

Accepted Manuscript

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PII: S1743-9191(16)30143-1

DOI: [10.1016/j.ijisu.2016.05.057](https://doi.org/10.1016/j.ijisu.2016.05.057)

Reference: IJSU 2825

To appear in: *International Journal of Surgery*

Please cite this article as: Cortese A, Caggiano M, Carlino F, Pantaleo G, Zygomatic fractures: Technical modifications for better aesthetic and functional results in older patients, *International Journal of Surgery* (2016), doi: 10.1016/j.ijisu.2016.05.057.

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Zygomatic fractures: Technical modifications for better aesthetic and functional results in older patients

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Keywords: Fracture, zygoma, PRF, elderly patients

Abstract

Introduction: The zygomaticomaxillary complex, with its intrinsically prominent convexity, is highly vulnerable to injury. In this study, we evaluated a novel combined approach to the reduction and stabilization of frontozygomatic dislocated fractures without aesthetic damage. **Materials and Methods:** Ten patients (mean age, 52 years) were referred for complex frontozygomatic dislocated fractures. Five patients underwent a transconjunctival approach without canthotomy in association with a transoral maxillary approach and lateral-rim skin incision, also without canthotomy. The other five patients underwent a traditional subciliary incision at the lower eyelid and a vertical lateral incision at the lateral orbital margin. Orbital floor reconstruction was achieved using two to three fixation points and autologous platelet-rich fibrin (PRF). During the 6-month follow-up, the patients were routinely evaluated using computed tomography. **Results:** Treatment was successful in all cases; there were no problems at surgery or postoperatively. During follow-up, all patients had satisfactory facial symmetry, no noticeable scar, ectropion, or lower-eyelid drop, and no functional impairment. **Discussion:** Aesthetic considerations are an important aspect of treatment planning in patients with orbitozygomatic fractures, because of the importance of the eye and lid areas to facial aesthetics. In our patients, good aesthetic results were achieved using a novel combined approach. In patients with a large orbital floor dislocation, the reconstructive titanium mesh can be covered by autologous PRF membranes to improve vascularization of the surgical site. By preventing aesthetic damage and functional impairment, our conservative approach is of particular utility in older individuals due to age-related tissue laxity.

1 Introduction

The zygoma is a quadrangular paired bone located in the midface connected to the maxillary bone on its medial surface (zygomaticomaxillary suture line), the frontal bone on its upper surface (frontozygomatic suture line), and the temporal bone on its lateral surface (zygomaticotemporal suture line). It also forms a deep attachment to the greater wing of the sphenoid bone (zygomaticosphenoidal suture line) [1]. This so-called zygomaticomaxillary complex is important both functionally (by serving as the buttress system of the midface) and aesthetically. Despite the strength and stability conferred upon the zygomaticomaxillary complex by other, thicker facial bones, because of its intrinsically prominent convexity it remains highly vulnerable to injury [2].

Zygomatic fractures are usually caused by a direct blow to the malar eminence or cheek during an assault. The functional and aesthetic consequences of a zygomatic

fracture include diplopia, impaired ocular mobility, hypoesthesia of the infraorbital nerve, mandibular hypomobility, loss of the cheek projection and thus a decreased facial width, enophthalmos, and hypophthalmos [3]. There are two different surgical approaches to the repair of these fractures, closed reduction and open reduction, with the choice depending on stability considerations. If, in response to finger pressure applied on the fracture, stability is preserved, then a closed reduction technique will be sufficient. However, if stability is insufficient, rigid fixation, and therefore open reduction and fixation, are necessary.

Open reduction is more widely accepted and involves a surgical incision to expose the zygomaticomaxillary complex followed by rigid internal fixation. Several types of incisions have been described in the literature [4]. They include a maxillary vestibular approach, a bicoronal scalp flap approach, a lateral canthal incision, transcutaneous lower-eyelid approaches (subciliary, subtarsal, infraorbital), and a transconjunctival (TC) approach with or without canthotomy.

The TC incision was introduced by Bourquet, who used it to explore the orbital rim and floor, and subsequently popularized by Tessier [5]. It produces better cosmetic results than can be achieved with any of the other commonly used incisions. However, because it provides only limited access to the orbital floor, its use should be restricted to fractures of the orbital rim and floor in which extensive fixation procedures are unnecessary [6].

Given the high aesthetic relevance of the midface, it is essential that the surgical treatment of dislocated fractures does not produce scars and/or aesthetic defects. Selection of the proper surgical technique, that is, one that adequately treats the fracture, maintains the patient's facial aesthetics and has an acceptable cost/benefit ratio, is essential. Because aesthetic repair is often the main or only indication for zygomaticomaxillary fracture surgery, the surgical strategy for the treatment of these fractures must follow the same criteria used in aesthetic surgery [7].

The surgical procedure for dislocated fractures commonly requires two or three fixation points: osteosynthesis is performed starting from the zygomatic-frontal suture,

when dislocated at this site, followed by zygomatic body fixation on the anterior sinus wall, anterior orbital floor margin fixation and, in patients with globe dislocation with diplopia, orbital floor reconstruction [8]. The aim of this study was to evaluate the ability of a TC approach without canthotomy in combination with a transoral (TO) maxillary approach and lateral-rim skin incision, also without canthotomy, to achieve adequate reduction and stabilization but without incurring aesthetic damage.

2 Patients and Materials

2.1 Patients

Ten patients diagnosed with dislocated zygomaticomaxillary complex fracture were selected for this study (Table 1, Fig. 1). All of them had been referred to the San Giovanni di Dio e Ruggi d'Aragona University Hospital (Salerno, Italy) after assault or accident. The exclusion criteria for this study were: fractures without displacement or an association with extensive bone or soft-tissue loss.

The following data were recorded in the patients' medical charts: age, sex, photograph of the injured area, etiology and site of fracture, associated maxillofacial injuries, radiographic findings, surgery details, duration of follow-up, and complications. Five of the patients with frontozygomatic dislocated fractures were treated using a TC approach without canthotomy in association with a TO maxillary approach and lateral-rim skin incision, also without canthotomy (TC/TO group). Two or three fixation points using autologous platelet-rich fibrin (PRF) were employed for orbital floor reconstruction. Autologous PRF is particularly useful in older patients, as it provides better bone fragment ossification and soft-tissue healing. The PRF was free of chemicals or drugs.

In patients with intense swelling of the orbital area, surgical correction was delayed until 5–7 days after injury. One hour before the surgical procedure, 12 mL of peripheral blood was withdrawn from the patient, collected in two 9-mL tubes without anticoagulant, and immediately sent to the laboratory of the University Hospital San

Giovanni di Dio e Ruggi d'Aragona of Salerno for PRF preparation using a single centrifugation step of 10 min at 3,000 rpm. After centrifugation, the PRF was collected from the middle of the tube; the red blood cells at the bottom of the tube and the acellular plasma at the top were discarded.

The other five patients comprised the control group. They were treated using a traditional subciliary lower-eyelid incision for a lower-border approach and a vertical lateral-orbit incision along the external margin for an orbital approach.

The follow-up period was 6 months. Postoperative clinical examinations were performed with special attention paid to the symmetry of the zygoma and canthal ligaments, enophthalmos, diplopia, ocular function, scarring, and ectropion. All patients underwent routine computed tomography (CT) imaging to evaluate the adequacy of reduction.

Methods

The 10 patients were operated on under general endotracheal anesthesia. In the TC/TO approach, the TC incision is made through the conjunctiva of the inferior fornix, from the caruncle medially to the lateral fornix, using a postseptal approach to avoid dissection of the lower-eyelid planes and to thus prevent postoperative lower-eyelid sagging.

With this incision, the orbital floor and the inferior border of the orbit are exposed. The conjunctival incision is made using a scalpel and bipolar cautery; the dissection is performed with the aid of a sharp eyelid scissor and follows the postseptal plane up to the periosteal plane of the inferior border. The periosteum is incised and elevated after visualization of the orbital floor fragments below the periosteal plane. A malleable retractor is used to retract the orbital tissues (Fig. 2).

A lateral skin incision approximately 2 cm long is made in the horizontal direction using a scalpel and bipolar cautery to control bleeding and then marked within the eye folds. The subcutaneous layer is dissected using a sharp scissors and extended until the muscular plane. A vertical incision of the periosteal plane along the lateral

border of the orbit prevents facial nerve injury. With this double-layer incision, the frontozygomatic rim of the fracture is exposed.

A mucoperiosteal horizontal incision is made through the maxillary upper buccal mucosa, slightly above the mucogingival junction, using a scalpel and bipolar electrocautery forceps. A subperiosteal dissection is subsequently performed with the aid of a periosteal elevator, which can be expanded to access the entire anterolateral bony surface, up to the borders of the piriform aperture and to the infraorbital rim, including the infraorbital nerve exit. A Rowe zygomatic elevator is inserted through the incision to achieve accurate reduction of the fracture.

Plates and screws are used to achieve fixation at two or three points. For a frontozygomatic fracture that is dislocated or multi-fragmented, the first fixation is placed across the fracture using a 5- to 7-hole micro-plate. The second is placed through the TC incision using a 5-hole (single rim fracture) or 7-hole (multi-fragmented or comminuted fracture) micro-plate with screws. In patients with orbital floor dislocation with diplopia or eye movement impairment, orbital floor reconstruction is carried out to release entrapped muscles (only a revision is performed in this case). The third fixation involves a maxillary vestibular approach and uses a larger 7-hole L-shaped mini-plate. This plate must be properly adapted for a zygoma fracture. The leg of the L-plate must be placed on the most lateral portion of the lateral maxillary buttress, where the bone is fairly thick. Reduction and proper positioning of the zygomatic body are performed by managing the zygomatic bone body fragment using an oral approach and a clamp applied at the lateral area of thick bone.

The lateral canthal skin incision and subcutaneous layer are closed using 6-0 PDS suture for the periosteal plane and 6-0 nylon for the skin suture (intradermal). The intraoral incision site is closed using 5-0 absorbable suture.

Given the rapid healing capability of the conjunctiva, the TC incision is not closed by suture, to avoid postoperative retraction of the eyelid. Rather, a PRF matrix is placed over the orbital floor because of its capability to increase osteoblast attachment and bone regeneration [8] and to prevent adhesions that will limit globe movement and lower-eyelid retraction. In addition, PRF promotes tissue healing, reduces postopera-

tive pain and edema, and limits infection [9], particularly in elderly patients. In case of an orbital floor bone defect $> 1.5 \text{ cm}^2$ or of globe dislocation and diplopia, the orbital floor is reconstructed using a titanium mesh covered by PRF autologous membrane (Fig. 3).

In the control group of patients treated using the traditional technique, a subciliary incision was made to approach the inferior margin of the orbit, followed by a vertical skin incision along the external margin to approach the orbit. Bone fragment fixation and orbital floor reconstruction were carried out as described for TC/TO patients.

3 Results

The mean age of the four male patients and one female patient in the TC/TO group was 52 years (range: 42–65 years). The right side was affected in three patients and the left in two patients. The causes of the injuries were sports accident in two patients, car accident in one patient, and domestic accidents in the other two patients.

In all five patients, dislocation of the zygoma was associated with either a multi-fragmented free bone segment of the orbit or a comminuted fracture. One patient had an associated blow-out fracture, another had associated nasal bone and mandible fractures, and three patients had associated nasal bone fractures. According to the Knight and North classification, two patients were in group V and three were in group VI [10].

All patients were operated on by the same surgeon (AC). The mean operating time was 90 min (range: 60–120 min). In the postoperative assessment, reduction of the fractures was satisfactory in all patients.

During the 6-month follow-up, all patients in the TC/TO group had satisfactory facial symmetry, no noticeable scar, ectropion, or lower-eyelid drop, and no functional impairment (Fig. 4). Moreover, none had persistent diplopia, enophthalmos or an alteration of visual acuity. On postoperative CT, there were no newly developed defects of the orbital floor, no herniation of ocular contents into the maxillary sinus, and no evidence of zygomatic asymmetry in any of the patients (Fig. 5).

The results for both the TC/TO and the control patients are reported in Table 2 at T0 (pre-operative time), T1 (post-operative time), T2 (1 month follow up), T3 (6 months follow up). In the former, mean lower-eyelid drop was 0.2 mm at T1 and 0 mm at T2. In the control patients, the corresponding values were 1.8 and 1.4 mm. The mean difference in lower-eyelid drop between the two groups was 1.6 mm at T1 and 1.4 mm at T2.

Discussion

This work demonstrated the successful use of a less invasive and more aesthetic technique for treating dislocated zygomaticomaxillary complex fractures. The inclusion of two to three fixation points using autologous PRF is of particular utility in older patients, in whom complications and lower-lid drooping are more frequent due to age-related tissue laxity.

Mandibular hypomobility associated with zygomatic fractures reflects, in rare cases, interference of the zygomatic body or arch with the coronoid process of the mandible. More often, it is caused by trismus, resulting from impingement of the displaced zygoma on the temporalis and masseter muscles. With physiotherapy, mandibular hypomobility is overcome even without surgical reduction of the zygoma. Entrapment of the rectus muscle is also rare in zygoma fractures, while diplopia is typically the product of edema and resolves spontaneously [11].

Thus, in most patients with orbitozygomatic fractures, the main indication for surgical treatment is aesthetic damage. In choosing among the different techniques available for the treatment of these fractures, the surgeon must take into account the associated postoperative facial aesthetic damage and assess the costs/benefits ratio. The eye and lid area are important determinants of facial aesthetics. The appearance of the lower eyelid contributes to the youthful appearance of the face. In young patients, the lower eyelids usually cover the iris border symmetrically for 2 mm [12]. After subciliary incision and eyelid dissection, lower-lid droop is a common complication, even in procedures performed by experienced plastic surgeons, and results in the

“round eye” that occurs with aging [13]. Particularly in monolateral surgery, as is the case in orbitozygomatic fractures, monolateral lower-lid droop will result in asymmetry between the two eyes and thus an unnatural appearance.

Therefore, to avoid lid dissection and postoperative droop, the most conservative orbital floor and inferior rim surgical approach should be chosen. In addition, in procedures in which a lateral canthal skin incision is used to obtain access to the frontozygomatic rim fractures, care must be taken to avoid postoperative visible skin scars. Eyebrow incisions must also be avoided because of the aesthetically poor results, as scar fibrosis and the associated alopecia are particularly visible in the eyebrow area. Using our combined TC/TO approach without canthotomy, zygomaticomaxillary complex fractures can be reduced without noticeable skin scars and the risk of many of the common postoperative complications, such as ectropion, entropion, scleral show, sagging of the lateral eyelid margin, hematoma, eyelid edema, orbital septum adhesions, scar contracture, horizontal laxity of the eyelid margin, and weakening of the pretarsal muscle, can be minimized [14]. Avoiding a canthotomy prevents lateral canthus dislocation and eye asymmetry. In this study, inferior orbital rim fixation was instead achieved using 5- to 7-hole microplates.

In dislocated fractures, two or three fixation points are necessary, depending on the grade, site of dislocation and whether the fractures are of the comminuted type [15]. Dislocation of the frontozygomatic rim necessitates open reduction at this site. In these patients, reduction and fixation are started in the frontozygomatic area, because a precise reduction is usually achievable, even in cases of multifragmented fractures. In addition, reduction and fixation at this site acts as a guide for the following fixations. Fixation of the zygomatic body is then performed through the oral access, with correct positioning confirmed through the TC access. Starting from the zygomatic frontal suture, when dislocated, followed by zygomatic-body fixation on the anterior sinus wall, anterior orbital floor margin synthesis, and, in patients with globe dislocation and diplopia, orbital floor reconstruction ensures the precise reduction and synthesis of the fracture. Our combined approach is in accordance with several of the

new maxillofacial surgery techniques described for plastic surgery, in which optimal facial aesthetics are the goal [16-18].

In patients with large orbital floor dislocation, a reconstructive titanium mesh can be covered by autologous PRF membranes. PRF is a gel-like biomaterial that contains high concentrations of several growth factors, including platelet-derived growth factor, transforming growth factor, vascular endothelial growth factor, and endothelial growth factor, all of which are secreted by platelets [19]. PRF stimulates and accelerates tissue healing and bone regeneration, reduces postoperative pain and edema, and prevents infection [9,20]. The leukocytes in PRF also contribute to preventing infection by enhancing immunity [21] and producing large amounts of vascular endothelial growth factor [22].

Conclusions

In zygomatic fractures, aesthetic repair is among the most important, if not the only, indication for surgery. The surgical strategy must therefore follow same criteria applied in aesthetic surgery. With our technical modifications of the surgical treatment of these fractures, the resulting, more conservative approach allows for a better aesthetic result and avoids many of the most common complications. Our method is particularly advantageous in older patients, because age-related tissue laxity often results in aesthetic damage and functional impairment following lower-lid surgery. Eyelid asymmetries arising from scleral show, lid retraction, and ectropion occur in up to 42% of lower-eyelid surgeries⁷. However, with our TC postseptal approach, dissection of the lower eyelid structures is avoided.

Competing interest

The authors have no competing interests to declare.

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| NAME | GENDER | AGE | FRACTURE CLASSIFICATION (K&N) | AFFECTED SIDE | ASSOCIATED FRACTURES | COMMINUTED (Y,N) | METHOD OF APPROACH | POINT OF FISSATION |
|------|--------|-----|-------------------------------|---------------|-------------------------|------------------|--------------------|--------------------|
| AS | Male | 51 | VI | Left | Blow out | Y | TC, TO, SI | 3 |
| FV | Male | 42 | V | Right | Nasal Bone and Mandible | N | TC, SI, TO | 2 |
| LG | Female | 53 | V | Right | Nasal Bone | N | TC, SI, TO | 2 |
| AV | Male | 65 | VI | Right | Nasal Bone | Y | TC, TO, SI | 3 |
| CS | Male | 51 | VI | Left | Nasal Bone | Y | TC, TO, SI | 3 |

Table 1. Patients of group 1: kind of fractures.

| Transconjunctival and lateral canthus approach by our technique | Lower eyelid drop at T0, T1 and T2, mm | Scar aesthetic score for lateral access |
|--|---|--|
| Case 1 | T0=0; T1=0; T2=0; T3=0 | 4 |
| Case 2 | T0=0; T1=0; T2=0; T3=0 | 4 |
| Case 3 | T0=0; T1=0; T2=0; T3=0 | 5 |
| Case 4 | T0=0; T1=1; T2=0; T3=0 | 4 |
| Case 5 | T0=0; T1=0; T2=0; T3=0 | 4 |
| Subciliar and lateral margin approach by ordinary technique | | |
| Case 1 | T0=0; T1=2; T2=1; T3=1 | 2 |
| Case 2 | T0=0; T1=2; T2=2; T3=2 | 3 |
| Case 3 | T0=0; T1=1; T2=1; T3=1 | 3 |
| Case 4 | T0=0; T1=2; T2=2; T3=2 | 2 |
| Case 5 | T0=0; T1=2; T2=1; T3=1 | 3 |

Table 2. Our transconjunctival and lateral canthus approach compared with the subciliar and lateral margin classic approach: lower eyelid drop compared with opposite eye at T0 (pre-operative time), T1 (post-operative time), T2 (1 month follow up), T3 (6 months follow up) and scar aesthetic score for lateral access incision in scale from 1 (worst) to 5 (best) at 6 months follow up.

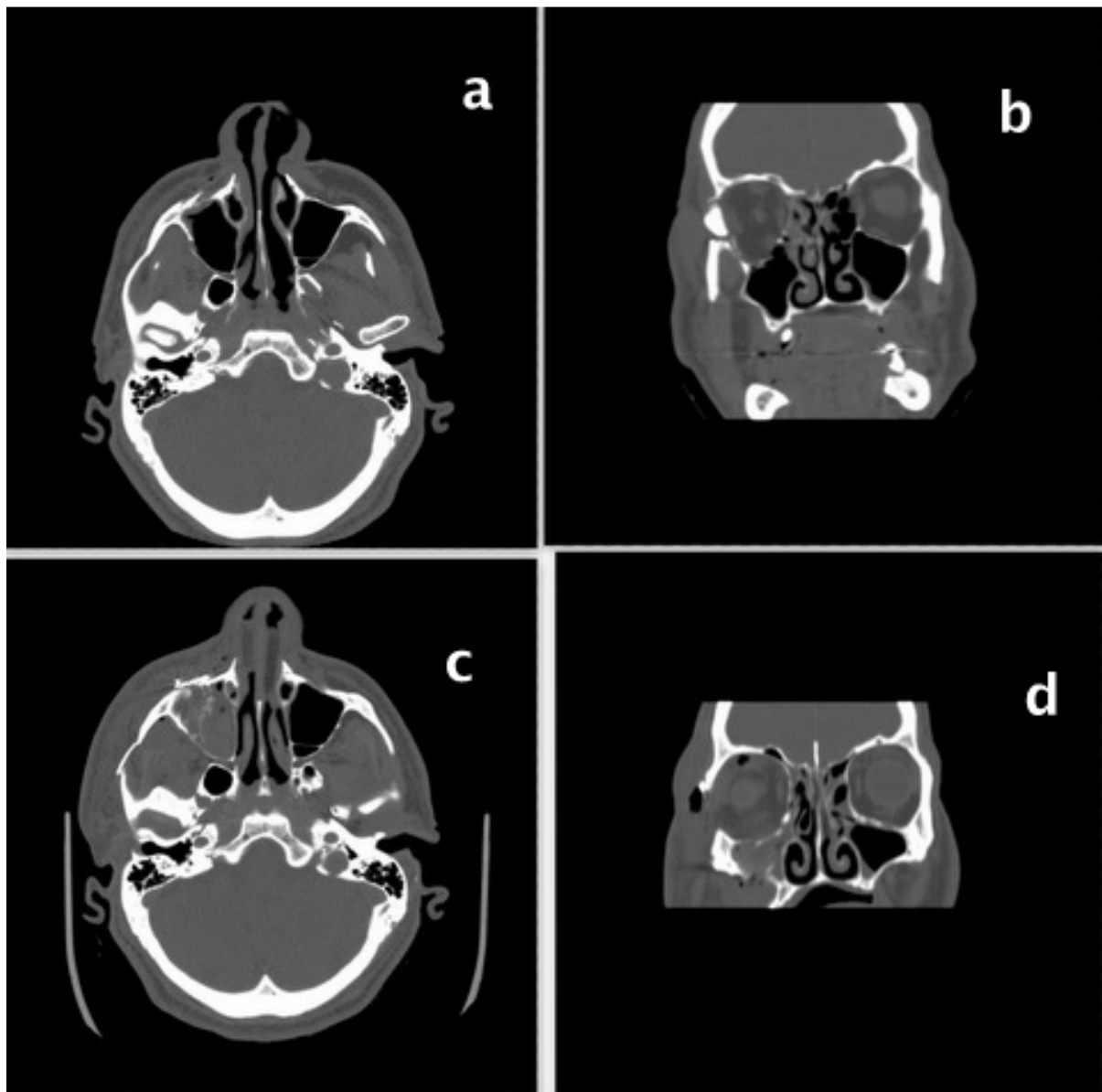


Fig. 1. Computed tomography images of a patient with a dislocated zygomaticomaxillary complex fracture. (a, b) Preoperative images. (c, d) Images obtained after surgery using a combined transconjunctival (TC) and transoral maxillary approach and lateral rim skin incision, both without canthotomy, together with two fixation points.



Fig. 2
Transconjunctival access to lower margin of the orbit: rim reduction and fixation by microplate and screws.

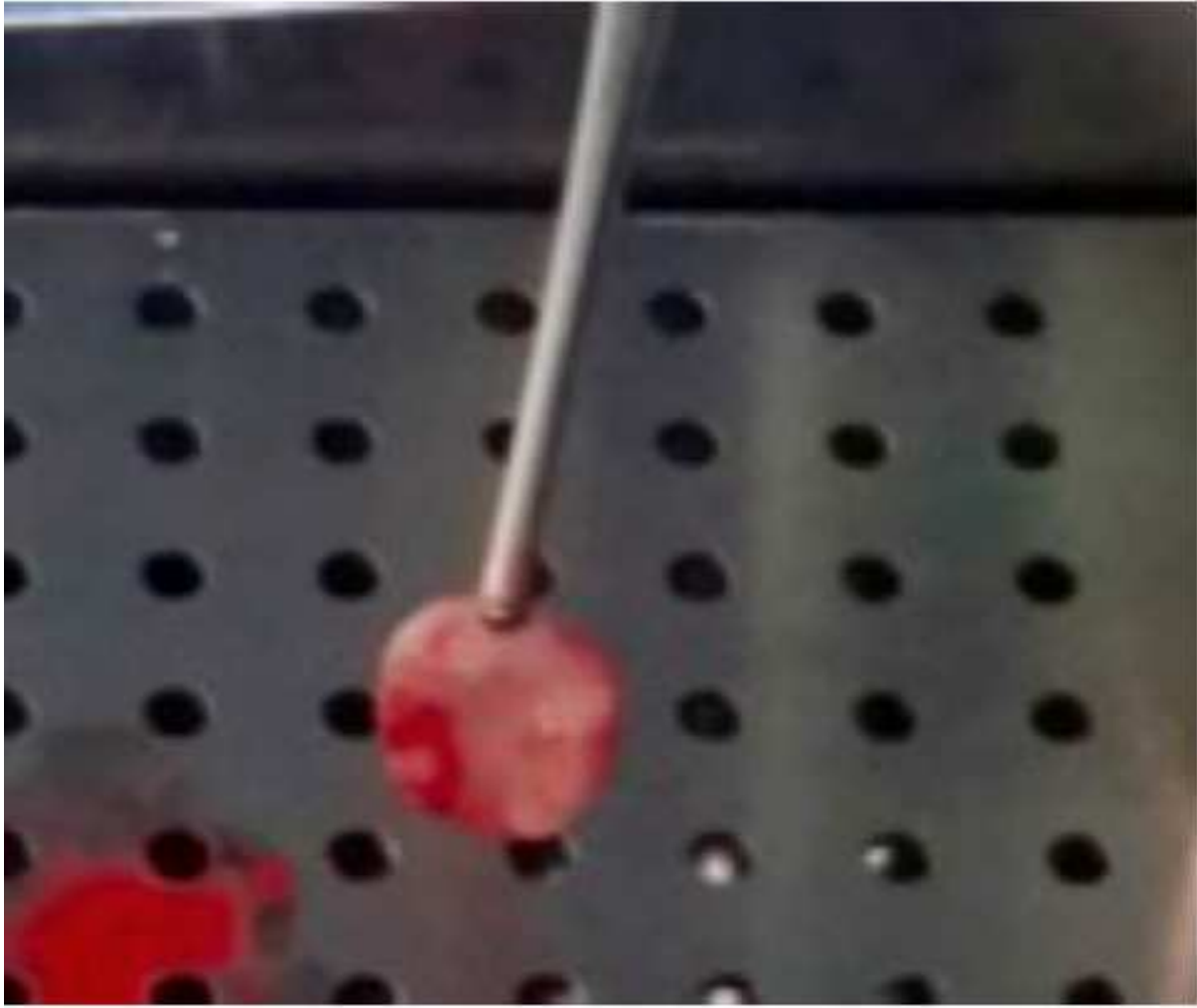


Fig. 3. Platelet-rich fibrin autologous membrane.



Fig. 4. The same patient as in Fig. 1, after 6 months of follow-up. The patient has satisfactory facial symmetry, without a noticeable scar, ectropion, or lower-eyelid droop and no functional impairment.



Fig. 5. The patient has no newly developed defects of the orbital floor or herniation of the ocular contents into the maxillary sinus and satisfactory zygomatic symmetry.