



# Novel Surgical Technique for Repair of Zygomatic Fractures: Lever Technique

Une nouvelle technique chirurgicale de réparation des fractures zygomatiques : la technique de levier

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## Abstract

**Background:** Zygoma is a very crucial component for the anteroposterior positioning of the midface and for the maintenance of facial contours. Zygomatic fractures are considered as the second most common type of facial fractures following nasal fractures. We have developed a new reduction technique called “lever,” which is based on the application of lifting force as an alternative to the methods in which the pulling force is applied. **Patients:** Over a 12-year period, 90 patients were treated with minimal access approach and 130 patients were treated with open reduction internal fixation (ORIF), using the lever technique. **Results:** In the follow-up period, no complications occurred in any of the patients who underwent minimal access approach. Miniplate removal operation was performed in 3 of the patients. Enophthalmos developed in one patient. Since 4 of the 7 suboptimal reduction patients did not experience any functional or cosmetic problems, no treatment was necessary and the remaining 3 patients underwent fat graft due to the presence of malar depression. **Conclusion:** This minimally invasive surgical procedure we have developed can be successfully used both in the minimal access approach and in ORIF, especially in delayed cases. We recommend this method due to the reasons that it is safe to conduct, easy to learn, fast to apply, simple to perform, and also economical to deploy.

## Résumé

**Historique :** L'os zygomatique est décisif pour le positionnement antéropostérieur de la partie médiane du visage et la préservation des contours du visage. Les fractures zygomatiques sont considérées comme la deuxième cause de fractures du visage en importance, après les fractures du nez. Les auteurs ont créé une nouvelle technique de réduction, la « technique de levier », qui repose sur l'application d'une force de soulèvement plutôt que sur les méthodes reliées à une force de tension. **Patients :** Sur une période de 12 ans, 90 patients ont subi un abord d'accès minime et 130, une fixation interne par réduction chirurgicale (FIRC) à l'aide de la technique de levier. **Résultats :** Pendant la période de suivi, aucun patient ayant subi l'abord d'accès minime n'a souffert de complications. Trois ont dû faire extraire des mini-plaques. Un patient a souffert d'énophtalmie. Puisque quatre des sept patients ayant subi une réduction sous-optimale ne présentaient aucun problème fonctionnel ou esthétique, ils n'ont pas eu besoin de traitement supplémentaire, et les trois autres ont reçu une greffe de tissus adipeux en raison d'un enfoncement malaire. **Conclusion :** Cette intervention peu effractive mise au point par les auteurs peut être utilisée avec succès pour l'abord d'accès minime et la FIRC, surtout dans les cas différés. Ils recommandent cette méthode parce qu'elle est sécuritaire, facile à apprendre, facile à appliquer et à exécuter et peu coûteuse.

## Keywords

closed zygoma reduction, facial trauma, minimal access approach, open zygoma reduction, zygomatic arch fracture, zygomatic fracture

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## Introduction

Zygoma is a very crucial component for the anteroposterior positioning of the midface and for the maintenance of facial contours.<sup>1</sup> Following nasal fractures, zygomatic fractures are considered as the second most common facial fracture type,<sup>2</sup> and these types of fractures represent 13% of all the craniofacial fractures.<sup>3</sup> Several techniques have been used to treat zygomatic fractures.<sup>4-10</sup> There is still controversy related to the subject and no consensus has been reached on the best surgical technique to be deployed for the treatment of zygomatic fractures. The common goal for the successful treatment of zygomatic fractures is accurate reduction and the 3-dimensional restoration of the disturbed anatomy to achieve preinjury cosmetic and functional appearance, while minimizing complications.<sup>11</sup> Fracture reduction can be performed through an open reduction internal fixation (ORIF) or with minimal access approach depending on the clinical signs and radiographic analysis.

Minimal access approach through extraoral, intraoral, or percutaneous accesses is used for most cases of pure zygomatic arch (ZA) fracture.<sup>9</sup> However, in these techniques, the fracture reduction is achieved by pulling force, which can lead to complications such as difficulty in manipulation, especially in severe depressive and delayed fractures, as well as inadequate reduction and extra fractures which may be caused due to the excessive and uncontrolled force exertion in fracture fragments. In this study, in order to remove the above disadvantages, we have developed a new reduction technique called the "lever," which is based on the application of lifting force as an alternative to various methods in which the pulling force is applied. We have used this technique for minimal access approach and for ORIF of zygoma fractures.

## Materials and Methods

### Patients and Methods

Over a 12-year period (2005-2017), 90 patients were treated with minimal access approach, while 130 patients were treated with ORIF using the lever technique in our department. The mean age of the patients was 40.2 years (range: 13-90 years), and there were 180 men and 40 women included in the study. It was observed that in 5 of the patients, bilateral zygomatic bone were affected. The affected side was the right side in 93 patients and the left side in 122 patients. The causes of the injuries were motor vehicle accident (71), falling down (66), physical assault (49), animal attack (15), sports injury (12), work-related injuries (5), and gunshot injury (2). There were maxillofacial traumas accompanying 72 patients. During treatment, maxilla in 41 patients, mandible in 19 patients, and frontal and nasal bone fractures were found in 15 patients. Table 1 shows the data of the patients.

In this case, we used a classification which classify the zygomatic fractures as monopod, dipod, or tripod fractures. The monopod fractures included (1) zygomaticofrontal (ZF), (2) zygomaticomaxillary, and (3) ZA fractures. The dipod fractures were subclassified into 3 types according to combination

**Table 1.** Demographic and Operative Details of Patients.

	Minimal Access Approach	ORIF	Total
<b>Gender</b>			
Male	73	107	180
Female	17	23	40
<b>Etiology</b>			
Traffic accident	17	54	71
Fall down	35	31	66
Assault	24	25	49
Animal attack	3	12	15
Sports injury	8	4	12
Work-related injuries	3	2	5
Gunshot injury		2	2
Mean of age	42.9	38.3	40.2
<b>Laterality</b>			
Right	40	53	93
Left	50	72	122
Bilateral		5	5
<b>Associated maxillofacial injuries</b>	3 cases	69 cases	72 cases
Maxilla		41	
Mandible	3	19	
Nasal bone		15	
Frontal bone		15	
Orbit		8	
Sphenoid bone		4	
Ethmoid bone		4	
Temporal bone		1	
Vomer		1	
<b>Treatment</b>	Closed reduction	Mini plate, K-wire	
<b>Complication</b>			
Persisted paresthesia		9	22
Pin removal		4	
Retreatment		4	
Fat graft application		3	
Enophthalmos		2	

Abbreviation: ORIF, open reduction internal fixation.

of the previously mentioned 3 sites, which were 1 and 2, 1 and 3, and 2 and 3. Tripod fracture included all 1, 2, and 3.<sup>12</sup> During the study period, in 220 patients, 225 zygomatic fractures were treated in total of 144 monopods (90 ZA fractures), 53 dipods, and 28 tripods fractures (Table 2).

The patients were evaluated by simple radiography (Water view or submentovertex view) and/or with computed tomography and with post-operative physical examination. Mean follow-up time was 16 months.

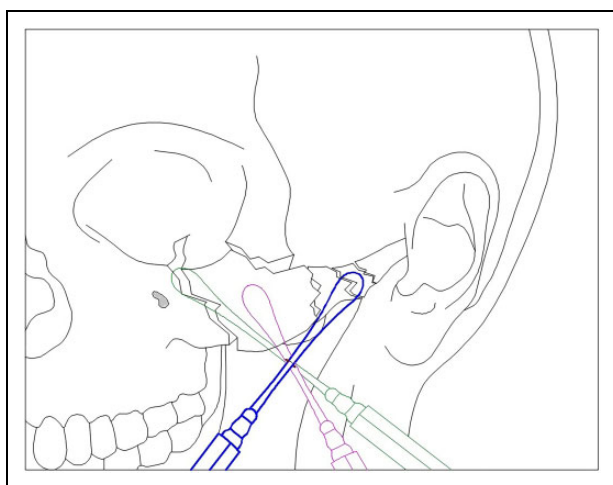
### Surgical Technique

Lever technique was used in isolated depressed ZAs and/or in body fractures. Lever technique was not used in isolated ZF fractures. The lower edge of the zygoma body was identified by palpation. A 4-mm incision was made parallel to the skin creases

**Table 2.** Classification of Zygomatic Fractures.

Location	Type	No. Cases	%
Monopod		144	64
	ZA	90	40
	ZM	47	20.9
	ZF	7	3.1
Dipod		53	23.5
	ZM + ZA	13	5.7
	ZF + ZM	34	15.2
Tripod	ZA + ZF	6	2.6
		28	12.5
Total	ZM + ZA + ZF	28	12.5
		225	100

Abbreviations: ZA, zygomatic arch; ZF, zygomaticofrontal; ZM, zygomaticomaxillary.



**Figure 1.** Schematic drawing of the Lever technique. It is possible to apply the device in different directions through the same incision so as to repair varies zygoma fractures.

under this point. The subcutaneous tissues and muscles were dissected by scissors parallel to the facial nerve, and the Yan-kauer nasal septum elevator was utilized under the zygoma or its arch according to the localization of the fracture. In minimal access approach operations, depression was palpated, and the fracture fragment was elevated until the reduction was confirmed by palpation and inspection. The ORIF operations also utilized the same technique for reduction. The fractures of the zygoma arch, body, and inferior orbital rim were simultaneously repaired using the lever technique in complex zygoma fractures (Figures 1–7). Subsequently, internal fixation was performed with miniplate screws similar to conventional methods or in some cases with K-wire.

## Results

No early complications, such as bleeding, hematoma, seroma, or infection, were observed in any of the patients. In the late period, no complications such as non-union or inadequate



**Figure 2.** Elevation of the depressed zygomatic body with Lever technique.



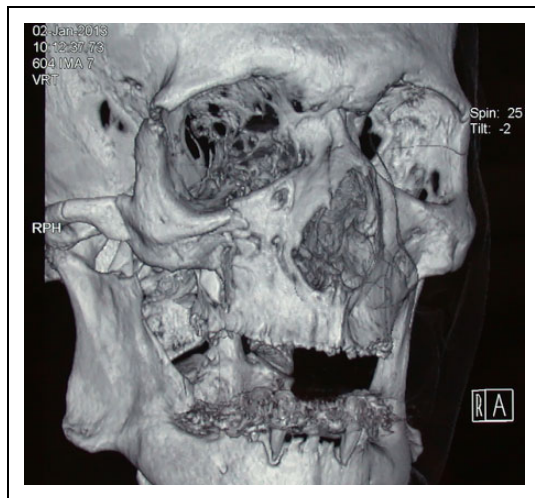
**Figure 3.** Elevation of the depressed zygomatic arch with Lever technique.



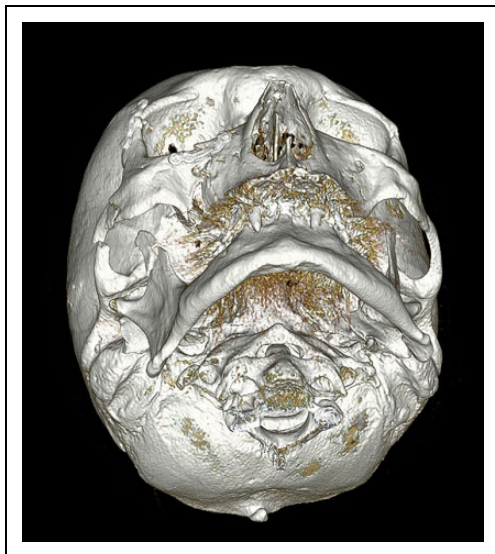
**Figure 4.** Preoperative basal view of a patient who had severe right malar depression due to the zygoma's tripod fracture.



**Figure 5.** Early postoperative basal view after repair of all fractures using Lever technique.



**Figure 6.** Preoperative 3D-CT aspect of the same patient.



**Figure 7.** Early postoperative 3D-CT aspect.

reduction in the fracture line occurred in any of the minimal access approach patients. Miniplate removal operation was performed in 3 patients who underwent ORIF and who were complaining of pain, while 1 patient was having the cause of palpable screw. Enophthalmos developed in one patient with panfacial trauma accompanied by a blow-out fracture and in one patient who was injured by a gunshot. Since 4 of the 7 suboptimal reduction patients did not experience any functional or cosmetic problems, no treatment was necessary, while 3 patients underwent fat graft due to the presence of malar depression. No facial nerve injury occurred in any of the patients. The operation scars, where the elevator was placed on the cheek site, were observed to be inconspicuous.

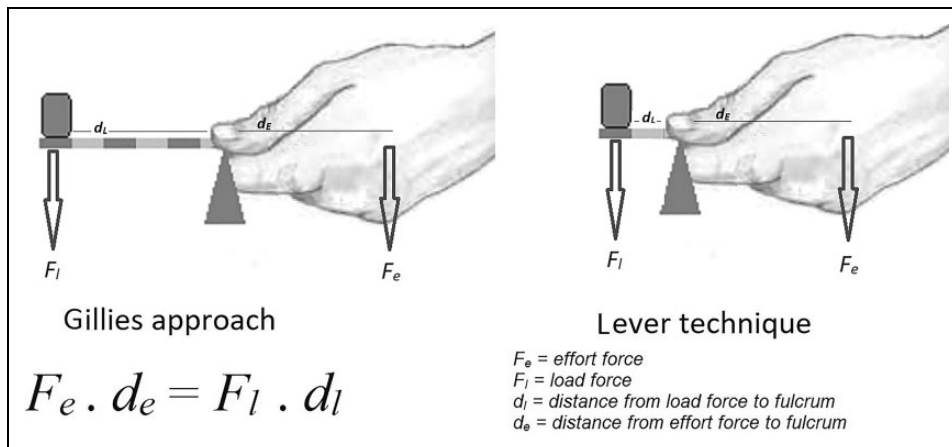
## Discussion

The Gillies temporal approach is most commonly applied for minimal access approach of isolated ZA fractures.<sup>13</sup> However, in this method, since the anatomically deep planes are reached, manipulation is very difficult and the zygoma body and orbital lower-rim cannot be reached with this technique. According to the Lever formula ( $F_e \cdot d_e = F_r \cdot d_r$ ), the greater the distance between the load and the fulcrum, the more force must be applied. In the Gillies approach, the distance from the temporal region, which is the fulcrum point to the zygoma which is accepted as the load is longer than the distance from the fulcrum point (cheek site) to the zygoma in the lever technique (Figure 8). Hence, we need to apply more force in the Gillies approach. This reduces the success of Gillies technique as compared to the lever technique and especially it may be insufficient in the delayed cases. Moreover, Ogden stated that the Gillies technique may lead to the middle temporal vein injury, which can potentially lead to hazardous bleeding.<sup>14</sup>

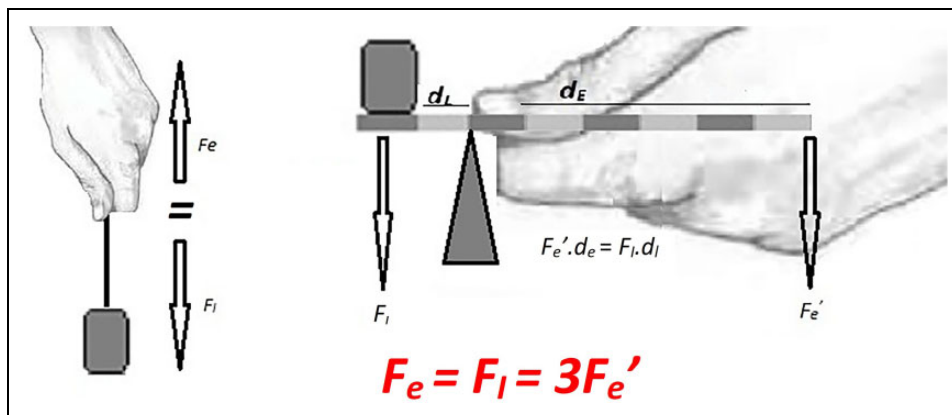
In addition to Gillies approach, several techniques have been reported in the literature for minimal access approach of ZA fractures: intraoral approaches,<sup>15</sup> towel clip,<sup>4</sup> the Volkman bone hook,<sup>6</sup> suture technique,<sup>16</sup> endoscopic reduction,<sup>9</sup> and ORIF using a bicoronal incision.<sup>1</sup>

The intraoral approach (Keen technique) provides access to the zygomatic body and the arch, but due to the intraoral flora, it may increase the infection rates.<sup>17</sup> Towel clip, bone hook, and suture technique are the other methods used in minimal access approach zygoma fractures. In these techniques, as the direct pulling force is applied to lift the zygoma, it is necessary to exert more force than the lever technique, in which only the lift force is applied (Figure 9). These techniques may also be inadequate for treatment in delayed cases.

The endoscopic technique requires the utilization of expensive instruments despite providing the maximum visualization potential and it has a long learning curve. Furthermore, the endoscopic technique also needs extensive access incisions.<sup>18</sup> An open coronal approach is required in posteriorly displaced fractures. This direct approach carries the risk of leaving a long scar, scalp numbness, alopecia, and injury to the temporal branch of the facial nerve.<sup>19</sup> These risks are present in addition to the usual risks associated with the long operation time.<sup>20</sup>



**Figure 8.** Schematic comparison of the Lever and Gillies techniques.



**Figure 9.** Schematic comparison of the Lever and other reduction techniques of the zygomatic body.

In minimal access approach techniques, reduction in classical ORIF techniques is performed by applying direct pulling force to the various surgical instruments mentioned above. Since there is no fulcrum point, as a result, significantly larger and uncontrolled force is applied, which can lead to extra fractures in fracture fragments, as well as complications such as inadequate or failed reductions in delayed cases. However, with the lever technique, reduction is achieved with the application of lifting force by supporting it from a fulcrum point located on the side of the cheek, so that the net force gain is obtained. Thus, the above complications are minimized since a more controlled force is applied. The advantage of the method comes from using the Lever technique in both ORIF and in minimal access approach to zygomatic fractures.

## Conclusion

Thanks to the Lever technique, it is possible to achieve successful reduction in all the fractures of the zygoma except the ZF fractures by directly taking advantage of the increased strength due to the lever effect. This minimally invasive surgical procedure, which we have developed, can be successfully used in both minimal access approach and ORIF, especially in

delayed cases. We recommend the utilization of this method as it is safe to perform, easy to learn, fast to apply, simple to conduct, and economical to deploy.

## Declaration of Conflicting Interests

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