Comparative In Vitro Effectiveness of Closed Root Debridement With Fine Instruments on Specific Areas of Mandibular First Molar Furcations. I. Root Trunk and Furcation Entrance*

Francisco J. Otero-Cagide and Barbara A. Long

The purpose of this study was to compare curets with a small blade to slim ultrasonic inserts on their efficacy in removing artificial deposits from the root trunk and furcation entrance areas of mandibular molars using an in vitro model simulating a Clinically closed root debridement approach. The study was conducted on 100 artificial mandibular first molars (50 right side and 50 left side) with anatomical roots. Root trunks, furcation entrances, and furcation areas of each molar were colored by a coat of black model paint. The teeth were fixed in a custom acrylic model and maintained in a firm position by modified acrylic occlusal splints. The root areas were covered with a heavy rubber dam imitating gingival tissue. The model was attached to a mannequin and mounted on a dental chair. Fifty molars (25 right, 25 left) were instrumented with the experimental curets and an equivalent number of molars with the ultrasonic inserts. The instrumentation was carried out by one experienced operator, spending 4 minutes on each molar. The instrumented areas were individually analyzed to determine the percentage of deposits remaining, using a computerized imaging routine system. One-way analysis of variance was conducted to test for differences between both types of instruments. Results revealed that the curets were significantly more efficient ($P < 0.01$) than the ultrasonic inserts in removing paint from both root trunks and furcation entrances. These findings should be corroborated in a clinical study to determine the potential value of the instruments tested during initial therapy or supportive care of involved mandibular furcations. J Periodontol 1997;68:1093–1097.

Key Words: Furcation/therapy; dental instruments; comparison study; scaling/methods; scaling/instrumentation; tooth root; molar.

Several long-term clinical trials have demonstrated that non-surgical and surgical elimination of subgingival plaque and calculus to achieve biologically acceptable root surfaces constitutes an essential component of appropriate periodontal therapy and, with subsequent proper postoperative supportive periodontal care, results in successful management of progressive periodontal disease.1–5 However, when molar teeth with furcation involvement were evaluated specifically, the long-term response to conventional therapy differed from non-molar teeth. Hirschfeld and Wasserman1 retrospectively reported that of 499 well-maintained periodontal patients with 387 mandibular first and second molars having furcation involvement, 61 (15.7%) were extracted over an average period of 22 years. In contrast, 37 cuspids with severe destruction in the same group had 0% mortality. The remaining patients in their study with a lower level of maintenance showed a higher percentage of multirooted tooth loss. In a prospective clinical trial evaluating four types of periodontal therapy over 5 years, Ramfjord et al.4 reported that 16 of the 17 teeth lost from periodontal disease had furcation involvement.

Pihlstrom et al.6 investigated the response of molar and non-molar teeth to either scaling and root planing alone, or to scaling and root planing followed by a modified
Widman flap. In moderately deep probing depths, the results indicated less reduction in probing depth and some loss of attachment on molars compared to non-molars for either method of therapy. At deep probing depths, there was no difference in clinical attachment levels between tooth types regardless of the treatment method. Kalkwarf et al.7 noted that following non-surgical and surgical modalities of therapy, there was a tendency for attachment loss to occur in furcation regions during the second year of supportive care regardless of the type of therapy rendered.

The reduced success rate of non-surgical and surgical non-root-resective or non-therapeutically therapy arresting the progression of periodontal disease on the furcation region may depend on the complex morphological characteristics of the area and limited access, which interfere with an adequate root preparation.8-11 A limited number of clinical investigations have focused on the effectiveness of root debridement specifically in the furcation area.10-17 Also, the designs of these studies have presented variations. Several studies compared conventional ultrasonic and hand instruments with and without surgical approach. The results demonstrated more effective debridement when surgical access was combined with ultrasonic instrumentation13 or if rotary instrumentation was used in conjunction with hand instruments.16,17 A few studies done in vitro have evaluated various newly designed ultrasonic and sonic inserts in furcations with a closed approach. One report revealed no differences between these instruments,18 while others19,20 found a ballpoint slim ultrasonic insert superior in the debridement of furcations.

A newly designed curet for anterior teeth has proven to be more effective than conventional curets in debriding narrow root surfaces in an in vitro model.21 The blade length is 50% shorter than a standard curet and has been designed to adapt more accurately to irregular root topography. The curets in the set for posterior teeth have never been evaluated experimentally. Taking together the evidence that newly designed ultrasonic inserts and curets appear to have better debridement results in areas with difficult access than their conventional counterparts, and since there is no study in the periodontal literature comparing these instruments in furcations, the aim of the present study is to compare curets with a small blade (approximately 2 mm long × 1 mm wide) to ultrasonic inserts (approximately 0.5 mm in diameter at the pointed tip) in their ability to remove artificial deposits from specific areas of the furcation region of mandibular first molars in an in vitro model, simulating a clinically closed root debridement approach. This study concentrates on the results obtained on the root trunk and furcation entrance. The findings on the furcation area will be reported later.

Figure 1. Photograph of experimental model showing the first molars fixed into position by means of an acrylic occlusal splint, with the root trunk and furcation entrance painted prior to rubber dam coverage.

MATERIALS AND METHODS

Preparation of Teeth and Study Model
One hundred artificial mandibular first molars (50 right side and 50 left side) with anatomical roots were used in this experiment. This type of molar was selected to eliminate the anatomical variations associated with natural teeth. The experimental areas consisting of the root trunk, furcation entrance on both the buccal and lingual aspects, and furcation area were uniformly coated with a layer of black model paint, attempting to imitate plaque and/or calculus deposits. The dental study model where the molars fit was duplicated in acrylic and sockets created in the areas of the mandibular first molars by removing acrylic. This allowed easy removal and replacement of the molars and simulated periodontal bone loss (Fig. 1). Two modified acrylic occlusal splints were constructed to maintain the molars in a firm position in the custom typodont. One splint had no extension of acrylic on the buccal sides at the level of the first molar to allow good access for instrumentation. Similarly, the second splint was devoid of lingual flange on the first molars. The root area was covered with a heavy rubber dam from the cemento-enamel junction to simulate gingival tissue. The model was attached to a mannequin and mounted on a dental chair, recreating a clinical situation.

Experimental Instrumentation and Analysis
Half of the molars (25 right and 25 left) were instrumented with the experimental curets,1 and an equivalent number of molars were debrided with the ultrasonic inserts3 at a medium power setting with adequate irrigation as recommended by Holbrook and Low.22 Each molar was

---

1Kilgore International, Inc., Coldwater, MI.
2Vision curvettes 11-12, 13-14, Hu-Friedy, Chicago, IL.
3Siilme EWP-12L-R, Dentsply Equipment Division, York, PA.
instrumented for 4 minutes. Two minutes were allotted for the buccal aspect and 2 minutes for the lingual surface. Instrument change time was not taken into consideration. All instrumentation was done by an experienced dental hygienist. Following instrumentation, each molar was removed from the model and placed in acrylic blocks which had been previously created to hold each molar with the same orientation for analysis of either the buccal root trunk and furcation entrance or the corresponding lingual areas. A computerized imaging routine was used to measure the extent of colored material removed from the experimental areas. The accuracy and precision of this system have been found to be high and eliminate the numerous technical problems associated with manual planimetric techniques. The computerized imaging routine has been previously described. Briefly, the imaging routine involved capturing and processing the image of each experimental area separately using a combination of a stereomicroscope (10× magnification), video camera, video-board, and computer monitor. To ensure that identical sample areas were evaluated, surface templates of four areas (buccal root trunk, buccal furcation entrance, lingual root trunk, and lingual furcation entrance) were produced for the right molars and four for the left molars. By using gray-scale thresholds in conjunction with a flood-fill algorithm, the area of black paint within the surface template could be accurately measured and the percentage of remaining colored material calculated. One-way analysis of variance was used to test for differences between the results achieved by both types of instruments on the areas studied.

**RESULTS**

A total of 98 molars were analyzed. One molar from each group was eliminated because of damage during the experiment.

The results showed that complete removal of all deposits from the areas examined was not attained. Table 1 summarizes mean percentages and standard errors of the remaining simulated deposits on the areas studied after using two different types of instrumentation. In the buccal root trunk, 17.2% and 2.3% were left after using the experimental ultrasonic tips and curets, respectively. For the lingual root trunk, the ultrasonic tips left 10% and the curets left 4.2%.

At buccal as well as lingual furcation entrances, the curets gave lower numbers of simulated deposits (7.5% and 6.5%) than those resulting from the use of the ultrasonic tips (55.2% and 42.6%).

It was evident that the root trunks were more effectively debrided than the furcation entrances. P measurements also indicated that the curets exhibited a superior effect in removing deposits from all the experimental areas in comparison to the results obtained with the ultrasonic tips (P < 0.01).

**DISCUSSION**

This study was designed to compare the debridement effectiveness of two recently introduced fine instruments on the root trunks and furcation entrances of mandibular first molars. The instruments compared seem to facilitate access into deep probing depths and to enable a better adaptation on irregular radicular areas. The results clearly demonstrated that the tested curets more effectively removed the artificial deposits than the ultrasonic tips from the areas studied. In addition, the root trunks were debrided more effectively than the furcation entrances.

These findings were based on an in vitro model which simulated a closed subgingival root planing procedure on mandibular first molars with a class II or III furcation involvement, and a probing depth of approximately 5 mm during initial preparation or supportive periodontal treatment. The experimental model attempted to recreate a particularly difficult clinical situation and had the advantage of standardizing some of the variables involved in this technique-sensitive procedure, so that the efficacy of the instruments investigated could be specifically evaluated. Identical root surfaces were used, and the experimental areas had the same amount of artificial deposit. Also, a predetermined instrumentation time of 4 minutes was used for each molar, which was similar to the time period spent by Patterson et al. and Takacs et al. after removing artificial calculus from furcations of mandibular molars.

In addition, a highly experienced and competent operator performed all the instrumentation to reduce the variability in results. Expertise could appear as a limitation since the outcomes may not represent the standard of debridement achieved by every therapist. However, it has been suggested that more experienced operators seem to enhance subgingival scaling in furcation areas in comparison to less experienced operators.

On the other hand, this in vitro model had several limitations that must be considered. The black paint used as artificial deposit cannot be compared to plaque and calculus in terms of its adherence and texture; however, it had been used by others. Removal of the paint depends on an active contact of the instrument with the root sur-
face; thus, the extent of removal of this material is a good indication of the instrument’s efficacy in debridement.

Similarly, there is a limited comparability of a rubber dam to gingival tissue, but this material restricted direct vision of the operator into the furcations and did not affect the debriding ability of the instruments tested. Takacs et al.\textsuperscript{20} used the same material and reported no problems. Accessibility was not a limitation for either type of instrument, and the higher debridement achieved by the curettes might have been the result of a better contact of the instrument with the root surface, which reflected the ability to adapt to irregular topography; consequently, more mechanical root coverage occurred during a root debridement type of stroke.

Morphological variations in natural teeth should be taken into account when interpreting the results obtained in this investigation. Because the furcations of the molars used had an identical entrance width of approximately 1 mm, the effectiveness demonstrated by the curettes may not apply to narrower furcations.

Recently, five different machining inserts were tested by Takacs et al.\textsuperscript{20} to determine their efficacy in removing artificial calculus from molar furcations. They used a similar experimental model as ours, except that the molars were not fixed in a dento-model but in blocks that could be held in the hand while the instrumentation took place. They demonstrated that a universal sonic scaler was the most effective instrument in furcation entrances. It left 22.7% of remaining deposits at the buccal entrance and 17% at the lingual entrance. Comparing these data with our findings, it is clear that a more efficient debridement was obtained using the curettes, with percentages of 7.5% and 6.5% for the same areas. However, it was interesting to note that after using the same ultrasonic tip, our study showed 55.2% and 42.6% of remaining deposits for the buccal and lingual entrances compared to their study, which obtained lower percentages of 39.5% and 33.9%, respectively. This could have been due to the fact that their non-fixed experimental model facilitated the instrumentation, and the method of scoring was not very precise.

Clinical studies have demonstrated that molar furcations with adjacent probing depths of 4 mm or greater responded less favorably to root debridement than nonfurcated sites with similar probing depths after 2 years.\textsuperscript{10,24} It appears that the limited response to instrumentation therapy in molar furcation sites is due to poor accessibility to the furcation area, as well as irregular root topography. In recent years, the need for extensive removal of cementum has been questioned since it has been shown that endotoxin is weakly bound to the external layer of cementum.\textsuperscript{25–27} Thus, instrumentation should aim at disrupting or removing subgingival plaque and calculus from the periodontally involved root rather than aiming at the removal of deeper cemental tissue. It has been reported that complete removal of subgingival plaque and calculus in molar furcations is rarely achieved even with an open approach.\textsuperscript{11,13,16,17} Conventional curets and ultrasonic inserts were used in those studies.

In conclusion, within the limits of this study, the results indicate that curets demonstrated to be superior to the thin ultrasonic inserts with respect to debridement of artificial deposits on the root trunks and furcation entrances of mandibular molars. It is suggested that the findings of this study should be corroborated in a clinical investigation based on clinical parameters of periodontal disease to determine the potential value of small-bladed curets in removing plaque and calculus on involved mandibular furcation areas during initial therapy or supportive care.

Acknowledgments
This study was supported by a grant from the Dean’s Medical Research Council, College of Dentistry, University of Saskatchewan.

REFERENCES

Send reprint requests to: Dr. Francisco J. Otero-Cagide, Dental Clinic, University of Saskatchewan, 105 Wiggins Road, Saskatoon SK S7N 5E4, Canada.

Accepted for publication March 27, 1997.