

THE EFFECT OF ATTACHMENT PICK-UP TIMING ON THE RETENTION OF LOCATOR OVERDENTURE POSTS

KHALIL ALEISA, BDS, MSC

ABSTRACT

The aim of this study was to evaluate the effect of the timing of pick-ups of retentive attachments on locator overdenture post retention. Forty-eight acrylic resin models of edentulous mandibles were prepared. A post space with a depth of 6 mm was drilled into 96 extracted, single-rooted teeth. In each model, two prepared roots were mounted in the canine position with 22 mm between them. The models were assigned to experimental and control groups (24 in each group). For the experimental group, 24 acrylic denture bases were fabricated on the resin models. Locator root posts were then luted into the post spaces using self-adhesive resin cement (RelyX Unicem). Retentive attachment pick-up was performed at two different times, either 15 minutes or 24 hours after locator post cementation. For the control group, there was no attachment pick-up, and the test was performed at either 15 minutes or 24 hours after cementation. Three screw-eye metal hooks were fixed to each acrylic base at the identical tripodal location to facilitate engaging the denture base to the load cell. After attachment pick-up, three braided chains (17 cm long) connected the metallic hooks of the denture bases to the load cell of the universal testing machine. A three-point vertical pull was employed 20 times. The dislodging forces were applied until displacement or separation of the specimens occurred. For both groups, each root / matrix specimen was vertically secured in the universal testing machine (Instron, Model 8500 Plus Dynamic Testing System). The force required to dislodge the locator post was determined using pneumatic grips that grasped the locator post head along its long axis. The data were statistically analyzed using two-way ANOVA and Student's t-test. The retention of the locator posts that were dislodged 24 hours after cementation was significantly higher than that of those dislodged 15 minutes after cementation in both the control and experimental groups ($P<.05$). There was a statistically significant difference in terms of post retention between the control and experimental groups for the locator posts tested after 15 minutes ($P=.02$). There was no significant difference between the control and experimental groups when tested at 24 hours ($P=.274$). It can be concluded that there was a significant increase in the retention of locator posts cemented with self-adhesive resin cement (RelyX Unicem) at 24 hours after cementation compared to that after 15 minutes. Attachment pick-up had a significant influence on the retention of the locator post at 15 minutes.

Key Words: Locator overdenture post, post retention, timing of pick-up.

INTRODUCTION

Attachments are often used to improve the retention and stability of root-supported complete removable overdentures (CROs).^{1,2} Attachments are simple connectors consisting of two or more parts.³ One part is connected or cemented to the root, and the other part is luted to the overdenture's acrylic denture base.⁴

There are several types of overdenture post designs available to provide retention between the retained roots and the overdenture prosthesis.^{2,5} The most used design is based on the ball and socket for retention of the prosthesis.⁵⁻⁷ The locator root-retained attachment (Zest Anchors Inc., Escondido, CA, USA) is a modified ball-and-socket supra-radicular design, which consists of a matrix (female or post) and a patrix (male cap

Correspondence: Dr. Khalil Aleisa, Assistant Professor, Department of Prosthetic Dental Sciences, College of Dentistry, King Saud University, P.O. Box 27677, Riyadh 11427, Saudi Arabia. E-Mail: drimplant_prostho@yahoo.com

or keeper). The matrix is composed of a locator abutment and its post, which is cemented into endodontically treated roots. The matrix is a locator cap with an interchangeable nylon insert. Retention of the CRO is provided when the matrix engages the matrix. The patient is able manually to engage and disengage the CRO.⁸

For locator root-retained attachment, the matrix is picked up into the overdenture base during the same appointment as the matrix (locator post) cementation. It has been found that the denture is inserted and removed, on average, 20-30 times during the insertion visit.⁸ The insertion and removal of the denture can create axial shear forces on the locator post, which may disturb the cement during setting and eventually affect post retention.⁹⁻¹⁴ It has been postulated that the forces generated during the preparation of cast posts and cores may negatively affect the cement film between the endodontic post and the tooth, and timing of the pick-up of the attachment may affect post retention.⁹⁻¹⁴ However, there is no evidence in the literature to support this argument. Therefore, the objective of this study was to evaluate the effect of the timing of the pick-up of the male retentive attachment on the retention of the locator overdenture post cemented with adhesive resin cement. The research hypothesis tested was that the timing of the pick-up of the attachment would not affect the retention of the locator overdenture post.

METHODOLOGY

A master educational mandibular edentulous model was selected for this study (Columbia Dentoform®, Columbia Dentoform Corporation, Long Island City, NY, USA). The model was free of ridge undercuts, providing no resistance to vertical dislodgement of the denture. Using a tungsten carbide bur (H257 RF, Komet Gebr. Brasseler GmbH & Co. KG, Lemgo, Germany) in a straight handpiece was fixed on a laboratory milling machine (Milling unit BF 2, Bredent GmbH & Co. KG, Senden, Germany), two parallel holes (8mm diameter and 20mm depth) were prepared in the master mandibular model near the canine area, with 22 mm between them (Figure I). The master model was duplicated using silicone-duplicating material (Rema Sil, Dentaaurum GmbH & Co. KG, Ispringen, Germany) to produce the silicone mold. Auto-polymerizing acrylic resin (Eco-CRYL Press,

Protechno, Vilamalla, Spain) was then poured into the silicone mold to produce 48 resin models of the edentulous mandible.

Ninety-six extracted permanent single-rooted human teeth were sectioned horizontally at one mm incisal to the cemento-enamel junction, using a straight fissure carbide bur (57L, Komet, Gebr. Brasseler GmbH & Co. KG, Lemgo, Germany) in a high-speed handpiece under copious water-cooling, leaving a flat coronal surface. The post space was prepared in the root canal with a depth of 6 mm, using Peeso reamers (Pulpdent Corporation, Watertown, MA, USA), followed by a locator pilot drill (Zest Anchors Inc., Escondido, CA, USA) in a slow-speed handpiece under copious water-cooling. The root canals were not subjected to root canal therapy. The prepared post spaces were then rinsed with an air-water spray and dried with air and paper points. Ninety-six locator root posts (Zest Anchors, Escondido) with a standard length of six mm were used for this study. All of the posts fit passively when completely seated in their respective canals.

To retain the teeth in the acrylic resin model during testing, the roots were roughened with an inverted cone carbide bur (L34, Komet, Gebr. Brasseler), and a hole three mm coronal to the apex was prepared using a small, round carbide bur (H71-005, Komet, Gebr. Brasseler). Orthodontic wire (Remanium spring hard wire, Dentaaurum Inc, Ispringen, Germany) 0.5 mm in diameter was inserted into that hole and was twisted to increase the retention. The prepared roots were then mounted parallel to each other in the two previously prepared holes in the acrylic resin models with auto-polymerized acrylic resin (Eco-Cryl Cold, Protechno), using a dental surveyor (J.M. Ney Co., Bloomfield, CT, USA) to orient the post space to the vertical axis (Figure II).

Locator Post Cementation

After canal irrigation with saline and drying with absorbent paper points, the locator posts were luted with dual-polymerizing self-adhesive resin cement (RelyX Unicem, 3M, St. Paul, MN, USA). The cement was used according to the manufacturer's instructions. The cement capsule was activated for two seconds and was mixed automatically in a high-speed amalgamator (CapMix, 3M ESPE, Seefeld, Germany) for 10 seconds. Afterwards, the resin cement was

applied into the canal post spaces by means of an elongation tip (3M ESPE, Seefeld, Germany). The posts were also coated with the cement and were inserted to the prepared canals with finger pressure, and excess cement was removed flush with the top of the tooth. Light polymerization tip (3M Elispar 10s, ESPE, Seefeld, Germany) was held vertically immediately above the projecting end of the locator post and luting agent was polymerized for 40 seconds. Finger pressure was maintained for additional five minutes (Figure II).

Denture Resin Base Fabrication

Twenty-four mandibular acrylic denture bases were fabricated on 24 resin-duplicated models using auto-polymerized acrylic resin (Eco-Cryl Press, Protechno). Three screw-eyed metal hooks were fixed to the acrylic base, at the tripodal location, at the midsymphysal region and bilaterally in the retromolar pad areas to facilitate engaging the specimen using the chains during testing¹⁵ (Figure III). The passive seating of each denture base onto the corresponding resin model was achieved by grinding the binding areas.

Specimen Distribution

The forty-eight specimens were assigned to two groups of 24 each (Table 1). For the first group (experimental), the attachment patrx was picked up into the acrylic denture base. For the second group (control), no pick-up procedures were performed. Each group was then subdivided into two equal subgroups of 12 each, based on the time of the pulling-out of the locator posts after cementation, either 15 minutes or 24 hours.

Attachment Incorporation into the Acrylic Denture Base (pick-up)

For the pick-up procedure, the manufacturer's instructions were followed. A spacer and a metal housing with a black processing male (Zest Anchors) were placed on each cemented locator post. Then the pick-up procedure was performed using auto-polymerized acrylic resin (Jet Denture Repair, Lang Dental Manuf. Inc, Wheeling, IL, USA) using standard clinical procedure. A locator male removal tool (Zest Anchors) was used to remove the black processing male from the metal denture housing and to replace it with a white retentive nylon male attachment (Zest Anchors).

Vertically Directed Dislodging Forces

Three braided chains 17 cm in length were connected to a metal O-ring, which in turn was connected to a metal S-shaped hook and was secured in the upper jaw of a universal testing machine (Instron, Model 8500 Plus Dynamic Testing System, Instron Corp., High Wycombe, UK). The three chains were connected with 3 S-shaped hooks and were secured to the 3 screw-eyes metal hooks that were fixed on the acrylic denture base. The mandibular acrylic models, with their acrylic bases, were secured to the lower jaw of the Instron machine. Each denture base was dislodged 20 times from the corresponding model holding the cemented matrix. The dislodgement force was applied vertically (axially), directly parallel to the path of insertion and withdrawal, until denture base separation occurred, as shown in Figure 3. The vertical separation of the specimen tested was set at 50 mm per minute of crosshead speed.¹⁶

Testing Procedure

For both groups, each root/matrix specimen was vertically secured in the universal testing machine (Instron, Model 8500 Plus Dynamic Testing System). The force required to dislodge the locator post was determined using pneumatic grips that grasped the locator post head along its long axis. A constant loading rate of 0.5 mm /min was applied until cement failure was achieved. The peak force at the point of extrusion of the locator post from the test specimen was taken as the point of bond failure and was recorded in Newtons (N).

Statistical analyses of the data were performed using two-way analysis of variance (ANOVA) and a Student's t-test. All statistical analyses were performed at a 0.05 level of significance using statistical software (Statistical Package for Social Sciences 16.0, SPSS Inc, Chicago, IL, USA).

RESULTS

The means of the locator post retention measurements and the standard deviations are summarized in Table 1. The highest mean retentive force was recorded for the locator posts that were tested 24 hours after cementation without pick-up procedures (147.2 N), while the lowest retention was recorded for locator posts tested 15 minutes after cementation with pick-

up procedures (49.7 N). Locator post retention increased as the testing time increased.

Two-way ANOVA demonstrated that there were significant differences between the two tested times ($P < .0001$), as well as significant differences between the pick-up and no pick-up groups ($P = .019$) [Table 2]. Comparing the means of post retention with regard to testing time, Student's *t*-tests revealed statistically significant differences between 15 minutes and 24 hours for both the control and experimental groups ($P = .007$, $P = .002$, respectively). Moreover, *t*-tests showed significant differences between the means of the post retention measurements for the control and experimental groups of locator posts tested after 15 minutes ($P = .025$). There was no statistically significant difference in post retention between the control and experimental groups after 24 hours of cementation ($P = .274$).



Fig. 1: A master mandibular model with 2 parallel holes 22 mm apart in the canine areas



Fig. 2: Extracted teeth mounted in the resin model and locator posts cemented to the prepared post spaces



Fig. 3: Position of the chains for the 3-point vertical pull-out which connected to the metallic hook of Instron testing machine.

DISCUSSION

This study aimed to investigate the effect of the timing of attachment pick-up on the retention of locator posts. In this study, the white retentive type of the male locator attachment was used to provide maximum retention. The white male attachment provides five pounds of retention and is considered the regular or standard retentive attachment for this system.³ Clinically, at the CRO placement appointment, the prosthesis is inserted and removed by the clinician and patient approximately twenty times for adjustments and for patient education.⁸ Therefore, in this study, to simulate the clinical situation, each overdenture was dislodged twenty times with vertically (axially) directed dislodging forces parallel to the path of insertion and withdrawal, until prosthesis separation occurred. The Instron machine was set at a crosshead speed of 50 mm/min for the vertical separation of the denture bases. It has been reported that the approximate speed of the movement of the denture away from the ridge during mastication is 50 mm/min.¹⁶ Given the lack of data on the effect of the timing of attachment pick-up on the retention of locator posts, comparisons were made with similar studies that used different types of endodontic posts.

The results of the present study rejected the null hypothesis that the timing of pick-up attachments

TABLE 1. MEAN AND STANDARD DEVIATIONS (SD) OF FORCES IN NEWTONS (N) REQUIRED TO DISLODGE LOCATOR POSTS (N=24)

Groups	Experimental Manipulation	Mean±SD
I	After 15 minutes with attachment pick-up	49.7±14.1 ^a
II	After 24 hours with attachment pick-up	131.2±46 ^b
III	After 15 minutes without attachment pick-up	73.2±25.7 ^c
IV	After 24 hours without attachment pick-up	147.2±60 ^b

Mean values designated with different superscript letters are significantly different (P<0.05).

TABLE 2. SUMMARY OF TWO-WAY ANOVA OF MAIN FACTORS (TIME AND PICK-UP PROCEDURE) AND THEIR INTERACTIONS FOR LOCATOR POST RETENTION

Source	Sum of Squares	df	Mean Square	F-Value	P-Value
Time	144832.574	1	144832.574	88.034	<.0001*
Pick-up	9347.700	1	9347.700	5.682	.019*
Time x Pick-up	336.897	1	336.897	.205	.652
Error	151357.256	92	2350.621		
Total	1272407.303	96			

* P<.05, df: degrees of freedom

would not affect the retention of locator posts. The main finding of the present study was that the retention of locator posts subjected to attachment pick-up forces was significantly lower than that of an equivalent control group when pick-up was carried out 15 minutes after cementation. In addition, the retention of locator posts 24 hours after cementation was significantly greater than that of posts 15 minutes after cementation. This observation is somewhat in agreement with other studies that used endodontic posts.^{13,14} Al-Ali et al.¹³ examined the contribution of testing time on the interfacial strength of cast posts and cores to radicular dentin. The results of the current study demonstrated that the forces required to dislodge locator posts from their roots were significantly lower for groups tested at 15 minutes after cementation compared with those tested at 24 hours, irrespective of attachment pick up. Moreover, there was a 146.15% increase in locator post retention for the experimental group tested at 24 hours compared to the experimental group tested at 15 minutes. The results of this study showed that the retention of locator posts increased as the time of posts pull out testing was delayed. Generally, the posts tested after 24 hours showed higher retention than those tested at 15 minutes. This finding was also in agreement with other studies that used metallic endodontic posts.^{13,14} This finding also indicated that the luting agent used to cement the locator posts into the post spaces required a longer time to set completely than previously thought. Li and White¹⁷

reported that resin cements undergo gradual maturation for a period of up to 1 month before achieving a steady state. This finding may explain the resulting reduction in post retention values at 15 minutes compared to 24 hours. Immature cement that is disturbed during the setting time by any dislodging force could be decemented, and consequently, easier post dislodgement could occur.⁹⁻¹⁴ However, the choice of a different luting agent might have affected the results of the present investigation.

The results of the present study showed that the experimental group tested at 15 minutes required the lowest dislodgement forces. There was a 22% decrease in locator post retention when compared to the control group, while the experimental group tested at 24 hours showed a 16% reduction in locator post retention compared with the equivalent control group. Picking up the patrix at 15 minutes after locator post cementation could have had a detrimental effect on the integrity of the cement film resulting in locator post loosening. These findings were in agreement with the recommendations of previous reports, which suggested avoiding core preparation soon after post and core cementation.⁹⁻¹⁴ On the basis of these findings, it can be recommended that clinically, the timing of the pick-up of the locator overdenture patrix into the prosthesis should be performed 24 hours after the cementation of the locator post and matrix. Immediate or early pick-up of the patrix after cementation of the locator post

with RelyX Unicem cement showed decrease in retention of these posts.

In this *in vitro* study, the teeth were carefully selected for standardized size and quality. Nevertheless, considerable variations in post retention, which resulted in somewhat high standard deviations, were observed. Such variations have been noted in similar previous experimental studies using extracted human teeth.^{4,5,13-14} One of the limitations of this study was the use of extracted teeth with no alveolar housing or periodontal ligaments, in contrast to teeth in the oral cavity. In addition, teeth in the mouth are subjected to different types of forces, such as compression, shear, and torque, as well as tensile stresses. However, the testing methods used in this investigation differed from the mechanical conditions that exist intraorally. This study evaluated only one type of force, which was the axial tensile strength. This test was used to determine the values required to remove the locator post from the root canal. Therefore, the retentive bond values observed in this study cannot represent values that would be observed clinically. However, the results could be used as a relative comparison of the effects of different timing conditions and of attachment pick-up on post retention. Moreover, the tensile pull-out test has been used in several studies to assess the retentive capacity of cemented posts.^{9,10,13,14} Finally, the results and the subsequent conclusions of this study might not be relevant to other combinations of attachment overdenture posts and cements. Further investigations into this field are warranted.

CONCLUSIONS

Within the limits of this *in vitro* study, the following conclusions may be drawn:

1. There was a significant increase in locator overdenture post retention after 24 hours of cementation.
2. Attachment pick-up had a significantly negative effect on locator post retention when carried out 15 minutes after cementation.
3. Attachment pick-up had no significant influence on locator post retention after 24 hours of cementation.

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