The Importance of Immediate Bone Block Autograft to Successfully Restore the Function and Aesthetic of the Anterior Alveolar Process and Teeth

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Maxillofacial traumatic injuries can damage the jaw, teeth, and soft tissues of the head and neck region. When these injuries occur, best practice is to reconstruct as comprehensively as is clinically prudent at time of injury. Smart and efficient procedures during the initial surgery can minimize subsequent reconstructive procedures in scope and number, minimize expense, and result in a better final aesthetic and functional outcome. Restoration of anterior alveolar jaw fractures with comminuted or avulsed segments becomes a complex prospect when left untreated after initial trauma or injury and can result in alveolar ridge defects that are difficult, costly, and cumbersome to repair. This case report details one 19-year-old woman who had a traumatic injury in these areas and has a best result outcome because of immediate reconstruction efforts involving a bone block autograft to preserve alveolar process anatomy.

Key Words: bone block autograft, trauma, alveolar jaw fracture, avulsed teeth, immediate reconstruction, innovative treatments, soft tissue grafts

INTRODUCTION

General maxillofacial injury

Most commonly associated with motor vehicle accidents, assaults, falls, or sports and work injuries, maxillofacial trauma encompasses any damages to the bony or fleshy structures of the face.1 Restoring crucial jaw, facial, and intraoral structures is imperative, requiring clinicians to exercise specific skills and techniques to provide competent treatment. Such abrupt injury also imparts significant emotional distress on the patient: response to the trauma may often overstate the severity of the injury, but clinicians must also be realistic about the likelihood of restoring full aesthetic structure.1,2

Treating clinicians must possess a full understanding of how an injury will influence long-term function and aesthetics as they face the complex dual task of restoring physical form and appearance. It is incumbent on those treating maxillofacial trauma to be current on the latest techniques and materials to achieve the best possible outcome at the time of the initial surgery.

Dentoalveolar injury

Very often, injury occurs to both teeth and surrounding soft tissue, so clinicians must implement treatment techniques for both. Failure to fully treat such dentoalveolar trauma by ignoring the alveolar process can result in defects not only to the smile and overall facial appearance, but also to the general functions of the jaw and teeth.2,3 Although the focus of trauma cases is often on other life-threatening injuries to the body, dentoalveolar structures cannot be overlooked or dismissed for later treatment because successful restoration of functionality and form depends on prompt attention. These defects become harder to reconstruct with postponed treatment and require multiple long-term reconstructive procedures.2

Many incidents necessitate both soft tissue and bone healing. These 2 injuries undergo different healing processes, so physicians must understand both to most successfully restore the patients’ former appearance.

Soft tissue healing

The healing of soft tissue wounds requires 3 phases of repair response.5 Phase 1, the inflammatory phase, consists of an immediate vascular influx and inflammation of the wound. The cellular infiltrate initially contains polymorphonuclear leukocytes, followed within 24 hours by monocytes. The mononuclear macrophages actively engage in phagocytosis, which helps in the formation of new blood vessels at the edges of the wound and results in the synthesis of granulation tissue.5 Their accumulation results in the familiar pain, swelling, redness, and warmth associated with injuries, as these cellular components form blood clots to seal the injured tissue. The second stage involves proliferative regeneration and collagen formation and generally begins about 4 days after injury. Fibroblasts begin synthesizing scar tissue and extracellular collagen. Although still undeveloped and loosely organized, it marks the beginning of rebuilding soft tissue. Its growth is aided by the formation of new capillary buds to deliver nutrients, and the injury site soon

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becomes filled with vascular granulation tissue that helps shrink the margins of the wound. During the final maturation phase of healing, extensive remodeling due to the shortening and extensive cross-linking of collagen fibers occurs. The consolidation of these fibers results in a strong scar and closed wound over a period lasting up to several months.\textsuperscript{5,6}

**Bone healing**

Bones in the human body serve several purposes. They act as the framework of the body to support softer tissue and protect internal organs. They also assist in movement and serve as the major reservoir of important minerals such as calcium and phosphorus, and its different types of marrow produce important blood cells.\textsuperscript{7} The bony structure of the human skull and maxillofacial region is complex and serves a variety of functions to facilitate eating, expression, and speech and maintain normal physical appearance. Injury to these bones, if not properly treated, can hinder these normal functions.\textsuperscript{8}

Human bone undergoes changes as osteoclasts and osteoblasts work in tandem to constantly break down and replace bone. This unique regenerative ability often allows bones to heal themselves when trauma occurs; however, medical attention is usually warranted to ensure proper immobilization, alignment, and restoration of the injured bone.\textsuperscript{7}

If the force of an injury overcomes the inherent strength of the bone, a fracture occurs. Bone undergoes 4 phases of healing. First, the trauma will result in severed vessels, and blood in the fracture site will clot and begin to stabilize the injury. The clotted blood supply allows some of the jagged bone to die, and an inflammatory response results as these dead cells are removed. Next, the clotted blood transforms over several days into a soft callus, and fibroblasts begin to produce collagen. This aids in a further transformation from soft to the tougher fibrocartilage-like callus. Third, after several weeks, osteoblasts begin producing new bone cells, and the callus becomes bone callus. This shell lasts for a few months before entering the final healing stage as the bone continues to form and return to its original shape and size.\textsuperscript{4,8}

**Healing process for dentoalveolar injuries and innovative treatments**

Due to the different healing processes for soft tissue and bone, treatment of dentoalveolar ridge injuries can be complicated, and there exists a wide variety of treatment options.\textsuperscript{9-13} The recession of the alveolar ridge at the site of trauma or defect and from surrounding teeth creates a serious problem for later implant placement.\textsuperscript{10,13} Without a proper increase in ridge volume and osseous structure, implants will not hold or successfully restore normal functionality or aesthetics.\textsuperscript{13} Immediate attempts to reconstruct the alveolar ridge are also crucial. Waiting to begin reconstruction can require multiple grafts and surgeries and take significantly longer once the ridge has been able to deteriorate in the trauma site and in adjacent regions.\textsuperscript{12} Such multistep rehabilitation efforts also may produce inconsistent regrowth in ridge height and most likely will not be able to restore the ridge to its previous volume.\textsuperscript{12}

Many studies cite autogenous bone grafts as a common and successful option for maintaining or restoring alveolar ridge volume.\textsuperscript{10-12} Especially in larger trauma sites.\textsuperscript{11} Such treatment has been shown to effectively restore the loss of bone mass to prepare for successful implants.\textsuperscript{10} Most commonly, the autogenous graft comes from the mandibular symphysis bone due to easy access, its corticocancellous bone structure that prevents significant graft resorption and provides shorter healing time, and a sufficient quantity of bone availability.\textsuperscript{14}

Several other techniques to maintain alveolar ridge density have also been tried, with the common goal of bone augmentation in the region of injury of defect.\textsuperscript{11} For example, alveolar ridge distraction techniques to induce new bone growth naturally in an affected area work well to prepare the region for better implant placements.\textsuperscript{11,12} However, this technique often requires long follow-up times, only works well in small regions of trauma,\textsuperscript{11} may not produce sufficient ridge height and soft tissue coverage, and can usually only either widen or lengthen the ridge in the affected region but not both.\textsuperscript{12} Other methods such as coral granule implantation,\textsuperscript{15} guided bone regeneration, osteoconduction,\textsuperscript{13} and cartilage grafts\textsuperscript{10} all show varying levels of success,\textsuperscript{10,13} but most tend to agree that bone block autografts yield the most successful and comprehensive results with the least amount of time and being the least invasive procedure.\textsuperscript{10-13}

The purpose of this case is to highlight an example of a dentoalveolar injury caused by a traumatic impact. Significant loss of form and function in both soft tissue and bone occurred, yet was treated with an immediate autogenous bone graft from the chin to compensate for the loss of dentoalveolar complex. As explained in this case report, the exercised procedures allowed for recovery and reconstruction in a 6-month period, with near complete restoration of the maxillofacial structures.

**Case report**

A 19-year-old female patient under the influence tripped and fell off a .91 m wall on the grounds of the Washington Monument. After sustaining trauma to her face (Figure 1), she was transported to the George Washington University Hospital Emergency Department. Prior to the fall, the patient had no missing or damaged teeth, yet the impact with the buccal alveolar segment caused the avulsion of teeth 22, 23, and 24. The crowns of teeth 8, 9, and 10 were also severely fractured (Ellis class II fractures).

Preliminary examination also revealed an acute comminuted fracture of the anterior mandibular alveolus with the 2 associated missing anterior mandibular incisors: numbers 23 and 24 (number 22 was retained only by a small fragment of gingival attachment at time of presentation and was severely avulsed). Additionally, an acute fracture of the anterior nasal spine was noted, and an irregularity with the left nasal bone was consistent with an acute minimally displaced fracture. The patient also had a subcentimeter hypodense focus anterior to the maxilla consistent with a bone fragment or foreign object. Also noted was some irregularity in the left temporomandibular articulation.
FIGURES 1–7. **FIGURE 1.** Front image of patient’s face 1 week after initial injury. **FIGURE 2.** The bone block was grafted from the region directly inferior to the avulsed teeth. This autograft preserved a soft tissue ridge for future implants. **FIGURE 3.** An incision from first molar to first molar was made to create a full-thickness flap during placement of the autograft. **FIGURE 4.** The 8 × 15 mm bone block autograft was secured by 4 Stryker screws and a square light plate, shown here. Note the near seamless integration of the graft and native bone. **FIGURE 5.** The initial fall caused severe fractures in the crowns of teeth 8, 9, and 10. **FIGURE 6.** Cone beam computerized tomography image of the buccal process at tooth 8, 1 week after injury. Note the fracture in the maxillary alveolar process. **FIGURE 7.** View of semirigid wire and resin splint in place.
The patient consented to immediate treatment for the facture of the mandible and stabilization with bone graft. The author, as lead surgeon, decided the best treatment course involved an immediate autograft to preserve the tissue architecture of the alveolar process. By taking donor chin block, directly inferior to the trauma site, and moving it superiorly to replace the lost volume of alveolar process and teeth, the surgery was able to preserve soft tissue foundation and bony ridge anatomy (Figure 2).

**Operative Procedure**

The patient was taken to the operating room and prepared in the normal manner, given general anesthesia and nasal intubation. Intraorally, she was prepared with chlorhexidine gluconate 0.12% oral rinse, and the perioral area was prepared with povidone-iodine. The patient was also given 900 mg clindamycin HCl intravenously.

Operatively, a full-thickness flap with intrasulcular incisions of the buccal mucosa of the mandible was raised from first molar to first molar inferiorly to the border of the mandible (Figure 3). Careful attention was made to avoid the inferior alveolar nerve at its exit from the mental foramen. The recipient trauma site with the missing buccal segment was prepared to receive a bone block graft by removing intraosseal bone and other irregularities to create an ideal flat recipient site. A Stryker micro saw was used to cut a donor bone block from the parasympyseal region immediately inferior to the recipient site. The approximate size of the block was 8 × 15 mm. The block was placed into the recipient site and secured with 4 Stryker micro screws (1.4 × 6 mm) and a square Stryker light microplate (Figure 4) (Stryker, Kalamazoo, Mich). The defect left from the harvest site was filled with a 50:50 ratio of Puros allograft (Zimmer Dental, Warsaw, Ind) and Bio-Oss xenograft (Geistlich Pharma AG, Wolhusen, Switzerland) and then covered with a collagen barrier membrane. The flap was then sutured with a tension-free primary closure, using 4.0 vicryl sutures. No intraoperative or immediate postoperative complications arose, and the patient was discharged from the hospital the following day. The patient was closely monitored and checked at weekly intervals in the office for the first month postoperatively. The graft and soft tissue continued to heal, with no recession of the attached gingiva.

In the maxillary region at the time of the accident, teeth numbers 8, 9, and 10 sustained fractures in the coronal sections (Figure 5). One week after the initial surgery, these 2 teeth were temporarily restored with resin in the office. At the initial postoperative visit, a cone beam computerized tomography (CBCT) scan (i-CAT, Imaging Sciences International, Hatfield, Pa) was taken, which revealed a fracture in the maxillary alveolar processes above tooth 8 that the hospital computerized tomography (CT) scan did not show (Figure 6). The fractured segment was reduced with a semirigid wire and resin splint, and a semirigid coronal splint was applied to hold the teeth and segment in position (Figure 7). After 1 more week, teeth 8 and 9 tested as nonvital, and endodontic therapy was performed in the office that day (Figure 8).

During a weekly monitoring visit 1 month after the initial accident, the author noted a very small (approximately 1 × 1.5 mm) soft tissue dehiscence exposed in the graft at the top of the ridge (Figure 9). To aid the soft tissue closure, this small exposed spicule of bone was ablated with an Er,Cr:YSGG Laser (33% air and 66% H2O, 15 pulses per second, 4.5 W; Biolase MD, Irvine, Calif) to remove the small exposed area, prevent exposure risk, and allow full soft tissue closure.

Eight weeks after the accident, the upper splint was removed, and the fracture and maxillary teeth appeared to be healing nicely.

At 12 weeks after surgery, 2 Astra Tech (AstraZeneca, London, UK) OsseoSpeed TX implants were inserted in the number 22 (3.0 × 13) and 24 (3.0 × 11) tooth positions (Figure 10). The Stryker plate and screws were removed after reflection of a full-thickness flap (Figure 11), and teeth 8 and 9 were prepared for permanent crowns by the author several days after (Figure 12). After 8 more weeks of healing, the implants were exposed with an Er,Cr:YSGG Laser (at the same settings as above), and impressions were taken for final custom abutments and final implant prosthesis (Figure 13). Final impressions were taken at 5 months, and restoration of all injuries was completed by the 6-month mark (Figure 14).

More than 3 years after the injury, the patient was seen to repair fractured porcelain on the incisal edge of tooth 24 and to take a final CT scan. These images revealed a fully healed fracture in the maxillary region above tooth 8 and exceptional healing compared with previous scans (Figures 15 and 16). Of note is the level of bone maintained in the alveolar ridge all the way up to the implant fixture necks and the remodeling of the donor bone block autograft site.

The patient, a college student at the time of the injury, was able to have treatment during breaks from school, and she was fully restored to a near ideal functional and aesthetic result in just over 6 months. The patient was also offered a soft tissue graft to increase the width of attached gingiva on the buccal marginal area, and she has elected to have this procedure at a future date. While this may have slightly enhanced the final results, there has been no loss of bone or gingival recession thus far, and no extra care has been needed.

The patient returned 2.5 years later to complete a subepithelial connective tissue graft to increase the width of attached keratinized tissue on the buccal aspect. Connective tissue was harvested from the left palate. The donor tissue was sutured into place with 4.0 vicryl sutures. The procedure was performed under local anesthesia with Septocaine 4% and 1:200 000 epinephrine. Figure 17 shows the results of the healed graft and the repaired lower prosthesis after a 3-year healing period.

**Discussion**

Dentoalveolar traumas are among the most common type of facial injury treated. The dual injury to both teeth or bone and its supporting fleshy tissue can cause serious health problems for patients and jeopardize the long-term functionality and aesthetics of the dental area if not appropriately treated. Due to the sensitivity of the maxillofacial region and its high proclivity for injury, dental providers are often faced with unique challenges in balancing the restoration of form and function.
FIGURES 8–14. **Figure 8.** Pre- and postoperative radiographs of endodontic therapy performed on teeth 8 and 9. **Figure 9.** Note the small, exposed piece of bone (blue circle). One month after the initial incident, this dehiscence was ablated with an Er,Cr:YSGG laser. **Figure 10.** Implant fixtures are shown replacing teeth numbers 22 and 24 which are the left lower canine and left central incisor. There was insufficient space to replace tooth number 23 as well and therefore a 3 unit splinted fixed partial denture was planned and fabricated. **Figure 11.** A full-thickness flap cut was raised to remove the mini fixation plate and screws. Note the maintenance of the soft tissue alveolar ridge. **Figure 12.** Teeth 8 and 9 were also prepared for permanent crowns 12 weeks after injury. **Figure 13.** Image shows the transfers copings in place for teeth 22 and 24. **Figure 14.** Final restoration of all teeth after 6 months of treatment.
FIGURES 15 AND 16. **FIGURE 15.** Comparative cone beam computerized tomography scans of the buccal process at teeth 8 and 22 from just after to over 3 years after injury. Note the healed fracture in the maxillary alveolar process. **FIGURE 16.** Panoramic scans from June 6, 2010 (top), and August 8, 2013 (bottom).
with innovative and time-sensitive techniques and helping the patient cope with the taxing psychological stress of the injury.

In treating this 19-year-old woman who had a traumatic fall resulting in the full avulsion of teeth 22, 23, and 24 and the severely chipped crowns of teeth 8, 9, and 10, swift operative action was imperative for near-full repair. A bone block autograft from the site inferior to the avulsed lower teeth was moved superiorly to stabilize the fractured mandible and to replace and preserve the lost alveolar process. After several weeks, implants were placed. Teeth 8 and 9 were repaired with endodontic therapy and crowns, and the fractured maxillary process was stabilized with a semirigid wire. All treatment efforts were very successful, with little to no complications and near-perfect restoration of normal function and appearance.

The key to this successful treatment lies in the immediate replacement of the bone block autograft. The immediate autograft in this case allowed for a greatly reduced reconstructive timeline and reduced the number of overall procedures required. With the extent of the trauma in this patient, the lower alveolar process would have soon begun to shrink significantly without the placement of the graft to preserve the ridge. This large defect would have necessitated several months of healing before beginning reconstruction attempts. Soft tissue grafts would have been needed to rebuild the alveolar process because a delayed bone graft would likely be less successful.

With the immediate graft, there was no loss of bone or tissue height in the traumatized region or in the sulcus and gingiva of neighboring teeth. Had this site been allowed to heal first, the tissue would have receded severely at the site of injury and along the adjacent teeth, limiting the height of the possible reconstructive ridge.

Although the end result of this treatment yielded a best-case outcome, some possible cranial distortions and damage to the temporomandibular joint were noted in comparing the final CBCT to the original. There is a pronounced difference and increased tilt in the mandibular process over the 3 years between in-office CT scans (Figure 18). Images of the condylar fossa also show abnormally shaped condyles and a diminished space between the condyle and jaw in both time frames. Most notably, however, the right condyle seems to be progressing further outward in the joint socket (Figure 19). Whether these
cranial structure changes are a result of the initial trauma or part of an inherent process is uncertain, but it is clear that some sort of treatment will be required eventually—the details of which are beyond the scope of this paper.

It is important that emergency and trauma teams are aware of the significance of immediate attention to intraoral injuries. Well thought out and executed treatment plans can significantly save time, money and stress for the patient and result in a better final outcome. These personnel should be knowledgeable of the options for dentoalveolar treatment and be able to act to preserve the form and function of structures in the maxillofacial region.

REFERENCES


Figure 19. Computerized tomography scans of the left and right condyles from June 6, 2010, and August 8, 2013.