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Case Report

A novel fixation method for panfacial fracture using an Ilizarov-type external fixator

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ABSTRACT

In general, internal plate fixation is mainly performed in order to reduce multiple facial bone fractures and rarely uses an external fixator. Although it would be ideal to successfully achieve or preserve the occlusal relationship of the upper and lower jaws, it is difficult to successfully manage multiple bone fragments in order to use them to achieve internal fixation, especially when treating a severely comminuted facial fracture. In addition, it is also important to prevent the onset of severe infection after sub-periosteal dissection, due to the presence of avascular bony fragments and an internal fixation implant which thus represents a foreign body. In order to treat extensive comminuted fracture without internal plate fixation, we performed external fixation using an Ilizarov-type external fixator. The Ilizarov-type external fixator is characterized by a few circular external structures and threaded rods. This device can be modified for use in the field of orthopedic surgery to correct three-dimensional deformities caused by fragile complicated fractures and bone defects. The advantages of the Ilizarov-type external fixator for treating panfacial fractures include a low invasiveness, utility in various fracture situations, easy adjustment of threaded rods, and a low potential cost. We herein report the first case of a severe panfacial fracture that was successfully treated using an Ilizarov-type external fixator.

Introduction

The Ilizarov-type external fixator can be applied in orthopedic surgery to correct three-dimensional deformities of extremities caused by fragile complicated fractures, bone defects and bone hypo-growth. This device is usually set while surrounded with a few circular external structures and threaded rods. We herein report the first case of a severe panfacial fracture including comminuted mandibular fracture that was successfully treated using an Ilizarov-type external fixator.

Case report

A 70-year-old woman suffered multiple severe general injuries after falling from a high altitude in a suicide attempt. On admission to our emergency center, no obvious airway obstruction was observed, but uncontrollable intraoral bleeding caused by a severe panfacial fracture was present. She showed hemorrhagic shock just after a computed tomography (CT) examination because of her

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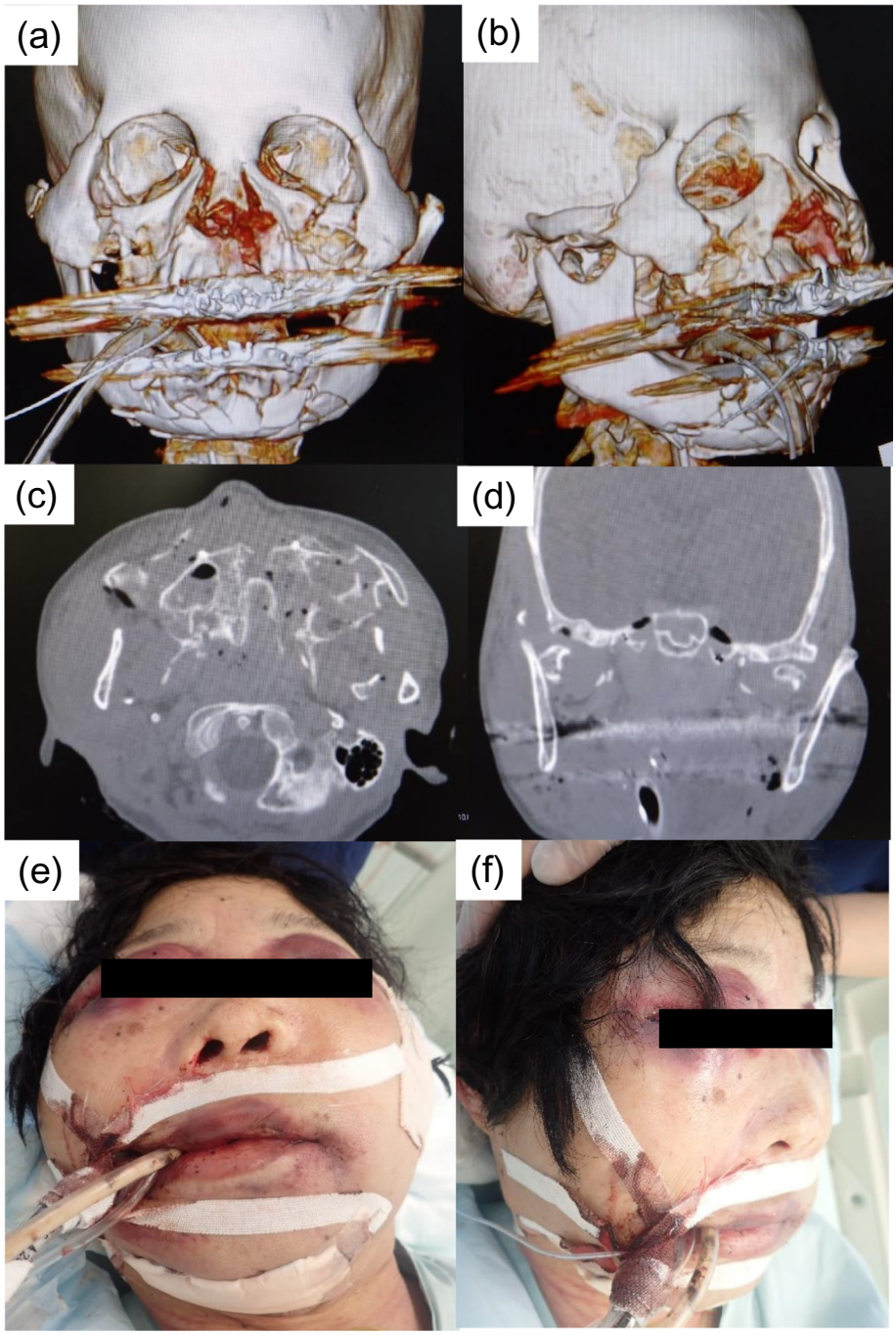

Fig. 1. Frontal (a) and right oblique views (b) of head three-dimensional computed tomography (CT) on admission. Axial (c) and coronal views (d) of midface CT on admission. Frontal (e) and right oblique appearance (f) after intubation on admission. An expanded facial width and flattening of the nose were observed.

incessant bleeding and was complicated with multiple-extremity trauma.

Emergency head and neck CT indicated the following: bilateral multiple maxilla and zygomatic fracture, palate crushing fracture, naso-orbito-ethmoidal (NOE) fractures, mandibular condyle open fractures, and mandibular body comminuted fracture (Fig. 1). After infusion 20 units of red blood cells (RBCs), 30 units of fresh-frozen plasma (FFP) and 40 units of platelets, her hemorrhagic shock was improved, and head and neck interventional radiology (IVR) was performed. As left maxillary artery extravasation was detected, only vascular embolization was immediately indicated, and early reduction of the pan-facial fracture was not performed in order to ensure stability of the vascular embolization.

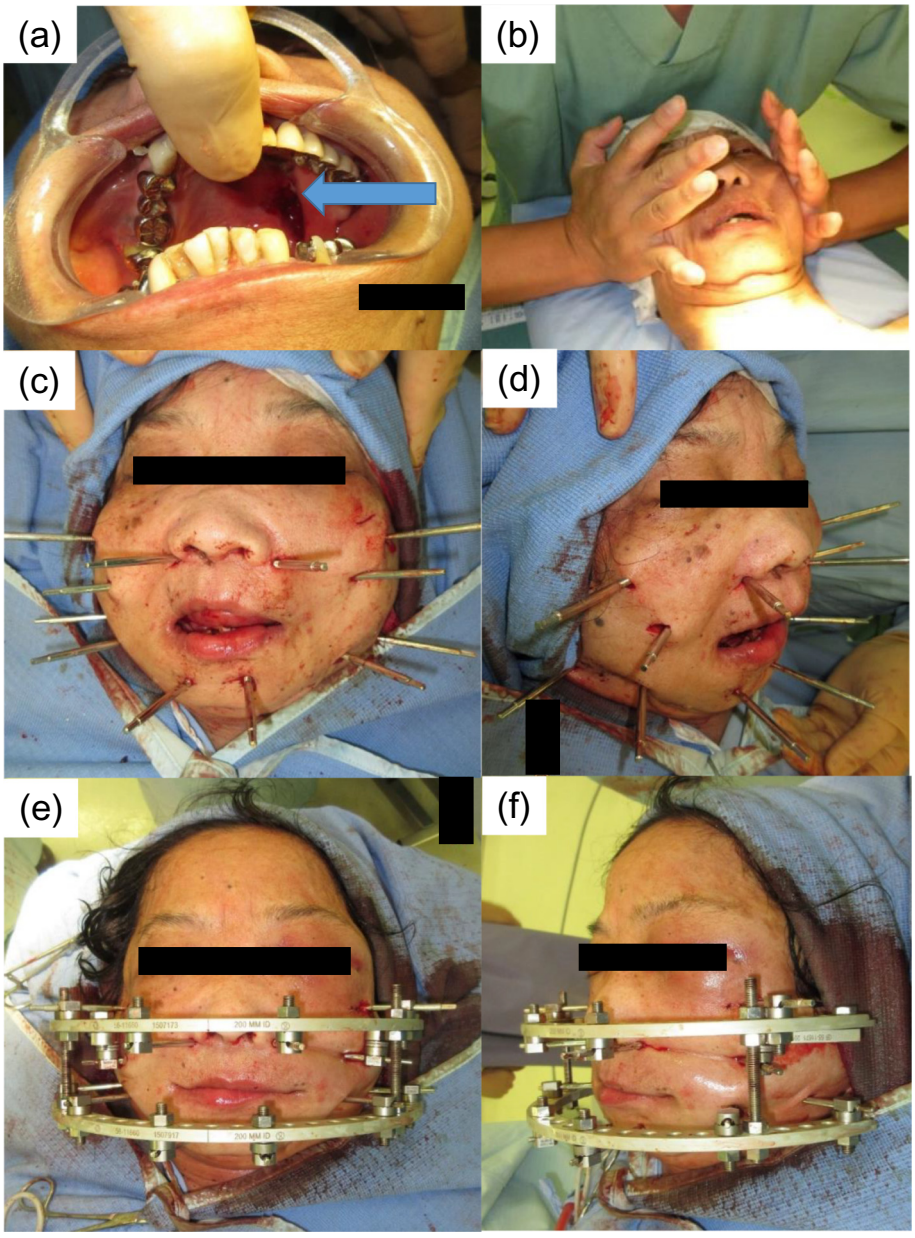

Fig. 2. An intraoral view showed the collapse of the dental arch with traumatic cleft palate (a). In order to improve the wide-dish face, the bilateral zygomatic areas were medially pressed manually from both sides (b). Intraoperative frontal (c) and right oblique view (d) just after 12 percutaneous pins had been placed to stabilize the fragile bone segments of the maxilla and mandible. Intraoperative frontal (e) and left oblique view (f) after Ilizarov-type external fixator attachment.

Four weeks after the injury, we were able to perform reduction surgery due to improvement in the patient's overall status. Due to concerns that sub-periosteal dissection to create the sub-periosteal cavity, avascularity of the bony fragments, and implantation of multiple plates and screws might exacerbate her condition and render her vulnerable to infection, we decided to perform Ilizarov external fixation for this case while using appropriate reduction and fixation devices.

First, in order to improve the wide-dish face, the bilateral zygomatic areas were medially pressed manually from both sides to restore the bilateral zygomatic bones to the normal facial width. There are no specific access routes for the insertion of threaded rods, and therefore we made holes in order to insert the relatively large-sized bone fragments. Twelve percutaneous pins for fragile bone segments of the maxilla and mandible were put in place, assisted by an intraoral incision, and then the threaded rods were used to control the positions of the bone fragments. The Ilizarov-type external fixator was then attached and then it was carefully adjusted into the correct position and location. The quality of reduction was ensured by confirming the zygomatic process distance and the reduction position of the dental arch under an intraoral incisional direct view (Fig. 2).

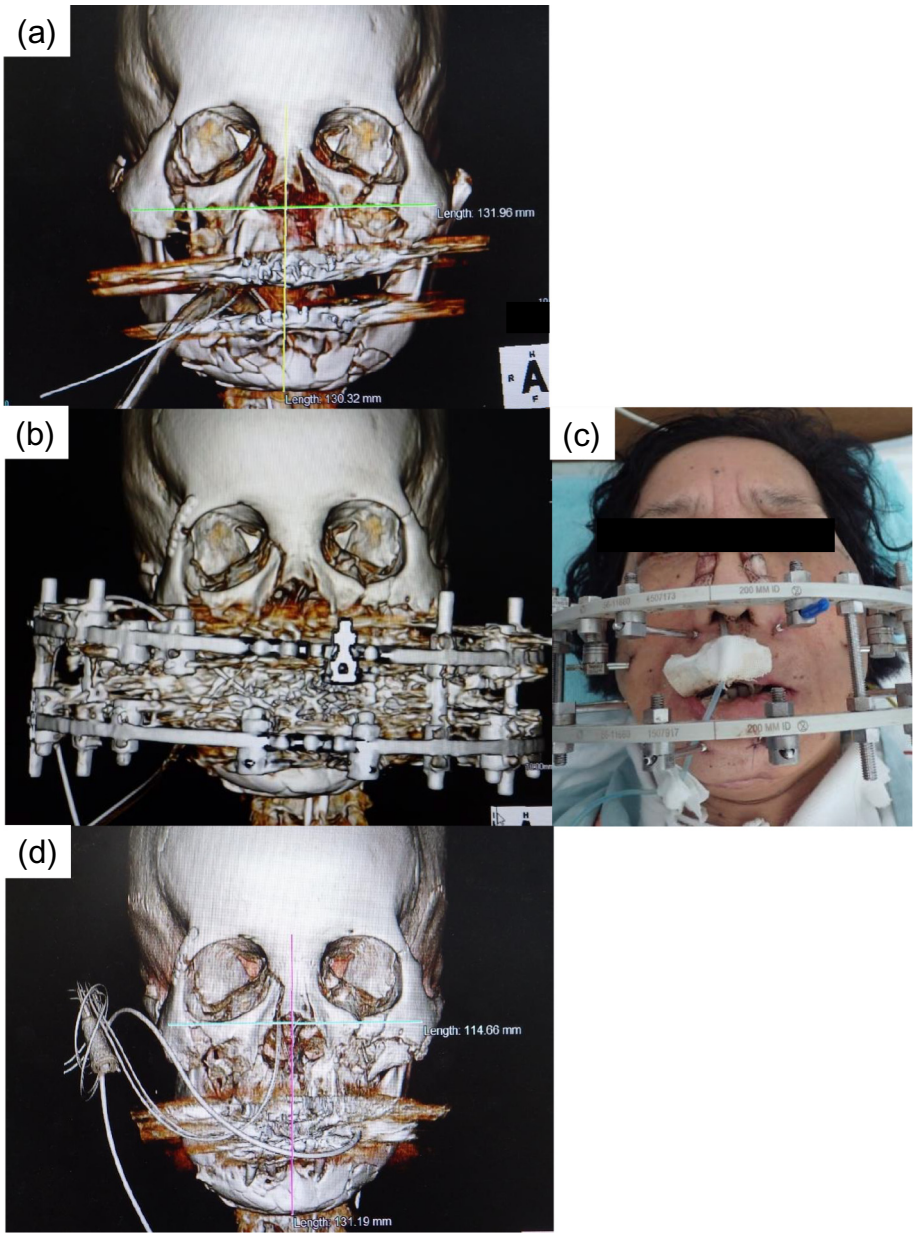

Fig. 3. Preoperative head three-dimensional computed tomography (3DCT) (a) showed dilated bilateral zygoma. Postoperative head 3DCT scans (b) and frontal appearance (c) are shown. Postoperative head 3DCT which was performed after the removal of the Ilizarov-type external fixator (d) showed that the facial width had decreased while its length had increased.

Nine days after the reduction surgery, due to unexpected acute cholecystitis, the intermaxillary fixation was temporary released, and an ENBD tube indwelling procedure was performed. *Re*-intermaxillary fixation was subsequently needed, and additional fixation of the right zygomatico-frontal suture was performed. Minor adjustment of the bone fragments was required; however, no infection of the rod sites occurred thanks to daily sterilization of the pin site. All of these devices were removed eight weeks after re-fixation without major complications. The distance between the zygomatic ridges was reduced by about 15 mm (Fig. 3). Nasal tube feeding was performed during external fixation. Five months after the injury, more orthodontic treatment was yet required, but the ability to ingest porridge-consistency meals and a 20-mm inter-incisal distance had been successfully achieved (Fig. 4).

Discussion

Internal plate fixation in the cranio-maxillofacial field is mainly indicated for various type of facial bone fracture and osteotomy operations. In rare cases, an external fixator is applied for panfacial fractures [1]. Only in cases of mandibular condyle fractures does

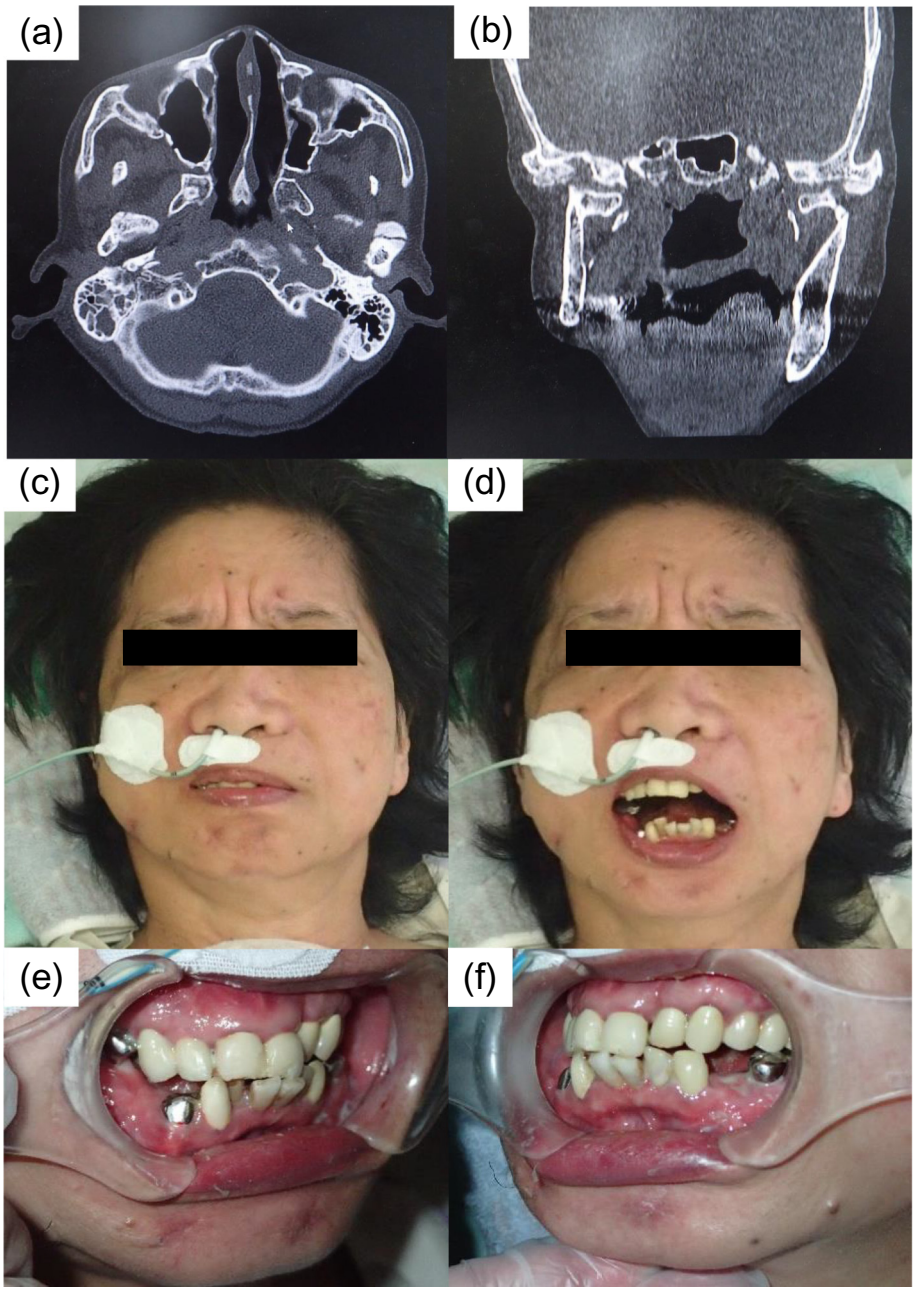

Fig. 4. Axial (a) and coronal view (b) of postoperative CT showed acceptable reduction of the bilateral maxilla and mandibular ramus. Frontal appearance of the closed mouth (c) and open mouth (d) at eight weeks postoperatively. Dentition views (e) (f) showed the occlusal conditions before orthodontic therapy.

internal versus external fixation tend to be multifactorial, and patient-specific factors often lead us to select the most appropriate management strategy. Although it would be ideal to successfully achieve or preserve the occlusal relationship of the upper and lower jaws, it is difficult to successfully manage multiple bone fragments in order to use them to achieve internal fixation, especially when treating a severely comminuted facial fracture. In addition, it is also important to prevent the onset of severe infection after subperiosteal dissection, due to the presence of avascular bony fragments and an implant which represents a foreign body. We therefore applied external fixation in the present case to treat an extensive comminuted fracture without internal plate fixation, and bone extending devices can be used to substitute for an external fixator.

In the field of orthognathic surgery, maxilla-extending devices that function by applying rigid fixation to the cranium with a halo ring are commonly used; such devices are useful for reduction of facial fractures [2,3]. The Ilizarov-type external fixator is widely used in cases of severe limb injury to correct three-dimensional dislocation of bone fragment [4–7]. We may therefore modify the

Ilizarov-type external fixator in order to use it as an external fixator for comminuted facial fractures. There have been several reports of facial fracture reduction using other external fixators, but those external fixators are mainly used for the treatment of only mandibular fractures [8–10].

The advantages of the Ilizarov-type external fixator for treating panfacial fractures include a low invasiveness, utility in various fracture situations, easy adjustment of threaded rods, and a low potential cost. In the present case of severe panfacial fracture, including mandibular comminuted fractures, the Ilizarov-type external fixator was primarily indicated and facilitated the achievement of an acceptable facial structure and appearance as well as good dental occlusion. Of note, there have been no reports concerning patients' tolerance during external fixation of comminuted facial fracture, so this should be explored in the future.

Declaration of Conflict Interest

None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this manuscript.

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