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Use of resorbable mesh and fibrin glue for restoration in comminuted fracture of anterior maxillary wall

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Background: The facial bone has a complex structure compared to other bones, and various types of fractures can occur due to its characteristics. Among them, in comminuted fractures of anterior maxillary wall, multiple depressed and impacted bony segments cannot be reduced easily when performing internal fixation using plates and screws or wires, and inadequate restoration leads to a range of complications. This paper introduces an alternative technique using a resorbable mesh with fibrin glue to restore comminuted fractures of anterior maxillary wall.
Methods: Thirteen patients were diagnosed with comminuted fractures of anterior maxillary wall between March 2017 and February 2018 in the authors' hospital. All patients with comminuted fractures of anterior maxillary wall underwent restoration using resorbable mesh with fibrin glue. The patients' demographics, causes of facial trauma, mean operation time, length of hospital stay, follow-up period, and complications were recorded.
Results: No major complications and only one hypoesthesia of the skin area was noted. Three months after surgery, the hypoesthesia recovered completely. After surgery (mean, 3.9 months; range, 2–12 months), computed tomography showed that the bone fragments in all patients were fixed successfully in their anatomical places.
Conclusion: In comminuted fractures of anterior maxillary wall, the use of a resorbable mesh with fibrin glue can be an advantageous and effective method for a successful restoration without complications.

Keywords: Maxillary wall / Fibrin glue / Resorbable mesh

Original Article

INTRODUCTION

The variety and severity of facial bone fractures require an across-the-board surgical technique and conceptual knowledge that is concentrated in the specialty. The treatment of minimally displaced and non-comminuted fractures is sufficient to maintain the mechanical offloading. In most other cases, however, the alignment of buttresses and interfragmentary osteosynthesis are necessary. Many methods and materials of fixation are available, such as interosseous wiring, use of metal or resorbable plate, screw, mesh, bone cements, and autologous bone graft. The treatment can be simple and satisfactory, but sometimes complex and frustrating.

The comminuted fractures of facial bone occur frequently in the anterior maxillary wall, orbital wall, and frontal sinus because these bones are very thin and can be broken easily. In comminuted fractures of anterior maxillary wall, the multiple small bone fragments cannot be reduced easily to their ana-

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tomical position. When restoring comminuted fractures of anterior maxillary wall, the fixation of small fragments is very difficult using plates and screws or wires. Moreover, severe comminution of very small and thin bones can make fragmentary reduction impossible. Sometimes, after inadequate reduction or fixation, comminuted fractures may break and remain as a bony defect. Therefore, the remaining small fragments are simply left untouched in a bony defect areas or removed.

To achieve a successful result in comminuted fractures of anterior maxillary wall, extruded bone fragments must be returned accurately to the anatomical position. Therefore, a new method to restore comminuted fractures of anterior maxillary wall more effectively using resorbable mesh (Osteomesh, Osteopore, Singapore) with fibrin glue (Greenplast Q, Green Cross, Yongin, Korea) was attempted. The fibrin glue is a dual-component material containing thrombin and fibrinogen [1,2]. During the early wound healing phase, it can help keep the surgical wound stable by a hemostatic reaction and adherence. The product is reabsorbed completely after a certain amount of time. Fibrin glue has been proven to be safe, with the rare exception of allergic and extremely rare anaphylactic reactions [3]. In addition, to obtain an optimal surgical result, a resorbable polycaprolactone (PCL) mesh was applied to prevent the bone fragments extruding from their original anatomical positions. PCL is FDA (Food and Drug Administration)-approved and has been used widely as an implant material in various areas. The material is preferred as a resorbable implant because the size and shape can be made precisely, making it suitable for fracture sites or bony defects. This paper reports the fixation of comminuted anterior maxillary wall fractures using a resorbable mesh with fibrin glue.

METHODS

The number of patients who underwent surgery with zygomaticomaxillary complex (ZMC) fractures was 53 between March 2017 and February 2018 in the Department of Plastic and Reconstructive Surgery of Chonbuk National University Hospital. In these cases of ZMC fractures, 15 patients were diagnosed with communited fracture of anterior maxillary wall. Fractures on the anterior maxillary wall in 15 patients were restored by using resorbable mesh and fibrin glue. We excluded two patients from data of this study because they lost to follow up or rejected the postoperative computed tomography (CT) evaluation.

All patients underwent surgery under general anesthesia. To reduce bleeding at the operative site, 2% lidocaine mixed with epinephrine at a ratio of 1:100,000 was injected into the incisional site. A resorbable mesh that is slightly larger than the fracture site was prepared and an accurate three-dimensional (3D) shape like the fracture site was made. After molding the resorbable mesh, bony fragments were collected and placed on resorbable mesh to their anatomical position. Fibrin glue was then sprayed to fix bony the fragments and resorbable mesh. The resorbable mesh with fixed bony fragments was inserted to return them to their original place. Finally, the resorbable mesh was fixed to the surrounding intact bone with two or three screws (Fig. 1). The incision was then closed.

The patients' demographics, causes of facial trauma, location of the fracture site, mean operation time, length of hospital stay, follow-up period, and complications were recorded. The follow-up period was defined as the length of time between the last visit and the date of surgery.

RESULTS

The patients were nine males and four females (mean age, 39.4 years; range, 17 to 78 years). Affected sides were five cases in left and eight cases in right. The causes of facial trauma were traffic accident (n = 5), slipping down (n = 3), violence (n = 1), fall down (n = 2), industrial accident (n = 1), and sports injury (n = 1). The mean follow-up period was 4.1 month (range, 3 to 12 month) (Table 1). The mean operation time was 86 minutes and length of hospital stay 7.1 days.

The complications was only one hypoesthesia of skin area (Table 2). Three months after operation, the patient with hypoesthesia was clinically well and the sensation of the skin area was completely recovered. In all patients, there were no cases of complication and collapsing of reduction fragments in the follow-up CT image (Fig. 2).

DISCUSSION

The comminuted facial bone fractures occur more frequently in thin bone (anterior maxillary wall, orbital wall, and frontal sinus) than in other facial bone fractures. The comminuted fracture of anterior maxillary wall occur frequently due to the relative anatomical position. The anterior maxillary wall is a very thin bone resulting from low loading during normal function because the load contribution occurs through the nasomaxillary buttress and zygomaticomaxillary buttress. This is because fracture of anterior maxillary wall tends to be more comminuted than other facial bone fractures.

Although it is difficult to restore, the inappropriate reconstruction of comminuted fractures of anterior maxillary wall increases the incidence of complications. Collapse of the sinus

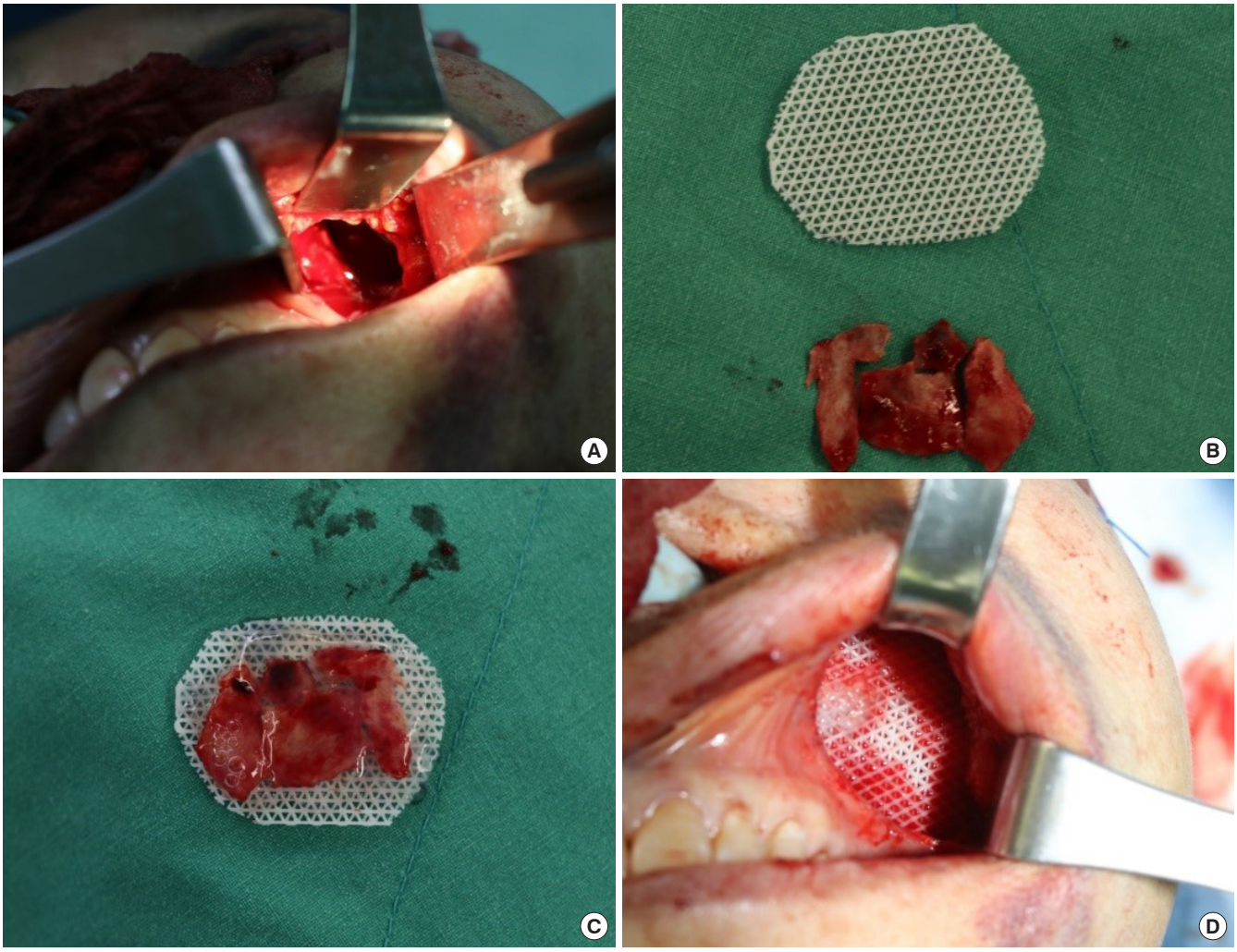

Fig. 1. (A) A defect of anterior wall of maxillary sinus caused by comminuted fracture. (B) The bony fragments were collected and placed to their anatomical position and resorbable mesh that is slightly larger than the fracture site was prepared. (C) Fibrin glue was sprayed to fix bony fragments on resorbable mesh. (D) A resorbable mesh with fixed bony fragments was inserted to return them to their original place.

Table 1. Patient demographics

Variable	Value (n = 13)
Sex	
Male	9
Female	4
Mean age (yr)	39.4
Affected side	
Left	5
Right	8
Cause of facial trauma	
Traffic accident	5
Slip down	3
Violence	1
Fall down	2
Industrial	1
Sports injury	1

Table 2. Complication

Complication	Number
Hematoma formation	0
Postoperative infection	0
Rhinitis	0
Hypoesthesia	1
Purulence discharge	0

lining and herniation of the facial structures into the sinus can lead to complications, such as sinusitis, rhinitis, bony defect, cosmetic deformity, and foreign body in the sinus [4-7]. On the other hand, the traditional technique using a plate, screw fixation, and interosseous wiring, have a limitation of restoring these bone fragments because the bony fragments are very thin and fragile. In this study, to reduce the number of complications, such as prolapse of the bony fragment and postoperative infection, which can occur when restored with traditional methods of plate, screw fixation and interosseous wiring, the authors attempted more efficient and simpler procedure for re-

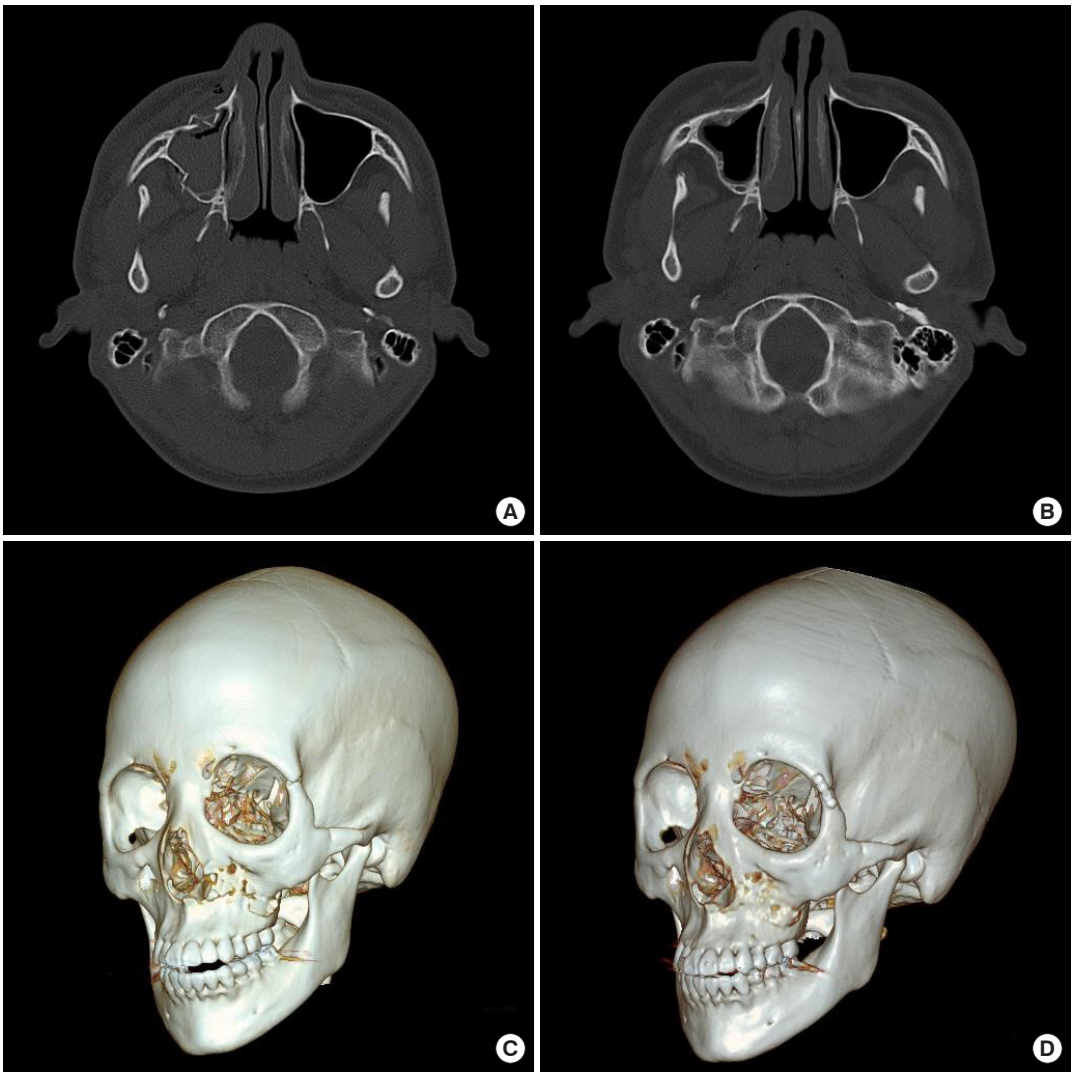

Fig. 2. (A) Preoperative facial computed tomography (CT) finding of 19-year-old man with right comminuted anterior wall of maxillary sinus fracture. (B) Postoperative 6 months facial CT image. Bony fragments are located in their anatomical position. (C) Preoperative three-dimensional CT image of 24-year-old women with left comminuted anterior wall of maxillary sinus fracture. (D) Postoperative 3 months facial CT image. Restoration of comminuted fracture was successful by using fibrin glue and resorbable plate.

storing comminuted fractures of anterior maxillary wall. A resorbable mesh, which can stably support the fractured small bony fragments and shield the sinus cavity, was applied and a surgical method combining fibrin glue to fix the small bony fragments with the mesh was performed.

The fibrin glue is a commercial human plasma-derived dual-component containing thrombin and fibrinogen in two syringes that are mixed immediately before application. The fibrinogen component contains calcium, which activates factor XIII. When the dual components are mixed for use, reproducing the last step of the coagulation phase, a cross-linked and stabilized fibrin clot forms by factor XIII [1,2]. Accordingly, fibrin glue has an effect on the early wound-healing phase through an adhesion and hemostatic reaction, and it can then decrease the shear force by increasing the adherence and maintaining their restoration stability in surgical wounds. For these reasons, fibrin glue has been used in many areas of surgery, including craniofacial surgery, skin grafting, microvascular surgery, breast surgery, facial lifting, and neurosurgery [2]. The structural bonding by fibrin clot can maintain for 3 weeks through its antifibrinolytic components. In addition, because the fibrin clot is reabsorbed completely after a certain amount of time, the fibrin glue does not increase the volume and fibrosis and foreign body reactions do not occur until resorption [8]. Song et al. [9] reported that 234 cases of ZMC fracture were fixed successfully without complications using fibrin glue. Jo et al. [10] reported successful restoration results with minimal complications in the reconstruction of 53 cases of orbital floor fractures using fibrin

glue. But, the use of these materials in a highly contaminated wounds such as open fractures should be considered carefully.

Song et al. [9] tried the fixation of bony fragments using only the fibrin glue. We applied to resorbable PCL mesh on fracture site because we have some apprehension of prolapse of the soft tissue or bony fragment into the sinus cavity. The major functions of resorbable PCL mesh on comminuted fracture site are maintaining anatomical shape of bony fragments and strong enough to prevent prolapse of bony fragments into the sinus cavity by herniation of soft tissue. On the other hand, the fixation using fibrin glue maintained for approximately 3 weeks that is not enough time for union of bony fragment. Hutmacher et al. [11] reported that fully interconnected scaffold architecture in PCL was completely 3D-filled by cellular tissue after 3 weeks. They shows that fibroblasts and osteoblast-like cells can proliferate, differentiate, and produce a cellular tissue in an entirely interconnected 3D PCL matrix. The combination of fibrin glue and resorbable PCL mesh is accompanied by bony union process and compensates for the disadvantages of each other.

Osteomesh (Osteopore) is a resorbable PCL mesh implant that is often used to restore various types of fractures in craniofacial surgery, such as medial orbital wall and orbital floor fractures, to fill bony defects. PCL implants made from a porous interconnected honey-comb architecture can provide a desirable osteoconductive environment to induce cellular growth, bone-directed differentiation, and tissue formation [11]. In addition, this implant is easy to handle, biocompatible with minimal tissue reaction. As mentioned earlier, the mainly use of a resorbable mesh in craniofacial surgery is for reconstruction of orbital floor fractures, and many articles have reported good results in restoring the orbital floor using a resorbable mesh with minimal complications [12,13]. The orbital floor and anterior maxillary wall have a similar anatomical shape and are very thin bones that make up the wall of the maxillary sinus. The authors suggest that a resorbable mesh can be used for successful restoration of the anterior maxillary wall. Furthermore, some recent papers have reported the development of advanced uses of the 3D printing technology in craniofacial surgery [14]. The use of a resorbable mesh with 3D printing surgery techniques can be particularly advantageous for personalized treatment through an exquisite and 3D restoration.

The limitation of this study is small sample size. On the other hand, the fixation of small bony fragments was good, as shown in the postoperative CT images. In addition, the other advantages of this method are that the operating time was reduced by the simple procedure and there were no complications. The use of a resorbable mesh with fibrin glue in comminuted fractures of anterior maxillary wall can be advantageous and effective compared to traditional techniques involving fixation using plates, screws and interosseous wiring. Furthermore, this technique can be applied to other type of comminuted fractures in facial trauma.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

PATIENT CONSENT

The patients provided written informed consent for the publication and the use of their images.

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