

Dental Rehabilitation Requires Balancing Therapy Needs, Desires, and Capabilities

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Abstract

Oral rehabilitation is the pinnacle of treatment and consists of a multi-faceted dental approach focused on restoring the functionality, appearance, and well-being of the mouth through a blend of different treatment modalities such as prosthetics, implantology, and orthodontics. It is essential to align the objectives of the treatment with the desires and capabilities of the patient. The initial phase involves a thorough clinical assessment along with radiological evaluation, which encompasses imaging of all teeth, specific imaging of individual teeth, and where necessary, a CBCT scan.

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Introduction

Reconstructive surgery in the maxillofacial region presents a distinct array of challenges for surgeons [1]. A defect in this area is often due to disease or injury, and such a defect can impact both appearance and functionality, potentially affecting speech, nutrition, swallowing, and aesthetics. Maxillofacial defects greatly influence the psychological and social well-being of patients. Therefore, it is crucial to address oral and dental rehabilitation to ensure complete recovery, and this cannot be overlooked and should be completed as soon as it is reasonably possible. Regrettably, current evidence indicates that many patients who undergo jaw reconstruction after pathological resection do not receive immediate placement of implants or provisional prosthetics during their initial surgery.

Immediate dental rehabilitation, which includes the use of dental implants and temporary prosthetics during primary reconstruction, offers several benefits such

as fewer surgical interventions and a quicker restoration of form and function. These benefits can enhance patients' psychosocial and overall wellness. Challenges to immediate dental rehabilitation may involve the learning curve associated with effective virtual planning of the reconstruction, understanding the complexities of 3D manufacturing, issues with financial reimbursements, and finding a suitable restorative practitioner who can provide the final restoration. Given that complete maxillofacial reconstruction involves dental rehabilitation, immediate dental rehabilitation should be seriously considered when possible.

Dental Health

A patient's dental history reflects their general attitude towards dental care [2]. Long gaps between dental visits and seeking treatment only when symptoms arise indicate a low prioritization of dental health and a likelihood that the patient will not value thorough periodontal care.

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It is important to ascertain the reasons behind any previous tooth loss and to document past and current dental treatments. Efforts should be made to obtain information, including radiographs, related to past dental work through written requests to prior dentists, and these written replies should be added to the patient's record. Another measure sometimes utilized to evaluate dental habits is how often a patient brushes (or claims to brush) their teeth. However, it is more critical to assess the effectiveness of the brushing technique rather than focus exclusively on how frequently it occurs. An individual who brushes once daily for four to five minutes generally achieves better oral hygiene than someone who brushes several times a day but does so ineffectively and for only brief moments.

In young individuals specifically, it is important to consider any previous orthodontic interventions. Prolonged use of fixed appliances can lead to a reduction in crestal alveolar bone, partly due to the movement of teeth and partly due to periodontal inflammation caused by restricted access for cleaning both interproximally and subgingivally. From a diagnostic perspective, it is particularly significant that teeth that have been tilted instead of moved consistently through bone often exhibit an angular shape of the alveolar crest on both mesial and distal surfaces. This kind of morphological appearance is reminiscent of the lesions typically associated with localized aggressive periodontitis.

Setup Surgery

Final bone graft procedures should be postponed until after the initial reconstructive surgery, even if this initial technique involves transferring soft tissue as well [3]. The main aim of this first surgery, known as "setup surgery," is to facilitate debridement, realignment of the bone, stabilization of the bone, and coverage of the soft tissue. This operation prepares the tissues for an upcoming graft that will remain free from infection or resorption, be accurately positioned for the best dental restoration possible, and lead to a stable, functional, and aesthetically pleasing result. The objective of this procedure is to remove nonvital bone, teeth, and fragments of foreign material to create well-defined bleeding ends of viable bone, align the segments with their anatomical orientation, and readjust and reattach any displaced or retracted muscles.

The typical approach for a setup surgery addressing an avulsive defect in the mandible involves making an incision along the submandibular midneck crease; this type of incision will also be utilized for the subsequent bone graft placement. The ends of the bone within the defect should be resected by approximately 0.5 to 1.0 centimeters to form a right-angled cutting surface and eliminate any irregular edges. Excising this amount of host bone will not significantly increase the size or complexity of the graft, while leaving even a minor fragment of nonvital bone or a protruding sharp edge can easily lead to an infection.

After the tissue is dissected, it is important to remove any nonliving bone pieces, bullet remnants, previously inserted wires, plates, screws, or fragments of teeth, followed by taking cultures. A coronoidectomy should be performed on the proximal bone fragment to allow for its proper repositioning,

ensuring that the condyle fits into the fossa and that the angle of the mandible aligns with the lower border of the distal segment. The temporalis muscle will reconnect to the mandible at the edge of the coronoid resection and regain its functionality. The distal segment is then correctly positioned back to its location before the injury by utilizing maxillomandibular fixation or Gunning splints. In this configuration, both the proximal and distal segments are firmly secured with a robust titanium reconstruction plate measuring either 2.4 or 2.7 mm, which will provide stability to the mandible during the healing period, maintain the jaw's alignment, offer contour, and act as a support for a bone graft in the following stage. Hence, it is crucial that this reconstruction plate is positioned accurately. It should be affixed along the lower border of the mandible and the back edge of the ramus, ideally secured with four bicortical screws in each segment (three screws per segment is the minimum requirement). The screw nearest to the boundary of each segment (mean screw) should have a minimum distance of 1 cm from the edge to prevent the bone from becoming devitalized. Adhering to these guidelines will help to avoid plate exposure, loosening, and fractures, ensuring long-term stability in most situations.

Once the bony segments are in alignment and the reconstruction plate is correctly placed, the surgeon should take the opportunity to free any muscles that may be tightened and entangled within scar tissue, such as the anterior digastric, mylohyoid, and masseter. These muscles should be stitched to the mandibular segments or to the plate using transosseous bur holes or unutilized plate holes, respectively. This approach allows the muscles to return to their original length and functionality, ensuring they will attach to the bone graft when it is inserted.

Maxillary Fracture

Typically, midface fractures are identified through clinical examination and verified with imaging techniques [4]. Various factors can complicate the initial clinical evaluation, such as facial swelling, significant nosebleeds, a severely displaced maxilla, or the patient being uncooperative or unconscious. In individuals with a history of blunt trauma to the face, specific clinical signs that should alert healthcare providers to the risk of a midfacial fracture include nosebleeds, bruising or swelling beneath the eyes, increased vertical height of the face (referred to as "equine facies"), or a wider face with reduced anterior projection (described as "dishpan facies"). The most accurate evaluation of the maxillary injury is often based on the status of occlusion. Signs such as malocclusion, movement of the maxilla, and dental fractures can indicate potential underlying maxillary skeletal issues. The occlusal pattern observed will typically be influenced by the direction of the fracture.

Transverse fractures similar to Le Fort allow strong medial pterygoid muscles to exert a pull downward and backward on the movable segment, causing the maxilla to shift backward (class III malocclusion), leading to early tooth contact in the molars and resulting in an anterior open bite. Vertical fractures that occur through the hard palate typically exhibit a crossbite due to an increased width of the maxillary arch from the upward and sideways displacement of the mobile sections.

A patient who is conscious and has a maxillary fracture typically indicates that their bite is not aligned correctly. For patients who are unconscious, a physical evaluation to assess the visible dental alignments and mobility of the maxilla becomes crucial. With the patient's mouth open and their head stabilized, the premaxilla can be held between the index finger and thumb to check for movement. If there is movement, palpating the nasofrontal junction, lateral orbital rim, and infraorbital rim can often assist in identifying the level of the fracture. Fractures of the maxilla that are impacted may not show any mobility, even when substantial force is applied. When a maxillary fracture is suspected, a comprehensive examination should encompass a thorough ophthalmological evaluation, documentation of an infraorbital neurosensory assessment, and a check of the dental arch and palate for signs of bruising, tearing of the mucosa, and displacement or loss of teeth. It is also beneficial to have access to pre-existing orthodontic and ophthalmological medical histories, if available.

Secondary Trauma

At first, immediate dental reconstruction was solely suggested for cases of secondary trauma or for repairing defects caused by benign conditions [1]. It was thought that performing these reconstructions in cancer cases would increase the risk of complications, particularly when the patient was to receive additional radiation therapy. Based on the authors' findings, postoperative radiation has not shown a link to lowered rates of implant integration, a view that is corroborated by recent studies. When implants are inserted immediately during the fibula reconstruction process, additional radiation treatment typically begins about 4 to 6 weeks afterward. After radiation therapy commences, it takes several additional weeks for the radiation doses to reach biologically significant levels. Since the majority of implant integration occurs before receiving the higher doses of radiation, the integration rate for implants placed in fibulas prior to radiation is superior to that of those placed after radiation.

Additionally, it is generally thought that reconstructing a composite defect with an osteocutaneous flap prohibits immediate dental rehabilitation due to concerns about achieving a seal that prevents leakage and the potential for diminished survival of the skin paddle. However, our findings indicate that skin paddles can be effectively used for immediate rehabilitation when properly designed. Indeed, a successful vestibular reconstruction relies heavily on the skin paddle. By placing implants along the junction of the skin paddle and the native mucosa, a nearly watertight closure can be achieved. This enhances the soft tissue interface, reducing tissue movement and promoting better implant health compared to the non-keratinized oral mucosa. The primary drawback of utilizing a skin paddle is the possible necessity for later debulking surgeries.

VSP

The prompt digital workflow for immediate dental restoration can take place in any practice or clinic equipped with suitable hardware and software [1]. Imaging prior to surgery involves either a maxillofacial CT scan or a cone beam computed

tomography (CBCT) scan, as well as CT angiography for both lower limbs to assess the presence and openness of blood vessels and to aid in planning the implants. The imaging of the lower limbs should have a slice thickness of 1 mm or thinner, and virtual surgical planning (VSP) should rely solely on data specific to the patient. It is crucial that the maxillofacial CT or CBCT is done while the teeth are slightly apart in an open position to facilitate more precise integration of the preoperative dental structure with the CT data. Intraoral scans or stone models can be transmitted to a surgical VSP engineer according to the surgeon's preferences.

During the VSP process, the removal of tissue and bone reconstruction is mapped out based on the nature of the pathology and the existing defect, followed by the virtual placement of implants. STL (StereoLithography) files for the virtual implants and abutments are imported into the planning interface and modified in line with conventional implant guidelines. We prefer that the implants emerge from the front surface of the fibula, as this positioning helps to align the skin flap for vestibule reconstruction. In situations where such positioning isn't feasible, implants may instead emerge from the back surface of the fibula to maintain the correct flap design. The implant guide is created digitally alongside the fibula osteotomy guide. It's essential to incorporate the drill offset into the guide based on the specific fully guided implant system being utilized.

Restoration

The most frequently utilized vascularized grafts for segmental defects of the mandible are the fibula and the iliac crest [5]. The fibula graft offers advantages such as sufficient length, strong stability, and the ability to adapt to the recipient area. However, its drawbacks include immobility for the patient after surgery, a decreased height of the graft which affects dental rehabilitation, and complications at the donor site. The iliac crest, on the other hand, is a curved piece predominantly made of cancellous bone that allows for three-dimensional reshaping into the form of a hemimandible, yet it comes with substantial postoperative pain, issues with walking, potential nerve damages, hernia risks, and sensations of numbness. Both graft options require an extended duration of surgery to extract and reshape the bone for suitable integration at the recipient site, as well as for managing the donor area. Additionally, such reconstructive techniques do not fully restore the functionality of the jaw. Achieving a nearly normal restoration for dental rehabilitation of the mandible is challenging in clinical practice.

Another significant issue is the difficulty in reproducing intricate facial shapes. For example, reconstructing segmental defects in the front part of the mandible proves difficult due to the specific bone structure in that area. Achieving the proper horseshoe shape to ensure the right contour and functionality with the constraints of using autogenous bone grafts presents significant challenges.

The midface region presents a significant challenge due to its complex structure and numerous interconnected and overlapping spaces. Prior to the introduction of advanced reconstructive methods, prosthetic devices were the sole option

to meet the functional and aesthetic needs of such a complicated defect. The use of free tissue transfers has enabled autologous reconstruction of the maxilla; however, both the functional and aesthetic outcomes remain suboptimal.

Implants

The successful placement of immediate dental implants into osseous free flaps is well established and has demonstrated a high success rate [1]. The incorporation of virtual surgical planning has further improved accuracy and success rates. Many challenges that previously hampered immediate implant insertion and dental prosthesis implementation can now be addressed more easily thanks to computer-aided design and computer-aided manufacturing technologies.

During the planning phase for the osseous free flap, the positions of the implants should be established. This allows for the production of customized cutting guides that include added features for precise implant insertion. Properly aligned implants are crucial for dental restoration, particularly in immediate scenarios. This slight modification in procedure significantly enhances the chances of providing a stable base for the immediate prosthesis delivery. By utilizing this protocol, the authors have achieved a consistently high rate of implant success in reconstructing defects caused by both benign and malignant conditions as well as trauma. With the introduction and use of CAD/CAM technologies, immediate dental rehabilitation has become both reliable and secure.

Implant Placement

In strategizing the placement of dental implants in the fibula, it is important to maintain around 15–18 mm of restorative space between the implant platform and the opposing occlusal surface [1]. Based on our observations, the distance between implants should be no less than 7 mm (from the external edge of one implant platform to the external edge of the adjacent one) to facilitate the cleaning of the prosthesis, and at least 3 mm from fibular osteotomies to preserve the integrity of the bony connection. Implant depths need to be planned such that the platforms are positioned 1–2 mm subcrestally to account for anticipated crestal bone loss.

After the VSP session, the engineer is asked to provide STL files representing the fibula reconstruction along with the implants. This process guarantees that the shells (fibula, implant, existing teeth) are accurately superimposed in the 3D environment. This phase is crucial to ensure the alignment of the planning session and the placement of the implants with the prosthesis fabricated in-house. The STL files for the patient are then uploaded into the 3D printer software to create the temporary prosthesis.

For the restoration of a partial arch in a patient who has some remaining teeth in the area that will be extracted, the design of the temporary prosthesis is based on the patient's current teeth. An intraoral scan captures the STL data, which is adjusted using software. A model is generated utilizing the closed model function. This results in producing a precise replica of the patient's existing teeth. Following this, a guide that relies on the

teeth is digitally created on the teeth that remain in the patient's opposing dental arch that is not being surgically altered. These two elements are subsequently joined with a connector placed in between. The prosthetic structure is then digitally refined, and the digital abutments for implants are removed from the design of the prosthesis using a Boolean subtraction method to make openings for abutment pickup during surgery. Finally, the prosthesis is fabricated either through 3D resin printing or by milling with PMMA, which stands for polymethylmethacrylate.

Management

Dental injuries often necessitate prompt care to alleviate discomfort and frequently to safeguard the teeth [6]. Timely intervention is crucial when there is exposure or a risk of exposure to the pulp chamber or when an individual tooth has been dislocated. As a result, the management of dental traumas usually takes precedence over most other fractures involving facial bones. In cases where a dentoalveolar fracture occurs alone, the injury is readily identifiable, and effective treatment is typically administered right away. Nonetheless, in situations where dental injuries occur as part of a broader facial trauma, the critical need for immediate care may be overlooked. Addressing dental injuries should be regarded with equal importance as treating facial cuts. Basic actions like realigning misaligned teeth and safeguarding the pulp are sometimes neglected during the initial care of a complicated facial injury. For an unconscious patient with multiple injuries who requires endotracheal intubation, stabilizing any loose teeth or alveolar segments will ease the repositioning of the tube and help prevent additional dental harm. Likewise, either covering or removing the exposed dental pulp will diminish the painful sensations that may lead to agitation in an unconscious individual. Naturally, all these interventions must be performed at the right time, depending on the patient's clinical condition.

When devising a thorough treatment plan for dentoalveolar injuries, numerous factors must be evaluated. The significance of conserving damaged teeth varies based on the complexity of the maxillofacial injury, the patient's age, their overall dental health including oral cleanliness, periodontal issues, and overcrowding, the location and severity of the dentoalveolar injury, as well as the patient's preferences. Generally, the outlook for injured teeth and the healing process for alveolar fractures tends to be more optimistic in younger individuals. Factors such as smoking and inadequate oral hygiene considerably heighten the risk of infection and tooth loss. Clinical conditions that suggest a positive prognosis include open root tips, intact gum tissues, no root fractures, and substantial periodontal bone support.

In young children, injury patterns differ from those observed in teenagers and adults due to the flexibility and thinness of the alveolar bone, which typically offers protection and prevents dental fractures. Segmental fractures of the alveolus are exceptionally uncommon for this same reason. More intricate dentoalveolar injuries generally affect the permanent teeth. When planning treatment, it is advisable to assess each tooth individually using the classification system presented here. Injuries sustained by a patient can vary from a minor chip off

a cusp or incisal edge to several fractured and misaligned teeth accompanied by a fracture of the supporting alveolus.

Conclusion

Complete oral rehabilitation involves fully restoring the oral cavity and pertains to the repair or substitution of every tooth within a patient's mouth. This process integrates the principles of aesthetic appeal and the technical aspects of restorative dentistry to enhance the health, functionality, and attractiveness of the oral cavity. Many individuals experience dental issues that require thorough treatment with the aim of achieving a final outcome that enhances both the functionality and appearance of the oral cavity.

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