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Case Report

Reconstruction of a traumatic midface defect involving both facial and dental elements: a 12-month follow-up case report

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Abstract: Background: Midface defects caused by trauma, tumor resection, and infection often involve various structures, such as the nose, maxilla, palate, and teeth. Although numerous maxiollofacial reconstruction techniques have been described in the literature, satisfactory reconstruction of large midface defects involving multiple anatomical elements remains to be challenging. Case presentation: This case report describes successful restoration of a complex midface defect and oronasal communication involving the right ala nasi, right basis nasi, apex nasi, columella nasi, partial upper lip, maxillary alveolar bone, and anterior teeth. A step-by-step reconstruction strategy, including the expanded forehead flap grafting, alveolar bone expansion, iliac bone grafting, gingival grafting, and dental implants-based prosthetic rehabilitation, was accomplished at multi-stages. During the 12-month follow-up after the treatment, no complications were observed. Conclusion: Satisfied functional and aesthetic results were achieved in this case.

Keywords: Midface defect, oronasal communication, expanded forehead flap, expanded alveolar bone regeneration, dental implant

Introduction

The human midface area, occupying the central portion of the face, shows great importance in aesthetic evaluation and orofacial function. Maxillofacial defects due to congenital malformation, trauma, tumor resection, and infection, often involve various structures, such as the nose, maxilla, lips, and teeth, which may lead to significant midface deformity and functional impairment [1-7]. Traditionally, large nasomaxillary defects have been managed with a prosthetic option, such as the removable obturator denture and nasal epithesis [2, 7-9]. Recently, Trevisiol et al. [2] reported a new approach to rehabilitate a large midfacial defect with a single combined zygoma-implants-based prosthesis, which was consist of a nasal epithesis and a overdenture connected at the same metal framework supported by four zygoma implants. Nasal reconstruction, oroantral communication closure, labial competence correction and dental prosthetic rehabilitation were successfully achieved by using this novel technique. However, as the application of prosthetic rehabilitation approach was significantly hindered by the inferior performance in speech, chewing, swallowing, aesthetic outcomes, material lifespan, and local infection control, surgical reconstruction of the complex midface defect is still the first choice for patients with good systemic condition and favorable prognosis [3-5, 10-15].

Since the 20th century, the technique of nasomaxillary reconstruction has undergone constant evolution and raised our contemporary expectations to achieve an aesthetic and functional rehabilitation, however, satisfactory reconstruction of extensive midface defect involving both nasal and oral elements remains to be most challenging, not only in terms of disease control but also in terms of the reconstruction of local anatomy and orofacial function [1-3, 6, 12, 16]. In this article, the successful management of a traumatic midface defect involving both facial and dental elements is

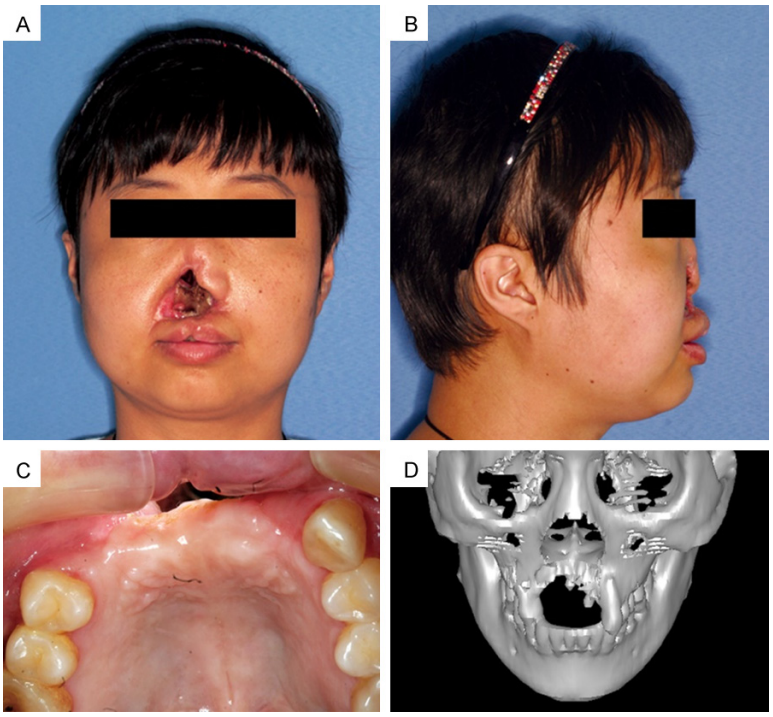

Figure 1. A, B. A nasolabial defect involving the right ala nasi, right basis nasi, apex nasi, columella nasi and partial upper lip was revealed. C, D. A maxillary defect involving anterior maxillary alveolar bone, labial sulcus, teeth as well as a 10 × 20 mm oronasal communication was revealed.

reported. A step-by-step reconstruction strategy, including the expanded forehead flap grafting, alveolar bone expansion, iliac bone grafting, gingival grafting, and dental implants based prosthetic rehabilitation was accomplished at multi-stages. Our management protocol and the treatment outcome are presented in detail.

Case presentation

This report was approved by the Institutional Review Board of Shanghai Ninth people's Hospital. The patient was fully informed of the treatment procedures and possible risks and gave written consent. All data generated or analyzed during this study are included in this published article.

A 34-year-old female was referred to our department for functional and esthetic rehabilitation of a traumatic midface defect following emergency treatment at a local hospital. The patient revealed a healthy non-smoking medical history until the accident. Physical examination revealed a nasolabial defect involving the right ala nasi, right basis nasi, apex nasi, columella nasi and partial upper lip, as well as a maxillary defect involving anterior maxillary alveolar bone, labial sulcus and teeth, which caused a 10 × 20 mm oronasal communication and upper lip collapse (**Figure 1**). Routine laboratory examinations produced normal results. Maxillofacial computed-tomography (CT) scans showed a severe alveolar bone defect extending from the right canine region to the left lateral incisor region (**Figure 1**).

The first stage procedure was performed under general anesthesia (**Figure 2**). A 200 ml silicone forehead tissue expander (Shanghai Winner Plastic Surgery Products Co, Shanghai, China) was implanted in the forehead. An alveolar and palate cortical osteotomy were performed between the first and second upper premolars. A modified teeth and bone based hybrid Hyrax rapid maxillary expander (Dentaurum, Germany) for alveolar protrusion was anchored with two Φ2 × 9 mm mini-implants (PSM Medical Solutions, Germany) placed in the anterior palate and 7 tooth bands cemented on the left upper canine, first upper premolars, first and second upper molars of both sides. Five days after the surgery, the Hyrax rapid maxillary expander was activated twice a day (1 mm per day) by the patient for 1 week and left in place for the 3-month consolidation phase (**Figure 2**). The forehead tissue expander was inflated with sterile normal saline twice a week (20 ml per week) for 3 months (**Figure 2**).

The second stage procedure was performed under general anesthesia by the plastic and reconstructive surgeon. The forehead tissue expander was removed and an immediate nasolabial reconstruction was performed using the expanded forehead skin flap along with reconstitution of the nasal skeletal framework with costal osseo-cartilage graft (**Figure 2**). After reconstruction, the division of the pedicle and flap debulking was performed.

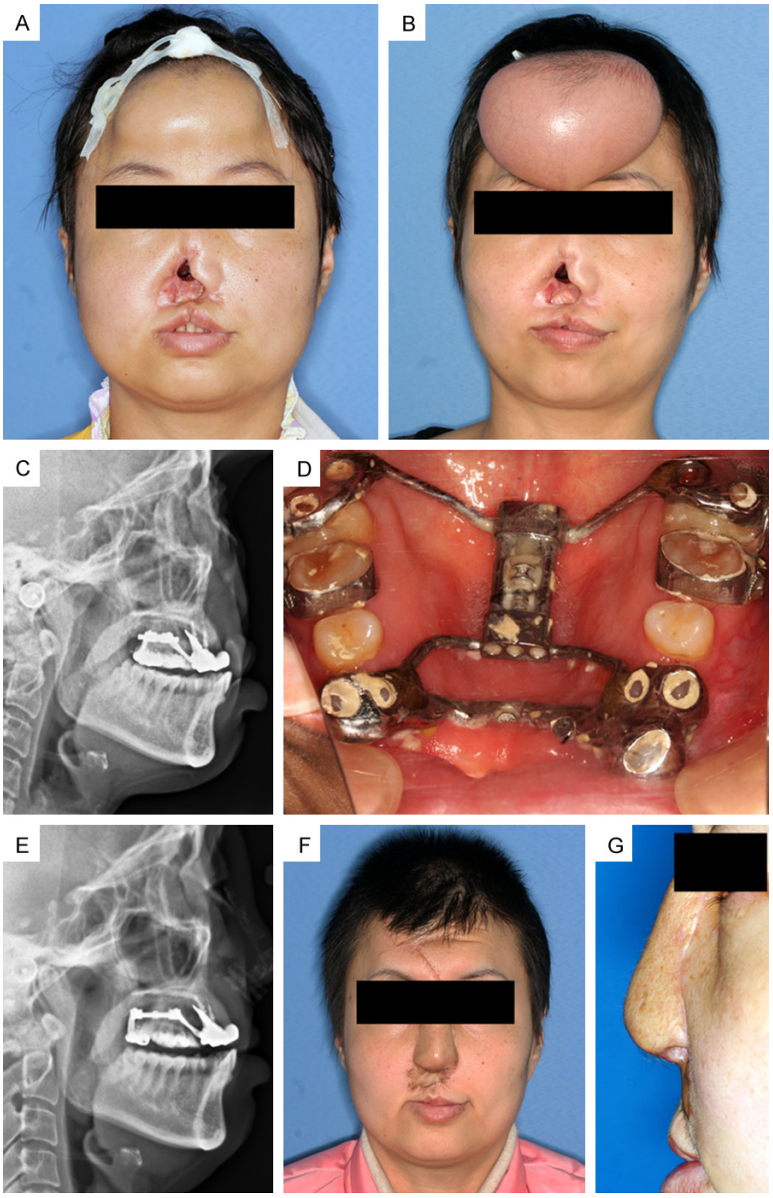

Figure 2. A. A 200 ml silicone forehead tissue expander was implanted in the forehead. B. The forehead tissue expander was inflated with sterile normal saline after 3 months. C. A modified hybrid Hyrax rapid maxillary expander was anchored after the alveolar and palate cortical osteotomy. D. The Hyrax rapid maxillary expander was activated to protrude the premaxillary for 7 mm and left in place for a 3-month consolidation phase. E. X-ray examination confirmed the successful protrusion of the premaxillary alveolar. F, G. The nasolabial reconstruction was performed using the expanded forehead skin flap along with reconstitution of the nasal skeletal framework with costal osseo-cartilage graft.

After a 6-month healing period, clinical examination revealed insufficiency of bone width and height of the protruded alveolar bone for implants placement as well as an absence of a labial sulcus in the anterior maxillary region (**Figure 3**). An iliac bone harvesting and grafting to the remnant alveolar ridge was performed (**Figure 3**). Followed by 3-months observation, a gingival grafting was performed to rebuild the labial sulcus (**Figure 3**).

Six months later, maxillofacial CT scans confirmed the well-regenerated bone volume and adequate shape of the premaxillary alveolar ridge (**Figure 4**). Three osseointegrated implants (Straumann, Switzerland) were placed in the newly reconstructed alveolar with good primary stability (**Figure 4**). After an osseointegration period of 3 months, the teeth defect was restored using a 3 implants-supported 5-unit porcelain-fused-to-metal bridge (**Figure 4**).

After the treatment, clinical and radiological examination was performed routinely, while no complication was observed during the one-year follow-up. Significant restoration of the upper lip length, nose height, facial convexity, and premaxillary dental alignment were achieved. The patient was satisfied with the treatment outcome in terms of the facial contour, dental occlusion and oral function (**Figure 5**). The lateral cephalometric tracings before and after the treatment were also recorded and evaluated (**Table 1**).

Discussion

Extended midface defects due to trauma, tumor resection or infection may involve both the facial and dental structures. A wide variety of reconstructive options including pedicled or vascularized free flaps as well as bone grafts have been suggested to reconstruct the defects in midface area, depending on the size, depth, color, dimension, and composition of the tissue needed [1, 3-5,

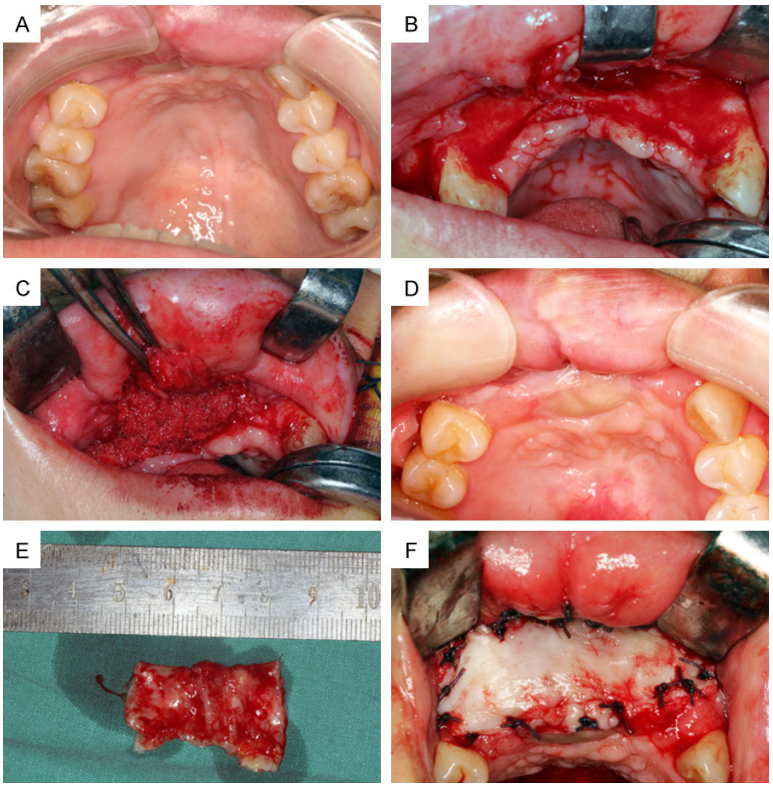

Figure 3. A, B. Insufficient height and width of the protruded alveolar bone for implants placement was revealed. C. An iliac bone harvesting and grafting to the remnant alveolar ridge was performed. D. Absence of the labial sulcus in the anterior maxillary region was revealed after the bone grafting. E, F. A gingival grafting was performed to rebuild the labial sulcus.

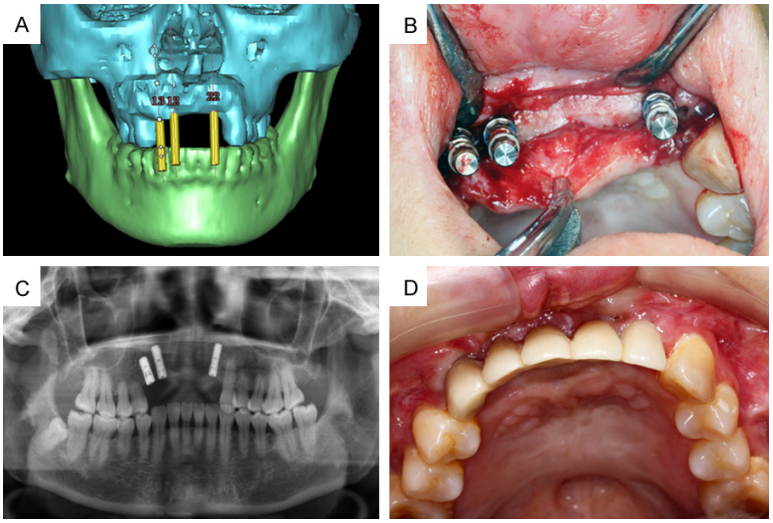

Figure 4. A. Maxillofacial CT scans confirmed the well-regenerated bone volume and adequate shape of the pre-maxillart alveolar ridge for dental implants placement. B, C. 3 osseointegrated implants were placed in the newly reconstructed alveolar bone according to the computer assisted surgical planning. D. After an osseointegration period of 3 months, the teeth defect was restored using an implant-based fixed bridge.

7, 10, 12-15]. In 2010, a widely accepted classification of the midface defects was recommended by Brown and Shaw, which not only provides a framework to explain the different problems and complexity of each defect, but also indicates a rationale for reconstructive options [7]. According to this classification, the midface defect presented in our patient falls into class VI c; a nasomaxillary defect extending from nose to the anterior maxillary alveolar bone and causing oronasal communication. This group of defects is more complicated, since both nasal and dental elements of the defect are involved and a multi-staged composite reconstructive strategy is usually required [3, 7]. To date, no optimal functional and esthetic reconstruction algorithm has been proposed in terms of this group of defect. In the present case, the successful restoration of an extensive traumatic midface defect is reported using the expanded forehead flap grafting, alveolar bone expansion, iliac bone grafting, gingival grafting, and dental implantation technique.

The nose, as the central part of the midface, is visible in most views of the face and is difficult to achieve favorable functional and aesthetic reconstruction outcome [15]. Basically, the most important principle of nose reconstruction is to avoid structure distortion and to provide an accurate skin match [3, 14, 15]. Although many local and free flaps have been used for nasal reconstruction such as the nasolabial flap, forehead flap and vascularized forearm flap, the expanded forehead flap is

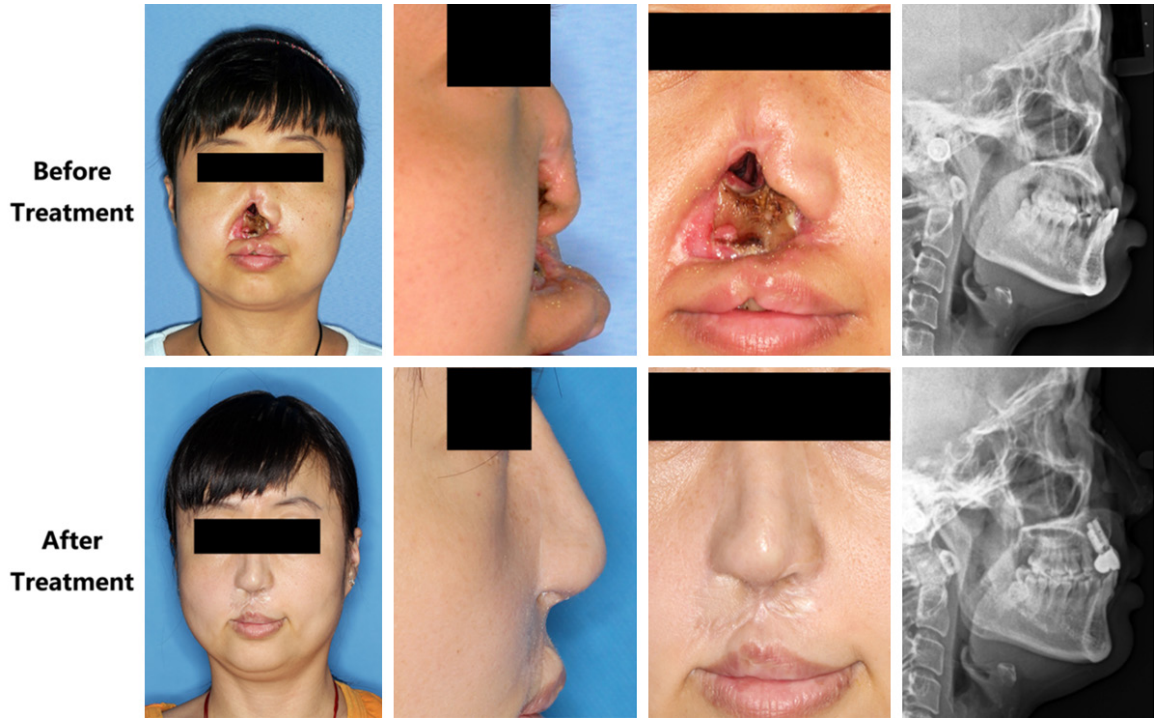

Figure 5. Photos and X-rays before and after the treatment shows that significant restoration of the upper lip length, nose height, facial convexity and premaxillary dental alignment were achieved. The patient was satisfied with the treatment outcome in terms of the facial contour, dental occlusion and oral function.

Table 1. Comparison of cephalometric changes of the patient before and after treatment

	Before Treatment	After Treatment	Normal range
Anterior Cranial Base	58.8	59	71±3
SNA	83.7	88.5	82.8±4.1
NA-FH	78.7	84.5	91±7.5
Upper Lip Length	18.6	22.8	20±2
SNB	84.2	83.7	80.1±3.9
MP-FH	31	32.1	27.3±6.1
Nose Height	N/A	42.4	45±3
ANB	-0.5	4.8	2.7±2
Facial Convexity Angle	N/A	9.2	12±4
UI-NA	N/A	21.8	22.8±5.2
Overjet	N/A	2.7	2±1
Overbite	N/A	2.6	3±2

Significant restoration of the SNA angle, ANB angle, NA-FH angle, upper lip length, nose height, facial convexity angle, UI-NA angle, overjet and overbite were achieved.

often the first choice for large or total nasal defect reconstruction, which can provide large amount of skin cover with suitable color and thickness as well as minimal scarring at the donor site [1, 3, 13-15]. Ramanathan et al. [1] recently reported a case series of staged reconstruction of congenital nasal cleft deformities using expanded forehead flaps. Notably, the congenital nasal clefts are often associated with abnormalities of the nose, upper lip, alveolar bone, which may significantly complicate the reconstruction of the inner nasal mucosa lining in the area of the oronasal communication. According to previous experience, application of cutaneous turn-in flaps from the skin and adnexal structures adjacent to the nasal defect are often preferred to achieve an close internal cover, which helps in reorienting the primary defect margins and placing the suture lines without disrupting the existing internal nasal lining [1, 14, 15]. Likewise, a 2-stage expanded forehead flap grafting and autologous costal cartilage grafting were used to restore the right ala nasi, right basis nasi, apex nasi, columella nasi and partial upper lip of our patient. The structured approach to reconstruct the nasal morphology and the underlying osseo-cartilaginous skeletal framework has helped to achieve a satisfactory result.

Another reconstruction challenge of this case lies in the three-dimensional maxillary defect

involving anterior alveolar bone, labial sulcus and teeth. The loss of the premaxillary teeth and alveolar bone together with oronasal communication leads to adverse changes of occlusal space, jaw relationship and upper lip support. Previously, vascularized free fibula flap with or without distraction osteogenesis was preferred to provide the bone and soft tissues in reconstruction of large traumatic maxillary defects [10]. Nevertheless, the intraoral skin flap or lack of attached gingiva may significantly impede further implants-based oral rehabilitation. In this case, we fabricated a customized tooth- and bone-anchored maxillary expansion device, which is a modification of the Hybrid Hyrax RPE appliance introduced by Wilmes et al. [17]. A premaxillary segmental osteotomy along with rapid maxillary expansion was performed to reduce the resistance to maxillary protrusion by the craniofacial skeletal architecture. By using this technique, new bone formation and advancement of the premaxillary bone residue was achieved with minimal invasion and lower risk of relapse. Another advantage of this technique is that the surrounding soft tissue was also regenerated in a controlled fashion, which helped to close the oronasal communication [10, 18]. However, as alveolar bone expansion per se could not satisfactorily reconstruct the intricate anatomy of the alveolar ridge. After a 6-month healing period, the width and height of the remnant alveolar ridge was further restored by iliac bone grafting, which allowed for the ideal placement of dental implants. The final facial contour and occlusal relation revealed a satisfactory and stable esthetic and functional improvement.

In conclusion, this case report addresses the successful step-by-step reconstruction approach of a complex midface defect involving both facial and dental elements with satisfactory functional and aesthetic outcomes.

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Disclosure of conflict of interest

None.

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