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CANALICULAR LACERATIONS: CAUSES, ASSOCIATED OCULAR INJURIES, AND AUDIT OF MANAGEMENT AT ST JOHN EYE HOSPITAL

Dr Stephanus J. Lindeque

Dr Kerry L. Alberto

Dr Trevor R. Carmichael

Dr Aubrey Makgotloe

An original published work submitted to the

Faculty of Health Sciences, University of the Witwatersrand,

in fulfilment of the requirements for the degree of Master of Medicine

Johannesburg, 2020

DECLARATION

I, Stephanus Johannes Lindeque, declare that this research report is my own work. It is being submitted for the degree of Master of Medicine in the branch of Ophthalmology in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

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DEDICATION

To my wife Ingrid, and daughter Ellia

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....Page 5

DECLARATION: Student's contribution to article and agreement of co-authors.....Page 6

PRESENTATIONS ARISING FROM THIS RESEARCH REPORT.....Page 7

PUBLICATIONS ARISING FROM THIS RESEARCH REPORT.....Page 7

ABSTRACT.....Page 8

LIST OF FIGURES.....Page 9

LIST OF TABLES.....Page 10

CHAPTER ONE – INTRODUCTION.....Page 11

CHAPTER TWO – METHODOLOGY.....Page 13

2.1 General methodology

2.2 Ethical considerations

CHAPTER THREE – RESULTS.....Page 14

3.1 Patient characteristics

3.2 Cause of injury

3.3 Canaliculus involved

3.4 Associated ocular injuries

3.5 Surgical management

3.6 Duration of surgery

CHAPTER FOUR – DISCUSSION.....Page 17

CHAPTER FIVE – CONCLUSION.....Page 19

REFERENCES.....Page 20

APPENDIX.....Page 22

Approved Research Protocol

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DECLARATION: Student's contribution to article and agreement of co-authors

I, Dr Stephanus Johannes Lindeque, WITS student number 369837, declare that this research report is my own work and that I contributed adequately towards the research findings published in the article stated below which are included in my research.

Signature of student: ……SEE ATTACHED PDF…… **Date** ……

Name of Primary Supervisor: …..Dr Kerry L. Alberto……

Signature of Primary Supervisor: …… SEE ATTACHED PDF..... **Date** ……

Agreement by co-authors: By signing this declaration, the co-authors listed below agree to the use of the article by the student as part of his Research Report.

Title: Canalicular lacerations: Causes, related ocular injury and management at St John Eye Hospital

Authors	Name and ORCHID ID	Signature	Date
1st	Stephanus J. Lindeque[1] https://orcid.org/0000-0001-6301-7297	SEE ATTACHED PDF	
2nd	Kerry L. Alberto[2] https://orcid.org/0000-0003-3485-4955	SEE ATTACHED PDF	
3rd	Trevor R. Carmichael[3] https://orcid.org/0000-0002-0659-6664	SEE ATTACHED PDF	
4th	Aubrey Makgotloe[4] https://orcid.org/0000-0002-8193-3245	SEE ATTACHED PDF	

[1] Registrar, Division of Ophthalmology, University of Witwatersrand, Johannesburg, South Africa

[2] Head of Department, Ophthalmology Department, Helen Joseph Hospital, Johannesburg, South Africa

[3] Former Academic Head (1997-2017), Division of Ophthalmology, University of the Witwatersrand, Johannesburg, South Africa

[4] Academic Head, Division of Ophthalmology, University of the Witwatersrand. Johannesburg, South Africa

Corresponding author: Stephanus J. Lindeque, steph_lindeque@yahoo.com

PRESENTATIONS ARISING FROM THIS RESEARCH REPORT

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ABSTRACT

Background:

Canalicular lacerations cause significant morbidity if unrepaired, and may be associated with serious ocular injuries. Few studies describe the causes of these injuries, and none of these were conducted in Southern Africa.

Aim:

This study's aim was to describe the incidence of canalicular lacerations in terms of their causes, associated ocular injuries, and management at St John Eye Hospital.

Setting:

St John Eye Hospital, Soweto, Gauteng, South Africa.

Methods:

This was a prospective descriptive study of all patients presenting with canalicular lacerations at St John Eye Hospital over a seven month period. Data was collected from the patient files and analysed using descriptive statistics.

Results:

78 patients presented at St John Eye Hospital with lid lacerations. Of these 78 patients, 26 (33.3%) had canalicular involvement. There was only slight male preponderance. The median age was 34 years. The most common cause of injury was assault (58%) usually involving a knife. 35% of the patients had an associated ocular injury. Globe rupture was relatively common (8%). All patients received lid repair under general anaesthetic. 19% received additional surgical procedures. The median duration of surgery was 103 minutes. Canalicular repair consumed 100 minutes of operating time per week.

Conclusion:

This study demonstrates that canalicular lacerations are relatively common at St John Eye Hospital. They are disproportionately caused by assault, and more often associated with serious ocular injuries than expected. They place considerable burden on already limited theatre resources, and may be of particular relevance in the South African setting.

LIST OF FIGURES

Figure Page

Chapter 3 - Results

Figure 3.1: Age distribution of patients with canalicular lacerations……..15

Figure 3.2: Major causes of canalicular injury……..15

Figure 3.2: Types of assault resulting in canalicular laceration……16

LIST OF TABLES

Table Page

Chapter 1 - Introduction

Table 1.1: Causes of canalicular lacerations in other studies……11

Table 1.2: Associated injuries of canalicular lacerations……12

Chapter 3 - Results

Table 3.1: Associated ocular injuries……16

Table 3.2: Additional surgical procedures performed……17

1. Introduction

Canalicular lacerations commonly occur in cases of traumatic lid laceration[1] and require prompt surgical repair ideally within 24–48 h.[2] If not adequately repaired, these injuries may result in significant morbidity in the form of chronic epiphora.[3] In addition, these injuries may be associated with significant trauma to the orbit and globe, requiring additional care.[3]

Canalicular lacerations either result from direct trauma, as with a sharp object, for example, blade or glass fragment, or indirectly because of lateral traction, such as that caused by blunt trauma at a point distant from the laceration.[4] Blunt craniofacial trauma may also result in nasolacrimal system fractures which affect the lacrimal sac and nasolacrimal duct. These fractures may lead to symptomatic lacrimal system obstruction in 10% of patients independent of canalicular laceration.[5]

Studies involving the causes of canalicular lacerations are limited.[3,6] Previous studies into the causes of canalicular lacerations have shown considerable variation in the mechanisms of injury in each region. These include lids hooking on garment fasteners,[1] physical altercations,[6,7,8] falls,[9] dog bites[10] and motor vehicle collisions.[11] The reason for this variation has been postulated, by Naik et al., to be because of socio-cultural differences amongst populations.[1] Therefore, it is reasonable to expect that the most common causes of these injuries in South Africans cannot simply be inferred from other studies.

Laceration of the eyelid is a well-described complication of both blunt and sharp trauma to the face,[12] and 16% of lacerated lids involve the canaliculi.[3] The lower canaliculus is lacerated more often than is the upper canaliculus, ranging from 52% to 78.5%, as opposed to 16.6% – 32% for upper canalicular injuries. Both canaliculi are lacerated in 4.8% – 15% of patients. These injuries tend to affect young patients more frequently, with the average age ranging from 16 to 39 years old. Men are disproportionately represented and form between 72% and 88.6% of presenting patients in the literature.[1,3,6,7,8,9,10,11,,13,14,15]

No single cause has been consistently shown to be most common. Frequently reported causes of canalicular injuries in other studies are physical altercations, animal bites, falls, road accidents and sharp objects such as tree branches.[7] Dog bites have been disproportionately found to affect children. A study found that dog bites were more likely to injure the canaliculi than other causes of lid injury.[16]

Findings of the respective studies are summarised in Table 1.1.

TABLE 1.1: Causes of canalicular lacerations in other studies.

Author	Region	Sample size	Most common cause	Second most common cause	Third most common cause
Jordan et al.[3]	Nashville, United States	236	Sharp objects (23%)	Dog bites (20%)	Blunt objects (18%) Motor vehicle crashes (18%)
Kennedy et al.[10]	Philadelphia, United States	222	Body contact from another person (36%)	Dog bites and scratches (14%)	Falls (15%)
Murchison et al.[8]	Philadelphia, United States	137	Assault (31.4%)	Dog bites (16%)	Falls (15%)

Wu et al.[11]	Taoyuan City, Taiwan	98	Road accidents (43%)	Falls (15%)	Animal bites (4%)
Al-Batayneh et al.[9]	Amman, Jordan	44	Falls (61%)	Road accidents (16%)	Sharp object trauma (14%)
Sendul et al.[6]	Istanbul/Kars/Konya, Turkey	42	Assault (33%)	Road accidents (24%)	Falls (14%)
Naik et al.[1]	Hyderabad, India	24	Fastening hook of saree (21%)	Metal rod injury (21%)	Bicycle handle impact (17%)

Canalicular lacerations are reportedly associated with other ocular injuries at a rate between 20% and 40%.[14] These injuries tend to occur more often when blunt injury is the cause of the canalicular laceration.[3] The frequency and nature of these injuries varies from study to study but common examples include commotio retinae, corneal abrasions, hyphaema, globe rupture, corneal laceration, scleral laceration, lens injury, vitreous haemorrhage, retinal haemorrhage, intraocular foreign body, and traumatic optic neuropathy.[1,3,6,8,9,14]

Findings of the respective studies are summarised in table 1.2:

TABLE 1.2: Associated injuries of canalicular lacerations.

Author	Region	Sample size	Total incidence of associated ocular injuries	Most common associated ocular injury	Second most common associated ocular injury	Third most common associated ocular injury
Jordan et al.[3]	Nashville, United States	236	6.4%	Globe rupture (4.2%)	Optic neuropathy (0.8%) Retinal detachment (0.8%)	-
Kennedy et al.[10]	Philadelphia, United States	222	Not specified	Commotio retinae (12.2%)	Corneal abrasion (10.8%)	Hyphaema (6.8%)
Murchison et al.[8]	Philadelphia, United States	137	32.1%	Intraocular injuries (19.7%)	Ocular surface injuries (12.4%)	-
Al-Batayneh et al.[8]	Amman, Jordan	44	29.5%	Not specified	Not specified	Not specified
Sendul et al.[6]	Istanbul/Kars/Konya, Turkey	42	33.3%	Conjunctival laceration (11.9%)	Corneal abrasion (9.5%)	Hyphaema (4.8%)
Naik et al.[1]	Hyderabad, India	24	25%	Hyphaema (8.3%) Intraocular foreign body (8.3%)	-	Corneo-scleral laceration (4.2%) Conjunctival laceration (4.2%)

The placement of a canalicular stent during reattachment of the severed canalicular ends has become widely accepted to be essential for successful outcomes.[12] The principles of surgical repair are early

anastomosis, stent placement and the use of magnification.[17] Repair techniques may be classified as bicanalicular or monocanalicular. Bicanalicular stents may be nasally or annularly intubated.

Bicanalicular repair with nasal intubation is considered to be the gold standard for both monocanalicular and bicanalicular repair.[18] It involves intubating both the injured and the uninjured canaliculus with a silicone tube, which is then fixated in the nose. General anaesthesia is recommended because of the painful nature of canalicular intubation into the nose and because patients tend to be young.[12]

Bicanalicular repair with retrograde probing and annular intubation involves the use of a curved metal probe (pigtail probe) to intubate both canaliculi in a ring-like fashion, under general anaesthetic. The risk of injuring the uninvolved canaliculus is increased when using this method, as false tracts may be created. As such, it is described as being best used as a last resort.[18] This technique is not possible in patients lacking a common canaliculus, and does not address obstruction distal to the canaliculi themselves. The pigtail probe has been successfully employed in the identification of the lacerated nasal canalicular end. This may be accomplished using a Wurst (hooked) probe, or a modified (eyed with smaller diameter) probe in up to 98% of cases. The modified probe has been shown to cause fewer complications such as false tract creation than the Wurst probe.[19]

Monocanalicular repair is accomplished using a silicone stent which is short and ends in a punctal plug. The stent is inserted into the punctum of the lacerated canaliculus and passed via the distal canalicular end into the lacrimal sac. This means there is no injury risk to the uninjured canaliculus.[1] The most widely used of these stents is the Mini-Monoka.[1] Aside from not risking the other canaliculus, this technique has certain advantages over conventional bicanalicular stenting. It is less invasive,[18] is less technically challenging, has fewer complications and may be performed under local anaesthetic in a cooperative patient.[6] A notable disadvantage of this technique is that the nasolacrimal duct is not intubated and thus the Mini-Monoka does not address lacrimal sac lacerations.[15]

Murchison et al. found no significant difference in the success rate of mono- and bicanalicular repairs, but did find that the training level of the surgeon significantly affected success for all types of repair. Furthermore, the success rate was much greater if the repair was performed in theatre, as opposed to a side room in casualty.[8]

The aim of this study was to identify causes of canalicular laceration seen at St John Eye Hospital (SJEH), Soweto, Gauteng Province, South Africa, as well as to describe the associated ocular injuries and the burden of management on theatre resources.

2. Methodology

2.1. General methodology

This was a prospective study describing the causes of injury and associated injuries of all patients with canalicular laceration presenting at SJEH over a 7-month period. Furthermore, the surgical procedure performed and the theatre time consumed were recorded. St John Eye Hospital is the ophthalmic department of Chris Hani Baragwanath Academic Hospital, which is the world's third largest hospital. It is located in Soweto, Gauteng Province, South Africa. St John Eye Hospital services approximately 50 000 ophthalmological patients annually. The hospital serves patients from Soweto, as well as patients from the surrounding Greater Johannesburg area. Furthermore, it functions as a tertiary referral centre for peripheral hospitals in Gauteng.

All patients who presented at SJEH, from 22 December 2017 to 22 July 2018, with a canalicular laceration were included in the study. Patients who presented in an unstable state and thus required urgent transfer to an emergency department for resuscitation were excluded.

Relevant data were collected from the files of patients. These included demographical data (age, sex and race), canaliculus involved, cause of injury, associated ocular injuries, surgical procedure(s) performed, theatre time consumed and whether general anaesthetic was administered.

Data analysis was carried out using STATISTICA v13.1. Categorical variables were summarised using frequency and percentage tabulation and illustrated by means of bar charts. Continuous variables were summarised by the mean, median and interquartile range, and their distribution was illustrated by means of histograms. Based on worst-case (for sample size) estimates of 50%, 5% precision and the 95% confidence level, a sample size of 385 would be required. The actual sample size of 26 in this study corresponds to a precision of 19.2% (rather than 5.0%), which is a limitation of the study.

2.2. Ethical considerations

Permission was obtained from the Medical Advisory Committee of Baragwanath Hospital, the Chief Executive Officer of Chris Hani Baragwanath Academic Hospital, and the Clinical Head of Department at St John Eye Hospital. A Protocol was approved by the Human Research Ethics Committee of the Witwatersrand (Protocol Reference Number M171031). All participants provided formal informed consent in writing. This study was carried out in accordance with the Declaration of Helsinki.

3. Results

3.1. Patient characteristics

During the period under review, 78 patients presented with lid lacerations at SJEH. Of these patients, 26 were found to have canalicular lacerations (33.3%). All patients who presented with canalicular lacerations consented to participate in the study.

Males accounted for 18 (69%) of the patients included in the study, and 25 (96%) of the patients were of African descent. There was 1 Caucasian patient (4%). The average patient age was 31.5 years. The median age of the patients was 34 years (interquartile range 25–39 years; range 10 months–60 years). Children accounted for four (15%) of the patients in this study. The distribution of the ages is shown in Figure 3.1 below.

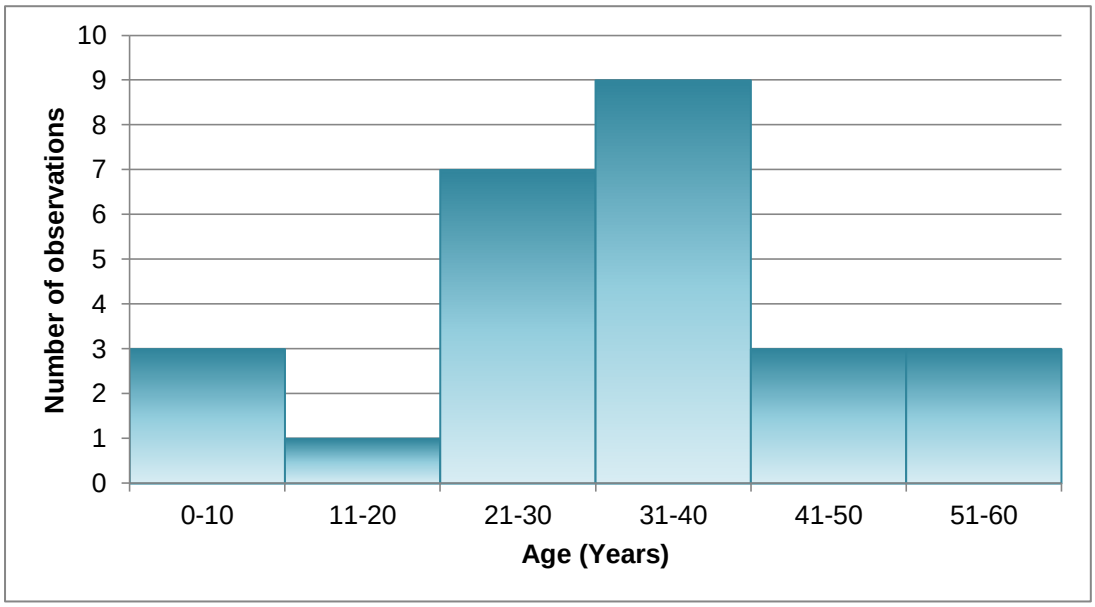


Figure 3.1: Age distribution of patients with canalicular lacerations

3.2. Cause of injury

The predominant cause of injury was assault which accounted for 15 (58%) of the 26 patients. The second most common cause was road accident which accounted for five patients (19%), of which three were motor vehicle collisions and two were pedestrian vehicle collisions.

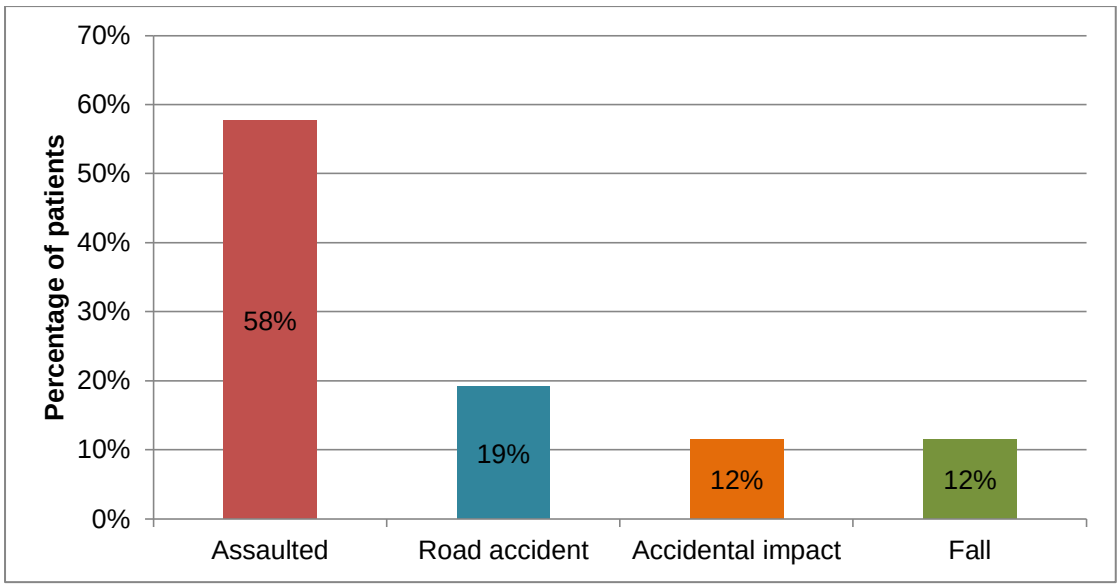


FIGURE 3.2: Major causes of canalicular injury.

The most common type of assault was being stabbed with a knife. This cause accounted for four patients, which was 27% of all assaults and 15% of all canalicular lacerations. The average age of assaulted patients was 31.5 years (range 10 months–44 years).

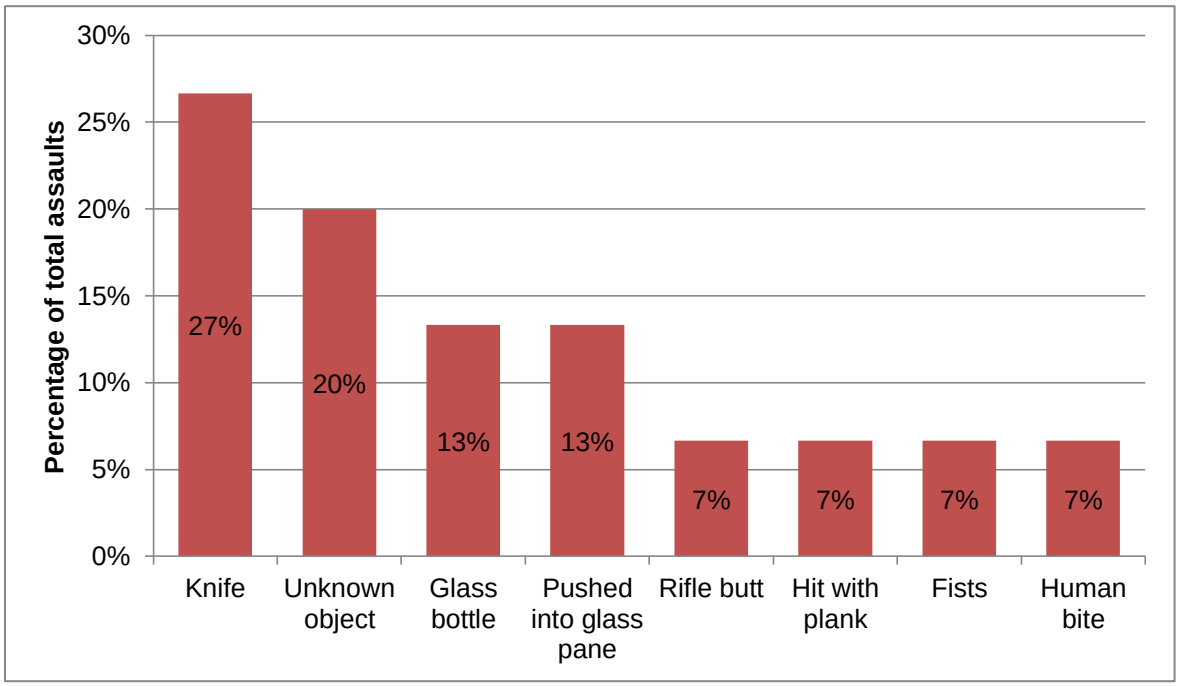


FIGURE 3.3: Types of assault resulting in canalicular laceration.

3.3. Canaliculus involved

A single canalicular laceration occurred in 23 patients (88%), three patients (12%) had both upper and lower canaliculi lacerated. Lower canalicular lacerations accounted for 18 (62%) of the 29 canalicular lacerations sustained by the 26 patients. The left lower canaliculus was the most frequently injured (*n* = 11; 42%), followed by the right lower (*n* = 7; 27%), the left upper (*n* = 6; 23%) and right upper canaliculus (*n* = 5; 19%). The majority of patients sustained left-sided canalicular lacerations (*n* = 15; 58%). Where assault was the cause, the left canaliculi were lacerated in eight patients and the right in seven patients (53% vs. 47%). No bilateral canalicular lacerations were observed.

3.4. Associated ocular injuries

Associated ocular injuries were detected in nine patients (35%). Traumatic uveitis (*n* = 4; 15%) and subconjunctival haemorrhage (*n* = 4; 15%) were the most common. Table 3.1 displays the incidence of each injury.

TABLE 3.1: Associated ocular injuries.

Associated Ocular injury	*n* (Total = 26)	Percentage
Nil	17	65
Traumatic uveitis	4	15
Subconjunctival haemorrhage	4	15
Globe rupture	2	8
Conjunctival laceration	1	4
Retrobulbar haemorrhage	1	4

Medial rectus avulsion	1	4
Optic nerve avulsion	1	4

Note: Percentages do not sum to 100% because some patients had more than one ocular injury.

3.5. Surgical management

All patients received lid repair under general anaesthetic. Canalicular repair was successfully performed in 24 cases (92%). In both cases the reason for unsuccessful repair was failed nasal intubation. The lacrimal sac was not explored by the surgeons, and so it is not known whether the lacrimal sac or the nasolacrimal canal was the point of obstruction. Bicanalicular repair with nasal intubation was employed in 23 cases (88%), whilst monocanalicular repair with a Mini Monoka tube was performed in one patient (4%). Additional surgical procedures were performed for five patients (19%); these are tabulated in Table 3.2.

TABLE 3.2: Additional surgical procedures performed.

Additional surgical procedure	*n* (Total = 26)	Percentage
Evisceration with silicone ball implant	2	8
Skin graft	1	4
Brow repair	1	4
Orbital floor repair	1	4

3.6. Duration of surgery

A total of 2985 min (49 h and 45 min) of general anaesthetic theatre time was consumed over the 7-month period. This amounted to 100 min per week. The average duration of surgery was 115 min, whilst the median duration was 103 min. The notable difference between average and mean duration is because of a single outlying case that consumed 265 min. The range was 45–265 min with an interquartile range of 90–135 min. The average duration for patients only comprising of lid and canalicular repair was 101 min.

4. Discussion

During this study, patients presenting with lid lacerations had more than double the canalicular involvement rate of 16% reported in the literature.[3] Had this incidence rate continued, it would have translated to 45 canalicular lacerations per annum at SJEH. This is a relatively high incidence. Jordan et al. have published the largest study on the subject and reported an incidence of 28 canalicular lacerations per annum.[3] These injuries may therefore represent a significant public health challenge in our setting.

Patients in his study tended to be older than those reported in other studies.[1,3,6,7,8,9,10,11,13,14,15] This is contrary to the notion that these injuries affect mostly young patients, and indeed, the ages of patients in this study ranged from as young as 10 months to as old as 60 years. The relatively low

number of children in this study may explain the relatively low incidence of dog bites as a cause of injury, as dog bites are known to disproportionately affect children.[16]

The expected male preponderance, while present, was lower than that reported by any other study we could find.[1,3,,6,7,8,9,10,11,13,14,15] This is unexpected, especially when considering that assault was by far the most common cause of injury.

The causes of injury reported in this study were similar in type to those reported in other studies, but the proportions were markedly different.[1,3,6,8,9,10,11] More than half of the patients in this study (58%) reported assault as the cause of their injuries. This cause of injury is also common in other studies, but the highest proportion reported was 36%.[10] Knife-related assault was an especially common cause of injury in this study and accounted for 12% of all patients. A number of assaults involved a glass bottle as the weapon. This mode of injury is not specifically reported in other studies. It is worth bearing in mind that one in five assaulted patients could not identify the object used in the assault, and as such, these estimates of knife and glass bottle assault are likely conservative.

The left canaliculus was more often lacerated in this study than the right (58% vs. 42%). It is tempting to attribute this difference to right-handed attackers, but it is not supported by the data. Only 53% of patients who reported assault as the cause of injury had a left-sided canalicular laceration. The left lower canaliculus was involved almost twice as any other canaliculus being injured in 42% of patients. The reason for this is unclear.

Associated ocular injuries were found in 35% of patients, which is in keeping with a rate considered normal in the literature (20% – 40%).[14] It is worth noting, however, that the author could find no study with a higher rate than 35%. The majority of these associated ocular injuries tended to be mild, the most common injuries being traumatic uveitis and subconjunctival haemorrhage. However, 8% of patients suffered globe rupture necessitating evisceration. This is nearly double the rate observed by Jordan et al. in the largest study conducted on this subject, a study where globe rupture is reported as the most common associated ocular injury.[3] This relatively high incidence of often serious injuries represents a considerable source of morbidity, as well as an additional burden on service delivery.

Despite resource limitations at SJEH, all patients received lid repair under general anaesthetic and canalicular repair in keeping with international standards. Providing this essential service comes at the cost of cancelling important elective surgeries, as there is currently no dedicated ophthalmic trauma theatre at SJEH.

The average duration of surgery was 115 min, but this is likely an overestimation as there was a single long outlying case (265 min). The median duration of 103 min is likely a better measure of resource burden, and this correlates well with the average duration of surgery for cases where only canalicular laceration repair was required of 101 min.

Over the 7-month period, canalicular laceration repair was demonstrated to consume 100 min of general anaesthetic theatre time every week at SJEH. This was purely the time spent operating and did not take into account the time spent inducing and reversing anaesthesia, as well as cleaning and draping of the patient. An audit of time consumed in theatre at a teaching hospital in Nigeria performing mostly cataract surgeries found that the average surgical duration of an ophthalmological case was 25.7 min.[20] If the average surgical time per ophthalmological case at SJEH is similar to this, this would amount to 202 patients every year not receiving their scheduled eye surgery. Funding a dedicated ophthalmic trauma theatre may alleviate this burden.

This study suggested that canalicular lacerations may represent an especially pronounced public health challenge in the South African context. The study was limited by its single-centre design, small sample size and relatively short data collection period. Further limitations are that the study did not assess surgeon experience level, postoperative management or postoperative outcomes. As there is a paucity of similar studies locally, multicentre studies with longer data collection periods are required to verify these findings.

5. Conclusion

This study demonstrates that canalicular lacerations are relatively common at SJEH. These are disproportionately caused by assault and more often associated with serious ocular injuries. This places considerable burden on already limited theatre resources and may be of particular relevance in the South African setting. More study is needed to verify these findings and identify potential strategies for primary prevention.

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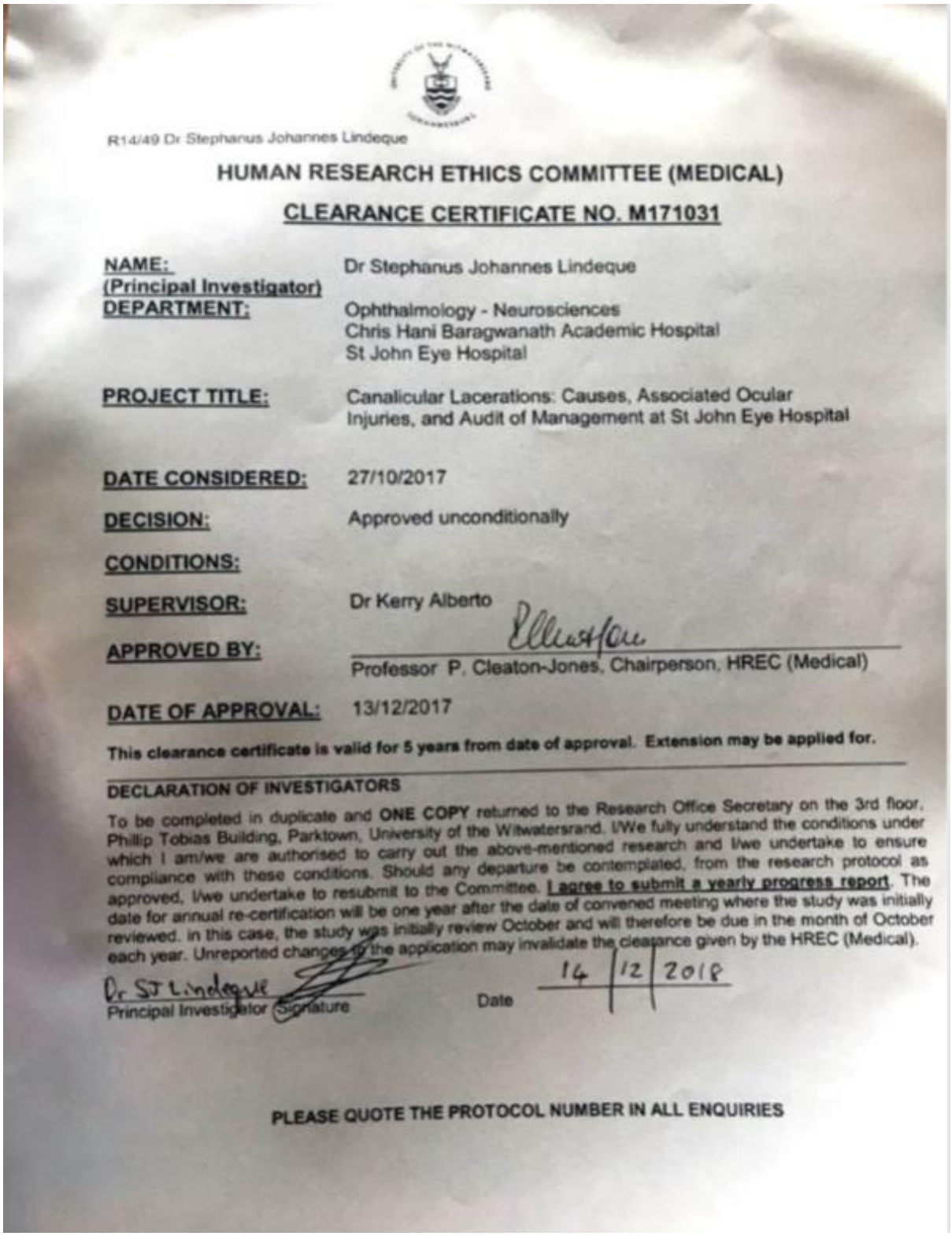
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APPENDIX



R14/49 Dr Stephanus Johannes Lindeque

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M171031

NAME: (Principal Investigator)	Dr Stephanus Johannes Lindeque
DEPARTMENT:	Ophthalmology - Neurosciences Chris Hani Baragwanath Academic Hospital St John Eye Hospital
PROJECT TITLE:	Canalicular Lacerations: Causes, Associated Ocular Injuries, and Audit of Management at St John Eye Hospital
DATE CONSIDERED:	27/10/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Kerry Alberto
APPROVED BY:	Professor P. Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	13/12/2017

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially review October and will therefore be due in the month of October each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Dr SJ Lindeque
Principal Investigator Signature

Date 14/12/2018

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES