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Review Article

Implant Applications for Maxillofacial Prostheses

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Abstract

Generally, many large tissue defects occur with surgery treatments of tumors in the maxillofacial region. Maxillofacial prosthesis application can be used as an alternative treatment for cases where plastic surgery reconstructions cannot be applied. While the retention of maxillofacial prostheses used to be provided generally via adhesive bands, adhesives in liquid or spray form, and tissue undercuts, the current treatment of an intra-oral edentulous condition is frequently conducted via osseo-integrated implants. The most significant problem facing the reinforcement of the facial implants is inadequate bone thickness. While the most suitable reinforcement points for implant are the temporal region and supra-orbital edge, the bone thickness varies between 2.5 and 6mm for those regions. This article reviews the application of implants in different maxillofacial prostheses.

Keywords: Extraoral implants, Intraoral implants, Pterygoid implants, Retention, Zygomatic implants.

INTRODUCTION

Accordingly, special extra-oral implants were designed with 3-4mm length, unlike oral implants. These implants have wing extensions in order to prevent excessive entrance of the implant into the bone [1-6]. Also, there are some holes which increase the surface area in order to provide mechanical stability and retention. Those implants have been used in clinics successfully for a long time. For maxillofacial defects, defect size and location, existing bone volume and quality, soft tissue, and mobility differ widely between individuals. So the number and locations of implants to be applied thereby differ. For example, while only two implants are enough for retention in auricular prosthesis, as many implants as possible should be applied for medium-large facial defects in order to distribute the pressure. In general, the temporal bone, supra-orbital edge, lateral orbital edge, zygomatic bone, piriform bump, and pterygoid process are determined as anatomical regions which have enough bone to sufficiently reinforce implants. Facial defect treatments should be considered individually and implants must be planted where there is enough bone volume. It is important to place implants in a parallel position in order to make measuring easier. The extension of the prosthetic surface increases as much as possible the retention and reinforcement of the prosthesis. Ideally, the edges of a prosthesis should extend to tissues with less movement. The regions where extra-oral implants may be placed can be classified in terms of volume as follows:

- Regions with 6mm or more bone thickness: 6mm dental implants and longer zygomatic implants can be used in these regions. These bone regions of the facial skull include the anterior maxilla, zygoma, and/or zygomatic arc. The lateral peri-orbital bone generally has a volume of 6-7mm thickness.
- Regions with 4-5mm bone thickness: a 4mm extra-oral implant or 5mm dental implants can be used in these regions. Those bone regions include the superior orbital edge, lateral orbital edge, inferolateral orbital edge, mastoid bump of temporal bone, and zygoma.
- Bones with 3mm or less thickness: the temporal bone, piriform bump, inferior orbital edge, nasal bone, and zygomatic bump are included in this group. Usage of 3mm extra-oral implants in those regions is indicated [1-5, 7-14].

The evaluation of existing bone structures in the implantation region is one of the most important issues of pre-operative planning. Advanced monitoring techniques such as Computerized Tomography (CT) and Magnetic Resonance Tomography (MRT) provide

monitoring of the anatomic status of soft and hard tissue defects, as well as the structure and thickness of existing bone. In cases where auricular defects would be treated via implant reinforced prostheses, mastoid bump, and air cells system, the location of sigmoid sinus and middle cranial fossa levels must be determined in order to prevent any defect during implant surgery. It is also important to have information about the location of the facial nerve canal. If orbital, nasal, or mid-facial prostheses are being planned, BT is required in order to determine the ideal implantation location in accordance with existing bone quality and volume, and to make prosthesis such that they hide the implant's locations and openings. For difficult cases where maxillofacial and intra-oral defects are combined, stereolithographic models may be useful in order to evaluate treatment alternatives. Additionally, bone volume and bone density measurements may be performed by new CT programs in order to place implant. Though those programs were designed for evaluating bone height and the width of maxilla and mandible in intra-oral implant treatments, they can also be used for the head and facial skull too.

Implant Applications

All other treatment options must be discussed before surgery. If the rehabilitation via a prosthesis reinforced by implant is considered after surgery, soft and hard tissues in the surgery region must be prepared for implant placement. The bone regions which are important for the placement of osseo-integrated implants should be protected as much as possible or they must be resized via various reconstructive procedures in accordance with implant placement. The thickness and mobility of soft tissues at the edge of defects are very important, especially for achieving aesthetic results. Because of the muscle movements in the face, the appearance of maxillofacial prosthesis around defects, where tissues move, causes various problems. As a result of these issues, the ideal indications of implant reinforced prosthesis are prosthetic treatments of auricular, nasal, and orbital resections. In order to prevent inflammatory reactions, thin and smooth tissue must be created around implants [1, 2, 15-17]. For an aesthetic appearance of a maxillofacial prosthesis, implants must be placed inside of the borders of the prosthesis. Many guides can be prepared for this purpose. The cheapest and easiest method among them is to prepare the prosthesis to be placed in the form of a wax package so that the implants can be placed with appropriate angle and position. As an addition to that simple method, much more standardized results can be achieved via applications such as tomography and 3D modeling. Through those methods, the locations of implants can be determined by computers, decreasing false rates. Enough bone volume is frequently not achieved after resection. Especially for medium-large facial defects and some birthmarks, computerized tomography scans and 3D models created by combining those scans may be useful by evaluating the potential bone regions and nearby structures. For example, the position of sigmoid sinus and the facial nerve canal, the middle cranial fossa level, the volume of mastoid and mastoid air cell system for some patients with congenital auricular defect must be determined very accurately.

For nasal defects, especially the positions of teeth, the base of nose must be evaluated by using radiography. Computerized tomography and 3D models gained from the data of tomography can aid in the determination of the bone volume and density in this and other potential implant regions. Additionally, those applications can also be used during production processes of facial implants [2, 5, 18].

Also, skin and soft tissues should be evaluated carefully. When soft tissues covering bone implants are attached to the lower periosteum and thinner than 5mm, it is easier to protect the health of those tissues. If the skin and soft tissues in the implant area include hair follicles, scar tissue, or residual tissues from previous reconstructive operations, those tissues must be cleared and covered with a graft. Generally, two phase surgery applications are preferred for existing craniofacial implant systems. One phase surgery procedures are generally used for uncomplicated cases such as auricular defects and hearing aids, but they generally require experience and carefulness. Surgery can be performed under local or general anesthesia, according to the surgeon's preference. Generally, the full thick flap is raised and potential implant regions are determined by using surgery stents produced in accordance with pre-surgery prognosis models. Implant regions are prepared and implants are placed nontraumatically. Then titanium healing caps are placed over the implants. After this process, the flap is placed over the implants. Following the healing, upper structures are placed over the implants by opening the upper surface of the implants. In this way, the two phased surgery is applied. If the one phase surgery is preferred, upper structures are placed directly over the implants and then the flap is closed. In the second surgery phase, the tissue flap around the implant must be thinned before upper structures are placed. Otherwise, epithelial rugae occur around the upper structure, making the provision of a healthy implant environment and hygiene would become impossible. Although upper structures longer than 4mm are available, usage of those will negatively affect loads over implants. The healing process of the mastoid region takes 3-4 months after those operations, while nasal, orbital, and mid-facial defects and radiotherapy-treated cases require at least 6 months [19, 10, 20-23, 11, 17, 12, 24].

Implants Used in Maxillofacial Prosthetic Treatments

- Intra-oral Implants
- Extra-oral Implants

- Zygomatic Implants

Implant contraindications

- Patients treated with high doses of radiotherapy,
- Patients with blood diseases,
- Patients with major psychological disorders,
- Patients with high risk of heart diseases,
- Patients with uncontrollable systemic diseases,
- Patients with alcohol and drug addictions,
- Young patients in adolescence,

Relative situations are as follows:

- Inadequate bone volume and bad bone quality,
- Hard and soft tissue pathologies,
- Patients who previously had addictions for tobacco, alcohol, and other
- substances.

Implant systems used in the maxillofacial area provide reinforcement in two ways:

- Bar systems: bar systems are systems which function by locking on a bar attaching metal or plastic retentive clips over implants. Although retentive clips provide more retention than magnets, they have a greater tendency to corrode. When they are exposed to bodily fluids,
- they do not corrode, unlike magnets. Retentive clips are used for people who are able to use their hands efficiently, when the highest retention is desired for low muscle power regions. For example, bar systems are the systems which are most preferred for retention in auricular prosthesis.
- Magnet systems: the other type of retention method is the usage of on implant reinforcements which do not require upper structure preparation and which are not attached to each other. This technique is a method which only a maxillofacial prosthesis expert experienced in dental technology can handle. It was seen that detached reinforcement structures can be cleaned more efficiently by patients than patients can clean the more complicated upper structures [1-3, 7, 9, 11, 13, 17, 18, 20].

In recent years, samarium-cobalt and neodymium-ferrus-boron magnets, which are more durable than chrome-steel, are being produced in 3mm diameter form. But magnet systems lose their retention specifications in time, which is why they need to be changed. Usage of magnet systems in prosthesis retention is useful, especially for patients who are not able to use their hands to insert or extract prostheses.

INTRA-ORAL IMPLANTS

Principles of Implantation for Intra-oral Defects

A classic prosthesis applies excessive pressure on auxiliary teeth in these kinds of defects, which causes periodontal damages. Especially for large and one-sided defects, cross arch stabilization and resistance against vertical movement of prostheses are lost. As a result of this, teeth which play a key role in handling may be lost. In order to prevent that loss, a couple of implants which are placed in or around the defect region can decrease the load on auxiliary teeth, and they can provide cross arch stabilization and also effective resistance against forces changing their locations. Implants provide advanced osseo-integration with bony grafts. After grafts extracted from the iliac crest are placed in the zygomatic arc region and grafts extracted from the skull are placed on infra-orbital region, contra arc stabilization can be provided by a placement implant.

Principles of Implant Placements for Sub-Maxilla Defects

The mandible may be resected marginally or segmentally in the case of the tongue, extra-molar region of mouth bottom, and corpus tumors events. In the case of marginal defected maxilla, prostheses meeting functional needs can be effectively produced by placement many implants without applying grafts. For segmental defects, asymmetry and malocclusion due to inner down deviation of rear sub-maxilla segments can be removed by placing bone grafts extracted from the fibula or iliac crest on the defect region. With reinforcements of many implants placed on and around the defected region, a reasonably functioning prosthesis can be produced. A waiting time period for 3-9 months is required for the total binding of grafts on the host surface. It is also possible to transport osseo-integrated implants, which are placed on iliac bone or fibula before graft application, to the defect region together with grafts. Possible residual mini plates inside of the bones must be removed before implantation. If the mucosa covering the bone is too thick for attachment of trans-mucosal abutments, they must be thinned. For the planning phase before the implantation process, the dentition status of the antagonist arc and vertical dimension, the patient's ability to provide daily oral hygiene and the prosthesis daily insertion and extraction properly must be considered, in addition to the construction level of surgery scar tissue, volume, position, innervations, and mobility of the residual tongue.

EXTRA-ORAL IMPLANTS

General Principles of Implant Supported Restorations of Extraoral Defects

- Implant abutments must be as optimal as the covering skin can provide,
- For preventing destructive forces, subcutaneous skin layers should be thinned surgically, and this process must be performed 10mm away from abutments,

- Implants should be 1cm away from each other for hygienic purposes,
- Bars fixed between abutments must be in accordance with natural contours of the face and they must be designed in order to provide required hygiene needs,
- Implants must be placed at least 7mm away from hairy skin. If that is not possible, a skin graft must be applied.

Implant Complication

1. **Ejaculating:** this is the most significant complication. An excessively large implant, implant material, the non-wirewound implantation after enucleation, the saturation of the tendon and conjunctiva under tension, infection, and the usage of non-appropriate prostheses in sockets are factors which contribute to the ejaculation. The ejaculation risk in porous implants is very low. The treatment is a secondary implantation, and the implants which are covered with autogenetic winding material are preferred. Also, a fatty skin graft should be preferred if the contradiction is associated with the case.

2. **Exposition**: the exposition of an implant started to be seen more frequently after the wide usage of especially porous implants. Exposition generally results with ejaculation in solid implants, but in porous implants with vascular reinforcement, it becomes a serious problem. The more biologically compliant materials of implants and the developments on techniques which are used in surgery have decreased the frequency, but they could not eliminate it completely. It is available to decrease the frequency by using implants of appropriate size, establishing a strong barrier at the frontal surface, suturing the scleral flaps in front of the implant as layers in evisceration, using the autologous and homolog winding material during enucleation, appropriately closing the tendon and conjunctiva layers, and preventing excessive pressures by applying place holders and prostheses.

3. **The migration of an implant:** migration is generally seen as downward migration of implant in orbita gravity, and it is most seen in non-integrated solid implants. The wound implantation decreases the frequency of migration. It is seen rarely in porous implants. Unless there is an apparent deformation in the socket and it prevents the implementation of prostheses, there is no need for treatment. The more complicated situations may lead to considerations regarding implant reposition or changing.

4. **The complications in porous implants regarding pins**: besides their contributions to the improvement of socket rehabilitation, porous orbital implants lead to some specific complications. The complications regarding pins are the most important ones. Infection, exposition, and migration are major complications. Minor complications are inflexion, formation of pyogenic granuloma, excessive secretion, bleeding, pin loss, and coverage.

The main complications of porous orbital implants are as follows:

- Exposition,
- Migration,
- Infection,
- Ejaculation,
- Pyogenic granuloma,
- Mass formation,
- Autonomous movement,
- Pain,
- Deficient implant blood build-up,
- Complications involving a pin: ejaculation, inflexion, embedding.

DISCUSSION

By way of fibro-vascular tissue moving into its canals, porous orbital implants become a living part of the body, so the complications are expected at low rates. Buettner and Bartley [25] reported the exposition complications have a rate of 22%. Evidently, the exposition is the most common and most discussed complication in porous orbital implants. Their frequencies vary between 0 and 22% in different series. The ejaculation risk in porous orbital implants is very low, while the presence of vascularized tissues under the implant smooth the treatment of that exposition through grafting. If the exposition occurs early after implantation, one must consider the deficient wound healing. For late occurring expositions, one must take into account the inappropriate relationship of prostheses and implants and the formation of necrosis due to excessive pressure, deficient coverage of tendon capsule over the implant, and deficient blood build-up in the implant. When we consider the complications according to types of porous orbital implants, there are serious differences between them in the literature. In a study conducted by Jordan et al., where they used four types of porous implants in 86 patients, they reported three natural HA, two bio-ceramic and one synthetic HA implant for exposition complications (7.7%). But then the authors expressed that they preferred to use the bio-ceramic orbital implants because of their bio-compliance, uniform porosity, and smoother surface [8, 14, 19, 26-33]. The implant infection is a rarely seen, but is a very serious complication. It may occur early (before prosthesis integration) or late (after integration). The early infections are due to deficient body resistance, vascularization problems around soft tissues, and implant expositions. For late developing infections, lesioned conjunctival mucosa is thought to be a reason for infection. Four possible mechanisms were reported for microorganism entrance: the period of placement of orbital implant, invasion style from exposition region, the process of screwing the implant for the pin, or the hematogenous dissemination during bacteremia. In the research literature, the implant infections have been

reported in a frequency between 0.01% and 3.9% in different case presentations or patient groups [26]. The systemic or topical anti-biotic treatment with a wide spectrum creates good results in implant infections and implants rarely need to be displaced. The implant infection must be considered for patients with persistent conjunctiva inflammation, secretion, and implant exposition.

CONCLUSION

Combined defects constitute 2% of all defects. For a determination of appropriate implantation areas in the maxilla, nasal, and orbital regions, a guide wax prosthesis model should be created. By using panoramic radiography and computerized tomography, the thickness and density of bone structures should be determined. It is possible to place implants in the glabella region of the frontal bone, beneath zygomatic arc, on pterygoid bone, at upper and lower orbital edges, and in alveolar processes. Bone grafts must be placed where the bone reinforcement is not sufficient. Large limited combined defect placement on bony structures on the periphery is more appropriate for their resistance to loads from their long axes. Implants placed at the center of defects transfer destructive forces to bones to which they are attached by being exposed to Class I level forces during rotational movements of the prosthesis [11-14]. Trans-mucosal and trans-cutaneous implants can be used as combined implants in cases where intra- and extra-oral defects exist simultaneously.

Conflict of Interest: No

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