Staged Rehabilitation of Posttraumatic Dentoalveolar Defect with Distraction Osteogenesis and Dental Implants

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Abstract

Rehabilitation of posttraumatic composite defects of anterior mandible following comminution type high-energy injury often presents a reconstructive challenge. Obtaining ideal osseous and soft tissue contours in these cases is a demanding task. We discuss a case of a young man, involved in a road-side accident leading to multiple fractures in his mandible with comminution of anterior alveolar ridge. We were able to achieve excellent results by planning and treating him in five sequential stages. First, the need for rigid internal fixation was addressed followed by bone augmentation with the dynamic osteodistraction method, dental implants, and prosthesis delivery. Satisfactory aesthetics and functions were noted at a 7-year follow-up evaluation of the patient justifying the multistaged rehabilitation treatment rendered.

Keywords
- alveolar ridge augmentation
- comminuted fractures
- distraction osteogenesis

Comminuted mandibular fractures are complex injuries, generally a result of significant impact on a localized area of jaw by high-energy trauma.[1]

Finn has defined comminuted fractures as the presence of multiple fracture lines leading to many small pieces within the same area of the mandible.[2] Most studies report 2 to 7% of mandibular fractures in their series as comminuted.[3,4]

The injury panorama of comminution encompasses fractures ranging from “relatively” simple fractures to complicated avulsive injuries with hard and soft tissue loss and continuity defects. With increasing severity of injury, these cases become more difficult to treat, and often a sequential multistaged treatment is required.

The case of anterior mandibular comminuted fractures comprising of composite defects with loss of alveolar bone, mucosa, and dentition presents a challenging situation to treat, and obtaining satisfactory outcomes from a functional and esthetic viewpoint becomes difficult. Alveolar ridge atrophy is a common sequela of comminution of alveolar process and dentition loss. The nature of alveolar ridge deficiency demands bone and soft tissue augmentation to guarantee adequate volume to provide proper interarch relations and allow satisfactory aesthetic, prosthetic, and occlusal results.

We report a traumatic injury case of comminuted fracture of anterior mandible, which was managed comprehensively through a “staged rehabilitation” of patient function and occlusion. We highlight the role of vertical distraction osteogenesis (VDO)/osteodistraction (OD) in alveolar ridge augmentation (ARA) in such cases to optimize clinical outcomes.

Case Report

A 21-year-old male patient reported to the Department of Oral and Maxillofacial Surgery, Postgraduate Institute of

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Dental Sciences, Rohtak with a history of a motor vehicular accident that resulted in the loss of his mandibular anterior teeth. Clinical and radiological examination revealed avulsed mandibular incisors, comminuted dentoalveolar process fracture, and multiple fractures of mandibular basal bone region. After a detailed examination and thorough diagnosis of the condition, a staged rehabilitation was planned comprising of fracture fixation followed by VDO in the anterior mandible and succeeded by implant-supported hybrid prosthesis.

Staged Treatment

Stage I: First Surgery

The patient was chosen for open reduction and internal fixation under general anesthesia. The comminuted mandibular basal bone fracture was treated by simplification of the fracture fragments with miniplates followed by fixation with minimal contact reconstruction plates through transoral route. The sites were primarily closed. Patient was on maxillomandibular fixation for 1 week postoperatively and was kept on a close follow-up thereafter.

At 6 months, the fractures had healed uneventfully with no mobility of fracture segments. Satisfactory posterior occlusion was achieved, but a severe anterior alveolar ridge deficiency was present, to the extent that prosthetic rehabilitation could not be performed without ridge augmentation (►**Fig. 1**).

Stage II: Second Stage Surgery

Second stage surgery was planned under conscious sedation at approximately 9 months. The surgery intended to remove the implant material used for fixation of fracture fragments with simultaneous placement of intraoral extraosseous alveolar distractor. A vestibular incision was made on the labial aspect in the intercanine region with care taken to preserve the alveolar crestal mucosa, thereby preserving blood supply for the crestal aspect of the transport bone segment and maintaining its vitality. Mucoperiosteal flaps were elevated to expose and remove the previous hardware. Also, the lingual mucosa was left attached to the bone to provide a blood supply via the periosteum.

The distraction device was temporarily placed to mark the position for the screws before performing the osteotomy cuts. Two vertical and one horizontal osteotomy cuts parallel to the alveolar crest were then marked with rotary burs, the drill holes were connected with an oscillating saw, and cuts were completed with osteotome. The osteotomized segments were mobilized.

The alveolar distractor device was fixed with monocortical screws to both the fragments. Mobilization of the osteotomized fragment was checked by activating the distractor to rule out any obstruction in free movement of the fragment. The osteotomized fragment was then approximated back to its initial position (►**Fig. 2**). Layered closure was done with activator screw of distraction device exposed within the oral cavity.

Stage III: Distraction Phase

After the latency period of 7 days, distraction was started at the rate of 0.5 mm per day with two turns of 0.25 mm daily. Distraction was continued for a total of 10 days with overcorrection followed by a consolidation period of 12 weeks (►**Fig. 3**).

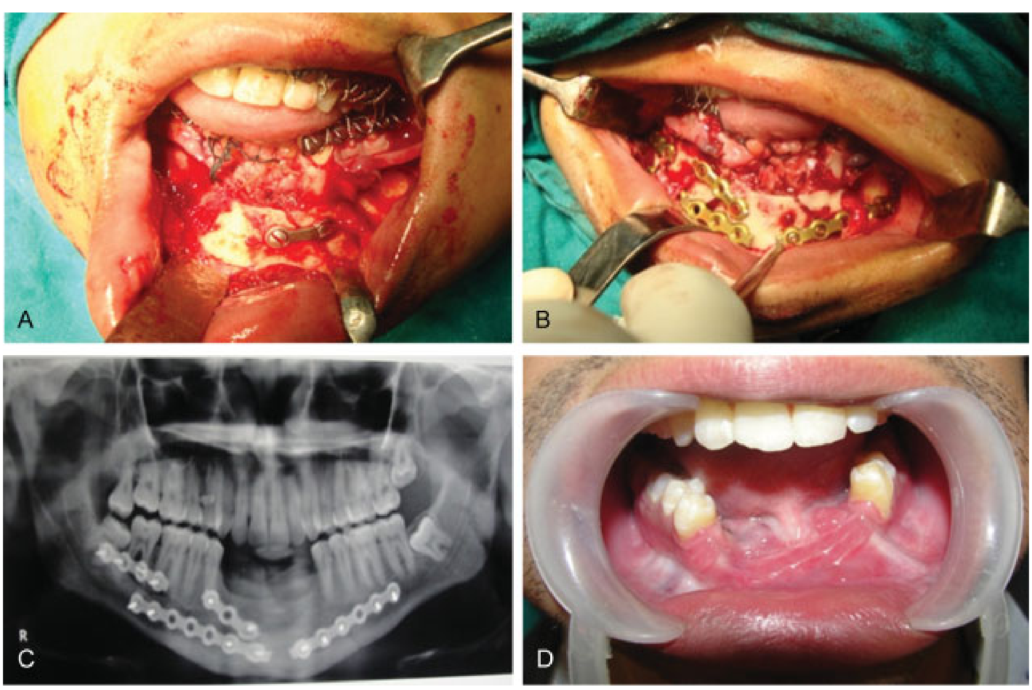

Fig. 1 First stage surgery. (**A**) Fracture simplification. (**B**) Fracture fixation. (**C**) Postoperative OPG. (**D**) Postoperative healing. OPG, orthopantomogram.

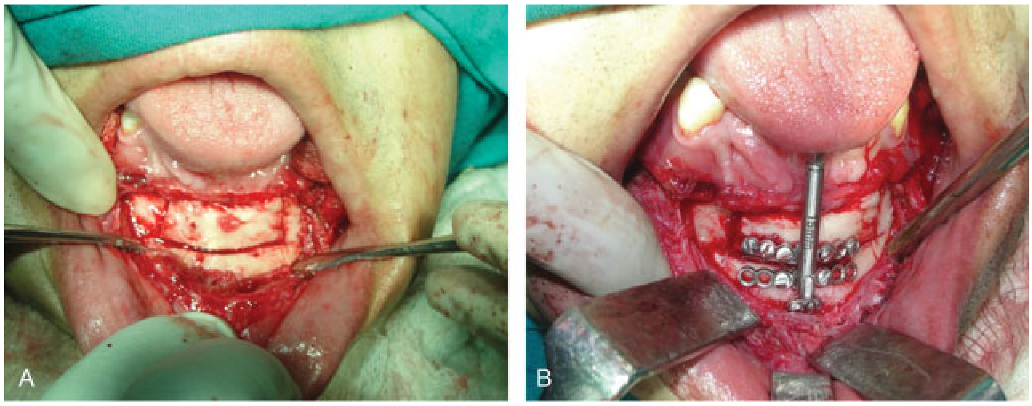

Fig. 2 Second stage surgery. (A) Osteotomy cuts. (B) Placement of intraoral distractor device.

Stage IV: Implant Placement

After the consolidation period of 12 weeks, the patient was taken up for third stage surgery to remove the distraction device and dental implant placement (►Fig. 4). This procedure was also performed under conscious sedation. Three endosseous implants were placed in the interforaminal region. Implants were loaded with abutments after the osseointegration period of 3 months.

Stage V: Prosthetic Rehabilitation

The final stage of rehabilitation involved placement of porcelain-fused-to-metal prosthesis; gingival portion was prosthetically replaced with pink porcelain (►Fig. 5A).

At subsequent follow-ups even after 7 years, the patient was extremely satisfied with the aesthetic and functional results (►Fig. 5B). Also, radiographically, the gain in bone height was retained (►Fig. 6).

Discussion

Often in the immediate postinjury period, the long-term final goal of treatment following comminuted orofacial fractures, with traumatic loss of teeth and alveolar bone, which involves attaining good dental rehabilitation and aesthetics, is overlooked. This is more common when the patient is treated in a general trauma setup as compared with treatment by a maxillofacial specialist with a dental background. Reconstructing the dentoalveolar defects is a difficult clinical scenario but may be simplified if due importance is given to the planning and staging of treatment. The technique of DO and dental implantology can be incorporated to optimize the bone and soft tissue for occlusal rehabilitation.

Our patient with a comminuted mandibular fracture was treated by planning his treatment with a calculated staged approach, anticipating the problems in the course of healing with the ultimate aim of dental rehabilitation.

Popularized by Finn,[2] conservative methods were widely supported for the management of comminuted oromandibular fractures because of the knowledge that stripping periosteum from the bony segments could be associated with morbidity due to devitalization leading to bone loss.[5]

During his management of World War I injuries, Kazanjian[6] was the first to recognize the need for open reduction of severely comminuted mandibular fractures, which has become the widely preferred standard of treatment today.[4,7]

Spiessl, Prein and Kellman stressed on the principles of load bearing rigid fixation for sound bone healing and low-infection rates in comminuted fractures.[8,9]

Ellis et al also found in a large sample of 10-year clinical study that open reduction internal fixation (ORIF) with a bone reconstruction plate had the lowest complication rate.[10]

In the first stage, our patient was primarily treated for the comminuted fracture of mandible in accordance with the same principles of load bearing reconstruction plate fixation. At the same time, anticipating the lack of hard and soft tissue, the sequential stages of DO and implant placement were planned.

Renapurkur and Troulis[11] state that the most challenging dentoalveolar defects are composite defects that lack both hard and soft tissues. These present an impediment to ideal

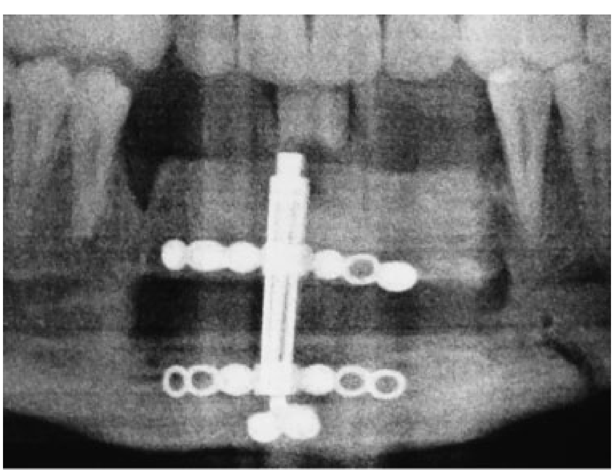

Fig. 3 The end of distraction phase.

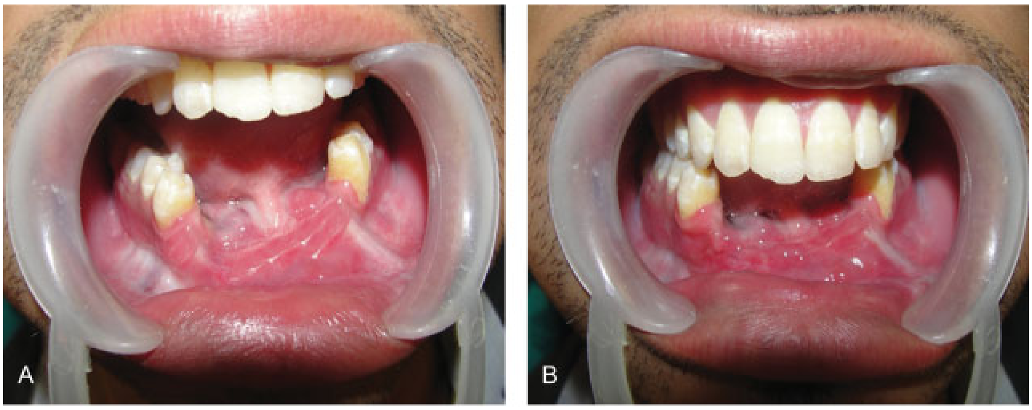

Fig. 4 Alveolar height. (**A**) Before ridge augmentation. (**B**) After ridge augmentation.

prosthetic appliance placement by creating aesthetic and functional handicaps. Posttraumatic avulsive dentoalveolar bony defects commonly present with atrophic alveolar ridges. Reconstruction of such alveolar ridge deficiencies is difficult in light of the fact that the disfigurement includes inadequacies in both the bone and the mucosa, necessitating a multistage treatment.[12]

Various reconstructive and regenerative techniques such as autogenous onlay bone grafting, guided bone regeneration (GBR) with a particulate graft, ridge splitting or expansion technique, osteotomies of the ridge or the jaws, and DO have been used with the specific end goal to vertically augment the alveolar ridge for prosthetic rehabilitation.[13] Each augmentation technique has its own advantages and

Fig. 5 Clinical pictures. (Row **A**) At 3-month postprosthetic rehabilitation. (Row **B**) At 7-year follow-up.

Fig. 6 OPG 7-year postrehabilitation. OPG, orthopantomogram.

shortcomings; however, there is insufficient evidence to indicate any preferred technique.[14]

Chin and Toth[15] were the first to demonstrate ARA application in humans after traumatic teeth avulsion and alveolar loss.

The simple method of distraction provides multiple advantages by eliminating the risk of bone resorption and donor-site morbidity as with autogenous bone grafts and risk of infection and membrane exposure as with GBR. Also, it requires less operative time. But the biggest advantage it provides is the simultaneous occurrence of histogenesis and osteogenesis with the original crestal attached mucosa intact.[14] Also, the crestal bone remains cortical and mature and is expected to resorb less than if the implant was placed in grafted bone.

Chiapsaco et al,[16] in a comparative analysis of autogenous onlay bone grafts and alveolar DO in alveolar ridge augmentation concluded that both techniques effectively improve the deficit of vertically resorbed alveolar ridges and survival and success rates of implants placed in the reconstructed/distracted areas are consistent with those of implants placed in native bone.

An adequate vertical bone height is a prerequisite for placing osseointegrated implants, and different authors have quoted values ranging from 5 to 10 mm.[17]

Based on the nature of defect in our patient, where the lack of supporting tissues was a limiting factor in implant rehabilitation, we chose the alternative method of VDO using an intraoral extraosseous alveolar distractor. The morphology of soft tissue at the site of alveolar ridge significantly impacts the success of implants; hence, we anticipated that the distinctive benefit of DO in improving both the bone availability and associated soft tissue would help create an anatomically more favorable foundation for later implant placement.

Distraction osteogenesis should not be applied in a very atrophic mandible, where a complete bone fracture may occur. In the anterior mandible, the osteotomy cuts for the transport segment should be planned keeping in mind some important factors. First, the osteotomy cut should be at a distance of 5 mm from the mental nerve. To lessen the likelihood of a fracture or resorption of the alveolar transported segment, care should be taken not to make it too small. The transported segment should be at least 4 to 5 mm in height for connection with the plate and screws while wide enough to contain within it the threaded rod and later, the dental implant.[18]

In our case as well, osteotomy cuts were made after insuring the transport segment height of 5 mm.

A histological study by Li et al indicated that proliferation of bone forming cells during DO is affected by the rate of distraction, and a slow rate of 0.3 mm/day does not maximally stimulate cell proliferation. A rate of 0.3 to 0.7 mm/day increases cell proliferation, and a distraction rate of 0.7 mm/day is optimal for cell proliferation and histological characteristics.[19]

Multiple studies have dealt with the latency period, rate of bone elongation, and the consolidation period in distraction.[20,21]

Vega and Bilbao report that a rate of 0.5 mm/day is considered standard for alveolar DO and that insufficient bone formation and evidence of complications were significantly related to augmentation rates greater than 0.5 mm daily.[22]

In our case, we followed a distraction rate of 0.5 mm/day with two turns of 0.25 mm in the morning and night after a 7-day latency period. Distraction was continued for a total of 10 days followed by a consolidation period of 12 weeks (84 days).

As a result of the distraction in our patient, a segment of bone was transported vertically to reconstruct the alveolar crest. New bone regenerated in the distraction gap, thereby providing support to the transported bone. This helped us achieve our anticipated goal of providing good bone and mucosa for implant anchorage and an aesthetically and functionally sound prosthetic reconstruction.

In agreement with the study of Robiony et al,[23] we observed an increased radio opacity of the distracted region in the patient's orthopantomogram in the second month postdistraction period.

Saulacic et al[21] in their systematic review found that failed implants were placed in the ridges following a mean consolidation period of 8.10 ± 2.51 weeks as compared with 12.43 ± 5.62 weeks for the successful implants.

In our case as well, three endosseous intraforaminal implants were placed after a 12-week consolidation period. Implants were loaded after an osseointegration period of 3 months, and a prosthesis of porcelain fused to metal having gingival portion recreated with pink porcelain was delivered. In long-term follow-up, no complication was found and the patient was extremely satisfied with the clinical outcome.

Although we encountered no complication in our case, recent literature cites several articles focusing on the complications of alveolar distraction. These studies have reported a wide array of complication rates, ranging from 30 to 100%.[22,24–26] Though frequent, they are rarely of a serious nature and most are related to a lack of experience and observed during the learning curve.

The most common complication was insufficient bone formation after the consolidation period, followed by regression of distraction distance and failures related to the device. Most of the complications encountered were easy to resolve. Implant placement was feasible with primary stability in distracted bone.

Despite being a part of the maxillofacial surgeon's armamentarium for over 20 years, the field of DO is underutilized in traumatic bone loss patients as compared with congenital defects such as asymmetry or hypoplastic bone. Literature citations reveal that there are clear indications for its use with dependable outcomes that are sometimes even more predictable than traditional bone grafting techniques with soft tissue augmentation in preparation for implant placement. The bone gain reached at the end of distraction has been found to be lasting with low-infection rates and limited morbidity. Why then should this ever-evolving field not be a more commonly used technique in the planning of our trauma victims?

Successful restoration of aesthetic, functional, and occlusal harmony in posttraumatic comminution injuries with both hard and soft tissue loss requires meticulous planning.

Allocating sufficient time for surgical planning at the very beginning of treatment is the most important element in successful bone regeneration with alveolar distraction.

These composite kind of intraoral defects are a challenging clinical scenario and we emphasize on the necessity of a "staged rehabilitation" approach. A surgeon proficient in utilizing the ever-evolving simple yet technique-sensitive fields of DO and implants may be able to optimize clinical outcomes for his patients without the need for more invasive surgeries.

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