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Post Tumor Ablation Mandibular Reconstruction: Review Article

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Abstract

Mandibular defects due to tumor ablation have morbidities including both function and cosmesis, and accurate Mandibular Reconstruction (MR) is demanding. Resection of the mandible is performed when a primary malignant neoplasm of the oral cavity directly extends to the gingiva covering the alveolar bone or spreads into the mandible. MR is necessary to offer these patients a better quality of life. Several useful classification systems have been designed to help in the description of mandibulectomy defects and explanation of the results. The commonest indication for MR is segmental bone loss. MR is aimed to restore the anatomy and function of the mandibular complex. Studies for assessment of the extent of malignant lesion or the fitness of the patient to withstand the planned surgery should be done routinely. Today, it is globally agreed that immediate MR is to be performed without risk for a late diagnosis of recurrent lesion. The options of MR are variable and range from simple primary closure to composite microsurgical free flaps; each modality has its advantages and drawbacks. Postoperative care should be provided to each patient individually.

Keywords: Mandibulectomy; Mandibular reconstruction; Segmental mandibular defect; Post tumor ablation; Free flaps; Bone graft; Mandibular distraction; Tissue regeneration

Abbreviations: MR: Mandibular Reconstruction; SMD: Segmental Mandibular Defect; MRPs: Mandibular Reconstruction Plates

Introduction

Mandibular defects due to tumor ablation have both functional and esthetic morbidities, and accurate mandibular reconstruction (MR) is a great challenge for surgeons [1]. The features of a successful MR include a healed wound, restoration of functional mastication, dentition, swallowing, articulation, and breathing, with re-establishment of the mandibular contours. Thus, MR is necessary as it makes the quality of life of such patients better [2].

The mandible is formed embryologically of two symmetric halves which unite at birth at the midline by a fibrous symphysis; ossification is accomplished by the second year of age [3]. The mandible is divided anatomically into one horizontal unit (the symphysis and the body on each side), two vertical units (the angle, ramus, coronoid process and condylar process form one vertical unit on each side) and three processes (coronoid, condylar and alveolar). The mandible harbors the inferior alveolar neurovascular bundles that transmit sensation from the chin, lower lip, teeth, and related mucosa via the mental nerve [4]. The mandible provides the attachment for several muscles and ligaments including the masticatory muscles, the suprahyoid muscles, and the stylomandibular, and sphenomandibular ligaments [5].

This article aims to presents a critical, constructive analysis of the literature in the field of MR through summary, classification, analysis, and comparison. The current article is a compilation of existing information in an easily accessible and concise manner. The authors have attempted to provide a scientific text relying on previously published literature or data. Selected studies are compared and summarized on the basis of the author's experience, existing theories and models. Results are based on a qualitative rather than a quantitative level.

Mandibulectomy Defects

Mandibulectomy is defined as the resection of a segment of the mandible. Mandibulectomies are either marginal (resection of the bone, teeth and neighboring soft tissues with maintenance of the continuity of the jaw) or segmental (where a part of the mandible is resected).

MR is indicated when a primary malignant tumor of the oral cavity directly extends to the gingiva over the mandibular alveolus or infiltrates into the mandible. If the tumor extends directly from the alveolar process to the cancellous portion of the mandible or if contiguous tumor infiltration to the lingual or facial cortex of the mandible is present, a segmental mandibulectomy becomes necessary [6].

A marginal mandibulectomy is performed to resect the mandibular alveolus, the lingual portion of the mandible, or both for tumors of the anterior oral cavity. It is, also, indicated for lesions adjacent to the retromolar trigone, whereupon the anterior surface of the ascending mandibular ramus, including the coronoid and the nearby alveolus, are resected. A reverse marginal mandibulectomy is performed in cases with soft tissue disease such as fixation of perivascular facial lymph nodes to the lower cortex of the jaw [6].

Several classification systems have been designed to help in the description of the defect and explanation of the results. Since Pavlov classified the defects of the mandible in 1974, [7] several classifications [8-11] have been reported. None of these classification systems are used universally, and many reports either only describe the defects rather than defining the variable aspects of the defects or the ideal modalities to reconstruct and rehabilitate [12]. A new system classifying the defects of the mandible according to the four corners of the mandible was proposed by Brown et al. [12]. This classification system helps prognostic prediction of both functional and esthetic outcomes.

Rationale of Mandibular Reconstruction

Indications

The commonest indication for MR is segmental bone loss. Most of such defects result from soft tissue tumor ablations that require segmental bony resection for local control. Tumors of bone origin may also indicate segmental resection, but these are less common [6,13,14].

Goals

MR is aimed to the restore the form and function of the mandible. This requires achieving satisfactory cosmetic, functional and anatomical results, with a pain-free mandibular movement and accepted soft tissue relationships to facilitate articulation and swallowing, and provide a base for dental rehabilitation [15].

Timing

The ideal time for MR represents a wide debate, especially in malignancy patients. Historically, the proponents of a staged or delayed reconstruction advise a period to observe the patient for developing a recurrence or to justify histo-pathologically free bony margins before reconstruction. Nowadays, on the contrary, there is a global acceptance that primary MR can be done with no risk for a delayed diagnosis of tumor recurrence [16]. Reports have shown that primary MR improves the quality of life and that most patients prefer primary MR [17].

Principles

- Some patients will be better managed by a downgraded reconstruction while for others, the best reconstruction should be offered [18,19]. The decision will be affected by the patient's general condition and medical comorbidities, the preoperative staging investigations, the aim of treatments (curative or palliative), and the expected ablative defect (dimensions and components), must be obviously considered as these will all have impact on the choice of donor site(s) for tissue transfer.
- Small Segmental mandibular defects (SMDs) should not be collapsed for primary fixation. This causes malocclusion and alterations in masticatory function. Also, SMDs should not be left floating, as muscle actions become unopposed and the soft tissues contract and shorten complicating secondary MR [4].
- Primary MR should be done so that adjuvant treatments are not delayed. Options include microsurgical and non-microsurgical techniques.
- Attention should be directed at inferior alveolar nerve reconstruction, especially in benign cases, since lower lip anesthesia and/or dysesthesia are bothersome morbidities for patients [20].

Options for reconstruction of marginal defects

Marginal mandibular defects are generally not reconstructed as they do not inflict the same detrimental impact, since the mandible remains in continuity. They are, however, amenable to height augmentation using non-vascularized bone grafts or, in specific circumstances, vascularized bone flaps for dental rehabilitation [6,13,14].

Reconstructive modalities for the composite marginal mandibulectomy defect can be primary closure, local flaps, split-thickness skin grafts, regional flaps, and free tissue transfer. If the remaining mandible is felt to be prone to fracture, reinforcement using a plate is advisable. In general, vertical height less than 11mm is the indication for a plate [6,21,22]. Reconstruction is performed accordingly as necessary using a skin graft or a free vascularized flap.

Options for reconstruction of segmental mandibular defects (SMDs)

The management of SMDs is complex and challenging. Different options of MR, that range from the bridging plates to the composite free flaps have been used; each has its advantages and disadvantages [6,23]. These options include collapse of the defect, MRPs, with or without soft tissue flaps (no bone reconstruction), bone grafts, and free bone flaps. Recent techniques include distraction osteogenesis, implantable biomaterials and tissue engineering.

Selection of the reconstruction technique is judged by multiple determinants which are (1) the surgeon's expertise and preference, (2) the site of defect, (3) the length of bone gape, (4) the extent of soft tissue loss, (5) the quality and the vascularity of the surgical area, and (6) the patient's general condition.

Vascular bone flaps provide a highly successful means of primary MR in most cases. They are the ideal treatment for defects larger than six centimeters and in the situations of irradiated tissues and irradiated wound beds [24].

Nonvascular bone grafts should be selected for lateral or posterior lateral defects smaller than 6 cm without extensive soft tissue loss in patients who have not or will not receive radiotherapy [4]. Success rates for non-vascularized bone grafts have been ranged from 38%-100% [25-28] and similarly failure rates have been ranged from 20%-81% [29-34].

Perioperative Care

Patient education and consent

The suspected functional deficits of the procedure should be carefully discussed with the patients and their relatives so that they establish appropriate suitable expectations preoperatively. Patients who undergo composite segmental mandibulectomy need to be informed that they will have permanent sensory loss of the ipsilateral lower lip and that his profile may change after surgery. In the majority of cases, as part of the surgery, the adjacent tissue must be resected to get free oncologic margins leading to undesired functional and/or cosmetic sequellae. Most patients will have neck dissection. Typically, incisions should be on the lower part of the face, in the chin and submandibular regions. Families must be informed of this. Management of the airways is a principal item during surgery and in the early postoperative period. Tracheotomy or nasotracheal intubation and overnight ventilatory support may be required in some patients. The patients should be informed and prepared for this incident [35].

Diagnostic studies

Investigations for assessment of the extent of malignant lesion or the fitness of the patient to withstand the planned surgery should be done routinely.

Diagnostic studies essential for MR include the following:

Preoperative imaging of the mandible: Plain x-ray may help in the clinical assessment, but it cannot accurately detect the extent of lesion. Preoperative computed tomography of the mandible is important to plan the expected defect. It can detect the extension of lesion inside the marrow space. Also, it can show cortical erosions which may be not be detected with plain radiographs. Owing to its poor ability to show the details of osseous anatomy, Magnetic resonance imaging is not used as a routine, but, can be used to study the extension of the tumor along the inferior alveolar nerve [36].

Computer-generated models or surgical guides (tactile medical imaging): This is the display, in physical form, of anatomic data obtained from medical imaging studies. Its principal applications are the stereolithography and the Three-dimensional (3D) printing. Stereolithography uses laser photopolymerization of a liquid polymer to construct a precise, stable, and sterilizable model of the skeletal structures of the patient. The Three-dimensional printing uses an inkjet-based printing technique to obtain a model by injecting a liquid into a plaster powder. These models are precise and opaque, but fragile and cannot be sterilized. Both types of models assist preoperative study and surgical planning, but the stereolithographic type can be utilized during surgery to help with pre-shaping and bending of reconstruction and fixation plates, and fashioning of bone grafts [37]. Recent innovations also help virtual surgical planning and generation of surgical guides from computer-based images. These guides are used during surgery to achieve accurate osteotomies and decreases operative time [38,39].

Preoperative vascular studies: They are essential to identify the vascular anatomy of the recipient and donor sites before free tissue transfer. Patients with malignancy may have abnormal or changed vessels to be used as recipient vessels for free tissue transfer, particularly if they are previously operated or received irradiation to the neck.

Preoperative angiography of the head and neck can detect the existence and the condition of arteries suitable for microsurgery and can also show the condition of the internal jugular vein. Vein grafting or vascular loop may be required in some patients when the neck is vessel-depleted. This is important in the decision making and planning of such patients and offers a clue for the success of MR [40].

Preoperative assessment of donor vessels is essential. Some patients may have scars after previous surgery that may have affected the potential donor vessels. Two critical conditions should be identified in patients planned for harvesting free fibula flap. The first is inadequate vascularity of the leg to allow harvesting of the peroneal artery and the second is the dominant peroneal artery system. Both situations can lead to ischemia of the foot and represent absolute contraindications for harvesting the free fibula flap. It was reported that dominant peroneal systems exist in about 5%-10% of peoples. Screening of potential patients with lower limb pulse examination can detect the need for preoperative lower limb angiography. Patients having normal lower limb pulse examination do not need preoperative angiography [41].

Postoperative care

Postoperative care is provided to each patient individually. Free flap patients are frequently transferred to the intensive care unit postoperatively for flap monitoring and supportive care; however, non-microvascular reconstructions are evaluated on an individual basis for care in the ICU. All patients after head and neck reconstructive surgery should have a thorough evaluation for postoperative upper airway edema and every effort made to secure the airways. Postoperative endotracheal intubation or tracheotomy may be necessary. Careful and frequent monitoring of the patient's cardiovascular status is important to ensure adequate volume status and perfusion of vital organs and tissue transfers. Free flap monitoring is performed hourly the first 48 to 72 hours. Most free flap failures secondary to anastomotic thrombosis are reported in the first 24 to 36 hours. No single technique for flap monitoring is considered the single most accurate. The flaps should be monitored for failure of the arterial and venous systems. Doppler ultrasound is an effective tool for monitoring arterial (and sometimes venous) flow within larger vessels within the flap. Color monitoring provides an effective means for assessing venous obstruction and the microcirculation. Capillary refill should be visible in adequately perfused flaps, and any sign of venous congestion should prompt a more thorough assessment of anastomotic patency. Patients are monitored closely for evidence of infection or wound healing issues [42].

Reconstructive Modalities

Collapse the defect

The simplest option for MR is to offer no reconstruction. Collapse of the mandibular segments and closure of the wound is rarely done nowadays but it can be performed for patients having lateral defects in the ramus, condyle and body. A characteristic deformity in the form of chin deviation toward the resection side and tongue elevation on the same side is produced. With physio-therapy, an accepted mandibular function can be maintained. Swallowing and speech can be affected depending on the extent of the resected soft tissues and the status of the remaining tissues after wound closure. Collapse of the defect should be chosen for cases associated with serious medical comorbidities or those with extremely poor prognosis [6].

Mandibular reconstruction plates (MRPs)

The location of the segmental defect is leading factor to choose primary reconstruction using the MRPs with or without a soft tissue flap or a secondary, non-vascularized bone graft where temporary fixation with a MRP is required.

Reconstructions of anterior defects and larger lateral defects using soft tissue flaps (free or pedicled) is associated with a higher incidence of complications mainly extrusion, particularly in the irradiated cases. This can be attributed to the narrow profile of the MRPs and contracture of the enveloping soft tissue leading to pressure necrosis. MRPs with or without soft flaps are associated with failure in the anterior part of the jaw. MR using the MRPs or the temporization with MRPs in a plan for secondary bone grafts should be selected for smaller gaps of the lateral or posterior regions of the mandible in cases not requiring irradiation and considered poor candidates for the free bone flaps [43].

Non-vascularized bone grafts

Benign tumors that allow soft tissue primary closure and do not need postsurgical radiotherapy remain the primary target for non-vascularized bone grafts. Grafts from the iliac crest were chosen based on its numerous advantages [44]. Although non-vascularized bone grafts decrease the time of operation and the hospital stay, the vascular flaps have shown increased incidence of bone union, rapid consolidation of the graft, and minimal morbidity of the donor-site [45].

Multiple factors can affect the success rates of various non-vascularized bone grafts for primary segmental MR. The most important factors are the type of the graft, the time of reconstruction, and the size and site of the defect [45]. Several authors reported about successful application of non-vascularized bone graft in reconstruction of large defects created by benign lesions under certain condition, which is the ability to attain a water tight closure at the intraoral side. This mainly depends on the status of the residual mucosa after excision of the lesion [23,29]. Defect sites are divided mainly into two main types; unilateral and midline crossing defects. Most of the complications occur with reconstruction procedures crossing midline. One of the most critical complications is wound dehiscence with its probable subsequent graft failure, especially if the reconstruction was accomplished through intra oral approach due to contamination of the surgical field with the microbial intraoral flora [46,47].

The iliac crest (both anterior and posterior) and costochondral (rib grafts) are the commonest donor sites for the non-vascularized bone grafts.

The iliac crest bone graft:

It has several advantages that includes; considerable volume of harvestable bone (50 cc–90 cc), possibility of a two-team approach, naturally contoured for MR, and little donor site morbidity if compared to free bone flaps. Moreover, it can be harvested in different forms like block, particulate, cortical, and cortico-cancellous. One of the main disadvantages of iliac crest bone graft is the graft volume loss. The Iliac grafts are associated with large degree of resorption which is due to its endochondral origin and cortico-cancellous morphology. Another disadvantage of the iliac crest is the limited length when compared to the free fibula flap [45,48].

Two approaches for iliac crest bone graft harvest are available depending on the amount of graft needed for reconstruction: the anterior approach and the posterior approach. The anterior approach may provide up to 50 cc of bone material and has the advantage of being obtained from the supine position. Both cortical and cancellous material may be harvested. The graft can be harvested from the lateral or the medial sides of the anterior ilium. The anteromedial approach has a technical advantage of avoiding the stripping of the gluteus medius, minimus, and tensor fascia lata muscles from their attachments to the iliac crest. This tends to result in less gait disturbance than the anterolateral approach, which requires elevation of the iliacus muscle from the medial cortex of the ilium. The posterior approach requires the patient to be positioned prone, essentially precluding simultaneous harvest, and requires a position change during surgery. It can provide up to 90 cc of graft material and is therefore useful for larger defects. Marx and Morales have also suggested that the posterior approach results in less postoperative gait disturbance compared to the anterolateral approach [42,49].

The costochondral grafts

The costochondral graft is considered a perfect option for reconstruction of mandibular condyles. This was attributed to its shape and cartilaginous nature that simulates the condyle of the mandible. Its main drawback is that it had unpredictable growth pattern, easily resorbed and donor site morbidity. In the past, the mandibular condyles are considered a growth center that assisted in the mandibular growth, recently and according to the functional matrix theory, it is considered to be a growth site that grows by the action of the surrounding musculature [48,50].

Vascularized Bone Flaps (Free Tissue Transfer)

The gold standard for reconstruction of long span SMDs is an osteo-cutaneous free tissue transfer combined with titanium plate fixation. Potentially, four donor sites are available for vascularized bone used in osseous MR: the fibula, the scapula, the iliac crest, and the radius. The challenge facing the surgeon involves selecting the best flap for restoring mandibular continuity while restoring the highest functional and esthetic results and carries minimal morbidity of the donor site [51]. Desirable criteria include length availability of donor bone, high-quality bone stock, versatility in shaping of the bony contour, flexibility in three dimensional in setting of thin and pliable soft tissues, ability of the bone to support the dental implants, and the possibility for a two team ablative/reconstructive simultaneous approach. All these characters, and others, are fully offered by the fibula osteo-septo-cutaneous free flap, which has increasingly been globally accepted as the best donor for reconstruction of SMDs [18,19,52,53].

The fibula osteoseptocutaneous free flap

It will provide a good reconstruction for isolated bone and compound defects, and for many composite defects. Usually it cannot offer sufficient soft tissues for large composite defects without inflicting sever donor site morbidity due to wide muscular harvest [18,54-56].

Important key points for harvesting fibula osteoseptocutaneous free flap:

- Angiography of the donor lower limb is not required routinely; it is indicated if the pedal pulses are abnormal or if there is a peripheral vascular disease or significant leg trauma [57].
- The fibula should always be harvested with a skin paddle, even for isolated bone defects, as it will be used as a monitor of vascularity for the underlying bone [58]. The skin paddle also provide tension-free soft tissue closure at the recipient site and augment volume or contour if required.
- It is necessary not to harvest the distal or proximal six centimeters of fibula in to maintain the stability of the ankle and knee joints [4].
- Primary donor site closure should only be performed if there is no risk of compartment syndrome from severe tension [4].
- It is important to exclude arteria peronea magna directly before harvest of the peroneal vessels; this can be achieved by examing the peroneal vessels for excessive size and by putting a microvascular clamp across the distal peroneal vessels early in the flap harvest to confirm the preservation of pedal pulsation and absence of foot ischaemia [4,59].

Advantages of the fibula osteoseptocutaneous flap that make it ideal for mandibular reconstruction include:

- Incomparable reservoir of strong, straight, long bone of nearly equal thickness and biomechanically strong triangular cross-section.
- Trusty acceptance of osseointegrated dental implants.
- Sizeable (2-3 mm) and long pedicle.
- Thin, pliable, wide, skin paddle (up to 22-25 cm in length and 10-14 cm in breadth) that can be inset into any conformation with regard to the bone.
- Ability to serve as a chimeric or flow-through flap.
- Donor site can provide ideal nerve graft for inferior alveolar nerve reconstruction if required.
- Possibility of a two-team approach to ablation and flap harvest.
- Allowing multiple osteotomies for bone contouring [19].

Owing to these advantages, the first-choice source of vascularized bone for reconstruction of SMD is the left fibula osteoseptocutaneous flap and the second choice is the right fibula. Therefore, it is unusual to resort to any of the available other osseous flaps [4].

Deep circumflex iliac artery composite flap

Although some prefer the use of deep circumflex iliac artery composite flap, its skin paddle is bulky and unsuitable for lining the oral cavity and has limited mobility with respect to the bone [60]. Moreover, its pedicle is short, the deep circumflex iliac artery supply is questionable to the skin paddle [61], and in spite of offer an excellent bone stock it cannot tolerate shaping osteotomies well. Donor site morbidity includes protracted gait pain and/or disturbance, lateral femoral cutaneous nerve dysesthesia, abdominal hernia, and pelvic fracture, although, some technical aspects can reduce such morbidities [62].

The radial forearm

Although it provides a pliable, thin, hairless and reliable cutaneous or fasciocutaneous flap, the underlying radius should be regarded as a poor choice of donor vascularized bone for the mandible due to its intolerance of contouring osteotomies, lack of bone stock, poor ability to support osseo-integrated implants and the high risk for subsequent radius fracture. Some have resorted to bone grafting (using the iliac crest bone graft) and/ or plating the radius after its harvest to reduce the risk of secondary radius fracture, but this procedure inflicts morbidity to donor site in an additional location that is itself fraught with donor site morbidities, and prophylactic plating is not cost effective [53,63,64].

The scapula donor site

It is versatile regarding the soft tissue reconstruction, but the quality of the donor bone does not reach that of the fibula, and its location on the back is a major disadvantage since it interferes with a two team approach, thus prolonging the operative time [4].

A double free flap reconstruction

Although a fibula osteoseptocutaneous free flap can provide a sizeable fasciocutaneous paddle and, if necessary, some muscle with the bone, but extensive composite mandibular defects generally require even more soft tissue. Harvest of additional muscles from the leg to increase the soft tissue volume will increase the donor site morbidities. In such situations, a double free flap can offer a superior reconstruction [18,54].

By performing a double free flap, the best donor osseous and soft tissue characteristics can be chosen separately to fulfill the requirements of the defect. This improves in setting, handling and contouring, thus avoiding critical flap folding and pedicle bending or tension. The popular options for a double free flap MR are the fibula osteoseptocutaneous flap for mandible with intra-oral lining and the anterolateral thigh flap for cheek volume and external facial coverage. Both flaps are distant from the head and neck, thus a two-team approach is feasible throughout the double flap surgery [4].

Implantable Biomaterials

Although autogenous bone grafting is considered the gold standard technique for reconstruction of mandibular bony defects [65], there are limits to the amount of the harvested bone for this purpose. Moreover, grafting techniques prolong the length of hospital stay, infection rate, and postoperative pain [66]. As such, there has been a serious interest to develop synthetic grafting materials for use in osseous reconstructive procedures. A variety of implantable materials are available for use in MR. A popular one is HydroSet (Stryker, Kalamazoo, MI). It is calcium phosphate cement which converts in situ to hydroxyapatite, serving as a powerfull osteoconductive and osteointegrative material [67]. Other implantable options include customized implants (75% methylmethacrylate styrene copolymer, 15% poly methylmethacrylate, and 10% barium sulfate), Delta [poly (L) lactide, 10% glycolide, and 5% poly (D) Lactide], and MedPor (high density porous polyethylene) [51,68].

The porous and crystalline characters of these compounds help anchoring the surrounding tissues to promote appropriate fixation. In addition to synthesized implantable materials, great interest has developed in integrating biologically active components into mandibular grafts to further facilitate bone formation [69].

The discovery of bone morphogenic protein, the principal activator of bone induction, has been an important step in the advance of synthetic bone grafts. Bone morphogenic proteins are members of the transforming growth factor b superfamily [70] and induce pluripotent mesynchymal stem cells to differentiate into osteoblasts, stimulating new bone formation. In the future, MR will rely on biosynthetic materials as the effectiveness, cost, availability, and training in the use of these techniques become more acceptable for widespread use. Presently, these materials are still under investigation and have a limited role in the reconstruction following tumor ablation [51].

Distraction Osteogenesis

Transport disc distraction osteogenesis is a special procedure used to generate bone through a defect. A bone disc is prepared beside the defect, then slowly and continuously mobilized till docking after the whole defect has been traversed. When docking is completed the newly formed callus calcifies and remodel. This procedure represents a reconstruction option for treating the segmental defects [69].

In spite of being a successful procedure for reconstructing larger segmental defects, its use is limited as it requires intact soft tissue and periosteum and a prolonged duration of treatment, which is not compatible with cases planned for adjuvant radiotherapy [71]. It does not fulfill all the standards of ideal MR. Also, the cosmetic results are not satisfactory due to the scars of pin tracks. Moreover, it depends on patient compliance and there is doubt regarding its efficacy in the sites of previous or pending radiotherapy [72]. Therefore, there is no sufficient data to support using transport disc distraction osteogenesis to reconstruct long span defects in the mandible in comparison with the available gold standard of free bone flaps [73].

Tissue Engineered Mandibular Grafts

Tissue engineering is an emerging treatment. It applies the scientific principles to design, fabricate, modify and grow the living tissues utilizing biomaterials, growth factors, and cells. Bone tissue engineering is aimed to regenerate the lost bone through the usage of growth factors and/or cells. This technique could potentially avoid requiring a second operative site for tissue harvest and provide sufficient bone volume and contour essential for cosmetic and dental occlusal rehabilitation [73]. A suitable carrier delivers osteogenic growth factors and autogenous bone precursor cells to the site of the defect. This carrier is a three dimensional scaffold which helps cell attachment and multiplication, and can be used as a vehicle to deliver the growth factors [74]. Scaffold should be robust enough to tolerate physiological stresses at the area of implantation [73,75]. The incorporation of the growth factors and the cells into scaffolds results in an osteoconductive and osteoinductive repair site to facilitate bone regeneration in large span defects [76].

Mesenchymal stem cells are pluripotent progenitor cells that with the can generate cartilage, bone, muscle, tendon, ligament and fat. The common source of mesenchymal stem cells is bone marrow. Other sources include the fetal lung, fetal liver and adult adipose tissue.. Fetal or neonatal cells are extremely useful for this purpose since they are naturally non-immunogenic and are a rich source of stem cells; this approach, however, represents a controversial ethical dilemma [77].

The ideal technique of new bone formation using tissue engineering scaffold should be justified with in vivo preclinical studies. These studies must be performed on a proper animal model with precise post experimental analysis [78]. Only after appropriate testing and comprehensive long-term review, the researchers and the clinicians become convinced that this new technique is safe, effective, and fulfill the criteria for optimal reconstruction [73].

Dental Rehabilitation

Although MR with a fibula free flap restores the function and the contour of the mandible, it does not solve the absence of teeth, thus leading to significant functional impairment. The usage of osseointegrated implants has been successfully restored this function in selected patients who are able to maintain oral hygiene and who are compliant with follow-up, which are concern that should be discussed before the insertion of osseointegrated implants [79]. Implants can be inserted primarily during the operation of reconstruction or secondarily at a later time. The procedure is subdivided into three steps. First, the implants are fixed to the bone graft. Four to six months later, when the bone union completes, the skin flap surrounding the implants is replaced with a palatal mucosal graft, and the capping screws are replaced by healing abutments. In addition to using the palatal graft, the skin paddle could be thinned or removed and substituted by a skin graft. Lastly, the superstructure is affixed to the implant after one month [80]. The success rate of dental implantation into mandibles with bone graft is more than 75% [81].

Conclusion

Mandibular defects due to tumor ablation have both functional and esthetic morbidities, and accurate reconstruction of the mandible is challenging. MR is necessary to make the quality of life of these patients better. Diagnostic studies to assess the extent of malignant disease or the ability of the patient to tolerate the proposed operation should be done routinely. Various techniques of reconstruction, ranging from simple primary closure to composite free flaps have been adopted; each has its advantages and disadvantages. Postoperative care should be provided to each patient individually.

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