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# Comparative Evaluation of Retention of Implant Supported Restorations Using Zinc Phosphate Cement with Two Different Cementing Techniques Before and After Thermocycling- An In-Vitro Study

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## Abstract

**Statement of problem:** Cementing technique helps us to improve retention and lessen the excess residual cement in implant supported restorations. Using different cementing techniques, the retentive strength of the implant supported restorations can be improved.

**Purpose**: the purpose of this study was to evaluate 2 cementing techniques for implant-supported restorations.

**Materials and method**: 40 full veneer metal crowns and 4 one-piece implants were used for retentive testing, were cemented using 2 cementing techniques; technique 1: cement was evenly placed in the intaglio surface of the metal crown and the excess cement was removed using an explorer. Technique 2: excess cement removal is done using a resin abutment replica. Out of the mentioned 40 metal crowns, 20 were used for thermocycling. 10 specimens of both the cementing techniques were used for thermocycling. For checking the retentive strength of the restorations after cementation, it was measured by pulling the crowns from the prefabricated loops from the block on a holder using the universal testing machine.

**Results**: among the four groups that were tested, the retentive strength of the resin abutment replica technique was maximum and that of conventional cementing technique being the least. The statistical analysis showed that the 'p' value was highly significant.

**Conclusion**: the application of the resin abutment replica cementing technique showed better retentive strength when compared to conventional cementing technique.

**Keywords:** Thermocycling, Biocompatibility, Translucency,

**Introduction**

The goal of modern dentistry is to restore normal contour, function, comfort, esthetics, speech and health, regardless of the atrophy, disease or injury of the stomatognathic system. However, more teeth a patient is missing, the more arduous this goal becomes with traditional dentistry[1]. As a result of research, advances in implant designs, materials and techniques have led to predictable success in their application, and several types of implants are now available for use in rehabilitation of different clinical problems. The use of dental implants in the treatment of complete and partial edentulism has become an integrated treatment modality in restorative dentistry[1].

Cemented prosthesis has considerable advantages over the screw retained prosthesis, including more passive castings, improved direction of loads, enhanced esthetics, improved access, progressive loading, reduced crestal bone loss and reduced complications, cost and time[2]. The main disadvantage of cemented prosthesis is their irretrievability. Implant screw joints are susceptible to screw loosening or fracture because of the magnitude and direction of oral forces and the strength limitations of the components. Also, the low-profile retention, limited interarch space and residual cement in the sulcus are some the other disadvantages of cement retained prosthesis[3]. Low viscosity and film thickness, long working time with rapid set at oral temperatures, low solubility, high compressive and tensile strengths, high proportional limit, adhesion to tooth structure and restorative materials, anticariogenic properties, biocompatibility, translucency, and radiopacity are the ideal properties of dental cement[4].

In the early years of cemented implant Zinc phosphate is the oldest luting cement (introduced in the 1800s), and has been used with a high degree of success for metal, metal-ceramic, and porcelain restorations; it is the standard to which other cements are compared[5]. Zinc phosphate functions by nonadhesive bonding, quickly reaching maximal physical properties within 24 hours. Compressive strength is very high, tensile strength low compared with other available cements. The set material is brittle and stiff, having a high elastic modulus. Early solubility is high, but falls rapidly as the cement ages, yet can be significant, especially in an acid environment. Minimal exposure to oral fluids is necessary (ie, well-fitting restoration margins are required) and caution is recommended for use in patients who have a very acidic diet, or who have acid reflux problems. At cost per unit dose, zinc phosphate is the least expensive luting agent[5]. Another major issue of cement retained implant prosthesis is excess cement. According to American Academy of Periodontology excess cement is one of the risk factor for periimplantitis and peri implant mucositis[6]. 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. periimplantitis may lead to inflammation, bleeding on probing, suppuration and peri implant attachment loss[7]. 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[8], 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[9]. 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[10].

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$\mu$m space[11]. Additionally, the amount of luting agent used mainly rely on clinician preference.

Managing cement volume is challenging because there needs to be enough cement to hold the crown to the abutment, but not so much that an excess becomes difficult to control and risks damage to the peri implant tissue if insufficiently removed[12]. Sometimes the precise design of the abutment and restoration allows the use of less cement to maintain the same retention. The problem is that even when the inside of the restoration is only one-third filled with cement, excess cement is still often expressed at the margins, which complicates cleanup, especially in restorations with deep subgingival margins[113,14,15]. Although some implant systems already have plastic stock abutments available for this technique, they are standard stock abutments that do not match the shape of the custom abutment, and managing cement is still a problem.

The purpose of the present study was to evaluate 2 techniques for cementing implant-supported restorations by assessing retention of the restoration. The null hypothesis was that no difference would be found in retention among the cementing techniques.

**Materials and method**

4 one-piece implants and 40 full veneer metal crowns (figure 1) were used in this study. The implants were fixed onto acrylic self-cure blocks (figure 2). The full veneer metal crowns were fabricated with loop on the superior surface of the crown.

Fabrication of resin abutment replica is done using a putty index, which was prepared for the abutment component of the single implant. Then self-cure acrylic resin is then mixed in the acrylic mixing rubber cup and poured into the putty index for the abutment and then dowel pin (Crosspin) is inserted in it, which acts as a handle for the resin abutment replica (figure 3). Once the acrylic resin hardens, the excess flash is removed. 20 such resin abutment replicas are prepared.

**Cementing the restorations on the implant blocks with conventional cementing technique**

On a cool glass slab, one scoop of the zinc phosphate powder was taken along with the liquid. Using a clean cement spatula, the powder and liquid are mixed. Using a probe, the cement is inserted into the restoration and then cemented onto the implant (figure 4). The excess is then cleaned of the restoration using an explorer. A load of 49N for 5mins (manually) using weighing machine was applied on the restoration. Conventional cementing technique was done with 20 samples.

**Group a:** was conventional cementing technique group-10 samples

**Group b:** was conventional cementing technique group with thermocycling-10 samples

**Cementing the restorations on the implant blocks with resin abutment replica technique**

On a cool glass slab, one scoop of the zinc phosphate powder was taken along with the liquid. Using a clean cement spatula, the powder and liquid are mixed. Using a probe, the cement is inserted into the restoration. The resin abutment replica is then inserted and excess cement is removed from the restoration using an explorer (figure 5). The restoration is then cemented onto the implant. The excess cement, if any, is again cleaned off the restoration. A load of 49N for 5mins (manually) was applied on the restoration. Resin abutment replica technique was done with 20 samples.

**Group c:** was resin abutment replica cementing technique group-10 samples

**Group d:** was resin abutment replica cementing technique group with thermocycling-10 samples

**Thermocycling of the blocks:** Ten hours after cementation, 10 samples of the conventional cementing technique and 10 samples of the resin abutment replica technique were subjected to 500 thermocycles using thermocycling chamber in 5°C and 55°C water baths with 30 sec dwell time in each water bath.

**Testing:** On the Universal testing machine (Star Testing System, STS 248) (figure 6) the cemented implant blocks were placed. The loops of the restoration were hooked on to the frame of the machine and pull-out test was performed on each of the 40 samples 10 hours after cementation.

Two cementing techniques have been used in this study. One is the conventional cementing technique, in which the cement is mixed on the cool glass slab and transferred to the intaglio surface of the restoration. The restoration is then cemented on the implant and the cement is allowed to set. The excess cement is then removed using an explorer.

Doing so can cause scratches on the implant surface. And remnant cement can cause periimplantitis. Periimplantitis may lead to inflammation, bleeding on probing, suppuration and peri implant 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[8], and change in abutment surface characterization due to content of fluoride which is known to etch titanium.

The resin abutment replica cementing technique was the method used to remove the excess cement for the cementation of the implant restorations. A putty index was prepared for the abutment component of the single implant. Then self-cure acrylic resin is then mixed in the acrylic mixing rubber cup and poured into the putty index for the abutment and then dowel pin (Crosspin) is inserted in it, which acts as a handle for the resin abutment replica. Once the acrylic resin hardens, the excess flash is removed. 20 such resin abutment replicas are prepared.

On a cool glass slab, one scoop of the zinc phosphate powder was taken along with the liquid. Using a clean cement spatula, the powder and liquid are mixed. As the intaglio surface of the restoration was very small, a probe was used to insert the cement into the restoration. The resin abutment replica is then inserted and excess cement is removed from the restoration using an explorer. The restoration is then immediately cemented onto the implant. The excess cement, if any, was again cleaned off the restoration. A load of 49N for 5mins (manually, using a weighing scale) was applied on the restoration. Resin abutment replica cementing technique was done with 20 samples.

Ten hours after cementation, 10 samples of the conventional cementing technique and 10 samples of the resin abutment replica technique were subjected to 500 thermocycles using thermocycling chamber in 5◦C and 55◦C water baths with 30 sec dwell time in each water bath.

On the Universal testing machine (Star Testing System, STS 248) the cemented implant blocks were placed. The loops of the restoration were hooked on to the frame of the machine and pull-out test was performed on each of the 40 samples 10 hours after cementation.

Statistical analysis showed that the resin abutment replica cementing technique thermocycled group has the highest mean value for retentive strength amongst all the groups, with the conventional cementing control group had the least mean value for the retentive strength (Graph 4). In between the conventional cementing technique, thermocycled group showed better retentive strength (Graph 1). Among the resin abutment replica cementing technique, thermocycled group showed better retentive strength compared to the control group (Graph 2).

In between the control group, resin abutment replica cementing technique showed better retentive strength than the conventional cementing technique (Graph 3). The 'p' value was highly significant ($p < 0.05$ - Significant, $p < 0.001$ - Highly significant).

In between the thermocycled group, resin abutment replica cementing technique showed better retentive strength compared to the conventional cementing technique (Graph 3). The statistical analysis showed that the 'p 'value was highly significant ($p < 0.05$ - Significant, $p < 0.001$ - Highly significant).

**Discussion**

The ideal goal of modern dentistry is to restore the patient to normal contour, function, comfort, esthetics, speech, and health[1]. What makes implant dentistry unique is the ability to achieve this ideal goal regardless of the atrophy, disease, or injury of the stomatognathic system. Dental implants are an effective and a popular option for replacing the missing tooth and form an important part of mainstream dental practice today. Their use often represents a better alternative over traditional options of tooth replacement. The selection of the method of crown retention presents the clinician with a treatment planning challenge that involves recognition of the desired treatment outcome.

The present study was designed to compare the retentive strength of zinc phosphate cement using two different cementing techniques on implant supported restorations before and after thermocycling. One piece Adin implants with cement retained restorations were used in the study.

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[16]. Cement, when used appropriately, can retain implant supported prostheses and provide retrievability. In addition, cement-retained prostheses have superior occlusion, esthetics, passivity and loading characteristics when compared with screw-retained prostheses.

It is well-documented in the dental literature that several factors influence the amount of retention in cement retained restorations, whether they exist on natural teeth or implant abutments. These factors are (1) taper or parallelism, (2) surface area and height, (3) surface finish or roughness, and (4) type of cement[16].

The fourth factor in retention is the type of cement. A wide variety of cements exist with varying degrees of strength. There are two main cements available for use in restorative dentistry provisional and definitive cements.

The utmost importance should be given while selecting the cement while keeping in mind the irretrievability of the restoration and adequate retentiveness, to sustain occlusal loading as well do not harm the abutment, implant fixture and peri implant tissue. Studies have done to give rank order of retentiveness of different commercially available cement for various clinical needs[6].

Zinc phosphate is the oldest luting cement (introduced in the 1800s), and has been used with a high degree of success for metal, metal-ceramic, and porcelain restorations; it is the standard to which other cements are compared[5]. It is the classical AB cement, being supplied as a separate powder/liquid system, the powder approximately 90% zinc oxide (ZnO) and the liquid approximately 67% buffered phosphoric acid. Aluminum (1%–3%) in the liquid is needed for the cement-forming reaction, and water (w33%) partially controls the reaction rate. The liquid bottle should remain closed unless dispensing to prevent water loss by evaporation, and batches of powder and liquid are matched by the manufacturer, so items should not be interchanged. Many modifications have been tried with no significant improvement in properties; silicate was added to provide a more translucent material for luting porcelain jacket crowns. Zinc phosphate should be mixed on a cool, dry, glass slab to slow the exothermic reaction, allowing maximum powder to be brought into the mix while controlling the viscosity. Powder should be incorporated into the liquid over 60 to 90 seconds in several small increments, by spreading the mix over a broad area with a metal spatula. The correct mix consistency for optimal strength and to allow complete seating of the restoration is important as strength is linear to powder/liquid ratio, but viscosity also increases. It should be fluid, yet string about 2 to 3 cm when lifting the spatula from the mix. The restoration should be seated within 3 to 5 minutes with firm, steady pressure, which should be maintained several minutes until the initial set has occurred. Zinc phosphate functions by non-adhesive bonding, quickly reaching maximal physical properties within 24 hours.

Compressive strength is very high, 646 HILL tensile strength low compared with other available cements. The set material is brittle and stiff, having a high elastic modulus. Early solubility is high, but falls rapidly as the cement ages, yet can be significant, especially in an acid environment. Minimal exposure to oral fluids is necessary (ie, well-fitting restoration margins are required) and caution is recommended for use in patients who have a very acidic diet, or who have acid reflux problems. At cost per unit dose, zinc phosphate is the least expensive luting agent. The pH of zinc phosphate is very low (less than 4) at 1 hour after delivery, but reaches neutrality by 48 hours. Its use is not recommended for deep preparations, or if pulpal irritation is a concern (because of low pH and hydraulic seating pressure). Some have recommended use of a cavity varnish or calcium hydroxide liquid over the preparation before cementation, if less than 1 mm of dentin remains between the pulp and cement. Use of a resin-based sealer is not recommended because of a marked reduction in retention. Because of early strength and acceptable physical properties, extremely low cost, and lack of technique sensitivity, zinc phosphate remains a good clinical choice for luting metal, well-fitting metal-ceramic restorations, long-span fixed partial dentures, and cast dowel (post) cores[17].

Zinc phosphate cement was used for the cementing techniques of the implant supported restorations in the study. It is a definitive cement for cementation. Traditionally, zinc phosphate cement has been the most popular material, despite its well-documented disadvantages, particularly solubility and lack of adhesion[27]. These drawbacks notwithstanding, the success of fixed prostheses has been well-documented. A recent meta-analysis of clinical data of conventional fixed partial dentures (FPDs) revealed an overall survival rate of 74.0 ± 2.1% after 15 years, 1 which represents outstanding clinical success. Nevertheless, many alternative materials have been introduced and recently resin cements have become popular, primarily because they have addressed the disadvantages of solubility and lack of adhesion[16].

The implant used in the study were cement retained one piece implant. Misch[1] outlined a series of advantages for cement-retained implant prostheses compared with screw-retained implant prostheses. If the issue of retrievability is set aside, it is difficult to justify the use of screws to retain prostheses, with the exception of limited abutment height. In areas of limited inter-ridge space, a screw is more effective than cement, because the abutment lacks the important factors of height and surface area as described earlier. Cemented prostheses have many substantial advantages. They provide a passive stable environment because they are cemented on well-adapted machined abutments with discrepancies in fit of the castings to the abutments being negated by the grouting action of the cement.

The idea of using the replica technique to facilitate the removal of excess cement extra orally just before intraoral technique. Various authors proposed the use of a ‘practice abutment’ without providing further data on the material or demonstrating the effectiveness of this technique. Later, a fast-setting vinyl polysiloxane was prepared as a material for chairside fabrication of a replica. Chairside time is usually time-intensive, so in the current study, an abutment replica was used with a model pin for optimal handling. However, this procedure proved to be cost effective and allowed a quick course of cementation along with the removal of 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 factors for periimplantitis and peri implant mucositis[6]. 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. Furthermore, margin location and presence of gap between the implant abutment and superstructure complicates the situation of excess cement and lead to bacterial colonization[7]. 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. 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[10].

Wadhwani[18] el al 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. 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[11]. Additionally, the amount of luting agent used mainly rely on clinician preference. Wadhwani[11] et al. describes a technique for reducing the excess cement before cementation is seating the restoration filled with cement on a practice abutment (analog abutment) extra orally. 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 Dumbrigue[13] et al they used polytetrafluoroethylene (PTFE) tape on the intaglio surface of the restoration which provide space of 50 $\mu$m 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[19] 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[4] et al 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.

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 peri implant gingiva consist of parallel or oblique gingival fibers and long epithelial attachment. It is also been advocated that presence of subgingival margins of 3mm or more screw-retained implant prosthesis is preferred[6].

**Conclusion**

Implants are an established treatment option for partially edentulous patients[20]. They can either be screw-retained or cement-retained on the implant abutments. Many current implant systems have abutments into which superstructures can be cemented. Because it is difficult to achieve a passive fit framework for screw-retained implant restorations, cement-retained implant prostheses have become increasingly popular. Maintaining the integrity and retention of these restorations are critical for the successful implant therapy. Cement retained restorations have the advantage of more ideal esthetics and easier home care in that they more closely mimic the natural teeth; however, the location of the margin of the cemented restoration is critical and can produce challenges[2].

Managing the cement volume is challenging because there needs to be enough cement to hold the crown to the abutment, but not too much that an excess becomes difficult to control and risks damage to the peri implant tissue if insufficiently removed. The resin abutment replica technique is a straightforward technique which is cost effective and not time consuming. It can be used with any implant-cemented restoration and is especially useful when an implant crown has a deep subgingival margin. Excess cement is decreased while maintaining the retention of the restoration.

From the following study, the following conclusions were drawn:

1. The retentive strength for conventional cementing technique was improved with thermocycled group in comparison to the control group.
2. The retentive strength for resin abutment replica cementing technique was improved with thermocycled group in comparison to the control group.
3. The resin abutment replica cementing technique showed better retentive strength when compared to conventional cementing technique.
4. Thermocycling showed better retentive strength irrespective of the cementing technique.

**Summary**

The introduction of osseointegration and the use of end osseous implants provide alternative treatment options to clinicians for all indications of edentulism. Implant-supported, fixed restorations are usually classified as screw- or cement-retained. The advantage of screw-retained restorations is the combination of a rigid connection between the restoration-abutment complex and its retrievability. However, these restorations are usually more expensive than cement-retained restorations because of the use of extra components and laboratory costs. Cement-retained restorations were introduced to compensate for problems of screw loosening and the lack of esthetics of screw-retained restorations. The lack of fastening screws in cement-retained restorations reduces the possibility of preload stress and screw loosening. The major advantages of cement-retained restorations are the passive fit of frameworks, enhanced esthetics resulting from lack of screw access holes, and reduced complexity of laboratory procedures and chair-side time. The disadvantages of cement-retained restorations include the requirement for extra time for cementation, removal of residual excess cement, limited design possibilities for superstructure, and the reduced possibility for modifying treatment in case of periimplantitis.

The existence of residual excess cement in peri-implant sulcus is a common complication of cement-retained implant prostheses. If there is excess cement located in the soft tissue deeper than 3 mm, it might be difficult to observe and remove. Insufficient removal of excess cement may result in swelling, soreness, exudation or bleeding on probing, and can initiate a local inflammatory process, which is evidence of peri-implant disease and can ultimately lead to implant failure. Moreover, removal of excess cement may cause scratching and gouging on the implant surfaces when plastic and metal scalers are used. Several authors have reported on techniques regarding procedures used to assist in minimizing residual excess cement extrusion.

The goals of this study were to present a clinical technique for the cementation of implant-supported fixed restorations and to address the major problems of conventional cementation by using an extraoral replica of the implant abutment and zinc phosphate cement. To select the appropriate cement type, clinician must balance different considerations.

A replica technique, combined with the use of zinc phosphate cement, has proven to be effective in achieving sufficient retention for fixed restorations cemented to the implants. thus, this cementation technique is recommended for clinical use. The purpose of this technique was to eliminate excess cement from the implant restoration by using a 2-step cementation process. A custom acrylic resin abutment, a duplicate of the titanium abutment, is fabricated before the restoration is cemented. At cementation, cement is placed inside the restoration, which is placed onto the acrylic resin abutment outside the mouth. The majority of the excess cement from inside the restoration is expressed onto the acrylic resin abutment. The restoration is then placed on the titanium abutment inside the mouth. The result is a minimum amount of excess cement expressed intraorally. This technique minimizes the adverse biological consequences of leaving excess cement beneath implant-supported restorations.

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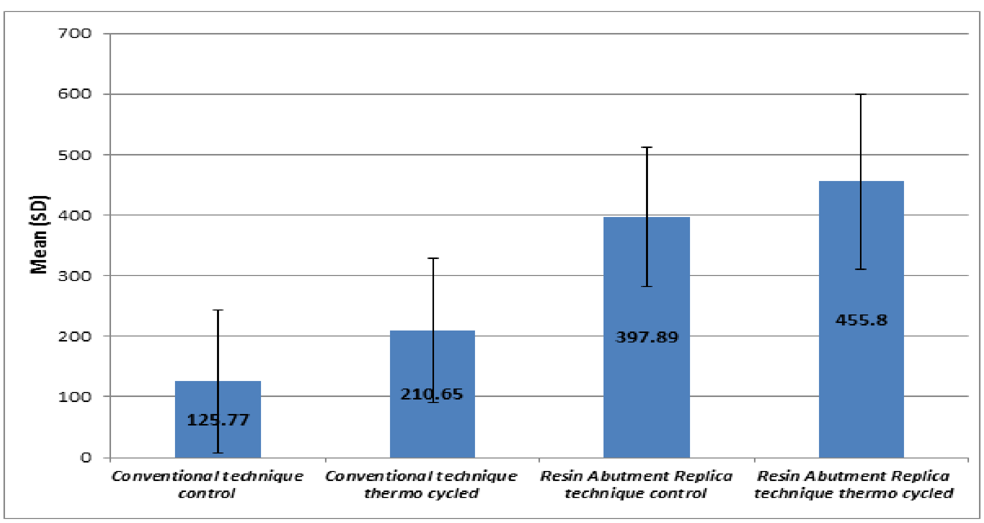
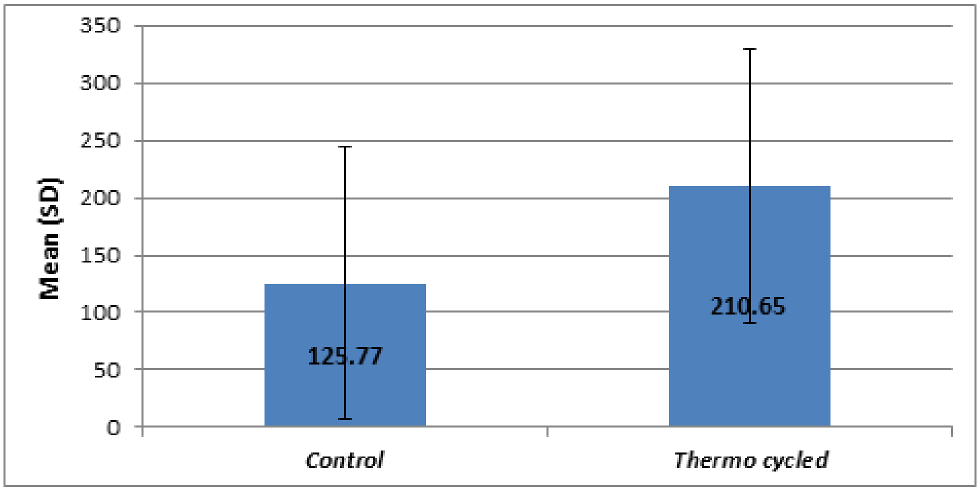
**Legend Figures**

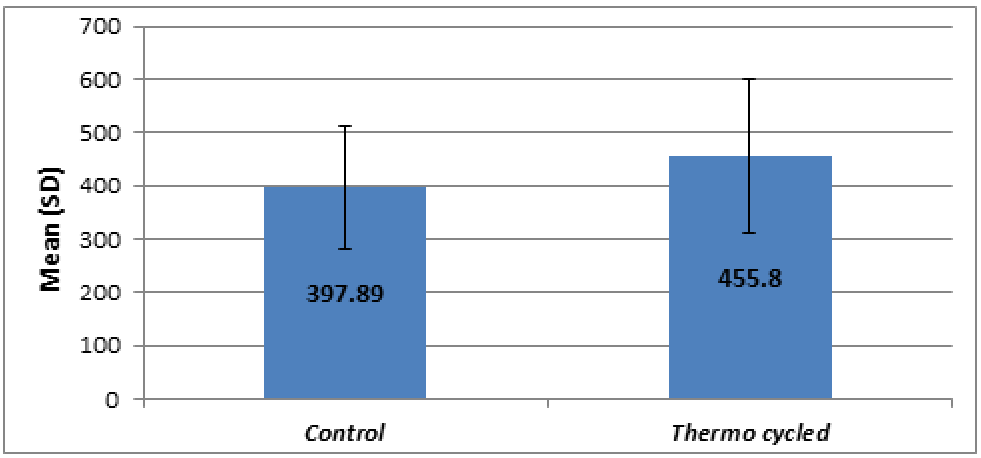
Graph 1: Comparison of the retention (pull out load) values in terms of {Mean (SD)} in control and thermo cycled group with both the techniques using ANOVA test.



Graph 2: Comparison of the retention (pull out load) values in terms of {Mean (SD)} among control and thermo cycled group using unpaired t test.




Graph 3: Comparison of the retention (pull out load) values in terms of {Mean (SD)} among control and thermo cycled group using unpaired t test.




Graph 4: Comparison of the retention (pull out load) values in terms of {Mean (SD)} in control group with both the techniques using unpaired t test.

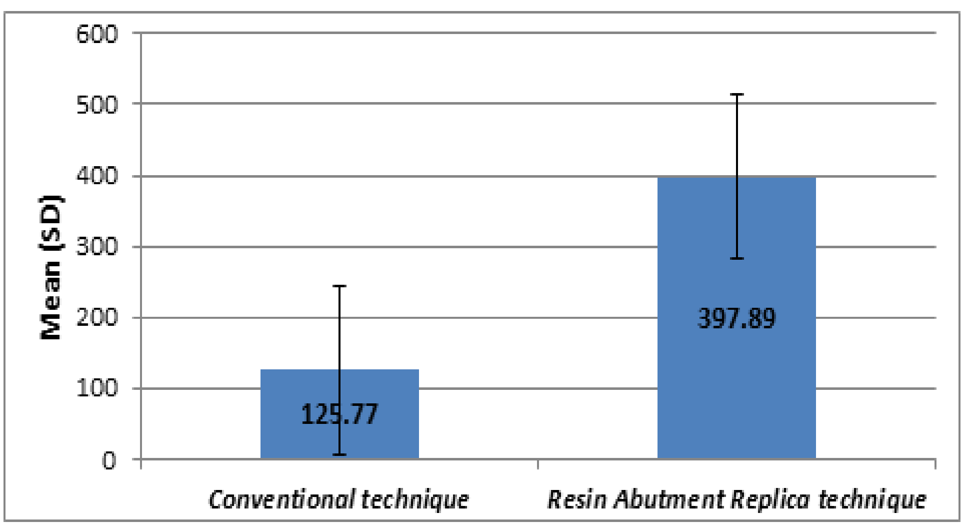



Figure 1: restoration samples.

Fig 2: Four Single Implants in Each Block.

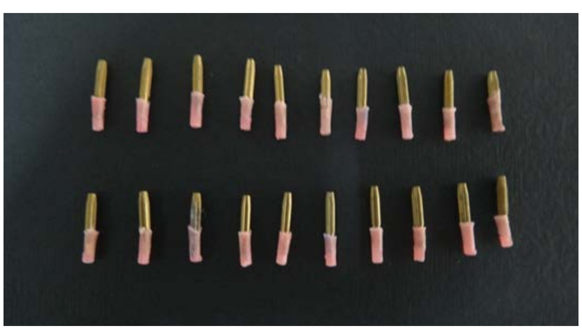


Fig 3: Resin Abutment Replica with Dowel Pin as Handle

Fig 4: Cementation of The Restoration Done on The Abutment.

Fig 5: Resin Abutment Replica Inserted into The Restoration.

Fig 6: Pull Out Test Being Performed.