Abutment Options for the Restoration of the Malaligned Implants: A Review

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It is rightly said, “implant dentistry is a prosthodontic discipline that happens to have a surgical component.” Even though the most recommended concept is restoration driven implant placement, the anatomical features of the bone may not allow for the ideal placement of the implant. One of the complications occurring during the implant placement is malalignment or placement in less ideal positions. Various techniques have been discussed in the literature to describe the correction of this malpositioning of the implants. These methods encompass both surgical and prosthodontic aspects. Where in surgical methods are more of invasive for an osseointegrated implant, prosthodontic methods offer better results with less complicated procedures with the use of customized or angulated abutments. This review gives an insight into the various options of abutment available for the restoration of the angulated implants.

Keywords: Angled abutment, Angled implant, Custom abutment, Malaligned implant

INTRODUCTION

Implantology is a branch which encompasses both surgical as well as prosthodontic disciplines of dentistry. Hence, prosthetic rehabilitation is no less important as compared to the surgical placement of implants. However, an implant prosthetic reconstruction does not offer miracles; complications, and failures are possible. The mere knowledge of the technique of implant treatment is not sufficient to eliminate all problems. The dentist has to be able to analyze a given clinical situation and evaluate its complexity. To eliminate complications, most recommended concept of implant positioning is the restoration driven implant placement according to prosthetic and esthetic demands. However, several anatomic constraints make it necessary to surgically position implants at angles that are not optimal for prosthetic restorations such as the width, height, and angle of the residual bony ridge, presence of bony undercuts, the inclination of the bone in the anterior maxillae, the shape of the arch, and maxillomandibular arch relationships. The position of the mandibular canal and ridge proximity to the paranasal sinuses are additional factors that may influence implant alignment. These conditions can be clinically managed by various surgical approaches such as horizontal and vertical bone augmentation, sinus elevation, and nerve repositioning. When overlooked, these conditions can lead to unfavorable implant placement and associated complications include off-axis loading. The angled load increases the amount of crestal bone stresses around the implant body, transforms a greater percentage of the force to tensile and shear force, and reduces bone strength in compression and tension leading in interface breakdown, bone resorption, prosthetic screw loosening, and restoration fracture. Complications may occur at any stage between implant placement and fabrication of the prosthetic restoration and can also be a result of a local deficiency of bone volume or quality. As a consequence, there is an inherent risk of placing the implant with too great buccal, labial, or lingual inclination. The treatment options for correcting severe implant malalignment usually include removal of the implant, transformation of the implant into a “sleeper,” submerging the failed implant and placement of other implants supporting the prosthesis. In cases where in the implant has osseointegrated and is anticipated to function optimally and unfavorable inclination is the only problem the use of angulated abutments or custom abutments can often improve the prosthetic results of implant restoration.

The objective of this article is to present the various prosthetic treatment options available to restore the function and esthetics of the malaligned osseointegrated implants.

The abutment attaches the crown to implant and prevent rotation between the components. There are different types of abutments are available to allow for variations in factors...
such as implant position, angulations, depth, and soft tissue contours. The abutment needs to resist the conventional compressive, tensile, and rotational forces, as it will not be joined to other implants or teeth. The abutment may consist of one, two, or three constituents either separate or unified. It consists of a base (fits into the anterotational component of the implant), head (protrudes permucosally and serves as the prosthetic retainer), and retaining screw (affixes them to the implant).\textsuperscript{17} The various implant abutment options available are prefabricated abutments (standard, straight, preparable, and angled abutments) and custom made abutments (fully customized and customizing the prefabricated abutments).

**CRITERIA FOR ABUTMENT SELECTION**

The selection of abutment depends on the implant angulation, soft tissue contours, esthetics, and the need for anti rotation locking, hygienic access, and retrievability for maintenance.\textsuperscript{18} The prefabricated abutments can be individually selected and modified in accordance with the desired contour of the restoration and its individual modification. Silicone keys made from the diagnostic wax-up can be used to select an abutment that needs the least modification to fabricate implant restorations with a better emergence profile and distribution of the load.\textsuperscript{19} For optimal esthetics and function adequate interocclusal space and sufficient soft tissue thickness above implant must be present.\textsuperscript{20}

**PREFABRICATED ABUTMENTS**

*Standard Abutments*

These are pre-made abutments normally made of titanium and supplied by the manufacturer in two pieces; abutment, and abutment screw. CeraOne, ST abutment, Abutment MH6/A0 (A15), and solid abutment are some of the examples of standard abutments.\textsuperscript{9}

*CeraOne abutments*

CeraOne abutment was introduced by Noble Biocare in 1991.\textsuperscript{21} It is the most frequently used abutment for single tooth restorations.\textsuperscript{21} It is machined in five different shoulder heights (1-5 mm) depending on the distance between the buccal and gingival margin and the implant head to allow subgingival margin placement. The abutment can be placed either during the surgical procedure or following soft tissue healing. The gold abutment screw must be tightened using the torque control set at 32 Ncm. Clinicians have found that these abutments yield nice esthetic results and have safe, fast, and easy handling.\textsuperscript{19} The available machined prosthetic components have more precise and constant marginal fit than those obtained by traditional prosthetic casting, as a machine fit is present between the external hex of the implant and the internal hex of the abutment, and between the external aspect of the abutment and the internal aspect of the provided ceramic or gold coping.\textsuperscript{20} They are simple to use, reduced chairside and laboratory time, predictable fit and retention for crown, can be used in straightforward cases where optimal space and implant orientation have been achieved. These cylindrical titanium abutments can be modified into an anatomically shaped titanium ceramic transmucosal element.\textsuperscript{22} The disadvantages are that the margin of the crown does not follow the gingival contour, cannot be customized for implant orientation or anatomical features, particularly not suited to very labially inclined implants.\textsuperscript{23}

**Straight Abutments**

They can be used only when the emergence profiles are or can be made parallel. Straight abutments if not parallel to each other can be prepared to proper contours by either of the two methods - Direct preparation in the mouth or implant transfer impression followed by bench preparation of abutments.\textsuperscript{17}

*PDQ abutment*

It is a prefabricated 1-piece abutment-crown system, which does not require the waxing and casting process. The PDQ abutment (Impac, Vident, Brea, Calif.) is bulb-shaped with a hexed-fitted surface and is made from a metal-ceramic alloy that is custom contoured by grinding to support a porcelain veneer. The porcelain is then fired to the contoured abutment to develop the 1-piece artificial crown. It is proposed that the PDQ system is less time-consuming for the dental laboratory technician and is likely to reduce laboratory costs, even then it is not well suited for malaligned implants because of the large and unfavourable location of the screw access opening.\textsuperscript{24} They facilitate reshaping of the abutment to develop support for the porcelain veneer not more than 2 mm thick. The disadvantages are that it is not well suited for misaligned implants because of the unfavorable location of the screw-access opening and inadequate support for the porcelain veneer, also may be unsuited for extremely small teeth such as maxillary lateral incisors and mandibular incisors because of the relatively large screw-access opening.\textsuperscript{24}

*Angled Abutments*

Angulated abutments were developed to restore the implants placed with pronounced facial angulation to avoid unesthetic facial screw-access holes while maintaining the retrievability of the prosthesis by screw retention.\textsuperscript{25} They are available in angulations from 10 to 30\textdegree,\textsuperscript{17} 15 to 35\textdegree.\textsuperscript{23} Most of the manufactured abutments are available in two-piece design which permits the seating of abutments on the implants and tightened using cover screw. Three
piece abutments are also available with separate bases which engage the antirotational component allowing six possible angulations. These angled abutments can be further modified either chairside or in the laboratory to meet the specific specific requirements of the individual case.17

The use of angled abutments is limited by the angulations available, large and bulbous collars, and the required vertical height of the restoration. These abutments allow for the correction of angulation discrepancies in a range of 15-30° from the vertical axis of the implant.21 A procedure to reposition the facial margin of the angulated abutments to avoid unesthetic display of metal in the anterior maxilla has been described.22 When angled abutments are used, it is necessary for the laboratory to provide an acrylic positioning jig to allow the clinician to correctly orient the abutments.23 The numerous advantages to the use of angled abutments are that when an improper jaw relation exists because of alveolar resorption or skeletal discrepancy, angulated abutments may compensate for buccolingual and mesiodistal implant angulation problems. In patients with compromised osseous anatomy, the implants may be placed in the most favorable positions in relation to the quantity and quality of available bone and angled abutments may be used to improve the engineering and mechanics of the prosthesis by correcting spatial relationships.2

Astra tech dental implant system
The new angled abutment this system provides esthetic solutions for screw-retained prosthetics in situations where fixtures are placed in buccally inclined positions. This consists of an abutment and an abutment screw and is manufactured from Grade-4 commercially pure titanium, Grade 4. It has an angle of 20° from the axial direction of the fixture and a low shoulder design for high esthetics, and the abutment can be rotated 360°.

Custom Abutments
The custom abutments can be fabricated using “add-to” abutments which are pre-machined or standard abutments to which gold or porcelain is added, preparable abutments which are manufactured in bulk material such as porcelain or titanium and which is modified to meet the specific needs, computer assisted design and computer assisted manufacturing (CAD-CAM) abutments, and copy milling technology.26

CUSTOMISING OR MODIFYING THE PREFABRICATED ABUTMENTS

The important advantages that the individually modified prefabricated abutments offer in the long-term clinical success of a restoration are the creation of a better emergence profile, modification of the abutment to match the contour of the restoration rather than designing the restoration to match the shape of the abutment, better distribution of stress and load, potential for better oral hygiene and creation of supragingival or subgingival margins in different cervical areas.

“ADD-TO” Abutments
These are the standard abutments to which gold or porcelain is added. The CeraOne abutment is modified with titanium ceramics. The ceramic modification is made to the anatomic contours of the transitional tissue on the cast. CeraOne gold coping is seated onto the modified abutment, and it is adjusted to allow for adequate space for a metal ceramic crown. The advantages of modified abutment are that it allows for the correction of implant angulation and gingival esthetics in thin tissue with porcelain blocking out the metallic collar of the titanium. The disadvantage is the questionable strength of the porcelain and the porcelain to titanium bond.22

Preparable Abutments
These abutments can be customized to achieve an “ideal” preparation contour and can be modified to resemble more accurately the cross-sectional shape of a natural tooth. These abutments should be prepared out of the mouth using high-speed instrumentation either chairside in the dental office or the laboratory by the dental technician, only if necessary small changes can be made intraorally using air-rotor under copious irrigation. The abutments come in a variety of diameters roughly corresponding to the dimensions of the teeth such as 4-4.5 mm (Upper lateral and lower incisors), 5.5 mm (upper central incisors, canines, premolars) and 6.5-7 mm (molars). Some of the preparable abutments for single tooth restorations are TiAdapt, CerAdapt, Profile B1 abutment, Abutment MH6/A0, CeraBase.

CerAdapt Abutment
The CerAdapt abutment introduced, in 1991, is the first all-ceramic alumina implant abutment by Nobel Biocare.27 It is an esthetic abutment and has light diffusion properties. The CerAdapt abutment is prepared as a core which is scanned and an AllCeram crown is fabricated according to the Procera technique and cemented over the core abutment which is scanned and AllCeram crown is fabricated according to the Procera technique. Both screw-retained and cement-retained prosthesis can be fabricated over this abutment. When direct retrievability is desired and the access channel has a favorable direction, one piece screw-retained crown is fabricated and when the screw-access channel is not desirable or somewhat malaligned a cemented crown is used. The advantage of this abutment is that it allows a better emergence profile because of its wider cervical portion and it also enables the differentiation in the gingival finish line of the preparation unlike in CeraOne.
where the gingival shoulder is pre-established at a single level. It is indicated in special situations like correction of slight changes in implant positioning and when translucent, thin gingiva is present and custom contouring of the margin in a shallow sulcus is required. The use of CerAdapt abutment should be avoided in patients demonstrating excessive chewing and biting forces, bruxism, or in case of significant angulation changes due to the limited strength of the material.

**TiAdapt Abutment**

TiAdapt abutments are often altered to coincide with the shape, contour, and position of the adjacent and antagonist teeth and the peri-implant tissues. They are marketed in several shapes, angulations, and diameter, with various cervical finish lines and different shoulder heights. The advantages of using the TiAdapt abutment are the simplified prosthetic procedures similar to standard and traditional methods of crown and bridge fabrication.

**FULLY CUSTOMISED ABUTMENTS**

They can be produced with even more allowances for compromised implant placement as compared to the preparable abutment. The trend toward impressing the implant and reproducing it in the laboratory rather than using a registration of a prefabricated, stock abutment placed on top of the implant has greatly increased the flexibility of implant prosthodontics and created a new standard for esthetic implant restoration.

**Universal Clearance Limited Abutment (UCLA)**

One of the most important innovations in custom implant abutment design was the UCLA abutment created by Lewis et al. The UCLA abutment provides an excellent option for customizing the restoration of implants with an external hexagon connection. The abutment and restorative coping are incorporated into one unit, reducing the number of interfaces and components in the restored implant pillar. The UCLA abutment allows the fabrication of custom abutments for use in difficult situations when there is limited interocclusal space, or when implant angulation is less than ideal and especially when the screw-access channel emerges through the facial surface. The practice of implant-level impression making can be traced directly to the UCLA abutment concept, from which a number of abutment options have evolved.

**Cast Abutments**

*AurAdapt abutment*

This abutment is fabricated of gold alloy which is used as a base and a wax-up is made over it and cast. To increase the resistance form, one long distal wall was designed on the left abutment and a near parallel wall extension with a dovetail was designed on the distal aspect of right abutment and the wax patterns were cast in noble alloy. A definite Ceramo-metal restoration with a good access for proper oral hygiene was given after a period of 3-month after provisional restoration delivery. The disadvantage is that gold is brought down to the implant level, thus interfering with the soft and hard tissue resulting in soft tissue recession and subsequent bone resorption.

**CAD/CAM Abutments**

**PROCERA system**

In 1998, Nobel Pharma developed the Procera system based on CAD/CAM technology for industrial production of titanium, alumina, or zirconia abutment. The abutments are designed by the Procera Network using the CAD or a special wax-up technique. The data are then sent to coping manufacturing facility for machining process, the custom abutment is then sent back to the laboratory for completion of restoration. These abutments were designed to allow the use of an internal counter-torque device to protect the implant-bone interface while the abutment screw is tightened. The external surface could now be modified as required by the restorative dentist. The modified screw design makes insertion of the head of the screw drivers easier allowing the use of traditional crown and bridge techniques for the fabrication of the restoration and make it retrievable if appropriate cement is employed on a preparation with adequate taper. With this technology the gingival wall abutment preparation, follows the gingival margin as in a natural tooth.

**COPY MILLED ABUTMENTS**

A custom milled abutment can be fabricated in titanium, alumina, or zirconia using a scanner and CAM. The process of copy milling is similar to key duplication and the machine has two co-rotating elements. Using the proposed procedure, functional and esthetic restorations can be fabricated despite axial malposition of the implants. The advantages of this technique include creation of a custom made titanium root form abutment that provides the flexibility to create an ideal emergence profile and an esthetic restoration which has a precise fit to the implant.

The limitation of this technique is that sufficient thickness of the gingival tissues is essential to mask the reflection of the metal. In contrast to the conventional procedure, a simplified technique was proposed where a resin duplicate of the provisional restoration is fabricated and scanned (Procera Forte Scanner; Nobel Biocare USA) for a custom copy-milled abutment.

A new implant restorative system using CAD/CAM technology (Encode; 3i Implant Innovations Inc., Palm Beach Gardens, FL, USA) consists of a coded healing abutment...
and a laser optical scanner interprets these codes, and a custom titanium abutment is designed and then milled. The advantages of this system are an anatomical emergence profile and the ability to correct an implant angle of up to 30° without compromising strength. The disadvantages of the technique include its limited use to a specific implant system (3i Implant Innovations, Inc.).30

CONCLUSION

In the midst of the various options available to prosthetically restore, the malpositioned implants with use of different abutments, there is no single ideal solution. The decision for the selection of the type of the abutment for a specific case in an individual with malpositioned implants lies solely on practitioner based on his assessment of case in terms of the severity of the angulations, esthetic requirements, and axial load distribution. The most favorable option can be chosen for the prosthodontic management of the osseointegrated implants and invasive surgical procedures could be avoided with knowledge of the available options of abutments.

REFERENCES