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ORIGINAL ARTICLE

Transconjunctival versus subciliary approach for orbital fracture repair—an anthropometric evaluation of 221 cases

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Abstract
Objectives In the literature, there is an ongoing discussion about the influence of orbital fractures and the surgical approach on the rate of eyelid deformities of the lower eyelid.
Materials and methods We present an evaluation of a series of 221 patients 9 months after zygomaticomaxillary complex fracture repair that underwent implant removal. Reference anthropometric data were measured on standardized pre- and postoperative photographs. Analysis included eye fissure width and height, lid sulcus and upper lid height, upper and lower iris coverage, position of cornea to palpebra inferior, canthal tilt, scleral show, ectropion, and entropion. Both operated and contralateral eyelids were evaluated as well as whether a transconjunctival or a subciliary approach was performed.
Results Time, surgery, and surgical approach presented significant effects on eye fissure index and lower iris coverage. Scleral show was significantly influenced by the surgical procedure itself as well as by the type of incision. The rate of ectropion increased significantly pre- to postoperative.
Conclusions The subciliary approach included the highest risk of lower lid retraction. The low pre- to postoperative increase of scleral show and ectropion compared to recent studies gives us an idea about the influence of the underlying trauma on the rate of lower lid retraction. The standardized measurements described are accurately and objective to evaluate postoperative results.
Clinical relevance The transconjunctival approach is preferable in orbital fracture repair.

Keywords Transconjunctival approach · Subciliary approach · Orbital fracture · Zygomaticomaxillary fracture

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Introduction

Surgical procedures in the face are a tremendous source of concern for patients. Facial injury such as zygomaticomaxillary complex (ZMC) fractures may lead to loss of an aesthetically pleasing appearance. Facial deformities and alterations secondary to a ZMC fracture and its operative therapy may affect patients' well being and social interactions. Thus, most patients are worried about their postoperative appearance, before undergoing repair of a ZMC fracture.

In the pursuit to achieve the best possible result in ZMC fracture repair, there is an ongoing discussion about the operative therapy of ZMC fractures. Especially the question whether a transconjunctival or a transcutaneous approach should be performed to access the inferior orbital rim and/or orbital floor is discussed controversially [1–14].

To date, many studies investigating the effect of transconjunctival and/or transcutaneous approaches include patients

with isolated orbital floor fractures, zygomaticomaxillary fractures, and/or combined orbitomaxillary fractures. Published results do not clearly differentiate between these aforementioned types of fractures [1–5, 8, 11, 13, 15–18]. It is obvious, as reported earlier, that different grades of severity and the mechanism of trauma are associated with the risk of developing en- or ectropion, as well [11, 19]. Thus, the inclusion of different types of orbital osseous trauma in studies reporting and/or comparing transconjunctival and transcutaneous approaches limits their validity.

Further limitations of published case series with regards to comparisons of complication rates of transconjunctival and transcutaneous approach are their retrospective character, variety of severity of trauma, and unknown dimension of preoperative lid laxity or deformity, which should be adjusted when evaluating outcomes [11].

In German-speaking countries, it is common to remove osteosynthesis materials after bone healing. The medical need of these procedures remains controversial and is an ongoing source of discussion. Removal of implants after ZMC fracture repair presents an excellent opportunity to take standardized pre- and postoperative photographs before performing a transconjunctival or a transcutaneous approach.

In order to retrieve the most possible information about the influence of the surgical procedure and selected surgical approach on the periorbital soft tissue architecture, standardized anthropometric measurements were performed. Normative anthropometric measurements of the face are related to attractiveness [20]. Their value is widely recognized [21–24]. Therefore, we believe that established photo-assisted anthropometric measurements of the periorbital region may help to control for

- The effect of implant removal on the operated eyelid by a comparison with the contralateral, unaffected side
- The effect of a transconjunctival or a transcutaneous approach on the operated eyelids by a comparison of standardized pre- and postoperative photographs without eyelid distortion by a current trauma.

In a group of 221 patients undergoing implant removal 9 months after surgical repair of a ZMC fracture, preoperative anatomic landmarks and periorbital relationships were measured in standardized photographs. Postoperative changes resulting from surgery and a comparison of either a transconjunctival or a transcutaneous approach performed were compared to the preoperative values.

Patients and method

Nine months after ZMC fracture repair, all patients were operated between September 2006 and September 2011 by the various surgeons of the Department of Cranio-Maxillofacial Surgery & Plastic Surgery at the University Hospital of Jena. In all patients implants of the frontozygomatic suture, the inferior orbital rim and the maxillary alveolus had to be removed. Generally, all implants were removed through the same approaches selected in the previous procedures when fracture repair was performed. The inferior orbital rim and orbital floor were exposed via a subciliary or a transconjunctival approach. All approaches were performed in a standardized manner according to the techniques described by Ellis and Zide [25]

The subciliary approach was performed in the manner of a step dissection. The transconjunctival approach was performed as a retroseptal technique. Lateral canthotomy and inferior cantholysis were always avoided. If necessary, alloplastic reconstruction of the orbital floor was performed using a polydioxanone sheet (Ethicon Products, Norderstedt, Germany), in severe cases by a titanium mesh (Synthes, Umirch, Germany). Implants at the zygomaticofrontal suture were placed through an eyebrow or upper blepharoplasty approach. The maxillary alveolus was reached through a maxillary vestibular approach. Osteosynthesis materials consisted in miniplates and/or microplates.

A photo- and radiographic description of three patients is shown in Fig. 1.

Objective rating scheme

Colored frontal view photographs with open eyes were taken before surgery and 3 months postoperatively with a Nikon D 80 camera (objective, Nikon AF Micro Nikkor 105 mm 1:2.8 D; aperture, f13; Nikon Corp, Tokyo, Japan). All photographs were taken by a professional photographer of the Clinical Media Center of the University Hospital of Jena. To minimize photographic distortion, only photographs in which the interpupillary axis was at the same level as the camera lens were selected [26]. Photographs were only used for further analysis when patients' faces were clearly at rest. Measurements were conducted using Adobe Photoshop CS2 (Adobe Inc, San Jose, CA, USA).

On the basis of predefined landmarks (Table 1) and data (Table 2), the following anthropometric dimensions and distances based on the work of Farkas and Munro [22–24, 27, 28] and well-known clinical data were measured or calculated (Fig. 2): (1) intercanthal index represented by the percentage of the intercanthal width (IW, en−en) of the biocular width (BW, ex−ex); (2) eye fissure index (EFI) basing on eye fissure height (EFH, Ps−Pi), the vertical distance from the margin of the inferior palpebra to the margin of the superior palpebra, as percentage of the eye fissure width (EFW, en−ex); (3) upper lid sulcus height (ULSH, LS−Ps), the vertical distance between upper palpebral margin and eyelid sulcus, as percentage of the upper lid height (ULH, Os−Ps), the distance between orbitale

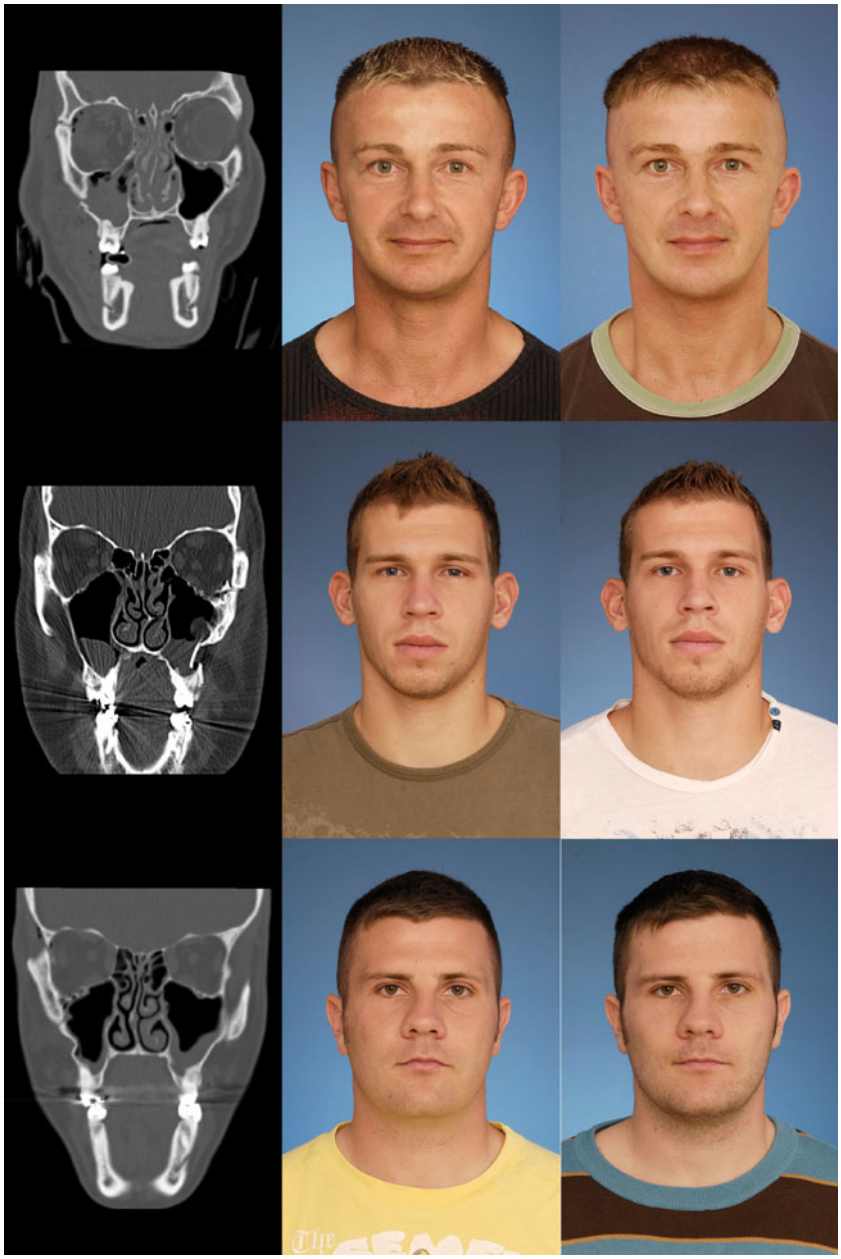

Fig. 1 *Left* coronar CT scan of the ZMC fracture, *right* standardized photography 9 months after surgery. The first patient above was operated through a transconjunctival approach among others, the patient in the middle through a subciliary approach, the deepest patient through a transconjunctival approach

superioris and upper palpebral margin; (4) upper iris coverage (UIC) representing the part of the iris covered by halving iris diameter and subtracting the free visible upper radius of the iris (Ic−Ps) as percentage of the total iris diameter (ID). (5) Lower iris coverage (LIC) representing the part of the iris covered by halving iris diameter and subtracting the

Table 1 Used anthropometric landmarks based on the investigations by Farkas

Ps	Palpebrale superioris
Pi	Palpebrale inferioris
En	Endocanthion
Ex	Exocanthion
Ic	Iris center
LS	Lid sulcus
Os	Orbitale superioris
CPi	Corneal palpebral inferior contact point

Table 2 Used anthropometric distances based on the investigations by Farkas

IW	Intercanthal width, en−en
BW	Biocular width, ex−ex
EFH	Eye fissure height, Ps−Pi
EFW	Eye fissure width, En−Ex
ULSH	Upper lid sulcus height, LS−Ps
ULH	Upper lid height, Os−Ps
ID	Iris diameter, iris height
UIRv	Upper iris radius visible
LIRv	Lower iris radius visible

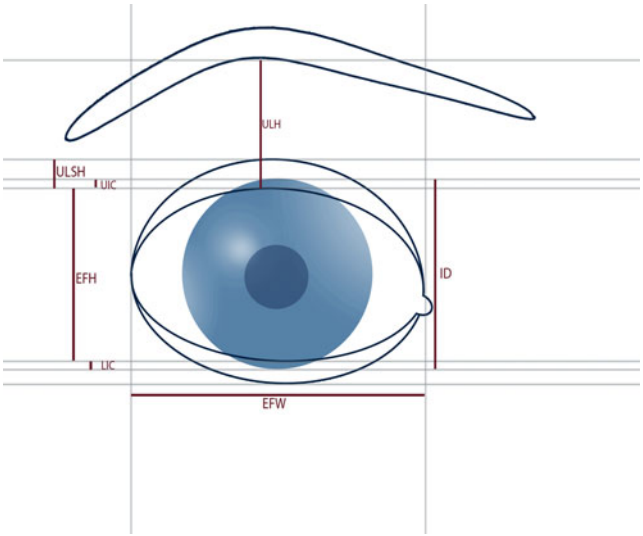

Fig. 2 Schematic picture with description of the used anthropometric distances. *ULSH* upper lid sulcus height, *ULH* upper lid height, *UIC* upper iris coverage, *LIC* lower iris coverage, *ID* iris diameter, *EFH* eye fissure height, *EFW* eye fissure width

free visible upper radius of the iris (Ic−Pi) (in the case of scleral show or ectropion, its values turned negative); (6) the position of the lower eyelid to the lower iris [29] was taken by placing a vertical reference line through the center of the iris (Ic); another line was drawn through the center of the iris (Ic) and the point of contact of the lower eyelid and cornea (Ic−CPi); the angle formed by both lines was measured in degrees (Fig. 3); medial deviations of the angle were measured as negative, lateral deviations as positive value; (7) canthal tilt [30] measured as the angle between the EFW (en−ex) and a horizontal reference line passing through the

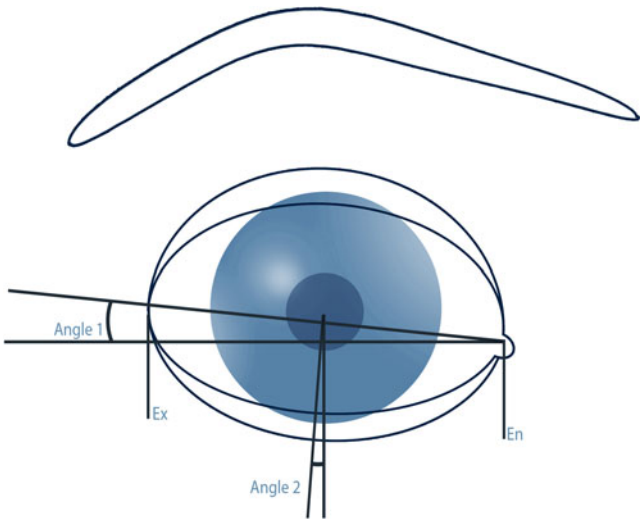

Fig. 3 Schematic picture of canthal tilt (*An1*), describing the inclination of the horizontal axis of the eye between endocanthion (*En*) and exocanthion (*Ex*). Furthermore, description of the position of the lower iris (*An2*) as the aberration of the contact point between cornea and lower eyelid from the vertical reference line through the center of the iris

endocanthion in degrees (Fig. 3); (8) scleral show; (9) ectropion; and (10) entropion.

All items were measured pre- and postoperatively on both eyes. Results were evaluated by pre- to postoperative changes on the operated and contralateral (not operated) side. Results were rated by pre- to postoperative changes in each individual. Impact of whether a transconjunctival or a subciliary approach was evaluated as well.

Statistical analysis

To evaluate the influence of operated/contralateral side and pre- and postoperative (Table 3) as well as surgical approach selected (Table 4) on intercanthal index, EFI, ULSH, UIC, LIC, position of lower eyelid to lower iris, and canthal tilt, two factorial mixed ANOVAs were conducted. McNemar tests and Fisher's exact tests were used to compare operated and contralateral eyes with reference to scleral show and ectropion. As entropion was not observed as a complication, it was therefore not included in the statistical analysis. All statistical operations were calculated using SPSS V 19.0 for Windows (SPSS, Inc, Chicago, IL, USA).

Results

Nine months after unilateral ZMC fracture repair, 221 white patients, 171 (77.4 %) men and 50 (22.6 %) women, were operated and met the inclusion criteria. Average age was 44.76±19.15 years at time of the implant removal. One hundred ten (49.8 %) patients were operated on the right, 111 on the left side (50.2 %). In 129 patients (58.4 %), implants at the inferior orbital rim were removed through a transconjunctival approach and in 92 patients (41.6 %) through a subciliary approach. Implants placed at the zygomaticofrontal junction were exposed via an eyebrow approach in 143 cases (64.7 %) and via an upper blepharoplasty approach in 78 cases (35.3 %).

A comparison of the pre- and postoperative state of the operated and the contralateral side is shown in Table 3.

EFI and LIC showed a statistically significant difference pre- to postoperative ($p<.001$) and between operated and contralateral side ($p<.001$). There was also an interaction effect between surgery and time detectable ($p<.001$) Scleral show did not differ significantly in pre- to postoperative values, but surgery had a significant impact on the pre- ($p<.001$) and postoperative ($p<.001$) rate of scleral show. Ectropia, which did not resolve spontaneously after ZMC fracture repair and required surgical revision, did not undergo implant removal. Therefore, there were no preoperative ectropia observed.

Table 3 Comparison of the results of the photographic measurements of the operated and the contralateral eyelids

Dimension	Preoperative operated	Preoperative contralateral	Postoperative operated	Postoperative contralateral	Significant difference, pre- vs postoperative (p)	Significant difference, operated or not (p)	Interaction pre/post-OP
IW/BW (%)	38.9±4.5	38.9±4.5	39.6±4.0	39.6±4.0	0.386	0.127	0.386
EFH/EFW (%)	35.8±5.2	34.4±4.2	37.1±5.3	34.6±4.1	<0.001	<0.001	<0.001
ULSH/ULH (%)	32.9±15.7	33.1±18.1	32.5±17.4	32.7±17.8	0.224	0.904	0.939
UIC (%)	17.14±7.8	17.7±8.0	17.6±7.2	17.6±7.3	0.467	0.631	0.220
LIC (%)	2.7±6.7	4.3±5.3	1.4±6.4	4.4±5.1	<0.001	<0.001	<0.001
Position of lower eyelid to lower iris (degree)	-0.5±4.4	-0.4±4.4	-0.6±4.3	-1.1±12.0	0.310	0.713	0.380
Canthal tilt (degree)	1.2±3.5	1.4±3.2	1.3±3.1	1.5±3.1	0.377	0.593	0.610
Scleral Show (%)	16.3	4.1	18.1	3.6	0.749[a]	p<0.001[b]	p<0.001[d]
Ectropion (%)	0	0	3.6	0	0.008[a]	–[c]	0.007[d]

[a] ANOVA for statistical reasons not conductible, McNemar test pre- vs. postoperative was applied

[b] Fisher's test OP preoperative

[c] No preoperative ectropion

[d] Fisher's test OP postoperative

The rate of ectropion presented a significant pre- to postoperative increase (p=.008). Postoperative, the rate of ectropion presented a significant association with surgery (p=.007) All ectropia resolved spontaneously under conservative management.

A comparison of the pre- and postoperative state of the operated side only clearly distinguishing between the surgical approach to the inferior orbita is shown in Table 4.

EFI presented significant differences pre- to postoperatively (p<.001) and whether a transconjunctival or a subciliary approach were performed (p=.016). LIC showed pre- to postoperative (p<.001), and depending on the approach selected (p=.036), significant changes. The postoperative rate of scleral show was significantly higher when a subciliary approach was performed (p<.001). Entropion did not occur. None of the patients presented persistent diplopia.

The other investigated parameters presented no significant changes.

Discussion

Discussion of the method

Because of the exposed position of the zygoma in the lateral part of the midfacial skeleton, ZMC fractures are among the most frequent fractures of the facial skeleton.

Table 4 Results of the pre- and postoperative photographic measurements of the operated side differentiated between the surgical approach to the inferior orbita

	Preoperative	Postoperative	Preoperative	Postoperative	Significant differences, PrePost	Sign approach
Approach	Transconjunctival		Subciliary		p value	p value
Cases	129		92			
IW/BW (%)	38.9±5.0	38.9±5.2	38.9±3.5	39.0±3.6	0.368	0.121
EFH/EFW (%)	34.9±4.1	35.9±5.1	37.1±6.3	38.9±5.0	<0.001	0.016
ULSH/ULH (%)	32.8±15.8	32.5±17.7	33.1±15.7	32.6±17.2	0.247	0.577
UIC (%)	17.3±8.1	17.8±7.4	16.9±7.3	17.3±7.0	0.474	0.751
LIC (%)	3.6±6.1	2.3±5.4	1.5±7.4	0.3±7.4	<0.001	0.036
Position of lower eyelid to lower iris (degree)	-0.9±3.9	-1.1±4.0	-0.8±5.0	0.01±4.7	0.376	0.353
Canthal tilt (degree)	0.9±3.6	1.0±3.1	1.8±3.2	1.6±3.1	0.531	0.155
Scleral Show (%)	7.8	8.5	21.7	31.5	0.749[a]	<0.001[b]
Ectropion (%)	0	1.6	0	6.5	0.008[a]	0.072[b]

[a] Significant difference pre- vs postoperative (McNemar test)

[b] Fisher's test interaction postoperative approach

Anatomic reduction of the zygoma, orbital floor, and zygomatic arch are necessary to re-establish facial symmetry and ensure the correct position of the eyeglobe and adequate mobility of the mandible. Today, rigid internal fixation by miniplates is a surgical standard in ZMC fractures. They are easy to adapt and support movements of the bone [10].

The zygomaticofrontal suture may be accessed through a lateral eyebrow, upper blepharoplasty, or an extended transconjunctival approach. The maxillary alveolus is usually accessed via a maxillary vestibular approach. The inferior orbital rim and orbital floor may be accessed via a transconjunctival or transcutaneous approach [31]. Because of the very fragile nature of the anatomy and the aesthetic importance of the lower eyelid, there is an ongoing discussion in the literature on which approach achieves the best results [2–7, 9, 11, 15, 21, 32].

As mentioned above, the comparison of the pre- and postoperative state in patients undergoing removal of osteosynthesis materials gives us an excellent opportunity to judge pre- to postoperative changes in absence of any acute trauma. It is the most minimal procedure known to us in which a transconjunctival or transcutaneous approach are performed. As a limitation, we have to point out that these patients all had a ZMC fracture and operative repair 9 months before implant removal. Anyhow, they seem adequate to us to help us judge the surgical outcome of a transconjunctival or transcutaneous approach.

We did not only evaluate classic parameters such incidence of diplopia, ectropion and entropion. In addition, we decided to perform extensive anthropometric measurements of the periorbital region. They are widely in use for the description and assessment of the periorbital architecture and are related to facial attractiveness [20]. They were also proven useful in the field of aesthetic surgery [23, 33] and in planning changes of facial proportions by orthodontics [34].

The application of anthropometric indices in two-dimensional photographic measurements as performed in this study has been shown to be entirely valid, as long as the indentified anthropometric landmarks are readily identifiable and the correct standardized photographic technique has been used [35]. There is a strong correlation between the direct evaluation of faces and the evaluation of standardized photographic records [36]. In the presented study, we retrospectively evaluated standardized clinical routine photographs. This procedure enabled us to evaluate a total of 221 patients.

Three-dimensional techniques like face scans may provide an even higher reliability as compared to the two-dimensional photographs, but still include the disadvantages of higher costs, more difficult application, and expenditure of time for their production. Therefore, they are not clinical routine in our department.

In our clinical experience, the lower eyelid morphology is widely stable 3 months after surgery. The standardized postoperative photographs evaluated in this study were routinely taken at a 3-month follow-up interval. This appraisal is maintained by the fact that the follow-up period may be ended 3 months postoperatively in uncomplicated cases, as published by Poeschl et al. [37].

Various anthropometric measurements of the periorbital region have been described [21, 22, 24, 27, 28, 38]. In our study, the intercanthal index, eye fissure index, upper lid sulcus height, upper and lower iris coverage, canthal tilt, and position of lower eyelid to iris were employed. All these indices are clinically relevant for the appreciation and judgment of the periorbital region and easy to measure on standardized photographs. Photographic distortion was controlled by exact photographic standardization, which has been earlier described elsewhere [26]. The measurement of the intercanthal index was performed as an additional control of the photographic dimension. It does not only provide information about the correct execution of the standardized photographic technique but also about the symmetry of the eyelids' position to each other.

Lower lid retraction was investigated by the EFI, LIC, and rate of scleral show and ectropion. The eye fissure height is reported to be 9–10 mm with open eyes straight ahead and is be measured between the margins of the upper and lower palpebra (Ps–Pi). The eye fissure width is referred to equal 30 mm. It is measured between the endo- and exocanthion [39]. We preferred to apply the EFI reflecting the relation between EFH and EFW. Even subtle lower eyelid retraction may be detected by measurements of EFI and leads to increased values. The measurement of EFI also gives quantitative information about the degree of lower lid retraction. Earlier studies evaluating the outcome of ZMC fractures repair or surgical approach to the inferior orbita only described the rate of lower lid retraction, mostly even only the rate of ectropion or entropion without any degree of quantification.

The LIC has a big impact on patients' appearance. The standard value is 7 % [24]. Analogous to the EFI, it may help to quantify the degree of lower lid retraction by decreased values, and it may be compared to the contralateral side or to the preoperative measurements. Negative values of the LIC occur in the case of scleral show.

Scleral show describes an aesthetically compromising malposition of the lower eyelid resulting in a sad-eyed appearance [40]. Normally, sclera should not be visible looking straight ahead [29, 39]. A reproducible quantification of scleral show is desirable for the judgment of the quantity of distortion and is not directly possible in photographic measurements. Therefore, scleral show was quantified by negative values of the LIC. A pre- to postoperative increase in the EFI may be used to quantify scleral show as well.

Ectropia are linked to lower lid retraction, but in a different manner than scleral show. Scleral show describes a

general and symmetric decline of the lower eyelid attached to the eyeglobe. Ectropia may be shaped medially or laterally and do not inevitably go along with excessive lower lid retraction but with blank leaved eyeglobe. In the judgment of the surgical outcome by different approaches to the inferior orbita, it is very important to differentiate between lower lid retraction, in terms of scleral show, and ectropion.

The position of the lower eyelid relative to the iris is adequate to judge traction on the lower eyelid or a changed position of the lateral canthus. It describes the standard contact point of the lower palpebra to the limbus corneae at the 6 o'clock position [29]. Traction and tension on the lower eyelid alters the contact point of cornea and lower eyelid.

The inclination of the eyelid has a major impact on the facial appearance. A negative canthal tilt [30] is clinically relevant as sad look may be a consequence of a lowered lateral canthus [29]. Canthal tilt is easy to identify and measure (see Fig. 3). Normally, it lies 10–15° [41] or 2 mm [39] above the medial canthus. Surgical procedures such as a lateral canthotomy or cantholysis may lead to a changed canthal tilt.

Measurements of the upper eyelid position were included in our study as well. This was necessary to ensure that changes of the upper eyelid architecture did not influence the measurements of EFI, for example. UIC measures the covered part of the upper iris. The preoperative means measured in our study (see Table 3) indicate that, compared to the standard values of 2 mm or 13 % of upper iris coverage [24], our patients even suffered from discretely descended upper eyelids. ULSH is a helpful measurement in the judgment of the position of the eyelid relative to the eyebrow. Considerations about this position give a lot of information especially about the upper periorbital architecture. As reported in earlier studies, the big range of its standard deviation limits the validity of ULSH [23].

Other anthropometric indices by Farkas and Munro, such as the orbital index, vertical orbit contour index, and eyelid height index, were not included in our study. They all include the anthropometric landmark of the inferior orbitale, which is not exactly and reproducibly measurable, when not marked before taking the photograph. The anthropometric landmarks of the intercanthal index, EFI, ULSH, UIC, and LIC were all easily and reproducibly definable in the frontal view photographs of our study.

Most patients are worried preoperatively about how they may look like postoperatively. The zygoma forms the malar prominence and critically influences the periorbital architecture, which is very important aesthetically. Inadequate reduction may not only lead to functional disabilities but also to a different facial expression and have major effects on patients' appearance and psychosocial health. For example, a lowered canthal tilt, which may occur if the zygoma is inadequately reduced, leads to a sad appearance [29]. The common criteria of evaluation of ZMC fractures consist of the rate of lower lid retraction, ectropion, entropion, and functional disabilities [4, 8, 9, 11, 12, 15, 21, 42]. These common criteria do not allow the detection of eyelid distortions such as a changed canthal tilt, for example.

We feel that the presented anthropometric measurements of the periorbital region may help us to objectify the outcome of ZMC fractures and to compare the results of transcutaneous and transconjunctival approaches. Also in judicial affairs, these measurements may help to obtain reproducible data.

Discussion of the results

The comparison of the pre- and postoperative situation, operated and contralateral side, as well as the surgical approach used did not show significant effects with regards to ULSH and UIC. This indicates that distortion of the upper eyelid by trauma or an upper blepharoplasty or lateral eyebrow approach did not occur (see Tables 3 and 4).

Canthal tilt did not present significant associations between operated and contralateral side, pre- to postoperative, and surgical approach selected. Position of lower eyelid to iris was neither influenced (see Tables 3 and 4). This indicates that 9 months after trauma, surgical repair, and plate removal, both decisive angles were not negatively influenced.

The significant increase in EFI and lowered values of LIC in the comparison of operated and contralateral eyelid and pre- and postoperative situation indicate lower lid retraction. This is confirmed by the significant association between scleral show and surgery as well as the pre- to postoperative significant increase in ectropion (see Table 3). Overall, in our study, the values for pre- to postoperative changes of scleral show and ectropion are lower than those rates reported in earlier studies including patients evaluated after orbital fracture repair [2, 4, 5, 8, 11, 12, 14, 15, 18, 19, 21, 42]. It seems that the higher rates of lower lid retraction are the consequence of the underlying trauma. It may also be an advice to investigate the influence of different severity and types of trauma on lower lid retraction in future studies.

We also investigated the influence of the surgical approach selected to expose the lower orbita (see Table 4). There was a significant effect on EFI, LIC, and rate of scleral show. The increased values of EFI and lowered values of LIC as well as the significantly higher rate of scleral show in patients that were operated through a subciliary approach indicate a significantly higher rate of lower lid retraction in this group.

These results do not contradict the present literature. Lower lid retraction is the most common complication after

a subciliary approach [3, 4, 15, 32, 43, 44]. Scar contracture, cicatricial connection among the septum orbitale, orbicularis muscle, and surrounding tissue, as well as loss of muscle tonus may cause scleral show and ectropion [32, 43]. Therefore, for some authors, the subciliary approach is unacceptable [32]. However, for some authors the subciliary approach still is first choice whenever the orbital floor must be exposed [5] because of its quick and complete access of the inferior orbita [45].

Most authors prefer transconjunctival incisions with- or without lateral canthotomy [1, 3, 6–8, 11, 13, 14, 16, 18, 21, 43, 44]. The transconjunctival approach helps to reduce complications such as lower lid edema or ectropion to a minimum [11, 14]. However, the risk of lower eyelid laceration as an intraoperative complication caused by excessive traction on the lower eyelid is higher compared to transcutaneous approaches [19]. Disadvantages of the transconjunctival approach include a high risk of entropion [19]. Scarring or reduction of the conjunctiva, subconjunctiva, or internal tarsus results in an inward bowing of the eyelid. This scarring leads to contracture at the tarsus as well as at the conjunctiva and subsequent lower lid malposition and entropion [19].

According to our experience, postoperative en- or ectropion is mostly related to inexperience in transconjunctival approaches. Besides an absolutely atraumatic operative technique, it is important to place the incision of the conjunctiva at the correct level of the fornix of the conjunctiva. If it is placed too far anterior, close to the eyelid edge, there might be traction postoperatively and shortening of the tarsal plate by fibrosis and scarring. If the incision is placed too far posterior, close to the globe, the risk of an injury of the inferior oblique muscle is increased [1]. Inadequate dissection of the anterior conjunctiva damaging the anterior septum seems to be responsible for most cases of postoperative lower eyelid distortion. Thus, blunt dissection has to be performed to expose the septum.

In our opinion, the retroseptal approach most likely prevents damage of the septum and inferior palpebral retraction [8, 25]. It is easy to perform and provides excellent access. However, the additional disturbance of the operative field by the intraorbital connective tissue is disadvantageous [1].

The expansion of the transconjunctival approach by a lateral canthotomy or cantholysis has been widely reported to be associated with a higher risk of lower eyelid malpositioning and asymmetry [1, 3, 13, 45] and even entropion [3]. Furthermore, the advantage of the transconjunctival approach with an invisible scar is lost when performing a lateral canthotomy. Other authors [1, 13] at our department prefer additional transcutaneous approaches such as an upper blepharoplasty and lateral eyebrow approach to gain access to the zygomaticofrontal suture.

During the past decades, the use of transcutaneous approaches decreased and the transconjunctival approach showed a continuous increase [46]. Altogether it seems that the transconjunctival approach includes a lower risk of postoperative ectropion and lower lid retraction in comparison to the subciliary approach. Our data confirm this (see Table 4).

We still see an indication for transcutaneous approaches in the case of multifragment fractures of the inferior orbital rim and fractures including the inferior lateral angle of the orbital rim. In these cases, we appreciate the complete access and survey of a transcutaneous approach. We think that the risk of lower lid distortion is lower in a transcutaneous approach in terms of a subtarsal approach than in a transconjunctival approach with lateral canthotomy or cantholysis. Subtarsal incisions were judged cosmetically acceptable and less risky in matters of lid retraction than subciliary approaches [21, 25, 32, 47]. The cutaneous lid incision of a subtarsal approach has to be placed 4–6 mm below the ciliary margin in a eyelid rhytid [45], thus leaving an acceptable external scar when concealed within this rhytid [44]. If postoperative retraction of the lower lid occurs, it should be managed conservatively by forced lid closure exercises and aggressive massage. The vast majority of these cases will resolve.

Altogether, it is important to state that the major determining factor for outcome is the experience of the surgeon and what kind of surgery is performed, rather than how the site is exposed [45].

Conclusion

The methods described here can give important references and help to objectify the results of orbital fracture repair. The presented rates and the amount of lower lid retraction in patients undergoing plate removal were lower than reported in earlier studies investigating orbital fractures and their operative therapy. The underlying trauma seems to have a high impact on the rate of lower eyelid distortion. The evaluation of the effects of transconjunctival and subciliary approaches on the periorbital architecture using anthropometric data was reliable and adequate. Not surprisingly, the subciliary approach exhibited a significantly higher rate of lower lid retraction than the transconjunctival approach.

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References

1. Baumann A, Ewers R (2001) Use of the preseptal transconjunctival approach in orbit reconstruction surgery. J Oral Maxillofac Surg 59(3):287–291. doi:10.1053/joms.2001.20997, discussion 291-282

2. De Riu G, Meloni SM, Gobbi R, Soma D, Baj A, Tullio A (2008) Subciliary versus swinging eyelid approach to the orbital floor. J Craniomaxillofac Surg 36(8):439–442. doi:10.1016/j.jcms.2008.07.005
3. Gosau M, Schoneich M, Draenert FG, Ettl T, Driemel O, Reichert TE (2011) Retrospective analysis of orbital floor fractures–complications, outcome, and review of literature. Clin Oral Investig 15(3):305–313. doi:10.1007/s00784-010-0385-y
4. Holtmann B, Wray RC, Little AG (1981) A randomized comparison of four incisions for orbital fractures. Plast Reconstr Surg 67 (6):731–737
5. Hwang K, You SH, Sohn IA (2009) Analysis of orbital bone fractures: a 12-year study of 391 patients. J Craniofac Surg 20 (4):1218–1223. doi:10.1097/SCS.0b013e3181acde01
6. Kushner GM (2006) Surgical approaches to the infraorbital rim and orbital floor: the case for the transconjunctival approach. J Oral Maxillofac Surg 64(1):108–110. doi:10.1016/j.joms.2005.09.019
7. Kwon JH, Kim JG, Moon JH, Cho JH (2008) Clinical analysis of surgical approaches for orbital floor fractures. Arch Facial Plast Surg 10(1):21–24. doi:10.1001/archfacial.2007.9
8. Manganello-Souza LC, Rodrigues de Freitas R (1997) Transconjunctival approach to zygomatic and orbital floor fractures. Int J Oral Maxillofac Surg 26(1):31–34
9. Nowinski D, Messo E, Hedlund A (2010) Treatment of orbital fractures: evaluation of surgical techniques and materials for reconstruction. J Craniofac Surg 21(4):1033–1037. doi:10.1097/SCS.0b013e3181e4345d
10. Olate S, Lima SM Jr, Sawazaki R, Moreira RW, de Moraes M (2010) Surgical approaches and fixation patterns in zygomatic complex fractures. J Craniofac Surg 21(4):1213–1217. doi:10.1097/SCS.0b013e3181e1b2b7
11. Ridgway EB, Chen C, Colakoglu S, Gautam S, Lee BT (2009) The incidence of lower eyelid malposition after facial fracture repair: a retrospective study and meta-analysis comparing subtarsal, subciliary, and transconjunctival incisions. Plast Reconstr Surg 124 (5):1578–1586. doi:10.1097/PRS.0b013e3181babb3d
12. Rohrich RJ, Janis JE, Adams WP Jr (2003) Subciliary versus subtarsal approaches to orbitozygomatic fractures. Plast Reconstr Surg 111(5):1708–1714. doi:10.1097/01.PRS.0000054209.18400.4E
13. Salgarelli AC, Bellini P, Landini B, Multinu A, Consolo U (2010) A comparative study of different approaches in the treatment of orbital trauma: an experience based on 274 cases. Oral Maxillofac Surg 14(1):23–27. doi:10.1007/s10006-009-0176-2
14. Zingg M, Chowdhury K, Ladrach K, Vuillemin T, Sutter F, Raveh J (1991) Treatment of 813 zygoma-lateral orbital complex fractures. New aspects. Arch Otolaryngol Head Neck Surg 117 (6):611–620, discussion 621-612
15. Wray RC, Holtmann B, Ribaudo JM, Keiter J, Weeks PM (1977) A comparison of conjunctival and subciliary incisions for orbital fractures. Br J Plast Surg 30(2):142–145
16. Novelli G, Ferrari L, Sozzi D, Mazzoleni F, Bozzetti A (2011) Transconjunctival approach in orbital traumatology: a review of 56 cases. J Craniomaxillofac Surg 39(4):266–270. doi:10.1016/j.jcms.2010.06.003
17. Suga H, Sugawara Y, Uda H, Kobayashi N (2004) The transconjunctival approach for orbital bony surgery: in which cases should it be used? J Craniofac Surg 15(3):454–457
18. Mullins JB, Holds JB, Branham GH, Thomas JR (1997) Complications of the transconjunctival approach. A review of 400 cases. Arch Otolaryngol Head Neck Surg 123 (4):385–388
19. Ridgway EB, Chen C, Lee BT (2009) Acquired entropion associated with the transconjunctival incision for facial fracture management. J Craniofac Surg 20(5):1412–1415. doi:10.1097/SCS.0b013e3181aee3ee
20. Edler R, Rahim MA, Wertheim D, Greenhill D (2010) The use of facial anthropometrics in aesthetic assessment. Cleft Palate Craniofac J 47(1):48–57. doi:10.1597/08-218.1
21. Bahr W, Bagambisa FB, Schlegel G, Schilli W (1992) Comparison of transcutaneous incisions used for exposure of the infraorbital rim and orbital floor: a retrospective study. Plast Reconstr Surg 90 (4):585–591
22. Koury ME, Epker BN (1992) Maxillofacial esthetics: anthropometrics of the maxillofacial region. J Oral Maxillofac Surg 50 (8):806–820
23. Raschke GF, Bader RD, Rieger UM, Schultze-Mosgau S (2011) Photo-assisted analysis of blepharoplasty results. Ann Plast Surg 66(4):328–333. doi:10.1097/SAP.0b013e3181fadd71
24. Starck WJ, Griffin JE Jr, Epker BN (1996) Objective evaluation of the eyelids and eyebrows after blepharoplasty. J Oral Maxillofac Surg 54(3):297–302, discussion 302-293
25. Ellis E IIIrd, Zide MF (2006) Surgical approaches to the facial skeleton. Lippincott & Wilkins, Philadelphia
26. Flowers RS, Flowers SS (1993) Diagnosing photographic distortion. Decoding true postoperative contour after eyelid surgery. Clin Plast Surg 20(2):387–392
27. Farkas LG (1981) Anthropometry of the head and face in medicine. Elsevier, New York
28. Farkas LG, Munro IR (1987) Anthropometric facial proportions in medicine. Charles C Thomas, Springfield
29. Biesman BS (1999) Blepharoplasty. Semin Cutan Med Surg 18 (2):129–138
30. Codner MA, Wolfli JN, Anzarut A (2008) Primary transcutaneous lower blepharoplasty with routine lateral canthal support: a comprehensive 10-year review. Plast Reconstr Surg 121(1):241–250. doi:10.1097/01.prs.0000295377.03279.8d
31. Evans BG, Evans GR (2008) MOC-PSSM CME article: zygomatic fractures. Plast Reconstr Surg 121(1 Suppl):1–11. doi:10.1097/01.prs.0000294655.16607.ea
32. Cole P, Kaufman Y, Hollier L (2009) Principles of facial trauma: orbital fracture management. J Craniofac Surg 20(1):101–104. doi:10.1097/SCS.0b013e318190e1b6
33. Gonzalez-Ulloa M (1962) Quantitative principles in cosmetic surgery of the face (profileplasty). Plast Reconstr Surg Transplant Bull 29:186–198
34. Gosman SD (1950) Anthropometric method of facial analysis in orthodontics. Am J Orthod 36(10):749–762
35. Edler R, Agarwal P, Wertheim D, Greenhill D (2006) The use of anthropometric proportion indices in the measurement of facial attractiveness. Eur J Orthod 28(3):274–281
36. de Almeida MD, Bittencourt MA (2009) Anteroposterior position of mandible and perceived need for orthognathic surgery. J Oral Maxillofac Surg 67(1):73–82
37. Poeschl PW, Baumann A, Dorner G, Russmueller G, Seemann R, Fabian F, Ewers R (2012) Functional outcome after surgical treatment of orbital floor fractures. Clin Oral Investig (in press)
38. Powell N, Humphreys B (1984) The five major aesthetic masses of the face. In: Proportions of the aesthetic face. Thieme-Stratton, New York, pp 15–40
39. Stewart JM, Carter SR (2002) Anatomy and examination of the eyelids. Int Ophthalmol Clin 42(2):1–13
40. Patipa M (2000) The evaluation and management of lower eyelid retraction following cosmetic surgery. Plast Reconstr Surg 106 (2):438–453, discussion 454-439
41. Patel MP, Shapiro MD, Spinelli HM (2005) Combined hard palate spacer graft, midface suspension, and lateral canthoplasty for lower eyelid retraction: a tripartite approach. Plast Reconstr Surg 115 (7):2105–2114, discussion 2115-2107

42. Hwang K, Kim DH (2011) Analysis of zygomatic fractures. J Craniofac Surg 22(4):1416–1421. doi:10.1097/SCS.0b013e31821cc28d
43. Kirby EJ, Turner JB, Davenport DL, Vasconez HC (2011) Orbital floor fractures: outcomes of reconstruction. Ann Plast Surg 66 (5):508–512. doi:10.1097/SAP.0b013e31820b3c7a
44. Sharabi SE, Koshy JC, Thornton JF, Hollier LH Jr (2011) Facial fractures. Plast Reconstr Surg 127(2):25e–34e. doi:10.1097/PRS.0b013e318200cb2d
45. Werther JR (1998) Cutaneous approaches to the lower lid and orbit. J Oral Maxillofac Surg 56(1):60–65
46. Courtney DJ, Thomas S, Whitfield PH (2000) Isolated orbital blowout fractures: survey and review. Br J Oral Maxillofac Surg 38(5):496–504. doi:10.1054/bjom.2000.0500
47. Rohrich RJ, Coberly DM, Fagien S, Stuzin JM (2004) Current concepts in aesthetic upper blepharoplasty. Plast Reconstr Surg 113(3):32e–42e