Enhancing retention of maxillary obturators using dental implants
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Introduction
Rehabilitation of maxillectomy patients can be challenging for both patients and prosthodontist. Obturator prosthesis is used as an effective means for rehabilitating maxillectomy cases. The most common prosthodontics treatment problems with maxillectomy patients are a lack of retention, stability, and support.

The size of the defect, the number of remaining teeth, the amount of the remaining bony structure, and the patient ability to adapt to the prosthesis are factors that affect the retention of the maxillary obturator.

The difficulty with prosthesis retention is a very important concern for maxillectomy patients.[1-3] The introduction of dental implants in obturator brings wonderful improvement in performance of obturator by exhibiting better mechanical qualities.

With different types of attachment, the dental implant solved the major problems that encountered with the conventional obturator.

Review of Literatures
Obturater defined as the maxillofacial prosthesis that used to close the defect and make separation of the oral from the nasal cavities in the way that prevent hyper-nasal speech and nasal regurgitation.

The obturator prosthesis facilitates speech and deglutition by replacing deficient tissues, reduce nasal regurgitation and hyper nasal speech, and improve articulation, deglutition, and mastication.

The academy of prosthodontic classified maxillary obturator prosthesis as surgical, interim, or definitive depending on the intervention time period used in the maxillofacial rehabilitation of the patient.[4]

Rehabilitation of maxillectomy patients can be done by surgical and prosthetic both approaches offer functional and aesthetic improvements. Unfortunately with advances in surgical procedures, reconstruction of maxillectomy defects surgically is not always possible because of the general health status of the patient, defect size, and possibility of tumor recurrence.[5]
The immediate obturator should be retrievable to evaluate the surgical area and detect tumor recurrence as early as possible. The presence of remaining teeth help not only in mastication, but the teeth also facilitate retention of the prosthesis, however, for completely edentulous patients with maxillectomy defect, fabrication of prosthesis is challenging even to the most skilled clinician.\[5\]

**Retention of Maxillary Obturators**

Retention is the basic requirement of any dental prosthesis, and it is defined as the "quality inherent in the dental prosthesis acting to resist the forces of dislodgement along the path of placement."\[6\]

Factors that affect retention: Include the level of direct and indirect retention achieved by the residual teeth; the size of the defect; the quality and quantity of tissue surrounding the cavity and muscular control.\[7\]

The retention of the prosthesis comprises the most common problem of prosthetic treatment of maxillectomy defect. The maxillectomy defects can be rehabilitated with simple conventional obturator prosthesis with various types of clasps as retention components, soft liner, and sectional prosthesis are another methods to enhance retention of the maxillary obturator.\[8\]

The patients with total bilateral maxillary resection are challenging for the maxillofacial prosthodontist. Support and retention of the prosthesis are often difficult to accomplish due to the missing of teeth, lack of desirable tissue undercuts, and the presence of non-keratinized nasal mucosa. Retention of such large obturator prostheses is generally a problem, and patients often must balance the obturator on the dorsum of their tongue.\[8\]

Bilateral undercuts in the lateral aspects of the resulting defect are favored and may assist with retention of the obturator. However, severe bimaxillary undercuts often make a proper lateral extension of rigid obturator prosthesis impossible. This may result in the loss of border seal, retention, and stability of the obturator prosthesis and the presence of space in which debris may collect.\[4\]

Conventional obturator prosthesis in many cases is incapable to provide appropriate retention, stability, and support. Hence, various types of precision attachments resolve this problem. The use of attachments has been described for increase stability and retention of the prosthesis and improve water and air tightness as well.\[7\]

To gain optimum retention, stability, support and esthetics, few maneuvers have been recommended. Means of retention for surgical obturator are suture retention, bone screw retention, spring retained surgical obturator, and circumzygomatic wiring for edentulous patients. For partially dentate patients, in addition to the above mentioned methods inter-dental wiring or suturing can also be attempted. Surgical obturators are modified with liners and tissue conditioners during interim phase.\[6\]

For definitive obturators, undercuts present in the defected area can serve as a mean of retention. If undercuts are blocked out completely, the obturator will have loss of retention, loss of stability, loss of border seal, and the presence of a space in which debris may collect. Weight of an obturator may be kept as minimum as possible to counter act the dislodging pull of gravity.\[10\]

Ueda et al. 1999 concluded that the soft silicone materials may be useful in selected edentulous patients with partial maxillectomy defects.\[11\]

Walter et al. 2005 reported that use of wrought wire or cast clasps, indirect retainers (clasps or labial flanges), making a bulb without a top, making a two-part surgical obturator, or use of a sectional obturator with magnets can also aid in retention.\[12\]

Osseointegrated implants may act as a preferable source of retention provided adequate quality and quantity of bone is available.

**Osseointegrated Implants with Maximally Obturator**

Following the introduction of osseointegration concept by Brånemark, the use of endosseous implants has become the state of the art, with many studies supporting its effectiveness, and predictability.\[13,14\]

Osseointegrated implants may assist retention, stability, and support of obturator prostheses, dental implants have significant advantages in the treatment of maxillofacial defects. The loss of soft and hard tissues often makes implant retained overdentures necessary to support adequately the lips and cheeks and restore oral function.\[8\]

Al-Salehi et al. 2007 reported that the implant overdenture is the treatment of choice when severe soft and hard tissue deficiency is present. Each case presents unique problems to the restorative dentist and dental technician in regard to the prosthetic design, which is primarily influenced by the number and distribution of the implants and the need for the prosthetic defect closure.\[15\]

Placement of osseointegrated implants can have a dramatic effect on the function of the prosthesis for the edentulous maxillectomy patient. Implants provide retention, enhance support, and improve the stability of the obturator prosthesis. Mastication is significantly improved, and speech and swallowing are made more efficient. Thus, adaptation to the prosthesis is much easier for the patient. In addition to its ability to provide better support and retention for the prosthesis, dental implants with attachment are able to reduce maxillary obturator movement.\[6\]

The overall survival rate for implants supporting maxillofacial prosthesis was reported to be more than 95%.\[11\] Dental implants can be used in both the defect and non-defect sides of the maxillary arch.\[7\]

**Implant sites in maxillectomy patients**

The number of implants and their location is determined by the nature of the defect and the available bony sites.
The residual pre-maxillary segment

The most ideal location for implants for most maxillectomy patients remains the residual pre-maxillary segment; this site is preferred because the anterior maxillary segment is opposite to the most retentive portion of the defect located along the posterior lateral wall. In addition, a satisfactory volume and density of bone can be found in the pre-maxilla in most patients, so that every effort is done to preserve this segment of bone as possible as can be (8).

The maxillary tuberosity

The maxillary tuberosity site is considered only when there is insufficient bone in the residual pre-maxilla. Since the bone is not very dense in the maxillary tuberosity, the bone implant interface that develops may not ensure a predictable outcome, as evidenced by the high failure rates at Stage II surgery. Because of this factor, some clinicians have recommended placing longer and misally inclined implants in the pterygoid plates. The edentulous posterior alveolar process may serve as an alternative site for implants if there is at least 10 mm of bone available beneath the maxillary sinus (8).

If the insufficient bone is present, the site may be augmented by elevating the sinus membrane and inserting an autogenous bone graft. This technique is becoming a popular option when treating nonsurgical patients, but its predictability in maxillary defect patients is yet to be determined (8).

Residual elements of the zygoma

Residual elements of the zygoma have also been used as implant sites. However, there are important disadvantages to being considered. First, the implants will be located high in the defect, making oral hygiene very difficult for the patient. Second, because the implants are generally positioned parallel to the plane of occlusion, they cannot be engaged aggressively. They can be used to facilitate retention, but lateral torquing forces delivered to the implants must be minimized (8).

Several investigators have reported that the zygomatic bone as an implant site is a simple, predictable, and cost-effective solution for the reconstruction of acquired maxillary bony defects (16-18).

The mean dimensions of zygomatic bone range from 14.1 to 25.4 mm in the anteroposterior (AP) length and 7.6-9.5 mm in mediolateral thickness. In addition, when the length of the zygomatic bone is measured along the potential implant axis, the measurements range from 14 to 16.5 mm, approximately 36% contact between the implant and the zygomatic bone (19).

Types of Osseointegrated Implant Used in Maxillectomy Patients

1. Conventional implants
2. Mini dental implants
3. Zygomatic implants.

Conventional dental implants

The advent of osseointegration initially created a significant benefit in this area of rehabilitation through the placement of implants in available maxillary bone (20-22).

Unfortunately, the anchorage sites for conventional implant are often limited because of resection or tissue loss, may be compromised by radiation of tissue beds, and may be localized in patterns that prohibit effective anterior-posterior spread and cross-arch stabilization (23,24).

Zygomatic implants

The zygomatic implant is a product of the remote bone anchorage concept and originally was developed for use in patients with challenging maxillary defects. More than 12 years of follow-up at the Bränemark Osseointegration Center (Göteborg, Sweden) has demonstrated a remarkably high rate of success for this implant when it is used to support a variety of maxillary defect prostheses (18).

Branemark developed the zygomatic implant as a solution to the lack of maxillary bony support for prosthetic rehabilitation (25).

The main characteristic of the zygomatic implant is a long implant (30-62.5 mm) that obtains its main anchorage from the zygoma bone in presence or absence of maxillary alveolar bone (19).

The zygomatic implant requires intraoral access to the area of zygomatic buttress through a transsinus approach. Once a suitable window has been created, piloting and implant placement are carried out. Healing for integration usually requires 5-6 months before impressions and subsequent prosthetic construction can be initiated. To minimize the complication of diverse angulations, the head of the zygoma implant has been engineered to allow prosthesis attachment (18).

Advantages of zygomatic implant

Avoids bone grafting and its morbidity, shorter treatment time frames, potential immediate function, and potential cost reduction (19).

Subsequent investigation into the use of remote bone anchorage, either through the residual maxilla or in defect areas, has allowed more extensive bone support to be incorporated into prosthesis design, reducing cantilever stress, and enhancing the cross-arch effect (18).

Disadvantages of zygomatic implant

Zygomatic implants placement are technique sensitive, needs general anesthesia and failures are more difficult to treat (19).

Bedrossian et al. 2001 reported that zygomatic implants are less resistant to rotational forces. It has been suggested that for better distribution of these forces, zygoma implants should be placed to allow the greatest AP spread. In addition, cantilevers in the prosthetic reconstruction should be avoided; cross-arch stabilization by splinting of all the implants is also recommended (26).
Unfortunately, these implants often project at divergent angles, which complicate impression and prosthesis construction procedures. The limitation in available implant lengths has also minimized the depth to which these implants can be placed through various tissue beds.[18]

**Mini-dental implant**

Bohle et al. 2008 found that the use of mini implants, as long-term survival data, is sparse; however, immediate improvement in stabilization and retention of obturators can be accomplished with their aid. Placing these implants, preferably at the time of the ablative surgery, will shorten or hasten the recovery process of the edentulous patient as the obturator will be more efficacious. If planned in conjunction with the surgical team, the implants can be placed with little to no extension of the overall operative time. The patient can then begin adapting to the stable interim prosthesis quickly following packing removal and may be rehabilitated to a near presurgical level.[27]

**Retention Mechanism for Implant Retained Obturator**

One of the most interesting and challenging aspects of the design is the attachment mechanism of the prosthesis to the implants.

A variety of retention mechanisms have been reported for implant-retained maxillary obturator including magnets,[15] clip-bar system,[17] and milled-bar prostheses.[28] Extra-coronal resilient attachment (ERA) and O-ring attachments were chosen by some clinicians due to the limited vertical space provided by the position of implants.[29]

**Magnet attachment**

Magnets provide a simple and useful method for attaching prostheses to dental implants. The magnet attachment characterized by small size enabling them to be incorporated into a maxillary prosthesis without interference, another advantages it had sufficient attractive force (7.2 N) to prevent prosthesis displacement. The magnet attachments can overcome the problems caused by non-parallel implants specially in case of zygomatic implant.[15]

Al-Salehi et al. 2007 one of most advantageous features of magnetic retention was it overcome the problems created by the mal-aligned zygomatic and conventional dental implants,[15], despite that magnets attachments do not provide adequate prosthesis retention in every case, the retention role of magnets coming from controlling vertical displacement of the denture. However, it has low resistance to lateral forces.[30] Moreover, magnets exert low lateral stresses which increase implant success.[31]

Drawbacks of Magnets include low corrosion resistance with the corrosive product and possible toxic effects, which may decrease their use in the oral environment, but studies have revealed that this adverse effect not observed clinically.[32]

**Stud attachments**

Stud attachments, including ball, locators ERA attachments were used to enhance retention of obturator, O-ring and ERA attachments were preferred by some clinicians due to the less vertical space requirement provided by the position of implants and the custom bar design and the need to create a harmonious path of insertion.[24]

**Bar attachment**

Fukuda et al. 2004 evaluated the clinical results of milled bar supported maxillary obturators after the surgical removal of maxillary tumors, the authors concluded that a maxillary obturator retained by milled bar attachments dramatically improve the retention of the prosthesis.[28]

Bar attachment had been used to splint implants supporting obturators for edentulous maxilla with no reported complication during the follow-up period. However, these implants are subjected to high levels of stresses that may affect bone and result in a reduction of bony support.[33]

The bar system rearranges the displacement of the obturator by distributing the load in the sense that the fulcrum implant will be always under compression and experiencing the maximum amount of load. Meanwhile, the other implants will be under a pullout and/or compressive loads, so they show a lesser rate of bone resorption.[33]

Both clinical experience and theoretical modeling suggest that cross-arch stabilization with a rigid splint framework with adequate anterior-posterior spread is essential for effective axial loading of the zygomatic implant. While maxillary defect patients may not have ideal residual anatomy, it is important to place the zygomatic and standard dental implant proper position and alignment that will enhance the splinting effect of the bar attachment assembly.[18]

**Conclusions**

Dental Implants with appropriate attachments system dramatically improve the retention of the maxillary obturators when recommended prosthetic protocols are followed for the rehabilitation of those cases.

**References**