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Changes in scleral exposure following Le Fort I maxillary advancement or impaction

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ABSTRACT

Background and objectives: Inferior scleral exposure is an aesthetic as well as functional concern. The purpose of this study was to evaluate and compare changes in scleral exposure following Le Fort I (LFI) maxillary advancement or impaction.

Methods: 43 patients with inferior scleral show who underwent LFI osteotomy were studied. Patients underwent two types of surgery: maxillary advancement was performed in 21 patients and maxillary impaction in 22 patients. Preoperative and 6-month postoperative frontal photographs of patients were analyzed with Adobe Photoshop CC 2018 and compared for scleral exposure by the ratio of the distance between inferior eyelid margin and corneal limbus to eye height.

Results: The mean maxillary movement was 6.14 mm advancement in LFI advancement group and 4.4 mm impaction in LFI impaction group. The mean scleral show ratio decreased by 4.25% (4.4% in the right and 4.1% in the left eye) in LFI advancement and 3.65% (3.5% in the right eye and 3.8% in the left eye) in LFI impaction group. These changes were statistically different in each group but they were the same when comparing two groups (p-value > 0.05).

Conclusion: Both LFI advancement and LFI impaction significantly decreased scleral exposure in our patients.

1. Introduction

Lower eyelid scleral show is an unpleasant facial feature in a relaxed neutral gaze. In many cases, the underlying problem is a skeletal deformity, which causes distortions in the covering soft tissues. In others, a mixed maxillofacial deformity constitutes the etiology. Further involvement of the soft tissues exaggerates the scleral show and contributes to esthetic dissatisfaction [1]. Besides the cosmetic implications, malalignment of the lower eyelid can cause lid laceration, foreign body sensation, blurry vision, and keratopathy. The latter could present as a chronic hypertrophic inflammation of conjunctiva with consequent keratinization and corneal damage [2].

A thorough understanding of the facial anatomy is key to diagnosis and treatment of inferior scleral exposure. As conjunctival

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epithelium continues to cover the scleral surface, moving elements of the lower eyelid are affected by midfacial skeletal structures [1, 3–6]. The optimal and desirable relationship between these structures is which in the lateral view, the most anterior point of the eyeball is seen posterior to the lower eyelid margin. Further forward position of the eyeball results in inferior scleral exposure and undermines the zygomatic prominence [1,5].

The role of midfacial skeletal structures in facial proportions has been further appreciated after observing the positive effects of inferior orbital rim and zygomatic augmentation. The excessive scleral show may be seen in patients with class III malocclusion and midfacial and maxillary deficiency who are candidates for Le Fort I (LFI) Advancement surgery, and patients with long-face syndrome and vertical maxillary excess (VME) who are candidates for LFI Impaction surgery [7].

Classically, surgery aims to correct the relationship of facial structures to achieve a desirable occlusion and esthetics. This is especially helpful for patients with VME who benefit from the Le Fort procedure with superior repositioning of the maxilla, which relieves the tension in facial muscles and decreases the inferior scleral exposure. Similarly, LFI with advancement may correct facial proportions and improve esthetics [5].

Soydan et al. [3] and Posnick and Sami [8] recently demonstrated the favorable results of advancement with or without superior repositioning of the maxilla for improvement of inferior scleral show. Advancement and impaction, however, have not been compared independently in the literature. We thus aimed to compare LFI advancement with LFI impaction for improving the scleral show in our patients.

2. Materials and methods

This study was conducted in accordance with the World Medical Association Declaration of Helsinki (of 1975 as revised in 2000) and was approved by the ethics committee of Shahid Beheshti University of Medical Sciences. In a retrospective chart review, we evaluated all patients with scleral show who underwent LFI advancement or LFI impaction in a Taleghani Hospital (Tehran, Iran) between 2003 and 2018. After exclusion of patients with systemic diseases, history of trauma, previous surgery, cleft lip or palate, and those with incomplete or inaccurate photographs or cephalograms, 43 patients were eligible.

All patients had standard frontal photographs in natural head position; otherwise, they were excluded from the study. Surgery had been performed by maxillofacial surgeons of Shahid Beheshti University of Medical Sciences (Tehran, Iran) from the pterygomaxillary fossa up to the piriform process (few millimeters above the maxillary teeth apices). For fixation, four plates (two on each side) and 16 titanium screws had been used in all patients.

Patients' photographs and lateral cephalograms at baseline and at least 6 months postoperatively were analyzed using the Dolphin software (version 10.5, Canoga Park, CA), and vertical and sagittal maxillary changes were determined by superimposition of before and after tracings. Adobe Photoshop CC 2018 was used to measure the distances on frontal photographs of patients in order to calculate lower eyelid scleral exposure (Fig. 1). All measurements were performed twice, 10 days apart, by a resident of orthodontics who was blinded to patient characteristics and groups.

The intraclass correlation coefficient (ICC) was calculated to assess the reliability of measurements. The mean and standard deviations of measurements and ratios were calculated and reported. Normality of data was tested using Kolmogorov-Smirnov or Shapiro-Wilk tests. The two groups were compared using repeated measure ANOVA. The association between final scleral exposure and surgery type, baseline scleral show, and the amount of advancement or impaction was investigated using linear regression analysis.

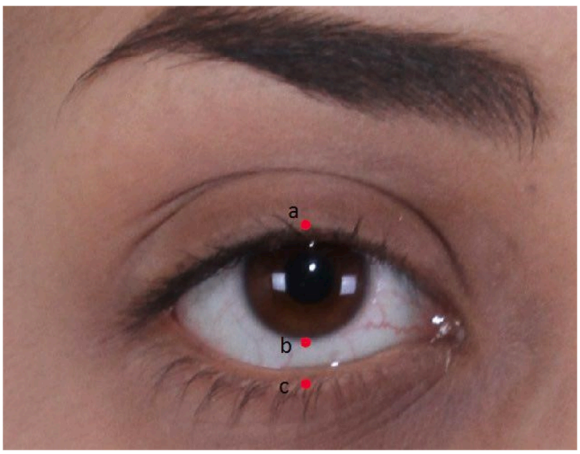

Fig. 1. The lower scleral exposure was determined by pixel count of the distance from the lower eyelid margin (c) to corneal limbus (b). The number of pixels within the palpebral fissure (a to c) was determined to calculate the ratio of lower scleral exposure to palpebral fissure height.

3. Results

21 patients (13 males and 8 females) underwent LFI advancement and 22 patients (10 males and 12 females) underwent LFI impaction. Patients' age ranged from 18 to 30 years with the mean of 22 years. The ICC was 0.95 for cephalogram tracings and 0.98 for photograph measurements. The mean advancement at point A in the LFI advancement group was 6.14 mm (range 2.2–10.2 mm) and the mean superior repositioning at point A was 4.4 mm (range 2–7.7 mm) in the LFI impaction group (Table 1). The scleral show significantly decreased in the LFI advancement group by 5.3% ($P = 0.014$) and 6.3% ($P = 0.010$) in the right and left eyes, respectively, and by 2.4% ($P = 0.026$) and 4.4% ($P = 0.014$) in the right and left eyes in the LFI impaction group.

4. Discussion

The positions and internal proportions of the eyes are of central importance to aesthetics of the face. The lower sclera should not normally be visible in neutral and relaxed frontal gaze [9,10]. Scleral exposure can be due to midface deficiency or maxillary hypoplasia and its skeletal and dentofacial consequences or can be associated with other conditions such as exophthalmos, senile lower lid laxity, history of trauma, or previous facial surgery [3,11]. In the latter instance, therapeutic options include fat transplantation, soft tissue augmentation, and infraorbital implants; in the former case, however, orthognathic surgery is the treatment of choice and can address both the soft tissue misconfiguration and the underlying skeletal deformity [12,13]. This is why careful clinical examination and evaluation of the orbit and periorbital area are warranted before the treatment strategy can be planned [14]. In this study, we reported our experience with two types of LFI surgery (advancement or impaction) and demonstrated their equal effectiveness in improving scleral exposure.

Our results are supported by the favorable ICC values of 0.95 for cephalometric and 0.98 for photographic readings, both of which indicate reliable measurements. For assessment of scleral exposure, we compared the distances between lower corneal limbus and inferior eyelid margin as well as palpebral fissure height using pixel counting method. Proportional comparison using pixel counts has the advantage of overcoming inaccuracies associated with actual measurement of distances on photographs. The same methodology was also used by Soydan et al. [3], Shafaee Fard et al. [14], and Posnick and Sami [8]. More recently, however, another method was developed by Magraw et al. [11] and also reported by Garaas et al. [15] using pixel count to calculate visible scleral surface area (SSA) and the distance from the inferior eyelid margin to the center of the pupil (MED). Both of these methods have some strengths and limitations. Nevertheless, they both rely on accurately taken facial photographs in natural head position.

Garaas et al. [15] showed that a modified LFIII osteotomy was superior to LFI osteotomy with maxillary bone grafting in reducing medial, lateral, and inferior scleral exposure. This treatment, however, is suitable for patients with deficiency due to the maxillary-malar complex retrusion but not for those with deficiencies limited to the midface and maxilla, where LFI is the procedure of choice [14]. On the other hand, Soydan et al. [3] compared LFI advancement to LFI advancement plus impaction and demonstrated that impaction did not add any extra benefit to advancement alone and suggested that impaction might only be effective if performed by greater than 3 mm. Since they did not evaluate LFI with impaction independently, this suggestion needs to be further studied. We hereby showed that LFI with impaction was as effective as LFI with advancement. Hence, our results are applicable to patients in whom LFI with impaction alone is warranted, such as long-face patients with VME.

In the present study, the mean amount of maxillary advancement at point A was 6.14 mm in advancement group, and the mean amount of maxillary impaction was 4.4 mm in impaction group; these reductions were statistically significant. In the study by Posnick and Sami [8], the maxillary surgical changes included 6 mm of advancement at incisors and 3 mm of impaction at incisors and molars. Soydan et al. [3] reported that the mean maxillary advancement was 7.3 mm in one group; while the mean maxillary advancement and impaction were 5 mm and 3 mm, respectively in another group. In the study by Magraw et al. [11] LF III surgical procedure resulted in 7.4 mm of maxillary advancement at point A. The mean amount of maxillary advancement was 3.75 mm at incisors in the study by Shafaee Fard et al. [14].

In our study, the mean reduction in the proportion of sclera show to eye height was 4.25% in maxillary advancement and 3.65% in maxillary impaction. In the study by Posnick and Sami [8] this ratio averagely decreased by 6% and 8% in the left and right sides, respectively. Soydan et al. [3], reported 6–8% reduction in this ratio in 2 study groups. In the study by Shafaee Fard et al. [14], this proportion decreased by 8% in a total of 16 eyes of 8 patients. Comparing the results of the present study with the study of Garaas et al. which showed a result of 3.79% change in sclera exposure [15] it can be concluded that the results are almost the same.

While the results of the aforementioned studies may seem numerically small, pre-to postoperative changes were statistically significant and clinical improvement was observed; lower sclera show completely resolved in two cases (Fig. 2).

Among the limitations of our study, we have to mention the retrospective nature, which could not address all possible confounders. Our surgical team, in addition, consisted of multiple surgeons, which can potentially introduce a source of bias due to various levels of expertise in these techniques.

Table 1
Amount of maxillary (A point) displacement after surgery in each group.

Group	Mean sagittal displacement (mm)	Mean vertical displacement (mm)
Le Fort I maxillary advancement	6.14	1.84
Le Fort I maxillary impaction	1.59	4.4

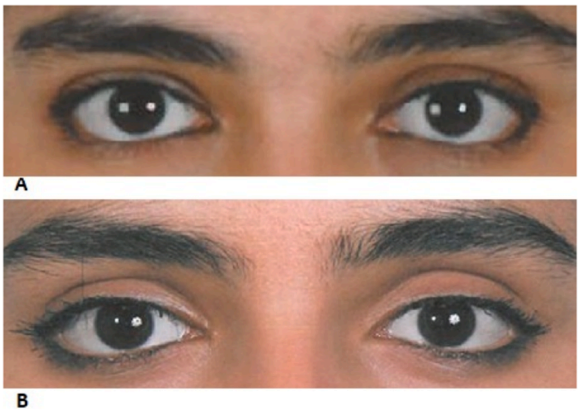

Fig. 2. Preoperative (A) and postoperative (B) frontal facial photographs of case #3.

5. Conclusion

To summarize, our study indicated nearly 4.25% decrease in scleral exposure after LFI advancement and 3.65% after LFI impaction, both significantly effective in decreasing scleral exposure.

Conflict of interests

The authors declare that they have no competing interests.

Ethical approval

This study was conducted in accordance with the World Medical Association Declaration of Helsinki (of 1975 as revised in 2000) and was approved by the ethics committee of Shahid Beheshti University of Medical Sciences. (Institutional Review Board: IR.SBMU.RIDS.REC.1395.351).

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