Selection of luting agent in implant retained prosthesis: A review

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Abstract

Implant dentistry is the branch of dentistry gaining popularity among dentist as well as in patient, which provide a clinical solution in cases of distal extention edentulousness, where conventional approaches fails to provide fixed treatment. Furthermore it is more conservative in terms of conventional FPD where tooth prepration is mandatory. Long-term predictability of implant restoration are well established, however agreement to prefer between screw-retained and cement retained restorations is always a topic of debate, which depends upon passivity of the framework, interarch space, occlusion, esthetics and loading characteristics. While cement retained restoration are better than screw in aspect of margin adaptation, occlusion, esthetics, passivity and cost reduction. But the major concern for the cement retained implant restoration is difficulty of retrievability, so it is very important to decide which type of cement should be used with different implant abutment characteristics such as abutment height, occlusal force, abutment surface characteristics and type of cement. Achieving a harmonious balance between mentioned factors can help us to achieve a cement retained prosthesis which can be retrieved without compromising survivability of the prosthesis.

Keywords: Implant Cements, retrievability

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Introduction

Implants have diversified the treatment options for edentulousness in the present era of dentistry. They have evolved as a better treatment modality in comparison with conventional approaches. Long-term predictability of implant restoration are well established. Agreement to prefer between screw-retained and cement retained restorations is always a topic of debate[1,2,3], which depends upon passivity of the framework, interarch space, occlusion, aesthetics and loading characteristics. While cement retained restoration are better than screw in aspect of margin adaptation, occlusion, aesthetics, passivity and cost reduction.[4,5] But the major concern for the cement retained implant restoration is difficulty in retrievability and excess cement.[4-11] According to the systematic review, none of the method is advantageous over other methods. Cement retained restoration have biologic complication whereas Screw retained restoration have more technical complication but according to most of the authors, Screw retained prosthesis is preferred because of ease in retrievability and higher biological compatibility[12]. The aim of this review is to attain a harmonious balance between the above mentioned factors, which in turn will help us to achieve a cement retained prosthesis, which can be retrieved without compromising survivability of the prosthesis.

Abutment factors

Two types of abutments that can be used with cement-retained restorations for implants are: (1) solid abutment, and (2) two piece abutments with a screw access chamber within them. There are many factors that can modify the amount of retention that can be achieved when luting a restoration to either an abutment or a natural tooth.[13]

1. **Abutment height:** Abutment height can significantly influence retention of implant-supported crowns.[14] Increase in height is not uniformly proportional with increase in retentive force. For instance, in any converging cylinder, with each successive millimetre of height the diameter becomes smaller and there is a reduction in area and hence reduced retention. In order to resist lateral forces, a wider diameter implant abutment requires a greater height than a smaller diameter implant abutment.[15] Also, using greater abutment height with narrow or wide platform implants positively influence the retention and minimum height required for adequate retention is 3mm.[16-17]
2. **Abutment width:** There is a linear increase in retention as the abutment increases in diameter. In a abutment having convergent walls, area near the gingival margin aids in greater retention. Width of the implant is more important factor than the height of abutment because of increase in surface area provided in comparison to increase in height.
3. **Abutment taper:** The critical nature of the convergence function is apparent. As the

convergence increases the available surface area decreases hence retention also decreases.[18-19] Ideal taper to provide optimal retention and reduced failure rates, as proved by Jorgensen,[20] is 6° for a prepared natural tooth, which would by all means be an ideal taper for an implant abutment as well.

4. **Abutment surface characteristics:** Surface roughness increases the retention due to setting up off micro retentive ridges and groove patterns. Airborne particle abrasion, roughening with a diamond rotary cutting instrument are frequently used method for modification of abutment surface. However, Airborne-particle abrasion with 50 µm of alumina can be more effective method to enhance retention.[21] Diamond burs and carbide burs both can be used however abutment modification with carbide burs provide better retentiveness.[22] Axial wall modification in which one of the wall has been removed while preserving the opening of screw access channel also increases the retention.[23] Tan KM el al[24] concluded that abutment with unprepared walls with totally blocked screw access opening have least retention when compared with 3 walls, 2 adjacent walls, 2 opposing walls, and 1 wall, and he said that both remaining number of axial wall and position of axial wall is a determining factor for retention of cement retained crown.

Retrievability

The main disadvantage of cement retained implant prosthesis over screw retained implant prosthesis is retrievability which may cause damage to the fixture as well as the prosthesis. Various authors report different methods for retrieving cement retained implant prostheses to ensure minimal distortion of the prosthesis such as, Using an abutment screw access guide (template).[25-26] However preparation of screw access hole doesn't compromise the retention of cement retained crown when access hole was filled with composite resin.[27] Another technique is Lingual retrieval slot mechanism, in this technique a lingual slot is prepared over castable screw retained abutment of 1mm axial depth and 3 mm mesiodistal width, and implant driver is engaged into the slot to retrieve the crown.[28] Further technique is, marking the angulation and screw access opening with ceramic stain on the occlusal surface of the restoration to locate the abutment screw.[29] In another method Cylindrical guiding hole is made on the lingual surface of the abutment and an access hole on the lingual side of the super-structure. For retrieval, the driver is inserted into the access hole and is turned, causing development of shear force which in turn debond the crown from the abutment.[30] CAD-CAM technology is used to determine the angulation and screw access opening through scanning.[31] Customizing retrieval slots in the abutment is also devised for crown retrieval, in this technique while preparing wax pattern for cement retained customized abutment, horizontal slot is fabricated on the mid-marginal position of the lingual surface and retrievability is achieved by rotating the driver.[32]

Excess cement

Excess cement is another major issue of cement retained implant prosthesis. According to American Academy of Periodontology excess cement is one of the risk factor for periimplantitis and peri implant mucositis.[33] Wilson suggested, that due to excessive cement, periimplantitis can occur ranging from 4 to 9 years after implant placement. Occasionally, it is possible, that cement remnants do not evoke any tissue response.[34] periimplantitis may lead to inflammation, bleeding on probing, suppuration and periimplant attachment loss. Foreign body reaction may also occur due to incorporation of cement in the host tissue. Cement may also cause allergic reaction due to content of hydroxyethyl methacrylate,[35] and change in abutment surface characterization due to content of fluoride which is known to etch titanium. Furthermore margin location and presence of gap between the implant abutment and superstructure complicates the situation of excess cement and lead to bacterial colonization. The amount of excess cement depends on the technique of cementation and also the type of cement, Cement viscosity, sub gingival margin placement, chemical composition of cement, diameter of implant.[36] other contributing factors include forces during placement, margin integrity, ability to remove unset cement, abutment material, texture, and shape. Visual and tactile method of locating and eliminating excess cement is clinically a challenging task.[37]

Wadhwani el al[38] concluded that zinc containing cements can be easily detected on radiographs even at 1mm thickness while glass ionomer cement and resin cement are not well demarcated at 1mm thickness and minimum 2mm of thickness is needed for their detection radiographically. Location of the excess cement is also very important to detect it radiographically, excess cement on the facial surface is very difficult to address due to overlap of metal implant component.

Several techniques were advocated by authors for detecting excess cement around implants. These methods include radiographic evaluation radio density of cements, dental endoscope, and flap retraction. Metal instruments such as curettes and scalers should be avoided on titanium implant abutment to remove excess cement which in turn could increase implant surface roughness and roughness is also one of the contributing factor in biofilm formation. However, according to Wilson,[39] Residual excess cement should always be checked and removed which resolve of peri-implant disease in 76% of the cases.

Amount of excess cement is directly related to quantity of cement used during cementation procedure.

Authors have described different ways to minimize it, such as application of thin layer of luting agent only on the axial wall of the restoration or application of thin layer only on the occlusal surface but none of the method have much clinical evidence on effect on implant longevity. The optimal cement volume necessary for cementation has been estimated to be 3% of the total crown volume, which fills an approximately 40 μm space.[40] Additionally, the amount of luting agent used mainly rely on clinician preference.

Herman et al.[41] describes a technique for reducing the excess cement before cementation is seating the restoration filled with cement on a practice abutment (analog abutment) extraorally. This abutment could be a stock analog or a customized analog made of poly(vinyl siloxane) (PVS). After immediate wiping of excess cement, the restoration would be placed in the mouth. Another technique is advocated by wadhwani et al[42] they used polytetrafluoroethylene (PTFE) tape on the intaglio surface of the restoration which provide space of 50 μm then VPS model of the restoration is prepared and luting agent is applied on the restoration after removing the PTFE tape and seated on the VPS die, excess cement is removed and restoration is placed in mouth. Timothy A. Hess[43] in 2014 described a technique in which PTFE tape is used but in spite of intaglio surface he used it on the abutment of which buccal mesial and distal surface have equigingival margins and lingual surface have supragingival margins and then crown is cemented intraorally and excess cement is removed and then PTFE tape is removed. Wadhwani et al[44] states that channel can act as a reservoir for excess cement if left open and not sealed off prior to cementation. It also has been proposed to create two vent holes on two opposing sides of the abutment 3 mm below the occlusal surface. Providing a venting hole on the occlusal or lingual aspect of the restoration is another way to control cement volume during cementation; however, more work is needed for creating the hole and filling it after cementation. Comparison of technique better for removal excess cement Cementation of implant restorations on a machined abutment using the practice abutment technique and definitive cement may provide similar uniaxial retention force and significantly reduced residual cement weight compared to the conventional technique of cement removal.[45]

Use of gingival retraction cord for preventing flow of excess cement in the in gingival sulcus is discouraged by most of the author due to risk of damage of peri implant periodontal attachment, as periimplant gingiva consist of parallel or oblique gingival fibers and long epithelial attachment.[46] It is also been advocated that presence of subgingival margins of 3mm or more srew-retained implant prosthesis is preferred.

Type of cement

In Cement retained implant prosthetics two types of cement can be used that is temporary or permanent. Choice of cement depends upon the loading protocol, retention required and retrievability.

Both temporary and permanent cement have their advantage and disadvantage over one another and use of a particular type of cement differs in accordance, specific with patients need. Temporary cement can be used where less retention is required, or in cases of progressive loading, with sufficient abutment height, width and taper, accuracy of fit of superstructure, and number of abutment present, or retrievability is required.[47,48] Another advantage is excess temporary cement are more easily removed. Authors suggested that temporary cementation may be more suitable for restorations supported by multiple implants. Acrylic/ urethane-based provisional cement (ImProv) and the zinc oxide eugenol-based provisional cement (Temp Bond) are commonly available and are specially made for cementation of implant restoration.[49] Other advantages are less technique sensitive, cost effective, and fractional stress relaxation, which may be a good quality for cements used for implant prostheses, because implant lacks periodontal ligament unlike natural teeth. Disadvantage of temporary cement are solublity, low retentive strength and poor radiodensity properties. Many thermocyclic study indicates that provisional cement are suitable for use to cement the superstructure in implant dentistry.[50,51] But due to significant solubility issues with temporary cement marginal gap between superstructure and abutment has been seen.

Permanent cement overcomes the major disadvantage of provisional cement that is retentiveness and have enhanced sealing ability with less chances of debonding. Resin cement have been proved to be most retentive luting cement and is ideal for definitive cementation of cement retained implant prosthesis,[52] Zinc phosphate cement also have comparable retentive strength and can also be used for the same purpose.

The utmost importance should be given while selecting the cement while keeping in mind the retrievability of the restoration and adequate retentiveness, to sustain occlusal loading as well do not harm the abutment, implant fixture and periimplant tissue. Studies have done to give rank order of retentiveness of different commercially available cement for various clinical needs.[53]

Comparative investigations on retentiveness of different cements[53].

Investigator	Evaluated cements	Test	Lowest retention	Highest retention
Schneider (1987)	Zinc phosphate, zinc silicophosphate, glass-ionomer, polycarboxylate	Tensile test in a universal test machine at a 0.5 cm/min crosshead speed using a 500 kg load cell	Polycarboxyl ate	Glass-ionomer
clayton et al (1997)	ZOE, glass-ionomer, hybrid glass-ionomer, composite resin, zinc phosphate	Tensile test in a universal test machine at a 5 mm/min crosshead speed	ZOE, and after that glass-ionomer	Zinc phosphate
Squier et al (2001)	Zinc phosphate, resin composite, glass ionomer, resin-reinforced glass ionomer, eugenol-free zinc oxide	Tensile test in a universal test machine at a 0.5 cm/min crosshead speed using a 50 kg load cell	Glass-ionomer and zinc oxide-non-eugenol	Zinc phosphate and resin-reinforced glass-ionomer
Mansour et al (2002)	Eugenol-free zinc oxide (Temp Bond NE), ZOE (IRM), zinc phosphate (Hy-Bond), RMGI (ProtecCem), polycarboxylate (Durelon), Panavia 21	Tensile test in a universal test machine at a 0.5 mm/min crosshead speed	Eugenol-free zinc oxide and ZOE, and after that zinc phosphate	Panavia 21
Akca et al 2002	3 temporary cements, polycarboxylate, glass-ionomer, zinc phosphate	2002Tensile test in a universal test machine at a 0.5 mm/sec crosshead speed with 1000 N load	Temporary cement	cements Glass-ionomer zinc phosphate cements
Maeyama et al (2005)	Eugenol-free zinc oxide, zinc phosphate, glass ionomer, resin-reinforced glass ionomer, composite resin	Tensile test in a universal test machine at a 0.5 mm/min crosshead speed	Eugenol-free zinc oxide, and after that zinc phosphate	Composite resin
Pan and Lin (2005)	Zinc phosphate cement, Advance, All-Bond 2, Panavia F, Durelon, Temp Bond, ImProv	Tensile test in a universal test machine at a 0.125 cm/min crosshead speed	Temp Bond, and after that zinc phosphate	All-Bond 2 and Panavia F
Wolfart et al (2006)	Eugenol-free zinc oxide (Freegenol), zinc phosphate (Harvard), glass ionomer (KetacCem), polycarboxylate (Durelon), self-adhesive resin (RelyX Unicem)	Tensile test in a universal test machine at a 2 mm/min crosshead speed	Eugenol-free zinc oxide, and after that zinc phosphate	Self-adhesive resin

Mehl et al (2008)	Eugenol-free zinc oxide (Freegenol), zinc phosphate (Harvard), glass ionomer (KetacCem), polycarboxylate (Durelon), self-adhesive resin (RelyX Unicem)	Tensile test with an experimental device	Zinc oxide and self-adhesive resin	Polycarboxylate
Sheets et al (2008	Zinc phosphate cement (Fosfato de Zinco), RMGI (RelyX), ZOE, eugenol-free zinc oxide (TempBond NE)	Tensile test in a universal test machine at a 0.5 mm/min crosshead speed	Eugenol-free zinc oxide	Zinc phosphate
Wahl et al (2008)	Zinc phosphate, resin composite, glass ionomer, resin-reinforced glass ionomer, eugenol-free zinc oxide	Tensile test in a universal test machine at a 0.5 mm/min crosshead speed using a 200 kgf load cell	Glass-ionomer and eugenol-free zinc oxide	Zinc phosphate and resin-reinforced glass-ionomer
Garg et al (2013)	Eugenol-free zinc oxide, resin-bonded, ZOE cement, zinc phosphate, polycarboxylate, glass-ionomer	Tensile test in a universal test machine at a 0.5 mm/min crosshead speed	Eugenol-free zinc oxide	Polycarboxylate

Conclusion

Selecting a type of implant prosthesis is still depends upon the clinicians choice, both cement retained implant prosthesis and screw retained implant prosthesis have their own advantages and disadvantages. However selecting a cement for cement retained prosthesis have evolved as a more systematic approach. Provisional luting cements have proven themselves efficient to use under implant restoration, as well as also provide ease of retrievability. On the other hand use of contemporary cements in implant restoration when added retention is needed is well established. Hence while choosing a cement for implant prosthesis clinician must always focus on various aspects such as retention required, abutment characteristics and retrievability. Additionally ways of limiting excess cement is also necessary to be in prime focus.

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