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EVALUATION OF USE OF NARROW DIAMETER IMPLANTS IN POSTERIOR REGION OF THE JAWS

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Abstract

The molars are one of the first teeth to be lost over lifetime; thus, their replacement is frequently needed. Implantation is generally the preferred choice to replace a missing single tooth avoiding vital teeth preparation and bridge fabrication. Placement of implant to replace a molar presents diagnostic, surgical, and prosthetic demands, such as an enlarged mesiodistal dimension and occlusal forces distribution. Poor bone quality in the posterior regions, especially the maxilla, could jeopardize the short- and long-term implant success. Anatomical considerations and adjacent vital structures (ie, maxillary sinus and mandibular canal), occlusal loads, and the occlusal table, which is frequently wider than the implant diameter, should also be of some concern. Quality and density of the bone in the posterior regions can compromise initial implant stabilization and load transfer to the bone. The most frequent single molar to be replaced is the first mandibular molar, because this tooth is lost first. Implantation in the posterior area is a predictable procedure over time. The low rate of complications in addition to the high long-term success rate make implant restoration a reliable solution to treat posterior partial edentulism. Hence the present study was planned for evaluation for evaluation of use of narrow diameter implants in in posterior region of the jaws.

The present study was planned in Department of Impalantology, Manipal College of dental sciences Manipal. Total 20 cases were enrolled in the present study. Out of that 10 cases were scheduled for single unit prosthetic rehabilitation supported by implant in the posterior region of the jaws was evaluated in Group A. These cases were implemented with the Narrow Diameter Implant (NDI). Remaining 10 cases were evaluated in the Group B as control cases. These control patients received the Regular Diameter Implant (RDI).

The data generated from the present study concludes that NDIs placed in posterior region of the jaws without sufficient bone thickness for placement of RDIs presented a high success and survival rate. In addition to that, NDIs presented marginal bone loss patterns similar to those for RDIs, both in the maxilla and mandible. Thus, it can be suggested that NDIs may be successfully used in the posterior regions of the jaws. More studies with longer follow-up intervals are, however, necessary to further evaluate single crowns supported by NDIs in the posterior region of the jaws.

Keywords: Narrow Diameter Implants, Posterior Region of the Jaws, Regular Diameter Implant, NDI, RDI, etc.

Introduction

A dental implant (also known as an endosseous implant or fixture) is a surgical component that interfaces with the bone of the jaw or skull to support a dental prosthesis such as a crown, bridge, denture, facial prosthesis or to act as an orthodontic anchor. The basis for modern dental implants is a biologic process called osseointegration, in which materials such as titanium form an intimate bond to bone. The implant fixture is first placed so that it is likely to osseointegrate, then a dental prosthetic is added. A variable amount of healing time is required for osseointegration before either the dental prosthetic (a tooth, bridge or denture) is attached to the implant or an abutment is placed which will hold a dental prosthetic/crown.

Success or failure of implants depends on the health of the person receiving the treatment, drugs which affect the chances of osseointegration, and the health of the tissues in the mouth. The amount of stress that will be put on the implant and fixture during normal function is also evaluated. Planning the position and number of implants is key to the long-term health of the prosthetic since biomechanical forces created during chewing can be significant. The position of implants is determined by the position and angle of adjacent teeth, by lab simulations or by using computed tomography with CAD/CAM simulations and surgical guides called stents. The prerequisites for long-term success of osseointegrated dental implants are healthy bone and gingiva. Since both can atrophy after tooth extraction, pre-prosthetic procedures such as sinus lifts or gingival grafts are sometimes required to recreate ideal bone and gingiva.

The final prosthetic can be either fixed, where a person cannot remove the denture or teeth from their mouth, or removable, where they can remove the prosthetic. In each case an abutment is attached to the implant fixture. Where the prosthetic is fixed, the crown, bridge or denture is fixed to the abutment either with lag screws or with dental cement. Where the prosthetic is removable, a corresponding adapter is placed in the prosthetic so that the two pieces can be secured together.

The risks and complications related to implant therapy divide into those that occur during surgery (such as excessive bleeding or nerve injury), those that occur in the first six months (such as infection and failure to osseointegrate) and those that occur long-term (such as peri-implantitis and mechanical failures). In the presence of healthy tissues, a well-integrated implant with appropriate biomechanical loads can have 5-year plus survival rates from 93 to 98 percent and 10 to 15 year lifespans for the prosthetic teeth. Long-term studies show a 16- to 20-year success (implants surviving without complications or revisions) between 52% and 76%, with complications occurring up to 48% of the time. [1]

The primary use of dental implants is to support dental prosthetics. Modern dental implants make use of osseointegration, the biologic process where bone fuses tightly to the surface of specific materials such as titanium and some ceramics. The integration of implant and bone can support physical loads for decades without failure. [2]

For individual tooth replacement, an implant abutment is first secured to the implant with an abutment screw. A crown (the dental prosthesis) is then connected to the abutment with dental cement, a small screw, or fused with the abutment as one piece during fabrication.[8] Dental implants, in the same way, can also be used to retain a multiple tooth dental prosthesis either in the form of a fixed bridge or removable dentures.

An implant supported bridge (or fixed denture) is a group of teeth secured to dental implants so the prosthetic cannot be removed by the user. Bridges typically connect to more than one implant and may also connect to teeth as anchor points. Typically the number of teeth will outnumber the anchor points with the teeth that are directly over the implants referred to as abutments and those between abutments referred to as pontics. Implant supported bridges attach to implant abutments in the same way as a single tooth implant replacement. A fixed bridge may replace as few as two teeth (also known as a fixed partial denture) and may extend to replace an entire arch of teeth (also known as a fixed full denture). In both cases, the prosthesis is said to be fixed because it cannot be removed by the denture wearer. [3]

A removable implant supported denture (also an implant supported overdenture is a type of dental prosthesis which is not permanently fixed in place. The dental prosthesis can be disconnected from the implant abutments with finger pressure by the wearer. To enable this, the abutment is shaped as a small connector (a button, ball, bar or magnet) which can be connected to analogous adapters in the underside of the dental prosthesis. Facial prosthetics, used to correct facial deformities (e.g. from cancer treatment or injuries) can use connections to implants placed in the facial bones. Depending on the situation the implant may be used to retain either a fixed or removable prosthetic that replaces part of the face. [4]

In orthodontics, small diameter dental implants, referred to as Temporary Anchorage Devices (or TADs) can assist tooth movement by creating anchor points from which forces can be generated. [5] For teeth to move, a force must be applied to them in the direction of the desired movement. The force stimulates cells in the periodontal ligament to cause bone remodeling, removing bone in the direction of travel of the tooth and adding it to the space created. In order to generate a force on a tooth, an anchor point (something that will not move) is needed. Since implants do not have a periodontal ligament, and bone remodelling will not be stimulated when tension is applied, they are ideal anchor points in orthodontics. Typically, implants designed for orthodontic movement are small and do not fully osseointegrate, allowing easy removal following treatment. [6]

Planning for dental implants focuses on the general health condition of the patient, the local health condition of the mucous membranes and the jaws and the shape, size, and position of the bones of the jaws, adjacent and opposing teeth. There are few health conditions that absolutely preclude placing implants although there are certain conditions that can increase the risk of failure. Those with poor oral hygiene, heavy smokers and diabetics are all at greater risk for a variant of gum disease that affects implants called peri-implantitis, increasing the chance of long-term failures. Long-term steroid use, osteoporosis and other diseases that affect the bones can increase the risk of early failure of implants. [7]

It has been suggested that radiotherapy can negatively affect the survival of implants. Nevertheless, a systemic study published in 2016 concluded that dental implants installed in the irradiated area of an oral cavity may have a high survival rate, provided that the patient maintains oral hygiene measures and regular follow ups to prevent complications. [8]

The long-term success of implants is determined, in part, by the forces they have to support. As implants have no periodontal ligament, there is no sensation of pressure when biting so the forces created are higher. To offset this, the location of implants must distribute forces evenly across the prosthetics they support. [9] Concentrated forces can result in fracture of the bridgework, implant components, or loss of bone adjacent the implant. [10] The ultimate location of implants is based on both biologic (bone type, vital structures, health) and mechanical factors. Implants placed in thicker, stronger bone like that found in the front part of the bottom jaw have lower failure rates than implants placed in lower density bone, such as the back part of the upper jaw. People who grind their teeth also increase the force on implants and increase the likelihood of failures.

The design of implants has to account for a lifetime of real-world use in a person's mouth. Regulators and the dental implant industry have created a series of tests to determine the long-term mechanical reliability of implants in a person's mouth where the implant is struck repeatedly with increasing forces (similar in magnitude to biting) until it fails. [11]

When a more exacting plan is needed beyond clinical judgment, the dentist will make an acrylic guide (called a stent) prior to surgery which guides optimal positioning of the implant. Increasingly, dentists opt to get a CT scan of the jaws and any existing dentures, then plan the surgery on CAD/CAM software. The stent can then be made using stereolithography following computerized planning of a case from the CT scan. The use of CT scanning in complex cases also helps the surgeon identify and avoid vital structures such as the inferior alveolar nerve and the sinus. [12]

After placement, implants need to be cleaned (similar to natural teeth) with a Teflon instrument to remove any plaque. Because of the more precarious blood supply to the gingiva, care should be taken with dental floss. Implants will lose bone at a rate similar to natural teeth in the mouth (e.g. if someone suffers from periodontal disease, an implant can be affected by a similar disorder) but will otherwise last. The porcelain on crowns should be expected to discolour, fracture or require repair approximately every ten years, although there is significant variation in the service life of dental crowns based on the position in the mouth, the forces being applied from opposing teeth and the restoration material. Where implants are used to retain a complete denture, depending on the type of attachment, connections need to be changed or refreshed every one to two years. A powered irrigator may also be useful for cleaning around implants. [13]

The molars are one of the first teeth to be lost over lifetime; thus, their replacement is frequently needed. Implantation is generally the preferred choice to replace a missing single tooth avoiding vital teeth preparation and bridge fabrication. Placement of implant to replace a molar presents diagnostic, surgical, and prosthetic demands, such as an enlarged mesiodistal dimension and occlusal forces distribution. [14-15] Poor bone quality in the posterior regions, especially the maxilla, could jeopardize the short- and long-term implant success. [16-17] Anatomical considerations and adjacent vital structures (ie, maxillary sinus and mandibular canal), occlusal loads, and the occlusal table, which is frequently wider than the implant diameter, should also be of some concern. [18-19] Quality and density of the bone in the posterior regions can compromise initial implant stabilization and load transfer to the bone. The most frequent single molar to be replaced is the first mandibular molar, because this tooth is lost first. [20-21] Implantation in the posterior area is a predictable procedure over time. The low rate of complications in addition to the high long-term success rate [22-24] make implant restoration a reliable solution to treat posterior partial edentulism. Hence the present study was planned for evaluation for evaluation of use of narrow diameter implants in in posterior region of the jaws.

Methodology:

Total 20 cases were enrolled in the present study. Out of that 10 cases were scheduled for single unit prosthetic rehabilitation supported by implant in the posterior region of the jaws were evaluated in Group A. These cases were implemented with the Narrow Diameter Implant (NDI). Remaining 10 cases were evaluated in the Group B as control cases. These control patients received the Regular Diameter Implant (RDI).

All the patients were informed consents. The aim and the objective of the present study were conveyed to them. Approval of the institutional ethical committee was taken prior to conduct of this study.

Following was the inclusion and exclusion criteria for the present study.

Inclusion Criteria: Patients of age ≥ 18 years-old, to require 2 implants in either the posterior maxilla or mandible (one NDI and one RDI) to be restore with a single crown and o exhibit an alveolar ridge 5-6 mm wide.

Exclusion Criteria: Patients with previous bone augmentation procedure at implant site, presence of untreated periodontitis, soft and/or hard tissues alterations, use of any drug that could affect bone metabolism, alcohol or tobacco abuse (> 10 cigarettes/day), presence of immune compromising conditions (HIV-positive, or under therapy with immunosuppressive drugs), pregnancy, presence of para functional habits; and history of radiotherapy of the head/ neck region.

Results & Discussion:

The utilization of small diameter implants has become more widespread because of the demand for endosseous implants in a wide range of osseous dimensions. Although bone-grafting procedures can idealize the width of the alveolar ridge, many patients decline because of the additional time, cost, and morbidity. Additionally, bone-grafting procedures do not resolve the issue of length in the mesial-distal dimension. As a result, small diameter implants are being used as an alternative diameter choice to gain case acceptance. The main advantages of this type of endosseous implant are its size, 1-piece design, and precontoured abutment, as well as the ease of the restorative phase.

Dental implants are intended to replace the missing roots of a tooth. In the case of a molar, a single implant may not achieve the crown root ratio of the original tooth subjecting the implant to increased occlusal forces. Owing to this reason, prosthesis mobility and screw loosening are the most frequent complications associated with single implant molar restorations. Another disadvantage of a wide-diameter implant is that if the implant fails to osseointegrate, a wider implant for replacement may not be available. In addition, many ridges may not have an adequate buccolingual dimension for placement of a wide-diameter implants.

Table 1: Age & No. of Cases

Group	Group A	Group B
Group of	Cases	Control
Implant Type	Narrow Diameter Implant (NDI)	Regular Diameter Implant (RDI)
No. of Patients	10	10
15 – 20 years	1	2
21 – 30 years	3	4
31 – 40 years	3	4
Above 40 years	3	0

Table 2: Position of Implants

Group	Group A	Group B
Group of	Cases	Control
Implant Type	Narrow Diameter Implant (NDI)	Regular Diameter Implant (RDI)
No. of Patients	10	10
Maxila pre molar	2	1
Maxilla molar	2	3
Mandible pre molar	3	4
Mandible molar	3	2

Table 3: bleeding on probing

Group	Group A	Group B
Group of	Cases	Control
Implant Type	Narrow Diameter Implant (NDI)	Regular Diameter Implant (RDI)
bleeding on probing	2	3
Mobility after 1 year	0	0
Supurration after 1 year	0	0

Balshi et al., 1979 compared the use of two implants to replace single missing molars to the use of a single-standard implant or a wide-diameter implant and found that the use of two implants to replace a single molar provides more surface area for osseointegration and distributes the occlusal forces over a larger area within the bone compared to one wide-diameter implant of the same length. [25] Romeo et al., Olate et al. (2010), Vigolo et al., and Buser et al. (1997) showed a satisfactory success rate using small-diameter implants, similar to that of standard-diameter implants. Chiapasco et al. (2006) concluded that the reported crestal bone loss figures around narrow implants were within the acceptable range. [26] Wolfinger et al., 2011 analyzed retrospectively the survival rate of implants used in pairs to support a single molar crown over a long-term follow-up period of 3–12 years and found that two implants for the replacement of a single molar had a higher survival rate and fewer complications when compared to single implants. [25]

Brian (2011) presented a case report where the author used two smaller diameter (3.0 mm × 2 mm) single-stage implants for replacement of the mandibular molar. The author stated that multiple small-diameter implants can increase the long-term prognosis of the prosthesis by increasing surface area and reducing screw loosening. [27]

Research has established the osseous dimensions required for long-term implant success. Treatment plans must be designed to incorporate the best implant modality for the ideal final prosthesis for the patient. Esposito and associates have stated that a minimum of 1.5 mm of space is required between a tooth and an adjacent implant surface. [28] Elian and colleagues demonstrated that 3 mm of bone is needed between 2 adjacent implants for success. [29] The cases presented in this paper demonstrate that 12 mm of mesial-distal dimension allows ideal spacing for 2 small diameter implants for predictable results in the mandibular first molar region. Use of 1 implant per root has been recommended as the appropriate treatment plan for implant mandibular molar replacement. [30-31] However, the osseous quantitative requirements preclude the use of conventional standard size implants (3.75 mm) in many clinical situations. Small diameter implants allow for successful placement with adequate osseous support. The 2-implant concept to replace a single molar allows for an enhanced prognosis by increasing implant surface area by splinting. Also, it eliminates the complication of abutment screw loosening by reducing detrimental rotational movements such as wobble or tipping. In addition, it reduces the size of the gingival embrasures often present when a single implant replaces a mandibular first molar. This clinical problem often becomes the patient's chief complaint after final restoration placement.

Single regular-diameter implants might be incapable of predictably withstanding molar masticatory function and occlusal loading forces. Wide-diameter implants are a suitable alternative for replacing a missing molar in some cases; however, the use of 2 implants has been successfully demonstrated to be a functional and more biomechanically sound method of molar replacement. [32] Wide-diameter implants are not always a treatment option for replacing a single molar, especially when the buccolingual dimension is deficient. The use of 2 implants might also provide better prosthetic stability and prevent rotational forces on the prosthetic components. Restoration of missing molars with 1 wide-diameter implant has a greater incidence of screw loosening [33] and, compared with 2 implants, has a greater incidence of prosthesis mobility6 and a higher failure rate. [34] When narrow implants are used as singletooth replacement, especially in the molar region, an increased risk of screw loosening or fracture exists due to the combination of high masticatory forces, buccal-lingual mandibular movement, and cusp-groove orientation. Therefore, the use of 2 implants to replace a single molar is a logical treatment solution to avoid prosthodontic complications. [35]

Conclusion:

The data generated from the present study concludes that NDIs placed in posterior region of the jaws without sufficient bone thickness for placement of RDIs presented a high success and survival rate. In addition to that, NDIs presented marginal bone loss patterns similar to those for RDIs, both in the maxilla and mandible. Thus, it can be suggested that NDIs may be successfully used in the posterior regions of the jaws. More studies with longer follow-up intervals are, however, necessary to further evaluate single crowns supported by NDIs in the posterior region of the jaws.

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