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Molar furcation entrance and its relation to the width of curette blades used in periodontal mechanical therapy

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dos Santos KM, Pinto SCS, Pochapski MT, Wambier DS, Pilatti GL, Santos FA. Molar furcation entrance and its relation to the width of curette blades used in periodontal mechanical therapy.

Abstract: *Aim:* The purpose of this research was to evaluate molar furcation entrances and the width of periodontal curette blades used in periodontal instrumentation. *Materials and methods:* One hundred extracted molars (50 upper and 50 lower) were analysed. The furcation entrances were measured using orthodontic wires of different predetermined diameters: 0.4, 0.5, 0.6, 0.7, 0.8 and 0.9 mm. McCall 17–18, Gracey 5–6 and Gracey 5–6 mini-five curette blades were measured at their anterior (AT), middle (MT) and posterior (PT) thirds by a single trained investigator, through the use of a digital caliper. *Results:* The results showed significant differences ($P < 0.0001$) in relation to furcation entrances. The buccal upper molar furcations showed the narrowest dimensions. In relation to the blade diameter, significant differences among the instruments were found for their MT and PT ($P < 0.0001$), but not for the AT ($P = 0.183$). Significant differences were found among curette manufacturers. Nineteen per cent of evaluated furcations presented entrances <0.60 mm and 75% of the blades at their AT presented width >0.60 mm. *Conclusions:* These findings demonstrated that some molar furcation entrances could not be adequately instrumented with the tested curettes. The use of other hand instruments, such as periodontal files, rotating instruments and ultrasonic devices should be taken into consideration during periodontal therapy.

Key words: calculus; hand instrumentation; periodontal instruments

Introduction

Manual instrumentation of root surfaces affected by periodontal disease comprises two phases – scaling and root planning. The objective of scaling is to remove calculus and the dental plaque from crown and root surfaces. During the root planning the operator tries to eliminate cementum or surface dentin that is rough, impregnated with calculus or contaminated with toxins or micro-organism. These procedures in combination to a strict daily oral hygiene programme, allows the patients to achieve and maintain periodontal health (1–6).

Periodontal curettes are the most used manual instruments in dental scaling and root planning. The variety of shapes and sizes of the periodontal curettes assures that they reach different anatomic structures such as furcations, narrow pockets, areas with depressions or radicular concavities (7–12).

Molars with furcation involvement present certain difficulties during periodontal treatment, due to anatomic characteristics of the region such as concavities, convexities and ridges (13). Furcation width, radicular divergence, root trunk length, furcation entrance size and the remaining bone support, all must be taken into consideration in the treatment planning and prognosis of periodontal disease (14–16).

Pretzl *et al.* (17) assessed tooth-related factors contributing to tooth loss over a period of 10 years after completion of active periodontal therapy showing that furcation involved teeth have a worse prognosis (13% tooth loss) than single rooted teeth (5%). Similar results were found by Dannewitz *et al.* (15) and Faggion *et al.* (16). Considering the above, even if the patient performs an effective dental plaque control, instruments used in furcation areas should have blades with ideal width to allow an adequate access to root surface instrumentation (14, 18).

In studies of curette blade width and different curette manufacturers, it was found that in general, over half of the curettes used have blades that are larger than the furcation entrance (18, 19). In addition, it has been found that furcation aperture was similar in the first upper and lower molars, while first molar furcations were larger than second molar furcations (20).

The aim of this study was to examine the relationship between molar furcation entrance size and the width of periodontal curette blades used during periodontal disease therapy.

Materials and methods

Furcation analysis

The 100 molars used (50 upper and 50 lower molars) were taken from patients due to prosthetic and periodontal reasons. All patients signed a consent form to ensure that they were freely donating teeth to this study (Approved by the Research Ethics Commission – Process number 02338/04).

The teeth were cleaned, identified according to crown morphology and then stored in a 10% formaldehyde solution. Only molars with normal furcations were used (molars with fused roots or injuries close to the furcation area were excluded from the sample).

Teeth were analysed under a stereoscope (LEB-3 Lambda®; Lamedid, Barueri, Brazil) at 6.3X, and those presenting residual tissue and/or root calculus were submitted to superficial instrumentation with an ultrasonic equipment (Jet-Sonic®; Gnatus, Ribeirão Preto, Brazil), using a 10P tip under low power, using water as a coolant agent. Finally, the teeth were brushed with detergent and water, using a toothbrush.

Furcation entrance sizes were measured with a stereoscope (LEB-3 Lambda®) at 1.5X, using different predetermined orthodontic wires of 0.4, 0.5, 0.6, 0.7, 0.8 and 0.9 mm (±0.01 mm) diameter (Dental Morelli Ltda, Sorocoba, Brazil). These wires were placed one at a time into the furcation entrances until the widest one size was perfectly adapted between the roots and at the same time touched the most coronal portion of the furcation dome. Thus, seven furcation size classes were established: (1) 0–0.4 mm, (2) 0.4–0.5 mm, (3) 0.5–0.6 mm, (4) 0.6–0.7 mm, (5) 0.7–0.8 mm, (6) 0.8–0.9 mm and (7) ≥0.9 mm. Each furcation was measured three times within a 48-h interval and the median value was used in the analysis.

Curette analysis

Mc Call 17–18 (n = 16), Gracey 5–6 conventional (n = 16) and 5–6 mini-five (n = 16) curettes from four different manufacturers were used, in a total of 96 instruments (available in Brazil and distributed by Neumar™ – Neumar Instrumentos Cirúrgicos Ltda, São Paulo, Brazil; Trinity™ – Trinity Indústria e Comércio Ltda, Me, São Paulo, Brazil; Hu-Friedy™ – Hu-Friedy Mfg. Co., Inc., Chicago, IL, USA and Millenium™ – Golgran Ind. Com. de Instrumentos Odontológicos Ltda, São Paulo, Brazil).

Curette width was measured in two ways (Fig. 1): first, the facial surface curette back (FS-B – facial surface and the most convex back part); second, the lateral surface and curette back

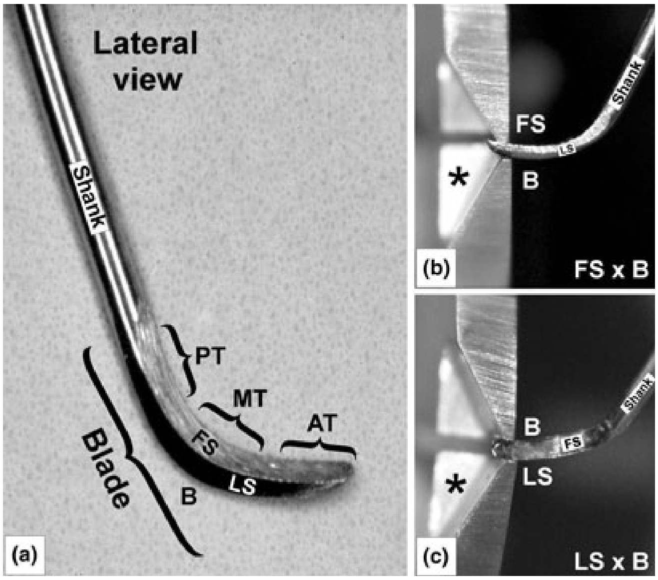

Fig. 1. Curettes – obtaining blade width. (a) Gracey curette showing the division into thirds (PT – posterior third; MT – middle third and AT – anterior third), where B – Back, FS – facial surface, LS – lateral surface. (b) Measure FS × B. (c) Measure LS × B. (*) Digital caliper. Blade width = LS × B + FS × B/2.

(LS-B – cutting edge until the upper ridge of the back in the intersection with FS). Finally, the mean of these parameters in the anterior (AT), middle (MT) and posterior (PT) thirds was taken. A digital caliper (Mitutoyo™ – 150 × 0.01 mm – Mitutoyo Sul Americana Ltda, Suzano, Brazil) was used for each measurement, which was performed three times per instrument, in a random order, with a 48-h interval apart. The mean value was used in the analysis.

To standardize the measurement of furcations and instruments, one single trained examiner carried out a calibration process consisting of two sequential measurement of 50 molar furcations and 20 curette blades, with a 48-h interval. The intra-examiner concordance analysis was calculated.

The statistical analysis was carried out using the software SPSS™ for windows version 11.5.1 (Chicago, IL, USA). The intra-examiner concordance rate for furcation entrances was confirmed by the weighted Kappa test. The reproducibility of the blade measurement data was tested with the intraclass correlation coefficient. For comparison of furcation entrance measures, the non-parametric Mann–Whitney and Kruskal–Wallis (Dunn *post hoc* test) tests were used. Analysis of the curette blade width was tested with ANOVA (Tukey *post hoc* test). The significance level was of 5% (α = 0.05).

Results

The Kappa test revealed good intra-examiner concordance (K = 0.62) for furcation entrance measurement. The reproducibility of blade width measures was consistent, with α = 0.97 (intraclass correlation coefficient).

In Fig. 2, the distribution of furcation entrance measures can be observed (mm) for upper and lower molars, in which 21% of the upper molars and 15% of the lower ones present entrances narrower than 0.60 mm. No differences were observed between upper and lower molars (P = 0.130 – Mann–Whitney). The comparison between the first and second upper molars did not present significant differences, similar results

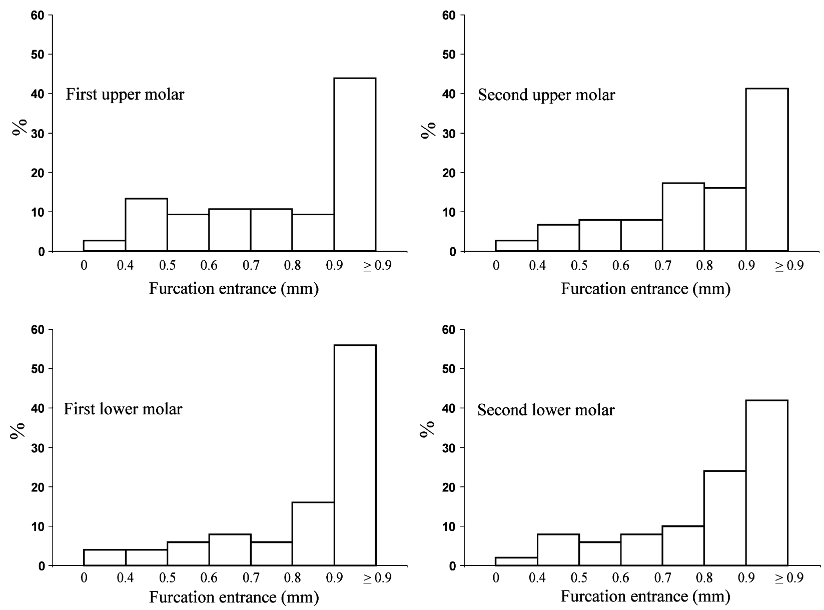

Fig. 2. Percentage distribution of the furcation entrance measures (mm) of molars. Non-significant differences between upper and lower molars (P = 0.130); between first and second upper molars (P = 0.599) and between first and second lower molars (P = 0.268). Mann–Whitney Test.

were found in the comparisons of the lower molars (respectively $P = 0.599$ and $P = 0.268$ – Mann–Whitney test).

The upper buccal furcation presented 36% of the entrances narrower than 0.60 mm and the upper mesial showed the widest measure, having only 10% of the entrances narrower than 0.60 mm (Fig. 3). Significant differences were observed between the entrance measure of the upper buccal furcation and all the others ($P < 0.0001$ Kruskal–Wallis test, Dunn *post hoc* test).

Table 1 shows the mean width of curette blades Mc Call 17–18, Gracey 5–6 and Gracey 5–6 mini-five at their different thirds. At the AT, the Mc Call 17–18, Gracey 5–6 and Gracey 5–6 mini-five curettes, respectively, had the following measures: 0.63 ± 0.12, 0.67 ± 0.06 and 0.63 ± 0.05 mm (non-significant differences $P = 0.183$ – ANOVA). A statistically significant difference was observed at the middle and PTs ($P < 0.0001$ – ANOVA, Tukey *post hoc* test), and also for the manufacturers of the curettes used in this study ($P < 0.05$ – ANOVA, Tukey *post hoc*-test).

Figure 4(a) shows the accumulated frequency of curette blade widths and the relative frequencies of furcation entrances. Seventy-five per cent of the curettes ($n = 72$) showed blade width >0.60 mm, thus, not being adequate for thorough instrumentation of 19% ($n = 47$) of the furcations. Considering the curette type, 22% ($n = 21$), 29% ($n = 28$) and 24% ($n = 23$) of the Mc Call 17–18, Gracey 5–6 and Gracey 5–6 mini-five blades, respectively, would not be effective for the treatment of furcations having ≤0.60 mm (19%) entrance.

Figure 4(b–d) shows the accumulated blade width frequency considering the type and manufacturer and the relative furcation entrance frequency. Considering the Mc Call 17–18 curettes at the AT, 100% ($n = 32$) of the Trinity curettes presented a <0.60 mm width, allowing an adequate treatment of 81% ($n = 203$) of the furcations. Nevertheless, Hu Friedy curettes would not allow the treatment of 55% ($n = 137$) of the furcations. Considering the Gracey 5–6 curettes, Hu Friedy instruments would have an adequate width for the treatment of 72% ($n = 180$) of the furcations (≥0.70 mm), while the same result would be expected for 75% of the Neumar and Trinity curettes and only for 25% of the Millenium curettes. The Gracey 5–6 mini-five curettes, Neumar and Trinity would be appropriate for the treatment of 72% ($n = 180$) of furcations, while only 50% of the Hu Friedy curettes would have the same performance.

Discussion

This study did not demonstrate differences between the furcation entrance measures of upper and lower molars (45% and 31% of the furcations were narrower than 0.80 mm

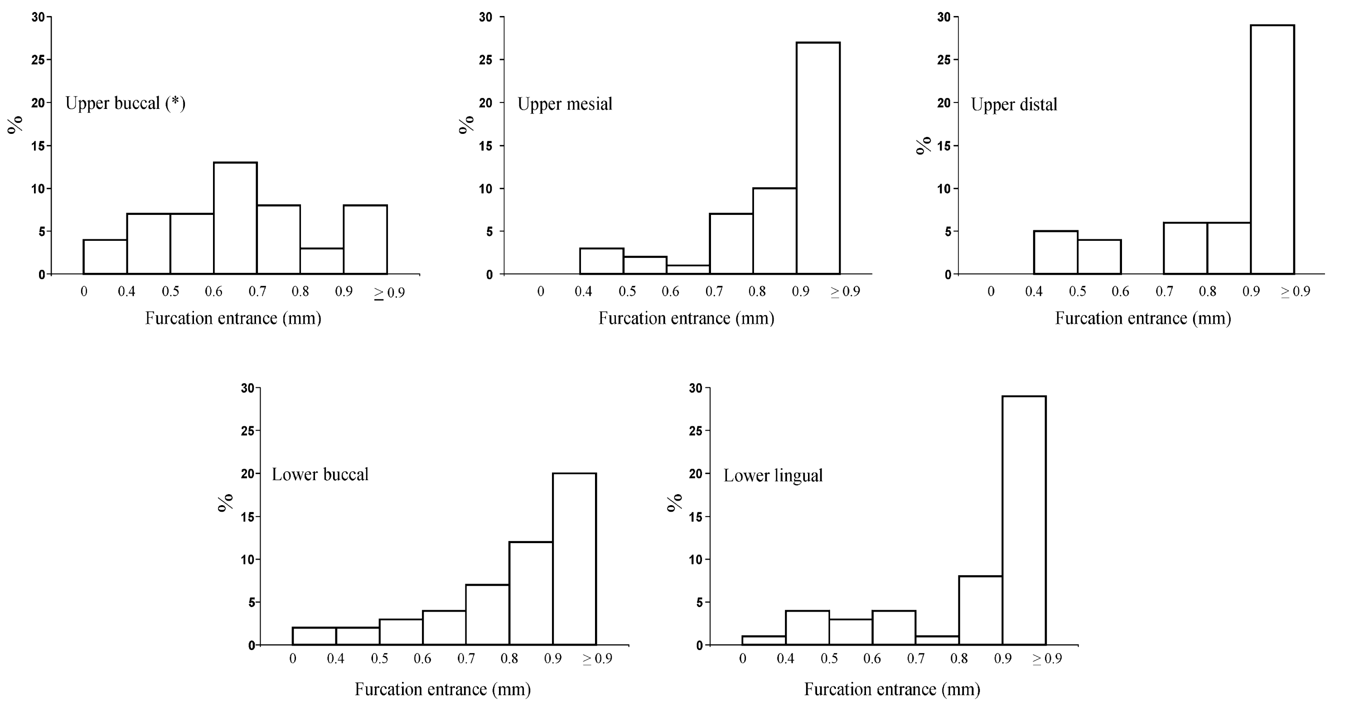

Fig. 3. Percentage distribution of the furcation entrance (mm). Significant differences between furcations (*) upper buccal 'versus' upper lingual, lower buccal and lower lingual ($P < 0.0001$ – Kruskal Wallis test and Dunn *post hoc* test).

Table 1. **Mean values (±SD) of blade widths (mm) of Mc Call 17–18 (MC), Gracey 5–6 (G) and Gracey 5–6 mini-five (GM) curettes at their anterior (AT), middle (MT) and posterior (PT) thirds according to the different manufacturers**

	MC (n = 32)			G (n = 32)			GM (n = 32)		
Brands	AT	MT	PT	AT	MT	PT	AT	MT	PT
Neumar (n = 8)	0.65 ± 0.03	0.89 ± 0.05	1.09 ± 0.04	0.67 ± 0.06	0.77 ± 0.07	0.97 ± 0.07	0.64 ± 0.05	0.71 ± 0.02	0.84 ± 0.02
Trinity (n = 8)	0.48 ± 0.04	0.78 ± 0.03	1.00 ± 0.03	0.66 ± 0.06	0.74 ± 0.06	0.88 ± 0.07	0.57 ± 0.03	0.63 ± 0.04	0.77 ± 0.02
Hu Friedy (n = 8)	0.79 ± 0.04	0.85 ± 0.04	0.95 ± 0.03	0.61 ± 0.02	0.70 ± 0.02	0.81 ± 0.02	0.70 ± 0.04	0.75 ± 0.04	0.87 ± 0.03
Millenium (n = 8)	0.61 ± 0.03	0.81 ± 0.03	1.03 ± 0.03	0.73 ± 0.05	0.79 ± 0.04	0.92 ± 0.04	0.62 ± 0.01	0.66 ± 0.01	0.76 ± 0.03
Mean (± SD)	0.63 ± 0.12	0.83 ± 0.06 #	1.02 ± 0.06 §	0.67 ± 0.06	0.75 ± 0.06 #	0.89 ± 0.08 §	0.63 ± 0.06	0.69 ± 0.06 #	0.81 ± 0.05 §

*P < 0.05, #P < 0.0001, §P < 0.0001, significant difference (ANOVA and Tukey *post hoc* test).

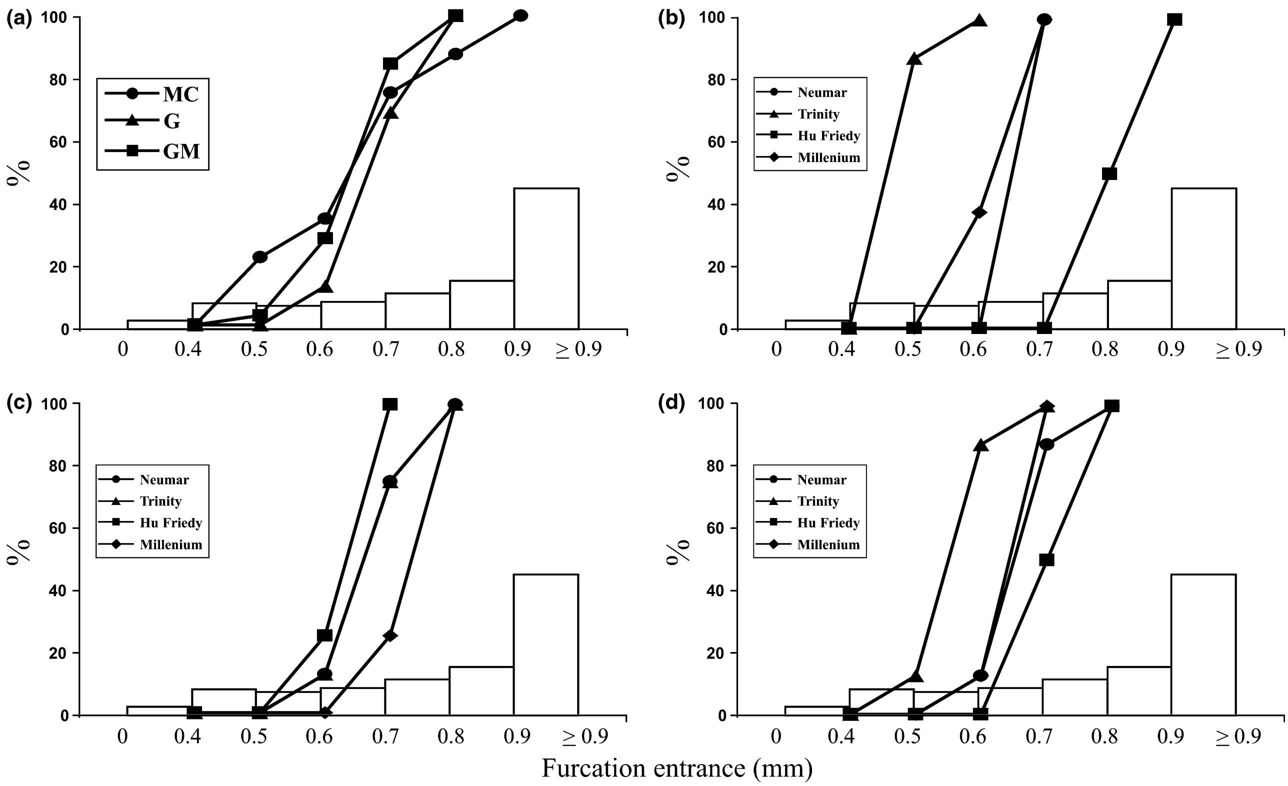

Fig. 4. Distribution frequencies (accumulated) of curette blade width (lines) at the anterior third and (relative) frequencies of molar furcation (histogram) entrances (mm). (a) Frequencies (accumulated) of Mc Call 17–18 (MC), Gracey 5–6 (G) and Gracey 5–6 mini-five (GM) curette blade widths. (b) Frequencies (accumulated) of Mc Call 17–18 curette blade widths from different manufacturers. (c) Frequencies (accumulated) of Gracey 5–6 curette blade widths from different manufacturers. (d) Frequencies (accumulated) of Gracey 5–6 mini-five curette blade widths from different manufacturers.

respectively). These data are different from those reported by Chiu *et al.* (19) who found that 85% and 58% of the furcations of upper and lower molars were narrower than or equal to 0.75 mm. By analyzing the teeth separately, first and second upper molars had 47% and 43% of furcations narrower than 0.80 mm respectively. Such differences showed not to be significant. The same happened with the first and second lower molars (28% and 34% respectively). Hou *et al.* (14) and Hou *et al.* (20) found significant differences among molars (first and second upper and lower molars), in which the second molars presented the smallest furcation entrance measures.

The percentages of furcation entrances narrower than 0.60 mm found in this study were: upper vestibular – 36%; upper mesial – 10%; upper distal – 18%; lower vestibular – 14% and lower lingual – 16%. When we considered the furcations narrower than 0.80 mm, we obtained: upper vestibular

– 78%; upper mesial – 26%; upper distal – 30%; lower buccal – 36% and lower lingual – 26% (significant differences were found between the upper buccal furcation and the others). Studies by Bower (18), Chiu *et al.* (19), Hou *et al.* (20) also revealed that the buccal furcation of the upper teeth presented the highest frequencies of entrances narrower than or equal to 0.75 mm (85%, 79% and 70% respectively).

The probable reasons for the differences found in the studies may be related to the ethnic group studied. In this research, teeth from Latin American patients were used. Bower (18) used teeth from North Americans and Chiu *et al.* (19), Hou *et al.* (14) and Hou *et al.* (20) from Chinese. The different methodologies employed for the evaluation may also have been responsible for the differences, as Bower (18) used calibrated metal tips with 0.25 mm and Hou *et al.* (20) used a digital measuring system.

Curettes are manual instruments widely used for scaling and root planning, fundamental steps performed during periodontal disease therapy. Mc Call and Gracey curettes can be used for subgingival instrumentation in regions of difficult access as narrow pockets, radicular concavities and furcation areas. For scaling and root planning in these regions the blade width plays an important role, as the blade should have such a width to allow effective root planning, without causing excessive injuries to the adjacent gingival tissue as well as being adequately resistant to breakdown (1, 7, 11, 18). In this study, Mc Call 17–18, Gracey 5–6 (conventional), Gracey 5–6 mini-five curettes were evaluated. Although Gracey 5–6 curettes were specifically designed for the anterior region and not for molars, the differences among all the Gracey curettes lie in the shank curvature and not in the blade characteristics, while the Gracey 5–6 mini-five curettes have 2 mm narrower blades than the conventional curettes.

Blade width variations could be demonstrated among the curettes investigated in this study, especially in the MT and the PT, with no differences at their AT. Bower (18) studied the width of different curettes and found a variation from 0.70 to 1.10 mm among the instruments. Chiu *et al.* (19) corroborated the results from Bower (18), with a difference ranging from 0.76 to 1.0 mm. The results found in these two studies were very similar to the present one, in which the blade width variation was: AT = 0.48–0.79 mm; MT = 0.63–0.89 mm; PT = 0.76–1.10 mm.

The variation found among these studies probably occurred because of the differences in the methodologies, as in Bower's (18) study the measurements were performed only at the AT of the frontal face, with a 0.05 mm accuracy. Chiu *et al.* (19) carried out measurements at 1 mm of the tip, without mentioning which faces have been evaluated. To characterize blade width, both measures (frontal and lateral face) should be considered, because during periodontal treatment, the instrument blade can be used in angles varying from 60° to 80°; therefore the instrument blade measured at only one face may not be reasonable to characterize its width.

Differences among the curette manufacturers were observed. For the Mc Call 17–18 curettes, Trinity presented the smallest (0.48 ± 0.04 mm) and Hu Friedy the largest width (0.79 ± 0.04 mm). Brazilian manufacturers produce Mc Call curettes with a sharper tip compared with the American manufacturers. Probably this design variation may have contributed to the differences found. Gracey 5–6 and Gracey 5–6 mini-five curettes also revealed differences from one manufacturer to another, although of smaller range (0.12 and 0.13 mm respectively).

In this study, 19% of the evaluated furcations presented entrances <0.60 mm and 75% of the blades, at their AT, presented widths >0.60 mm. Considering that root instrumentation in the furcation region is mainly performed by the AT, it could be stated that 34% of the blades of Mc Call 17–18 curettes, 13% of Gracey 5–6 and 28% Gracey 5–6 mini-five curettes would not be adequate for an effective treatment at these furcations. Analyzing the curettes from different manufacturers, for the Mc Call 17–18, Hu Friedy curettes would not adequately fit 55% of the furcations. With the Trinity, only 19% of the furcations could be treated. With the Gracey 5–6 curettes, the Hu Friedy curettes would be proper for the treatment of 72% of the furcations, while the same access would only be possible for 25% of the Millenium curettes. With the Gracey 5–6 mini-five curettes, 39% of the furcations would not be adequately treated with the Hu Friedy curettes.

A periodontal curette with narrow blades could be more effective in hard-to-reach regions (4). Singer *et al.* (10), when comparing *in vitro* the effectiveness of conventional and reduced blade curettes, found that instruments with smaller blades were more effective. Similar results were also found by Otero-Cagide and Long (5), who demonstrated *in vitro* that the Gracey mini-five curettes were more effective in the removal of deposits in furcation regions than the tips used in ultrasonic equipments. Chiu *et al.* (19) suggests that a better instrumentation of these areas could be achieved by using curettes that have already been frequently used and sharpened because they present with a reduction on their blade width.

Periodontal curettes with wide blades may render curettage procedures difficult, but they should not be too narrow, especially at their middle and PTs due to an increase in the risk of breaking the instrument during the therapy. The results revealed that all the analysed instruments had a progressive increase on their blade widths from the AT towards the middle and PTs, which seems to be important to prevent curette breaking during periodontal instrumentation.

The fact that blade width did not present significant differences among the evaluated instruments at their ATs does not imply that they are equally effective in subgingival instrumentation because not only the blade width but also the extension, cutting edge and blade angle in relation to the shank of the curette must also be taken into consideration.

During scaling and root planning there must be an adequate space to allow the instrument blade certain movement amplitude against the root surface. Otherwise, if the blade has the same width as the furcation entrance it probably will not provide the instrument an effective stroke to remove biofilm and dental calculus from the root surface.

This study confirms the access difficulties that may be found for the instrumentation of inter-radicular regions, considering the furcation entrance as well as the blade width of the employed instruments. Molar furcations are still considered as one of the most frequent failure points in periodontal therapy. Thus, the use of other hand instruments, such as periodontal files, rotating instruments and ultrasonic devices with special tips should be taken into consideration to achieve a greater effectiveness during periodontal therapy.

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