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SCREW RETAINED VS. CEMENTED RETAINED FIXED PROSTHODONTIC CROWNS AND BRIDGES OVER DENTAL IMPLANTS - LITERATURE REVIEW

ЗАШРАФЕНИ НАСПРОТИ ЦЕМЕНТИРАНИ ФИКСНИ КОРОНКИ И МОСТОВИ НАД ЗАБНИ ИМПЛАНТИ - ЛИТЕРАТУРЕН ПРЕГЛЕД

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Abstract

Aim of the study: To determine the similarities, differences, advantages and disadvantages between the two different techniques of restorations over dental implants. **Material and methods:** Published articles in different journals were reviewed: Pub Med / MEDLINE; "Scopus", "Web of Science", "Google Scholar", "Science Direct", "Research Gate" etc. In this retrospective study, collecting of the literature was done by searching the key words: screw retained, cemented retained, FDP, dental implants etc. **Results:** These types of restorations are both methods of restorations over dental implants, but neither one of them is a definitive answer to all cases of restorations. As in almost all of the time in medicine, there is no one-size-fits-all rule for each case. **Conclusions:** Both techniques are similar in restoring the problem over dental implants but are very different in the way they do that. Determining factor in deciding which of the techniques will be used is the interaction between the technical factor and the clinical case. **Key words:** Screw Retained, Cemented Retained, Dental Implants, Prosthodontic.

Апстракт

Цел на трудот: Да се утврдат сличностите, разликите, предностите и недостатоците помеѓу двете различни техники на реставрација над забните импланти. **Материјал и метод:** Прегледани беа објавени статии во различни списанија: Pub Med / MEDLINE; „Scopus", „Web of Science", „Google Scholar", „Science Direct", „Research Gate" и др. **Резултати:** Овие типови реставрации се двете методи за изработки на надоместоци над импланти, но ниеден од нив не представува идеално решение кај сите случаи на реставрации. Како и за се во медицината, не постои едно единствено решение за сите случаи. **Заклучок:** Двете техники се слични во решението кај надоместоците над импланти, но многу различни во начинот на изведувањето. Детерминирачкиот фактор за избор на техниката која би се користела е поврзаноста помеѓу техничкиот фактор и самиот клинички случај. **Клучни зборови:** зашрафени, цементирани, дентални импланти, протетика.

Introduction

Implants placed during the development era had high failure rates and as a consequence, easy and frequent removal of the prostheses was of paramount importance[1-3]. Screw retention in implant-supported prostheses was developed in response to the need for retrievability even though occlusion and aesthetics were sacrificed. As knowledge increased and techniques advanced, implant survival rates moved rapidly from 50% to 90% success[1-5].

With this dramatic increase in survival rates, the issue of retrievability has not been as clinically significant. However, the use of screw retention, with all of its disadvantages, still remains the retention mechanism of choice for many practitioners, which can be seen by the product lines of implant manufacturers. Many practitioners do not consider cement retention an option in implant-supported restorations because they believe that cemented restorations are not retrievable[6]. Cement, when used appropriately, can retain implant supported prostheses[7].

The process of choosing between screw retained and cemented retained is a long debate. Clinical studies and literature review tried to answer the question "Which of the solutions will provide best long-term stability, retrievability,

retention and all the other factors?", but in time, the screw retained restorations were favoured.

Most of the authors agree that there is no definitive answer for all the clinical cases and the advantages and disadvantages should be taken into account before choosing one option or the other. Both types of restorations have their limitations, but if executed correctly both of them should be giving correct and predictable results.

Fixed partial dentures (FDP) present a very good treatment option for patients with single or multiple teeth loss[8]. This predictable and good option has had exponential growth and usage due to the osseointegration process of the implants, refined surgical techniques, clean implant surfaces and accurate fit of the implant abutments. These days, the main focus is on manufacturing of the individual abutments via digital methods[9].

In a retrospective analysis, the number of cases treated, that are related to a cemented manner or screw retained, can be easily identified.

A careful analysis identified the trend of cases with the advantages and disadvantages of one technique or the other.

The evaluation of majority of the authors was leaning towards the advantages and disadvantages, and in making comparisons in relation to the factors that affect results and the final success [9,10].

Aim of the study: To determine the similarities, differences, advantages and disadvantages between the two different techniques of restorations over dental implants.

Material and methods

In order to achieve our goal of best possible literature review, our search focused on collecting literature from: Pub Med / MEDLINE, "Scopus", "Web of Science", "Google Scholar", "Science Direct", "Research Gate" etc. Similar platforms include a huge number of scientific articles and different medical journals.

In this retrospective study, collecting of the literature was done by searching the key words: screw retained, cemented retained, FDP, dental implants etc.

Based on these key words, 95 abstracts were identified. The first selective method has the possibility of selecting corresponding articles with interest in quality for our study. Duplicate articles were removed from the process of analytic review. Comparison method was used for two different FDP techniques.

Results and discussion

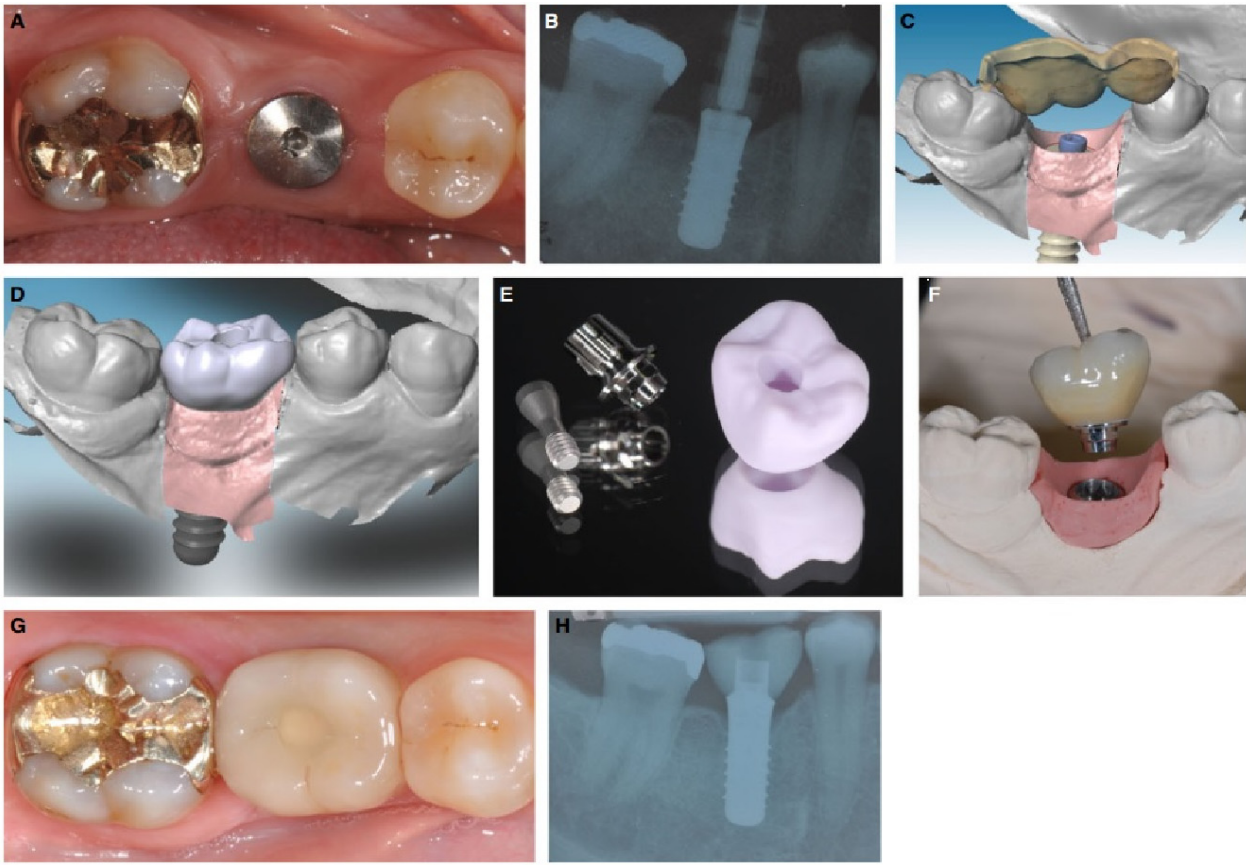
Long-span prostheses should preferably be screw retained for easier maintenance – it has been discussed in the literature that long-span restorations have a higher risk of complications. However, if the implant is not placed in a prosthetically ideal position – with the future access hole of the planned crown below the planned incisal edge position – cement retention is often the only treatment option. Therefore, proper treatment planning and prosthetically-driven implant placement should be mandatory for implant therapy[11].

A major disadvantage of cement retention is the difficulty of removing excess cement, which has been associated with the development of peri-implant diseases such as peri-implant mucositis and peri-implantitis. Consequently, this adds an additional risk factor to the overall treatment[11]. Screw retained implant-supported prostheses were initially used when implants were invented, especially supporting full-arch prostheses for edentulous patients with the 'ad modem Branemark' protocol. The invention of the UCLA (The UCLA Abutment is a castable abutment offered with a machined gold alloy base or in a fully castable version) gold custom abutment in 1988 allowed an easier workflow for screw retention, as it permitted the retention of a prosthesis directly on or inside the implant without the use of a transmucosal abutment[11]. However, the reconstruction was cost-intensive, and according to Taylor et al.[12] & Agar et al.[13] classic publication on 'implant prosthodontics' in 2002, screw retained restoration involved nearly four times the component cost of cemented restoration. With the evolution of prosthetic components' designs and digital workflow, the costs have decreased in the meantime.

A combined approach with an individualized abutment that is bonded to a prefabricated titanium or zirconium dioxide base offers a cost-efficient solution; however, this abutment type lacks long-term documentation. A case with the use of his abutment is illustrated in Fig. below. Cementation can be achieved with provisional or definitive cement. Provisional cementation allows retrievability to a certain extent, while the risk for leakage and loss of retention may be higher compared with definitive cementation. In order to maintain retention during its use, basic mechanical parameters are crucial: these factors include height, diameter, conicity, indexing, surface roughness of the abutments, number of abutments related to number of teeth to be replaced, alignment of abutments in the dental arch, straight or angled configuration, and the presence of extensions.

1. Aesthetics

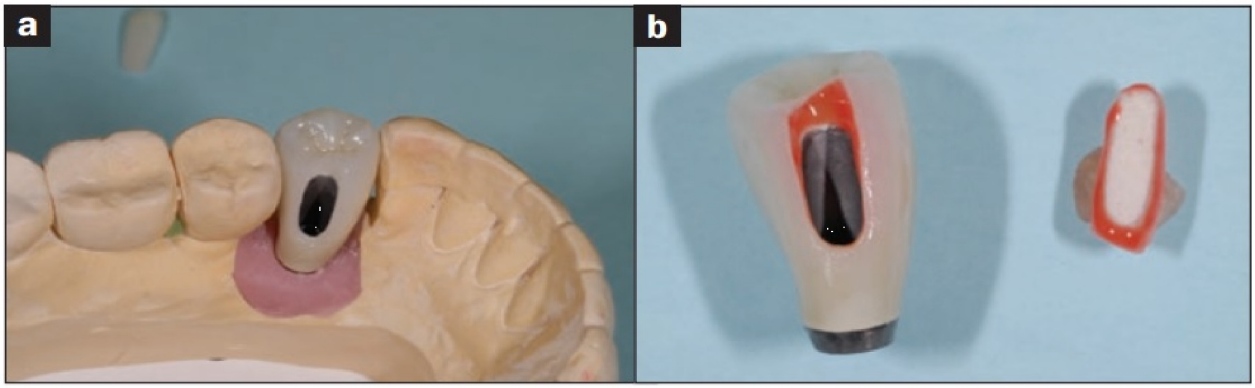
When the implant is placed in the ideal position, predictable aesthetics can be achieved with either screw- or cement-retained restorations[14]. One of the debates regarding using screw retained restorations is the screw access



Picture 1.

channel that may be placed in an aesthetic area. When there is difficulty in placing the implant in an ideal position for any anatomic limitation, the pre-angled or custom abutments can be used so that the screw access channel is relocated away from aesthetic area. The use of an opaquer in combination with a resilient composite offered a significant aesthetic improvement of implant restoration [15].

With patients demanding more aesthetic restorations today, clinicians are continually seeking the most biomimetic techniques or materials. It is well documented in literature that clinicians believe cement retained restorations are more aesthetic[16]. This thought arises solely from the lack of a visible screw access hole. However, selecting a cement retained restoration exclusively based on aesthetic outcome is unfounded; the aesthetic outcome



Picture 2.

has little to do with the method of retention to the implant. Rather, aesthetics is multifactorial and depends on patient selection, tissue volume, tissue type, and implant position. The trajectory of the implant will only determine the type of retention method, whether it be cement or screw retained. For anterior restorations, the use of pre angled abutments, angulated screw channels (ASCs), or dynamic abutments can redirect a screw access opening to the cingulum area where it is not visible. For posterior restorations, several aesthetic techniques exist to blend the screw access hole with the restoration, utilizing a silicone plug and resin opaque or a pressed ceramic plug[2]. Cement-retained restorations offer easier access to the posterior of the mouth, especially in patients with limited jaw opening. In addition to the difficulty of access, the use of screw-retained restorations in the posterior part of the mouth may carry a risk of swallowing or aspirating the screw or screwdriver.

2. Occlusion

Hebel and Gajjar[17] stated that the size of the occlusal access is determined by the retaining screw diameter which, for larger implants (for example, in the posterior regions of the mouth) obliterate a large portion of the occlusal table. In addition, the screw access hole is often in the central fossa of the crown where centric contact should be. Since the access hole can often involve up to 50% – 60% of the occlusal table, Vigolo et al.[18,19] argued that the opposing occlusion is usually developed with the head of a retaining screw or on composite restorative material instead in the screw hole. Jivraj[3] and Chee[20] stated that the importance of building opposing contacts on the restoration itself versus the screw access filling material. In their opinion, no untoward wear or instability to the occlusal contacts occurs, provided that the screw access filling material is not needed to maintain the occlusion. The major argument against using screw-retained restorations is dealing with the screw access hole. Another technique is to fabricate a porcelain plug and the porcelain used on the restoration can be etched easily with hydrofluoric acid, and then silane should be applied. This allows for resin bonding of the 2 surfaces. Colours are easy to match and resin options are available to provide an indiscernible margin. This technique is similar to the one used with porcelain veneers on natural teeth.

This can be also seen clinically, as reported in a study by Nissan et al.[11] where 221 implants were followed for over 15 years; ceramic fracture occurred at a statistically significantly higher rate in screw retained (38%) than in cement retained (4%) metal ceramic restorations. Utilization of a screw access channel modifies the position of the center of mass of the ceramic bulk, and occlusal forces must be redirected to the peripheries of the occlusal table. The result is often local failure of the metal ceramic bond and detachment of the porcelain. Interestingly, Sailer et al.[21] performed a systematic review of 59 clinical studies and found that chipping of the veneering ceramic tended to occur more frequently with the screw retained restorations for single crowns. Yet, for full arch restorations, ceramic chipping was observed more frequently with cement retained prostheses. This led others to question whether the screw access channel is the primary cause for weakened porcelain and increased fracture incidence. In their 10 year randomized controlled trial, Vigolo et al.[18,19] reported a lack of prosthetic complications related to porcelain fracture in their screw retained metal ceramic restorations. Although only a small sample size of thirty implants was used, they ensured accurate evaluation of the occlusal scheme and provided appropriate variations to the occlusal contacts (both static and dynamic) to reduce technical failure rates. Similar results have been found in a recent in vitro

Picture 3.

study using newer materials (zirconia and lithium disilicate). The researchers found no significant differences in fracture rates between the crowns with or without an occlusal screw access channel.

3. Interocclusal space and retention

There are several factors that affect the retention of cement-retained restorations such as taper of abutment, surface area and height, surface roughness, and type of cement[15].

Taper greatly affects the amount of retention in cement-retained restorations. Regarding surface area and height, the subgingival placement of the implants provides longer implant abutment walls and usually a larger surface area than prepared natural teeth[15]. The minimum abutment height for using cement-retained restorations with predictable retention was documented to be 5 mm[15]. Therefore, when the interocclusal space is as little as 4 mm, screw retained restorations may be used, since these restorations can be attached directly to implants without intermediate abutment. Increased surface roughness will offer increased mechanical retention for cements, therefore, roughening the implant abutments using diamond burs or grit blasting will provide higher retention. However, because of the ideal taper and long surface provided by implant abutments, there will usually be no need for roughening the abutment surface to increase retention.

Cement application techniques appear to be used arbitrarily with little understanding by clinicians regarding how or where to apply the cement. Many studies report phrases such as "the cement was loaded into the crown," but advice is not given as to how this procedure was performed. In addition, protocols for the amount of cement that should be used are lacking. Wadhwani et al.[22] found that for the same crown form to be cemented, clinicians used cement weights ranging from 3.2 mg to 506.4 mg. A formula was created to determine the actual amount of cement needed (assuming 40 μm cement space) and was calculated to be 13.6 mg, or 3% of the crown's total volume. Clearly, some crowns were underfilled and many were overfilled resulting in cement extrusion. To prevent extrusion into sulcular peri implant tissues, Wadhwani[22] suggests performing a pre-extrusion step extraorally before cementing. Excess cement is removed extraorally from the crown using a custom copy abutment, then cemented intraorally. Using a computational fluid dynamics model, Wadhwani et al.[22] were able to demonstrate that the ideal location to place cement was a small bead circumferentially around the crown margin for ideal cement coverage. Other techniques (circumferential placement at the occlusal third, brush on application, and gross fill) demonstrated inferior results in comparison. They also found that seating the crown slowly was more ideal as rapid seating would cause too rapid a flow due to the shear thinning properties of the cement and leave an incomplete sealing of the margin. Abutment modification with internal vent holes resulted in less air trapping and less cement extrusion.

4. Provisionalization and gingival molding

Jivraj and Chee[3,20] reported that a screw retained provisional restoration can be used with ease to incrementally expand the peri implant tissues until fully seated. In addition, following implant surgeries where the provisional restoration is to be placed immediately, a screw retained option is the preferred method; it is difficult to manage the bleeding and to cement a restoration in a clean environment for ideal tissue health. Another advantage of a screw retained provisional restoration is that it can be used as a pick up type impression coping.

A soft tissue cast is poured around the exposed provisional after an impression coping is attached, yielding a soft tissue cast identical to the soft tissue form intraorally. This provides the laboratory with a model of an exact replica of the emergence profile that should be transferred to the definitive restoration.

5. Passivity

In a screw retained prosthesis, torque that is applied to a screw forces the mating screw threads together until the shaft of the screw begins to elongate[23]. This produces a clamping force within the system known as preload. Not all torque that is applied to the screw is converted into preload. Slight discrepancies between the two mating components will create frictional and misfit resistance within the screw. The screw bends and deforms to compensate for the strain at the interface and results in a lower clamping force. Ultimately, a lower clamping force will occur, leading to future screw loosening or fatigue fracture. Passivity refers to a state of existing without resistance, and when applied to implant prosthetics, it translates into a lack of any misfit forces being generated within the prosthetic system[24]. It is technically very difficult to achieve a completely passive framework in a screw retained prosthesis.

In the cemented version, individual abutments are screwed onto the implants and the superstructure is cemented overtop. The cement layer (typically about 40 μm) compensates for unintended dimensional discrepancies between the abutment and the restoration, successfully acting as a buffer space[2].

Most of the frameworks being used currently may not be totally passive, yet are functioning normally. Passivity is listed as an advantage of a cement retained prosthesis.

In a systematic review that evaluated the 5 year survival rates of screw retained implant supported single crowns, abutment screw loosening was reported at 12.7%. Other studies have shown similar screw loosening rates of 5.8% and 6.7%.

Screw fractures appear to be less common in screw retained prostheses occurring at 1.5% in one study, and 3.9% in another study by Sailer et al.[21]. It has been observed that screw fractures occur primarily at the first occlusal screw thread.

Freitas et al.[25] proposed that the failure occurs in this region because bending forces are concentrated the most at this level of the screw. Screw retightening has been reported to be necessary, especially within the 1st year of functional loading. The goal is to re-establish the optimum preload stress on the abutment screw to counter the possibility of screw loosening. This should be performed with caution as Yilmaz et al.[26] found that second torques applied to the screws can rotationally displace abutments as much as 9 μm. A rotation >5° can cause a reduction of 63% in screw joint stability. If a patient has a loosened abutment screw, Assenza et al.[27] stress the importance of replacing the screw entirely instead of simply retightening the existing one. The old screw has most likely undergone deformation changes due to misfit stress and a re torqued screw may experience fatigue fracture if the same preload stress is applied. The majority of technical failures in the past were blamed on the inaccuracy of the fitting components which allowed for micro movement. With the introduction of more precise abutments and screws which improved the abutment to implant ratio, fewer technical complications are being seen with both screw and cement retained crowns.

In fact, a recent systematic review reports that they found no statistically significant difference between cement and screw retained restorations for technical outcomes.

6. Biological complications

In natural teeth, the barrier of collagen limits bacterial ingress and can damage from physical trauma[2]. The arrangement of the fibres results in compartmentalization that localizes diseases and limits their spreading[28]. Implants do not have inserting Sharpey's fibres, instead, they have circumferential fibres that sling around the implant and attach through hemidesmosomes (a weak attachment mechanism)[29]. This creates a single "compartment" so any disease will affect the entire implant. Bacterial infection is a major factor leading to bone loss and implant failure in healthy individuals. Any subgingival irregularity (such as calculus or residual cement) may assist in the microbial colonization of implants and may lead to peri implant disease.

Recent studies have demonstrated that peri implant tissues around screw retained restorations have fewer biological complications. In vitro studies demonstrate that cement retained prostheses luted (coated) to titanium abutments with simulated margins have shown to leave a surprisingly large quantity of cement remnants. Clinically, Wilson[30] found an 81% correlation between excess cement left in the peri implant tissue and the occurrence of sulcular bleeding or suppuration.

Weber et al.[31] found that after 6 and 12 months of implant loading, cement retained crowns consistently demonstrated a higher degree of sulcular bleeding and plaque accumulation than screw retained crowns. When restorations are luted to the implant abutment, extruded cement has enough hydraulic pressure to tear the delicate tissues surrounding the implant instead of being deflected out. Even on smooth surface implants, Agar et al.[13] demonstrated that it was not possible to completely remove a resin cement.

Some researchers have found the opposite, more soft tissue complications around screw retained prostheses. However, the problem was associated only with screw retained single crowns that had loose abutment screws creating a micro gap. The inflammation healed soon after the retightening of the screws once the gap was closed.

7. Retrieval of cemented restorations

Retrieval of cemented implant restorations is often more difficult than the one from natural teeth[18]. Despite the use of a provisional cement, it may function more like a definitive luting agent between a metal–metal interface. If the crown must be removed due to a loosened abutment screw, any force applied to the restoration on a loosened abutment has the potential for damaging the internal threads of the implant and it often becomes safer to simply cut off the crown[32].

Several techniques have been proposed to increase the ease of retrievability of cement retained implant crowns.

- A lingual access channel extending through the crown and into the abutment near the cervical crown abutment interface is made. The crown is then cemented and the channel is filled with resin to serve as a locking mechanism. If the removal is warranted, the resin is simply removed and an ultrasonic device or crown remover is used to lift the crown[33].

- A drilling template can be fabricated based on an angulation analysis from a radiograph as a way to more accurately locate the screw access hole[34].

- Unique surface stains can be applied on the occlusal surface at the location of the screw access channel to identify its location[35].

- Finally, a combination implant crown utilizes principles from both a screw and cement retained prosthesis. The definitive crown is cemented to the abutment extraorally where excess is easily removed. Then, the cemented unit can be screwed onto the implant intraorally through a screw access channel which is later closed with composite resin[36].

In spite of all the proposed techniques for improving the retrievability of cement-retained restorations, screw retention becomes more necessary in extensive cases where prosthesis needs more maintenance, so cantilevered prostheses and full arch implant reconstruction are best restored with screw retention.

Conclusions

After careful studying of the collected literature, we reached the following conclusion:

- Both techniques are different, but each one has their advantages and disadvantages.
- In the end, the decision depends on the clinicians and the case.
- The determining factor for using one or the other technique depends on the interaction of technical factors-clinical one and vice versa.

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