Internal splinting method for isolated zygomatic arch fracture using endotracheal tube: A new method

İzole zigomatik ark kırıklarında endotrakeal tüpün internal splint olarak kullanılması: Yeni bir yöntem

Use of the endotracheal tube for zygomatic arch fractures

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Öz

Amaç: Bu çalışmanın amacı şişirilmiş endotrakeal tüpün yeni, basit bir internal siplint yöntemi olarak izole zigomatik ark fraktürlerinde kullanımının sonuçlarını değerlendirmek. Gereç ve Yöntem: Bu yöntem ile izole zigomatik ark fraktürüne sahip 16 erkek ve 4 kadın toplam 20 hasta opere edilmiştir. Zigomatik ark fraktürleri Gillies yöntemi ile redükte edildikten sonra endotrakeal tüp zigomatik ark arkasına yerleştirilerek internal siplint olarak kullanılmıştır. Üç tanesi insilün bağımlı diabet olan hastaların yaş ortalaması 29 bulunmuştur. Hastalar postop ortalama 6,8 ay takip edilmiştir. Hastalar preop ve postop 1.gün ve 3. aylarda hem klinik hem de bilgisayarlı tomografi (BT) ile değerlendirilmiştir. Bulgular: Postoperatif dönemdeki klinik ve BT değerlendirmelerinde yetersiz redüksüyon, yetersiz stabilizasyon, fasiyal sinir yaralanması ve enfeksiyon gibi herhangi bir komplikasyon ile karşılaşılmamıştır. Tüm hastalar bu yöntemi iyi tolare etmiş ve bir şikayetleri olmamıştır. Tüm hastalarda normal zigomatik ark kontürü ve yüz simetrisi görülmüştür. Tartışma: Bu yeni yöntem basit ve komplikasyonsuzdur. Ayrıca küçük bir kesi ile girilip endo trakeal tüp tamamen temporal fasya altına yerleştirildiği için enfeksiyon riskini en aza indirmektedir (özellikle diyabet hastalarında). Endotrakeal tüp kafının şekli nedeniyle redükte edilmiş kırık hattına daha geniş yüzeyli basınç uygulamakta ve yer değiştirmemektedir. Bu nedenle bu yeni yöntem izole zigomatik ark kırıklarının tedavisinde kullanılabilir.

Anahtar Kelimeler

Endtrakeal Tüp; İnternal Splint; İzole; Zigomatik Ark; Fraktür

Abstract

Aim: The aim of this study was to evaluate the results of the inflated endotracheal tube for simple internal splinting in the treatment of isolated zygomatic arch fractures as a new method. Material and Method: A total of sixteen male and four female patients with isolated zygomatic arch fractures were reconstructed using this method. Reconstruction was performed with temporal approach and internal splinting method and inflated endotracheal tube was used for internal splinting. The median age of the patients was 29 years. Three patients had insulindependent diabetes mellitus. Mean follow-up after surgery was 6.8 months. Patients were evaluated both clinicall and with computerized tomography scan (CTS) preoperatively, postoperative 1 day, and postoperative 3 months. Results: We did not encounter any complications such as poor reduction, insufficient stabilization, facial nerve injury, or infection. All patient tolerated the method well and did not complain about comfort. All patients demonstrated normal zygomatic contour and facial symmetry. Discussion: This new method is simple, easy and complication free. In addition, a small incision is used and the internal splint is totally embedded under the temporalis fascia to minimize the risk of infection, especially for patients with diabetes mellitus. The endotracheal tube applies pressure over a longer segment of reducted fracture and there is no displacement because of the elliptical shape of the cuff. Therefore, this new method can be used for the treatment of isolated zygomatic arch fractures.

Keywords

Endotracheal Tube; Internal Splint; Treatment; Isolated; Zygomatic Arch; Fractures

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Introduction

The zygomatic arch is formed by temporal and zygomatic processes. It is palpable and visible on the cheek and the temporal area. Its sharp upper border is obscured by the attachment of temporal fascia, and the lower border is attached to the masseter muscle [1]. Between the zygomatic arch and the skull, the coronoid process of the mandible moves freely when the mouth is opened and closed. A fracture, which generally depresses this arch, implicates a partial or total obstruction of the movement of the condyle and of the coronoid process of the mandible, affecting the opening and closing of the mouth [2].

Isolated zygomatic arch fractures (IZAF) account for approximately 4.5% [3] to 10% [4] of all fractures of the midface. They usually result from a direct force of low velocity during sports, falls, traffic accidents, or assaults. Various methods have been used in the treatment of IZAF. The aim of the present study was the investigate whether the endotracheal tube (Figure 1) could serve as a versatile method in IZAF and its advantages over similar methods.

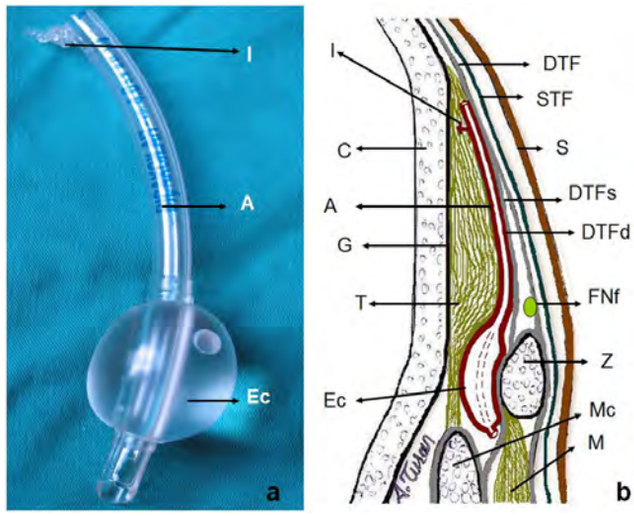


Figure 1. Appearance of prepared pediatric endotracheal tube and schematic diagram after introduction under the zygomatic arch. a: Inflated pediatric endotracheal tube after being prepared for the new method. b: Schematic diagram of the inflated pediatric endotracheal tube after introduction under the reducted zygomatic arch fracture. I, inflating lumen; A, air connector; Ec, cuff of the endotracheal tube; G, galea; C, calvarium; T, temporalis muscle; DTF, deep temporal fascia; DTFs, superficial layer of DTF; DTFd, deep layer of DTF; STF, superficial temporal fascia; FNf, frontal branch of the facial nerve; S, skin; Z, zygomatic arch; Mc, coronoid process of mandible; M, masseter muscle.

Material and Method

A four-year (2013–2017) retrospective study involving 20 patients admitted and treated for isolated zygomatic arch fractures at the department of plastic, reconstructive and aesthetic surgery was done.

Sixteen male and four female patients with isolated zygomatic arch fractures were treated using this method. Patients were evaluated both clinically and using computerized tomography scan (CTS) preoperatively (Figure 2), postoperative 1 day, and postoperative 3 months. Postoperative assessment was performed by means of clinical and radiographic (CTS) examination to check the position of the inflated tube under the zygomatic arch (Figure 3).



Figure 2. Preoperative radiologic and intraoperative clinical views of Case 1. a: Axial computerized tomography scan (CTS) image showing medial displacement of the two fragments in a "W" or "M" shaped pattern of the left isolated zygomatic arch fracture (arrow); b: The prepared pediatric endotracheal tube over the malar area and a skin incision made for the Gillies approach (arrow). ET, endotracheal tube.



Figure 3. Postoperative clinical and radiologic view of Case 1. a: The postoperative appearance of the malar area and sutured Gillies incision (arrow); b: The postoperative axial CTS image showing internal splinting of the reducted left zygomatic arch fracture (arrow). ET, endotracheal tube.

Operative Technique

The fracture site of the zygomatic arch and the incision site were outlined with a marking pen. The incision site was determined according to the length of the endotracheal tube so that the cuff of the tube would stay beneath the fracture site (Figure 2b). A pediatric endotracheal tube with a 4 mm internal diamater was used in all patients (ID 4mm, CE&ISO Goldenwell China) (Figure 1a). Depending on the case, approximately 8-10cm above the fracture site a skin incision of 2cm length was created in the hair-bearing scalp as described by Gillies (Figure 2b). Dissection was carried down to the deep temporal fascia, just superficial to the temporal muscle. A blunt dissector was passed through the incision downward on the surface of the temporal muscle until it reached the deep surface of the displaced arch, so that a cleavage plan could be prepared under the deep temporal fascia between the zygomatic arch and the incision site. An elevator was used to reduce the depressed segment of the arch. Adequate reduction was evaluated by palpating the skin directly overlying the arch fragments and comparing it with the non-fractured site. The pediatric endotracheal tube was introduced through the incision to serve as an internal splint under the reducted arch. The cuff of the tube was inflated with 5 to 7 ml saline. Inflating lumen of the cuff was cut above the bifurcation point after being fixed with several knots (Figure 1a). The cranial end of the tube was anchored to

the deep temporal fascia with a single 4-0 nylon suture. The tube was embedded in the subfascial plane and the skin was closed primarily (Figure 3a). The endotracheal tube was kept under the zygomatic arch for 3 weeks. The patients received a central myotonolytic agent (tizanidin 1x 6 mg, p.o.) during this postoperative period to minimize the displacement force of the masseter muscle. The endotracheal tube was removed after 3 weeks.

Case Reports

Case 1: A 28-year-old woman admitted to our clinic with an IZAF on the left side. On the CTS a depressed fracture of the zygomatic arch was observed (Figure 2a). Closed reduction and internal splinting with an endotracheal tube was performed through a temporal approach. Reduction was evaluated with CTS one day postoperatively (Figure 3b) and the patient was discharged. Control CTS demonstrated a normal zygomatic contour and facial symmetry.

Case 2: A 44-year-old man presented with an isolated fracture of the left zygomatic arch (Figure 4a). The medical history revealed that he had sustained a road traffic accident several days prior. Closed reduction and internal splinting with an endotracheal tube were performed with the same method as described previously (Figure 4b). Reduction was evaluated with CTS one day postoperatively (Figure 5) and the patient was discharged. Postoperative 12 month CTS demonstrated a good reduction and contour of the zygoma (Figure 6). The patient healed without any complications.

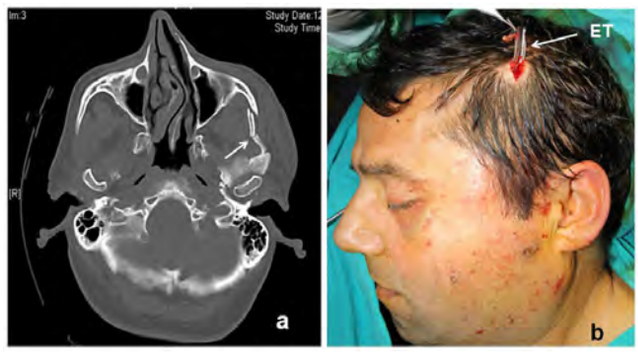


Figure 4. Preoperative radiologic and intraoperative clinical views of Case 2.
a: The axial CTS shows an isolated fracture of the zygomatic arch on the left side (arrow).
b: Preoperative views of Case 2 after introduction and inflation of the endotracheal tube. ET, endotracheal tube.

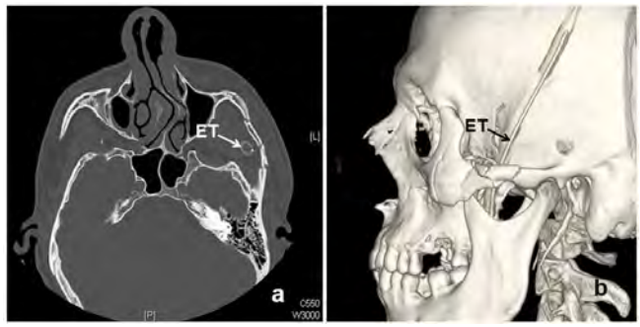


Figure 5. Radiologic views of Case 2 at postoperative 1 day.
a: The axial CTS views of the inflated endotracheal tube under the reducted zygomatic arch (arrow). ET, endotracheal tube.
b: The 3D-CTS views of the reducted zygomatic arch fracture and inflated endotracheal tube under the zygomatic arch (arrow). ET, endotracheal tube.

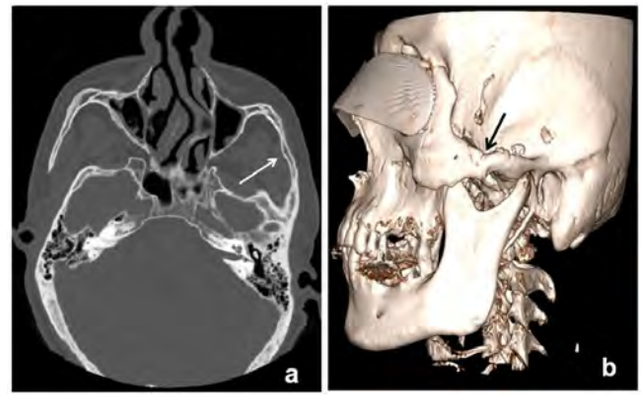


Figure 6. Radiologic views of Case 2 at postoperative 12 months .
a: The axial CTS demonstrates a good reduction and anatomical contour of the zygoma (arrow).
b: The 3-D CTS demonstrates a good union of fractured segments of the zygomatic arch (arrow). The patient healed without any complication.

Results

The median age of the patients was 29 years. The etiology of the fractures was a direct punch over the zygomatic arch in seven patients (35%) and traffic accident in the remaining thirteen (65%) patients. Three patients were suffering insulin-dependent diabetes mellitus. Eight patients were operated on under local anesthesia, whereas general anesthesia was necessary for twelve. All patients were discharged one day postoperatively. Median follow-up after surgery was 6.8 months (range: 3 to 14 months). The endotracheal tubes used as a internal splint were kept in place for 21 days in all patients. None of the 20 patients needed a secondary operation. In the present study, no complications such as poor reduction, insufficient stabilization, facial nerve injury, or infection were encountered. This method was well tolerated by all patients. In all patients, a normal zygomatic arch contour and facial symmetry was achieved.

Discussion

The reported rate of IZAF ranges between 4.5% and 10% among midface fractures [3,4].

Isolated fracture of the zygomatic arch is not unusual and is generally a result of a direct blow to the face. In the radiological examination, medial displacement of the two fragments in a “W” [5] or “M” [2] shape is observed in most of the cases. Treatment options for isolated zygomatic arch fractures range from closed reduction without fixation (stabilization) to open reduction with fixation [6], and sometimes multiple incisions to achieve a successful reduction.

There is a consensus in the literature that open reduction and rigid fixation is the treatment of choice for comminuted and displaced fractures. However, the best method of management in reduction and fixation of less-severe fractures is still controversial. In this context, open reduction procedure carries a potential risk for facial nerve injury, scalp numbness, and alopecia [7]. In routine clinical practice, closed reduction with or without stabilization generally is used for treatment of IZAF.

In some long-term follow-up studies on IZAF, good results have been reported with the closed reduction only method [8]. In a clinical study, Rodriguez and Casado [5] have found that more than 90% of the fractures were stable enough not to require any additional measures due to the splinting effect of the tem-

poralis fascia and the ventral periosteum of the arch. They suggested that reduction only is sufficient in the treatment of these cases. On the other hand, some authors recommended internal [9] or external [10] splinting for stabilization and protection after closed reduction of the IZAF. Their standpoint is that the pull force of the masseter muscle and external pressures on the fractured site can redisplace the fractured segments.

Closed reduction takes less operating time, leaves minimal incision scars, and incurs less soft tissue violation. Moreover, because the periosteum is not violated, better bony union can be expected. Inadequate mechanical fixation and poor visualization are the main disadvantages of the closed reduction techniques [11]. Closed reduction is performed through temporal [12], transoral [13], and transcutaneous [14] approaches in most cases of IZAF. Endoscopically assisted closed reduction techniques have some advantages such as magnified direct visualization, a decreased complication rate, and a better result than the conventional methods. However, this technique has the disadvantage of a relatively longer operative time and is more expensive [15]. The transoral approach has several advantages, such as absence of a skin incision, technical ease, and minimal dissection and bleeding [16]. However, it is very easy to introduce the oral flora into the infratemporal fossa and the risk of infection is increased with this method. On the other hand, the transcutaneous approach is easier as it directly approaches the fracture site with less risk of infection [17] and shorter operating time [18]. Various devices have been manufactured for the transcutaneous approach to reduction of IZAF, such as bone hooks [19], screws [20], curved mosquito [17], and towel clips [18].

Closed reduction with a curved mosquito can cause hematoma because of blunt dissection through the masseter muscle [17]. Reduction with the insertion of a bone hook can be technically difficult while dealing with a depressed arch [21] and using a towel clip can cause inadvertent facial nerve injury [18]. Transcutaneous screw reduction seems to be a less invasive method for zygomatic arch fractures; however, it is difficult to apply in older patients where the bone is friable [20]. Therefore, it seems reasonable to assume that splinting of the fractured segments after closed reduction is a safer method in the treatment of IZAF. There are two main methods described in the literature for stabilization and protection of the fractured bone segments after closed reduction. These methods are known as external splinting and internal splinting. Orthopedic finger splints [22] and custom-made devices have been used for external splinting. However it is difficult to adapt them where there is considerable soft tissue swelling [10]. Also, there can be pressure necrosis of the skin beneath the splint and a risk for facial nevre injury [23]. The present author reveals that this method is more comfortable in comparison of external splinting methods in terms of physical appearance.

Foley catheter [19] and epistaxis balloon [23] have been used for internal splinting of reducted arc fractures. The main idea is that internal splints serve as a more comfortable method than external splints. Both the Foley catheter and the epistaxis balloon are made of flexible rubber so they need a rigid guide to be introduced under the fractured arch. Also it is difficult to bury both tubes under the skin owing to their design. In comparison, burying the endotracheal tube is an advantage. Also, the semi-rigid structure of the tube does not necessitate any rigid guide for its introduction.

The Foley catheter is inclined to superior or inferior displacement under the reducted zygomatic arch because of its spherical shape. The other alternative method for the treatment of fractures is use of the endotracheal tube. The endotracheal tube method was first described by Turan et al. for internal splinting of the reducted IZAF [24]. The advantage of using the endotracheal tube is the elliptical shape of the cuff, which applies pressure over a longer segment of reducted fracture and avoids displacement. The endotracheal tube method offers the possibility of readjusting the volume of the cuff to maintain the appropriate position of the fractured segments. The modification of burying the inflation tube under the temporalis fascia was made after the publication of the first letter [24] and the patient series was increased. Usage of the Botulinum toxin has already been described for eliminating the displacing force of the masseter muscle on the fracture site [25]. In the present study, tizanidine was used instead of botulinum toxin to minimize the pull of masseter muscle. Also, in our study we did not paralyze the masseter muscle because muscle activity is known to enhance fracture union.

This method eliminates the potential problems inherent to external splinting methods and it has advantages over other internal splinting methods. For these reasons, this method can be suggested in the treatment of isolated zygomatic arch fractures.

Conclusion

Use of an endotracheal tube for splinting after closed reduction of IZAF has many advantages such as small incision, easy access to the fracture site, ease of burying the tube under the skin, less risk of infection, and better splinting of the fracture owing to the elliptical shape of the cuff of the endotracheal tube. Therefore, this new method can be used as an alternative approach in the treatment of IZAF fractures with satisfactory results in clinical practice.

I have no financial relationship with the organization that sponsored the study.

Conflict of Interest Statement:

The present author discloses that they have no financial and personal relationships with other people or organisations that could inappropriately influence (bias) their work. Examples of potential conflicts of interest include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding.

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