, I 2004, 'The journal of inflammation', *BioMed Central*, vol. 1, no. 1, viewed 7 April 2016, < <http://journal-inflammation.biomedcentral.com/articles/10.1186/1476-9255-1-1>>.
91. Tabbara, K Abu El-Asrar, A & Khairallah, M 2014, *Ocular Infections*, Springer, Berlin – Heidelberg.
92. The College of Optometrists 2014, *Early artificial eyes*, image, viewed 4 August 2014, <<http://www.collegeoptometrists.org>>.
93. The Discovery Eye Foundation 2016, 'Pupils respond to more than light', image, *The Discovery Eye Foundation*, viewed 5 July 2016, < <http://discoveryeye.org/pupils-respond-to-more-than-light>>.
94. The Herb Museum, *Scarface (1932)*, image, viewed 11 August 2016, <<http://herbmuseum.ca/content/scarface-1932>>.
95. The Jack McGovern Coates Disease Foundation 2014, *The Jack McGovern Coates Disease Foundation*, Canada, viewed 14 April 2016, <<http://www.coatsdiseasefoundation.org>>.
96. Tips Curing Disease 2013, 'Anophthalmos and microphthalmos: Causes and treatment for small eye syndrome', image, *Tips Curing Disease*, viewed 9 August 2016, <<http://www.tipdisease.com/2013/10/anophthalmos-and-microphthalmos-causes.html>>.

97. University of Rochester Medical Centre 2016, 'Encyclopedia; Haemophilus Influenzae Infections', viewed 23 August 2016, <
<https://www.urmc.rochester.edu/encyclopedia/content.aspx?ContentTypeID=90&ContentID=P02520>>.
98. Urban Heat Island 2015, 'How it works: Behaviour of light', image, *Urban Heat Island*, viewed 5th August, <<https://sites.google.com/a/wyckoffschoools.org/urban-heat-island/how-it-works/behavior-of-light/absorption-reflection-transmission>>.
99. U.S National Library of Medicine 2016, 'Health conditions: retinoblastoma', image, *Genetics Home Reference: U.S National Library of Medicine*, viewed 9 August 2016, <<https://ghr.nlm.nih.gov/condition/retinoblastoma>>.
100. Verma, A & FitzPatrick, D 2007, 'Anophthalmia and microphthalmia', *Orphanet Journal of Rare Diseases; BioMed Central*, vol. 27, no. 1, viewed 14 April 16, <<http://ojrd.biomedcentral.com/articles/10.1186/1750-1172-2-47>>.
101. WebMD 2015, 'Eye Health Centre; Conjunctivitis', image, *WebMD*, viewed 10 September 2015, <<http://www.webmd.com/eye-health/inflamed-conjunctiva>>.
102. Wikia, *Freddy Krueger (Reboot Timeline)*, image, viewed 11 August 2016, <[http://nightmareonelmstreet.wikia.com/wiki/Freddy_Krueger_\(Reboot_Timeline\)](http://nightmareonelmstreet.wikia.com/wiki/Freddy_Krueger_(Reboot_Timeline))>.
103. Wikipedia 2014, 'Corneal Limbus', image, *Wikipedia The Free Encyclopedia*, viewed 28 November 2014, <https://en.wikipedia.org/wiki/Corneal_limbus>.
104. Wikipedia 2016, 'Moshe Dayan', image, *Wikipedia The Free Encyclopedia*, viewed 11 August 2016, <https://en.wikipedia.org/wiki/Moshe_Dayan>.