ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 2, Issue – 6, November - December - 2019, Page No. : 465 - 470

Prosthetic Design Considerations for Single Implant Restoration in the Aesthetic Zone: An overview

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Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Placement of a dental implant following extraction of a single tooth in the aesthetic zone is a frequent and clinically demanding indication of implant therapy. The anterior single implant restoration provides a predictable solution for the partially edentulous patient. The two main approaches in the prosthetic design for the single implant restoration are the screw-retained and cement-retained restorations. Although both approaches have been proven to work from a standpoint of long-term implant stability, other considerations arise when aesthetic outcome, ease of fabrication and delivery are discussed. To guarantee a predictable outcome, the operator should choose a design that offers maximum prosthetic versatility. Combining prosthetic versatility with ease of delivery is often a clinical and laboratory challenge. Prosthesis designs that provide the freedom to select a wide variety of restorative materials may be cumbersome to deliver along with maintenance and vice-versa. This article narrates the advantages and shortcomings of each design along with a combination of the favourable aspects of these two restorations. It enables the clinician to achieve optimal aesthetics in the aesthetic zone combined with a simple and time efficient delivery.

Keywords: Implant, Aesthetic zone, Screw retained, Cement retained, Design concepts

Introduction

Restoration of missing anterior teeth with dental implants is a routine and well documented procedure. The ability to achieve an indistinguishable restoration is the primary goal in the replacement of such a tooth. Achieving this goal on the prosthetic aspect essentially includes ease of delivery along with a balance between simple design and clinical management. This requirement may seem uncomplicated, but contemporary designs and ease of clinical managements are hard to combine. The following article provides an overview of possible designs for the maxillary anterior implant-supported restoration for systems that include an implant-abutment complex and it presents an alternative design for such a restoration.

Clinical Considerations

For a dental implant to be surgically placed and successfully integrated, the concept of letting the restoration to be the guide for surgical placement has gained immediate acceptance. Three factors must be considered in determining the implant position: 1) buccolingual and mesiodistal position of the implant platform, 2) angulation of the implant body, and 3) apical position of the implant head, also known as countersinking. None of these three factors involve just routine positioning. Other factors such as the surgical site and the type of prosthetic design also affect the decision of where to place the actual implant. In general,

contemporary approaches view the bony site as an extension of the desired restoration. Thus, in cases of hard and soft tissue deficiencies, the implant placement should not be compromised. This is the essence of 'site development' concept.

Bucco-lingual and Mesio-distal position of the Fixture head:

To simplify restorative procedures, the ideal bucco-lingual and mesio-distal position of the implant platform is at the root area of the tooth it replaces. The centre is measured at the level at which the implant head is positioned, that is , if the implant platform is placed in an apical position that is 3mm apical to the cemento-enamel junction of the tooth it is replacing, the proper buccolingual-mesiodistal position is at the centre of the tooth root at this level. In the past, hard and soft tissue deficiencies at the labial aspect resulted in implant placement that was lingual to the ideal aforementioned position.

Currently, labial deficiencies can be corrected surgically with high success rates and should not be a reason for lingual positioning of the platform. The only reason for placing the platform slightly to the lingual aspect is consideration of the clinician's method of choice for a screw retained prosthesis. However, one has to be careful positioning the implant lingually. Placing the implant too far to the lingual aspect will result in a restoration that has an abrupt buccal emergence profile, which does not facilitate maintaining a proper oral hygiene. The amount of lingual displacement of the implant head in comparison to the ideal position is primarily dependent on the diameter of the access hole required for the abutment screw. The bigger the screw access hole, the more lingually the implant is positioned.

Implant Angulation

It can be described as the imaginary line through which the screw access traverses the crown. Even when this angle is corrected with an angled abutment, this line still traverses the crown at the original angulation. An implant positioned at the optimal bucco-lingual and mesio-distal position has an angulation in which the screw traverses the restoration at the incisal edge. This angulation is optimal because the screw is in the centre of the restoration in all dimensions, which enables the fabrication of a restoration with a gradual transition contour (also referred to as emergence profile) in all dimensions and that is easy to clean and maintain. Clinical considerations, such as the presence of a thin buccal cortical plate, may result in an implant that is angulated so that the screw traverses the restoration buccally to the incisal edge. Various manufacturers have designed implant abutments that can compensate a considerable amount of angulation without the need for custom - fabricated abutments.

Implant Countersinking

The apical positioning of the implant platform below the soft tissue is performed to make the implant abutment attachment invisible. The amount of this countersinking is primarily dependant on the width of the implant platform and the buccolingual-mesiodistal width of the restoration. The implant is countersunk to provide enough length to form a gradual emergence profile from the implant platform to the height of contour of the restoration. Theoretically, the wider the implant, the less it has to be countersunk. However, there is a limit to the implant width that a buccal cortical plate at a given site can accommodate. Even if there is room for a very wide implant, the superficial placement of this wide platform may result in an optical reflection, a "show through" of the implant through the thin bony plate. Once created, such an aesthetic deficiency cannot be corrected. Clinical reports seem to indicate that the recommended amount of countersinking of implants replacing maxillary incisors is around 2-4mm. For maxillary central incisors, 2mm to

4mm of countersinking have been suggested for an implant with an average platform diameter of about 4mm, and also for a narrower implant platform diameter for restoring maxillary lateral incisors.

Prosthesis Design Concepts

Single implant restorations can be screw or cement retained. Both were introduced in the late 1980s and early 1990s, both are acceptable and both are having unique advantages and disadvantages.

Screw-retained restoration

Lewis and colleagues enabled dentists to restore the partially edentulous patient with dental implants in a simplified manner with the UCLA abutment. This abutment consisted of a castable component that is attached to the implant platform, either not engaging the anti-rotational mechanism in multiple units or engaging the anti-rotational mechanism on the implant platform in a single implant restoration. This novel approach for restoring the partially edentulous patients one of the building blocks of single- implant restorations. This prosthesis design was advocated for both anterior and posterior implants, but when it is used for anterior implants, it requires an implant angulation that facilitates access to the screw; thus, the implant platform is positioned lingually to the ideal position. The UCLA abutment concept was also innovative in that it enabled the restorative team to overcome unfavourable implant angulation. It was later extended into cemented and/or segmented designs. Screw-retained restorations allow the clinician to retrieve the restoration, if needed, in a simple manner. However, the real advantage of the screw retained restoration is the simple clinical management of the restoration in the delivery appointment. Since the screw-retained restoration is one piece prosthesis, it is simply placed and screwed in.

Despite the aforementioned advantages, this design has some shortcomings. The principal disadvantage is its lack of versatility in design. In most situations, the restoration is a one-piece porcelain-fused-to-metal restoration. Initially, the metal framework is waxed and then cast in any suitable alloy, next porcelain is fused to this abutment. It may be noted that some ceramic abutments can be used as a foundation to which porcelain is added to form an all-ceramic screw retained restoration. But their availability is even limited for a few implant categories. There are potential drawbacks to the use of a gold alloy based abutment. First, although an acceptable clinical fit with a cast component is an attainable goal, this fit is inferior to machined components. Even if the cast component has a pre-fabricated gold alloy base, the risk for damage due to improper waxing, poor investing, poor casting and poor divesting makes this option secondary to machined components. Second, the potential for an unfavourable mucosal attachment to the gold alloy exists. Thus, although an all-plastic component is very affordable, it should be used only if the following component is not available. Most manufacturers offer a plastic abutment with a gold-alloy base. In comparison to the cast mating surfaces of the plastic abutment, the gold alloy base offers a precise machined fit. The use of such an abutment is a much safer choice and justifies the cost-difference between the two. However, even the pre-machined gold alloy base is not better than completely machined components. Third, there is a potential for a lack of proper mucosal attachment in comparison to titanium-based and ceramic-based abutments.

Although these concerns have not been verified in a human clinical study, one should certainly consider them when selecting an abutment material. In summary, the advantages that the screw-retained restoration offers are ease of delivery and retrievability. These advantages are

offset by the lack of prosthetic versatility in design, the manual labour and precision required to fabricate the abutment, coupled with the potential for poor mucosal attachment.

Cement - retained restoration

The cement- retained restoration is a two-piece prosthesis, an abutment and a crown; the angulation of the implant is such that the long axis of the implant is directed at the proposed incisal edge of the restoration. The biggest advantage that the two-piece abutment-crown design offers is clinical versatility. One can select from a variety of abutment and crown materials and mix and match between them to achieve a combination of proven biocompatibility of titanium or ceramic abutment and any crown material that will be suitable to the specific case. This is a big contrast to the screw retained restoration, which offers the same combination regardless of the case specifications. The other advantage is that the implant can be positioned ideally without concern for a screw access helping in creation of desired emergence profile.

There are however few concerns that are related to this design. If the clinician uses a provisional cement, it can wash out and the crown can loosen. In some situations, even loss of the crown has been reported. Re-cementation of such a restoration is not necessarily a simple task. Within a few minutes of the crown's loosening and its subsequent dislodgement, the peri- implant tissue collapses around the abutment making re-cementation a time consuming procedure. A possible solution can be use of a permanent cement, after properly torquing the screw. The downside is that if the abutment screw comes loose after permanent cementation, a complete remake of the restoration is required. However, it is the operators' opinion that the biggest challenge with a cemented restoration is the complexity in clinical delivery and/or re-cementation. The desired countersinking of the implant platform is about 2-4mm at the mid-buccal area. Because of the scallop of the gingival tissues, this countersinking can be about 5-7mm from the tip of the papilla to the implant platform at the interproximal area of an anterior tooth.

Unless the abutment margins closely follow the scallop of the gingiva, maintaining a clean working field during cementation and cleaning off the excess cement can be extremely challenging. Use of CAD-CAM custom-designed titanium abutment (Procera, Nobel Biocare USA, Inc, Atlantis Components, Inc,Cambridge, MA) or custom designed CAD-CAM ceramic abutment (Procera) overcomes this challenge since such an abutment can be designed to precisely follow the gingival scallop. Such abutments should be considered as treatment options in patients with highly scalloped tissues. To wrap up, the greatest advantage of the cement retained restoration, using a titanium or ceramic abutment is prosthetic versatility and proven biocompatibility of the abutment. Although clinical management of the restoration at delivery and dislodgement of the crown are the biggest challenges.

Discussion

Implant supported restorations are well-established treatment option, to replace the missing teeth. With the advancement of implant surfaces and designs, prosthetic components, clinical techniques, and dental materials, successful, functional and stable treatment can be achieved. Selection of type of connection between the final prosthesis and implant is a criterion of significant importance. Screw-retained implant restorations have advantage of predictable retrievability enabling ease of hygiene maintenance, repairs or any required surgical interventions, and require a minimal inter-occlusal space. These restorations require precise, prosthetically driven placement of the implant due to the position of the screw

access hole. The manufacturing is more technique sensitive and demanding when compared to cement-retained prosthesis. Cement-retained restorations are more cost efficient, capable of compensating for implant position discrepancies, passivity of fit, improved esthetics and easier control of occlusion. However, a major problem of cement retention is excess cement, which creates an anaerobic niche for undisturbed growth of a bio-film and plays a significant role in the development of infections and progressive bone loss. Various reviews on advantages and disadvantages of the two connection systems reveal conflicting information. However, review done by Weber and Sukotjo on effect of choice of connection between prosthesis and implant, on implant and prosthesis survival, found no statistically significant differences between screw and cement-retained prosthesis. Various animal and in vitro studies have focused on technical and biological complications in screw and cement-retained prostheses. These include a porcelain veneer fracture, screw loosening, loss of retention, peri-implantitis and bone loss being the most prevalent complications. A systemic review by Sailer et al. on survival and complication rates of screw and cement-retained restorations reported no statistically significant difference for the restoration survival. However, cement-retained restorations exhibited higher rates of biological complications with an increased incidence of bone loss and peri-implantitis. Based on their improved retrievability, the screw-retained prostheses were given preference, although they did exhibit more technical complications.

Summary and Conclusion

Retention system that is more functional and stable in the successful management of future failures and complications should be selected based on individual patient situation since both screw- and cement-retained have their advantages and disadvantages. Increased implant predictability, patient demand for high esthetic outcomes and lower cost recommend use of cement-retained restorations for implant-supported single crowns. Due to increased technical and prosthetic complications associated with screw-retained prosthesis, cement retained restorations are preferred in patients with para-functional habits. For multiple unit implant supported restorations, and in patients with limited interarch space, screw retained restorations are more acceptable.

Disclosure: The author has no financial interest in any of the companies whose products are mentioned in the article.

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