

# Assessment of the lateral pterygoid plate fractures during Le Fort I osteotomies regarding the angulation of the osteotome

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## SUMMARY

**Aim.** This study aimed to clarify the relation between the angulation of the curved osteotome and fracture of the pterygoid plate during Le Fort I osteotomy.

**Material and methods.** Twenty-one specimens of hemisectioned Turkish skulls were used for the study. The maxilla was sectioned transversely on the floor of the pyriform aperture and posteriorly to the lateral pterygoid plate with a mechanical saw. The pterygomaxillary junction was separated with a curved osteotome by angulating the osteotome with, 0° and -30° to the occlusal plane. The undesired fractures of the lateral pterygoid plate were determined. Among 21 specimens, 7 pterygomaxillary junctions were separated with an angle of +30°, 7 with 0° and 7 with -30° to the occlusal plane.

**Results.** In group +30°, the undesired fracture occurred in 6 of the cases. In group -30°, the undesired fracture was determined in one case. In cases where the separation was performed by placing the osteotome parallel to the occlusal plane all plates remained safe.

**Conclusion.** Within the limited knowledge of the current study it can be concluded that the osteotome should be placed parallel to the occlusal plane.

**Key words:** pterygoid plate, LeFort I, osteotome.

## INTRODUCTION

Le Fort I osteotomy is a widely used maxillary surgical intervention for the correction of dentofacial deformities (1). During this procedure, pterygomaxillary disjunction via an osteotome is required for the complete mobilization of the maxilla.

Complication rates secondary to secondary fractures of Le Fort I osteotomy varies from 6.1% to 9.1% (2). In addition, it has been reported that many complications of Le Fort I osteotomy occur from unfavorable disjunction of the pterygoid plates from the posterior maxillary wall, including excessive bleeding (3, 4), cranial nerve injury (5-7), carotid artery injury (8) and blindness (9). According to Ueki et al. (11), anatomic variants of the skull base such as bony defects or incomplete ossifications, abnormally thick posterior walls of the maxilla and pterygoid plates could increase the risk of the above mentioned complications.

Dolanmaz et al. (12) have suggested that the incidence of complication was reported to be less for pterygomaxillary disjunction carried out with curved osteotomes. In addition, proper positioning of the curved osteotome in the pterygomaxillary fissure could avoid damaging the pterygoid plates and adjacent structures. It has been also strictly recommended that the pterygomaxillary disjunction osteotome should be placed parallel to the maxillary occlusal plane to avoid injuring the internal maxillary artery (13).

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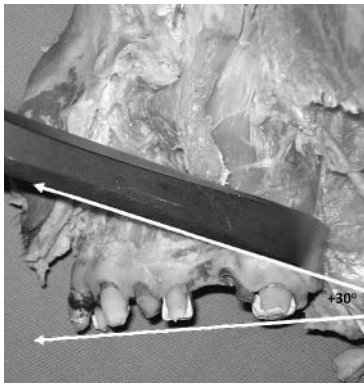
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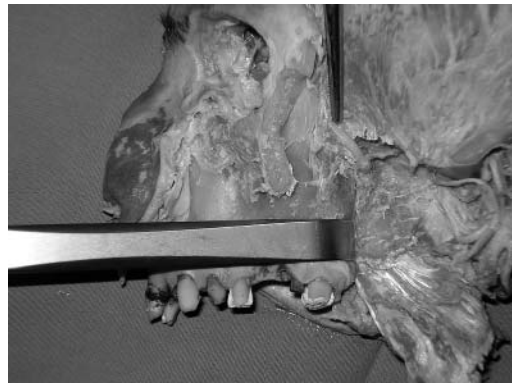
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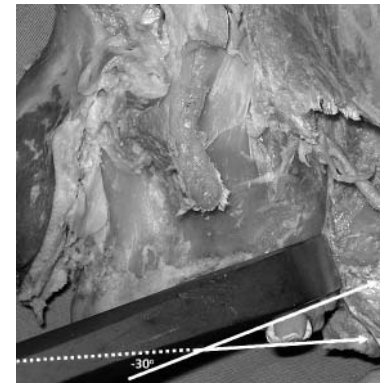
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**Fig. 1.** Placement of the curved osteotome with an angle of  $+30^\circ$  (Group A)



**Fig. 2.** Placement of the curved osteotome with an angle of  $0^\circ$  (Group B)



**Fig. 3.** Placement of the curved osteotome with an angle of  $-30^\circ$  (Group C)

This anatomical study aimed to clarify the relation between the angulation of the curved osteotome and unfavorable fracture of the pterygoid plate during Le Fort I osteotomy.

## MATERIAL AND METHODS

This study was based on twenty-one hemisectioned specimens of 11 embalmed adult cadaveric heads (10 male, 2 female) from body donation to the Anatomy Department of the Gulhane Military Medical Academy. There were 14 males and 2 females of undetermined age. None of the cadavers had any clinical evidence of a previous mandibular or facial trauma, surgery, tumor, or any other maxillofacial pathologic features. All specimens maintained enough complement of teeth in the maxilla enabling the identification of the maxillary occlusal plane.

The cadavers were used after obtaining the appropriate consents and approvals. All methods for securing human tissue were humane and complied with the tenets of the Declaration of Helsinki.

### Surgical procedure

The upper lip was resected and a mucoperiosteal flap was elevated between the upper right first molar and upper left first molar in the buccal sulcus. A curved osteotome was placed in the pterygomaxillary fissure and the pterygomaxillary junction was separated by angulating the osteotome with,

- A.  $+30^\circ$  (Group A, n:7 hemi heads) (Figure 1);
- B.  $0^\circ$  (Group B, n:7 hemi heads) (Figure 2);
- C.  $-30^\circ$  (Group C, n:7 hemi heads) (Figure 3)

to the maxillary occlusal plane. Multiple blows with the mallet were performed for the separation. The control of the osteotomy was maintained by the palpation of the osteotome palatally at the pterygomaxillary junction while jiggling the osteotome at the osteotomy site. The unfavorable fractures of the lateral pterygoid plate were determined. Among 21

specimens, 7 pterygomaxillary junctions were separated with an angle of  $+30^\circ$ , 7 with  $0^\circ$  and 7 with  $-30^\circ$  to the occlusal plane.

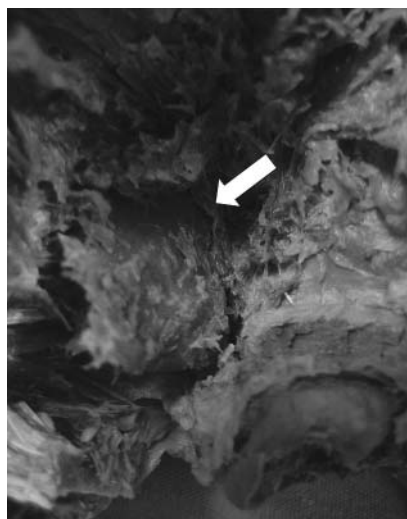
## RESULTS

In group A ( $+30^\circ$ ), the undesired fracture occurred in 6 of the cases. Four of these (Figure 4) were resulted from improper disjunction of the upper third of the lateral pterygoid plate. The other two fractures were decompression-like fractures (Figure 5). In group C ( $-30^\circ$ ), the undesired fracture was determined in one case (decompression-like). In cases where the separation was performed by placing the osteotome parallel to the occlusal plane (Group B) all pterygoid plates remained intact (Table 1).

## DISCUSSION

Many of the complications of the Le Fort I osteotomy have been attributed to unfavorable disjunction of the pterygoid plates from the posterior maxillary wall (Table 2) (2, 14). In Le Fort I osteotomy, following the detachment of the nasal septum from the nasal crest of the maxilla and the cut of the maxillary antral walls, the only remaining bony attachments preventing mobilization of the maxilla are the bilateral junctions between the pterygoid plates of the sphenoid bone and the pyramidal process of the palatine bones. It is extremely valuable avoiding this unfavorable fractures before they occur, because manipulation of the bones at the base of the skull during surgery may inadvertently cause damage to the vessels and nerves in the region, resulting in life-threatening complications (15).

Several authors have indicated that understanding the anatomy of the pterygomaxillary junction region could help preventing blood loss in Le Fort I osteotomies. Sicher and Du Brull (16) have described a reinforcing pillar system in the maxilla



**Fig. 4.** Fracture of the lateral pterygoid plate resulting from unproper dysjunction



**Fig. 5.** Decompression-like fracture of the lateral pterygoid plates

and the pterygoid plates which may resist horizontal fractures of the pterygoid plates during pterygomaxillary disjunction (2) In a radiological study of Ueki et al., (11) the importance of the CT examination to recognize the anatomy of pterygomaxillary region and the exact positions of descending palatine artery before Le Fort I osteotomy is emphasized. Hwang et al. (17) stated that preoperative computed tomography review of the thin pterygomaxillary region and concaved pterygomaxillary fissure is greatly helpful to the surgery.

Numerous studies have focused on the safety end effectiveness of down fracture in Le Fort I oste-

**Table 1.** The description of the data showed that the placement of the osteotome with an angle of +30 resulted in unfavorable fracture of the pterygoid plates in 85.7% of the hemi heads.

Group	Angulation	Hemi heads (n)	Fractured pterygoid plate (n)	Percentage
A	+30°	7	6	85.7%
B	0°	7	0	0%
C	-30°	7	1	14.2%

**Table 2.** Possible complications resulting from unfavorable pterygomaxillary disjunction (Adopted from Lanigan et al.1993 and Wilson et al, 2000).

- Major arterial bleedings resulting from the internal maxillary artery and its terminal branches (descending palatine and sphenopalatine arteries)
- Major venous bleedings resulting from the pterygoid plexus
- Tears in muscles adjacent to the pterygoid plates resulting in venous and arterial bleeding.
- Epistaxis (anterior or posterior)
- Pseudoaneurysms and arteriovenous fistulas.
- Ophthalmic complications including complete visual loss
- Cranial nerve III and cranial nerve VI palsies
- Epiphora resulting from surgical trauma of the nasolacrimal duct

otomies performed with and without the separation of pterygomaxillary junction. Dolanmaz et al. (12) have stated that the use of osteotomes for pterygomaxillary disjunction increases the incidence of fractures in maxillary osteotomy. Besides that, Kamg et al. (18) have emphasized the importance of complete pterygomaxillary separation during Le Fort I osteotomies in avoidance of one of the most serious complication of the procedure: internal carotid artery injury. They have indicated that if a secure and complete pterygomaxillary separation is not achieved before maxillary down fracture, the presence of a bony protrusion that projected posteriorly from the base

of the sphenoid, lying inferior to the foramen lacerum and could pose a considerable risk to the internal carotid artery due to its size, shape, and location.

Trimble and Tideman (19) suggested a safer posterior osteotomy through the maxillary tuberosity posterior to the second molar after extraction of the third molar teeth. Separation of the maxilla from the skull base may also be achieved by the osteotome transecting the tuberosity, however, osteotomy through the tuberosity reduces unfavourable fractures of the pterygoid plates and also increases the safety margin by avoiding encroachment on structures of the sphenopalatine fossa (20). Therefore, ptery-

gomaxillary disjunction remains still as a versatile component of Le Fort I procedures.

Previous studies have proclaimed that, forces generated during pterygomaxillary separation are the most likely cause of unfavorable secondary fractures (14, 21, 22). According to the results of the current study, in 6 of 7 cases, placing the osteotome with an angle of +30° resulted in undesired fractures. In four specimens, fracture has occurred in upper third of the plates. Unsufficient separation of the pterygomaxillary junction might necessitated an application of an overabundant force during disjunction and resulted in this complication. Besides that, decompression fractures (two cases from the Group A and one case from the Group B) might be attributed to unproper placement of the osteotome which might resulted in excessive and

unbalanced force transduction direct to the plate during blowing with the mallet.

It is obvious that the discontinuity resulting from a decompression fracture could complicate a successfully pterygomaxillary disjunction. However, to our opinion, a fracture of the upper third of the pterygoid plate can cause more serious complications because of its close proximity to the the sphenopalatine fossa.

Might one conclude that, the results of the current study are controversial, thus forces generated during the maxillary osteotomy and downfracture were not measured and standardized. In the current study, same surgeon performed the multiple blows with the mallet for the separation to overcome the problem regarding the standardization of the force applied.

The thin pterygomaxillary region and less concave pterygomaxillary fissure draw precautionary attention to vulnerable pterygoid plates fractured in the procedure of Le Fort I osteotomy (17). The angulation of the curved osteotome plays a key role in avoidance of possible complications secondary to unfavorable fractures of the pterygoid plates. Within the limited knowledge of the current study, it can be concluded that the curved osteotome should be placed parallel to the maxillary occlusal plane.

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**Contribution:** AG, HAA, MA and MŞ have designed the study, AG and CK has performed the dissections, AG, MG and YA have written and edited the paper.

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