Numerical guidelines for selection of implant supported prostheses for completely edentulous patients

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Planning of the prosthetic design in implant supported rehabilitations is based on the anatomical situation, patient's esthetic and functional requirements and economics. The goal of treatment must be to offer an optimum restorative solution with minimum surgical morbidity. This article presents numeric guidelines aimed at helping the clinician for making a prudent choice of restorative material and design in implant prosthodontics.

KEY WORDS: *Clinical guidelines, edentulous, implant prosthesis, prosthesis design, treatment planning*

INTRODUCTION

Edentulism is debilitating. It adversely impacts nutrition, esthetics, self confidence and social life of the individual.[1] Significant numbers of complete denture wearers are dissatisfied; with complaints ranging from loose lower dentures, sore spots, inability to eat various kinds of food etc. Implants have revolutionized the way edentulous patients are rehabilitated and have immensely improved their quality of life. Dental technology has been in overdrive over the past decade to bring in a wide variety of prosthetic solutions to restore completely edentulous patients using implants. Treatment planning for fully edentulous patients is based on the anatomical situation, available bone for placement of implants, ridge relation, lip support, smile line, manual dexterity, patient's desires and economics. Several articles have been published to specify the minimum space required for different implant restorations.[2-5] The clinician may choose the material and restorative design and make the patient's condition fit into the requirements. In many cases this could lead the clinician to cut away too much good bone to gain restorative space. Instead, a better approach would be to see the restorative space the patient presents with and choose the best restorative material and design to fit that space. The authors present a numerical guideline based on the interarch space available for selecting different type of prostheses.

REPORT

Numerical guidelines for selection of implant prostheses

There are a plethora of prosthetic options ranging from removable overdentures to fixed prostheses which can be screw retained or cement retained on prefabricated/custom abutments. Several articles suggest guidelines aiming at simplifying decision making process.[2-8]

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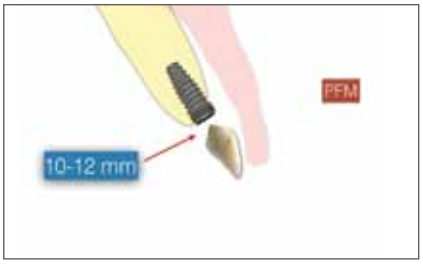

Fig 1 Restorative option of choice when available interarch space is about 10-12 mm

Fig 2 Maxillary Porcelain fused to metal prostheses when the interarch space is 10-12 mm

Regardless of the degree of ridge resorption, just as in traditional complete denture fabrication, the position of incisal edge of upper incisors is determined by esthetics, phonetics and lip dynamics.[9,10]

In esthetic analysis, 2-4 mm of the maxillary incisor should be visible depending on age and gender of the patient. In phonetic analysis, when patient enunciates F and V sounds, the incisal edge should touch vermilion border of the lower lip. Once the incisal edge position has been established the length of the central incisors is determined. On an average the length of the central incisors is 10.5 mm;[11] this can be more in elderly patients who exhibit gingival recession. The axial inclination of the central incisors should provide adequate support for the upper lip. Once the crown length and angulation have been determined, the distance between the cervical crown margin of the central incisor and residual bone crest can be assessed. The clinician must be well informed about the minimum thickness needed to fabricate prostheses with any given material. The available interarch space or restorative space is measured from the implant prosthetic platform/ alveolar ridge crest to the proposed incisal edge in the anterior region and occlusal plane in the posterior region and this space will govern the selection of the prosthesis.[12]

Key Point

Edentulism is debilitating. It adversely impacts nutrition, esthetics, self confidence and social life of the individual

Restorative design options as per the available interarch space

A. Interarch space 10-12 mm

A prosthesis designed for this space appears to replace only the anatomical crowns of the missing natural teeth. This prosthesis looks very similar to most traditional fixed prostheses.

Fixed restorative option for this category would be porcelain fused to metal prosthesis/monolithic zirconia/layered zirconia which could be screw retained or cement retained based on location of screw access openings.

As the interarch space is restricted, use of overdentures for these patients should be avoided.

Fig 1 illustrates the available space and restorative option for this category.

Fig 2 depicts a cement retained metal ceramic prosthesis in situ.

B. Interarch 12-15 mm

A prosthesis designed for this space would appear to replace not only the anatomical crown of the tooth but also a part of the adjoining soft tissue.

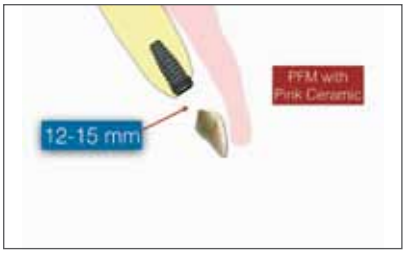

Fig 3 Restorative option of choice when available interarch space is about 12-15 mm

Fig 4 Porcelain fused to metal prosthesis with tissue shaded ceramic when the interarch space is 12-15 mm

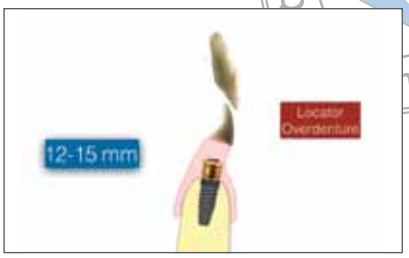

Fig 5 Attachment of choice for a removable prosthesis when interarch space is 12-15 mm

Fig 6 Locator attachments for removable prostheses when interarch space is 12-15 mm

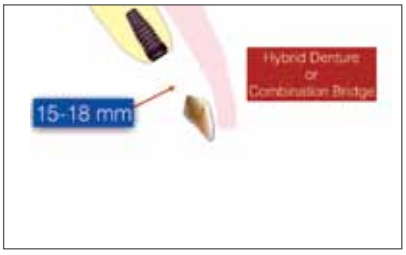

Fig 7 Restorative option of choice when available interarch space is about 15-18 mm

Fig 8 Hybrid Denture when the interarch space is 15-18 mm

Fixed restorative option for this category would be porcelain fused to metal/monolithic zirconia/layered zirconia with pink ceramic. This prosthesis could be screw retained or cement retained based on location of screw access openings. As the degree of resorption has increased, the use of pink ceramic becomes important. Pink ceramic may be avoided if patient has a very low lip line and does not show gingival tissues during smiling.

Fig 3 illustrates the available space and restorative option for this category.

Fig 4 depicts cement retained metal ceramic prosthesis in situ.

In case a removable prosthesis needs to be provided when the interarch space is 12-15 mm (Fig 5), the choice of design of attachments would be a Locator type of attachment. Fig 6 illustrates the locator attachments for an overdenture. In such cases since the bone resorption is not too much and the posterior ridge anatomy is still quite good, an overdenture retained by implants and supported by tissues is viable. This will allow the clinician to fabricate overdentures with 2-3 implants in the mandible while in the maxilla this option is still not feasible as the implants must be splinted in the maxilla. Splinting would need fabrication of a bar attachment which would not be possible in this limited interach space.

C. Interarch 15-18 mm

As the degree of resorption increases further, use of traditional designs of porcelain fused to metal will make the prosthesis too heavy. In such cases there are three restorative options.

a. Hybrid prosthesis: Metal framework with acrylic/composite resin teeth.

b. Hybrid prosthesis with a biocompatible high performance polymer (Bio HPP) as a framework material. This material has been shown

Key Point

Treatment planning is based on the anatomical situation, available bone for placement of implants, ridge relation, lip support, smile line, manual dexterity, patient's desires and economics

Fig 9 *(a)* Bio HPP Framework *(b)* Bio HPP framework with resin teeth

Fig 10 *(a)* Maxillary Combination Bridge when interarch space is 15-18 mm *(b)* The milled titanium framework with individual struts to receive cement retained crowns *(c)* The convex and polished undersurface of the combination bridge to facilitate hygiene *(d)* The combination bridge prosthesis with individual crowns

to have high impact strength and wear resistant resin teeth can be bonded onto the framework.

c. Combination Bridge (Screw Retained Framework with individual or splinted crowns)

Fig 7 illustrates the available space and restorative options for this category.

Fig 8 depicts the hybrid prosthesis in situ. Figs 9a-9b illustrate the Bio HPP framework with resin teeth. Figs 10a-10d illustrate the combination bridge.

In case removable prostheses need to be provided when the interarch space is 15-18 mm, the choice of design of attachments would be a Ball & Socket (Fig 11) or a Locator type of attachment. A milled low profile bar attachment is a possibility here; however the choice should be made with caution as some bar designs need much more interarch distance. Fig 12 illustrates the ball and socket attachments for an overdenture.

Key Point

Regardless of the degree of ridge resorption, just as in traditional complete denture fabrication, the position of incisal edge of upper incisors is determined by esthetics, phonetics and lip dynamics

D. Interarch more than 18 mm

In such cases the degree of resorption has advanced to such great levels that using any form of fixed prostheses will make the prostheses design biomechanically unfavorable and unaesthetic. As the maxilla resorbs upwards and inwards, it becomes narrower and more constricted. Several patients with this condition will need a flange to provide lip support for esthetics. The preferred restorative choice in this category is the overdenture with different attachments. In such cases, since ridge resorption and consequent

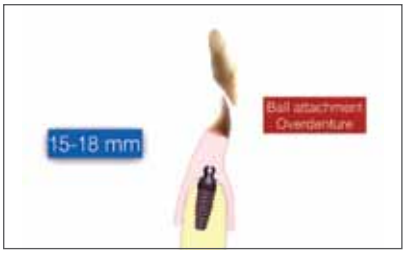

Fig 11 Attachment of choice for a removable prosthesis when interarch space is 15-18 mm

Fig 12 Ball and socket attachment for removable prostheses when the interarch space is 15-18 mm

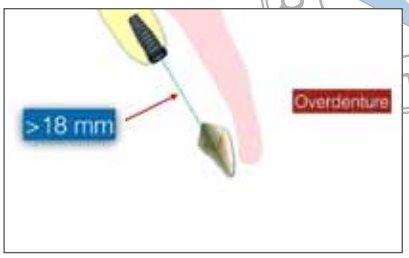

Fig 13 Restorative option of choice when available interarch space is more than 18 mm

Fig 14 *(a)* Maxillary Overdenture with milled bar framework and attachments *(b)* Maxillary Overdenture when there is interarch space more than 18 mm

Fig 15 Telescopic attachments for overdentures

interach space is too much, sufficient number of implants must be placed to derive retention, stability and support from the implants. The posterior ridge anatomy in these situations is too poor to provide any support to the overdenture. A minimum of four implants in maxilla and mandible in recommended here.

Fig 13 illustrates the available space and restorative option for this category.

Figs 14a, 14b illustrate a bar retained maxillary overdenture in situ.

Telescopic Attachments may also be used with overdentures in any of the interarch space categories (Fig 15). The lesser the space, lesser will be the height of telescopes and greater should be the parallelism between them for retention by friction fit.

DISCUSSION

The restorative materials available for rehabilitation can be broadly classified into framework materials and veneering materials (Fig 16). Prostheses framework can be made from noble metals/base metals/titanium/zirconia with titanium base or a more recent addition biocompatible high performance polymers (Bio HPP). Veneering materials may be ceramics, acrylic resin or composite resin.

When there is minimal bone resorption and an interarch space of about 10-12 mm, the space is just about adequate for a fixed prosthesis replacing the clinical crown height of the teeth. The prostheses may be screw retained or cement retained on prefabricated/custom abutments. This type of a treatment plan is best suited for patients where the extractions have been recently done and the residual ridge resorption has not advanced to a clinically significant level. Generally, no bone grafts may be necessary and the biomechanics of the prostheses is most favourable for a favourable

Key Point

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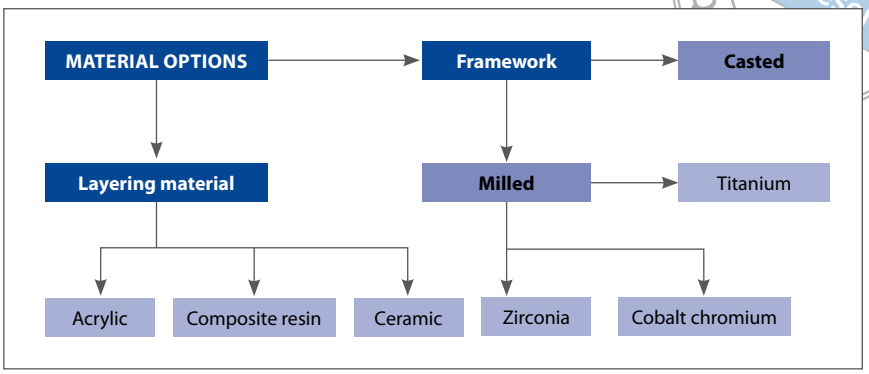

Fig 16 Restorative Material Options for Implant Prostheses

force transfer along the long axis of the implant. In such cases the use of tilted implants is discouraged as that requires much more restorative space (15 mm-18 mm). Resorting to procedures like alveoloplasty in order to gain restorative space, which is common practice must be done judiciously.

The selection of type of prostheses based on available interarch space is tabulated in Table 1.

Key Point

Noble metals are not frequently used due to high cost of fabrication

In situations where the resorption has further progressed and there is an interarch space of 12-15 mm, it would necessitate a similar prosthesis which would not only replace the clinical crown but also part of the soft tissue. Material of choice for these prostheses would be metal ceramic. The metal substructure could be a noble metal or base metal like cobalt chromium. Noble metals are not frequently used due to high cost of fabrication. Casting of large base metal frameworks is often accompanied by defects due to their high solidus temperatures which increases their contraction on cooling, lower density and lower thermal conductivity in comparison with noble metals.[13] With advances in computer aided technology and computer aided machining; it is possible to mill the base metal frameworks to achieve accurate and passive fit of the framework.[14] When the interarch space is 12-15 mm, the metal framework will be larger to maintain the overlying ceramic in a thickness of no more than 2 mm. This is necessary to minimize ceramic fracture or chipping.[15] A large metal framework increases weight of the prostheses. Milling a titanium framework would overcome this shortcoming due to its lightweight. The soft tissue can be replicated with tissue shaded ceramic for a base metal framework and tissue shaded composite for a titanium framework due to its predictable bonding.

As the resorption advances the available restorative space that has to be accounted for in the prostheses increases. Interarch space of 15-18 mm would imply considerable degree of ridge resorption. A hybrid prosthesis is indicated in these situations. Hybrid prostheses are essentially like fixed dentures without flanges and have a metal substructure that is screwed onto the implants. The denture teeth and pink acrylic tissue replacements reduce the impact force of occlusal loads. The tissue side of the hybrid denture is made convex to facilitate cleaning. Hybrid dentures have prosthodontic complications involving screws for implant/abutment and abutment/prosthesis complexes and resin structures within the prosthesis which require maintenance.[16] Also the acrylics used in these designs have the inherent problem of water sorption and plaque retention leading to peri-implant hygiene issues.

Table 1	Numerical guidelines for selection of prosthesis based on interarch space	
	Interarch distance (From implant platform/ Ridge crest to Incisal edge/Occlusal plane of opposing dentition)	**Type of prostheses**
1	10 mm - 12 mm	*Fixed Option:* a. Porcelain Fused to Metal b. Monolithic/Layered Zirconia *Removable Option* and *Hybrid Prosthesis* contraindicated
2	12 mm - 15 mm	*Fixed Option:* Same as above with the addition of Pink Ceramic to replace lost soft tissues *Removable Option:* Overdenture with Locator or Telescopes Bar Supported Overdenture is contraindicated
3	15 mm - 18 mm	*Fixed Option:* • Hybrid Prostheses (Metal Framework with Acrylic Resin) • Hybrid Prostheses (Bio-HPP Framework with Composite resin Teeth) • Combination Bridge (Screw Retained Milled Framework with Small Units of cement Retained Bridges/ Crowns) *Removable Option:* Overdenture with Ball abutments or Locator or Telescopes Low profile milled Bar Supported Overdenture
4	>18 mm	*Fixed Option* Contraindicated *Removable Option:* Overdenture supported/retained by Milled or Casted Bar attachments or Telescopes.

A more esthetic and long lasting alternative would be the combination bridge, which has a milled titanium bar framework with abutment like struts screwed on to the implants with individual crowns cemented on to the framework. If an individual crown fails because of chipping of veneering porcelain, that crown can be easily removed and replaced without having to remove the whole prostheses. If the composite simulating the soft tissue fails, it can be repaired intraorally without removing the prosthesis. The selection between the two would be based on the condition of the opposing arch, patient's desires and economics. The occlusion must be adjusted to have uniform contacts of equal intensity on both sides. The added advantage of this prostheses design is that even if the screw access channels emerge from the labial aspect, they can be masked by the overlying crown that can be luted on the framework with a provisional cement. The prosthesis can be made at the implant level or at the abutment level. The manufacturing of these prostheses requires extremely precise impressions, verification jigs, accurate bite registration and a full contour trial before the milling process is commissioned.

Interarch space of more than 18 mm means there has been extensive resorption. Such clinical situations need a flange for lip support to improve esthetics. Also, the vertical and horizontal cantilever component is excessive. It is best to opt for removable dentures in such situations for favourable biomechanics and to provide lip support. In patients with limited manual dexterity; it is preferable to opt for overdentures instead of fixed hybrid dentures as this would allow the patient to clean the prosthesis extraorally.

Bone augmentation has been preferred to prosthetic replacement when rehabilitating edentulous patients using implant supported prostheses to reduce the space for the clinical crown and to improve biomechanics. Extensive augmentation procedures are not easily acceptable to patients due to the high morbidity of the procedure. Hence, in cases where grafting

Key Point

Hybrid prostheses are essentially like fixed dentures without flanges and have a metal substructure that is screwed onto the implants

is not a preferred option, as contingency planning or as a choice, we must be able to offer optimal restorative solutions to our edentulous patients. The authors suggest the use of these numerical guidelines to make a prudent choice of restorative material and design in implant prosthodontics which would aid in treatment planning before surgical implant placements. It is recommended to make a trial denture for the patient first and approve the esthetic, phonetic and vertical dimension parameters. The trial denture may then be removed from the cast on the articulator to measure the available interarch distance. It is better to choose the best prostheses in the available space rather than predetermine the prostheses design and make the patient fit into the requirements of the same.

Implant prosthodontics involves decision making on type of prostheses and materials during treatment planning prior to implant placement. The use of the available interarch distance is a reliable clinical guideline to choose the type of restorative material and design based on the minimum space these require. Using this guideline and co-relating it with the lip dynamics and patients' requirements can lead to a treatment plan that is not only esthetically acceptable but also functionally viable in the long term. It will also save the clinician from facing a tough clinical scenario where the implants have been placed only to find that there is not enough or too much restorative space available for the type of prostheses that has been promised to the patient. The clinician can now use these guidelines as a ready reckoner for treatment planning in implant dentistry. In case newer designs or materials get introduced in the future, they can be conveniently placed in any of the above categories based on how much interarch space they require.

Key Point

Bone augmentation has been preferred to prosthetic replacement when rehabilitating edentulous patients using implant supported prostheses to reduce the space for the clinical crown and to improve biomechanics

Acknowledgements

The authors acknowledge Adaro Dental Laboratory and Katara Dental Laboratory for their laboratory support.

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