ORIGINAL RESEARCH

Surgical stent and C-Arm guided reduction and Stabilization of Isolated Zygomatic Arch fracture: A novel maneuver

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ABSTRACT

Isolated zygomatic arch fractures are usually treated by means of blind procedures. The assessment of reduction is done by crepitus sound and digital perception of the surgeon during the procedure. Post-operative conventional radiographs are the only way to evaluate the accuracy of the reduction due to excessive edema associated with these fractures. This paper describes a technique in which isolated zygomatic fracture is stabilized using self-cure acrylic surgical stent and wires guided by needles following its indirect reduction under the surveillance of C-Arm.

KEYWORDS: Isolated zygomatic arch fracture, C-Arm image intensifier, Acrylic surgical stent

INTRODUCTION

Zygomatic fractures are the second most encountered fractures of the face and managed by maxillofacial and plastic surgeons.[1] Isolated zygomatic arch fractures (IZAFs) account for approximately 4.5% to 10% among a variety of mid-face fractures. These fractures are usually outcomes of a direct impact of low-velocity force to the midface usually caused by road traffic accidents, falls, interpersonal violence and sports injuries. A plethora of methods has been advocated for the treatment of IZAF.[2]

Isolated and long-standing zygomatic arch fractures present as a pond like depression on the concerned side of the face. Most of them are stable when reduced; owing to inter-digitation of bone ends and because fragments are held in a vertical plane. (Temporal fascia upwards and the masseter muscle downwards.) That is why most fractures need not be fixed after achieving the reduction. However, although fragments are reduced, often the adequate stabilization cannot be achieved.[3]

Various direct and indirect methods have been published in the journals regarding the reduction of a zygomatic arch fracture. Surgically first evidence of reduction of zygoma fracture was reported by Duverney in 1751. Keen introduced the transoral approach in 1909, which was later modified by Goldthwaite and Quinn. Gilles et al. described an approach via temporal fossa approach in 1927 and became famous globally for treatment of isolated zygomatic arch fractures. In the same way, Dingman and Natvig defined a supraorbital approach as an extraoral substitute in 1964. In all these techniques various methods were used for the fracture reduction such as Rowe's elevator, Foley urinary catheter, Kelly hemostat, or similar instrument placed between the arch and coronoid process in order to get the desired reduction. In a percutaneous approach, a towel clip passed beneath the arch has been documented in a case series by Hwang and Lee[4] but the use of a towel clip for reduction is not too reliable because it renders the probability of relapsing arch after reduction when not stabilized.

Historically Several extra oral fixation methods had been proposed such as placing a wire around the zygomatic arch and attaching the wire to a plaster head-cap using a stainless steel synthetic bow that extends from ear to ear or using fox eye shield.[3]

Various elevators, hemostats, and bone clamps had been used for reducing and fixing fractures. Since orbital fractures involve a fewer or all zygomatic articulations, most of the techniques, reduction is not only difficult, but also inaccurate, and impossible to sustain.[1]

Apart from being intolerable to the patients. In 1997 Griffin et al. provided the first description of using C Arm fluoroscopic technique in the management of an isolated zygomatic arch fracture.[5] Over the years various classifications have been proposed which were lacking in consistency and were not able to highlight the necessary management protocols. Özyazgan et al.[6] classification of

How to cite this article:
Wadhwani P, Bedi RS, Chauhan H, Mani S, Srivastava AP, Dixit R. Surgical stent and C-Arm guided reduction and Stabilization of Isolated Zygomatic Arch fracture: A novel maneuver. Int J Oral Health Med Res 2017;4(3):21-25.

zygomatic arch fractures is the commonly used classification nowadays.

1. Isolated zygomatic arch fractures (type I)
   A. Dual fracture (type I-A)
   B. More than 2 fractures (type I-B)
      1) V-shaped fracture (type I-B-V)
      2) Displaced (type I-B-D)

2. Combined zygomatic arch fractures (type II)
   A. Single fracture (type II-A)
   B. Plural fracture (type II-B)
      1) Reduced (type II-B-R)
      2) Displaced (type II-B-D)

CASE REPORT

A 44-year-old man reported to the OPD of Saraswati Dental College and Hospital with a history of a hit by the cow on the left side of the face. Clinical examination revealed a depression and marked pain on the left side of his face. Radiological examination revealed isolated undisplaced fractures of the zygomatic arch Type 1-B-V on the left side (Fig 2). The fracture type was classified as per the Ozyazgan et al. based on computed tomography CT images obtained before surgery. His medical history was unremarkable.

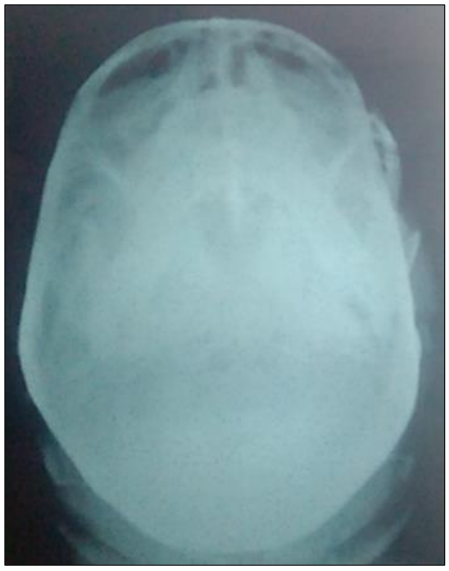

Fig 2: Pre-Op SMV Radiograph

An impression was taken from the contralateral unaffected side of the face to provide a model for symmetrical reduction of the zygomatic arch. A plaster model was constructed, and a self-curing acrylic bow was constructed on the model (Fig 3). Keen's approach was used under general anaesthesia; a radiograph was taken preoperatively using C Arm and standards were set.(SMV view angulation 115' from a supine patient, exposure time 2 sec, 1.8,Kvp 80.ADONIS 9 inches HF, C-Arm was used.) Fig 1,4.

Under proper aseptic condition, (Lignocaine: Add::1:200000, LOX 2%) was administered. An incision commencing from canine to first molar region was placed

Fig 3: Acrylic Splint Showing Defect

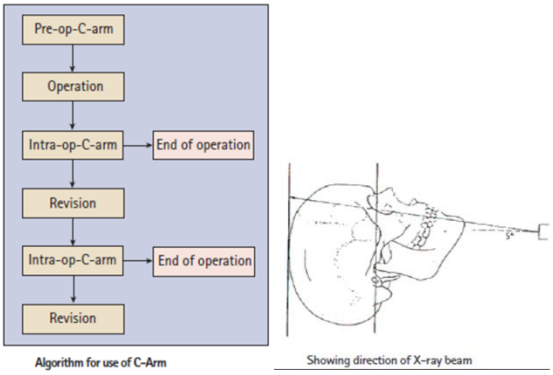

Fig 1: Approach for Treatment

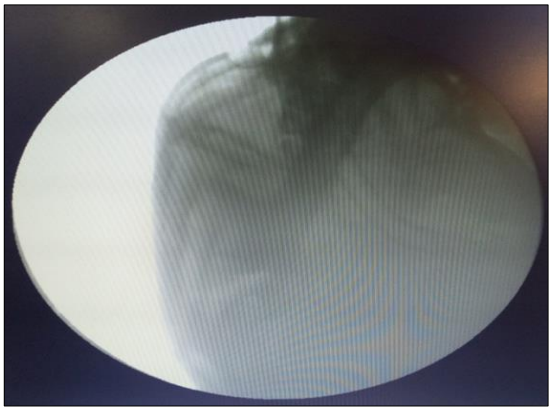

Fig 1: Approach for Treatment

Fig 5: Intra-OP Placement Of Surgical Stent

in the vestibular region 5-6 mm below mucogingival junction but inferior to the zygomatic buttress. (When used for an isolated arch fracture, a limited incision of about 2 cm is indicated but may be extended accordingly) After that, a Molt periosteal elevator was placed via the incision, and proper contact with the lateral antral wall was maintained followed by supraperiosteal dissection that exposed the infratemporal surfaces of the maxilla and zygoma. The medial surface of the zygomatic arch was dissected freed, and the coronoid process was located. The flat blade of the Kilner malar elevator (18cm) elevator was gently introduced into the incision site and placed under the infratemporal surface of the zygomatic bone.

With the surgeon's free hand placed over the operative site, the elevator was pulled superiorly and laterally. The blade is then swept laterally, medial to the zygomatic arch and lateral to the coronoid process. With a lateral pull along the fractured portion of the arch, followed by a sweeping and lateral force, the zygomatic arch component was reduced. Just after the assumed reduction done, again another radiograph was obtained with C-Arm. The stability of reduced fragments checked which was found adequate.

When reduction was achieved, two needles of 16 gauge were inserted: inferior and superior to the arch conferring the arch at a suitable angulation. Starting from the superior needle, a long wire of 26 gauge was passed in infratemporal region. The passed wire was again inserted via the tip of the inferior needle. Two ends of the wire were used to stabilize the pre-fabricated self-cure acrylic splint. An iodoform Vaseline gauge was placed between skin and acrylic bow in order to avoid skin necrosis Fig 5. The patient was taught to follow a soft diet for about 8-10 days after the operation in order to limit the use of the pulls downward pulling masseter muscle.

DISCUSSION

Matsuda et al. had proposed the hook screw for reduction of fractures. In the same way, Kim et al. and Moon et al. presented a method in which a 2-mm intermaxillary fixation screw was placed to hold a wire through the fracture sites. Rao and Rao used mono cortical screws and a self-holding screwdriver for reduction, but fixation using screw can only be done in properly visible areas and is therefore not feasible for reduction of the lateral part of zygomatic area.[7]

With a Steinmann pin Park et al. had testified external suspension with a Kirchner wire after closed reduction and fixation. Uda et al. introduced closed reduction and internal fixation by means of a Carroll-Girard screw. Hook wire and provided a confident approach of reduction but was not suitable for tiny fragments of bone as well as the impinched zygomatic arch. Secondly, hook traction has the tendency to leave a scar at the skin penetration site. Although it is only a slit incision, depressed or pigmented scar in some patients have been observed.[7]

C-arm in the intraoperative evaluation would confirm the adequacy of the procedure. In addition, we contrasted the surgeon's subjective evaluation with the objective evaluation of the radiographic control after completing the reduction. The technology facilitates surgeons to react instantly intra-operatively when an insufficient reduction is detected.[8]

Image intensifiers expose the patient and surgical team under radiation, although this radiation dose is 60 to 80% less than spiral CT radiation. In supine position, difficulty is felt in projection due to lack of unfamiliarity with this technique. Shared space at the head end with anesthetic equipment are some worries met during the procedure but practice the same team more and more times can vanish this problem.[9]

IZAFs give rise to a V-shaped depression on the lateral aspect of the face. One definite fracture line with bending or greenstick fractures in two adjacent areas to produces a W shape of the arch and a V-shaped deformity. Indirect reduction without fixation is generally used for such cases most of the time .Indirect reduction is achieved by Gille's temporal approach, Upper buccal sulcus, Bala Subramanian approach, Keen's approach of lateral coronoid and Quinn approach may also be used.[10]

Temporary support after reduction of zygomatic bone, a variety of materials has been suggested as external devices. An acrylic bow tied on zygomatic arch externally , silicone nasogastric tubes, wooden tongue blade, extraskeletal pins , tampons, kirschner wires and custom splints, etc., had been reported . Antral pack of gauge and antral balloon (Shea Anthony Balloon technique) were very famous. Limitation of these two methods was they exerted mechanical support to the reduced zygomatic bone only on the anterolateral aspect but in case of associated depressed zygomatic arch fracture, support in manditory from the mediolateral or postero-lateral portion. As a solution to this problem, Jarabak used Foley's catheter via oroantral approach and stabilized the arch in 1959. Gutman et al. used Foley catheter for zygomatic bone fractures reduction in 1965. Podoshin and Fradis applied the procedure by using Foley's catheter below zygomatic arch via the Gille's temporal approach. While Maron and Glover used Foley's catheter in the management of tripod fractures. The patient had difficulty in mandibular movements during the initial post-operative days of surgery due to the placement of the catheter in the infratemporal fossa that prevented the coronoid from moving freely and suspected complication in the technique was the tendency of retrograde infection.[10] Both isolated and ZMC-combined arch fractures most often require nonvisualized reduction of the displaced arch.[5]

Despite the on-going development of ultrasound equipment, the perfect visualization of the bony surface is not always achieved, and images occasionally display multiple echoes superficial to fracture lines, hampering interpretation.[5] Gross traumatic swelling and emphysema hamper clear detection of the bony surface.

Ultrasonography visualizes areas around fracture lines, and the whole zygomatic body and arch contour are not always imaged. Intraoperative CT techniques are expensive and time-consuming, and the availability is also limited.[5] 3D imaging using cone beam CT C-arm system, with radiation exposure equivalent to low-dose CT, can be used to visualize the facial bones but not to image bony alignment during repositioning maneuvers. Although 3D navigation guided operation can provide ideal reduction and fixation, it is cumbersome, experimental, and expensive, and not presently appropriate for routine zygomatic fractures.[5] Czerwinski et al. have recently proposed a new C-arm technique involving biplane fluoroscopy of the zygomatic "projection view" and "rotation view." Although this technique requires an intraoperative orthogonal change in the position of the C arm, the authors claimed that it enhances the accuracy of reduction.[5]

Kelley et al. cautioned that the term "zygomatic arch" is a misnomer because this structure is mostly linear through its course. Reduction of the arch with an excessive arch-like, but not anatomic, contour disturbs facial width and malar projection in combined fractures, indicating the importance of comprehensive contour correction over recovery, which is merely focused on bony continuity of the arch. This pitfall might be avoided using intraoperative imaging confirmation of the overall arch shape and malar contour.[5]

IZAFs generally implicate a partial or total obstruction of the movement of the condyle and of the coronoid process of the mandible, altering the opening and closure of the mouth. Successful reductions are often difficult to evaluate clinically because of the great amount of swelling that often accompanies these fractures.[11]

The operative procedures which do not facilitate visualization of the fractured segment during the surgery, leads to inadequate reduction and also results in complications including persistent esthetic concerns, diplopia, orbital dystopia, malunion, and significant residual deformity.[11] The sonography does not show slightly displaced fractures properly, so assessment for precise reduction is not possible. CT Scan is considered gold standard in the diagnosis of zygomatic arch fractures. However, its intraoperative use for the assessment of reduction of zygomatic arch requires a special operating table and does not cost effective.[11]

Therefore the use of C-Arm intraoperatively allows for dynamic visualization and the immediate monitoring of the adequacy of fracture reduction. This method can reduce the requirement of radiographs and CT scans postoperatively in order to assess zygomatic arch fractures and, thus overcomes the disadvantages of radiography and palpation. It has a user-friendly nature and low emission levels.[11] The open reduction has a potential risk for facial nerve injury, scalp numbness, and alopecia. Rodriguez and Casado observed that above 90% of the fractures do not need any added actions owing to the splinting effect of the temporalis fascia and the ventral periosteum of the arch.[2]

Closed reduction of fracture requires a smaller amount operating time, ends with nominal scars of incision, and incurs less soft tissue violation. Moreover, because the better bony union can be expected due to nonviolation periosteum. Inadequate mechanical fixation and poor visualization are the main disadvantages of the closed reduction techniques. Closed reduction is performed through temporal, transoral, and transcutaneous approaches in most cases of IZAF.[2]

Endoscope aided techniques of closed reduction have some benefits like direct and enlarged visualization, less complication, and a healthier result than the conventional methods. But it takes a relatively longer operative time and is costly. The benefits of the transoral approach are absence of a skin incision, technical ease, minimal dissection and bleeding however, it easily facilitates the oral flora, into the infratemporal fossa and increases risk of infection.[2]

Closed reduction with a curved mosquito can cause hematoma because of blunt dissection through the masseter muscle. Reduction with the bone hook can be technically difficult while dealing a depressed arch with a towel clip may lead to unintentional injury of facial nerve.[2] Transcutaneous screw reduction is a less invasive method for zygomatic arch fractures; but it is not easy to apply in aged patients with friable bones. Therefore, it seems reasonable to assume that splinting of the fractured segments after closed reduction is a safer method in the treatment of IAAF. There are two main methods described in the literature for stabilization and protection of the fractured bone segments after closed reduction, i.e., external and internal splinting[2]. The Foley catheter, when used internally is inclined to superior or inferior displacement under the reduced zygomatic arch because of its spherical shape. Turan et al. firstly introduced the endotracheal tube method for internal splinting of the reduced IZAF. The elliptical cuff of endotracheal tube exerts pressure over a longer segment of reduced fracture and avoids displacement. The endotracheal tube method offers to readjust the volume of the cuff to maintain the appropriate position of the fractured segments.[2]

Botulinum toxin has been documented for abolishing the displacing force of the masseter muscle over the fracture site.[2] Tizanidine was also used in place of botulinum toxin for the same purpose.

CONCLUSION

Use of C-Arm provides the surgical advantage of immediate on table appreciation for the adequacy of the desired reduction, thus reducing the need of postoperative radiographs thereby diminishing the overall cost and treatment time for the patient. The use of acrylic splint as a surgical stent is a simpler method to gauge the aesthetic correction along with maintaining necessary post-

operative stability.

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Source of Support: Nil
Conflict of Interest: Nil