Endoscopic-Assisted Zygomatic Arch Fracture Repair With a Preauricular Approach

La réparation endoscopique d'une fracture de l'arcade zygomatique par une approche pré-auriculaire

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Abstract

Introduction: Because of numerous negative sequelae with open techniques, endoscopic techniques are beginning to be widely used for maxillofacial fractures. Many endoscopic approaches for this area have been described according to several dissection plans and incisions. The aim of the present study was to report a new surgical incision and dissection method for zygomatic arch fracture that aims at reducing the complication rate of previously defined techniques. **Material and Methods:** The authors operated on 8 patients with a new endoscopic-assisted surgical technique. This study focused on evaluating the complication rate and surgical comfort of these patients. **Results:** Of the 8 patients, the plate was palpable in the zygomatic arch in one. No complications occurred due to this technique during the 1-year follow-up. Symmetrical facial contour and inconspicuous scars were obtained in all patients. Average operative time was 3 hours; hospitalization time was 1.6 days. **Conclusion:** This study demonstrates that an endoscopic-assisted surgical approach with a preauricular mini-incision can be safely performed in isolated multifragment zygomatic arch fractures. Using individually designed plates improved our results. This technique is easy to apply, its cosmetic results are good, and its complication rate is low.

Résumé

Introduction : En raison des nombreuses séquelles des techniques ouvertes, les techniques endoscopiques commencent à se généraliser en cas de fractures maxillofaciales. De nombreuses approches endoscopiques sont décrites dans cette zone en fonction de plusieurs plans de dissection et de plusieurs incisions. La présente étude visait à rendre compte d'une nouvelle méthode d'incision chirurgicale et de dissection en cas de fracture de l'arcade zygomatique afin de réduire le taux de complications des techniques déjà définies. **Matériaux et méthodologie :** Les auteurs ont opéré huit patients à l'aide d'une nouvelle technique chirurgicale endoscopique. La présente étude s'est attardée sur l'évaluation du taux de complications et du confort chirurgical de ces patients. **Résultats :** La plaque était palpable dans l'arcade zygomatique d'un des huit patients. Aucune complication n'a découlé de cette technique pendant le suivi d'un an. Tous les patients avaient un contour facial symétrique et des cicatrices discrètes. L'opération était d'une durée moyenne de trois heures et l'hospitalisation, de 1,6 jour. **Conclusion :** La présente étude démontre qu'une approche chirurgicale assistée par endoscopie avec mini-incision préauriculaire peut être effectuée en toute sécurité en cas de fractures isolées et multifragmentées de l'arcade zygomatique. L'utilisation d'une plaque personnalisée améliorait les résultats. Cette technique est facile à exécuter, donne de bons résultats esthétiques et s'associe à un faible taux de complications.

Keywords

endoscopy, zygomatic arch, zygomatic fractures

Introduction

Isolated zygomatic arch fractures make up 5% to 10% of complex zygomaticomaxillary injuries.¹ The endoscopic approaches used to overcome the problems that may arise due

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Table 1. Characteristics of Patients With Multiple Zygomatic Arch Fractures.

	Age	Sex	Etiology	Complication	Operation Time	Discharge From the Hospital (Day)	Classification of Fracture
1	16	Male	Traffic accident	Nil	3	1	Class II
2	26	Male	Assault	Nil	3	2	Class I
3	20	Male	Assault	Nil	3	1	Class I
4	64	Male	Falling	Nil	4	2	Class II
5	55	Male	Traffic accident	Palpable plate	3,5	1	Class III
6	35	Male	Traffic accident	Nil	2,5	3	Class I
7	25	Female	Falling	Nil	2,5	1	Class I
8	28	Male	Assault	Nil	3	2	Class II

Figure 1. Diagram of zygomatic arch fracture classification is according to the zygomatic arch classification of Hönig et al.

to fracture repair with classical methods are now being widely used in the repair of multifragment zygomatic arch fractures.² In this study, patients underwent mini-preauricular incision as a new approach, which may be an alternative to the open technique. Herein, we discuss the advantages of our method compared to classical endoscopic methods and details of the surgical and technical used.

Materials and Methods

Between April 2014 and January 2016, 8 patients with zygomatic arch fractures were operated on with the preauricular endoscopic approach in our clinic (Table 1). This study followed the Declaration of Helsinki on medical protocol and ethics and the regional ethical review board of local committee approved the study. Patients with isolated multiple fractures of the zygomatic arch irreducible with the minimal access open approach were enrolled in our study. "It is considered that multifragment zygomatic arc fractures cannot be adequately stabilized by minimal access open methods." Patients with other zygomatic fractures with or without facial fractures were excluded. Three-dimensional (3D) tomography was used to reveal the shape and other components of the fracture. All fractures were classified according to the zygomatic arch classification of Hönig et al to aid in the decision about whether surgery should be performed³ (Figure 1). Patient's operation and hospitalization times were recorded. Postoperative 3D tomography was performed routinely for control. Patients were followed for 12 months to document complications, such as nerve damage, scar quality, and temporal hollowing.

Figure 2. A, The green field shows unaffected right zygomatic arch, the red one is mirror image of the contralateral right zygomatic arch, fracture under the red area is remarkable. B, The images are zygomatic arches separated from main skeleton during plate bending phase; the red one is mirror of the green one. C, The plate is twisted to fit the mirror image of unaffected zygomatic arch with SimPlant Master Crystal version 13. D, Before the operation, the 2.0-mm plate is bended to fit the shape of template completely.

Presurgical Preparation

Individually designed plates were used for reduction in this study. The data obtained from 3D tomography were transferred to the SimPlant Master Crystal v13 (Materialise Dental, Leuven, Belgium) program. Using the mirror image of the contralateral zygomatic arch as a reference, a virtual plate was created as digital data (Figure 2). With a 3-D printer, a plastic model of this virtual plate was obtained for each patient individually. This plastic mold was used as a template for our plate, and a real titanium alloy 2.0-mm plate that bended according to this template was sterilized for use during surgery.

Surgical Technique

During the surgical procedure, visualization was obtained with a 4-mm-diameter rigid 30° view angle of the endoscope system (Karl-Storz, Tuttlingen, Germany). In the preauricular endoscopic approach, a 1.5-cm mini skin incision was made at the

Figure 3. Illustration of reduction of fractured arch and the placing screws using a transcutaneous trocar.

point where the crus helix was joined to the facial skin. The zygomatic process of the temporal bone was reached to create an entry that is large enough to accommodate the endoscopic system. The dissection of the arch was performed using the endoscopic view. After dissection of all the fractured areas of the zygomatic arch, fractures were elevated using the Gilles elevator. This elevator was used at a level by entering from the temporal hairy skin. An individually designed plate was placed along the zygomatic arch with the assistance of the endoscope via the preauricular mini-incision. The lateral first screw was placed immediately on the proximal part of the process of the temporal arch to avoid damage to the temporomandibular joint under direct view. The following second screw was then placed next to the first one. The medial part of the plate was attached to the zygomatic bone with 2 screws. In some cases, to provide plate adaptation and screw placement, a mini-incision was added at this stage on the lateral rim, which allowed only 2 screws to be placed (Figure 3). This lateral rim incision is generally required in this technique. The elevated parts of the fracture with Gilles retractor were fixed with 1 or 2 screws to the plate that stabilized it medially and laterally. These screws were fixed with the trocar, then placed in the zygomatic arch perpendicularly to the skin (Supplemental Video 1).

Results

Seven male and 1 female patient were operated on with the preauricular endoscopic approach. The average age of the patients was 33.6 (range, 16-64) years. The etiologic agent in 3 patients was a traffic accident, in 3 physical assault, and in 1 fall. In all patients, a localized depression was present in the trauma area. The average hospital length of stay for all patients was 1.6 days. The average operative time was 3 hours. In the intraoperative period, none of the patients had a major complication. Postoperative 3D tomography showed that both zygomatic arches were symmetrical in all cases. No temporal hollowing was seen in any patient. All patients were followed up for 12 months. The facial contour was symmetrical in all

Figure 4. A, Case 2 in table: Class I zygomatic arch fracture on the left side can be seen on axial section of computed tomography. B, Aspect of the fracture line on oblique view of 3-dimensional (3D) computed tomography. C, The repaired zygomatic arch fracture on the left side can be seen on axial section of computed tomography. D, Aspect of the repaired fracture line on oblique view of 3D computed tomography.

patients at 1 year postoperatively, and the scar in front of the ear was inconspicuous. The plate was palpable on the zygomatic arch only in 1 patient. No surgical procedure was performed (Figures 4 and 5).

Discussion

Bicoronal or similar incisions are indicated in multifragment zygomatic arch fractures that cannot be repaired with minimal access open as in classical methods. Another way of reaching the zygomatic arch is intraoral approach. This technique was described by Keen in 1909 and different variations of it were also used by some authors.^{4,5} On the other hand, the coronal approach has many undesirable complications, such as temporal hollowing, weakness or permanent paralysis of the frontal branch of the facial nerve, alopecia, loss of sensation posterior to the incision, excessive blood loss, and a lengthy operative time.⁶ In an attempt to avoid these complications, an endoscopic approach to zygomatic arch fractures has become popular in recent years.² Many endoscopic methods and approaches have been described for this purpose.^{1,7-9} However, there is no currently accepted standardized endoscopic-assisted fixation technique. The endoscopic approach to zygomatic arch fractures was first performed by Kobayashi.¹⁰ In the cases presented by Kobayashi, 2 incisions were made to repair the zygomatic arch fracture endoscopically. The first incision was in the temporal hairy skin and the other was in the upper gingivobuccal sulcus. The author pointed out that a large

Figure 5. A, The patient is indicated number 5 in table, class III zygomatic arch fracture on the right side can be seen on axial section of computed tomography. B, Image of fracture line on oblique view of 3-dimensional (3D) computed tomography. C, The repaired zygomatic arch fracture on the right side can be seen on axial section of computed tomography. D, Image of repaired fracture line on oblique view of 3D computed tomography.

dissection was needed for visualization of the fracture, but temporal nerve damage can occur during this technique.¹⁰ He also mentioned that the fixation process was difficult, because of the use of reduction materials. But in our technique, fixation is easier because it is made transcutaneously and perpendicular to the surface of the plate.

In our patients, the fractures could be seen without the necessity of dissection in the temporal fascia and can be fixed without additional materials. Placing the plate on the arch is also very easy with our technique (Figure 6). There is no buccal incision in which the plate and screw can come into contact with contents of the mouth. Lee et al used the same dissection method with Kobayashi and added that the method could

prevent temporal hollowing.¹¹ A modification of this dissection plan was made by Chen et al to avoid damage to the frontal branch of the facial nerve. However, moderate temporal hollowing was described in 1 patient in their study.⁷ In our study, fracture segments could be seen by direct observation without the necessity of extensive dissection. Because the temporal fat pad was preserved, no complication-like fractures were seen, such as temporal hollowing. Czerwinski and Lee used a different preauricular incision similar to our incision and their study was published in 2004.² But their incision was extended to the temporal region. Therefore, it is not appropriate to consider it as a mini-incision. To repair multipart fractures of the zygomatic arch is a great challenge with endoscopic approaches. Some authors fixed all parts of the fracture *ex vivo*.^{2,8} Although this technique provides comfort, it has the major disadvantage of arch resorption.⁸ In our study, no bone fragment was removed from its current position. Minimal dissections were made and zygomatic arches were separated from the muscle and fascia connections, except the outer surface. Xie et al reported cases of endoscopic arch repair that required the incision to be more superior but not prolonged to scalp, because they could see the superficial temporal fascia.¹ Our dissection plan is the same as Xie's dissection plan. Here the author used a 1.5-mm adaptation plate (Item no. 447.100; Synthes USA) designed according to the shape of the zygomatic arch intraoperatively. The excessive force exerted on the screws to form the plate according to the shape of the arch may cause stress shielding-related bone resorption. Some studies emphasize the importance of the 3-D design to prevent this effect.¹²

Owing to the 3-D image software used in our method, the time spent to adapt the plate during operation was reduced. More stable 2.0 plates can be used, because they can be designed before surgery, according to the shape of the zygoma. Thus, resorption was avoided by eliminating the need to bend a plate over the zygoma. The critical point here is whether or not it is rigid fixation. Appropriate adaptation of the plate to the arch surface is more important to prevent the resorption. Although palpable palate was seen in one patient, we thought it is not related to our technique. In thin-skinned patients, the plate on the zygomatic arch can

Figure 6. A, The fracture line is visualized without additional materials and extensive dissection. B, Appearances of completely fixed zygomatic arch with individually designed plate. C, Screws were fixed by the trocar, which was placed perpendicularly to zygomatic arch.

cause such problems.^{13,14} The lower profile plates may be used to decrease plate palpability.

In addition, with this approach, which has not been previously described in the literature, limited dissections contributed to avoiding resorption, preserving the temporal branch, and reducing other complications. Inconspicuous scars were obtained with mini-incisions at the lateral rim and trocar puncture area. Lateral rim incision is similar to lateral part of lower blepharoplasty incision. The buccal incision that may cause contamination of the mouth with the plate screw was avoided.

The most important factors limiting the repair of endoscope-assisted zygomatic arch fractures are appropriate incision selection and possible complications. Although the incisions and dissections on the scalp may cause alopecia, temporal hollowing, and nerve damage, the incisions made in the face area may be confronted with the marked scar tissue. In addition, the added buccal incision causes contamination with the mouth contents. Therefore, no intraoral incision was used in our technique.

In our method, an incision other than the classical Gilles incision (0.5 cm) was not made. Keen approach also can be used for reduction of arc instead of Gilles's incision. When it is necessary to place the plate using this incision, the infraorbital nerve limits visualization of the infraorbital rim.⁵ In the face region, hidden scars are obtained with mini-preauricular (1.5 cm) and mini-lateral rim incision.

Multiple transfacial incisions and having a long operation time may be limitations of this study. In addition, it may be difficult to use this technique for centers where endoscopic surgery cannot routinely be performed.

Endoscopic-assisted repair of multifragment zygomatic arch fractures, reduction and fixation with mini-incisions, and designing a plate with 3D technology eliminate many undesirable problems. We think that it is a surgical method that can be safely used in multifragment zygomatic arch fractures that cannot be repaired with minimal access open techniques, because it is very easy to perform and to apply, does not require extra equipment, and is a minimally invasive procedure.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

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