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Review Article

Dentistry Section

Minimising Excess Cement in Cement Retained Implant Prosthesis for Enhanced Clinical Outcome: A Literature Review

MOHINI SANJAY KHANDEKAR[1], SEEMA SATHE[2], SUREKHA DUBEY[3], TANVI JAISWAL[4], POOJA CHITLANGE[5]

ABSTRACT

Cement retained implant prosthesis is a fixed dental prosthesis that is retained by dental cement applied to the abutment or implant component. It is a widely employed treatment modality to rehabilitate edentulous spaces. It has several advantages such as ease of use, predictable outcomes, decreased lab costs and ability to provide a secure and aesthetically pleasing result as there is no visible access screw hole. However, the main challenge encountered with cement retained implant prosthesis is minimising excess cement around the implant crown. It is a well-documented risk factor for causing inflammation, bone loss, and peri-implant disease, which can ultimately lead to implant failure. Several techniques have been described in the literature to minimise excess cement, including abutment design modifications, cementation protocols, and the use of barriers or indexing methods. The present literature review critically evaluates the methods aimed at minimising residual cement during cementation of the implant crown. It underscores the importance of technique sensitivity, clinician training, and continued research to develop universally effective methods. Incorporating these strategies can prevent peri-implant disease and ensure long-term implant success by providing a safer alternative to traditional cementation practices.

Keywords: Abutment design modification, Edentulous patients, Implant cementation, Implant stability

INTRODUCTION

Implant prosthesis is frequently used to rehabilitate partially and completely edentulous patients. The prosthetic superstructure can be secured using two retention mechanisms-screw and cement. The process of cement retained prosthesis involves attaching a custom-made crown, bridge, or full arch restoration to a dental implant by placing it over an abutment and securing it with a specialised cement [1].

Cement retained implant prosthesis have several advantages such as passive fit, improved aesthetics, better control over occlusion, elimination of prosthetic screw loosening [2]. Moreover cement retained prostheses provide improved accessibility in the posterior areas. They are more economical, relatively simple and also exhibit inferior porcelain fracture rates when compared to screw retained [3].

The major challenges associated with cement retained prosthesis include reducing the amount of residual cement in peri-implant sulcus and achieving sufficient retention to reduce the risk of de-cementation [4,5]. The presence of residual cement in the peri-implant sulcus may lead to several complications such as soreness, bleeding on probing, initiation of local inflammatory response which may lead to peri-implant disease leading to implant failure [6,7].

Overall, cement-retained implant prostheses remain a preferred choice in many clinical settings due to their reliable outcomes, simplicity, and aesthetic potential. With ongoing improvements in materials and techniques, the success rate of this type of restoration continues to rise, making it a mainstay in modern implantology.

MATERIALS AND METHODS

Search strategy: A comprehensive search of literature in English language was conducted in electronic databases PubMed and Google Scholar to identify studies evaluating techniques to reduce excess cement in cement-retained dental implants. The following search string was used ("dental implant" OR "cement-retained implant" OR "implant-retained prosthesis") AND ("excess cement" OR "residual cement" OR "cement extrusion") AND ("minimisation" OR "reduction technique" OR "cementation method"). The initial search retrieved 85 articles. The articles published between the years 2001-2024 with full text links available were selected. Twenty articles were the total number of articles referred but the techniques for the review were from 9 relevant articles.

Chee WWL et al., (2013) conducted an in-vitro study to evaluate and compare the amount of excess cement wherein using four different methods for cementation of implant crowns [8]. In the present study ten implant abutment replicas embedded in acrylic resin blocks were used. A total of 40 implant crowns were casted and cemented onto the abutment replicas. For these two types of cements were used-zinc oxide eugenol and resin modified glass ionomer cement. Cement application was done using four different methods as discussed below:

a) Cement applied to the internal marginal area of crown only: The cement was mixed according to the manufacturer's instructions and it was applied only to the internal marginal area of the casted crown [8]. The crown was seated onto the abutment replica. The excess cement was removed mechanically and weighed.

b) Cement applied to the apical half of the crowns: In this group the cement is applied only to the apical part of the casted crowns and then they were cemented onto the abutment replicas [8]. The residual cement was removed mechanically and then quantitatively measured.

c) Cement applied to the axial walls: In this method of cement application the cement is mixed and applied to the axial walls of the crown internally excluding the occlusal surface [8]. Any excess cement was cleared off and measured.

d) Use of cementation device: Here the crown was filled with cement and then seated on putty index formed to internal configuration of restoration [8]. This thinly coats the internal surface of the crown with cement.

It was concluded from the study that the use of cementation device significantly reduced the amount of excess cement [8]. However, no correlation was found between the volume of cement used for cementation and the amount of residual cement [8].

Merits of cementation device: The amount of cement extruding sub gingivally is significantly reduced. Due to controlled distribution and less volume of cement, the cementation process is cleaner. Once the putty index is made, it can be used for multiple adjustments.

Demerits of cementation device: This method is technique sensitive as proper seating of the crown in the putty index is essential for optimum retention. It involves an extra step adding to time and complexity.

Use of Polytetrafluoroethylene (PTFE) Tape

Hess TA et al., (2014) described the use of a PTFE tape below the implant crown during the cementation process to reduce the amount of excess cement [9].

In this technique, a PTFE tape was used around the abutment before seating the implant crown such that it protects the adhesion of cement to the subgingival aspect of the Implant Crown with Asthetic Abutment Margin (ICEAM) [9]. Petroleum jelly was applied to the porcelain on the ICEAM. PTFE tape was now stretched around ICEAM from lingual to the buccal side and both the ends are twisted together. The twisted region of PTFE tape was thinned to a thickness of 0.4 to 0.7 mm such that there is minimum enlargement of the peri-implant sulcus in an accessible and desirable area. Now the ICEAM was placed and tightened according to the manufacture's instructions. Care was taken that no PTFE is present above the gingival margin. Bitewing radiograph was taken to verify the fit of the crown to the ICEAM abutment and the crown was cemented. Excess cement removed and the PTFE tape was untwisted and the mesial and distal ends were lifted incisally.

Merits: The PTFE tape prevents the adherence of dental cement to the implant abutment surface without enlarging the sulcus as it is only 50 micron thick [9].

Demerits: Improper packing of the tape into the sulcus may lead to compromised results. Another disadvantage of this technique is the need for a radiographic exposure to verify the fit of the crown.

Two Step Cementation Technique

Galván G et al., (2015), described a two-step cementation technique involving the fabrication of an acrylic replica of the custom titanium abutment [10]. In this technique, an acrylic replica of the custom titanium abutment is obtained by direct impression of abutment using polyvinyl silicone [10]. A thin layer of petroleum jelly is applied sub gingivally and the titanium abutment is fixed to the implant intra orally with definitive torque levels. The screw access hole is filled with teflon tape. The definitive restoration is then filled with the desired luting agent and seated firmly onto the acrylic resin trial abutment. The trial abutment is removed immediately from the restoration. Then the definitive restoration is seated onto the titanium abutment intraorally so that minimum amount of cement is expressed around the restoration margins.

Merits: This technique is useful in cases of deep subgingival margins. It allows minimising the excess cement while maintaining the required level of retention.

Demerits: It involves an extra lab procedure of fabricating an extraoral replica of the abutment which adds to cost and time.

G Cuff System

Deogade SC et al., (2015) recommended the use of a Gingival (G) system to minimise the amount of residual cement [11]. A G cuff is a plastic collar used to retract the gingival soft-tissue. The size of the abutment is checked on the G cuff measuring tool and accordingly the G cuff is selected from the kit. The marginal fit of crown fit is checked intraorally on the abutment. Now the crown is unscrewed and placed again with the G cuff with a 20 Ncm torque [11]. The extra part of the collar is cut with a curved scissor and an Intraoral Periapical (IOPA) is taken to verify whether the fit of the G-guff-abutment complex to the implant fixture is accurate. The luting cemented is mixed and the crown is cemented onto the abutment. The excess cement is cleaned and the G cuff part is cut with scissors and removed carefully with the help of scissors. Thus, by acting as a barrier the G cuff seals the apical part of the gingival margin and by keeping the occlusal part free allows the flow of excess cement [11].

Merits: G cuff has the ability to isolate the finish line and prevent its contamination from saliva thus improving the bond strength of the restoration [11]. It is user friendly and non-traumatic to the soft-tissues.

Demerits: A radiograph is however, required to ensure the correct fit of the G cuff which causes radiation exposure to the patient. If repeated imaging is carried out during the procedure it is of concern. It is effective for a short time period and not suitable when prolonged gingival retraction is required. Selecting the size of the G cuff is critical as too large or too small size of the cuff may cause the leakage of the excess cement leading to tissue irritation and associated complications.

Extraoral Replica

Frisch E et al., (2015) conducted a clinical study using an extraoral replica fabricated with pattern resin in a dental office specialising in implant therapy (Northen Hessia implant centre, Germany) which was reviewed by Ethics Commission of the Albert Ludwigs university, Germany [12].

An extraoral replica of the crown was fabricated using pattern resin and a model pin [12]. First the intaglio surface of the crown was coated with petroleum jelly. Then pattern resin was mixed and filled in the crown and a model pin was inserted. After the pattern resin was completely set the replica was removed. The abutment and the intaglio surface is cleaned using acetone and superheated steam. The definitive abutment was fixed to the implant and the access holes were filled with soft wax. The abutment was dried completely. Now the crown is filled with cement and the replica is attached to it. The excess cement was flushed out and now the crown is seated intraorally on the definitive abutment. A dental probe was used to remove the excess cement around the margins. A radiograph was taken for evaluation. This extraoral replica technique with the use zinc oxide eugenol cement resulted in clinically acceptable retention with decrease in the excess cement [13].

Merits: The use of extraoral replica provides an accurate template for proper seating of the restoration thus enhancing precision. It also reduces the risk of dislodgment or misalignment during seating along with preventing over cementation.

Demerits: It is technique sensitive as precise indexing of the pattern resin is required to match the abutment accurately. It involves involves an extra lab step which is time consuming and requires extra cost.

Use of Modified Copy Abutment

Rayyan MM and Makarem HA (2016) used a modified copy abutment fabricated using a hot thermoplastic material [14]. The accurate fit of the crown restoration is verified into the implant abutment. The abutment is replaced in its laboratory analogue. The intaglio surface of the crown is wet with a micro brush; the water will act as a separating medium that prevents the copy material from sticking to the crown. Now hot melt thermoplastic material heated to 70°C-80°C was injected into the crown until it is full and the material is just extruding [14]. Before the material hardens a dowel pin with a threaded tip is inserted into it to enable easy removal after hardening.

The hardened thermoplastic material is removed and compared with the abutment to ensure no voids are present and that the finish line of the abutment has been accurately duplicated in the copy

abutment. The abutment is then transferred to the patient's mouth and tightened into place; luting agent is mixed and applied to the intaglio surface of the crown and then the copy abutment is fitted into the crown and any excess cement removed. The abutment replica is removed from the crown while the cement is yet to set completely. The cement should be retained inside the crown. The crown is then cemented intraorally over the implant abutment.

After proper seating, no or very little excess cement will remain which can be easily removed with a microbrush.

Merits: There are several advantages of this technique when compared with the conventional technique of copy abutment fabrication using teflon and polyvinysiloxane. The hot melt thermoplastic material used is hydrophobic so water acts as a separating media which prevents adhesion of cement to the copy abutment. Cement space is created due to the contraction of the thermoplastic material on cooling. The thermoplastic material captures the exact shape of the abutment and offers a more accurate seat than pattern resin abutments, especially in cases of custom abutments.

Demerits: The thermoplastic material tends to distort under heat and stress; so improper handling of the material can lead to a misfit. It involves an extra procedural step.

Use of Petroleum Jelly

Romanos GE (2019) published an article in the international journal of oral maxillofacial implants describing a cementation technique which has been proven in various clinical settings, such as the Dental School at the University of Frankfurt/Germany (1993 to 2004), New York University College of Dentistry (2004 to 2007), Eastman Institute for Oral Health (2007 to 2012), and Stony Brook University School of Dental Medicine (2012 to today) in the residency programs and in the faculty practices [13].

The abutment and the peri-implant soft-tissues were thoroughly dried and isolated with cotton rolls buccally and lingually. The restoration framework was dried using an air syringe. A thin layer of cement material was applied inside the prosthesis framework using a periodontal probe or dental explorer, and then it was positioned over the abutments. The patient was asked to bite against the cotton rolls and side to side to bring the crown in exact position.100% pure petroleum jelly in liquid form (Vaseline, Unilever) was applied buccally and interproximally as soon as this stage is complete (and in occlusion). The liquid moisturiser is allowed to flow lingually beneath the framework and also in the peri-implant sulcular area.

The cement material was allowed to set for 30 to 60 seconds, and using the air-water syringe from the unit (under pressure), the excess cement was washed out from the subgingival areas. Any excess cement is checked for with a dental explorer.

Merits: It is user friendly, cost effective and no special equipment or training is required making it of universal use. It can be used for different implant designs and independently of the platform position (crestal or supracrestal) without the risk of impaction of excess cement [14].

Demerits: It is difficult to restrict the application to a thin uniform layer. Excess application may cause irritation of tissue in some patients.

Use of Cement Shield Membrane

Hass RC et al., (used a membrane of PTFE to minimise the residual cement in cement retained implant prosthesis [15].

In this technique, a cement shield membrane of PTFE was prepared such that it extended one tooth beyond implant area on each side [15]. It was stretched to a width of 75 µm so that the thickness decreases to 25 µm. The membrane was placed such that it completely covered the abutment, adjacent teeth, and surrounding soft-tissues [15]. The intaglio surface of the crown is loaded with cement and made to seat completely on the shield protected abutment. The crown and the membrane are then removed immediately with all the excess cement attached. After removing the membrane and all the excess cement from the crown with a gauze pad the crown was reseated onto the dry abutment and a radiographical evaluation was done.

Merits: By acting as a physical barrier between the soft-tissues and residual cement, it reduces the risk of peri-implantitis. It is compatible with all cements thus allowing its use in various clinical situations.

Demerits: Proper positioning of the membrane is critical as it may interfere with crown seating and also cause patient discomfort. It is a of single use which adds to consumable costs.

Crown Venting Technique

Schwedhelm ER et al., (2003) suggested a crown venting technique for the cementation of implant-retained crowns [16]. A small hole or vent is created in the crown during its fabrication process. The location of the vent can be palatal or occlusal. In an in-vitro study conducted by Wang F et al., in March 2024 consisting of two groups –vented and non vented crowns where the margin in placed 1mm below the artificial gingiva it was found that area and depth values of the excess cement in each quadrant in the vented group were significantly smaller than that in the non-vented group [17].

Merits: The vent provides an escape way for the excess cement without affecting the retention of the implant crown. It can be used for routine procedures, as it is simpler, faster, and less costly method. As the risk of entrapped air or cement is reduced, it provides a better marginal fit.

Demerits: If the vent holes are not positioned properly, it may lead to aesthetic concerns, inaccurate fit or compromise the structural integrity of the crown.

Wall Technique, Rim Technique, Increased Cement Space

Moran H and Bittner N (2024) conducted an in-vitro study minimising excess cement around implant restorations consisting of three methods to evaluate the amount of cement excess [18]. Custom titanium abutments and zirconia crowns were designed digitally and milled in the form of maxillary first molar. With n=10 three techniques wall layer technique, rim technique and increased cement space were employed to cement the crowns.

The wall technique: in this technique a temporary cement was used to cement the implant crown to the abutment [18]. The cement was mixed according to the manufacture's instructions and was applied to the intaglio surface of the crown on all the axial walls. The crown was now cemented onto the abutment. Digital photographs were taken and the distance travelled by the cement below the finish line on all aspects was measured using an image editing software. The excess cement was now removed and the same was weighed.

The Rim technique: in this technique a temporary cement was applied only to the cervical region of the intaglio surface of the digitally designed and milled zirconia crown [18]. These crowns were now cemented onto the titanium abutments. The cement displacement was measured with the help of digital photographs. The residual cement was removed mechanically and weighed.

In the third method the cement space was increased to 60 mm (in other groups it was 40 mm) [18]. the temporary cement was mixed and applied to the intaglio surface of the zirconia crowns. The distance travelled by the cement below the finish line on the mesial, distal, buccal, and lingual surfaces was measured. Excess cement was removed and weighed for each specimen.

On statistically analysing the results of a previous study, it was found that the wall technique resulted in least amount of excess cement

Year	Study	Method	Description of method	Results of the method
2013	Chee WWL et al., [8]	Four methods of cementation were used wherein the volume of cement and the area of cement application differed.	The methods included applying cement only to the marginal area of the intaglio surface of the crown, applying cement to the apical half of the crown, applying cement to axial walls of the internal surface and using a cementation device.	Least amount of excess cement was found when a cementation device was used. No statistically significant difference in excess cement was found in other groups.
2014	Hess TA et al., [9]	Polytetrafluoroethylene (PTFE) tape	A 50 micron Polytetrafluoroethylene (PTFE) tape was used before seating the crown on an ICEAM abutment which prevented the adhesion of resin cement to the peri-implant tissues.	Excess cement is prevented from adhering to the implant abutment. This technique allows complete removal of excess cement after seating the crown.
2015	Frisch E et al., [12]	Extraoral Replica technique	An extraoral replica of the implant crown was used before the final crown cementation with zinc oxide eugenol cement which resulted in decreased residual cement with acceptable retention of the implant crown.	The use of extraoral replica reduces excess cement around the implant without compromising retention.
2015	Galvan G et al., [10]	Two step cementation technique	An acrylic replica of the abutment was used for cementation to minimise the amount of excess cement intraorally.	Minimum amount of cement is extruded intraorally thus minimising its adverse biological effects.
2015	Deogade SC et al., [11]	G cuff system	A plastic collar known as G cuff was used which acts as a barrier for the cement to penetrate into the apical portion by allowing the excess cement to flow freely occlusally.	This technique controls the flow of cement around the implant abutment and thus minimises the risk of excess residual cement to be left in the subgingival sulcus.
2016	Rayyan MM and Makarem HA [14]	Use of modified copy abutment	An abutment replica of thermoplastic material was fabricated and used to decrease the excess cement.	The modified copy abutment is inexpensive
2019	Romanos GE [13]	Use of Petroleum jelly	Petroleum jelly acts as a separating media which prevents the adhesion of the cement to the soft-tissues.	Simple to use technique which reduces excess cement around implants.
2020	Haas RC and Haas SE. [15]	Cement Shield technique	A thin membrane of Polytetrafluoroethylene (PTFE) was used to shield the soft-tissues by excess cement which flows during cementation of the implant crown.	Reduces the risk of peri-implant diseases by minimising excess cement
2024	Moran H et al., [18]	Wall layer technique, rim layer technique and increased cement space	Cement was applied to the cervical region only; cement applied to the axial walls of the crown and increased cement space were used as methods to decrease the amount of excess cement.	Cement applied to the axial walls of the crown resulted in minimum excess cement while there was no effect of increased cement space on the excess residual cement.

[Table/Fig-1]: Summary of various cementation techniques used [8-15,18].

and there was no significant effect of increased cement space on the displacement of cement and amount of residual cement [18].

However, the result of the present study is in contrast to the study conducted by Chee WWL et al., (2013) which stated that there was no difference in the amount of excess cement whether the cement was applied to the axial walls of the intalglio surface of the crown or only to the internal cervical margin of the crown [8].

The difference in the results maybe due to the fact that the study by Winston et al., did not include any digital measurements in contrast to the one conducted by Moran H and Bittner N (2024) which used an image editing software to measure the distance travelled by the cement below the finish line [18]. The description of various cementation techniques have been described in [Table/Fig-1].

Apart from the method used for implant crown cementation, the isolation method used during cementation of the implant crown, type of cement used, emergence profile of the prosthesis, instruments used to remove excess cement also affect the amount of residual cement left around the implant prosthesis which further increases the risk of periimplantitis and implant failure.

Taking the methods of isolation into consideration, rubber dam was the most suitable for temporary cement, whereas for resin cement PTFE tape was found to be the most effective [19].

Among the types of cement, polycarboxylate cement exhibited the highest residual cement amount, followed by temporary implant cement and resin cement [20]. Cements that tend to leave more undetected excess have a higher prevalence for peri-implant inflammation leading to bone loss [19].

Metal scalers are commonly used for the removal of excess cement after implant crown cementation. However, they have a disadvantage of forming scratches on the titanium surface. The use of resin scalers minimises the scratches but are less effective in the removal of excess cement [19].

The cementation technique should minimise the cement excess without compromising the retention of the prosthesis. Along with this it should ensure precision fit of the implant crown and should be easy to use in daily practice. Not all techniques will encompass all the ideal requirements, so based on the clinical situation, availability of materials, and individual preference the cementation technique to minimise cement excess is selected.

CONCLUSION(S)

With the various techniques described in the current literature, the challenge of minimising excess cement around the implant crowns has been addressed to some extent. The use of various cementation techniques such as the extraoral replica technique, G cuff aids, application of petroleum jelly to abutments, use of PTFE tape, cementation devices, and cement shield membranes-have emerged as practical strategies to control excess cement thereby reducing the risk of peri-implant diseases and increasing the implant longevity. These techniques, when used individually or in combination, yield promising results. The choice of technique depends on the complexity of the case, the type of restoration, and individual clinician preference. Ultimately, achieving long-term success in cement retained implant prosthesis requires a thorough understanding of prosthetic planning and minimising the residual cement to decrease the risk of peri-implantitis. Future research should focus on optimising materials, improving cementation protocols, and further minimising associated risks.

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PARTICULARS OF CONTRIBUTORS:
1. Postgraduate Student, Department of Prosthodontics, DMIMS, Wardha, Maharashtra, India.
2. Professor, Department of Prosthodontics, DMIMS, Wardha, Maharashtra, India.
3. Professor and Head, Department of Prosthodontics, DMIMS, Wardha, Maharashtra, India.
4. Associate Professor, Department of Prosthodontics, DMIMS, Wardha, Maharashtra, India.
5. Postgraduate Student, Department of Prosthodontics, DMIMS, Wardha, Maharashtra, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Mohini Sanjay Khandekar,
Pannalal Nagar, Amravati, Maharashtra, India.
E-mail: mohiniskhandekar@gmail.com

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