A New Proposal of Classification of Zygomatic Arch Fractures

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Purpose: Among facial fractures, zygomatic arch fractures occur rather frequently. Facial fractures have recently been classified in fine detail according to computed tomographic findings. Nevertheless, there exists no classification of the zygomatic arch fracture, which has a physiognomically important place, to provide guidance for treatment. We aimed to make a detailed classification of zygomatic fractures in various shapes, which does not exist in the literature, and to form an algorithm for treatment.

Patients and Methods: A total of 451 patients with zygomatic arch fractures treated in our clinic from 1987 through 2004 were assessed retrospectively from the treatment viewpoint together with radiological and clinical findings.

Results: At the end of this assessment, arch fractures were divided into 2 groups: 1) isolated fractures in which the zygomatic arch alone broke, and 2) combined fractures in which the zygomatic arch broke together with the other facial bones. Isolated fractures were also divided into 2 subgroups as A) 2 fractures in the arch, and B) more than 2. Isolated arch fractures with more than 2 fracture lines were also classified as V-shaped fractures where fragments are partially reduced and those where fragments are displaced. As for combined fractures, they were subgrouped as A) single fracture in the arch, and B) plural. Plural fractures were further classified within their own group, also according to whether fragments were displaced or not.

Conclusion: In the 2 fractures and V-shaped fracture subgroups of isolated fractures, preservation of fragments in reduced position was satisfactory during the closed reduction and afterwards. As for those with more than 2 fractures of isolated arch fractures, they required open reduction and internal rigid fixation. The same treatment was used in combined zygomatic arch fractures where there were more than one displaced fractures. In addition to classification, we formed an algorithm to guide us in treatment based on our series.

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Zygomatic arch fractures are frequently encountered among facial fractures. Such fractures may have different structures as a result of their etiology and therefore the treatment to be given should be constructed according to these fracture structures.

Some of the zygomatic arch fractures may be in the form of isolated fractures in the arch only and result from localized forces landing on the face laterally and having relatively less impact, especially in sports and blow injuries. The others are in the form of a component of zygomatic bone fractures, or Le Fort III level fractures. When not treated properly, the arch fractures may lead not only to various cosmetic deformities related to skeletal structure of the face but also to functional disorders resulting from the pressure on the choriond process or ankylose with the mandible.

Maxillofacial fractures have been defined and classified in great detail by virtue both clinical and computed tomography (CT) findings.19 Isolated arch fractures have appeared as a separate class among zygomatic fractures but details have not been provided in the other classifications either, as in

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the Knight and North classification,\(^8\) which is quite established and frequently used.

Primarily, classification of fractures greatly facilitates the surgeon’s choice of treatment to be used. Another use of classification is that it constitutes a common terminology among surgeons and enables communication. Classification also enables etiological assessment, cognition of the fracture types expected according to the etiology, and thus facilitates diagnoses and treatment.

The purpose of this study is to make a detailed classification of the fractures of the zygomatic arch, which does not exist in the literature, and to create its treatment algorithm.

### Patients and Methods

The hospital records of the patients with fractures of the zygomatic arch, among midface fractures (including the upper rims of the orbits and maxillary alveolar region), who were followed up in our clinic for maxillofacial trauma from 1987 to 2004, were studied retrospectively. Investigated in the study were the ages and genders of the patients, how they were traumatized, the types of fractures and the treatment given. Special care was taken to distinguish the subtypes of the arch fractures by means of both clinical records and the sources of radiological images (Waters, submentovertex, and CT).

### Results

In the study, 689 patients with midface fracture were assessed; of these, 451 patients, 365 male and 86 female with ages varying between 3 and 85 years, had zygomatic arch fracture. As for those with the fractures of zygomatic arch, 321 had zygomatic bone and 88 Le Fort III fractures, and 42 had isolated fractures of the zygomatic arch only. Broken zygomatic arches in 451 patients numbered 539.

### Classification

It was observed that zygomatic arch fractures were divided into 2 main groups by their radiological and clinical findings:

1. Isolated zygomatic arch fractures localized in the zygomatic arch alone (type I),
   2. Combined zygomatic arch fractures in which the fracture in the arch was a component of zygomatic bone fracture or of Le Fort III level fracture (type II).

Isolated arch fractures (type I) were divided into 2 subgroups depending on the number of fracture lines in the arch:

   A. Two fractures (type I-A)
   B. More than 2 fractures (type I-B).

In most cases with 2 fracture lines in the zygomatic arch, although the broken segment of the bone

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**Table 1. Classification of Zygomatic Arch Fractures**

<table>
<thead>
<tr>
<th>1. Isolated zygomatic arch fractures (type I)</th>
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<tbody>
<tr>
<td>A. Dual fracture (type I-A)</td>
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<tr>
<td>B. More than 2 fractures (type I-B)</td>
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<tr>
<td>1) V-shaped fracture (type I-B-V)</td>
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<tr>
<td>2) Displaced (type I-B-D)</td>
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<table>
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<tr>
<th>2. Combined zygomatic arch fractures (type II)</th>
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</thead>
<tbody>
<tr>
<td>A. Single fracture (type II-A)</td>
</tr>
<tr>
<td>B. Plural fracture (type II-B)</td>
</tr>
<tr>
<td>1) Reduced (type II-B-R)</td>
</tr>
<tr>
<td>2) Displaced (type II-B-D)</td>
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**Figure 1.** Schematic classification of zygomatic arch fractures. Özyazgan et al. Classification of Zygomatic Arch Fractures. J Oral Maxillofac Surg 2007.
shifted toward the temporal fossa, they were also observed to have moved upward and downward. Isolated arch fractures with more than 2 fracture lines (type I-B) also were observed to be in the form of 1) V-shaped, relatively reduced fracture, or 2) displaced fractures in which broken segments had been completely unattached. V-shaped fractures are those reported in most references as isolated zygomatic arch fractures. In such fractures there are 3 separate fracture lines and 2 bone fragments. Fragments have not been completely detached and the front-back continuity of the zygomatic arch has relatively been preserved. Two fragments that relatively rotated like a hinge moved medially from the fracture lines on the zygomatic and temporal sides, shifting horizontally toward the temporal fossa along the third fracture line in the middle.

Combined zygomatic arch fractures are divided, depending on the number of fracture lines, into:

A. Single fracture (type II-A)
B. Plural fractures (type II-B).

Some of the combined fractures with a single fracture line in the arch were found to have been separated whereas others were not. Nevertheless, they were assessed in the same group because their treatment did not differ. Among the combined fractures, those in the type II-B subgroup with more than one fracture in the arch were seen to be either of reduced, or displaced type.

The types of fractures described above are listed in Table 1 and shown schematically in Figure 1.

In the assessment of fractures of zygomatic arch according to etiological basis, the most common causes of both combined and isolated zygomatic arch fractures were found to be traffic accidents (69% and 42%, respectively) (Table 2). The majority of the patients was placed in the 26 to 35-year age group in both isolated and combined arch fracture groups (Table 3).

### TREATMENT

**Type I (Isolated Zygomatic Arch Fractures)**

In the subgroup of 2 fractures, displaced bone segment underwent closed reduction through temporal approach followed by external splinting to be followed up. Of the isolated zygomatic arch fractures, those V-shaped fractures mentioned in textbooks and having 3 fracture lines went through closed reduction with Gillies method and followed up with the suggestion that that region of the patients’ face be protected against trauma, and the patient receive soft diet. An approximately 2-cm long incision was made in the hairy skin, preferably in the temporal region for
closed reduction in the Gillies method. From this incision, the deep fascia of the temporal muscle was also incised and the Rowe elevator was introduced from underneath this fascia to beneath the fragment in the zygomatic arch region. While the zygomatic arch was being kept in control externally with the other hand, the reduction of the fragments was achieved by laterally raising the tip of the elevator, which is under the fragmented bone segment. In V-shaped fractures, whereas in this process fragments generally remain stable restored in their anatomic positions, in the majority of cases where there were dual fractures in the arch, the fixity of the fragment could not be achieved through this process. Therefore, an external splint was provided to keep this unstable fragment in place. The splint was made of a metal plate long enough to extend from the tragal region to the malar projection and shaped to fit the zygomatic arch. Two percutaneous sutures were placed in such a way as to pass under the fragment using an atraumatic suture size 0 with a circular curve 5/8 needle. The ends of the suture were knotted on the splint in order to suspend the broken fragment (Fig 2).

Open reduction and internal rigid fixation were realized in cases where there were more than 2 fracture lines in isolated zygomatic arch fractures. For this operation, lacerations were used if available; otherwise, hemicoronal incision was used as a means of approach.

**Type II (Combined Zygomatic Arch Fractures)**

In cases where there is only one fracture line in the arch as a component of zygomatic bone fracture, the zygoma was reduced and internal rigid fixation was done from the regions of infraorbital rim, frontozygomatic, and maxillozygomatic buttresses. In selected cases, closed reduction of the zygomatic bone was done, using the bone hook. In some cases where the reduction of the zygomatic bone posed difficulty, the reduction of the zygomatic bone was completed by means of bone hook or Rowe elevator and then rigid fixation was started. In Le Fort III level fractures also, the rigid internal fixation was completed for the fractures in the nasofrontal and frontozygomatic regions. In all patients, lacerations were primarily used, which would enable us to reach the fracture lines for internal rigid fixation. In some cases lacerations were unavailable, so access to the infraorbital rim was achieved through subciliary or midtarsal incision, to the frontozygomatic region through lateral intrabrow incision, to maxillozygomatic buttress through upper gingivobuccal incision, and to nasofrontal region either through bicoronal incision or through transverse incision from the nasal root. No additional intervention was made in the arch in such fractures where the

![FIGURE 2](image1.jpg)

**FIGURE 2.** On the left, preoperative radiological image of an arch fracture in a patient with the fracture type I A; on the right, suspension of broken fragment onto an external splint after reduction.

single fracture line in the arch was a component of Le Fort III level or of zygomatic bone fractures.

Reduction and fixation in the zygoma or in the other parts of the Le Fort III fracture were realized without intervention in the arch in cases where there were more than one fracture, but reduced fragments of combined arch fractures. However, in cases where such fragments were displaced, the zygomatic arch was also reached and internal rigid fixation together with the other fracture lines was performed.

Use was made of the titanium miniplate and screws in all of the internal rigid fixations. In cases where both arches required intervention for the rigid fixation of the zygomatic arch, access to fragments was realized through bicoronal incision, and in unilateral ones a hemicoronal incision was made. To ensure the preservation of the frontal bundle of the facial nerve, great care was taken during the dissection of fascial planes in temporal region.

All patients went through an ophthalmologic examination preoperatively.

Preoperative and postoperative radiological images of the patients treated with the techniques described above for each of the varying types of arch fractures are presented in Figures 2 through 7.

**Discussion**

Even though fractures of the zygomatic arch appear to be minor, they are important. Correct treatment of the zygomatic arch, which is an important component in most orbitozygomatic fractures and connects posteriorly to temporal bone and anteriorly to the zygoma, plays the key role in the optimal treatment of the zygoma and midface fractures. When they are not treated properly, they may cause not only the facial skeleton to be impaired if there is a combined fracture, they may impede the movements of both the mandible and ankylose with the mandible, completely preventing the movements of the jaw.

In this series the percentage of fractures, among the midface fractures, related to the arch is as high as 65.3% (450/689), a factor that renders arch fractures important. As for the proportion of isolated fractures among all arch fractures, it is 9.33% (42/450), again a nonnegligibly high ratio. This ratio is consistent with what was reported previously in the literature.

When classifying the fractures in our series and dividing arch fractures into subgroups, theoretically we anticipated subgroups in which 2 or more fractures were reduced or displaced. However, in our
study we observed that isolated arch fracture did not have reduced forms in either case. In our opinion, the reason for this is that the forces strong enough to cause a fracture in the arch are again strong enough to cause the displacement of the fractured segments that has occurred. As for the combined fractures, there may be more than 1 unseparated broken segment in the arch because the main fracture-producing forces affect the zygomatic or other facial bones. Therefore, those forces break off bone-connecting points other than the arch. Meanwhile they may form fractures such as in green stick in the arch under the effect of rotational or momentum forces.

In the single fracture subgroup (type II-A) of type II combined arch fractures, correct and appropriate reduction and fixation of the fractures other than the arch must provide 3-dimensional complete reduction of the zygomatic bone, and therefore the broken arch has to be anatomically aligned. Proper stabilization of the other fractures should ensure the adequate fixation of this fracture also, but assurance must be obtained that anatomic reduction has been realized. Therefore, additional intervention was not made in the arch in those combined fractures with a single fracture line in the arch. Nevertheless, it has been reported that intervention in the arch proper is necessary in displaced arch fractures that lead to the loss of projection in anteroposterior plane. In the types of combined fractures with plural fractures, we applied the treatment on the basis of whether a segment or segments became reduced, neglecting absence or presence of projection loss. The reduced ones did not receive any adjunct treatment after the routine treatment of the bone. However, additional reduction of the broken bone in the arch was also realized using Gillies method, notably in cases where the zygoma was shifted medially and the broken fragments were excessively angulated without becoming separated from each other. In these fractures, the broken fragment in the arch, which had been angulated but not displaced owing to the preservation of
the periosteal continuity, did not require adjunct treatment because they had been settling back into their anatomic positions as a result of the reduction and fixation of the other fracture lines. In cases where the broken segments became displaced in combined arch fractures, open reduction of the arch and internal fixation were realized adjunctive to the treatment of other bones (Fig 7).

The delicate nature of the arch region renders difficult the processes of bone drilling and screwing in cases where rigid fixation is required, whether they are isolated or combined fractures. Because the point connecting the arch to the temporal bone also bears the same characteristics, it is a region that frequently gets broken, and the fractures here often manifest in the sagittal plane (Fig 8). Given the delicate and weak structure of the whole arch of this region in particular, it may be appropriate to use micro- rather than miniplates and screws in the fractures of the arch.

For the treatment of V-shaped fractures in the subgroup of more than 2 fractures in the arch of the isolated arch fractures in our classification, the literature suggests the Gillies method be used,2,20 and in our experience, this application also has been seen to be satisfactory. It also has been reported that in such fractures, satisfactory results have been obtained from closed reduction using percutaneous J-shaped hooks from the arch region.1,19 However, here also there is the warning that care must be taken when inserting the hook and doing traction for the reduction of the fracture lest the facial nerve be injured.1,19 The Gillies method appears to be safer in this respect. In both cases, if the stabilization of the arch region is believed to be inadequate at postreduction digital examination, the transition to open reduction and internal fixation is indicated. Another alternative suggested in unstable reduction is percutaneous stenting.20 There was no need for a second open reduction and rigid fixation or external splinting after the closed reduction application in our series.

Dissimilar treatment methods for V-shaped arch fractures are also suggested in the literature.13,21,22 One such method, suggested by Werner et al, is the fracture reduction using endoscopic method.13 Another team applying endoscopic reduction method in the comminuted fractures of the zygomatic arch is Chen et al.21

The fixation of the unstable arch fractures with external splinting was reported previously in the literature together with different applications.12,23-26 One of the methods used to keep the reduced arch in this position is to place under the arch various inflatable temporary implants for support in the temporal fossa.11,25 In our case, however, as it appeared in our algorithm, if there were 2 fractures in the arch and if the broken fragment was likely to shift medially, we made use of a metal splint placed on the skin in a way to attract it laterally (Fig 2).

Based on the experience obtained in this series, we have designed a proposal of algorithm to divert the treatment of zygomatic arch-related fractures according to their types (Fig 9). In this retrospective study, we have found that the majority of the treatment modalities we have applied on our patients with favorable results has fit our algorithm. Given the results we obtained, we think that it is proper that the treatment should be structured according to the algorithm.

**References**

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