AESTHETIC OUTCOMES USING TRANS-CONJUNCTIVAL VS TRANSCUTANEOUS APPROACHES FOR ORBITAL TRAUMA

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A mini-thesis submitted for fulfilling the requirements for the Degree of Master in Dental Surgery in the discipline of Maxillo-Facial and Oral Surgery, Faculty of Dentistry, University of the Western Cape.

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October 2020

KEYWORDS

Aesthetics

Orbital trauma

Subtarsal

Transcutaneous

Transconjunctival

ABSTRACT

Aesthetic outcomes using transconjunctival vs transcutaneous approaches for orbital trauma.

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MDS (MFOS) mini-thesis, Department of Maxillo-Facial and Oral Surgery, Faculty of Dentistry, University of the Western Cape.

Introduction: Maxillofacial and oral surgeons often encounter challenges when choosing an appropriate surgical access for patients who sustained periorbital and orbital trauma. There are various surgical approaches/incisions (transcutaneous and transconjunctival) used to access the periorbital skeletal framework. However, there is no consensus in the literature regarding the aesthetical outcome of these approaches/incisions. Complications of the lower lid such as entropion, ectropion, retraction of lower lid, scarring, oedema of lid, canthal mal-position and chemosis are associated with these approaches. Surgeons are posed with these challenges and aim for best aesthetic outcomes and low post-operative complications.

Aim: The aim of this study was to compare aesthetic outcome of the transcutaneous approach (subtarsal) to that of the transconjunctival approach when managing orbital trauma.

Objectives: The objectives were to compare the aesthetic outcomes between the transconjunctival and transcutaneous (subtarsal) approach; to assess unwanted clinical outcomes, such as scaring, lid malposition (ectropion, entropion, scleral show), lid oedema, chemosis, haematoma, ecchymosis, wound dehiscence, infection and canthal malposition for the two approaches.

Methodology: Twenty-two patients were enrolled in this study, 11 of which underwent "transconjunctival incision", and 11 underwent "subtarsal incision". A high quality digital photograph of each patient's face was taken at specified time periods up to nine months after surgery. Ten Maxillofacial and Plastic surgeons were instructed to rank order the 22 photographs applying Q-sort scaling.

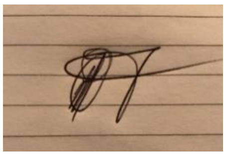
Results: Eleven patients underwent the transconjunctival (retroseptal) incision. Ten of which had pure blowout fractures and one had a zygomatic complex fracture. Of the 11, seven were black Africans, two were Caucasians and two mixed race. There were four males and seven females in the transconjunctival incision group. The remainder of the 22 underwent the transcutaneous (subtarsal) incision. Six of the 11 were black Africans and five mixed race. There were nine males and two females in the tranconjunctival group. In this group, two patients had pure blowout fractures and nine had zygomatic complex fractures.

Scars were visible in the subtarsal group after six months in seven out of the 11 cases (63.6%), but all the scars were rated as mild on the modified Vancouver Scar Scale. Scleral show was noted after six months in four of the 11 cases with the subtarsal approach and in two of the 11 cases with the transconjunctival approach. Only one case of ectropion was seen with both approaches and only one case of entropion was noted in the transconjunctival group. According to the findings of the study, both approaches were found to have good aesthetic outcomes. Results from the expert rating showed a high-quality rank of 96.8% for the transconjunctival incision versus 90.5% for the subtarsal incision.

Conclusion: Both approaches demonstrated good aesthetic results. The transconjunctival incision was associated with scleral show and entropion, while the subtarsal incision was more associated with scar formation. However, when performed meticulously, both incisions can provide aesthetically pleasing results.

DECLARATION

I declare that '**Aesthetic outcomes using transconjunctival vs transcutaneous approaches for orbital trauma**' is my own work, that it has not been submitted for any degree or examination at any other university, and that all sources I have used or quoted have been indicated and acknowledged by complete references.

Signed: 

Gugulethu Mhlanga

October 2020

DEDICATION

This thesis is dedicated to my family, especially my wife, son, mother and my adorable cousin Siphesihle Mguga, and friends, for their unconditional love and support throughout my training.

ACKNOWLEDGEMENTS

The completion of this research project could not have been accomplished without the willingness and guidance of the following individuals:

- Professor J.A. Morkel, for going more than an extra mile in assisting me with training and the research project.
- Dr G.J. Hein, for training.
- Prof Herman Kruijsse for guidance and statistical analysis.
- Dr F Titinchi for proof reading and recommendations.
- Dr N Behardien for her support while Prof Morkel was away.
- Ms C. Marlow and Mrs T Suleman, for their invaluable assistance in accessing hospital records.
- Ms C Mhlanga and S Mguga, for their proficient assistance with word processing.
- All my consultants and fellow registrars for their advice and constant support.
- The nursing and supporting staff at both Tygerberg and Groote Schuur Academic Hospitals for their constant support and encouragement.
- The many patients who made my training and this study possible.
- A special expression of gratitude to all those individuals whom I have omitted. Your contribution to my training is invaluable.

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ABBREVIATIONS

CT	Computed tomography
MRI	Magnetic resonance imaging
NOE	Naso-Orbital-Ethmoid
ZMC	Zygomatic complex
VSS	Vancouver scar scale
BLAF	Black African
CAU	Caucasian
MR	Mix Race
mVSS	Modified Vancouver scar scale

GLOSSARY

Canthal malposition or lower lid retraction: Canthal malposition or lower lid retraction is commonly defined as a lid margin position below the inferior limbus

Ectropion: Ectropion has its etymological origin in the Greek "ektrep-ein" meaning everted eyelid

Entropion: It is an inversion of the lower eyelid. It may develop as a result of congenital involutional or cicatricial causes

Haematoma: Haematoma, is a localized collection of blood, usually clot-ted, in an organ, space or tissue, due to a break in the wall of a blood vessel

Lid oedema: Lid oedema is an inflammation or excess fluid (oedema) in the connective tissues surrounding the eye

Scar: Scars form as the body's natural response to injured tissue, and is a normal endpoint of tissue repair in humans and un-dergo regeneration till maturation has been reached

Scleral show: Scleral show is an anatomical condition in which the sclera area is visibly exaggerated

Wound dehiscence: Wound dehiscence is a separation of the layers of a surgical wound, it may be partial or only superficial or complete with separation of all layers and total disruption.

Chapter 1

Introduction

Maxillofacial, Plastic and Craniofacial surgeons often encounter patients who present with orbital injuries such as zygomatic complex (ZMC), naso-orbital-ethmoid (NOE), orbital rim and orbital floor fractures. These fractures result in functional or aesthetic problems, which then become an indication for treatment or surgical correction. Surgeons are often posed with a challenge in selecting the correct treatment approach that will optimise exposure and improve aesthetic outcomes (Lim *et al*. 2014). A variety of surgical approaches to the zygoma and orbit exist, each with its own advantages and disadvantages. Surgical approaches should allow adequate visualisation for reduction and fixation with fewer complications and satisfactory aesthetic outcomes.

The most common complications following surgical management of the orbital floor and periorbital area include lower lid complications (Ridgway *et al*. 2009). Lower lid complications comprise of several functional and aesthetics problems, including but not limited to lid mal-position (ectropion, entropion, lower lid retraction, and scleral show), scarring, canthal mal-position, lid oedema and chemosis. In the South African context, it is worth noting that dark skinned people, especially those of African descent have a high prevalence (16%) for keloids formation (Niessan *et al*. 1999) which could play a role in the aesthetic outcomes.

Traditional approaches to the orbital floor and/or infra-orbital rim have been the transcutaneous incisions, which are placed in the infra-ciliary area. They include subciliary, subtarsal, and infra-orbital approaches. The subciliary incision is made two millimetres below and parallel to the lash line; it extends from the punctum at the medial aspect to 15 millimetres beyond the lateral canthus. The subciliary is further subdivided into a skin flap, a stepped skin-muscle flap and stepped muscle flap according to the path of dissection through the orbicularis oculi muscle. The subtarsal incision is placed about five to seven millimetres from the lower eyelid margin (Converse 1944). In the infraorbital rim incision, skin, subcutaneous tissue, orbicularis muscle, and periosteum are incised concomitantly (Baqain *et al*. 2008). The level at which the incision is made from the ciliary margin differentiate these incisions, and the final cosmetic results are influenced by the anatomy of the region and the plane of dissection (Baqain *et al.* 2008).

There have been several studies conducted to compare the unwanted outcomes associated with the transconjunctival and transcutaneous incisions but less attention has been given to compare these two surgical approaches in regard to the aesthetic outcomes.

Chapter 2

Literature Review

1. Introduction

In the literature review, a brief overview of orbital trauma will be presented, followed by the types of surgical approaches available and the possible complications involved. A more extensive literature review will be presented on the topic of transconjunctival and subtarsal incisions as used in the peri-orbital region. A comparison of these incisions in regard to aesthetic outcomes will be discussed.

2. Orbital Trauma

Orbital and peri-orbital trauma is defined as trauma to the bone surrounding the orbit as well as the soft tissue. Most of these injuries occur as a result of blunt trauma, usually motor vehicle accidents, interpersonal altercations, sports accident, and falls. Fractures that involve the orbit may affect the internal orbit, the external orbital frame, or both. The literature reports that the orbit is involved in a high percentage (47%) of cases in severely injured patients admitted to trauma centres (Palmier *et al.* 2012).

The orbit is made up of seven bones (sphenoid, frontal, zygomatic, ethmoid, lacrimal, maxilla, palatine) situated within the skull and is described as a pyramidal or conical-shaped chamber. It is composed of four walls, namely the floor, roof, medial wall, and lateral wall. The walls are formed by different bones of the orbit. The thinnest of them are the medial wall and the floor. Orbital wall fractures are classified as pure and impure blow-out fractures and blow-in fractures. They can involve a single wall or two or more walls (Fonseca *et al.* 2009). The most commonly fractured walls of the orbit are the floor, medial wall and rarely the lateral wall.

Fractures of the internal orbit generally take place by one of two processes. The theories proposed are the "hydraulic and buckling theories". In the "hydraulic or indirect theory", the force is directed to the globe itself, which results in a sudden increase in intra-orbital pressure that applies an outward force against the internal orbital walls, the weakest of which fractures. This gives the explanation why most orbital blow-out fractures occur just medially in the orbital floor (Palmier *et al.* 2012).

In the "buckling or direct theory" the force is applied directly to the bone, often the zygomatic bone or the infraorbital rim, or both. This produces an orbital floor fracture through direct transmission of energy from the orbital rim to the floor and results in a compression-type fracture (Palmier *et al.* 2012).

When the internal orbital fracture occurs, the volume occupied by the soft tissue contents (the eye and adnexa) may expand or contract secondary to the direction of displacement of the orbital fracture (i.e., blow-in or blow-out). Blow-in fractures normally occur in the orbital roof and are associated with high-velocity injuries involving the anterior skull base. They result in decrease of orbital volume and downward and forward displacement of the globe, whereas most blow-out fractures, occur on the inferior or inferior-medial aspect of the orbit and result in volumetric expansion with displacement of the globe posterior-medially and inferiorly (Palmieri *et al.* 2012; Fonseca *et al.* 2009).

Fracture displacement and orbital expansion or contraction may lead to extra-ocular muscle restriction, diplopia, enophthalmos, and/or proptosis. Extraocular muscle restriction and diplopia are generally the result of muscle contusion, entrapment of either the extra-ocular muscle or the soft tissue adjacent to the muscles. Cranial nerve paresis (oculomotor, trochlear, or abducens cranial nerves) can be seen which may cause deviation of the visual axes (Palmieri *et al.* 2012).

There is a specific subset of orbital injuries known as a "white eye blow-out fracture" that usually occur in children younger than 18 years of age. Classically, there is a history of trauma with minimal signs of soft tissue injury. The children present with no subconjunctival haemorrhage, but with up gaze diplopia and general malaise. Complete immobility of the ocular globe may occur which is associated with enophthalmos. A high proportion present with bradycardia (oculovagal reflex). This clinical phenomenon is regarded as a maxillofacial emergency and is an indication for immediate orbital exploration with release of the entrapped extra-ocular muscle. (Palmieri *et al.* 2012).

The external orbital frame fractures can be defined as fractures involving Zygomatic complex fractures, NOE fractures, Le fort II and III, and/or a combination. Zygomatic complex fractures (ZMC) are often found in association with the orbital fractures. Signs include paraesthesia in the distribution of the infraorbital nerve, motility problems with diplopia, trismus, and depressed malar eminence.

ZMC fractures can be classified using the Zingg *et al.* (1992) classification system which recognizes three types of fractures based on the number of pillars involved. Type A is an isolated fracture involving only one zygomatic complex pillar. Type A1 is an isolated zygomatic arch fracture, type A2 isolated lateral orbital wall fracture and type A3 isolated infra-orbital rim fracture. Type B is a complete mono fragment zygomatic fracture (tetrapod fracture) where all four pillars of the zygomatic bone are fractured. Type C is a multiple fragment zygomatic fracture (comminution) (Zingg *et al.* 1992).

Indications for surgical repair are much the same as for other orbital fractures. These would include persistent diplopia, enophthalmos, trismus, and an aesthetically unacceptable appearance. Surgical approaches to access the fracture are typically the subtarsal, transconjunctival, blepharoplasty and the coronal incisions (Palmier *et al.* 2012; Fonseca *et al.* 2009).

Naso-Orbital-Ethmoid (NOE) fractures normally occur as a result of high-velocity blunt force trauma to the midface. They involve the nasal bone, orbit, ethmoidal sinus and may result in cerebral spinal fluid (CSF) rhinorrhoea due to an associated base of skull fracture. NOE fractures are challenging to diagnose. They are even more difficult to treat and to achieve desired aesthetic results. An assessment of NOE fractures involves total ophthalmology examination, visual inspection of the traumatized canthal region and bimanual palpation of the medial canthus. Markowitz (1991) classified NOE fractures by recognizing three types of fractures based upon the degree of fracture comminution and medial canthal involvement. Type I fractures has a large central segment of bone with the medial canthal tendon attached to it. Type II fractures show more comminution than Type I but still have a stable (but smaller) segment of bone to which the medial canthal tendon is attached. Type III NOE fractures show severe comminution of the bones with minimal attachment or avulsed of the medial canthal tendon. Access to the fractures is best gained through a coronal, subtarsal or transconjunctival incisions. (Palmieri *et al.* 2012; Fonseca *et al.* 2009).

Le Fort I, II and III midface fractures are named after René Le Fort, a French army surgeon who developed the classification in 1901. The Le Fort I fracture will not be discussed as it does not involve the orbit. (Palmier *et al.* 2012; Fonseca *et al.* 2009)

The Le Fort II fracture is a pyramidal shaped fracture through the nasal root, the medial orbital floors, the inferior orbital rim, the anterior maxillary sinus wall and proceed under the zygoma through the pterygoid plates. This fracture essentially separates the body of the maxilla from the face (Palmier *et al.* 2012; Fonseca *et al.* 2009).

The Le Fort III fracture passes through the nasal root, along the medial orbital walls then posteriorly just inferior to the optic canal. It continues along the floor to the lateral orbital wall and then through the fronto-zygomatic suture and zygomatic arch. This fracture causes complete craniofacial dysjunction (Palmier *et al.* 2012; Fonseca *et al.* 2009). Access to these fractures can be gained through the subtarsal, trans-conjunctival incisions, and/or the coronal incision especial for the Le Fort III fracture.

Fractures of the orbit can have immediate and long-term effects on ocular function and facial aesthetics. Indications for surgical repair and reconstruction of peri-orbital and orbital fractures are orbital floor fractures with diplopia, motility restriction, trismus aesthetically significant enophthalmos, telecanthus, and depressed malar eminences. Trapped extraocular muscles causing an oculocardiac reflex (bradycardia), warrant urgent surgical intervention. (Fonseca *et al.* 2009).

3. Surgical Approaches

3.1. Transconjunctival Surgical Technique and Possible Associated Complications

In 1924, Bourgnet described the transconjunctival approach for the lower eyelid blepharoplasty. The technique was further used by Tenzel and Miller 50 years later to repair small orbital floor fractures. It gained popularity after Tessier used it on three patients with orbital injuries. Tessier was familiar with the technique seeing that he used it for patients with craniofacial dysostoses (Tessier 1973). In 2016 Strobel *et al.* noted that this approach was highly useful to access the orbital floor and infraorbital rim, and was considered superior in that the hidden scar was in the conjunctiva. If performed meticulously, the scar was invisible and seldom resulted in unwanted outcomes.

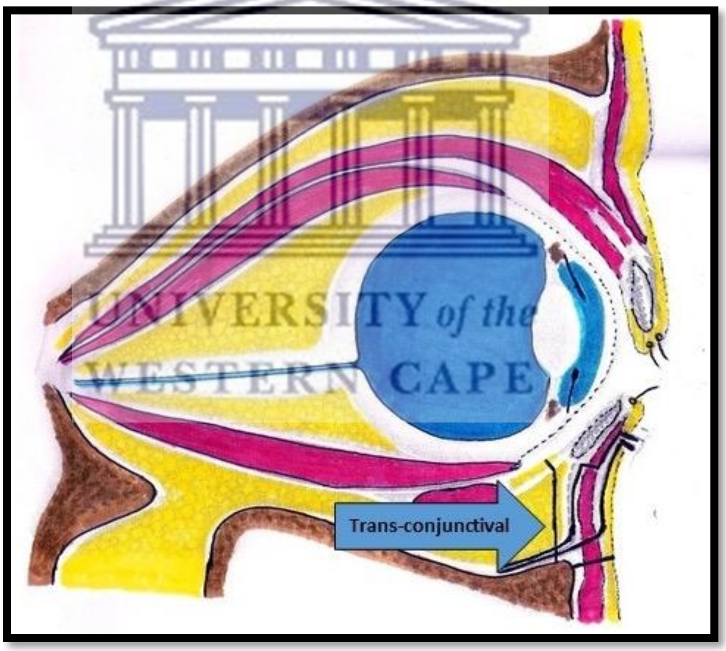

Figure 1: Transconjunctival dissection technique *(Sketched by JA Morkel &G Mhlanga)*

There are two dissection techniques that can be used for the transconjunctival approach (Figure 1). These are the preseptal and the retroseptal technique. In the retroseptal technique, the conjunctiva is dissected from behind the orbital septum caudal to the bone, whereas in the preseptal the orbital septum is incised beneath the tarsus and is followed caudal to the orbital rim (Schmal *et al*. 2006). The preseptal technique has been associated with post-operative entropion whereas the retroseptal technique has not often been implicated (Schmal *et al.* 2006).

Between 2002 and 2006, Lee *et al*. (2006) conducted a retrospective study evaluating 53 patients with zygomatic complex fractures, which were treated with a single transconjunctival incision and two-point fixation. Of the 53 patients, three developed post-operative complications. One had a persistent scleral show post operatively, and two had mild pigmentation at the lateral canthal incision site.

In 2008, Clinton and Kriet conducted a study to critically evaluate complications of the transconjunctival vs. the transcutaneous approach. In this study 28% to 42% complications were reported of temporary lower lid malposition (lid shortening, scleral show, ectropion and entropion) with the transconjuctival approach vs. 0.5% with the transcutaneous approach.

In 2011, Santosh and Girradi evaluated a trans-conjunctival preseptal approach for orbital fractures in 15 patients to assess adequacy of exposure, intra-operative and post-operative complications. Only one of the 15 patients had a post-operative complication, which was a sclera show of one millimetre that resolved within three months. No permanent complications were encountered, and aesthetic outcomes were satisfactory in all patients.

3.2. Transcutaneous approaches surgical techniques and possible complications

The transcutaneous approaches are the surgical technique of choice in training institutions because of its simplicity and a degree of safety it provides for possible damage to the globe. These incisions are designed in either lower or upper eyelid to gain access to the orbital rims/floor or upper orbit respectively. They have been placed in the subciliary area, subtarsal, and mid-lid or infraorbital area. These skin incisions will undoubtedly produce scars with the infraorbital incision being the worst. It is suggested if possible, that the infraorbital incision should be avoided (Baqain *et al.* 2008).

The subciliary technique, also known as the blepharoplasty or infra-ciliary incision or technique, was first described by Converse and colleagues in 1944. The incision is placed two millimetres below the lash line over the tarsal plate. It has been determined that it results in little or no perceivable scar and allows easy access to the lateral orbital rim. There are three dissection techniques that can be followed (Figure 2). The skin flap dissection, the skin-muscle flap dissection and the stepped skin muscle flap dissection (Ellis and Zide 2006; Strobel *et al*. 2016; Rohrich *et al*. 2003). The skin flap technique is no longer favoured nor performed as it is associated with a high rate of complications, ectropion, skin necrosis and ecchymosis (Ellis and Zide 2006;Strobel *et al*. 2016; Rohrich *et al*. 2003).

The subtarsal approach also described and suggested by Converse and colleagues in the 1960s, is the same as the subciliary but with a few important differences. The skin incision (through skin and muscle) is at the inferior margin of the lower tarsus, in the subtarsal fold which is normally in the natural skin crease of the middle of the lower eyelid. This technique has been studied extensively with little complications and acceptable aesthetics and hence most units and surgeons prefer this approach (Strobel *et al*. 2016; Rohrich *et al*. 2003; Baqain *et al.* 2008).

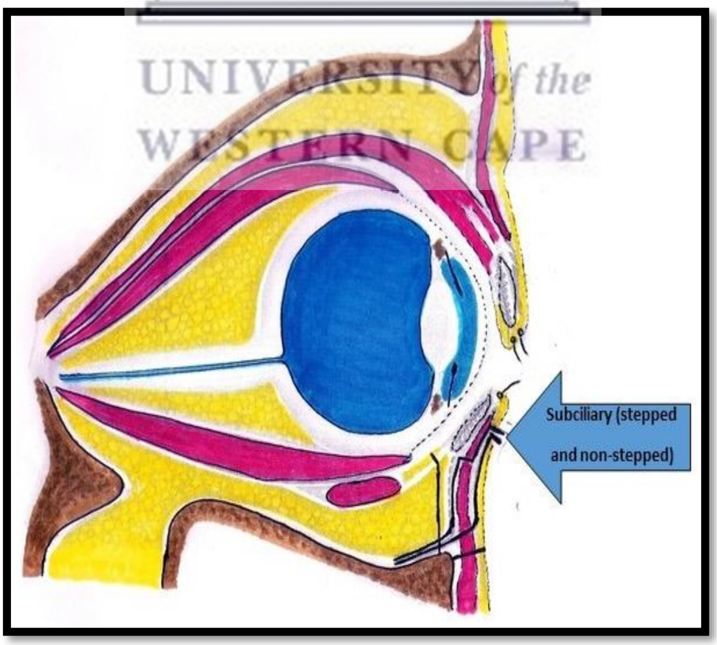

Figure 2: Subciliary dissection technique *(Sketched by JA Morkel &G Mhlanga)*

The infraorbital (orbital rim) approach is no longer an incision of choice (Figure 3). It has relative indications such as presence of conjunctival or orbital pathologies, hypertrophic orbicularis oculi muscle, laceration of the infraorbital rim area, persistent globe oedema, presence of globe prosthesis, or an unstable globe or corneal injury (Werther 1998).

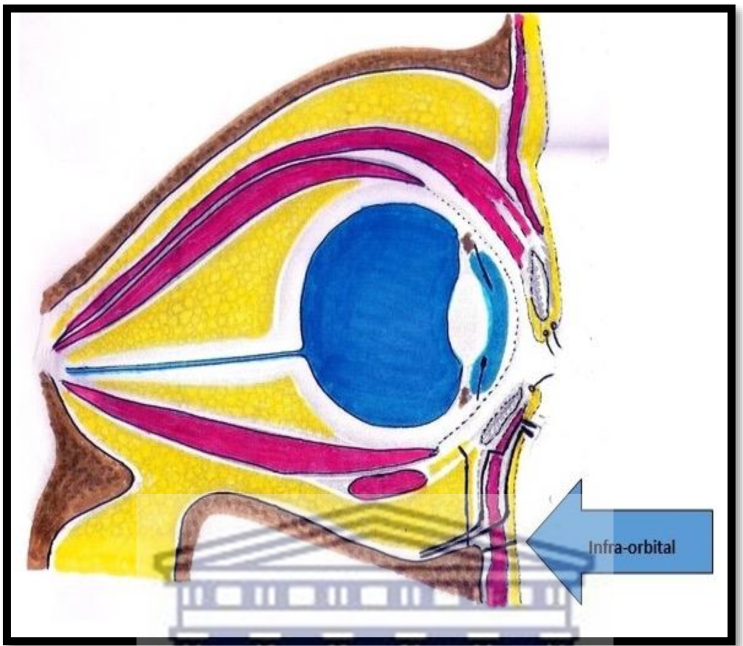

Figure 3: Infra-orbital dissection technique *(Sketched by JA Morkel &G Mhlanga)*

De Melo Crosara *et al*. (2009) compared the aesthetic results achieved after 20 subciliary, 22 subtarsal, and 16 infra-orbital incisions. They found that of the subciliary, subtarsal and infra-orbital incisions, 0%, 32, and 69% had noticeable scars respectively. They also reported that subciliary incision had 0% ectropion and chronic oedema, and 20% scleral show. The subtarsal incisions had 18% ectropion, 3% scleral show and 0% chronic oedema and the infra-orbital incisions had 1% ectropion, 19% scleral show and 12.5% chronic oedema. In this study it was not stated whether the patients were dark or light skinned, nor was the level of experience of the surgeons and the number of the operators noted, as these may have influenced the variables.

3.3. Scarring

Scars form as part of the body's natural response to injured tissue. The process of scar formation reflects the body's attempt to restore tissue strength and integrity. The imperfect nature of this process results in the morphologic differences between scarred and normal tissue. The gross differences between scarred and normal tissue reflect histologic differences that define a scar. A mature scar, the final product of normal wound healing, is characterised by its disorganised array of collagen and loss of dermal appendages (Hardy 1989).

For physicians, scars represent an endpoint in tissue healing. However, for patients scars often have deeper, more personal meanings. Deformities from disease, violent trauma, or aberrations of development can result in lifelong physical and psychological burdens (Lorenz *et al*. 2013; Strobel *et al.* 2016; Rohrich *et al.* 2003).

There are surgical techniques that can reduce unwanted scarring. The importance of tension free wound closure in preventing scar widening and hypertrophic scarring is well documented and noted in the literature (Lorenz *et al*. 2013; Master *et al.* 2010). Surgical incisions should be always placed parallel to the natural skin tension lines. This placement location has two advantages: the scar is parallel or within a natural skin crease, which camouflages the scar, and the location places the least amount of tension on the wound. Keeping the initial dressing on for 48–72 hours, the time required for epidermal closure, is an often-used strategy to maintain wound sterility. Surgical site infection is prevented by the use of peri-operative antibiotics and debridement of devitalized tissue (Lorenz *et al*. 2013).

Sutures should be removed within three to five days on the face and can then be reinforced with adhesive tape strips. Failure to remove sutures in a timely fashion can result in a disfiguring railroad scar pattern from suture marks (Lorenz *et al*. 2013). Alternatively, subcuticular sutures or adhesive tissue glue can be used for final skin apposition. Permanent sutures such as nylon benefit from inciting less of an inflammatory reaction than absorbable biodegradable sutures. Both permanent and absorbable subcuticular stitches can be left untied with the ends secured by tape to avoid granuloma formation around knots. Removal of permanent subcuticular suture can be aided by interval externalisation of the stitch so as not to have to pull the entire stitch through the wound (Lorenz *et al*. 2013).

Factors that contribute to poor wound healing may also contribute to poor scarring. These factors are poor nutrition, diabetes, obesity, and radiation exposure may all hamper wound healing, leading to an increased risk of infection. Wound infections and foreign-body reactions can lead to wound dehiscence and poor scarring. Patients with these comorbidities should be considered at higher risk for wound complications and poor scarring. Medications such as corticosteroids can also negatively affect tissue healing. Genetics has also been implicated in scarring and keloid formation, yet the exact mechanism has not been established (Lorenz *et al.* 2013; Fearmonti *et al.* 2010).

Dark skinned patients are prone to hypertrophic scars and keloid formation which are difficult to treat either surgically or medically (Smith and McGrouth 2013; O'Sullivan *et al.* 1996). Several studies have shown that individuals of certain races (African and Asian) are more susceptible to keloids scar formation. The incidence of keloids formation in dark versus light skinned is as high as 16% (Niessen *et al*. 1999).

Furtado *et al*. (2012) evaluated keloids recurrence after surgical excision using a prospective longitudinal scar assessment scale on 25 patients. During a period of six months the following observations were noted: 15 patients out of the 25 had recurrence within three months of surgical excision, and an additional three patients has recurrence within six months of surgical excision. These findings highlight the challenges posed by scar treatment, specifically keloids and hypertrophic scars.

Scar treatment vary depending on the type of scar ranging from a conservative to an invasive treatment, consisting of surgical excision, cryosurgery, brachytherapy, laser, intralesional steroids injection, intralesional bleomycin injection, silicone gel, interferon, 5-fluorouracil, photodynamic therapy and compression therapy. It has been determined that all scar treatment procedures may decrease the severity of the scar but would not result in complete resolution (Durani and Bayat 2008).

3.4. Retro-Septal (Fornix) Technique

In the retro-septal surgical approach, local anaesthesia with vasoconstrictor is injected into the conjunctiva of the lower eyelid. A corneal shield is placed, as tarsorrhaphy sutures cannot be used in this technique. The lower eyelid is everted, and several traction sutures are placed from palpebral conjunctiva to skin. Using the traction sutures or a Demars retractor to evert the lower eyelid, a 15-blade is used to make an incision through the conjunctiva at the arcuate line within the conjunctival fornix (Figure 4). Dissection is carried posterior to the plane of the orbital septum. The incision may extend as medial as the lacrimal sac. At this point, orbital fat and contents extrude into the operative field and is retracted superiorly. With a Demars retractor positioning the lower eyelid forward, an incision is then made through periosteum immediately posterior to the orbital rim. Periosteum is incised with a fine tip electrocautery and a sub-periosteal plane dissection is carried to access the orbital rim, anterior zygoma, and maxilla. Closure of the periosteum is done with an absorbable 4/0 Vicryl ® suture and the conjunctiva is not sutured to prevent irritation to the globe (Ellis and Zide 2006).

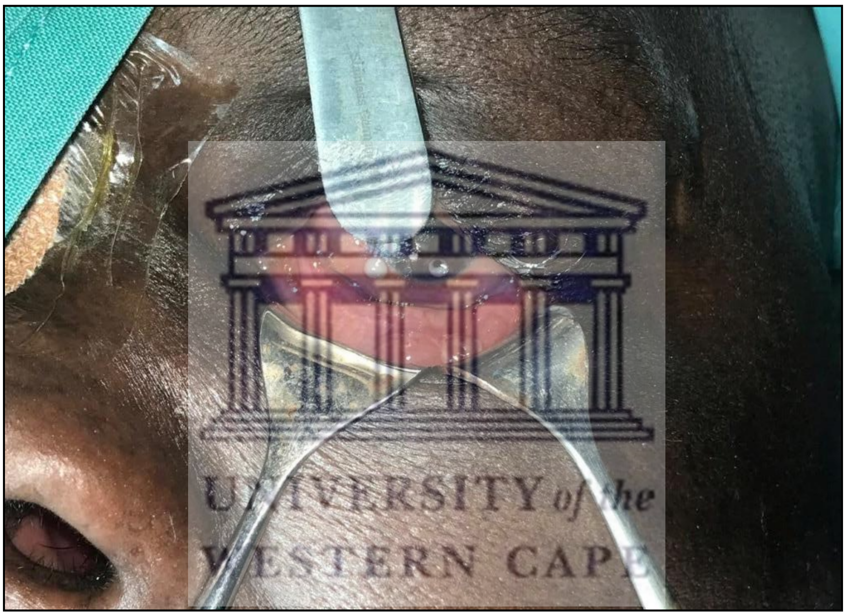

Figure 4: Intra operative transconjunctival approach

3.5. Subtarsal Technique

The subtarsal surgical approach starts by placing a corneal shield or tarsorrhaphy sutures. Marking the skin incision is done along the lower border of the tarsal plate in the subtarsal fold. When oedema precludes the presence of normal skin creases, the surgeon can measure approximately five to seven millimetres from the lower eyelid margin and then follow an inferior lateral vector to a point just past the lateral orbital rim. A local anaesthetic with vasoconstrictor is administered and the incision is then made through skin and preseptal muscle to the orbital septum. The skin muscle flap is elevated by retracting the tarsorrhaphy suture superiorly and a blunt tipped scissors is used to dissect and spread the orbicularis oculi off the orbital septum in an inferior vector to the infraorbital rim. A double skin hook assists with inferior retraction of the lower eyelid skin. Once the anterior edge of the infraorbital rim is visualized, an incision through periosteum is made with a fine tip electrocautery. The periosteum is closed with a 4/0 absorbable Vicryl ® suture and the skin with a 5/0 nylon subcuticular technique (Ellis and Zide 2006; Baqain *et al*. 2008; McInnes *et al.* 2006).

3.6. Subciliary Technique (Stepped Skinned Muscle Technique)

In the subciliary technique, a corneal shield or tarsorrhaphy suture is placed to protect the globe. For the tarsorrhaphy suture, a 5-0 nylon horizontal mattress suture is placed (McInnes *et al.* 2006). The incision is made approximately two millimetres below the eyelashes along the entire length of the eyelid. It may be extended laterally or inferolaterally within a natural skin crease up to two centimetres past the lateral canthus. It is important to note that the anterior temporal branch of the facial nerve crosses the zygomatic arch approximately three centimetres lateral to the lateral canthus. A local anaesthesia with vasoconstrictor is administered after marking the incision. The initial incision is made through skin only caudal to orbicularis oculi. Using the tarsorrhaphy suture to retract the lower eyelid superiorly, subcutaneous dissection just superior to the pretarsal musculus orbicularis oculi toward to the inferior orbital rim is then performed with a pointed scissors to a depth of four to six millimetres (Ellis and Zide 2006). Using a blunted tip scissors, the orbicularis oculi muscle is then dissected in the horizontal direction of its fibres down to the periosteum of the lateral orbital rim. After adequate development of a pocket between orbicularis oculi and the septum orbital, the muscle is incised inferior to the level of the initial skin incision, making sure to leave a cuff of pretarsal orbicularis oculi attached to the tarsal plate. The remaining inferiorly based skin-muscle flap is then retracted inferiorly to where the orbital septum terminates and transitions to orbital periosteum. An incision is then made through periosteum at the zygoma and maxilla at a level three to four millimetres below or lateral to the orbital rim to stay inferior to the orbital septum with a fine tip electrocautery. Sub-periosteal dissection is performed over the maxilla, zygoma, and inside the orbit. Only periosteum and skin is closed with a 4/0 Vicryl ® suture and 5/0 nylon suture (subcuticular) respectively (Ellis and Zide 2006).

3.7. Infra-orbital Technique

The infraorbital incision/technique is advised only to be used when there is an existing skin laceration in the infraorbital area, otherwise it is not a technique of choice (Ellis and Zide 2006).

3.8 Aesthetic outcomes after transconjunctival vs transcutaneous incisions

There are very few studies in the literature that compare aesthetics outcomes of the subtarsal versus transconjunctival approaches. More studies compared the subciliary with the transconjunctival approach.

In 2016, a study by Strobel *et al.* assessed the aesthetic and functional outcome in 45 patients post transconjunctival (n=15) and subtarsal (n=30) approach over a 6-30 month period. Complications were noted and the scar formation was assessed using the modified Vancouver Scar Scale. Photographic images were assessed by experts and non-experts. In the subtarsal approach, discrete scar formation was noted in seven of the 30 cases. However, no statistically significant differences in conspicuous scars and asymmetries were noted between the subtarsal and transconjunctival techniques ($P>.05$).

In a study by Haghighat et al. (2017), the authors conducted research on 51 patients to assess bleeding, surgical access, ectropion and scar formation in subciliary, subtarsal and transconjunctival incisions for the treatment of zygomaticoorbital fractures. They found that bleeding was not significant in any of the approaches, but ectropion was found to be more common in the subciliary group and the scarring more evident (VAS score) in the subtarsal and subciliary groups. They concluded that the transconjunctival approach was the appropriate choice for zygomaticoorbital fractures.

Chapter 3

Aims and Objectives

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1. Aim

The aim of this study was to compare aesthetic outcome of the transcutaneous approach (subtarsal) to that of the transconjunctival approach when treating orbital trauma.

2. Objectives

The objectives of this study were:

1. To compare the aesthetic outcomes between two surgical approaches (subtarsal and transconjunctival) when treating orbital trauma.
2. To assess unwanted clinical outcomes, such as scaring, lid mal-position (ectropion, entropion, scleral show), lid oedema, chemosis, haematoma, ecchymosis, wound de-hiscence, infection and canthal malposition for the two approaches.

Chapter 4

Materials and Methods

1. Study Design

This study was prospective and descriptive study.

2. Sample size/Participants

The study involved 22 patients presenting with orbital injuries and requiring surgical repair. The sample size was based on the number of patients presenting with orbital fractures requiring surgical intervention over a 12 month period. Every month, at least one patient undergoes either transconjunctival or subtarsal incision at the Department of Maxillo-Facial and Oral Surgery unit, Groote Schuur Hospital. All surgical procedures were performed by the primary researcher.

3. Selection Criteria

Inclusion criteria:

1. Patients with orbital injuries where local approaches were indicated.
2. Trauma not older than 14 days.
3. Complete patient records (demographic details; radiographs and imaging).

Exclusion criteria:

1. Previous radiotherapy
2. Skin lacerations or perforations in the surgical region
3. Infection
4. Poor Nutrition (Bulimia Nervosa, Anorexia, Marasmus and kwashiorkor)
5. Immune compromise (e.g. patient with Aids excluding HIV, cancer and chronic steroids use)

6. Uncontrolled diabetes
7. Collagen abnormality
8. Burns
9. Albinism
10. Previous orbital surgery
11. Any other dermatological condition
12. Not willing to be followed up
13. History of keloid formation.

4. Methods of Data Collection

4.1 Aesthetic Outcome

A standardized high quality digital photographic documentation of all 22 patients was performed. Photographs were taken nine month after surgery. Pictures of the 22 patients were taken with an SLR Canon 100 from a producible angle with a grid on the background to ensure similarity and consistency. All photographs were standardised according to lens selection and exposure settings. The aesthetic outcomes of the incisions/approaches were obtained through the Q-sorting method. Q sort or Q-methodology (also known as Q-sort) is the systematic study of participant viewpoints. Q-methodology is used to investigate the perspectives of participants who represent different stances on an issue, by having participants rank and sort a series of statements. Ten experts or judges (five senior registrars in Maxillofacial and five in Plastic surgery) were presented with 22 pictures of the patients nine months post-operatively. They were informed about the unilateral orbital surgery performed on all the patients. The experts were instructed to rank-order 22 photographs from high to low on levels of aesthetics. Three crucial characteristics of aesthetic experience are: fascination with an aesthetic object (high arousal and attention), appraisal of the symbolic reality of an object (high cognitive engagement), and a strong feeling of unity with the object of aesthetic fascination and aesthetic appraisal (Marcovic 2012). All pictures were marked on the back: X1 to X11 for transconjunctival approach, and Z1 to Z11 for the subtarsal incision. Pairwise comparisons methods were used to analyze the multiple population means in pairs to determine whether they are significantly different from one another.

The Kendall's Coefficient of Concordance (W) test was used to determine the level of agreement amongst the experts. Multidimensional scaling (Prefscal) was used to analyse how the pictures and experts related or mapped mutually.

4.2 Clinical outcome

The assessment comprised of a standardised examination form with a yes or no indicating present or absent of the associated complication. The analysis was methodologically designed to target the specific variables, which were scleral show, ectropion, entropion, haematoma, ecchymosis, chemosis, lid oedema, wound dehiscence, and infection. In addition, the visual outcome of the subtarsal scar was evaluated using the modified version of the Vancouver scar scale (mVSS) (Idriss and Maibach 2009). (Data was collected at 24 hours, 7 days, 21 days, three months and six months.)

- Scleral show, entropion, and ectropion were assessed by performing a snap test (distraction test).

- Canthal malposition was assessed using the snap test, as well as the bow string test to assess the position of both the medial and lateral canthi position, which could be damaged when using the trans-caruncular and/or lateral canthotomy incisions during the transconjunctival incisions.

- Post-operative scar formation was assessed separately using the VSS assessment form (see appendix IIIA) whereby the severity of the scar was determined by assessing vascularity, height, pliability and pigmentation of the scar. It was then further classified according to the modified Vancouver scar scale (appendix IIIB), whereby if scar scores zero, was interpreted as no scar formation, one-four mild scar formation, five-seven moderate scar formation and eight-ten severe scar formation.
- Haematoma and ecchymosis were assessed clinically and documented as present or not present.

- Lid oedema and chemosis were assessed clinically and documented as present or not present after excluding any systemic causes.

- Wound dehiscence was assessed clinically and documented as present or not present.

- Wound infection was assessed clinically and documented (present or not present) if there were pus and/or cellulitis present.

The nominal occurrence or presence of complications in the clinical outcome of both procedures was presented as frequencies over five intervals. Fisher's Exact Test was used to test the difference between both procedures on the incidence of complications where applicable.

5. Ethical Considerations

The study proposal was presented to the Faculty of Dentistry's Research Committee at the University of the Western Cape and was approved by the Biomedical Research Ethics Committee (approval number: BM/16/5/14), University of the Western Cape (Appendix IV).

Permission from the patients were obtained via informed consent (Appendix VI). The research purpose and objectives of the study were explained to each patient by using an information sheet (Appendix V). Confidentiality was maintained and participants had the right to withdraw from the study at any time without deprivation of their rights and future treatment. Procedures for confidentiality of data were adopted. All data collection forms were stored securely and will be shredded after five years. Electronic data were stored on password-protected computer. Serial numbers were used instead of names for data interpretation and analysis.

Chapter 5

Results

5.1 Demographic

The study involved 22 patients that presented with orbital injuries requiring surgical repair (Table 1). Eleven patients underwent the transconjunctival (retroseptal) incision. Ten of which had pure blowout fractures and one had a zygomatic complex fracture. Of the 11, seven were black Africans, two were Caucasians and two mixed race. There were four males and seven females in the transconjunctival incision group. The remainder of the 22 underwent the transcutaneous (subtarsal) incision. Six of the 11 were black Africans and five mixed race. There were nine males and two females in the tranconjunctival group. In this group, two patients had pure blowout fractures and nine had zygomatic complex fractures.

Table 1: Cross tabulation: Patient demographics and age distribution

Procedure	Gender	Ethnicity	10-19	20-29	30-39	40-49	50-59	N
Transconjunctival	F	Bl Af	0	2	1	1	1	11
		Cau	0	0	0	2	0	
		M R	0	0	0	0	0	
	M	Bl Af	0	1	1	0	0	
		Cau	0	0	0	0	0	
		M R	1	0	1	0	0	
Subtarsal	F	Bl Af	0	0	2	0	0	11
		Cau	0	0	0	0	0	
		M R	0	0	0	0	0	
	M	Bl Af	0	2	1	0	0	
		Cau	0	0	0	0	0	
		M R	0	0	5	1	0	

5.2 Aesthetic outcome of the surgical approaches

Overall, the level of agreement between the experts (raters) was high (Kendall's coefficient of concordance, W = 0.942 and significant). The null-hypothesis that the rankorders were independent was rejected as the p-value was less than the significance level 0.01 (Chi-square $_{(df=21)}$ = 197.76).

Figure 5 presents the frequency of occurrence of the rankorders per picture. For example, picture X1 was given *rankorder 5,* four times, three times *rankorder 3*, twice *rankorder 4* and once *rankorder 2.* Picture Z3 was given *rankorder 19* once, *rankorder 21* five times, and *rankorder 22* four times. It is important to note that some pictures were ranked almost in the same order. This depicted that there was good similarity in findings of the experts who did the assessment of the aesthetic outcomes.

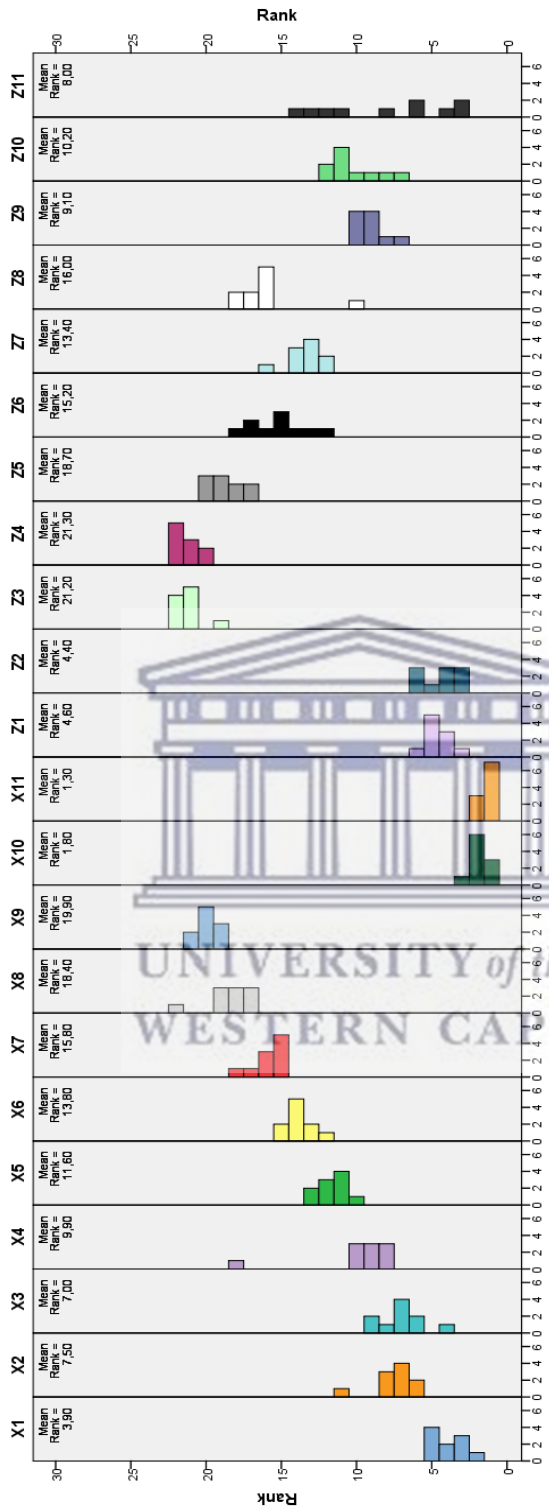

Figure 5: Frequency of occurrence of the rankorder per pictures

The PREFSCAL analysis provides insight in the clustering of the pictures based on their rankorder. For example, one would expect a cluster X (transconjunctival) and a cluster of Z (subtarsal) pictures relatively at far distance of each other if, the pictures of patients with transconjunctival approach were ranked consistently as aesthetically poorer than those that had transcutaneous (subtarsal) approach.

The pictures, based on their rankorder, were projected in a two-dimensional space with a fit that accounted for 99% (stress 0.00075) of the total variance. Figure 6 shows three evident clusters: one in the left bottom quadrant and two clusters in the right bottom quadrant of the two-dimensional space. The remaining pictures are scattered. It also shows what pictures are rated alike: the shorter the distance the more identical the pictures are ranked.

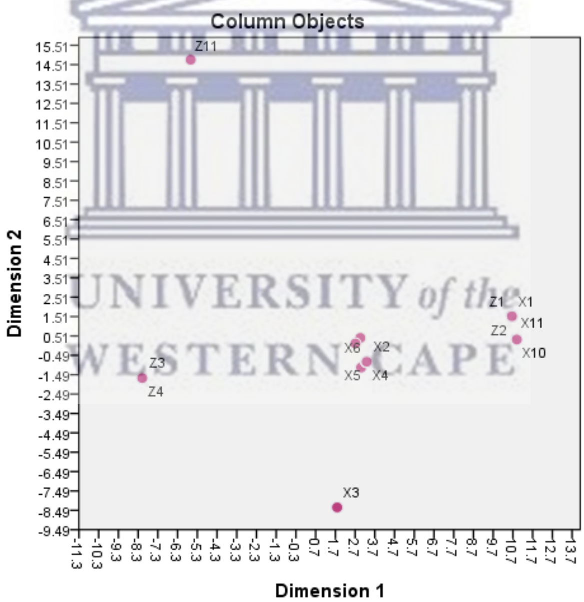

Figure 6: Two-dimensional solution of the pictures

The chart above only shows 14 of the 22 pictures. This is due to the scaling of the graph. Pictures with almost equal coordinates are located so near that they overlap and are hidden in the graph. Table 2 presents the coordinates of each picture per dimension and allow to identify the locations of the hidden pictures.

Table 2: Picture coordinates

Pictures	Dimension	
	1	2
X1	10.659	1.504
X2	3.325	-.784
X3	1.793	-8.335
X4	3.304	-.803
X5	3.287	-.824
X6	3.283	-.825
X7	3.281	-.826
X8	2.968	.411
X9	2.718	.118
X10	10.894	.336
X11	10.901	.325
Z1	10.642	1.559
Z2	10.649	1.528
Z3	-8.091	-1.661
Z4	-8.092	-1.663
Z5	3.005	-1.120
Z6	3.272	-.833
Z7	3.283	-.825
Z8	3.278	-.832
Z9	3.307	-.801
Z10	3.290	-.823
Z11	-5.640	14.762

The pictures that cluster more or less in the centre (0,0) of the two-dimensional space are X2, X4, X5, X6, X7, X8, X9, Z5, Z6, Z7, Z8, Z9, Z10. This indicates that these 13 pictures have specific aspects in common that relate to aesthetics and are different from the cluster on the right side and Z3 and Z4 on the left side. Likewise, pictures X3 and Z11 must have such different aspects that they have little in common with the clustered pictures.

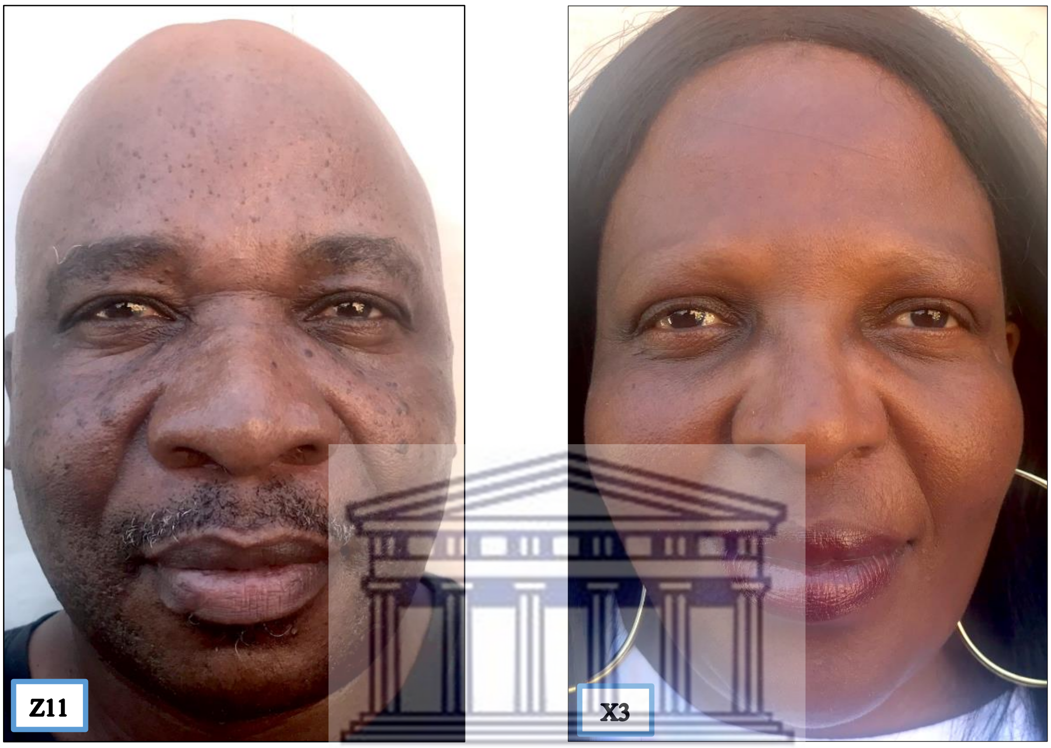

Figure 7: Z11 and X3

Although not exclusive, the second dimension is dominated by pictures Z11, and X3. To explore the effects on the location of the remaining pictures, a second PREFSCAL was conducted with both Z11 and X3 removed. This slightly increased the fit and revealed more clusters (Figure 8).

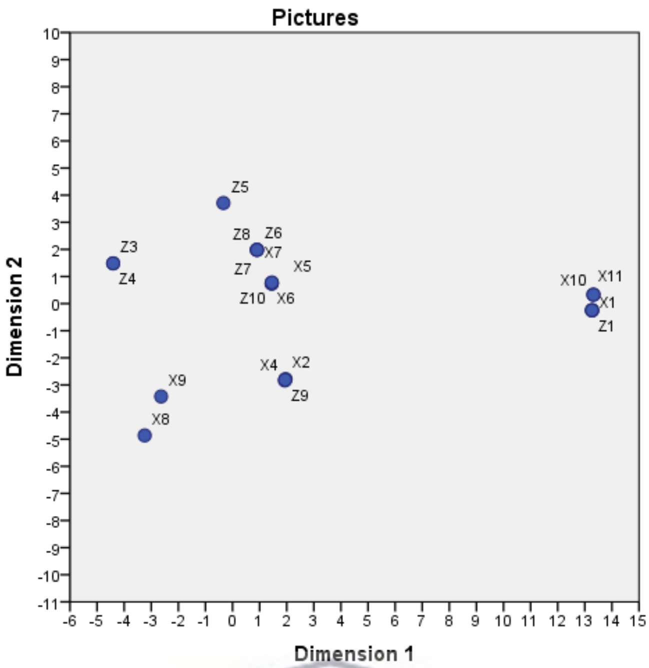

Figure 8: Two-dimensional mapping of the pictures

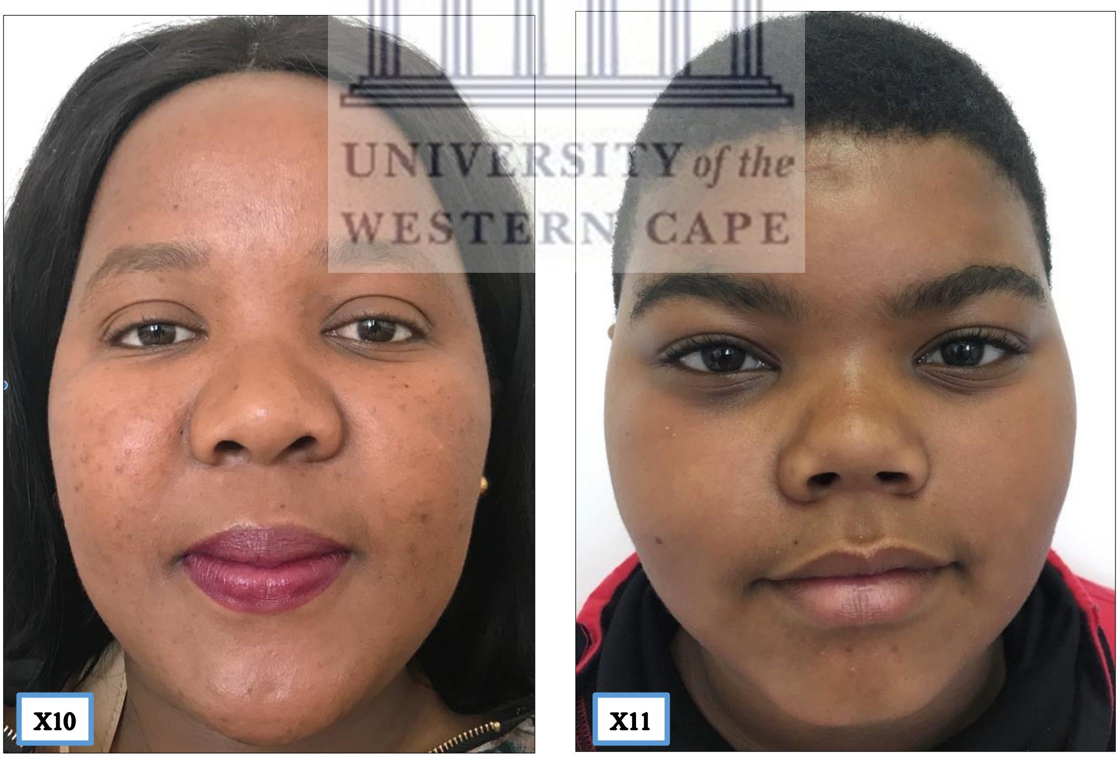

Figure 9: X10 and X11

Figure 10: X1 and Z1

To identify the hidden (Z) pictures, the picture coordinates are presented in Table 3.

Table 3: Pictures after removing Z11 & X3

Pictures	Dimension	
	1	2
X1	13.267	-.246
X2	1.957	-2.783
X4	1.928	-2.837
X5	1.448	.750
X6	1.447	.743
X7	.901	1.983
X8	-3.244	-4.863
X9	-2.637	-3.423
X10	13.316	.330

X11	13.316	.329
Z1	13.267	-.245
Z2	13.267	-.245
Z3	-4.406	1.483
Z4	-4.406	1.484
Z5	-.336	3.710
Z6	.901	1.985
Z7	1.447	.743
Z8	.901	1.982
Z9	1.942	-2.811
Z10	1.451	.780

Pictures Z1 and X1 (Figure 10) have almost equal coordinates and cluster with X10, X11 (Figure 9). Pictures Z7, X6, X5 and Z10 have almost equal coordinates and cluster rather close to the cluster of Z8, Z6 and X7. Pictures Z3 and Z4 have equal coordinates. Pictures Z5, X8 and X9 suggest having unique characteristics or little in common.

It is clear that the aesthetics of the pictures is judged (ordered) by two underlying factors. It is not evident that these are based on the surgical procedures.

Comparing these communalities within and between the clusters show that pictures with more similar aesthetics and no signs of post-operative complications were clustered closer to each other, while pictures that presented with some sort of complication, though not so pronounced, were at a far distance from the rest. For example in case of Z5 it was noted that patient initially presented with strabismus and formed a mild scar, X8 chronic lid oedema and X9 with entropion and increased scleral show as shown in Figure 11 below.

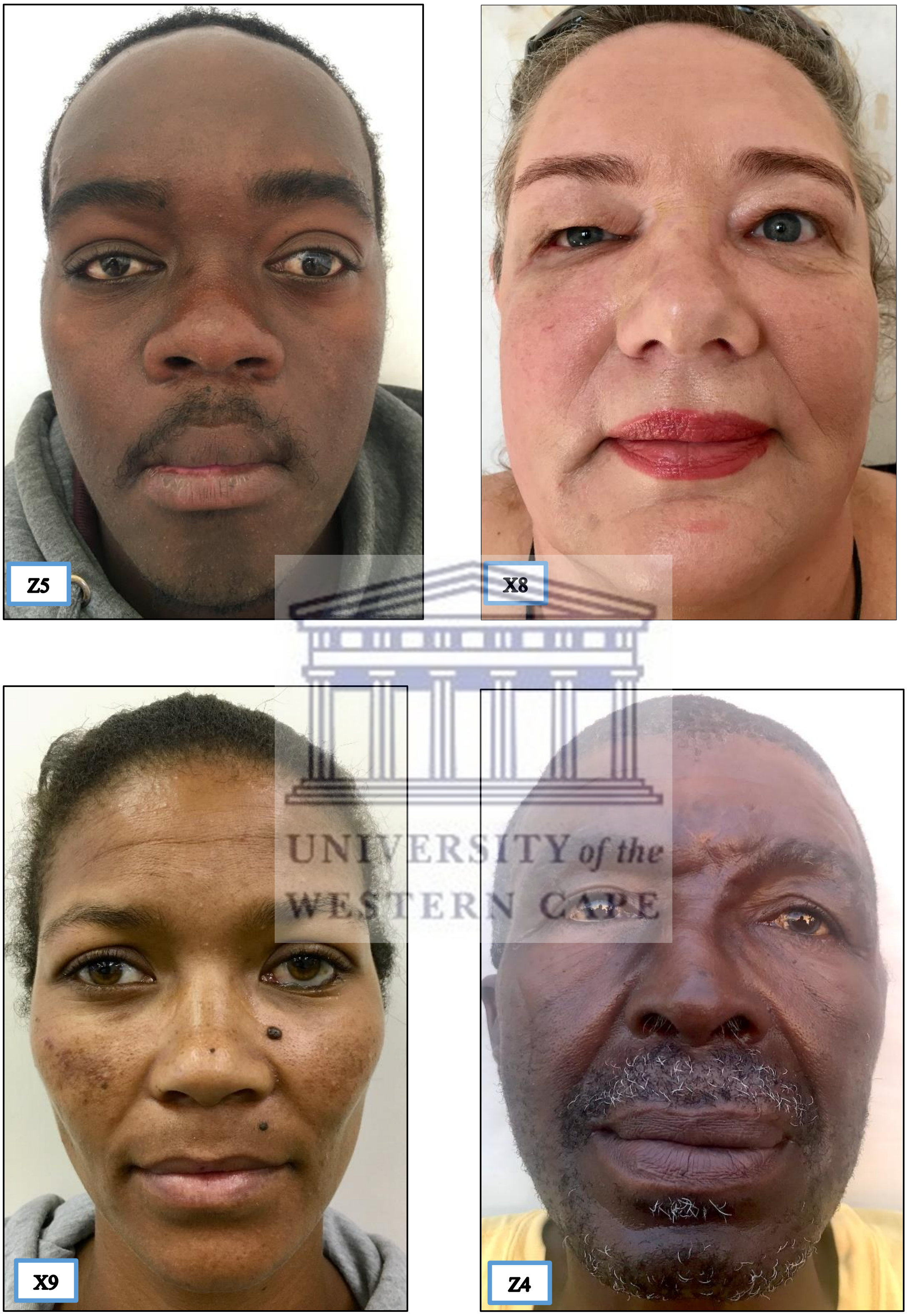

Figure 10: Z5, X8, X9, Z4

Equal to the mapping of the pictures in a dimensional space, PREFSCAL provides insight in the interrelationships of the experts. If characteristics, such as experience, are at stake, the experts would group less homogeneous. Figure 12 shows that Expert 1 deviates strongly from the other experts. He or she is largely responsible in its contribution to define Dimension 2. Also, experts 3 and 4 deviate from the main experts.

The discrepancy could have been caused by different factors such as raters bias, raters emotional state/reaction, and their visual perception, remembering that all pictures were rated according to the most symmetrically pleasing appearance post-operation. This implies that the raters might not have known which side of the eye underwent the surgical incision.

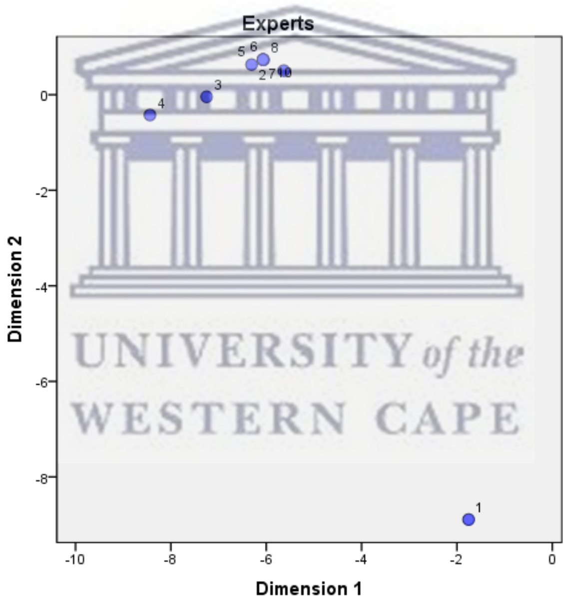

Figure 12: Two-dimensional representation of the raters

Despite the discrepancy between some raters, a closer look at figure 12 shows that most experts have a higher level of agreeability, hence they cluster closer to each other. This can be validated by observing the rankorder frequency in figure 5. For example, picture X11 was given a rankorder 1 seven times and rankorder 2 three times, while picture Z4 was given a rankorder of 22 five times. It can be noted that the experts' rating and perceptions did not deviate much from each other. However, in few cases, the raters' level of disagreement was rather high. To illustrate, expert no. 10 gave picture Z11 a rankorder of 3, whilst expert no. 3 rated it 11; picture X3 was given a rankorder of 4 by one expert, and rankorder of 8 by another.

Table 4 displays the coordinates used to plot the raters representation graph (figure 12). Raters 9 and 10, proved to have the closest coordinates, hence they overlap in the figure above. This shows that both experts had high levels of concordance in most pictures.

Table 4: Raters coordinates

Experts		
	Dimension	
	1	2
1	-7.253	-2.326
2	-6.411	1.732
3	-7.040	-2.214
4	-6.711	-2.123
5	-6.489	-2.036
6	-6.195	1.601
7	-6.378	1.314
8	-6.414	1.733
9	-6.413	1.733
10	-6.418	1.735

5.3 Complications after six months (180 days): subtarsal vs transconjuctival approach.

Returning to the representativeness of the patients (pictures) used in the Q-sorting procedure and particularly the different surgical procedures through the assessments of a set of complications. Table 5 compares the complications seen at six months (180 days) between the subtarsal and transconjunctival approaches.

The complication 'SCAR' is added to table for completeness but is irrelevant to test since, typically, the transconjunctival approach does not cause external scar. The only significant factor was the scar formation seen with the subtarsal approach. Of importance was the mVSS for all the cases were rated as mild at 180 days (six months).

Table 5: Subtarsal vs. transconjunctival (TCA) approach complication occurrences at six months

			Procedure	
			Subtarsal	TCA
SCLERA SHOW	1*	Count*	4	2
	2	Count	7	9
ECTROPION	1	Count	1	1
	2	Count	10	10
ENTROPION	1	Count	0	1
	2	Count	11	8
HAEMATOMA	2	Count	11	10
CHEMOSIS	2	Count	11	11
LID OEDEMA	2	Count	11	11
WOUND DE-HINSCE	2	Count	11	11
INFECTION	2	Count	11	11
CANTHAL MAL-POSITION	1	Count	0	1
	2	Count	11	10
ECCHYMOSIS	2	Count	11	11
SCAR	1	Count	7	0
	2	Count	4	11

* Presence=1; Absence=2

Table 6 presents the complication that occurred for the subtarsal approach over time. The data shows that six out of the remaining 10 complications were absent after six months. The difference between the procedures of the four complications that were present, were tested with the Fisher's Exact Test. None were significant P>.05.

Table 6: The occurrence of complications in the subtarsal approach (N=11)

			Day				
			1	7	21	90	180
SCLERA SHOW	1*	Count	0	3	4	4	4
	2	Count	11	8	7	7	7
ECTROPION	1	Count	0	1	1	1	1
	2	Count	11	10	10	10	10
ENTROPION	2	Count	11	11	11	11	11
HAEMATOMA	2	Count	11	11	11	11	11
CHEMOSIS	2	Count	11	11	11	11	11
LID OEDEMA	1	Count	10	6	1	0	0
	2	Count	1	5	10	11	11
WOUND DEHINSCE	2	Count	11	11	11	11	11
INFECT	2	Count	11	11	11	11	11
CANTH	2	Count	11	11	11	11	11
ECCHY	1	Count	5	3	0	0	0
	2	Count	6	8	11	11	11
SCAR	1	Count	11	11	11	7	7
	2	Count	0	0	0	4	4

* Presence=1; Absence=2

Table 7 is a representation of the complications that occurred over time in the transconjunctival approach. The table shows that the complications ectropion, haematoma, wound dehiscence, infection and malposition of canthal had negligible occurrences with the transconjunctival incision. However, lid oedema, chemosis and to a lesser extent scleral did occur more frequently.

Table 7: The occurrence of complications in the transconjunctival approach (N=11)

			Days				
			1	7	21	90	180
SCLERA SHOW	1*	Count	1	1	2	2	2
	2	Count	10	10	9	9	9
ECTROPION	1	Count	0	1	1	1	1
	2	Count	11	10	10	10	10
ENTROPION	1	Count	1	1	1	1	1
	2	Count	10	10	10	9	8
HAEMATOMA	2	Count	11	11	11	10	10
CHEMOSIS	1	Count	9	2	1	0	0
	2	Count	2	9	10	11	11
LID OEDEMA	1	Count	11	6	3	1	0
	2	Count	0	5	8	10	11
WOUND DE-HINSCE	2	Count	11	11	11	11	11
INFECTION	2	Count	11	11	11	11	11
CANTHAL MALPOSITION	1	Count	1	1	1	1	1
	2	Count	10	10	10	10	10
ECCHYMOSIS	1	Count	5	4	1	0	0
	2	Count	6	7	10	11	11
SCAR	1	Count	1	1	1	0	0
	2	Count	10	10	10	11	11

* Presence=1; Absence=2

Chapter 6

Discussion

Surgical access to the orbital area has its own challenges, as it is performed in one of the most prominent cosmetic areas of the face. The orbital area characteristically has the thinnest skin on the face, so any minor complication may result in prominent aesthetic and functional concerns. As the subtarsal incision is often associated with scaring, the transconjunctival approach is generally favoured. However, the latter has its own complications.

In terms of the aesthetic outcome, the findings of this study showed that the transconjunctival approach and the subtarsal were ranked the same by the experts. It was found that there was no significant difference between the two approaches. It is important to note that there was a level of agreement by the experts which gives the findings of the current study validity. Strobel *et al.* (2016) compared the long-term aesthetic outcomes of the subtarsal with the transconjunctival approach. The researchers also found that the subtarsal approach compared favourably with the transconjunctival approach in regard to long-term aesthetics.

Haghighat *et al.* (2017) compared scar formation in the subciliary, subtarsal and transconjuctival approaches by using a 10-unit visual analogue scale (VAS). They found that the VAS scores were 3.7 for the subciliary, 4.0 for the subtarsal and 0.0 for the transconjunctival groups. In studies by Baqain *et al.* (2008) and Ridgway *et al.* (2009), the researchers found unfavourable scars in 8.3% and 1.4% respectively when using the subtarsal approach. In the current study, scars were visible in the subtarsal group after six months in seven out of the 11 cases (63.6%), but all the scars were rated mild on the mVSS.

According to literature, the main advantage of the transconjunctival retro-septal incision is that it has excellent aesthetic results, as the scar is hidden behind the conjunctiva

(Sudhir *et al.* 2018). If a canthotomy is performed with the incision, the only visible scar is seen at the lateral extension, which, most often heals with an inconspicuous scar. No scars were noted with this procedure in the current study. Another advantage is that these techniques are rapid, and no skin or muscle dissection necessary. The only challenge with this approach is the limitation of medial extension of the incision by the lacrimal drainage system (Sudhir *et al.* 2018). In the current study, no injury to the lacrimal drainage system was reported.

In the present study, scleral show (Figure 13) was noted after six months in four of the 11 cases with the subtarsal approach and in two of the 11 cases with the transconjunctival approach. In studies by Rohrich *et al*. (2002) and De Melo *et al*. (2009) they found that scleral show and scar formation were more associated with the subtarsal incision. In studies that compared different cutaneous incisions involving scleral show, it was found that scleral show was higher in the subciliary approach that the subtarsal approach (Appling *et al.* 1993).

Figure 13: Scleral show.

Other complications noted in the current study were minimal. Only one case of ectropion was seen with both approaches and only one case of entropion was noted in the transconjunctival group. This compares well with Stobel *et al*. (2016) where it was found that comparable complications were found with both the subtarsal and transconjunctival approaches.

Wilson and Ellis (2006) summarised their paper that compared surgical approaches to the infraorbital rim and floor by stating that oral and maxillofacial surgeons are more likely to manage complications from the subtarsal approach such as scleral show, ectropion and scars than they might mange complications from the tranconjunctival approach such as lid malposition, entropion, scleral show, ectropion and conjunctival granulomas. In more resent papers the transconjuctival approach is favoured (Al-Moraissi *et al.* 2017; Haghighat *et al*. 2017).

Chapter 7

Limitations

Every researcher experiences some form of limitation. All limitations encountered by the author are explained below.

- Time Constraint

All patients were only followed up for a period of six months as the study was conducted for a limited period from January 2018 to March 2019. The study could have been improved had more time been allocated to this research project.

- Patient follow-up

Long-term patient follow-up was found to be a problem. The latter could be due to socio-economic factors.

- Patient numbers

The study was limited to 22 patients. A larger sample would have given the study more validity.

Chapter 8

Conclusion

This study had two main objectives. Firstly, to compare the aesthetic outcomes between two surgical approaches in the treatment of orbital and periorbital fractures. Secondly, to assess which of the two has the lowest unwanted clinical outcomes such as scar formation and lid malposition. The two approaches included in this study were the transconjunctival and subtarsal incisions.

Both approaches demonstrated good aesthetic results. The transconjunctival incision was associated with scleral show and entropion, while the subtarsal incision was more associated with scar formation. However, when performed meticulously, both incisions can provide aesthetically pleasing results. The transconjunctival and subtarsal approaches should not be seen as competing, but should be applied in a case specific manner.

References

Al-Moraissi, E., Elsharkawy, A., Al-Tairi, N., Farhan, A., Abotaleb, B., Alsharaee, Y., Oginni, F.O., Al-zabidi, A., 2018. What surgical approach has the lowest risk of the lower lid complications in the treatment of orbital floor and periorbital fractures? A frequentist network meta-analysis. Journal of Cranio-Maxillofacial Surgery, 46(12), pp.2164-2175.

Al-Moraissi, E.A., Thaller, S.R., Ellis, E., 2017. Subciliary vs. transconjunctival approach for the management of orbital floor and periorbital fractures: A systematic review and meta-analysis. Journal of Cranio-Maxillofacial Surgery, 45(10), pp.1647-1654.

Appling, W.D., Patrinely, J.R., Salzer, T.A., 1993. Transconjunctival approach vs subciliary skin-muscle flap approach for orbital fracture repair. Archives of Otolaryngology--Head and Neck surgery, 119(9), pp.1000–1007.

Baqain, Z.H., Malkawi, Z., Hadidi, A., Rajab, L.D., 2008. Subtarsal approach for orbital floor repair: a long-term follow-up of 12 cases in a Jordanian teaching hospital. Journal of Oral and Maxillofacial Surgery, 66(1), pp.45-50.

Clinton, D.H., Kriet, J.D., 2008. Surgical approaches to orbit. Peri-operative techniques in Otolaryngology, 19,132-139

De Melo Crosara, J., Da Rosa, E.L.S., E Silva, M.R.M.A., 2009. Comparison of cutaneous incisions to approach the infraorbital rim and orbital floor. Brazilian Journal of Oral Sciences, 8(2), pp.88-91.

De Riu, G., Meloni, S.M., Gobbi, R., Soma, D., Baj, A., Tullio, A., 2008. Subciliary versus swinging eyelid approach to the orbital floor. Journal of Cranio-Maxillofacial Surgery, 36(8), pp.439–442.

Durani, P., Bayat, A., 2008. Levels of evidence for the treatment of keloid disease. Journal of Plastic, Reconstructive and Aesthetic surgery, 61(1), pp.4-17.

Durani, P., McGrouther, D.A., Ferguson, M.W.J., 2009. Current scales for assessing human scarring: a review. Journal of Plastic Reconstructive and Aesthetic Surgery, 62(6), pp.713-720.

Ellis, E., Zide, M.F. eds., 2006. Surgical approaches to the facial skeleton. Lippincott Williams & Wilkins.

Fearmonti, R., Bond, J., Erdmann, D., Levinson, H., 2010. A review of scar scales and scar measuring devices. Eplasty, Jun:10e43.

Fonseca, R.J., Marciani, R.D., Turvey, T.A., 2009. Oral and Maxillofacial Surgery (Vol. 2, pp 202-255). i9781416066576. © Saunders Elsevier.

Furtado, F., Hochman, B., Ferreira, L.M., 2012. Evaluating keloid recurrence after surgical excision with prospective longitudinal scar assessment scales. Journal of Plastic, Reconstructive and Aesthetic Surgery, 65(7), pp. e175-e181.

Hardy, M.A., 1989. The biology of scar formation. Physical Therapy, 69(12), pp.1014-1024.

Haghighat, A., Moaddabi, A., Soltani, P., 2017. Comparison of subciliary, subtasal and tranconjunctival approaches for management of zygomaticoorbital fractures. British Journal of Medicine and Medical Research, 20(4), pp.1-9.

Langsdon, P.R., Rohman, G.T., Hixson, R., Stumpe, M.R., Metzinger, S.E., 2010. Upper lid transconjunctival versus transcutaneous approach for fracture repair of the lateral orbital rim. Annals of Plastic Surgery, 65(1), pp.52-55.

Lee, E.I., Mohan, K., Koshy, J.C., Hollier, L.H., 2010, November. Optimizing the surgical management of zygomaticomaxillary complex fractures. In Seminars in plastic surgery (Vol. 24, No. 04, pp. 389-397). © Thieme Medical Publishers.

Lewis, C.D., Perry, J.D., 2009. Transconjunctival lateral cantholysis for closure of full-thickness eyelid defects. Ophthalmic Plastic and Reconstructive Surgery, 25(6), pp.469-471.

Lim, N.K., Kang, D.H., Oh, S.A., Gu, J.H., 2014. Orbital wall restoring surgery in pure blowout fractures. Archives of Plastic Surgery, 41(6), p.686.

Lorenz, P., Bari, A.S., 2012. Scar prevention, treatment, and revision. Plastic Surgery. 3rd ed. London: Elsevier Saunders, pp.297-318.

Marcovic, S., 2012. Components of aesthetic experience: aesthetic fascination, aesthetic appraisal, and aesthetic emotion. Iperception, 3(1), pp.1–17.

Markowitz, B.L., Manson, P.N., Sargent, L., Vander, C.K., Yaremchuk, M., Glassman, D., Crawley, W.A., 1991. Management of the medial canthal tendon in nasoethmoid orbital fractures: the importance of the central fragment in classification and treatment. Plastic and Reconstructive surgery, 87(5), pp.843-853.

Master, D.L., Hanson, P.R., Gosain, A.K., 2010. Complications of mandibular distraction osteogenesis. Journal of Craniofacial Surgery, 21(5), pp.1565-1570.

McInnes, A.W., Burroughs, J.R., Anderson, R.L., McCann, J.D., 2006. Temporary suture tarsorrhaphy. American Journal of Ophthalmology, 142(2), pp.344-346.

Mohamed, F.I., 2020. Subciliary Versus Subtarsal Approach for the Management of Infraorbital Rim and Orbital Floor Fractures. An Anthropometric Analysis. Egyptian Dental Journal, 66(2-April (Oral Surgery), pp.931-942.

Niessen, F.B., Spauwen, P.H., Schalkwijk, J., Kon, M., 1999. On the nature of hypertrophic scars and keloids: a review. Plastic and Reconstructive Surgery, 104(5), pp.1435-1458.

Novelli, G., Ferrari, L., Sozzi, D., Mazzoleni, F., Bozzetti, A., 2011. Transconjunctival approach in orbital traumatology: a review of 56 cases. Journal of Cranio-Maxillofacial Surgery, 39(4), pp.266-270.

Palmieri, C.F., Ghali, G.E., 2012. Late correction of orbital deformities. Oral and Maxillofacial Surgery Clinics, 24(4), pp.649-663.

Ridgway, E.B., Chen, C., Colakoglu, S., Gautam, S., Lee, B.T., 2009. The incidence of lower eyelid malposition after facial fracture repair: A retrospective study and meta-analysis comparing subtarsal, subciliary, and tranconjunctival incisions. Plast Reconstr Surg, 124(5), pp.1578-86.

Ridgway, E.B., Chen, C., Lee, B.T., 2009. Acquired entropion associated with the transconjunctival incision for facial fracture management. Journal of Craniofacial Surgery, 20(5), pp.1412-1415.

Rohrich, R.J., Janis, J.E., Adams, W.P., 2003. Subciliary versus subtarsal approaches to orbitozygomatic fractures. Plastic and Reconstructive surgery, 111(5), pp.1708-1714.

Santosh, B.S., Giraddi, G., 2011. Transconjunctival preseptal approach for orbital floor and infraorbital rim fracture. Journal of Maxillofacial and Oral surgery, 10(4), pp.301-305.

Schmäl, F., Basel, T., Grenzebach, U.H., Thiede, O., Stoll, W., 2006. Preseptal transconjunctival approach for orbital floor fracture repair: ophthalmologic results in 209 patients. Acta Otolaryngologica, 126(4), pp.381-389.

Smith, O.J., McGrouther, D.A., 2014. The natural history and spontaneous resolution of keloid scars. Journal of Plastic, Reconstructive and Aesthetic Surgery, 67(1), pp.87-92.

Son, D., Harijan, A. 2014. Overview of Surgical Scar Prevention and Management. J Korean Med Sci, 29:751–757.

Strobel, L., Hölzle, F., Riediger, D., Hilgers, R.D., Modabber, A., Gerressen, M., 2016. Subtarsal versus Transconjunctival Approach—Esthetic and Functional Long-Term Experience. J Oral Maxillofac Surg, 74(11), pp.2230-2238.

Sudhir, M. V. S., Rajasekhar, G., Reddy, E. S., Jesudass, G., Laxmi, C. S., Babu, P. C., 2018. Versatility of Transconjunctival Approach in Maxillofacial Trauma-A Prospective Study and Review of Literature. Journal of Clinical & Diagnostic Research, 12(8), pp.16-18.

Tee, B.C., Sun, Z., 2015. Mandibular distraction osteogenesis assisted by cell- based tissue engineering: a systematic review. Orthodontics & Craniofacial Research, 18, pp.39-49.

Tessier, P., 1973. The conjunctival approach to the orbital floor and maxilla in congenital malformation and trauma. J. Maxillofac. Surg, 1, pp.3-8.

Werther, J.R., 1998. Cutaneous approaches to the lower lid and orbit. J Oral Maxillofac Surg, 56(1), pp.60-65.

Wilson, S., Ellis III, E., 2006. Surgical approaches to the infraorbital rim and orbital floor: the case for the subtarsal approach. J Oral Maxillofac Surg, 64, pp. 104-107.

Zingg, M., Laedrach, K., Chen, J., Chowdhury, K., Vuillemin, T., Sutter, F., Raveh, J., 1992. Classification and treatment of zygomatic fractures: a review of 1,025 cases. J Oral Maxillofac Surg, 50(8), pp.778-790.

Appendix I: Data Collection Sheet

Clinical assessment form. Rated as Yes =1 /No=2

Clinical outcome	Mark X 24hrs	Mark X 7days	Mark X 21days	Mark X 84days	Mark X 168days
SCLERAL SHOW					
Yes					
No					
ECTROPION					
Yes					
No					
ENTROPION					
Yes					
No					
CANTHAL MAL-POSITION					
Yes					
no					
HAEMATOMA					
Yes					
No					
ECCHYMOSIS					
Yes					
no					
CHEMOSIS					
Yes					

No					
LID EDEMA					
Yes					
No					
WOUND DEHISCENCE					
Yes					
No					
INFECTION					
Yes					
No					

Appendix IIA: Pairwise Comparison of the Pictures

Pairwise Comparisons					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
X11-X10	.500	2.904	.172	.863	1.000
X11-X1	2.600	2.904	.895	.371	1.000
X11-Z2	-3.100	2.904	-1.067	.286	1.000
X11-Z1	-3.300	2.904	-1.136	.256	1.000
X11-X3	5.700	2.904	1.963	.050	1.000
X11-X2	6.200	2.904	2.135	.033	1.000
X11-Z11	-6.700	2.904	-2.307	.021	1.000
X11-Z9	-7.800	2.904	-2.686	.007	1.000
X11-X4	8.600	2.904	2.961	.003	.707
X11-Z10	-8.900	2.904	-3.065	.002	.503
X11-X5	10.300	2.904	3.547	.000	.090
X11-Z7	-12.100	2.904	-4.167	.000	.007
X11-X6	12.500	2.904	4.304	.000	.004
X11-Z6	-13.900	2.904	-4.786	.000	.000
X11-X7	14.500	2.904	4.993	.000	.000
X11-Z8	-14.700	2.904	-5.062	.000	.000
X11-X8	17.100	2.904	5.888	.000	.000
X11-Z5	-17.400	2.904	-5.992	.000	.000
X11-X9	18.600	2.904	6.405	.000	.000
X11-Z3	-19.900	2.904	-6.853	.000	.000
X11-Z4	-20.000	2.904	-6.887	.000	.000
X10-X1	2.100	2.904	.723	.470	1.000
X10-Z2	-2.600	2.904	-.895	.371	1.000
X10-Z1	-2.800	2.904	-.964	.335	1.000
X10-X3	5.200	2.904	1.791	.073	1.000
X10-X2	5.700	2.904	1.963	.050	1.000
X10-Z11	-6.200	2.904	-2.135	.033	1.000
X10-Z9	-7.300	2.904	-2.514	.012	1.000
X10-X4	8.100	2.904	2.789	.005	1.000
X10-Z10	-8.400	2.904	-2.893	.004	.883
X10-X5	9.800	2.904	3.375	.001	.171
X10-Z7	-11.600	2.904	-3.994	.000	.015
X10-X6	12.000	2.904	4.132	.000	.008
X10-Z6	-13.400	2.904	-4.614	.000	.001
X10-X7	14.000	2.904	4.821	.000	.000
X10-Z8	-14.200	2.904	-4.890	.000	.000

Appendix IIB: Pairwise Comparison of the Pictures

X10-X8	16.600	2.904	5.716	.000	.000
X10-Z5	-16.900	2.904	-5.820	.000	.000
X10-X9	18.100	2.904	6.233	.000	.000
X10-Z3	-19.400	2.904	-6.680	.000	.000
X10-Z4	-19.500	2.904	-6.715	.000	.000
X1-Z2	-.500	2.904	-.172	.863	1.000
X1-Z1	-.700	2.904	-.241	.810	1.000
X1-X3	-3.100	2.904	-1.067	.286	1.000
X1-X2	-3.600	2.904	-1.240	.215	1.000
X1-Z11	-4.100	2.904	-1.412	.158	1.000
X1-Z9	-5.200	2.904	-1.791	.073	1.000
X1-X4	-6.000	2.904	-2.066	.039	1.000
X1-Z10	-6.300	2.904	-2.169	.030	1.000
X1-X5	-7.700	2.904	-2.651	.008	1.000
X1-Z7	-9.500	2.904	-3.271	.001	.247
X1-X6	-9.900	2.904	-3.409	.001	.151
X1-Z6	-11.300	2.904	-3.891	.000	.023
X1-X7	-11.900	2.904	-4.098	.000	.010
X1-Z8	-12.100	2.904	-4.167	.000	.007
X1-X8	-14.500	2.904	-4.993	.000	.000
X1-Z5	-14.800	2.904	-5.096	.000	.000
X1-X9	-16.000	2.904	-5.510	.000	.000
X1-Z3	-17.300	2.904	-5.957	.000	.000
X1-Z4	-17.400	2.904	-5.992	.000	.000
Z2-Z1	.200	2.904	.069	.945	1.000
Z2-X3	2.600	2.904	.895	.371	1.000
Z2-X2	3.100	2.904	1.067	.286	1.000
Z2-Z11	-3.600	2.904	-1.240	.215	1.000
Z2-Z9	-4.700	2.904	-1.618	.106	1.000
Z2-X4	5.500	2.904	1.894	.058	1.000
Z2-Z10	-5.800	2.904	-1.997	.046	1.000
Z2-X5	7.200	2.904	2.479	.013	1.000
Z2-Z7	-9.000	2.904	-3.099	.002	.448
Z2-X6	9.400	2.904	3.237	.001	.279
Z2-Z6	-10.800	2.904	-3.719	.000	.046
Z2-X7	11.400	2.904	3.926	.000	.020
Z2-Z8	-11.600	2.904	-3.994	.000	.015
Z2-X8	14.000	2.904	4.821	.000	.000
Z2-Z5	-14.300	2.904	-4.924	.000	.000
Z2-X9	15.500	2.904	5.337	.000	.000

Appendix IIC: Pairwise Comparison of the Pictures

Z2-Z3	-16.800	2.904	-5.785	.000	.000
Z2-Z4	-16.900	2.904	-5.820	.000	.000
Z1-X3	2.400	2.904	.826	.409	1.000
Z1-X2	2.900	2.904	.999	.318	1.000
Z1-Z11	-3.400	2.904	-1.171	.242	1.000
Z1-Z9	-4.500	2.904	-1.550	.121	1.000
Z1-X4	5.300	2.904	1.825	.068	1.000
Z1-Z10	-5.600	2.904	-1.928	.054	1.000
Z1-X5	7.000	2.904	2.410	.016	1.000
Z1-Z7	-8.800	2.904	-3.030	.002	.564
Z1-X6	9.200	2.904	3.168	.002	.355
Z1-Z6	-10.600	2.904	-3.650	.000	.061
Z1-X7	11.200	2.904	3.857	.000	.027
Z1-Z8	-11.400	2.904	-3.926	.000	.020
Z1-X8	13.800	2.904	4.752	.000	.000
Z1-Z5	-14.100	2.904	-4.855	.000	.000
Z1-X9	15.300	2.904	5.269	.000	.000
Z1-Z3	-16.600	2.904	-5.716	.000	.000
Z1-Z4	-16.700	2.904	-5.751	.000	.000
X3-X2	.500	2.904	.172	.863	1.000
X3-Z11	-1.000	2.904	-.344	.731	1.000
X3-Z9	-2.100	2.904	-.723	.470	1.000
X3-X4	-2.900	2.904	-.999	.318	1.000
X3-Z10	-3.200	2.904	-1.102	.270	1.000
X3-X5	-4.600	2.904	-1.584	.113	1.000
X3-Z7	-6.400	2.904	-2.204	.028	1.000
X3-X6	-6.800	2.904	-2.342	.019	1.000
X3-Z6	-8.200	2.904	-2.824	.005	1.000
X3-X7	-8.800	2.904	-3.030	.002	.564
X3-Z8	-9.000	2.904	-3.099	.002	.448
X3-X8	-11.400	2.904	-3.926	.000	.020
X3-Z5	-11.700	2.904	-4.029	.000	.013
X3-X9	-12.900	2.904	-4.442	.000	.002
X3-Z3	-14.200	2.904	-4.890	.000	.000
X3-Z4	-14.300	2.904	-4.924	.000	.000
X2-Z11	-.500	2.904	-.172	.863	1.000
X2-Z9	-1.600	2.904	-.551	.582	1.000
X2-X4	-2.400	2.904	-.826	.409	1.000
X2-Z10	-2.700	2.904	-.930	.353	1.000
X2-X5	-4.100	2.904	-1.412	.158	1.000

Appendix IID: Pairwise Comparison of the Pictures

X4-X6	-3.900	2.904	-1.343	.179	1.000
X4-Z6	-5.300	2.904	-1.825	.068	1.000
X4-X7	-5.900	2.904	-2.032	.042	1.000
X4-Z8	-6.100	2.904	-2.101	.036	1.000
X4-X8	-8.500	2.904	-2.927	.003	.791
X4-Z5	-8.800	2.904	-3.030	.002	.564
X4-X9	-10.000	2.904	-3.444	.001	.133
X4-Z3	-11.300	2.904	-3.891	.000	.023
X4-Z4	-11.400	2.904	-3.926	.000	.020
Z10-X5	1.400	2.904	.482	.630	1.000
Z10-Z7	3.200	2.904	1.102	.270	1.000
Z10-X6	3.600	2.904	1.240	.215	1.000
Z10-Z6	5.000	2.904	1.722	.085	1.000
Z10-X7	5.600	2.904	1.928	.054	1.000
Z10-Z8	5.800	2.904	1.997	.046	1.000
Z10-X8	8.200	2.904	2.824	.005	1.000
Z10-Z5	8.500	2.904	2.927	.003	.791
Z10-X9	9.700	2.904	3.340	.001	.193
Z10-Z3	11.000	2.904	3.788	.000	.035
Z10-Z4	11.100	2.904	3.822	.000	.031
X5-Z7	-1.800	2.904	-.620	.535	1.000
X5-X6	-2.200	2.904	-.758	.449	1.000
X5-Z6	-3.600	2.904	-1.240	.215	1.000
X5-X7	-4.200	2.904	-1.446	.148	1.000
X5-Z8	-4.400	2.904	-1.515	.130	1.000
X5-X8	-6.800	2.904	-2.342	.019	1.000
X5-Z5	-7.100	2.904	-2.445	.014	1.000
X5-X9	-8.300	2.904	-2.858	.004	.984
X5-Z3	-9.600	2.904	-3.306	.001	.219
X5-Z4	-9.700	2.904	-3.340	.001	.193
Z7-X6	.400	2.904	.138	.890	1.000
Z7-Z6	1.800	2.904	.620	.535	1.000
Z7-X7	2.400	2.904	.826	.409	1.000
Z7-Z8	-2.600	2.904	-.895	.371	1.000
Z7-X8	5.000	2.904	1.722	.085	1.000
Z7-Z5	5.300	2.904	1.825	.068	1.000
Z7-X9	6.500	2.904	2.238	.025	1.000
Z7-Z3	7.800	2.904	2.686	.007	1.000
Z7-Z4	7.900	2.904	2.720	.007	1.000
X6-Z6	-1.400	2.904	-.482	.630	1.000

Appendix IIE: Pairwise Comparison of the Pictures

X2-Z7	-5.900	2.904	-2.032	.042	1.000
X2-X6	-6.300	2.904	-2.169	.030	1.000
X2-Z6	-7.700	2.904	-2.651	.008	1.000
X2-X7	-8.300	2.904	-2.858	.004	.984
X2-Z8	-8.500	2.904	-2.927	.003	.791
X2-X8	-10.900	2.904	-3.753	.000	.040
X2-Z5	-11.200	2.904	-3.857	.000	.027
X2-X9	-12.400	2.904	-4.270	.000	.005
X2-Z3	-13.700	2.904	-4.718	.000	.001
X2-Z4	-13.800	2.904	-4.752	.000	.000
Z11-Z9	1.100	2.904	.379	.705	1.000
Z11-X4	1.900	2.904	.654	.513	1.000
Z11-Z10	2.200	2.904	.758	.449	1.000
Z11-X5	3.600	2.904	1.240	.215	1.000
Z11-Z7	5.400	2.904	1.859	.063	1.000
Z11-X6	5.800	2.904	1.997	.046	1.000
Z11-Z6	7.200	2.904	2.479	.013	1.000
Z11-X7	7.800	2.904	2.686	.007	1.000
Z11-Z8	8.000	2.904	2.755	.006	1.000
Z11-X8	10.400	2.904	3.581	.000	.079
Z11-Z5	10.700	2.904	3.685	.000	.053
Z11-X9	11.900	2.904	4.098	.000	.010
Z11-Z3	13.200	2.904	4.545	.000	.001
Z11-Z4	13.300	2.904	4.580	.000	.001
Z9-X4	.800	2.904	.275	.783	1.000
Z9-Z10	-1.100	2.904	-.379	.705	1.000
Z9-X5	2.500	2.904	.861	.389	1.000
Z9-Z7	4.300	2.904	1.481	.139	1.000
Z9-X6	4.700	2.904	1.618	.106	1.000
Z9-Z6	6.100	2.904	2.101	.036	1.000
Z9-X7	6.700	2.904	2.307	.021	1.000
Z9-Z8	6.900	2.904	2.376	.018	1.000
Z9-X8	9.300	2.904	3.202	.001	.315
Z9-Z5	9.600	2.904	3.306	.001	.219
Z9-X9	10.800	2.904	3.719	.000	.046
Z9-Z3	12.100	2.904	4.167	.000	.007
Z9-Z4	12.200	2.904	4.201	.000	.006
X4-Z10	-.300	2.904	-.103	.918	1.000
X4-X5	-1.700	2.904	-.585	.558	1.000
X4-Z7	-3.500	2.904	-1.205	.228	1.000

Appendix IIF: Pairwise Comparison of the Pictures

X6-X7	-2.000	2.904	-.689	.491	1.000
X6-Z8	-2.200	2.904	-.758	.449	1.000
X6-X8	-4.600	2.904	-1.584	.113	1.000
X6-Z5	-4.900	2.904	-1.687	.092	1.000
X6-X9	-6.100	2.904	-2.101	.036	1.000
X6-Z3	-7.400	2.904	-2.548	.011	1.000
X6-Z4	-7.500	2.904	-2.583	.010	1.000
Z6-X7	.600	2.904	.207	.836	1.000
Z6-Z8	-.800	2.904	-.275	.783	1.000
Z6-X8	3.200	2.904	1.102	.270	1.000
Z6-Z5	3.500	2.904	1.205	.228	1.000
Z6-X9	4.700	2.904	1.618	.106	1.000
Z6-Z3	6.000	2.904	2.066	.039	1.000
Z6-Z4	6.100	2.904	2.101	.036	1.000
X7-Z8	-.200	2.904	-.069	.945	1.000
X7-X8	-2.600	2.904	-.895	.371	1.000
X7-Z5	-2.900	2.904	-.999	.318	1.000
X7-X9	-4.100	2.904	-1.412	.158	1.000
X7-Z3	-5.400	2.904	-1.859	.063	1.000
X7-Z4	-5.500	2.904	-1.894	.058	1.000
Z8-X8	2.400	2.904	.826	.409	1.000
Z8-Z5	2.700	2.904	.930	.353	1.000
Z8-X9	3.900	2.904	1.343	.179	1.000
Z8-Z3	5.200	2.904	1.791	.073	1.000
Z8-Z4	5.300	2.904	1.825	.068	1.000
X8-Z5	-.300	2.904	-.103	.918	1.000
X8-X9	-1.500	2.904	-.517	.605	1.000
X8-Z3	-2.800	2.904	-.964	.335	1.000
X8-Z4	-2.900	2.904	-.999	.318	1.000
Z5-X9	1.200	2.904	.413	.679	1.000
Z5-Z3	2.500	2.904	.861	.389	1.000
Z5-Z4	2.600	2.904	.895	.371	1.000
X9-Z3	-1.300	2.904	-.448	.654	1.000
X9-Z4	-1.400	2.904	-.482	.630	1.000
Z3-Z4	-.100	2.904	-.034	.973	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Appendix IIIA: Vancouver Scar Score

Scar characteristic	Score
Vascularity	
Normal	0
Pink	1
Red	2
Purple	3
Pigmentation	
Normal	0
Hypopigmentation	1
Hyperpigmentation	2
Pliability	
Normal	0
Supple	1
Yielding	2
Firm	3
Ropes	4
Contracture	5
Height (mm)	
Flat	0
＜2	1
2～5	2
＞5	3
Total score	13

Appendix IIIB: Classification of scar formation using the modified Vancouver scar scale.

Score	Classification
0	No scar formation
1-4	Mild scar formation
5-7	Moderate scar formation
8-10	Severe scar formation

Strobel et al. Subtarsal Versus Transconjunctival Approach. J Oral Maxillofac Surg 2016.

Appendix IV: Information Letter

I, Dr JGA Mhlanga (currently a qualified dentist enrolled in a specialist training program), plan to conduct a Randomise clinical trial study to assess the clinical outcomes of the transcutaneous incision when compare to trans-conjunctival (retroseptal) incision, scar formation and other clinical features/complications. The study requires that patients to be dark skinned or light skinned with orbital trauma/injuries that require repair, where local approaches are indicated. Number of studies have been conducted that compare the transcutaneous technique to trans-conjunctival technique assessing clinical outcome, however to my knowledge there are no studies that has assessed the clinical outcomes of transcutaneous techniques versus trans-conjunctival technique on dark skinned patient especial scar formation assessment, which is a major concern in the modern society.

Participants in the study will be assessed clinical, immediately post-operative, at 24 hours, 3weeks and 3 months post operatively. The Vancouver scar scale scar form, clinical assessment form and visual assessment score will be use by the investigator, to assess the scar and other clinical features/complications. Patient will be randomized but will not be forced to a specific technique if they feel the other technique is a better one. The results of the data will be used to compile our overall results. Participating in the study is on a voluntary basis. You may withdraw from the study at any time. Participating in the study or refusing to participate will not harm or prejudice you in any way. Participating in the study will benefit future patients. All information will be kept strictly confidential.

Thanking you in anticipation.

Dr JGA Mhlanga (Researcher) Registrar (Maxillo-Facial and Oral Surgery)

Contact details: Tel: (021) 937 3119 Mobile: 076 850 5851

If you have any other queries, you are welcome to contact my supervisor, Prof Morkel and Dr Hein at 021 937 3119

I, (Patient name) ...., fully understand the information supplied to me by Dr JGA Mhlanga in the above information letter.

Signature…………………………

Date…………………………….

Appendix V: Consent Form

I, Mr/Mrs/Miss..
Date of Birth: ....
File no./Hosp. Sticker...

I am willing to participate in the study as described to me in the patient information letter by Dr JGA Mhlanga. I understand that participation in the study is voluntary.

The study is approved by the Ethical and Research Committee of the University of the Western Cape and participation in this study is on a voluntary basis. I have been adequately informed about the objectives of the study. I also know that I have the right to withdraw from the study at any stage which will not prejudice me in any way regarding future treatments. My rights will be protected, and all my details will be kept confidential. No personal information will be published.

I hereby consent to be part of the research/study.

Patient's/patient's parent or guardian's name: ....
Patient's/patient's parent or guardian's signature: ....
Witness's name: ....
Witness's signature: ....

Researcher's signature…………………………………Date ……………………..…………
Dr JGA Mhlanga