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Effect of Ultrasonic Vibration on Post Removal in Extracted Human Premolar Teeth

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The purpose of this study was to determine the effectiveness of ultrasonic vibration in removing Paraposts from extracted teeth. Paraposts were cemented in mandibular premolars to a depth of 9 mm with zinc phosphate cement and the teeth placed in four groups. Group 1 received no vibration. Group 2 received vibration for 4 min, group 3 received vibration for 12 min, and group 4 received vibration for 16 min. Tensile forces were applied to the posts and mean dislodgment forces compared. The mean force (kg) required to dislodge the Parapost in group 1 was 24.92 ± 1.64 SEM; in group 2, 25.01 ± 1.80; in group 3, 24.08 ± 2.29; and in group 4, 12.41 ± 2.60. There was a significant difference between group 4 and groups 1 to 3 (p = 0.0003). Results of this study indicate that 16 min ultrasonic vibration is an effective method for removing Paraposts from human premolar teeth.

Ultrasonic instrumentation was originally introduced to endodontics by Richman in 1957 (1). Since 1957, a variety of applications have been proposed. Ultrasonic instruments have been advocated for canal cleaning and shaping (2); removal of silver points (3), objects (4), and pastes (5) from the root canal space; removal of posts (6); obturation (7); and root end preparation during surgery (8). With the advent of ultrasonics, sonic instruments were developed and advocated for many of the same endodontic procedures (9–12).

Ultrasonic units are either magneto-strictive, with electromagnetic energy being converted to mechanical energy (Cavi-Endo, Dentsply Intl., Inc., York, PA) or piezoelectric, wherein crystal deformation is converted to mechanical oscillations (ENAC, Osada Electric Co., Tokyo, Japan). Sonic devices operate on air pressure. In a recent study, Buoncristiani, et al. (13) compared the ability of ultrasonic and sonic instruments to remove #5 stainless steel Paraposts (Coltene/Whaledent, Inc., Mahwah, NJ) cemented in extracted teeth with zinc phosphate cement at a depth of 4 mm. The posts were subjected to constant traction, while the various instruments were applied. Results indicated a statistically significant difference between the ultrasonic instruments and the sonic instrument. The Densonic Sonic Scaler (Dentsply) was not effective in removing the posts. The median time required for post extraction for the ultrasonic units was 6.0 min for the Cavitron Cavi-Endo, 8.3 min for the ENAC instrument, and 41.2 min for the Neosonic (Amadent, Cherry Hill, NJ). Both the Cavitron Cavi-Endo and the ENAC were significantly faster than the Neosonic; however, there was no statistically significant difference between the two ultrasonic instruments.

The efficacy of ultrasonic instrumentation in the removal of posts under clinical conditions has not been scientifically demonstrated, and the vibration time required for removal of posts has not been established. The purpose of this study was (a) to evaluate the effect of ultrasonic vibration on the removal of Paraposts from human mandibular premolar teeth, and (b) to determine the vibration time necessary for loosening the post.

MATERIALS AND METHODS

Thirty-six extracted human mandibular premolar teeth were used in this study. The teeth were stored in 10% formalin before the experiment. The crowns were sectioned from the root with a high-speed handpiece and 557 fissure bur at a level 1 mm above the cementoenamel junction measured from the buccal surface. Access to the pulp chamber and radicular space was obtained with the 557 fissure bur. A working length was established by placing a small file to the apical foramen and subtracting 1 mm. Straight line access was established using #3 and #4 Gates Glidden drills. The canals were prepared apically to a size 40 K-type file with a step-back preparation to a size 60 file. Irrigation was accomplished using 2.5% sodium hyphochlorite between file sizes. The canals were dried and obturated with gutta-percha and sealer using lateral condensation. Immediately following obturation, post space was created using a 5 to 7 heated plugger to a depth of 9 mm. The canals were enlarged with a #4 Parapost drill. Following canal enlargement to accommodate the concomitant stainless steal Parapost, the canals were irrigated with 5.0 ml of sodium hypochlorite and dried with sterile paper points. Paraposts were then cemented in the canal to a depth of 9 mm with zinc phosphate cement (Fleck's, Mizzy, Inc., Cherry Hill, NJ) The roots were notched on the external surface, embedded in a cylinder of acrylic, and stored for a minimum of 1 month at 37°C and 100% humidity.

The 36 teeth were divided into four groups each consisting of nine teeth. Group 1 received no vibration and served as controls. The teeth in groups 2 to 4 were subjected to ultrasonic vibration using the ENAC ultrasonic unit and the ST-13 ultrasonic scaling

Table 1 Mean tensile force required to dislodge Paraposts (kg)

Group		Mean ± SE
1	No ultrasonic vibration	24.92 ± 1.64
2	4 Min ultrasonic vibration	25.01 ± 1.80
3	12 Min ultrasonic vibration	24.08 ± 2.28
4	16 Min ultrasonic vibration	12.41 ± 2.60

* Statistically significant difference ($p < 0.05$; $p = 0.0003$).

tip at high power. The vibration time for group 2 was 4 min; group 3, 12 min; and group 4, 16 min. Vibration was applied to the post at the posttooth interface by holding the tip perpendicular to the post in a horizontal plane. The tip was placed on the mesial, distal, buccal, and lingual surfaces for an equal period of time.

A Zwick 1445 Universal Testing Machine (Ulm, Germany) was used to apply tensile forces to the posts at a test speed of 5 mm/min.

Dislodgement forces were recorded and analyzed using a one-way ANOVA and the Tukey-Kramer Multiple Comparisons Test. A $p < 0.05$ was accepted as statistically significant.

RESULTS

Results of this study are summarized in Table 1. The mean force (kg) required to dislodge the Parapost in teeth receiving no vibration (Group 1) was 24.92 ± 1.64 SEM. The mean force required to dislodge Paraposts from teeth receiving vibration was 25.01 ± 1.80 SEM for group 2, 24.08 ± 2.29 for group 3, and 12.41 ± 2.60 for group 4. There was a statistically significant difference between group 4 and groups 1 to 3 ($p = 0.0003$).

DISCUSSION

Restoration of an endodontically treated tooth frequently requires the placement of a post to retain a core before placement of a coronal restoration. Should a post fracture or endodontic retreatment become necessary, the post must be removed. Factors that might effect the retention of a post are: (a) the type (custom versus proprietary), (b) the post design (parallel versus tapered, smooth versus serrated, and threaded versus nonthreaded), (c) the cementing medium (zinc phosphate cement, polycarboxylate cement, composite, and glass ionomers), and (d) the depth of embeddment (14, 15). Each of these factors plays a role in retention, and a variation of any one factor can change the retention of the post. The cementing medium plays a critical role in post removal, because disruption of the cement bond securing the post is the most likely mechanism of action for ultrasonic vibration.

Ultrasonic vibration has been advocated as a method of post removal. However, there is limited scientific evidence evaluating the method. In the Buoncristiani, et al. (13) study, the posts were only embedded 4 mm, and they were subjected to constant traction during the experiment. In clinical situations, it is recommended the post be embedded to a depth at least equal to the length of the clinical crown (14, 15). In addition, it is not feasible to apply a constant tensile force to the post while utilizing the ultrasonic instrument to break the post dentin cement bond. The current study attempted to replicate a clinical situation. Results are similar to the Buoncristiani, et al. (13) study. Variations in the vibration time required to dislodge the post may be attributed to the differences in post diameter, the depth of embeddment, or the experimental design.

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