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Editorial

C. ESTRELA, MSc, PhD

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Much to do about research

The increase of dental schools in Brazil has been a matter of preocupation. First of all, how has the qualification for teaching been considered? What are the criteria stablished to choose a professional responsible for dozens of students?

The editors of this Journal believe that willingness is an important factor, but it is not enough to overcome the complexity involved in teaching-learning process. There should be emphasis on the formal qualification of the prospective lecturers through MSc and PhD degrees and the practice of research as a routine.

Simple but consistent research can be done independent on the finantial dificulties a school may have. Students should be involved in the practice of research, to overcome the mythic aspect assumed by many practitioners.

Ethics involved in research should also be a matter of consideration. The limits of human and animal testing have long been discussed in Europe and North America. The stablishment of guidelines for studies in Brazil and South America could help interaction among the research institutions, thus enhacing what we all seek for: serious and consistent research as an attitude towards teaching.

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SHAPING OF SIMULATED ROOT CANALS BY THE M4 HANDPIECE AND SAFETY HEDSTROM FILES WHEN ORIENTED INCORRECTLY

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The aim of this study was to assess the shaping ability of the M4 reciprocating handpiece and Safety Hedstrom files in simulated canals when the files were oriented incorrectly in relation to the canal curvature, that is, with their ground surface on the outer aspect not the inner. A total of 40 simulated canals of various angles and positions of curvature were prepared using a standard regimen. Pre- and post-operative longitudinal images of the canals were taken with a video camera and stored and manipulated in a computer with image analysis software. The presence of canal aberrations and the amount of material removed as a result of preparation were determined from composite images of superimposed pre- and post-operative views. Zips and elbows were observed in 9 out of 40 canals with no significant difference between canal shapes. Ledges were found in 27 canals and perforations in only 1. Excess removal of material from the inner aspect of the canal at the curve to create a danger zone was found in 19 canals, but only in those with 40° curves. Significant differences in total canal width between the canal types were seen at the zips and elbows ($P<0.05$) and at the danger zones ($P<0.001$). Transportation at the danger zones varied significantly between the canal types ($P<0.001$). Under the conditions of this study, the M4 handpiece and Safety Hedstrom files when used incorrectly were less than ideal and created many aberrations including the removal of excess resin along the inner aspect of canals at the curve. Original canal shape had a substantial influence on the outcome of shaping procedures. Care should be exercised when using Safety Hedstrom files to ensure they are oriented correctly.

Key words: Canal preparation, shaping, reciprocating handpiece, simulated canals

INTRODUCTION

Adequate preparation of the root canal system is an important factor in root canal therapy [14, 20]. For gutta-percha, the optimum shape is a continuously tapering and conical form with the smallest diameter at the apical limit of instrumentation [19]. In curved canals it is important that preparation does not straighten the canal unduly since this can result in an hour-glass shape and irregularities such as ledges and perforations. Poor shape and the presence of aberrations may compromise the long-term success of treatment by making cleaning less efficient and obturation more difficult. Of most concern is the transportation of canals at the apex, to create a zip [21], and at the danger zone alon the inner aspect of the curve with the potential for strip perforations [2].

A number of hand preparation techniques have been described which aim to provide the optimum shape. Unfortunately, evidence suggests that although modern instruments and techniques have led to an improvement in the final canal shape the ideal form is not achieved consistently [4,6,7,12]. In addition, most hand preparation techniques are time consuming and technically demanding since they require the use of a variety of burs combined with large numbers of instruments often used at different working lengths.

The unpredictable outcome and complex nature of hand preparation techniques has directed attention towards mechanical methods of canal preparation. The reciprocating handpiece was developed many years ago [13,18] and is used extensively throughout the world. Although clinicians rely on such devices for their safety and cleaning potential [15,18] most research suggests that the use of files in reciprocating handpieces creates poor canal form with the strong possibility of aberrations and poor flow characteristics [1,17,22]. However, although clinical evaluations are rare, at least one report has concluded that the technique produces a success rate comparable to most conventional hand techniques [23].

Recently, interest in reciprocating devices has returned with the development of the M4 handpiece (Kerr Corporation, Romulus, Mi, USA). Although the device is similar to the original concept of an alternate clockwise/ counterclockwise partial rotation, the new device rotates through only 30° either side of zero rather than 90°. Furthermore, the instruments recommended for use with the M4 are modified Hedstrom files made from stainless steel (Safety Hedstrom files, Kerr Corporation) which have been ground on one side to reduce the aggressive cutting potential of the conventional files along the inner aspect of canal curves [4,6,7]. No reports on the shaping ability of the M4 handpiece used in conjunction with Safety Hedstrom files have been published. One important factor to be considered during the use of the system is the fact that the operator must ensure the ground, flattened surface of the file is oriented towards the inner aspect of the canal curve during use. It is conceivable that errors could be made in this respect by accident or through misuse by inexperienced

clinicians.

The aim of this study was to determine the shaping ability of the M4 handpiece and Safety Hedstrom files when oriented incorrectly during the preparation of simulated root canals in resin blocks. The effect of canal shape was determined by assessing development of canal irregularities and the amount and location of resin removed from the canal wall during preparation.

MATERIALS AND METHODS

Construction of simulated canals

A total of 40 simulated root canals in plastic blocks were constructed using a technique described previously [11]. Annealed silver points (size 20) used as templates to form the canals were precurved using a canal former prior to embedding in clear resin. Four canal shapes were fabricated, all with a radius of 16 mm :

- 20 degree curve, 8 mm from the canal orifice
- 20 degree curve, 12 mm from the canal orifice
- 40 degree curve, 8 mm from the canal orifice
- 40 degree curve, 12 mm from the canal orifice

Instruments

Canal preparation was completed with an M4 handpiece (Figs. 1 and 2) and Safety Hedstrom files (Fig. 3). Figure 3 shows clearly the ground and flattened surface designed to be used along the inner aspect of the curve, however, in this study the flattened surface was oriented along the outer aspect, that is, incorrectly.

Preparation of simulated canals

Canals were prepared by one operator. Ten canals of each shape were prepared. Each canal was prepared short of the actual end point to a length of 16 mm. During preparation, each resin block was placed in a holder to aid handling and to ensure that the process was carried out with purely tactile sensation, however, the direction of the curve of each canal was always known. Copious irrigation with water was used throughout and was introduced with a 27 gauge needle and a syringe. Irrigant was used between each instrument to a total volume of 50 ml for each canal.

A size 15 Safety Hedstrom file in the M4 handpiece was advanced to the full length of the canal, with the flattened flutes oriented to the outer curvature of the canal, and the handpiece activated. The file was allowed to float in and out of the canal with no attempt at circumferential or anticurvature filing. This process was repeated with files 20 through to 30 with the flattened flutes always oriented incorrectly. The procedure continued with a stepback phase whereby a size 35 instrument was used 1 mm short of the full working distance, followed by a sizes 40, 45 and 50 at distances of 2, 3 and 4 mm from the end-point of preparation. Care was taken to ensure the flattened flutes were always towards the outer aspect of the curve and that the files simply floated in and out of the canal. Copious irrigation with water was performed throughout.

Assessment of canal preparation

Preparation time. The time taken to prepare each canal was recorded in minutes and seconds. It included only active instrumentation and not irrigation time or the time taken to change files.

Change of working distance. Following preparation the master apical file was introduced as far as possible and its length within the canal measured to the nearest 0.5 mm. The change in working length was computed by subtracting the final length from the pre-operative length, 16 mm.

Blockages. A record was kept of those canals which became blocked with debris during preparation.

Canal aberrations. Commercial digitising image equipment (Seescan, Cambridge, UK) was customised and used to produce images of the simulated canals for comparison and evaluation. Two images of each canal were produced, the first prior to preparation, and the second at the end of preparation. The equipment allowed the two digitised images of each canal to be superimposed so that changes could be assessed. Comparisons were made between the pre-operative and post-operative images to determine the development of canal aberrations. Comparisons were also made between the images when evaluating the amount of resin removed during preparation.

A simple direct visual assessment was made of the presence or absence of the following canal irregularities :

Apical zip: irregular widening of the area at the end-point of the canal where resin had been removed largely from the outer aspect of the curve (Fig. 4).

Elbow: a narrow region of the canal associated with and coronal to a zip (Fig. 4).

Danger zone: excessive removal of resin from the inner aspect of the curve always associated with a narrower region more coronally (Fig. 5).

Coronal narrow: the narrowing of the canal associated with and coronal to a danger zone (Fig. 5).

Perforation: a separate and distinct false channel created towards the end-point of the canal which was not confluent with the original canal and which occurred along the outer aspect of the curve (Fig. 6).

Ledge: a distinct irregularity (step) along the outer wall of the canal at or near the curve not substantial enough to be considered a perforation (Fig. 7).

Amount of resin removed. The amount of resin removed was determined on the external and internal aspects of the curve and carried out perpendicular to the axis of the original canal. Measurements were made at a variety of positions along the canal length but specifically at the widest part of the zip and elbow (when present) and at the widest point of the danger zone and coronal narrow region (when present).

Transportation. the lateral movement of the centre of the post-operative canal away from the centre of the pre-operative canal, was computed from the measurements of resin removed from the external and internal aspects of the curve at the aberrations.

Recording, storage and analysis of data

Data was recorded directly onto coding sheets and then keyed into and stored in a desktop computer. Following error and range checks, the data was analysed using MINITAB for Windows (Minitab Inc., State College, PA, USA), an interactive statistics package. Analysis of variance (ANOVA) was used to evaluate the affect of canal

shape on removal of resin and preparation times. A Chi-square analysis was used to evaluate the effect of canal shape on the number of aberrations and the incidence of blockages.

RESULTS

Preparation time

The time taken to complete preparation of the canals is shown in Table 1. Analysis of variance confirmed there was no significant variation in preparation time between canal types. Overall, the average time taken to prepare the specimens was shortest for the 20°, 12 mm canals and longest for the 40°, 8 mm canals. For each position of curve (8 mm or 12 mm) the 40° canals took longer to prepare than the 20° canals. The results were inconsistent for each angle of curve (20° or 40°).

Change of working distance

The mean loss of working distance was 0.25 mm in 20°, 8 mm canals with no change noted in 40°, 12 mm canals. In the 40°, 8 mm and 20°, 12 mm canals the change in working length resulted in the canals becoming longer by, on average, 0.2 and 0.05 mm respectively. The difference between canal shapes was significant ($P<0.005$).

Blockages

No canals became blocked with resin debris.

Canal aberrations

Apical zips and elbows. Overall zips and elbows were found in 9 (23%) of the canals (Table 2). The majority were created in 20°, 12 mm and 40°, 12 mm canals (3 each); only three 8 mm specimens were affected. The difference between canal shapes was not statistically significant. The distance of the zips and elbows from the end-point of preparation did not vary significantly by canal shape.

Perforations. Only 1 perforation was found. It occurred in a 40°, 12 mm canal 1.45 mm from the end-point of preparation.

Ledges. Ledges were found in 27 (68%) specimens (Table 3). Despite the minor variations there was no significant difference between the canal shapes for the incidence of ledges. The ledges occurred between 2 and 3 mm from the end-point of preparation but there was no significant difference between canal shapes for this parameter.

Danger zones. Excessive removal of resin from the inner aspect of the canal curve occurred in a total of 19 (48%) canals. Table 4 highlights the incidence of danger zones in the various canal shapes. All but one of the specimens with 40° curves were affected; no defects were seen in 20° canals. The difference between canal shapes was statistically significant ($P<0.001$). By definition, the incidence of coronal narrow regions was identical.

The positions of the danger zones in relation to the end-point of preparation varied significantly ($P<0.001$) between the canal shapes. In the 40°, 8 mm canals the distance was on average 7.7 mm and in the 40°, 12 mm canals, 4.2 mm. This trend was also apparent for the narrow regions which occurred 11.2 mm and 6.7 mm from the end-point respectively.

Width measurements

The mean total widths of zips and elbows in the various canal shapes are listed in Table 5. Analysis of variance confirmed there were significant differences between canal shapes ($P<0.05$) for both aberrations. For each position of curve (8 mm or 12 mm) the width was greater in 40° canals, whilst for each degree of curvature (20° or 40°) the width was greater in 8 mm canals.

Table 6 provides data on the width of resin removed from the outer aspect of the curve at zips and elbows. The trends between canal shapes were similar to the total widths and the differences were significant for both aberrations ($P<0.05$).

The mean total widths at the danger zones and coronal narrow regions are given in Table 7 and the mean widths of resin removed from the inner aspect of the curves in Table 8. There were highly significant differences ($P<0.001$) between canal shapes for both aberrations. Overall, the danger zones were more pronounced in 40°, 8 mm specimens. A similar trend for excess removal of resin along the inner aspect of canals was noted in 40° specimens at other positions along the canal length, particularly at the apex of the canal curve, a position more towards the end-point than the danger zones, as well as more coronally at a point half-way towards the orifice on the straight part of the canals.

Table 9 describes the amount of absolute transportation at the zips, that is, ignoring whether the direction of transportation was towards the inner or outer aspect of the curve. Despite the trend for transportation to be greater in 40° canals analysis of variance confirmed this was not significant. Table 10 highlights the degree of transportation at the danger zones, the clear differences between canals was significant ($P<0.001$). Transportation was also significantly greater in 40° specimens compared to 20° at the apex of the curve and along the straight portion of the canals.

Table 1. Mean time (min) taken to prepare canals

Canal shape			
20°, 8 mm	40°, 8 mm	20°, 12 mm	40°, 12 mm
4.33	*4.42*	*3.91*	*4.10*

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Table 2. Incidence of zips and elbows by canal shape

Canal shape				
20°, 8 mm	**40°, 8 mm**	**20°, 12 mm**	**40°, 12 mm**	**All**
2	1	3	3	9

Table 3. Incidence of ledges by canal shape

Canal shape				
20°, 8 mm	**40°, 8 mm**	**20°, 12 mm**	**40°, 12 mm**	**All**
8	9	5	5	27

Table 4. Incidence of danger zones and coronal narrow zones by canal shape

Canal shape				
20°, 8 mm	**40°, 8 mm**	**20°, 12 mm**	**40°, 12 mm**	**All**
0	10	0	9	19

Table 5. Mean total width (mm) of zips and elbows

	Canal shape			
	20°, 8 mm	**40°, 8 mm**	**20°, 12 mm**	**40°, 12 mm**
Zip	0.46	0.68	0.43	0.59
Elbow	0.44	0.67	0.40	0.55

Table 6. Mean width (mm) of resin removed from the outer aspect of the original canal at the zips and elbows

	Canal shape			
	20°, 8 mm	**40°, 8 mm**	**20°, 12 mm**	**40°, 12 mm**
Zip	0.156	0.350	0.126	0.227
Elbow	0.105	0.241	0.073	0.133

Table 7. Mean total width (mm) of danger zone

	Canal shape	
	40°, 8 mm	**40°, 12 mm**
Danger	0.857	0.677
Narrow	0.663	0.553

Table 8. Mean width (mm) of resin removed from the inner aspect of the curve at the danger zone and coronal narrow

	Canal shape	
	40°, 8 mm	**40°, 12 mm**
Danger	0.357	0.195
Narrow	0.105	0.054

Table 9. Absolute transportation (mm) of canals at zips

Canal shape			
20°, 8 mm	**40°, 8 mm**	**20°, 12 mm**	**40°, 12 mm**
0.060	0.175	0.056	0.095

Table 10. Absolute transportation (mm) of canals at danger zones

Canal shape	
40°, 8 mm	**40°, 12 mm**
0.165	0.060

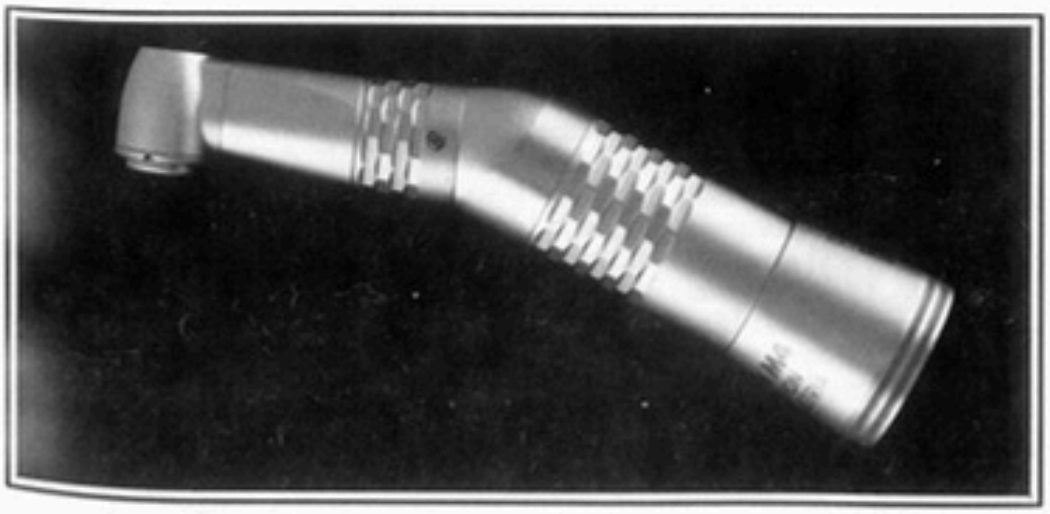

Fig. 1
Lateral view of M4 Handpiece

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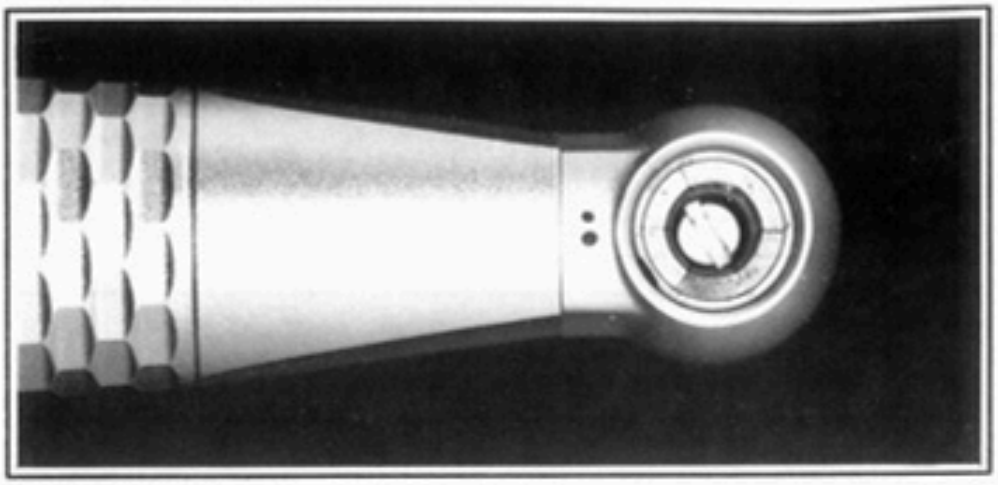

Fig. 2
Inferior view of head of M4 handpiece showing chuck for handles of conventional hand instruments

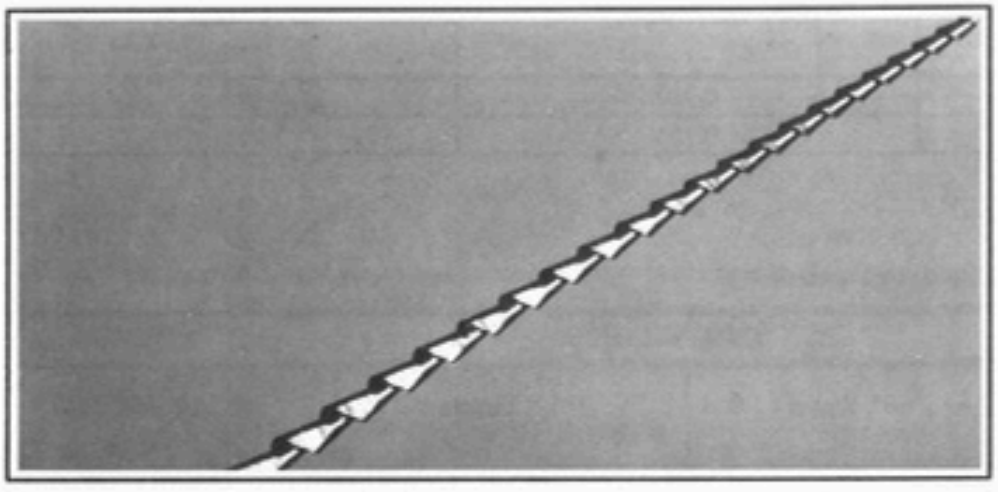

Fig. 3
Safety Hedstrom file showing ground flattened surface

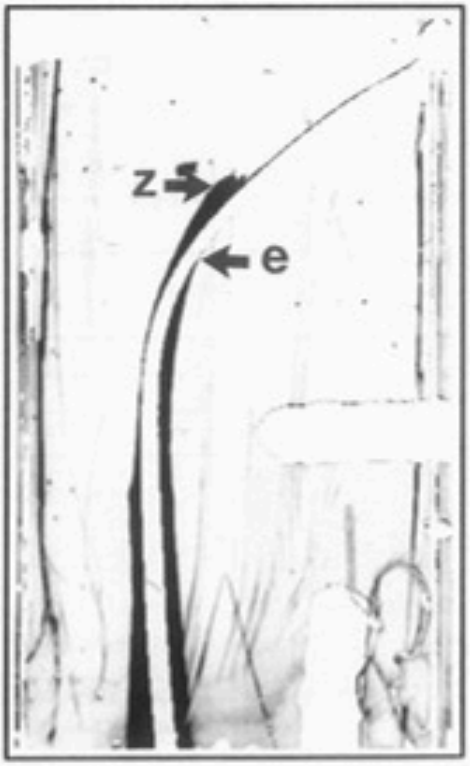

Fig. 4
Composite photograph of a superimposed pre-operative (white region) and post-operative (black region) image of a simulated canal showing a zip (z) and elbow (e)

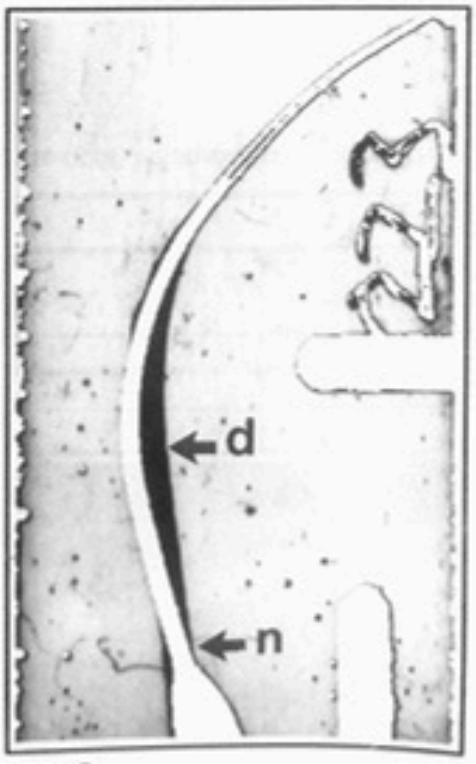

Fig. 5
Composite photograph of a superimposed pre-operative and post-operative image of a simulated canal showing a danger zone (d) and region of coronal narrowing (n)

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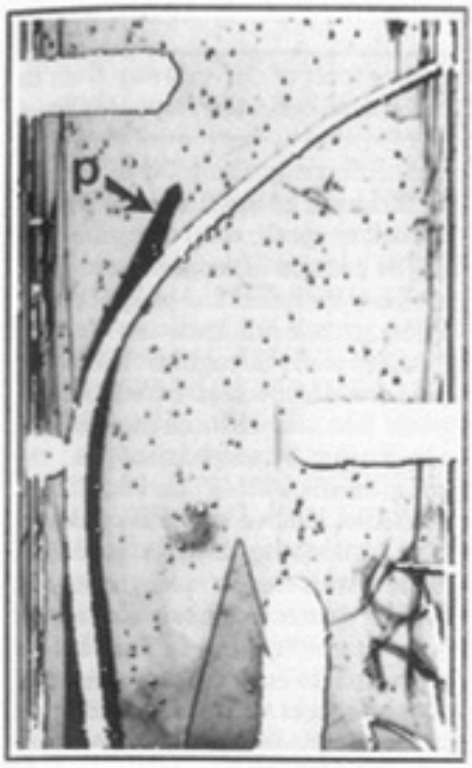

Fig. 6
Composite photograph of a superimposed pre-operative and post-operative image of a simulated canal showing a perforation (p)

Fig. 7
Composite photograph of a superimposed pre-operative and post-operative image of a simulated canal showing a ledge (l)

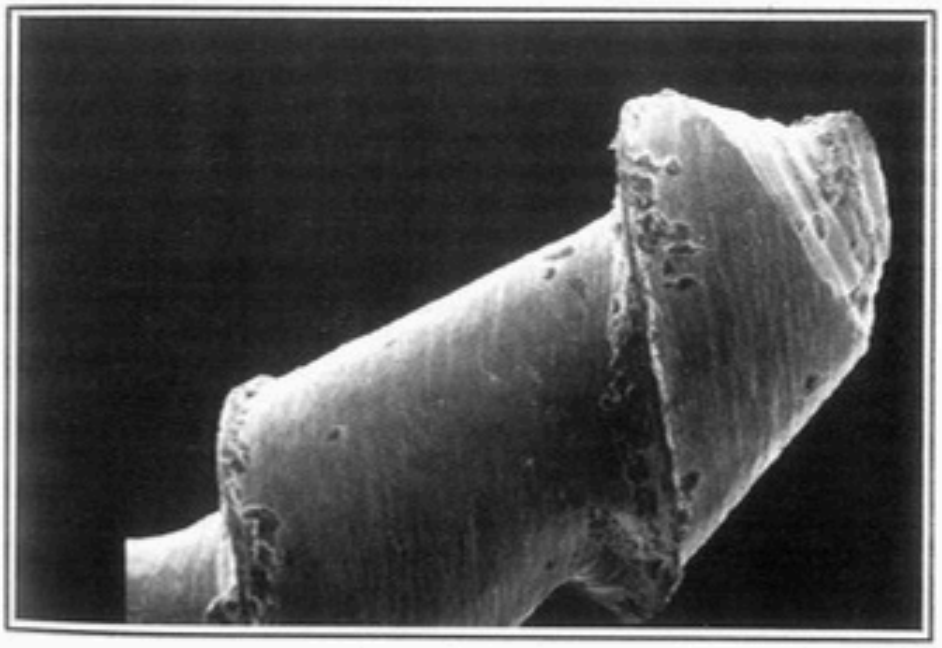

Fig. 8
Scanning electron photomicrograph of the tip of a Safety Hedstrom file showing sharp blade (original magnification x250)

DISCUSSION

The advantages of using simulated canals in clear resin blocks to assess instruments and preparation procedures have been identified previously both for hand techniques and mechanical devices [3,16]. The purpose of this study was not to produce a definitive description of the action of the M4 handpiece and Safety Hedstrom files but rather to provide a clear account of the effectiveness of the instruments under strictly controlled conditions *in vitro*. In particular, the ability to test the technique using standardised and predetermined canal shapes removed a variable that is difficult to control using real teeth. However, because of the use of resin rather than dentine, a degree of caution should be exercised in the interpretation of the results and their extrapolation to the clinical situation.

During the study, each group of canals was prepared in an identical way using a standardised technique developed and practised extensively prior to the study proper. Care was taken to check the preparation technique with the clinician responsible for the development of the files and shaping methodology (L.S. Buchanan, personal communication 1995). The incorrect use of Safety Hedstrom files was thought to be important and required investigation. Clearly, there is a likelihood that the files will be used incorrectly in clinical practice and the outcome of that eventuality must be determined.

The preparation time represents the efficiency of the technique. Speed itself is not the main criterion by which canal preparation should be judged, however, when taken together with other parameters it provides a useful indicator

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of instrument performance and efficiency. This study highlighted the fact that canal shape did not affect preparation time. This is in contrast to hand preparation techniques [6] which have been associated with significant increases when used in canals with severe curves.

Overall, preparation time was rapid and shorter than that achieved with hand instruments tested under identical conditions when filing or balanced force techniques were used [6-9]. Clearly, the M4 handpiece also has other advantages such as simplicity, reduced hand and finger fatigue, safety and convenience [15,18]. However, these are only relevant if the technique creates the desired canal shape.

Blockages with resin debris did not occur during preparation to confirm the advantage of the Hedstrom file noted when used by hand in a filing motion [6,12]. Clearly, the reciprocating motion did not influence this instrument characteristic.

Most canal irregularities are thought to be caused by inflexible files straightening within the canal. Classically, this phenomenon produces an hour-glass preparation [21]; the apical region is transported producing a zip on the outer aspect of the curve whilst excess preparation on the inner aspect of a curve causes a danger zone. Theoretically, aberrations would be expected to increase as canal curvature increases and as file flexibility decreases [6,12].

Overall, the incidence of zips was relatively high with 23% of specimens affected. Indeed, this is higher than noted previously with Hedstrom files manipulated by hand [4,7] and may be the influence of the more rapid mechanically generated movement. However, close inspection of some instrument tips using scanning electron microscopy revealed a trend for the instruments to be far from blunt (Fig. 8). Although not every instrument was examined under scanning electron microscopy the potential for at least some instruments to have aggressive tips must be of concern. Clearly, such tips would predispose to zip formation, particularly when manipulated so rapidly in the handpiece. It must be appreciated that the grinding procedure used to reduce the cutting blades on the one side does not extend near the instrument tip. Indeed, the flattening process appears to effect only the coronal portion which would be in contact normally in the region of the curve.

Ledges on the outer aspect of curves away from the end-point of preparation was again the responsibility of the instrument tips confounded by instrument flexibility. Although not measured in this study, flexibility of stainless steel Safety Hedstrom files must be less than ideal with the result that their tips tended to cut the resin along the outer aspect of the curves. The creation of ledges would affect the obturation process since spreaders and pluggers could snag and fail to penetrate to their full distance.

The creation of danger zones through the removal of excess resin along the inner aspect of curves was an expected finding given that the instrument was used incorrectly. However, it must be emphasised that this problem only occurred in canals with 40° curves. Clearly, in 20° canals the files did not remove excess resin despite the fact that the cutting blades along the file were of the normal pattern. Whether such danger zones would be produced in real teeth using dentine as the substrate is open for debate, what is in no doubt, however, is that the instruments have the potential to create excess removal of material along the inner aspect of curves when used incorrectly with the ground surface towards the outer aspect.

Interestingly, the removal of material along the inner aspect of curves occurred over a large area and not at one point. It was also worse in 8 mm canals, that is, those with long sweeping curves. These features are characteristic of conventional Hedstrom files when manipulated by hand [7] and used in identical canal shapes.

CONCLUSION

Under the conditions of this study, preparation of simulated canals with Safety Hedstrom files oriented incorrectly and manipulated by an M4 handpiece created a substantial number of zips, ledges and danger zones. The incidence of these aberrations was influenced significantly by canal shape. Clearly, clinicians should be careful when orienting the Safety Hedstrom files to ensure the ground flat surface is towards the inner aspect of the curve.

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IN VITRO ANALYSIS OF GAS RELEASED USING DIFFERENT CONCENTRATIONS OF SODIUM HYPOCHLORITE WITH 3% HYDROGEN PEROXIDE

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Gas released from the chemical reactions between sodium hypochlorite (0.5, 1.0, 1.5, 2.0, and 2.5%) and 3% hydrogen peroxide was investigated. The number of moles of released gas was measured to determine the pressure generated by the gas released in a closed system connected to a mercury manometer. The pressure data were submitted to the Clapeyron equation (P.V=n.R.T) and the number of released gas moles was determined. The differences among the multiple comparisons were statistically significant and the linear correlation between the concentration of sodium hypochlorite and the amount of released gas was directly proportional.

Key words: sodium hypochlorite, hydrogen peroxide, gas release.

INTRODUCTION

GROSSMAN[4] reported a technique for the irrigation of root canals with the alternate use of 5% sodium hypochlorite and 3% hydrogen peroxide to enhance the cleaning of root canals. When these solutions react with each other, effervescence occurs which produces a large release of gas.

STEWART[9], MILANO et al.[7], and LEONARDO[6] studied the antimicrobial action of the alternate use of sodium hypochlorite and hydrogen peroxide on microorganisms present in infected root canals and found high levels of negative bacteria immediately after treatment.

From the 1970s on, microbiological studies reported significant levels of anaerobic microorganisms in root canals, particularly in cases of pulp necrosis and chronic periapical lesions[1,3,5,11-13].

STEWART et al.[10] suggested the use of urea peroxide in the root canal to react with 5% sodium hypochlorite. Urea peroxide is more slowly decomposed than hydrogen peroxide, which releases the rising oxygen less intensely. The cream containing urea peroxide proposed by STEWART et al.[10] is known as RC-prep. PAIVA and ANTONIAZZI[8] proposed the use of ENDO-PTC cream (also made with urea peroxide) for root canal cleaning. According to these authors, this cream must be neutralized with Dakin's solution.

This proposal of STEWART et al.[10] as well as that of PAIVA and ANTONIAZZI[8] substitutes hydrogen peroxide with urea peroxide in the reaction with sodium hypochlorite. They are different proposals from that of GROSSMAN[4], although with similar results, i.e., the promotion of gas release inside root canals. Since this chemical reaction is still used, this investigation seeks to quantify gas release in effervescent reactions between different concentrations of sodium hypochlorite and 3% hydrogen peroxide.

MATERIAL AND METHODS

Different concentrations of sodium hypochlorite (0.5, 1.0, 1.5, 2.0, 2.5 and 5.0%) were prepared by diluting 12% sodium hypochlorite. The active chlorine levels of sodium hypochlorite were titrated with the iodometry method to establish the exact concentrations of the products. By using the same dilution method, 3% hydrogen peroxide was prepared from 30% hydrogen peroxide (Reagen).

The proportion of the reagents used was 1:1 (10 ml sodium hypochlorite for 10 ml hydrogen peroxide). The reactions occurred in a kitasato whose upper opening was corked and which was connected to a mercury manometer, thus making a closed system. At first, the reagents were stored in the kitasato in isolated reservoirs and only when the system was closed were the reagents placed in contact by tilting these reservoirs. Using the mercury manometer, the pressure generated by the gas release was determined.

Figure 1 shows the device used to collect and measure the pressure of the released gas.

By relating the pressure data to the volume of the container and to room temperature, the amount of released gas was calculated in number of moles using the Clapeyron equation (P.V=n.R.T), in which P is the pressure in mmHg, V is the volume of the container in liters, n is the number of moles of produced gas, R is the universal constant of the ideal gas (62.3 mmHg x liter x mol^{-1} x $kelvin^{-1}$), and T is the temperature in kelvin (room temperature in °C + 273).

RESULTS

Figure 2 shows the mean pressure in mmHg of the reactions between different concentrations of sodium hypochlorite and 3% hydrogen peroxide.

Figure 3 shows the mean number of moles of released gas in the reactions between sodium hypochlorite at different concentrations and 3% hydrogen peroxide obtained with the Clapeyron equation.

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The data were submitted to non-parametric statistical analysis using the Kruskal-Wallis test. The calculated (H) value of Kruskal-Wallis was equal to 57.4985. The value of c^2 for 5° liberty was equal to 57.50 and the probability of H_0 for this value was 0.00%. The means were compared two by two and there was a significant difference at the level of 1.0% (a = 0.01) among the comparisons.

By applying the correlation and linear regression test, a linear relation which was directly proportional at the level of 1% between the concentration of sodium hypochlorite and the gas released was found, i.e., the greater the concentration of sodium hypochlorite reacting with 3% hydrogen peroxide, the greater the release of gas. The smallest amount of gas release occurred with 0.5% sodium hypochlorite, followed by the concentrations 1.0, 1.5, 2.0, 2,5, and 5.0%.

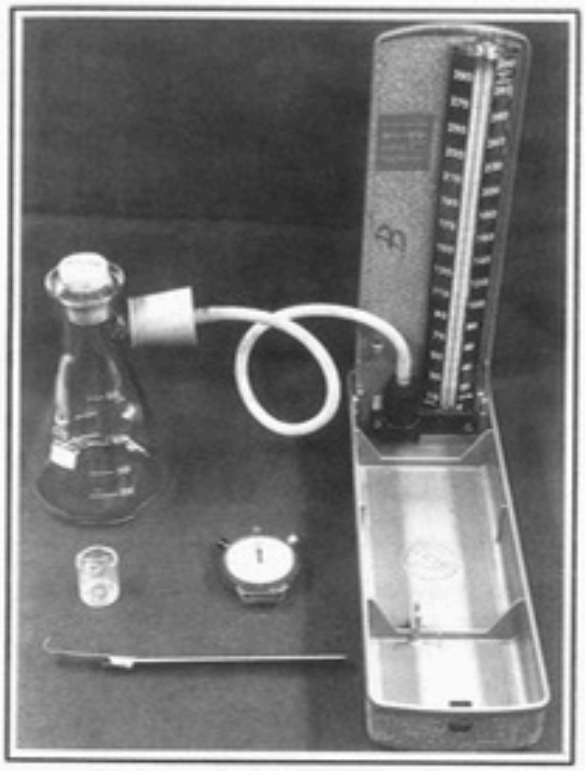

Figure 1. Device used to collect and measure the pressure of the released gas.

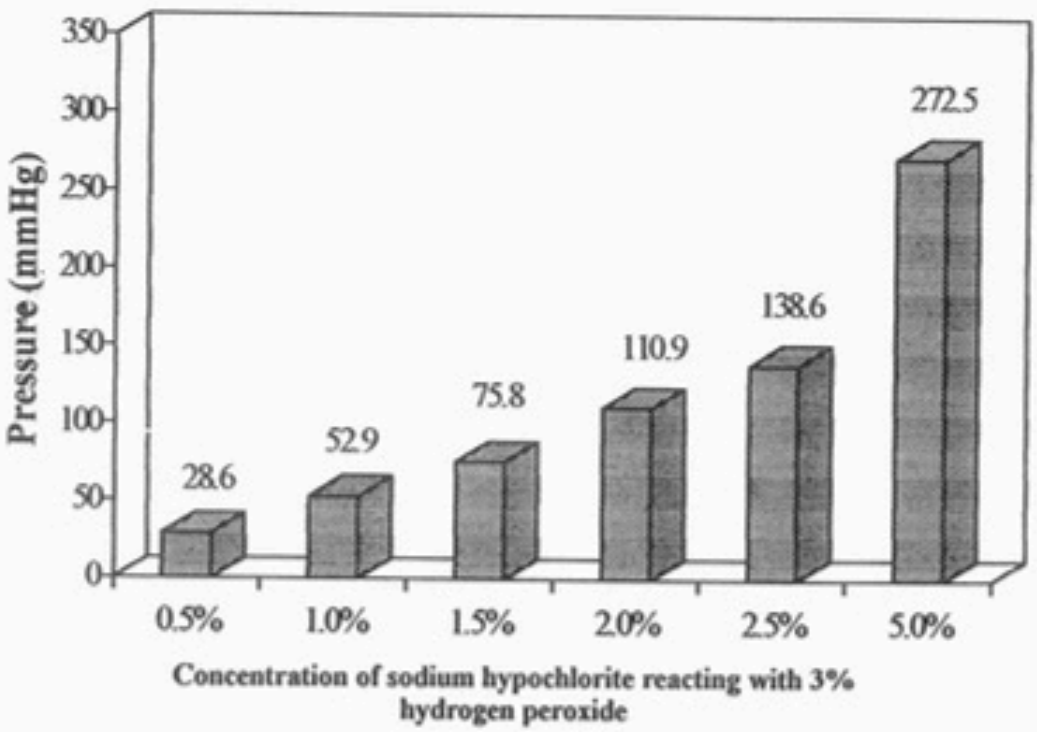

Figure 2. Mean pressure (mmHg) obtained in the chemical reactions between different concentrations of sodium hypochlorite and 3% hydrogen peroxide.

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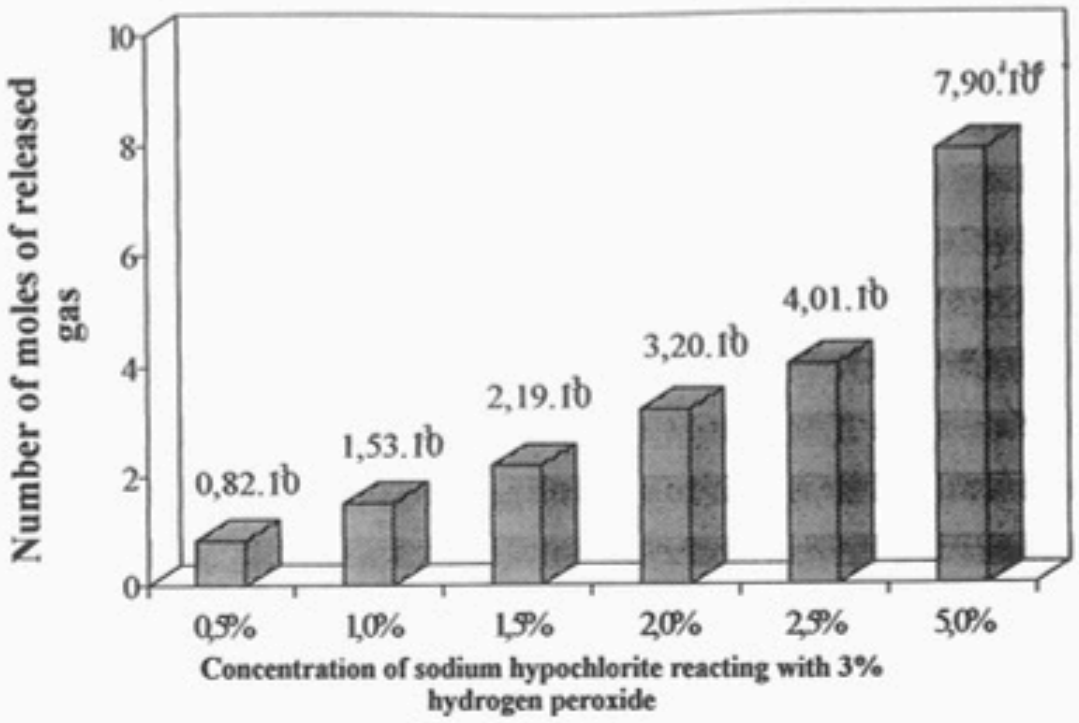

Figure 3. Mean number of moles of released gas in the chemical reactions between different concentrations of sodium hypochlorite and 3% hydrogen peroxide obtained with the Clapeyron equation

DISCUSSION

The method proposed in this study is efficient to quantify the gas release in effervescent reactions and presents a high level of reproducibility.

In order to quantify the gas release, the Clapeyron equation or the state equation of the ideal gas was used. Ideal gas or perfect gas is the one that strictly follows the Boyle-Mariote, Charles and Gay-Lussac laws under any temperature and pressure conditions.

The number of moles of released gas in the reactions between sodium hypochlorite and 3% hydrogen peroxide fundamentally depends on the concentration of sodium hypochlorite used. The greater the concentration, the greater the gas release will be (rising oxygen).

The gas release which occurs in the reaction between sodium hypochlorite and hydrogen peroxide is very important for endodontic therapy since effervescence enhances the process of residue removal from the root canal interior thus providing cleaner canals. By observing the chemical formula of the reagents, it is believed that part of the released gas is oxygen, which permits an antimicrobial effect on the microorganisms present in cases with pulp necrosis.

Thus, when sodium hypochlorite in the studied concentrations reacts with hydrogen peroxide, a gas release reaction which has various effects is obtained: the reactions generate products of smaller energetic quantity than that of the reagents, promoting exothermicity. This fact was observed by BARBIN et al.[2], who also found a directly proportional relationship between the concentration of sodium hypochlorite reacting with 3% hydrogen peroxide and exothermicity; increase in the cleaning capacity of the root canals and a probable production of rising oxygen with antimicrobial action on anaerobic microorganisms.

In this study the greater the concentration of sodium hypochlorite used to react with 3% hydrogen peroxide, the greater the amount of produced gas. Thus, in root canals with pulp necrosis and/or periapical lesions, more concentrated sodium hypochlorite may be used to obtain a greater amount of released gas, which will enhance the cleaning of the root canal.

CONCLUSIONS

We conclude that:

1. All the studied concentrations of sodium hypochlorite (0.5, 1.0, 1.5, 2.0, and 2.5%) reacting with 3% hydrogen peroxide produced measurable gas release.

2. There is a directly proportional linear relation between the concentration of sodium hypochlorite reacting with 3% hydrogen peroxide and gas release. Therefore, the greater the concentration of sodium hypochlorite reacting with 3% hydrogen peroxide, the greater the gas release.

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EDTA EFFECT ON ROOT DENTIN pH AFTER EXCHANGE OF CALCIUM HYDROXIDE PASTE

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The aim of this research was to analyze *in vitro* the influence of EDTA on root dentin pH during exchange of calcium hydroxide paste. Thirty maxillary central human incisors were selected, and after opening the pulp chamber, root canals were prepared using a stepback preparation technique associated with Gates-Glidden burs. Sodium hypochlorite 1% was used as the irrigating solution, and the root canals were then dried and filled with EDTA for 3 min. Root canals were then again irrigated with sodium hypochlorite, dried and completely filled with calcium hydroxide paste, using saline as the vehicle. Each tooth had its crown adapted in carnauba wax mounted in the middle of the base of a platform that was filled with saline solution up to 1 mm from the root tip, and purges were performed with nitrogen in the remaining space. Analysis of the diffusion of hydroxyl ions was carried out by a colorimetric method, using a universal indicating solution. This analysis was done at 7, 15, 30, 45, 60 and 90 days; after each analysis the calcium hydroxide paste was exchanged in the root canals and EDTA was applied for 3 min. The results showed a pH change of 6-7 to 7-8 after 30 days, remaining at this level at 90 days in the apical and middle thirds; and at the cervical thirds there was a pH change of 6-7 to 7-8 after 30 days, and a change of pH to 8-9 at 60 days remaining at this level at 90 days. The Kruskal Wallis test showed no significant difference between the third and the time (a = 0.05).

Key words: calcium hydroxide, intracanal dressing, hydroxyl ions.

INTRODUCTION

The antimicrobial control of root canal infections with apical periodontitis has received special attention in endodontic therapy. The cleaning and shaping demonstrated to reduce considerable number of microoraganisms present in main canal. SYDNEY and ESTRELA[21] studied the influence of root canal preparation on anacrobic bacteria in teeth with asymptomatic apical peridontitis using bacterial samples and microbiological analysis taking as the master apical file, the third and fourth instrument after the initial file that binds slightly at the apical third. Preparation of the root canal using saline solution reduced the number of anacrobic bacteria but did not eliminate them. When 1% sodium hypochlorite was used as to irrigate the qualitative reduction was more significant but did not eliminate all. These findings are in agreement with those of BYSTROM and SUNDQVIST[4] that evaluated the efficacy of mechanical root canal instrumentation of microbial elimination, and observed that use of na intracanal dressing may increase the antimicrobial effect eliminating microorganisms wich remained after instrumentation.

Calcium hydroxide has been the intracanal dressing most recommended[1,5-13,22] due to its enzymatic properties: the activation of tissue enzymes such as alkaline phosphatase resulting in a mineralizing effect, and the inactivation of bacterial enzymes confering the antibacterial effect. These properties may be explained by the ionic liberation and diffusion of the calcium hydroxide paste[5,6].

TRONSTAD et al.[22] verified pH changes in different areas of root dentin in monkey teeth after filling root canals with calcium hydroxide paste. Untreated teeth with pulpal necrosis had a pH of 6.0 to 7.4 in the pulp, dentin, cementum, and periodontal ligament. Replanted and nonreplanted teeth with complete root formation and treated with calcium hydroxide showed pH values in the circumpulpal dentin of 8.0 to 11.1, and in the more perpheral dentin of 7.4 to 9.6. In teeth with incomplete root formation, the entire dentin showed a pH of 8 to 10. The pH of the cementum was not influenced by calcium hydroxide; however, in resorption areas, an alkaline pH was also observed at the exposed dentinal surfaces. NERWICH et al.[15] analyzed changes in pH of radicular dentin, for a period of four weeks using calcium hydroxide as the intracanal dressing, and reported that 7 days are necessary for the hydroxyl ions to reach the external radicular dentin. ESTRELA et al.[7] studied the dentinal diffusion of hydroxyl ions of calcium hydroxide pastes at the apical third, prepared with different acid-base vehicles, in an inert nitrogen atmosphere. Diffusion analysis of the hydroxyl ions was carried out by a colorimetric method at 7, 15, 30, 45 and 60 days. Calcium hydroxide pastes prepared with saline solution and anesthetic solution showed a pH change of 6-7 to 7-8 after 30 days, remainning at this level at 60 days. In the polyethylene glycol 400 group, the same alteration occured at 45 days, and continued at 60 days. The pH inside the root canal did not change during these 60 days. FUSS et al.[9] observed intracanal pH changes of calcium hydroxide pastes sealed in root canals for 30 days and exposed to carbon dioxide *in vitro*. Sixty-two single-rooted human teeth were endodontically prepared, separated at random into six equal groups to be filled with either Calxyl, hydrocalcium, or a paste made by mixing calcium hydroxide power with either distilled water, camphorated p-monochlorophenol, local anesthetic solution, or Solvidont. Cavidentin was used to seal the coronal orifice of the teeth that were placed individually in vials containing 10 mL distilled water. Five vials of each group were exposed to air at room temperature, whereas the other five vials were exposed to carbon dioxide in a closed container. The pH of the paste

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in the root canal was measured after 30 days. There was not significant ($p>0.01$) change in the pH (mean 13.11) of the pastes placed in teeth before and after exposure to air, whereas the pH of the pastes in teeth exposed to carbon dioxide was significantly ($p< 0.01$) reduced (mean 12.54). There was no significant diference in pH between the six preparations.

Various researchers have discussed the release and diffusion of calcium and hydroxyl ions of calcium hydroxide in radicular dentin using different methods[2,7-13,15-18,22]. The presence of calcium ions of calcium hydroxide paste in the calcified bridge after pulpotomy and in the interior of dentinal tubules was detected by HOLLAND[11] and HOLLAND et al.[12,13], who found gross granulations present, highly birrefringent to polarized light and which reacted positively to Von Kossas's method. The dentinal permeability is reduced by the increase of calcium ion concentration inside the dentinal tubules, through physical blocking, as reported by PASHLEY et al.[17] . ESTRELA[5] ,through chemical analysis of calcium and hydroxyl ions of calcium hydroxide paste in connective tissue of the dog, showed that for the molecular weight and liberated calcium ions obtained by condutimetric analysis, in 1 mol of calcium hydroxide dissiciated, 45.89% are hydroxyl ions and 54.11% are calcium ions.

Calcium hydroxide has been used to maintain the cleasing obtained with biomechanical preparation, to control microorganisms that survived biomechanical preparation, persistent exudate, apicification, perfuration, root resorption, treatment of extensive periapical lesions and clinical situations that need dressing changes.

Many factors may alter the level of hydroxyl ions in the interior of dentinal tubules, such the speed of liberation of the ions due to vehicle, the degree of calcification, and dentinal permeability, directly influencing antimicrobial action and osteoclasts present in root resorption. FOSTER et al.[8] demonstrated that calcium hydroxide diffuses from the root canal to the exterior surface of the root and that the removal of the smear layer may facilitate this diffusion.

Considering the possibility of reduction of dentinal permeability after using calcium hydroxide paste as an intracanal dressing, the objective of this research is study the EDTA effect on root dentin pH after exchange of the calcium hydroxide paste at 7, 15, 30, 45, 60 and 90 days.

MATERIAL AND METHODS

Thirty maxillary central human incisors, extracted for differents reasons, with mature apexes, were selected for this research. After opening the pulp chambers, root canals were prepared with k-files (Maillefer, Switzerland) to 1 mm of the radiographic apical vertex, using a stepback preparation technique. The cervical third was enlarged with # 3 and # 4 Gates-Glidden burs, and the adapted lateral limit of instrumentation corresponded to the 4th instrument subsequent to that which just penetrated into the canal (anatomic instrument).

Three mL of 1% sodium hypochlorite was used as the irrigating solution after each file while instrumenting the root canals. The canals were dried and filled with EDTA trisodium, pH 7.2, and stirred for 2 min using a # 1 spiral lentulo[14] (Maillefer, Switzerland) and than remained for 1 min.

Each root canal was again irrigated with 2 mL of 1% sodium hypochlorite, dried and completely filled with calcium hydroxide paste (Quimis - Mallinkrodt Inc., USA), using saline as the vehicle, with a viscosity of 3501 cP-0.1 rpm (Reometer Digital Brookfield, model DV-III-LV), corresponding to the consistency of toothpaste, with a pH of 12.6 determined using a pHmeter (Analion, pH Digital, PM 605)[3]. The pulp was doubly sealed with gutta-percha and zinc oxide-eugenol cement.

Each tooth had its crown adapted in carnauba wax mounted in the middle of the base of a platform. Each platform was filled with saline solution up to 1 mm from the root tip, and purges were performed with nitrogen in the remaining space. The platform remained completely sealed, in the absence of light and maintained at a constant temperature of 37°C. The Figure 1 showed tooth mounted in the middle of the base of a platform.

Analysis of the diffusion of hydroxyl ions was carried out by a colorimetric method. A universal indicating solution was applied over the apical, midle and cervical third surfaces of each tooth. The pH was determined comparing the color of the analysed surface with a standard scale prepared in test tubes with tampon solutions with pH ranging from 4 to 12. This analysis was done at 7, 15, 30, 45, 60 and 90 days; after each analysis the calcium hydroxide paste was exchanged in the root canals with 5 mL saline and mechanical stirring with files, dried, and EDTA was applied for 3 min, dried again, and filled with calcium hydroxide paste.

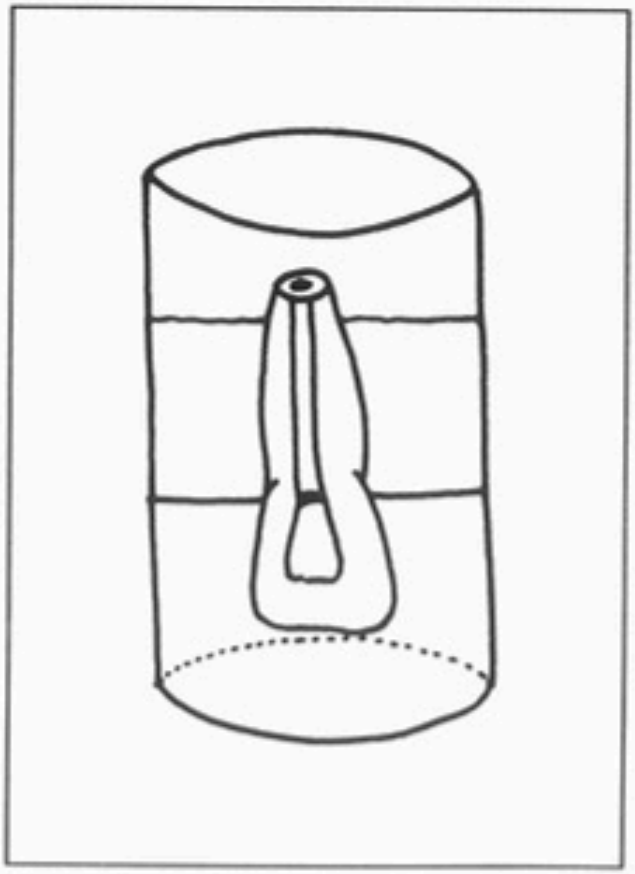

Figure 1 - Tooth mounted in the middle of the base a platform

RESULTS AND DISCUSSION

Different microbial species present in infected root canals maintain high virulence. The predominance of anaerobic bacteria determines the potential of these infections. The intracanal dressing acts on these different microbial species, characterized by energetic metabolism achieved by breathing or fermentation, like other clinical situations, such as apicification, perfuration, and inflamatory external resorption.

Calcium hydroxide is the most used intracanal dressing due to its biological and bacteriological properties. It reaches microorganisms in the interior of dentinal tubules as well as root resorption areas. The liberation of hydroxyl ions of calcium hydroxide, resulting in high pH, influences bacterial growth and multiplication. A higher concentration of hydroxyl ions will cause greater inativation of bacterial enzymes altering chemical transport of nutrients and its ionization state, causing toxic effects on the bacterial cell.

Various studies have reported pH changes in root dentin surfaces when using calcium hydroxide[7,9,14,22]. Dentin permeability, calcification degree, and the speed of liberation of hydroxyl ions of calcium hydroxide paste is directly associated with the paste vehicle.

ANTHONY et al.[1] analyzed the effect of three vehicles (PMCC, Cresatine and saline solution) on the pH of calcium hydroxide and concluded that saline solution is the logical alternative as vehicle for calcium hydroxide paste. ESTRELA[5] analyzing the liberated calcium and hydroxyl ions of calcium hydroxide paste, in the presence of connective tissue of the dog, reported that the liberation of hydroxyl ions was proportional to that of calcium ions. The paste with polyethylene glycol 400 vehicle showed a smaller percentage of calcium and hydroxyl ions liberation than saline solution and anesthetic solution.

Hydrosoluble vehicles (saline solution, anesthetic solution, disttiled water) allowed more rapid of ionic liberation than viscous (polyethylene glycol 400) and not hydrosoluble vehicles (PMCC), wich may influence the pH change in root dentin[5]. It was observed that even with vehicles with different acid-base characteristics the pH of calcium hydroxide pastes remain high, saline solution - pH 6.0 ($Ca(OH)_2$ paste – pH 12.6), anesthetic solution - pH 3.6 ($Ca(OH)_2$ paste - pH 12.4), and polyethylene glycol 400 - pH 10.5 ($Ca(OH)_2$ paste – pH 12.6)[7].

The diffusion of calcium ions into the interior of dentinal tubules may alter dentin permeability[13,16,17]. EDTA has been used when it is necessary to remove the smear layer after biomechanical preparation, increasing of dentin permeability[14,19,20].

FOSTER et al.[8] demonstrated the effect of smear layer removal on the diffusion of calcium hydroxide through radicular dentin in forty single-rooted teeth. After cleaning and shaping, each root was placed in a dilution vial containing 10 mL normal saline, and the pH and Ca^{2+} levels were recorded after 24 h. The root in group 1 then received a final irrigation with 20 ml of normal saline. Group 2 was irrigated with 10 ml of 17% EDTA followed by 10 ml of 5.25% NaOCl to remove the smear layer. Group 3 was irrigated in the same manner as Group 2, but calcium hydroxide was placed in the root canal. Group 4 was irrigated with 20 ml of NaOCl and calcium hydroxide was placed in the root canal. The pH and Ca^{2+} levels were recorded at 1, 3, 5 and 7 days. There was no statistically significant difference in either H^+ or Ca^{2+} concentration among the four experimental groups of roots after instrumentation with saline irrigation and storage in the dilution vials for 24 h. The Ca^{2+} concentration was higher in the smear layer removal group only at 24 h after calcium hydroxide placement and at 1 and 3 days after the creation of the artificial defect. Calcium hydroxide diffuses from the root canal to the exterior surface of the root and the removal of the smear layer may facilitate this diffusion.

The method for evaluation of pH changes in root dentin may not be ideal, but has it has shown to be efficient.

The values of pH change in root dentin during the exchange of calcium hydroxide paste at intervals of 7, 15, 30, 45, 60 and 90 days, influenced by the use EDTA, is shown in Table 1. Kruskal Wallis test showed no significant difference between the third and the time ($p = 0.05$). The pH of the apical and middle thirds of radicular dentin showed few variations and was not as high. At the cervical third the pH was greater than the other thirds at 60 and 90 days. This fact may be explained by the greater number of dentinal tubules with larger diameters than those of the midle and apical thirds.

CONCLUSIONS

Based on the conditions of this study, the results showed a pH change of 6-7 to 7-8 after 30 days, remainning at this level at 90 days in apical and middle third. At cervical third a pH change of 6-7 to 7-8 after 30 days, remainning at this level at 60 days, and than change of 7-8 to 8-9 remainning at this level at 90 days.

Table 1 - EDTA effect on root dentin pH at the exchange of calcium hydroxide paste

Time	Third		
(days)	Cervical	Middle	Apical
7	6 - 7	6 - 7	6 – 7
1	6 - 7	6 - 7	6 – 7
30	7 - 8	7 - 8	7 – 8
45	7 - 8	7 - 8	7 – 8
60	8 - 9	7 - 8	7 – 8
90	8 - 9	7 - 8	7 – 8

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EVALUATION OF ENDODONTIC SEALER RADIOPACITY USING DIGITIZED IMAGING EQUIPMENT

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The radiopacity of Fillcanal®, N-Rickert®, Sealer 26® and Sealapex® endodontic sealers was compared using Accu-Ray's digitized imaging equipment. No significant difference was found among Fillcanal®, N-Rickert® and Sealer 26®. Only Sealapex® showed significantly lower optical density when compared to the other sealers.

Key words: Radiopacity, Endodontic sealer, Digitized imaging

INTRODUCTION

Root canal obturation is the extensive filling of the canal with inert or antiseptic material which both hermetically and permanently seals the canal. Moreover, it should not interfere but rather stimulate apical and periapical repair to be carried out following root canal endodontic treatment.

MCELROY[11] sought an hermetically obturated canal with gutta-percha acknowledged as an ideal sealing material. Sealers used in association with gutta-percha, and their physico-chemical characteristics including radiopacity have been studied for over eighty years [1-5,8,9,11,16] thus attesting the importance of obtaining high-grade obturations. These fillings may only be seen radiographically. The image obtained by X-Rays whether from conventional or digitized imaging equipment constitutes a single way to checkthe quality of an obturation. For that reason the clinician seeks the best sealer radiopacity possible as gutta-percha has been widely accepted as a filling material.

The sealers most widely used in Brazil are: N-Rickert®, a zinc oxide eugenol cement containing silver, Fillcanal®, a zinc oxide eugenol composite, Sealapex®, a calcium hydroxide cement, and Sealer 26®, an epoxy resin containing calcium hydroxide.

The study and usage of digitized imaging has been enhanced for 3 main reasons: little exposure time to radiation, no need for film developing, and time-saving. Furthermore, images may be thoroughly analyzed since numerical and graphic evaluations are easily quantified as in optical density.

Accu-Ray is a direct CCD (Charge Couple Device) system. It consists of 3 main components: a conventional X-Ray equipment coupled to a silicon sensor which catches the image and sends it to a computer monitor.This system provides the following advantages: little exposure time, no need for films, darkroom or processing solutions, low working time and easy image handling. However, thre are some disadvantages: small area covered by the sensor as compared to the film with no loss to endodontics though since the objective is usually one single tooth, difficult access to some areas, operator training and, most important, the high cost of this modern technology[2,3,6,10,12,13,15].

The aim of this study was to compare the radiopacity of the most commonly used endodontic sealers by a digitized imaging system (Accu-Ray) and to determine quantitatively the radiopacity of each sealer.

MATERIAL AND METHODS

A pilot study was conducted using 10-mm-long polyethylene tubes obtained from an atoxic Scalp-vein 19G syringe to prepare the test units. Four samples of each sealer were prepared: Fillcanal®, N-Rickert®, Sealer 26® and Sealapex®.

Initially sixteen 10-mm-long segments were cut from part of the Scalp-vein tube using a scalpel. The sealers were mixed according to manufacturer instructions, inserted in insulin syringes and injected in to the tube (2 samples of each). To simulate the oral environment, the sealers were hardened in an oven at a temperature of 37°C with a flask containing water to keep the humidity at approximately 95%. The tubes containing the sealers remained were held in this environment for 24 hours and were stored for 14 days in a humid environment.

Next, two additional test units were prepared and maintained in the oven under the same conditions , however, the hardening time according to the manufacturer instructions (Table 1). A 20-minute hardening time was assigned to N-Rickert® since there are no manufacturer's instructions as to hardening time and it is a Zinc-Oxide Eugenol composite similar to Fillcanal®.

table 1

Sealer	Hardening time
Fillcanal®	20 min.
Sealapex®	60 min.
Sealer 26®	12 hours
-Rickert®	*

RESULTS

Using the Accu-Ray system, the optical density was evaluated by graphs and the colorimetric method which consists of different colors corresponding to a specific range of optical density values.

red: from 208 to 228 pixels. green: from 190 to 207 pixels. blue: from 160 to 189 pixels. white corresponds to the voids.

Analysis was performed by placing one sample of each sealer on the sensor plate forming 4 groups of 4 samples. The results shown on tables 2, 3, 4 and 5, graphs 1 and 2 and figures 1, 2, 3 and 4 were obtained evaluating and quantifying the radiopacity with radiographic and colorimetric analyse.

Table 2. Test units that remained for 24 hours under a temperature of 37°C, relative humidity of approximately 95% and storage time of 14 days.

Sealer/Hardening time	0.10	0.06
N-Rickert®	216-220	224-228
Fillcanal®	216-220	224-228
Sealapex®	184-188	208-212
Sealer 26®	216-220	224-228

Graphic 1: Graphic evaluation of the optical density

Table 3. Test units that remained for 24 hours under a temperature of 37°C, relative humidity of approximately 95% and storage time of 14 days. Sample 2

Sealer/ Hardening time	0.10	0.06
N-Rickert®	208-212	224-228
Fillcanal®	208-212	224-228
Sealapex®	160-172	204-208
Sealer 26®	208-212	224-228

Table 4. Test units that remained for the manufacturer instructed time under 37°C, relative humidity of approximately 95% and storage time of 14 days. Sample 1

Sealer/Hardening time	0.10	0.06
N-Rickert®	208-220	216-220
Fillcanal®	208-220	216-220
Sealapex®	160-172	200-204
Sealer 26®	208-220	216-220

Graphic 2: Graphic evaluation of the radiopacity

Table 5. Test units that remained for the manufacturer instructed time under 37°C, relative humidity of approximately 95% and storage time of 14 days. Sample 2

Sealer/Hardenig time	0.10	0.06
N-Rickert®	208-212	224-228
Fillcanal®	208-212	224-228
Sealapex®	160-172	204-208
Sealer 26®	208-212	224-228

The Kruskal-Wallis test for statistical significance showed that there was no significant difference (p=0.05) in optical density among the sealers: N-Rickert®, Fillcanal®, Sealer 26® and Sealapex®. The results are shown in Figures 1, 2, 3 and 4.

No significant difference in hardening time and after 14 days was found on the optical density.

DISCUSSION

According to FIDEL[4] who performed the Kruskal-Wallis test from optical densities found using a photo-densitometer, there was no significant statistical difference (p=0,05) in radiopacity among the sealers: Fillcanal®, Sealer 26® and Sealapex® among others Furthermore, HYDE[7] and SILVA[14] found no significant difference in radiopacity among the sealers tested.

The results are easily displayed with digitized imaging. As the image goes directly to the monitor no chemical processing of the X-Ray is necessary. Thus, it is possible to compare numerous data accurately since there are fewer variables interfering in the final result.

Accu-Ray's high-technology enables osseous repair analysis as well by comparing the stored images with the control. Storage and time does not affect the image. Several images can be superimposed on the screen to prepare graphs or to color the images identifying treatment failures. With the computer it is easy to identify bubbles, fractured instruments, over instrumentation, anatomic faults, etc... by magnifying the image or enhancing part of it.

This study has shown that the digitized imaging system is an additional resource for the endodontic clinician and may be widely used in the dental office to improve practice. However, the results obtained in this study on optical density showed no significant statistical difference among the endodontic sealers as well as in other previous studies using a photodensitometer.

Nonetheless, radiopacity differences among the different sealers are clinically observed by the naked eye. N-Rickert® shows a distinct radiopacity due to silver in its chemical composition. Fillcanal® is still largely used due to the excellent radiopacity. Several authors, among them Holland et al.[7], attest to the usage of iodoform in calcium hydroxide based sealers to improve their radiopacity thus proving that clinically there are significant differences in radiopacity among the sealers studied.

CONCLUSION

Accu-Ray's digitized imagine system is an excellent supplement to the dental office offering several additional resources for the analysis of endodontic treatment results.

No significant statistical difference in optical density was found among the endodontic sealers analyzed by digitized imaging. This differs from clinical observation, but is in agreement with other studies.

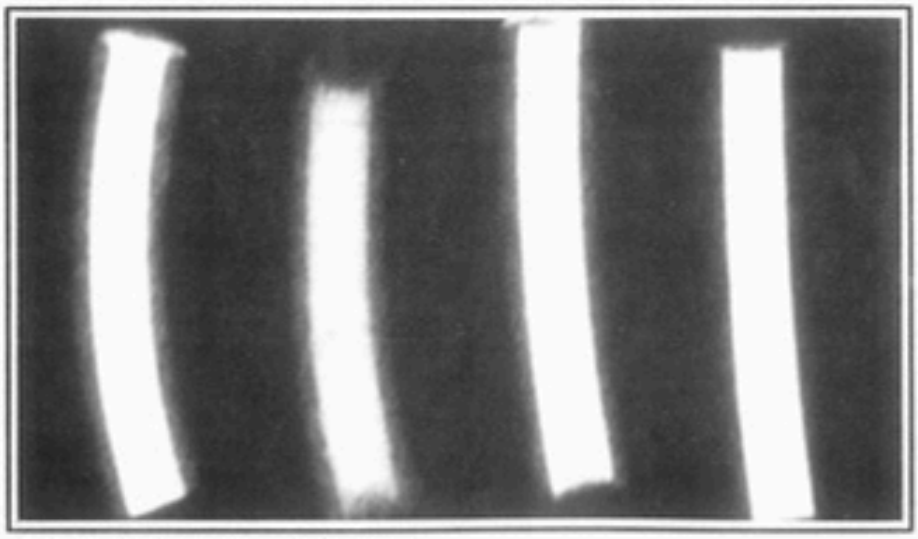

Figure 1:Radiographic evaluation

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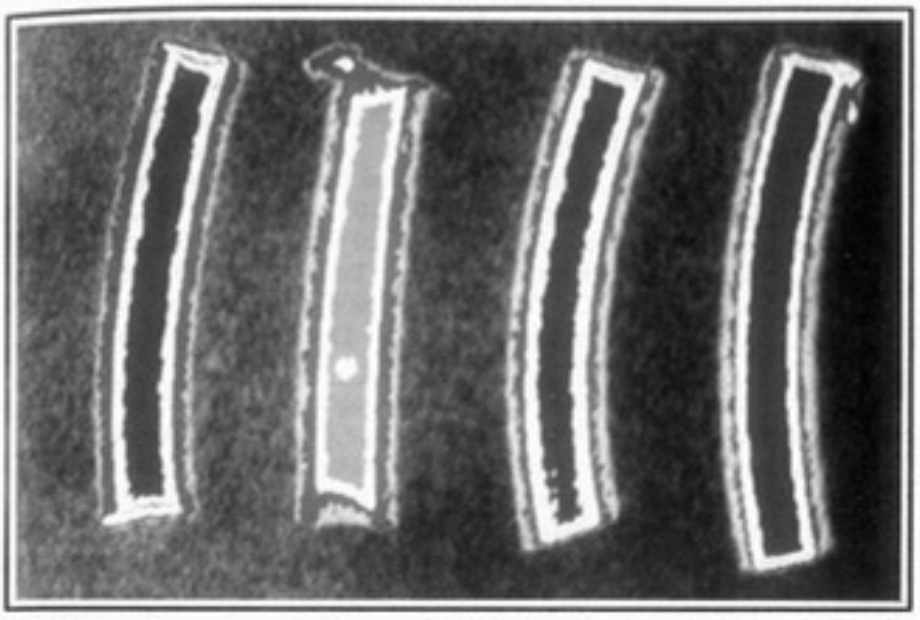

Figure 2: Colorimetric Analysis Evaluation

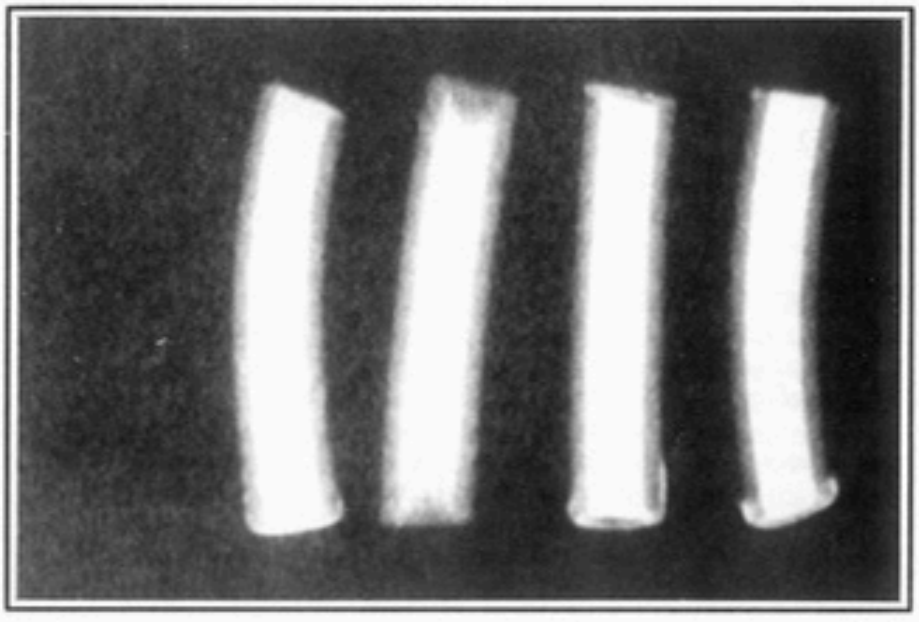

Figure 3: Radiographic evaluation

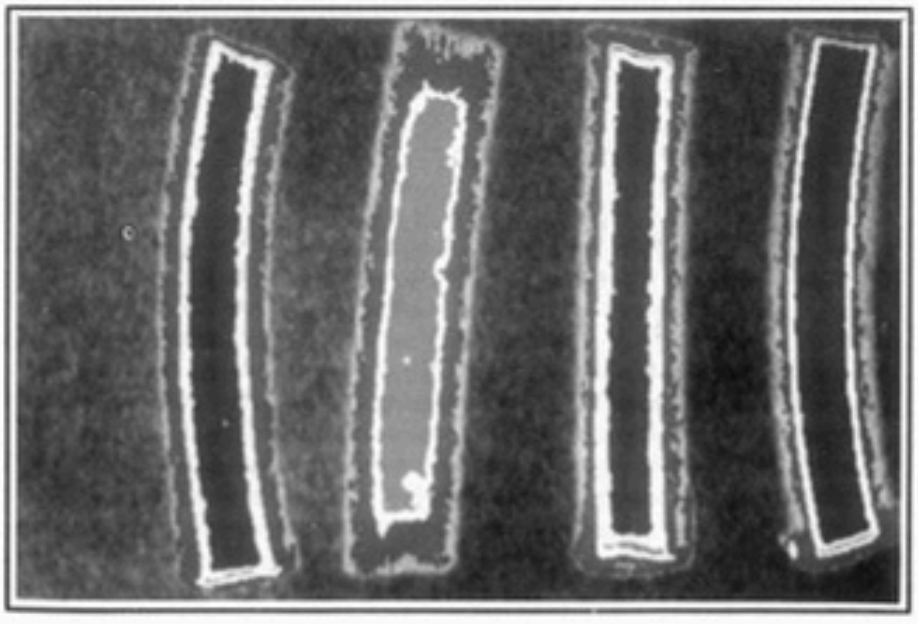

Figure 4: Colorimetric analysis evaluation

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INFLUENCE OF THE USE OF ENDO PTC ON THE PERIAPICAL SEAL OF ROOT CANALS

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Twenty extracted human single-rooted teeth were instrumented with the aid of Endo PTC varying the final flush with either a detergent/antiseptic solution or 1% sodium hypochlorite. The root canals were filled and leakage was evaluated using blue-methylene dye and a stereomicroscope. A final flush with detergent/antiseptic solution resulted in significantly less leakage.

Key words: root canal, therapy.

INTRODUCTION

Hermetic root canal filling is one of the main goals of endodontic therapy. According to SELTZER[9] the reasons for this are: persistence of granulation tissue, stagnation of fluids, exchange of metabolites. permeability of occlusal restorations, gingival recession and periodontal disease. Among the factors that determine hermetic root canal sealing are the adequate chemo-mechanical preparation and physical properties of the sealing materials.

We must consider the use of creamy substances such as RC-Prep and Endo PTC for the chemo-mechanical preparation. In 1969 STEWART et al.[10] reported the use of a mixture of EDTA and urea peroxide in a water-solution vehicle of Carbowax (RC-Prep) as an aid in cleaning and shaping root canals. PAIVA and ANTONIAZZI[6] proposed a new creamy substance similar to that reported by STEWART et al.[10] containing Tween 80 (Endo PTC) instead of EDTA. Their evaluation indicated that the agent was significantly effective in reducing the incidence of positive cultures at the second appointment. These creamy agents are used alternately with sodium hypochlorite with a final irrigation of sodium hypochlorite in the case of RC-Prep and with detergent/antiseptic in the case of Endo PTC.

COOKE et al.[3] compared the periapical seal in root canals instrumented with aid of RC-Prep or sodium hypochlorite and verified major leakage for RC-Prep. They suggested that RC-Prep may remain in the canal and affect the seal of the root canal filling. BIESTERFELD and TAINTOR[2] studied the quality of the periapical seal after to the use of RC-Prep or Salvizol and did not find significant differences in leakage.

OLLAND et al.[4] detected the presence of fragments in root canals of dog's teeth after instrumentation with Endo PTC and a final flush with sodium hypochlorite. ARAUJO and GOLDBERG[1] analyzed the presence of detritus in root canals instrumented with RC-Prep and RC-Prepsem combined with 5% sodium hypochlorite. They verified the presence of the creams in 96% of the root canals of single-rooted teeth and 93% of multi-rooted teeth.

VARGAS[11] evaluated the efficiency of three techniques of final irrigation (1.8 ml detergent/antiseptic solution, 10.8 ml detergent/antiseptic solution with 10.8 ml Dakin's solution and 10.8 ml detergent/antiseptic solution) in the removal of Endo PTC after its use in simulated canals and found the best results with detergent/antiseptic solution.

PAIVA et al.[7] studied the periapical seal in root canals instrumented with various chemical substances among them the Endo PTC alternated with sodium hypochlorite with a final irrigation with detergent/antiseptic solution and found the minimum leakage for the teeth instrumented with Endo PTC.

The purpose of this study was to evaluate the periapical seal obtained using Endo PTC and 1.0% sodium hypochlorite solution followed by of 1.0% sodium hypochlorite or detergent/antiseptic solution as irrigants.

MATERIAL AND METHOD

This study was carried out with 20 freshly extracted human single-rooted teeth that were stored in glass vials containing saline for a period of 72 hours.

Endodontic access was made according to standard tecniques and working length was determined by passing a #10 file to the apex and adjusting it back 1.0 mm. The contents of the root canals were removed with a #10 file and saline.

The teeth were then divided randomly into two groups (A and B) of 10 each. The root canals were instrumented according to standard technique using Endo PTC alternated with 1.0% sodium hypochlorite and varying the final flush as follows: Group A - final irrigation with detergent/antiseptic solution; Group B - final irrigation with 1.0% sodium hypochlorite.

The surfaces of the teeth were then impermeabilized by using nailpolish leaving the apical foramen region denuded. The next phase consisted of immersing each tooth in a glass vial containing blue-methylene dye where they remained for 72 hours at 36°C. The teeth were then partially covered with stone gypsum and after setting each block was cut to obtain a longitudinal hemisection, which was evaluated for dye penetration using a stereomicroscope.

The data were submitted to statistical analysis by the Mann-Whitney U test.

RESULTS

The medium depth of dye penetration for each group is reported in Table 1. Endo PTC followed by final irrigation with a detergent/antiseptic solution resulted in less leakage.

Table 1. Extent of apical dye penetration (mm)

Group	No.	Minimum	Maximum	Mean	Mann Whitney U test
A	10	0.32	1.64	0.97	13
B	10	0.96	2.41	1.65	87

Group A: final irrigation with detergent/antiseptic solution
Group B: final irrigation with 1.0% sodium hypochloritez calculated value -2.7979
Probability of equality 0.26% Significant at 1% ($\sigma = 0.01$)

DISCUSSION AND CONCLUSIONS

The relationship between chemo-mechanical preparation of the root canal and root canal filling is well known a correct cleaning and shaping creates conditions for the hermetic sealing of the root canal system. It is important to consider the chemical substance used during the cleaning of the root canal as its use is an important aid in the disinfection and removal of detritus that may to interfere with hermetic sealing.

The use of creamy substances has proved to be a valuable aid in negotiating root canals. These substances contain urea peroxide that reacts with sodium hypochlorite causing an effervescence process that removes residue and liberates oxygen that cleans the root canal system. Endo PTC is a creamy substance that contains urea peroxide, Tween 80 and Carbowax that is used alternated with sodium hypochlorite. The technique that employs Endo PTC recommends a final irrigation with a detergent/antiseptic solution with to remove the residue of cream that may remain in the root canal after instrumentation.

The purpose of this study was to verify the apical leakage resulting from the use of Endo PTC submitted to two regimens of final irrigation. Our data showed a significant difference with the use of detergent/antiseptic solution as final irrigant that promoted less leakage. Previous studies reported the presence of detritus with the use of creamy substances and final flush with sodium hypochlorite[1,4,11].

We believe that the use of detergent/antiseptic solution gave better results due to the fact that detergent possesses low surface tension and consequently provides better cleaning after root canal instrumentation. One of the reasons that the use of Endo PTC with a final flush of detergent/antiseptic solution promotes better sealing is based on the studies of ROBAZZA et al.[8] and MOURA et al.[5] who detected a great increase in dentin permeability when they used this chemical method in root canal preparation. This increase in dentin permeability is probably responsible by better contact between the filling material and the canal walls mainly in the apical third.

This assertion agrees with the results obtained by PAIVA et al.[7] who found less leakage with the use of Endo PTC with a final flush of detergent/antiseptic solution compared with other irrigants.

Sodium hypochlorite has the poorest properties when used as a solvent for Endo PTC as reported by VARGAS[11].

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18º CONGRESSO INTERNACIONAL DE ODONTOLOGIA DE SÃO PAULO

Projeto Qualidade de Vida

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WORKSHOP (4hs)	**WOR-06**- Reforço intra-radicular, colagem de retentores(pinos pré-fabricados) imediatamente após o tratamento endodôntico Mário Luiz Zuolo / Noboru Imura	28-T

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ANALYSES OF THE SURFACES OF GUTTA-PERCHA CONES AFTER THE CHEMICAL STERILIZATION

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Eighty gutta-percha cones (# 50; Dentisplay and Odacam) were used. Seventy samples were immersed in chemical agents used in sterilization for 30 min: 5% sodium hypochlorite, 3% iodate alcohol, Germekil, Cidex, 2% chlorhexidine or in 10% fenicada glycerin, and an environment with formaldehyde vapors for 7 days. Scanning electron microscopy showed that, in relation to the control group, the external surfaces of the gutta-percha cones did not suffer alterations in morphologyafter contact with the chemical agents used.

Key words: Gutta-percha cones, chemical sterilization, root canal obturation

INTRODUCTION

Before gutta-percha cones are used in the obturation of root canals they must be sterilized. Several chemicals are used for different times giving emphasis to immersion in solutions of sodium hypochlorite[11], iodate alcohol[9], fenicada glycerin[4], composed of quaternary ammonium[1], glutaraldehyde solutions[3], chlorhexidine solutions[12] and formaldehyde vapors[7]. Previous studies have analyzed the antibacterial efficiency of these substances. However, there is little information in the literature in relation to the chemical alterations, dimensions and morfology of cones after contact with these agents.

Complete sealing is of utmost important root canal obturation to prevent the development of microorganisms. The absence of complete sealing has been attributed as one of the major causes of unsuccessful endodontic treatment[2,3,8,9].

Defective endodontic obturations are mainly due to non-adaptation of the gutta-percha cones in the apical area. One of the factors for this adaptation to occur is that the master cone presents similar dimensions to the last instrument used in the apical preparation of the root canal. Thus dimension alterations of the cones during sterilization can cause incomplete impermeability of the endodontic obturation.

The purpose of this work is to analyze the external surface of gutta-percha cones before and after contact with chemical agents frequently used in sterilization.

MATERIALS AND METHODS

Eighty gutta-percha cones (number 50, Dentisplay and Odacham) were used. Ten samples formed the control group and the remaining samples were divided in seven groups of ten specimens each and submitted to solutions of 5% sodium hypochlorite, 0.3% iodate alcohol, Germekil (Darrow Laboratory S.A. - Rio de Janeiro, Brazil), Cidex (2% glutaraldehyde; Johnson-Johnson Medical - São Paulo, Brazil), 2% chlorhexidine, 10% of fenicada glycerin, and an environment of formaldehyde vapors of 4 g/L. The samples immersed in sodium hypochlorite, iodate alcohol, Germekil, Cidex and chlorhexidine remained in the solution for 30 min and in the fenicada glycerin in formaldehyde vapors for 7 days. The samples were then washed with distilled water and prepared for scanning electron microscopic analysis (JEOL, model USM U2). Observations were done at the tip and body of the cones and the morphology of the samples that were immersed in the chemical agents were compared with the control group.

RESULTS AND DISCUSSION

The samples from the control group showed longitudinal grooves, associated to the manual process of rolling during manufacture; there were no differences among the commercial brands analyzed. At a greater magnification, micro-porosity was observed in each sample, some with fragments adhering to the surface. The tip of the cones were round and with a smooth finish. (Figure 1 - a, b, c)

GOLDBERG et al.[6] using scanning electron microscopy obseved that the gutta-percha cones had an irregular finish at the its terminal portions. These differences, according to this study may, can be related to a better standardization and care in the manufacture of these materials.

Different commercial brands of gutta-percha cones are normally manufactured with the percentage in weight of 20% gutta-percha, 66% zinc oxide, 4% silicate of zinc and approximately 10% wax, coloring, antioxidant, opacity. According to FRIEDMAN et al.[5] gutta-percha cones had 23.1% organic substances and 76.4% inorganic substances. Therefore, it was expected that the chemical agents used in this study would transform the cone surfaces, mainly the coloring, wax and gutta-percha. However, even though the samples were kept in contact with the chemical agents for a longer time than indicated for sterilization, scanning electron microscopic analysis did not show surface alterations at the tip or in the bodies of the gutta-percha cones (Figure 2 - a, b).

MOLLER and ORSTAVIK[10], after analyzing the physical properties of gutta-percha cone, kept in different antiseptic solutions, noted that with the time cones suffered reduction of rigidity and alteration of dimension. The differences of these results in relation to the present work is possibly due to differences in methodology.

The results in this work showed that the external surface of gutta-percha cone did not suffer alterations in morphology after immersion in 5% sodium hypochlorite, 0.3% iodate alcohol, Germekil, Cidex, 2% chlorhexidine, 10% fenicada glycerin, and in na environment with formaldehyde vapor.

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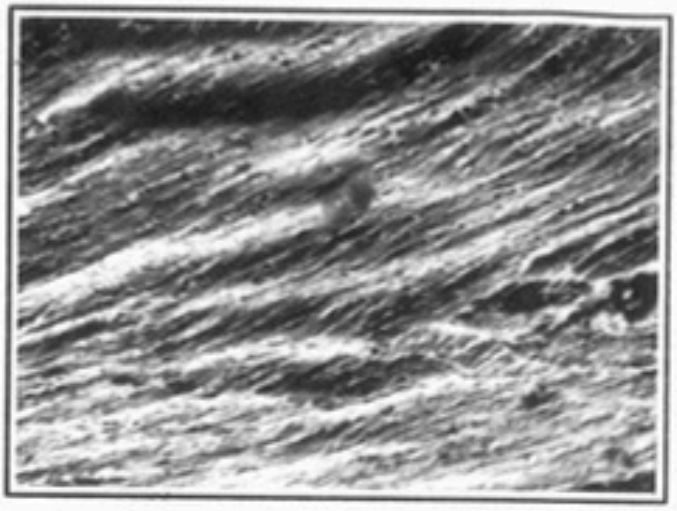
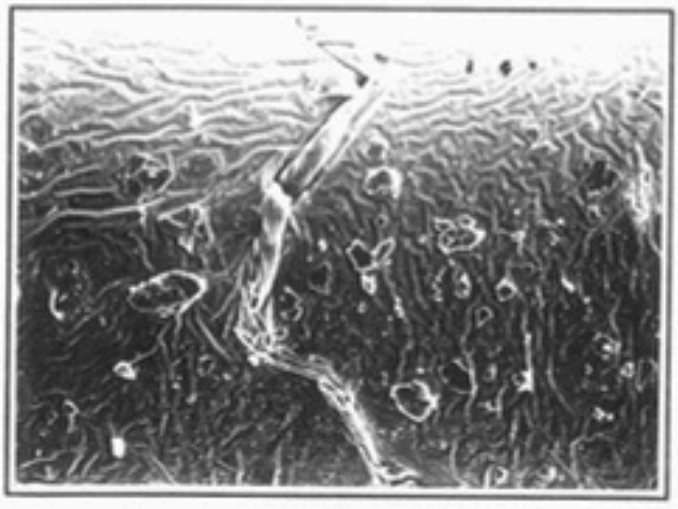




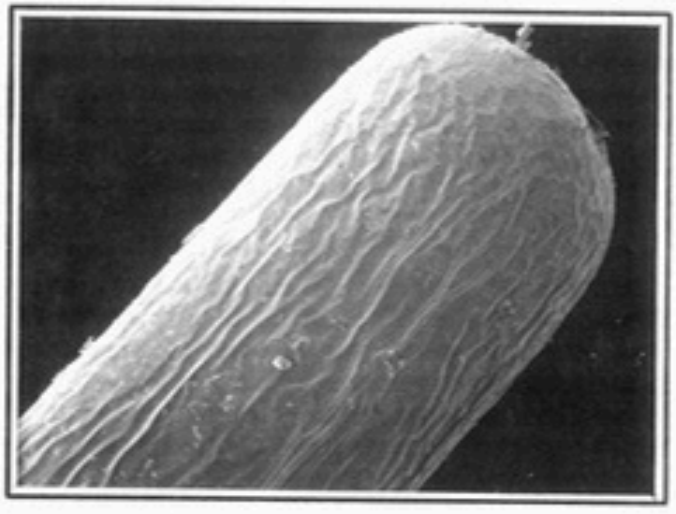
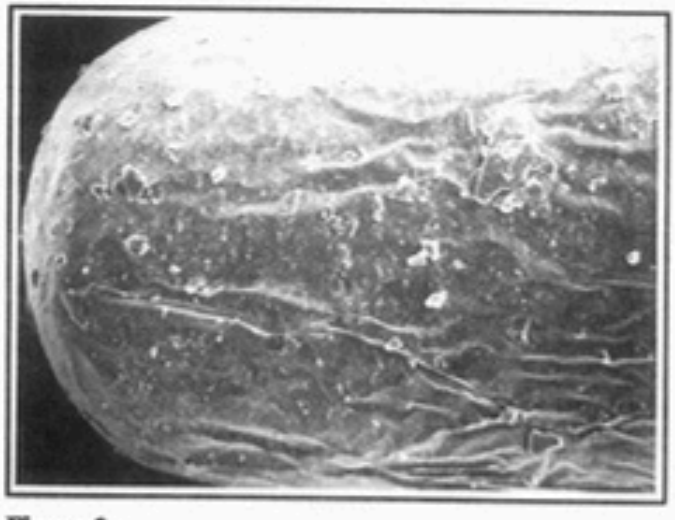


Figure 1.

1a - Control group samples showed micro porosities. 3000x (Dentsplay)
2a - Control group samples showed fragments adhering to their surface
3a - Control groups samples showed round tips



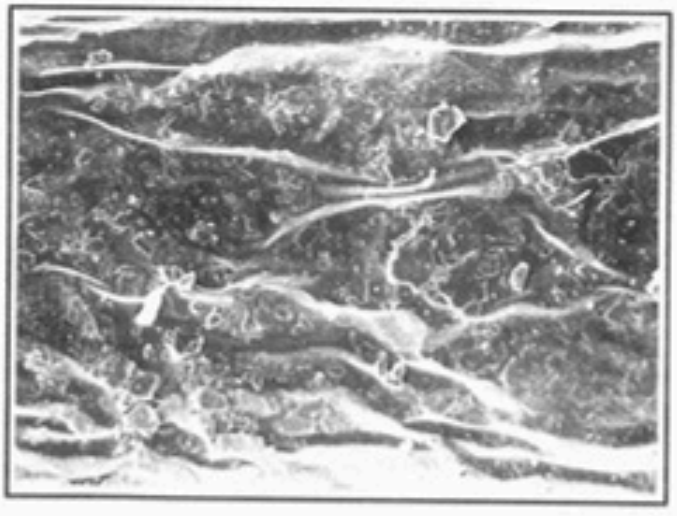


Figure 2.
2a - The sample didn't show alterations in its tip after immersion in sodium hypochlorite. 150x (Dentisplay)
2b - The sample didn't show alterations in its body after the immersion in sodium hypochlorite. 150x (Dentisplay)

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CALCIUM HYDROXIDE PULPOTOMY IN YOUNG PERMANENT TEETH WITH PERIAPICAL INVOLVEMENT

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In the present study was avaluate the clinical and radiographic response of permanent molars with caries induced pulp exposure, thickening of the periodontal ligament and periapical bone rarefaction submitted to the calcium hydroxide pulpotomy technique. According to the clinical and radiographic criteria adopted for evaluation, total or partial success was obtained in 85%. In conclusion, this technique, when properly indicated, could be a rational alternative for the treatment of young permanent teeth.

Key words: calcium hydroxide, pulpotomy.

INTRODUCTION

From a clinical viewpoint, there is general consensus that the presence of radiographically visible periapical bone rarefactions is always associated with pulp necrosis or irreversible pulpitis. The execution of the root canal treatment is recommended in these cases[15]. However, histological studies have demonstrated that periapical pathologies may not necessarily indicate the presence of pulp necrosis and that some teeth with thickening of the periodontal ligament and small periapical bone rarefaction may still have pulp vitality, with the presence of few inflammatory cells in the apical region of pulp tissue[12]. LANGELAND et al.[6] believe that thickening of the periodontal membrane, as well as periapical rarefactions may be due to the diffusion of bone resorption mediators or of cytotoxic products originating from the pulp chamber in an apical direction, and that after pulpotomy this source of toxin release may be eliminated, leading to a rapid resolution of the process and preserving the vitality of the pulp remnants.

The objective of the present study was to evaluate the clinical and radiographic response of permanent molars with caries-induced pulp exposure, thickening of the periodontal ligament and periapical bone rarefaction submitted to the calcium hydroxide pulpotomy technique.

MATERIAL AND METHODS

The study was conducted on 20 permanent molars, 18 lower and 2 upper teeth, of 20 patients of both sexes aged 8 to 24 years. Initial clinical examination showed that the teeth presented caries-induced pulp exposure, with 4 of them presenting a hyperplastic pulpitis. Radiographically, the selected teeth presented thickening of the periodontal ligament, with slight periapical bone rarefaction involving one or more roots. None of the patients reported prolonged spontaneous pain or the need to use analgesics. Also, the patients did not report systemic alterations and none of the teeth studied had been previously treated.

After local anesthesia using vasoconstrictive anesthetics (3% Citanest with octapressin or 2% xylocaine with norepinephrine - Merrel Lepetit-Farmacêutica e Industrial de São Paulo), isolation of the dental area with rubber dam and antisepsis of the operative field with 0.3% iodine alcohol, the carious tissue was fully eliminated with smooth conventional rotation spherical burrs and the roof of the pulp chamber was removed with sterilized number 2 spherical diamond tips at high speed and under refrigeration. Intrapulp anesthesia was not used in any case. The crown pulp, which was clinically supposed to be pink-reddish in color, be resistant to the cut, with "bright red" bleeding and mild hemorrhage, was amputated with sterilized sharpened curettes and hemostasis was obtained with abundant irrigation with physiological saline. A sterilized dry cotton pellet soaked in Otosporin (Wellcome-Zeneca Ltda.) was then placed on the pulp tissue and the cavity was sealed with a cotton wick and with zinc oxide-eugenol cement (Zoecim/S.S. White) for a period of 48 hours.

In the second session, under conditions of isolation with rubber dam and antisepsis of the surgical field, the dressing was removed, the pulp chamber was irrigated with physiological saline and a thick layer (approximately 2 mm) of calcium hydroxide paste p.a. (Merk-Darmstadt, Germany) and distilled water was placed on the pulp remnant without pressure. The tooth was then restored with silver amalgam (Velvalloy, S.S. White) condensed on a zinc phosphate cement base (Zinc cement, Lee Smith) during the same session.

Thirty days after the end of treatment, a postoperative control was performed by clinical and radiographic examination, a procedure later repeated at 2 to 3 month intervals for a period ranging from 6 to 21 months. The success of treatment was clinically evaluated by absence of pain, gingival edema or a fistula, and radiographically by the formation of a mineralized tissue barrier, by total or partial repair of the areas of periapical bone rarefaction, by the reestablishment of normal periodontal ligament thickness, by the integrity of the lamina dura and by the absence of internal dentin resorption.

RESULTS

The results obtained are presented in Table 1. According to the clinical and radiographic criteria adopted for evaluation, total or partial success was obtained in 17 cases (85%). In 14 cases (70%) there was full disappearance of periapical radiolucent areas with reestablishment of the integrity of the lamina dura (Figures 1A, B and 2A, B). In 3 cases (15%) there was partial but significant repair in the areas of periapical bone rarefaction, suggesting that total regression of the periapical pathology may occur over longer follow-up periods, considering that the present cases were followed up for only 6 months.

In the 3 remaining cases (15%) there was no reduction of the periapical radiolucent areas, with acute recurrence being observed in one case and increased periapical involvement in the other two.

Radiographically, we did not observe internal dentin resorption, dystrophic calcifications or obliteration of the root canal over the period of observation.

A barrier of mineralized tissue was observed in one or all roots of 70.6% of the successfully treated cases.

DISCUSSION

Teeth with extensive carious lesions, with vital pulps and periapical reactions may be submitted to the technique of calcium hydroxide pulpotomy with a prognosis considered to be extremely favorable [2,9,10,12].

CALISKAN[2] stated that calcium hydroxide pulpotomy is conditioned by the presence of pulp vitality, with the clinical aspect of the pulp being the most important factor. HOLLAND and SOUZA[3] confirmed this statement by emphasizing that the main indicator for a diagnosis of vitality is the macroscopic aspect of pulp tissue, i.e., this tissue should be pink-reddish in color, be resistant to the cut, with "bright red" bleeding and mild hemorrhage, and these were the criteria also used in the present study.

Among the factors affecting the prognosis of pulpotomy, of fundamental importance are the extent of pulp pathology[14] bacterial contamination[4], extra-pulp blood clot[13,14], maintenance of the aseptic chain[8,11] and the choice of capping material.

In the present study, we performed treatment using the mediated technique, i.e., placement of an Otosporin dressing for 48 hours before pulp capping with calcium hydroxide in distilled water. CALISKAN[2] obtained 92.3% clinical and radiographic success in human teeth with periapical involvement after performing pulpotomy and immediately covering the area with calcium hydroxide and distilled water. RUSSO et al.[12], in a clinical and radiographic study of human teeth with periapical lesions submitted to the pulpotomy technique, concluded that the rate of success was greatly increased when an anti-inflammatory dressing was used for 48 hours before placement of the calcium hydroxide paste and distilled water, probably because of its action in the control of pulp inflammation.

Aware of the importance of the capping material in the prognosis of pulpotomy, we opted for calcium hydroxide on the basis of reports by other authors who recommend it as a material of excellent tissue compatibility and as an inducer of mineralized tissue [5,7,17].

Although radiographic visualization of a mineralized tissue barrier indicates successful treatment, the opposite may not be true since even in teeth with wide root canals the barrier is sometimes present histologically but its dimensions and radiopacity are not sufficient for detection by radiographic examination[16]. In view of these considerations, in the present study we used a clinical-radiographic examination to determine the success of treatment, with emphasis on the absence of symptoms, recovered integrity of the lamina dura, regression of periapical reactions and the presence of the mineralized tissue barrier.

Full (70%) or partial (15%) repair of the areas of periapical bone rarefaction occurred in the patients studied after calcium hydroxide pulpotomy and observation for 6-9 months. We believe that, after a longer period of observation, we may obtain a higher rate of total regression since CALISKAN[2] reached clinical and radiographic success in 92.3% of cases after a follow-up period of 16-72 months.

We performed calcium hydroxide pulpotomy on 4 teeth with chronic hyperplastic pulpitis and were successful in all cases, while CALISKAN[1] obtained a rate of success of 91.7%.

In 1982, Russo et al.[12] obtained radiographically visible reduction of areas of periapical bone rarefaction in 6.7% of their patients submitted to pulpotomy, with an anti-inflammatory dressing left in place for 48 hours and capping with calcium hydroxide in distilled water, after periods of more than 2 months. Full repair of these areas of periapical bone rarefaction occurred in 93.3% of cases. In our study, 70% of the patients presented full repair and 15% partial repair after a period of more than 6 months.

RUSSO et al.[12] reported an 85% success rate observed histologically after pulpotomy, with the presence of mineralized tissue. In our study this barrier of mineralized tissue was observed radiographically in one or all roots in 70.6% of cases.

Thus, on the basis of the present results and of the statement by HOLLAND and SOUZA[3], who reported that the success rate of biopulpectomies executed by endodontists is 95% but is reduced to 40% when the procedure is performed by a general clinician, we may conclude that the technique of calcium hydroxide pulpotomy is valid for permanent teeth. HOLLAND and SOUZA[3] also stated that the success obtained after pulpotomy is 85% for both general clinicians and endodontists since this is a technique of easier execution than instrumentation and obturation of root canals which, when properly indicated, could be a rational alternative.

CONCLUSIONS

1 - According to the clinical and radiographic criteria adopted for evaluation, total or partial success was obtained in 85% of the cases, for a period ranging from 6 to 21 months.

2 - A barrier of mineralized tissue was observed in one or all roots of 70.6% of the successfully treated cases.

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Table 1 . Postoperative evaluation of permanent molars with thickening of the periodontal ligament and periapical bone rarefaction submitted to the technique of calcium hydroxide pulpotomy.

Patient no.	Observation time (months)	Repair of areas of bone rarefaction	Reestablishment of lamina dura integrity	Internal dentin resorption	Mineralized tissue barrier	Clinical signs and syntoms
1	17	Absent	Absent	Absent	Absent	Normal
2	6	Partial	Partial	Absent	Absent	Normal
3	6	Total	Total	Absent	Absent	Normal
4	7	Absent	Absent	Absent	Absent	Normal
5	19	Total	Total	Absent	Present	Normal
6	14	Absent	Absent	Absent	Absent	Normal
7	15	Total	Total	Absent	Present	Normal
8	6	Total	Total	Absent	Present	Normal
9	6	Partial	Partial	Absent	Absent	Normal
10	20	Total	Total	Absent	Present	Normal
11	21	Total	Total	Absent	Present	Normal
12	9	Total	Total	Absent	Present	Normal
13	19	Total	Total	Absent	Present	Normal
14	19	Total	Total	Absent	Present	Normal
15	14	Total	Total	Absent	Present	Normal
16	6	Partial	Partial	Absent	Present	Normal
17	7	Total	Total	Absent	Present	Normal
18	21	Total	Total	Absent	Absent	Normal
19	16	Total	Total	Absent	Absent	Normal
20	6	Total	Total	Absent	Present	Normal

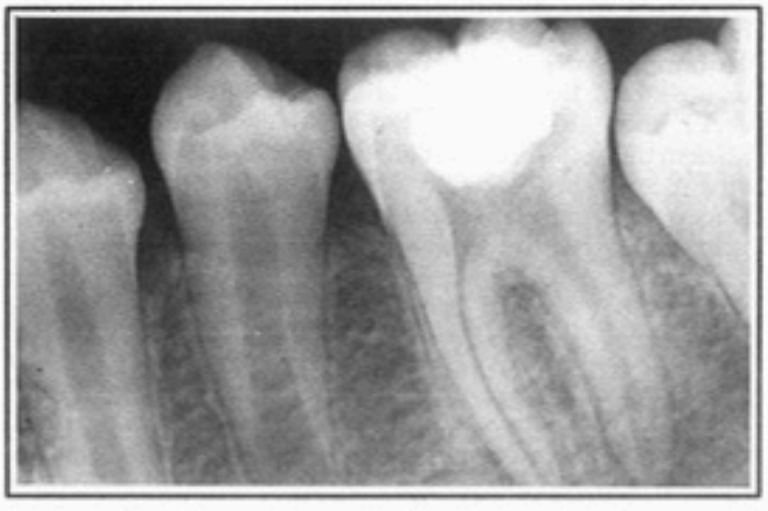
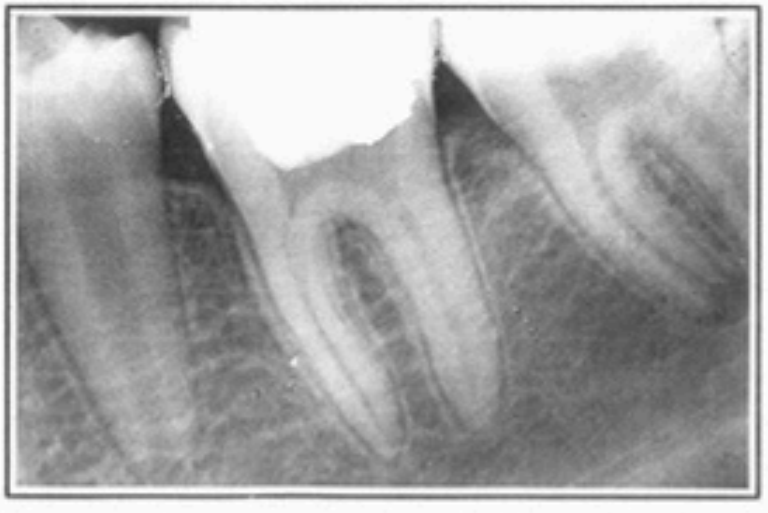


Figure 1.

(a) Periapical radiograph of mandibular first permanent molar selected for treatment by pulpotomy - dressing - calcium hydroxide with radiolucences in the apical region.



(b) Follow-up 16 months after pulpotomy treatment. Normal appearance of periapical tissues and restoration of the integrity of the lamina dura. Note the dentine bridge formation.

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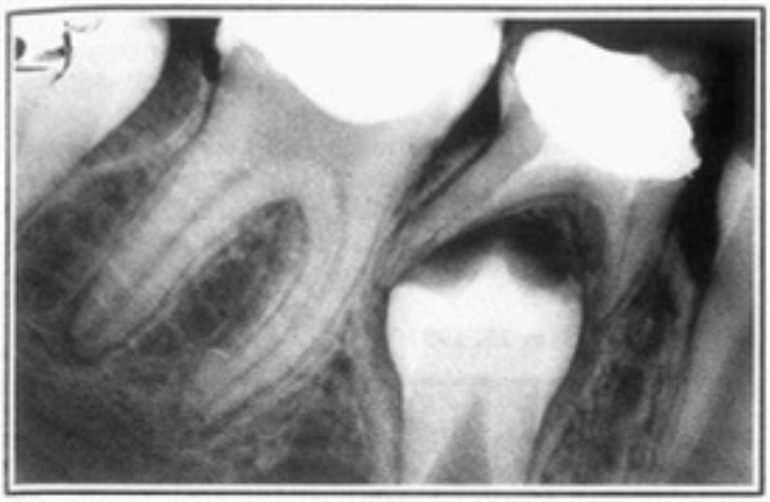

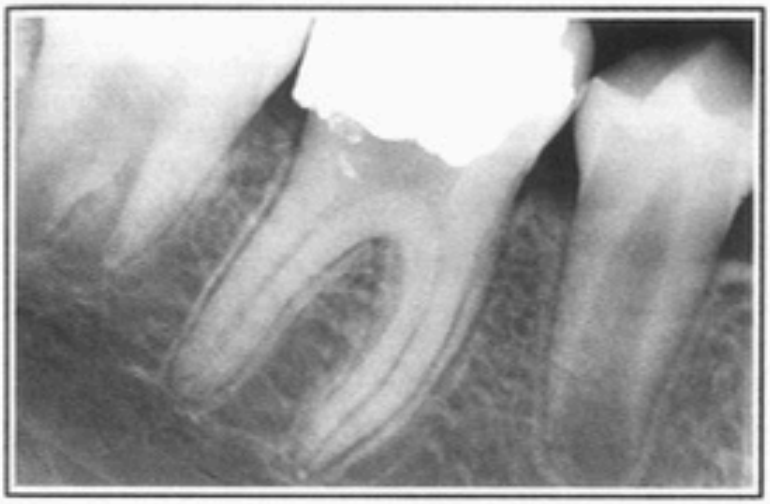

Figure 2 .
(a) Periapical radiograph of mandibular first permanent molar showing enlarged space of periodontal membrane.

(b) Follow-up 20 months after pulpotomy treatment. Periapical radiograph showing healing of periapical tissues and dentine bridge formation.

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SHELF-LIFE OF 5% SODIUM HYPOCHLORITE SOLUTIONS

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The effects of storage time and temperature on the stability of 5% sodium hypochlorite solutions were studied for 18 months. The samples were stored at ambient temperature, lower part of refrigerator (9 °C) and receiving direct sunlight. The available chlorine was determined quantitatively each month by iodometric titration. All solutions showed degradation versus time, and no significant difference in the chlorine loss was found among the three groups.

Key words
Sodium hypochlorite, chlorine loss, storage.

INTRODUCTION

The use of sodium hypochlorite (NaOCl) as an antiseptic began by the end of 18th century, with the water of JAVELLE (1792), a solution containing sodium and potassium hypochlorite, according to PUCCI[9]. This author also relates that Labaraque's liquor, a solution containing 2.5% sodium hypochlorite, appeared in 1820.

A solution containing 0.5% available chlorine with boric acid to reduce its pH was proposed by DAKIN[3], in order to disinfect wounds during World War I.

The introduction of 5% sodium hypochlorite in dentistry was made by WALKER[13], reinforced by GROSSMAN and MAIMAN[4].

The effects of sodium hypochlorite on the pulp tissue dissolution, on the dentin permeability, on the cleaning of the root canal and its bactericide action were studied by many authors, among them SHIH et al.[10], PÉCORA[6], WAYMAN et al.[14], BAUMGARTNER and CUENIN[2], JOHNSON and REMEIKIS[5], BARBOSA et al.[1] and PÉCORA[7].

The purpose of this study was to investigate the effects of time and storage temperature on the active chlorine loss of 5% sodium hypochlorite solutions, for 18 months.

MATERIAL AND METHODS

The 5% sodium hypochlorite solution used in this study was dispensed at the Endodontics Research Laboratory at FORP-USP, and its active chlorine concentration was determined by iodometric titration. After this, the solution was divided in three different groups, stored in amber glass bottles tightly closed.

The different temperatures and ambient conditions used in this research were determined by observing habits and situations found in dental practices.

The bottles were kept in the following conditions for 18 months: a) ambient temperature, away from sunlight; b) lower part of refrigerator (9 °C); c) receiving direct sunlight by the morning.

The quantitative iodometric titrations were made every 30 days, three repetitions each in order to minimize the experimental error. The amount of available chlorine of each experimental group was determined after a arithmetic mean of the three results.

RESULTS

Table 1 indicates the mean results of available chlorine found in the 5% sodium hypochlorite solutions stored at different conditions and their respective chlorine loss over the time.

The Kruskal-Wallis test indicated that there were no statistic differences between the results ($p>0.05$). The linear regression analysis showed correlation by the level of 1%, indicating an inversely proportional relation between the storage time and available chlorine of the solutions.

Figure 1 shows the degradation curves of the different experimental groups.

DISCUSSION

An essential factor in the success of an endodontic treatment is the correct cleaning and disinfection of the root canal system. Its correct chemo-mechanical preparation depends not only on the ability of the dentist, but also on the quality of the products used.

Sodium hypochlorite solutions are of an unstable nature, due to the high rates of available chlorine loss. Knowing this, the professional must give preference to fresh prepared solutions, stored in amber glass bottles tightly closed; by doing so there will be no risk of using a NaOCl solution with available chlorine rates below nominal.

The statistical analysis showed that there is no influence of temperature on the degradation of sodium hypochlorite solutions, when stored in amber glass bottles tightly closed; the loss of active chlorine over time was similar in the three different experimental groups.

The results found in this study allow to state that storage time exercise great effect on the degradation of sodium hypochlorite solutions.

As can be observed in table 1, after approximately 300 days a 5% sodium hypochlorite solution has its available

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chlorine reduced by half, no matter where the solutions were stored. PISKIN and TÜRKÜN[8], in a similar experiment, found the same available chlorine loss in 5% NaOCl solutions stored at 24 °C, although state that this loss is reduced when the solutions are kept in low temperatures.

The dentist doesn't necessarily need to discard this solution; it can be used in procedures where there is no need of high chlorine concentrations.

But, on the other hand, if the professional wants to use a 5% sodium hypochlorite solution, he must do it in the 30 first days from the production date (table 1). As many professionals prefer to use a sodium hypochlorite solution with available chlorine concentrations of 4 to 5%, the product can be used for 150 days from the production date.

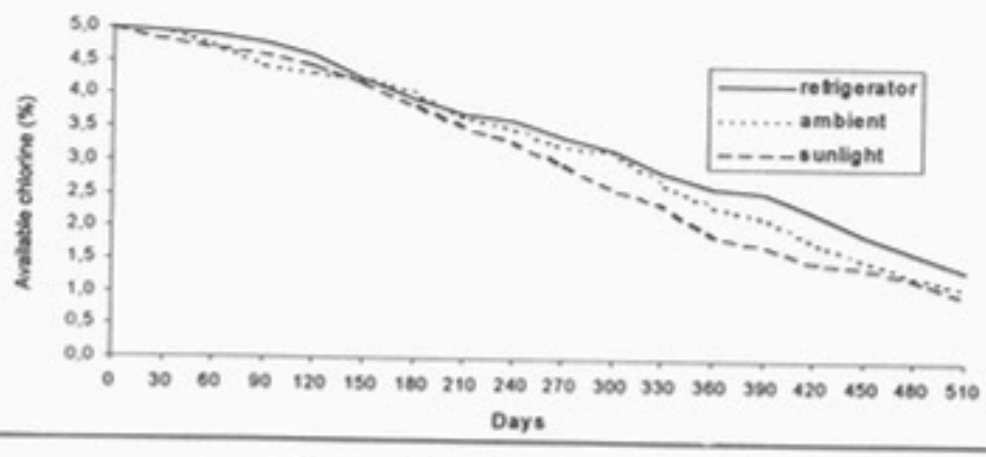
After 510 days, it was observed that the solutions had only 1% of available chlorine; this concentration is also very utilized in endodontics.

According to the methods used and results found in this study, we can conclude that when the 5% sodium hypochlorite solution is kept in amber glass bottle tightly closed, the available chlorine loss is directly proportional to the storage time, independent of temperature conditions.

Table 1:
Mean results of available chlorine found in 5% sodium hypochlorite solutions stored at different conditions and their respective chlorine loss over the time.

Time (days)	Storage conditions					
	Refrigerator		Ambient		Direct sunlight	
	NaOCl concentration	loss (%)	NaOCl concentration	loss (%)	NaOCl concentration	loss (%)
0	5.00	0.0	5.00	0.0	5.00	0.0
30	4.94	1.2	4.96	0.8	4.83	3.4
60	4.90	2.0	4.77	4.6	4.72	5.6
90	4.78	4.4	4.43	11.4	4.62	7.6
120	4.59	8.2	4.32	13.6	4.45	11.0
150	4.22	15.6	4.26	14.8	4.19	16.2
180	3.93	21.4	4.07	18.6	3.83	23.4
210	3.71	25.8	3.67	26.6	3.52	29.6
240	3.63	27.4	3.51	29.8	3.30	34.0
270	3.38	32.4	3.23	35.4	2.97	40.6
300	3.19	36.2	3.16	36.8	2.62	47.6
330	2.86	42.8	2.70	46.0	2.38	52.4
360	2.64	47.2	2.36	52.8	1.92	61.6
390	2.55	49.0	2.19	56.2	1.77	64.6
420	2.26	54.8	1.84	63.2	1.53	69.4
450	1.93	61.4	1.58	68.4	1.46	70.8
480	1.66	66.8	1.32	73.6	1.29	74.2
510	1.40	72.0	1.14	77.2	1.01	79.8

Figure 1:
Degradation curves of 5% sodium hypochlorite solutions stored under different conditions.



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DENTAL TRACTION AS A SOLUTION FOR COSMETIC PROBLEMS OF ENDODONTIC ORIGIN WITH PERIODONTAL IMPAIRMENT

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The purpose of the study is demonstrate the use of dental traction as an alternative treatment for unsuccessful lateral sealing of the perforation of a tooth prescribed for extraction, in which the patient showed an extensive amalgam tattoo with significant cosmetic impairment

Key words: Dental traction, tattoo,perforation.

INTRODUCTION

The number of patients who need paraendodontic surgery[6] after unsuccessful endodontic treatment is very significant. The main surgical procedures are curettage of the apical area, apicectomy, and apicectomy followed by retrofilling or retroinstrumentation, as well as the sealing of the perforation in the floor of the pulpar chamber and the lateral side of the root canal.

There is a high rate of success when the precise indications and contra-indications for lateral sealing of the perforation are correctly diagnosed. The factors concerning prior unsuccessful endodontic treatment can be decisive in the outcome of future surgical procedures[9].

Several materials are used for retrofilling and for the filling of the lateral perforations. These present many problems related to their use and manipulation during surgical procedures, due to the difficulty of working in a wet area, which is one of the primary issues involved in the choice of the materials. In the absence of adequate retrofilling material, silver or copper amalgam are still frequently used[1,3]. The dentist needs to be aware that amalgam can cause infiltration and chromatic alterations, eventually tattooing the tissue.

In the majority of cases, the amalgam tattoo is brownish or even bluish-black. It is a common occurrence according to BUCHNER and HANSEN[2] and HARRISON et al.[5] occurring in four distinct ways: gum condensation during restoration with amalgam; penetration of particles in the mucous damaged by revolving instruments during the removal of amalgam restorations; introduction of loose fragments during dental extraction in the alveolus or under the periosteum; particles in contact for an extended period of time with the connective tissue by amalgam retrofilling, with no prescription for treatment. BUCHNER and HANSEN[2] describe the amalgam as an inert material and according to ELEY[4], when any inflammatory reaction is noted, its extension depends on the size of the amalgam fragment and its composition. The following clinical case demonstrates the use of dentl traction as an alternative treatment for unsuccessful lateral sealing of the perforation of a tooth prescribed for extraction, in which the patient showed an extensive amalgam tattoo with significant cosmetic impairment.

CASE REPORT

A female patient, L.C.E., 28 years old, presented an extensive amalgam tattoo on the buccal surface of the left lateral incisor (Figure 1). Her primary concern was cosmetic. After the anamnese, clinical examination, radiographic analysis (Figure 2), and periodontal probing (Figure 1), it was confirmed that the tooth was lost, due to the almost complete absence of the buccal bone. Prior clinical history indicated the presence of a fistula in the buccal area, and a former attempt to perform lateral sealing with amalgam 8 years before the present examination. After this surgery the patient reported gradual darkening of the area. The normal procedure adopted in these cases is the lifting of a total flap, and the removal of the pigmented connective tissue. Several surgeries may be necessary for complete removal. In this case, there was an periodontal pocket (7 mm) making extraction necessary. However, extraction would create a depression, worsening the condition of the area even more. Orthodontic traction of the tooth for extraction was planned. The coronary traction is also called forced eruption, orthodontic extrusion, or vertical extrusion. Slow traction enables the alveolar bone to follow the tractioned tooth. An acrylic plate was manufactured with a thickness of 1.5 mm (Figure 3a) with occlusion properly adjusted. In the area of the tooth to be tractioned, the buccal acrylic was completely removed, leaving only the occlusion stop that not only maintains tooth restriction, but also works as a reference point for future removal.

A temporary one with a "button" of acrylic resin was placed on the tooth to be tractioned, in which an edge of the elastic band was adapted. The other edge of the elastic band was adapted in the palatine area of the acrylic plate, as shown in Figure 3b. Several successive wearings took place in the tractioned tooth, at intervals according to Figure 11, until the tooth was contained (Figure 4), so that the fibers of the tractioned periodontal ligament may exercise the highest possible potential on newly formed bone, bringing along the alveolar bone[7] (Figure 5). During the tooth extraction a complete flap was made in order to allow access to the connective tissue tattooed with amalgam. The tissue was removed (Figure 6). The Figure 7 demonstrates newly formed bone tissue due to traction. The result was such that osteoplastia was performed to enable better shaping of the bone area. During the second periodontal

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surgery, more of the connective tissue tattooed was removed using a cuticle pliers (Figure 8). In order to prevent a depression in the sutured gum tissue, a connective tissue graft was placed using material removed from the palate. Figure 9 demonstrates the sutured area with the connective tissue properly placed. After the last surgical procedure, the healing process lasted 3 months until the gum tissue was completely healed. After this period, an osteo-integrated implant was placed. Figure 10 (a and b) shows the gum tissue before the treatment and after the implant, and figure 10c the final result with the prosthesis in place.

DISCUSSION

This clinical case demonstrates one approach for solving cosmetic problems through traction, implants of connective tissue, and osteo-integrated implants. Cases like this, where the tooth was lost due to various reasons, are common in clinical dentistry. Many professionals, in an attempt to cover their mistakes, or because of lack of knowledge of this technique, extract the tooth. If the tooth treated with the procedure described above was removed, there would be a loss in the dimensions of the gum tissue and normal bone in the area, both in height and in thickness, aggravated by the amalgam tattoo.

When a tooth with a deep periodontal pocket is extracted, there is no way to know the thickness of the bone after complete remodeling of the bone area. Many times a bone implant is needed to achieve sufficient thickness in order to obtain an excellent positioning for the implant. The gum tissue also normally results in an apical position on the neighboring teeth, needing several gengival grafts and connective tissue grafts in order to arrive at a "solution" to the problem. Seldom are the results considered ideal, especially when there is loss of gum tissue height[8].

Slow dental traction acts in such way that the bone and gum tissue follow the tooth, recovering the height and thickness of the bone, as well as the height of the lost gum, even preventing difficult treatment of the bone and gum tissue

This clinical case demonstrates a highly predictable clinical treatment for cosmetic problems where the tooth is lost due to periodontal problems.

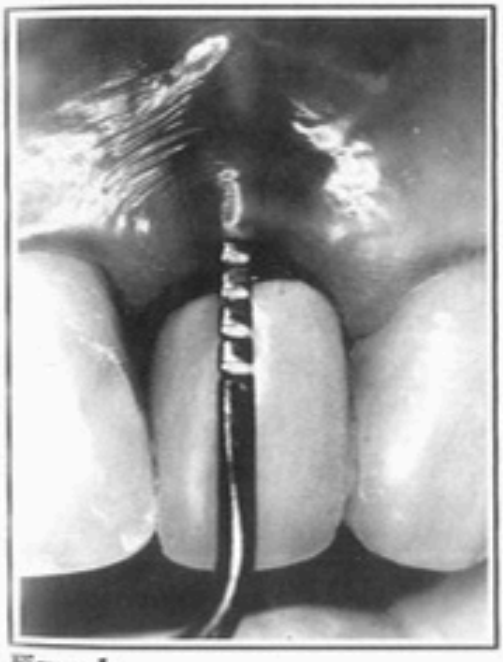

Figure 1.

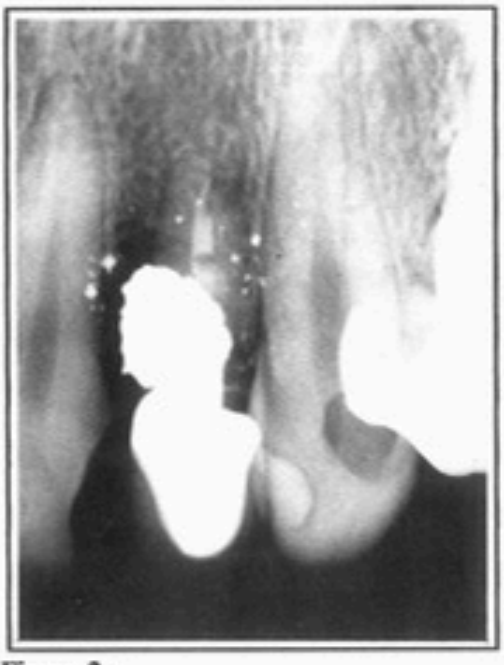

Figure 2.

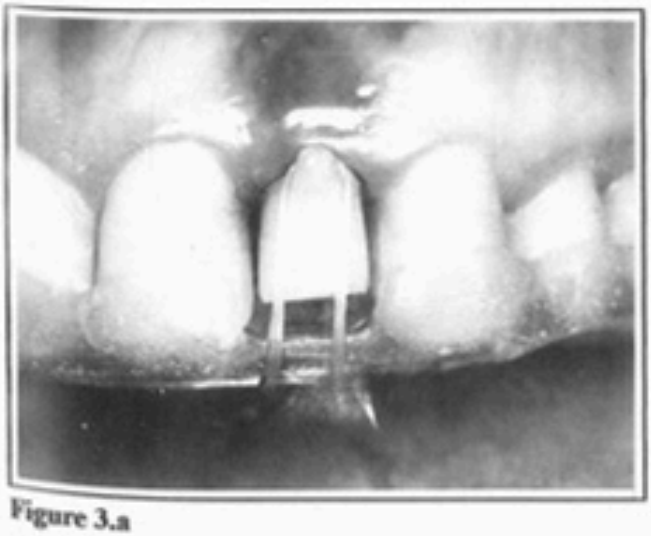

Figure 3.a

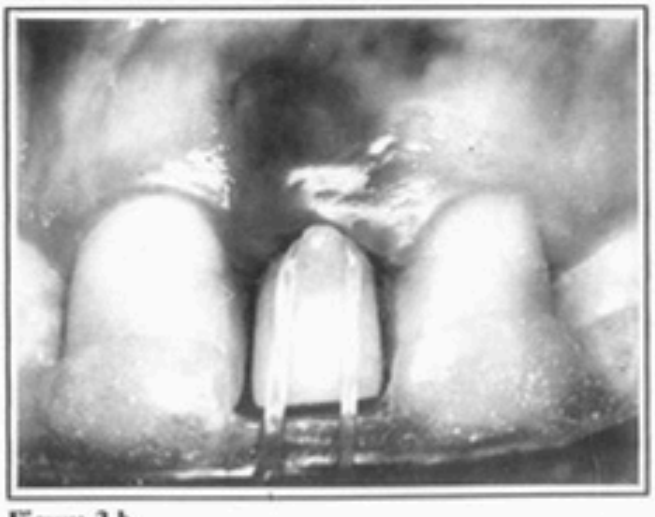

Figure 3.b

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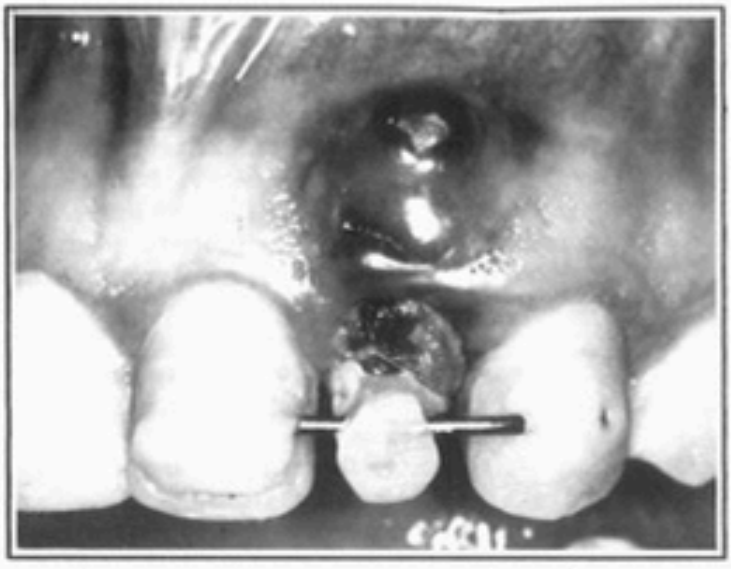

Figure 4.

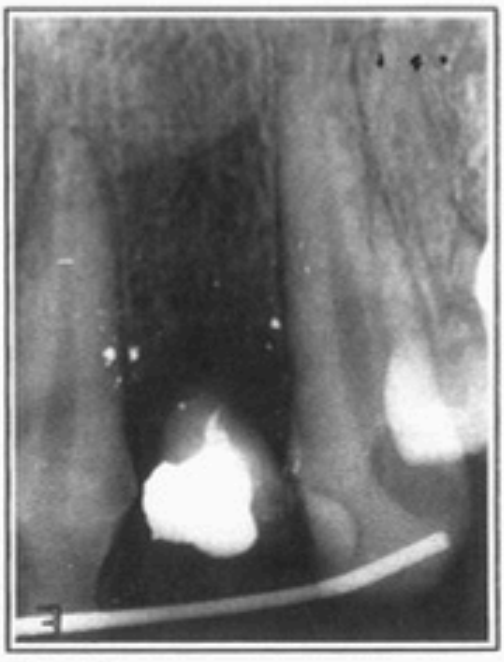

Figure 5.

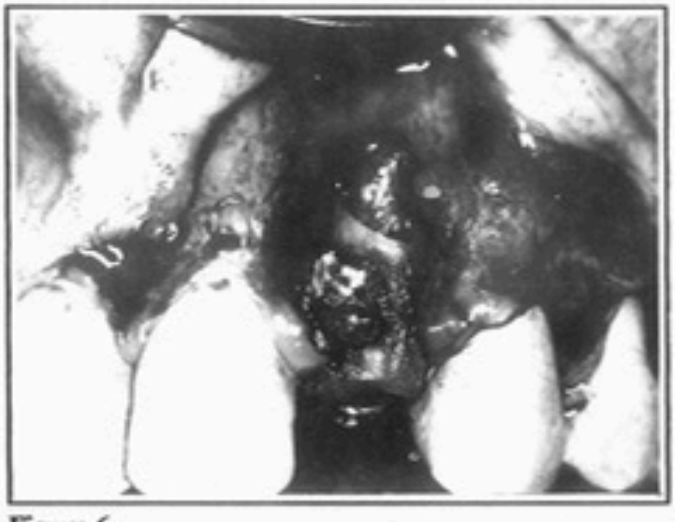

Figure 6.

Figure 7.

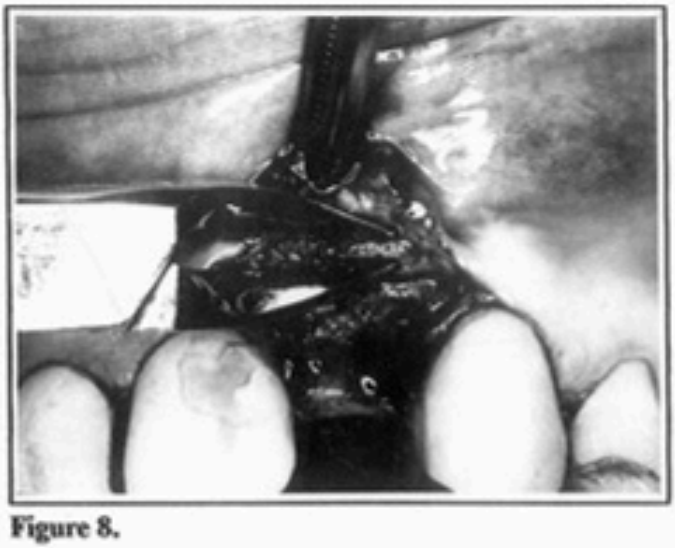

Figure 8.

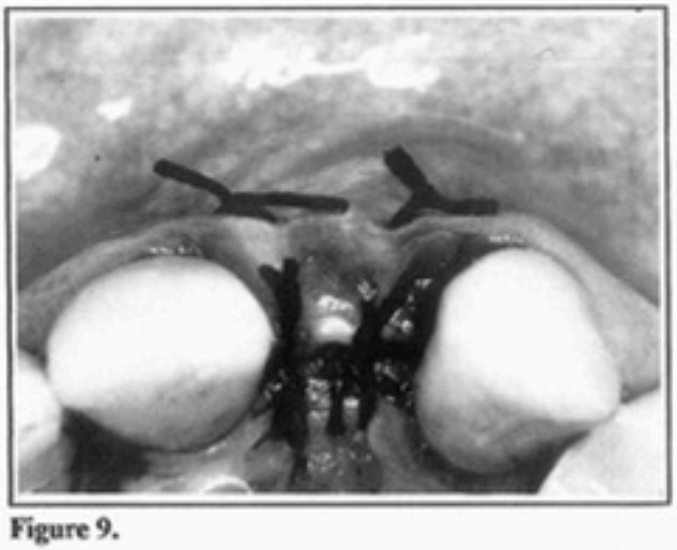

Figure 9.

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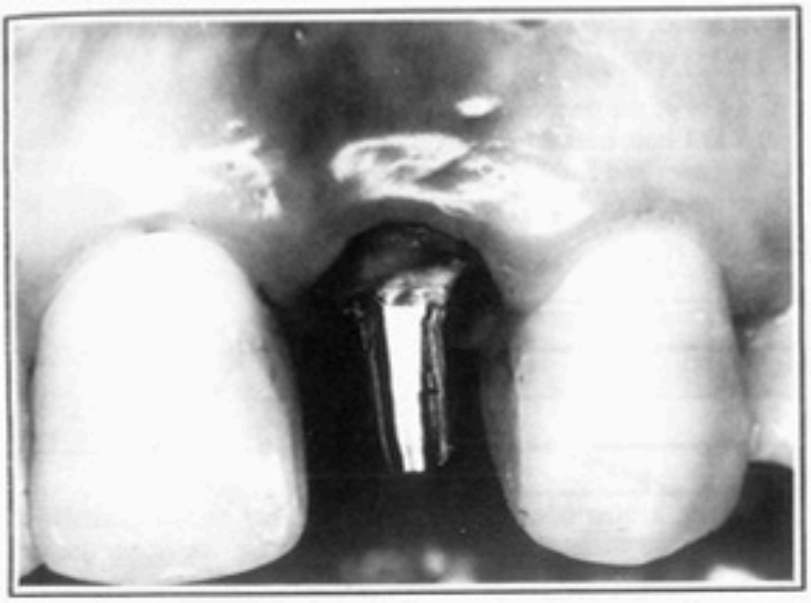

Figure 10 . a

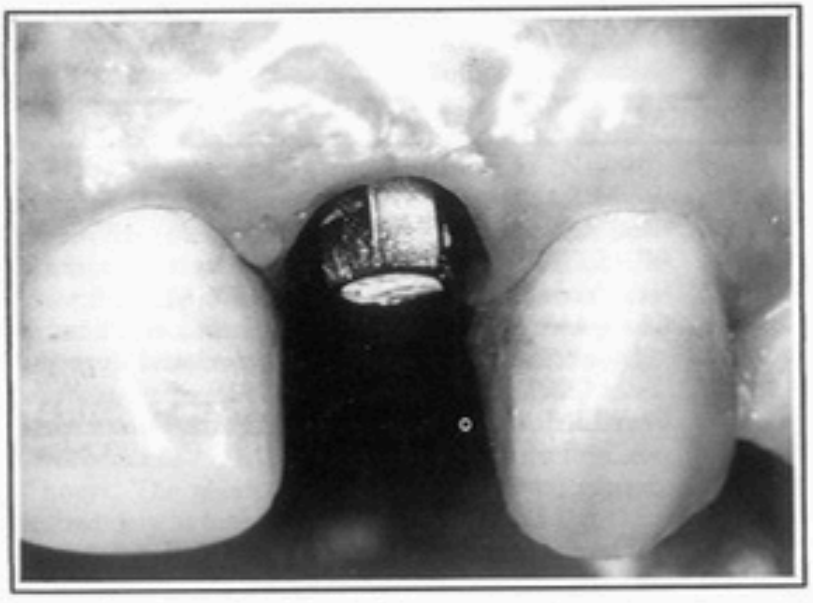

Figure 10 . b

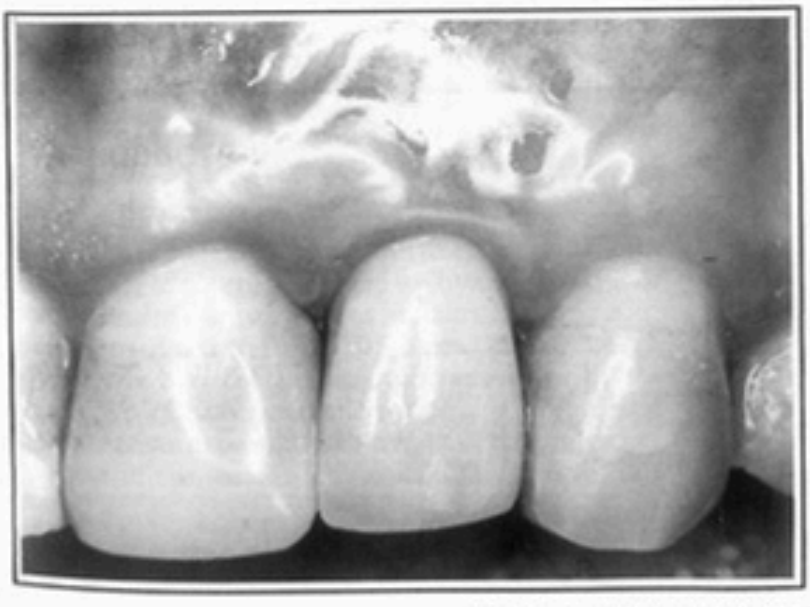

Figure 10 . c

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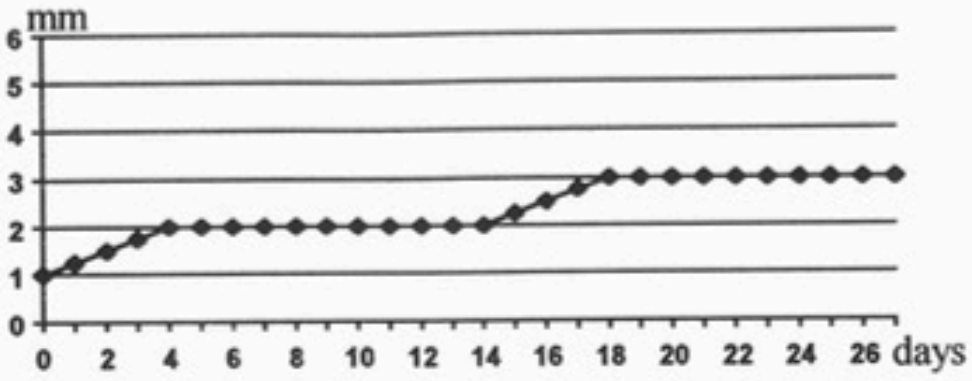
Figure 11.

Figure 11 shows the wearing away of the tractioned tooth in relation to time (days), 0-4, wears away 0.5 to 1 mm, next 8 to 12 days of a waiting period. New wear away of 0.5 to 1 mm and another waiting period. This procedure is repeated according to the need of each case.



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EVALUATION OF THE STERILITY AND ANTIMICROBIAL ACTIVITY OF GUTTA-PERCHA CONES

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Microorganisms and their products and subproducts play an important role in the etiology an persistence of diseases of endodontic origin. On this basis, technical procedures are currently being used to control and maintain the aseptic chain throughout endodontic treatment, among them the phase of root canal sealing. The objective of the present study was to evaluate the sterility and antimicrobial activity of gutta-percha cones. The study was conducted on 110 gutta-percha cones of the following commercial brands: Dia Dent (N = 25, Korea), Tanari (N = 25, São Paulo, SP), Odacham (N = 20, Petrópolis, RJ), Dentsply (N = 20, Petrópolis, RJ), and Kerr/Sybron (N = 20, Michigan, USA). Using sterilized pliers, the cones were removed from their sealed packages under a laminar flow hood, immersed in test tubes containing thioglycollate broth and incubated at 37ºC for 20 days. Microbial growth was checked daily on the basis of the turbidity of the culture medium. The antimicrobial activity of the gutta-percha cones was determined by measuring the inhibition haloes on a plate inoculated with the standard microbial strain *Micrococcus luteus* (ATCC-9341) incubated at 37ºC for 24 hours. The results showed that microbial growth occurred only in tubes containing cones of the Dia Dent and Tanari brands (8% each) and that only cones of the Kerr/Sybron brand did not show any antimicrobial activity. These results permit us to conclude that it is necessary to disinfect gutta-percha cones before clinical use and that, in general, gutta-percha cones present antimicrobial activity.

Key words: Gutta-percha cones, extent of contamination, antibacterial activity.

INTRODUCTION

The control of infection during Dentistry procedures is an essential condition for successful treatment and for the maintenance of patient health and well-being. The risk of transmission of diseases such as hepatitis B, candidiasis, tuberculosis, diphtheria and AIDS, among others, through perforations with contaminated instruments or by the introduction of pathogenic microorganisms when dental materials come in contact with tissues of the oral cavity are some of the reasons that explain the need for this control[2,3].

According to WARWICK[8], today the prevention of microbial contamination during the fabrication of products is more important than ever because of the changes that have occurred in the behavior of the market. The protection of a product against microbial contamination during manufacturing depends on factors such as the microbiological quality of the components, i.e., raw material or supply used. Among the supplies, those derived from natural products are susceptible/prone to contamination and therefore should be submitted to microbial monitoring before formulation.

If we consider endodontic treatment to be analogous to the fabrication process, we shall clearly see the need to evaluate the microbiological quality of each instrument and of the equipment, materials and products to be used. Thus, it is important to determine the sterility of the materials used, especially when they are stored for long period of time before being utilized or when they are kept buried inside root canals, as is the case for gutta-percha cones. The direct contact of gutta-percha cones with the periapical region can serve as a vehicle for the transport of microorganisms to periapical tissues[3], with the consequent need to determine the sterility of these materials during their clinical use.

MONTGOMERY[4], in an analysis of different commercial brands of gutta percha cones from sealed packages, noted that 8% of the cones were found to be contaminated after being removed from the sealed package. MOORER and GENET[6] questioned the need for decontamination of gutta-percha cones before their clinical use since they observed a reduction in number of viable bacteria after placing gutta-percha cones in culture. Do gutta-percha cones have antibacterial activity? Is this antibacterial activity responsible for the decontamination of gutta-percha cones used clinically?

In view of the above considerations, the objective of the present study was to determine the extent of contamination of gutta-percha cones of different commercial brands and their antibacterial activity.

MATERIAL AND METHODS

I - Evaluation of the Extent of Contamination of Gutta-Percha Cones

The following commercial brands were evaluated: Dia Dent (Korea), Tanari (São Paulo, SP), Odacham (Petrópolis, RJ), Dentsply (Petrópolis, RJ), and Kerr-Sybron (Michigan, USA), for a total of 110 gutta-percha

cones distributed into the following numbers and sizes: Dia Dent - 13 # 15 to # 40 cones and 12 # 45 to # 80 cones; Tanari - 13 # 15 to # 40 cones and 12 # 45 to # 80 cones; Odacham - 20 # 15 to # 40 cones; Dentsply - 20 # 15 to # 40 cones; Kerr/Sybron - 20 # 14 to # 40 cones.

Using sterilized pliers, the cones were removed from their sealed packages under a laminar flow hood (Veco, Campinas, SP), immersed in test tubes with screw-on caps containing thioglycollate medium (Difco) and incubated in an oven at 37ºC for 20 days. Microbial growth was checked daily on the basis of the turbidity of the culture medium.

II - Antimicrobial Activity

Boxes containing 103 gutta-percha cones (20 from Dentsply, 20 from Dia Dent, 21 from Kerr/Sybron, 22 from Odacham, and 20 from Tanari) were opened under a laminar flow hood and the cones were removed with sterilized pliers and deposited on Petri dishes (20 x 100 mm) containing 20 mL Mueller Hinton Agar Medium (Difco) inoculated with the standard strain *Micrococcus luteus* (ATCC-9341) by the pour plate method. The plates were kept at room temperature for 2 hours before incubation, as recommended by MOORER and GENET[6], and then incubated at 37ºC for 20 to 24 hours. Antibacterial activity was determined by the formation of inhibition haloes along the cone. After the incubation period, optimization was performed by adding 1.0% agar gel with 0.1% triphenyltetrazolium chloride (Merck) as recommended by BEGUE and KLINE[1]. After gel solidification, the plates were incubated at 37ºC for approximately 30 minutes and the diameters of the inhibition haloes were measured with a millimeter ruler.

DISCUSSION

Gutta-percha cones are products essentially consisting of a vegetal substance associated with other components that confer better physical properties on them, such as hardness and radiopacity. These substances (zinc oxide, barium sulfate etc.) cause the gutta-percha cones to have diverse final properties. Their clinical indication is based on the fact that these materials are well tolerated by periapical tissues by being easily removed in case of retraction, and is also based on their antibacterial effect. The antibacterial activity of the cones and their ability to eliminate the microorganisms that may be deposited on their surface, as well as the need for decontamination before their clinical use, have been the subjects of several studies.

The measurements of the inhibition haloes performed in the present study demonstrated the bactericidal activity of the gutta-percha cones tested. Only cones of the Kerr/Sybron brand did not present this activity. MOORER and GENET[2], in 1982, also detected antibacterial activity in gutta-percha cones when using standard strains inoculated into culture medium. These investigators carried out the agar diffusion test, osmolarity measurements, microscopic analysis, X-ray diffraction and scanning electron microscopy studies to identify the biologically active component which was extracted from the gutta-percha cones. They observed that barium and zinc particles were mobilized or extracted from the cones when in contact with water or serum, with zinc oxide being the major compound mobilized or extracted. They also observed that, the longer the time of contact between cones and water or serum, the greater the release of zinc from the cones. Zinc oxide, in addition to being the major component of gutta-percha cones, is also responsible for their antibacterial properties.

Table 1 . Level of contamination of 110 gutta-percha cones of five different brands.

	Brand				
Growth	**Dentsply**	**Dia Dent**	**Kerr/Sybron**	**Odahcam**	**Tanari**
Positive	0	2 (8.0%)	0	0	2 (8.0%)
Negative	20 (100%)	23 (92.0%)	20 (100%)	20 (100%)	23 (92.0%)
Total	20 (100%)	25 (100%)	20 (100%)	20 (100%)	25 (100%)

Table 2 . Diameters of the inhibition haloes of 103 gutta-percha cones of five different brands in the presence of the standard microbial strain *Micrococcus luteus* ATCC 9341.

	Micrococcus luteus (ATCC 9341)			
	Diameter (mm)			
Brand	**Number**	**mallest**	**Widest**	**Mean**
Dentsply	20	10.0	19.0	14.0
Dia Dent	20	11.0	16.0	13.1
Kerr/Sybron	21	0.0	0.0	0.0
Odahcam	22	14.0	16.0	14.8
Tanari	20	13.0	17.0	15.2

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Thus, it is possible that cones of the Kerr/Sybron brand contain an insufficient amount of zinc oxide that cannot induce the antibacterial activity.

In our study, wider diameters of the gutta-percha cones did not lead to greater antibacterial activity by increasing the contact surface.

With respect to the level of contamination of the cones tested, only the Dia Dente and Tanari cones presented growth, both at an 8% rate, a result similar to that reported by MONTGOMERY[4]. This investigator submitted the "contaminated" gutta-percha cones to *in vitro* disinfection with PVPI and observed a 50% reduction of contamination after 4 minutes of immersion, and 100% decontamination after 6 minutes of immersion.

SILVA et al.[7], after contaminating gutta-percha cones of four different brands with various species of microorganisms for varying period of storage, observed that only one commercial brand presented safe conditions for utilization, and concluded that the cones should be disinfected before use.

By comparing the presence of antibacterial activity and the extent of contamination, in the present study we observed that some of the Dia Dent and Tanari cones were contaminated even though they presented antibacterial activity. Thus, we agree with MONTGOMERY[4] when he states that, even though gutta-percha cones present antibacterial activity, in general this activity is not sufficient to prevent bacterial growth.

The present data suggest the need to submit the final product to "microbiological quality control", and also to at least occasional monitoring on the part of clinicians.

CONCLUSIONS

1. Only cones of the Dia Dent and Tanari brands presented contamination (8% in each).
2. Only cones of the Kerr/Sybron brand did not present antibacterial activity.
3. There is no direct relationship between the antibacterial activity of gutta-percha cones and their extent of contamination, so that it is necessary to decontaminate them before their clinical use.

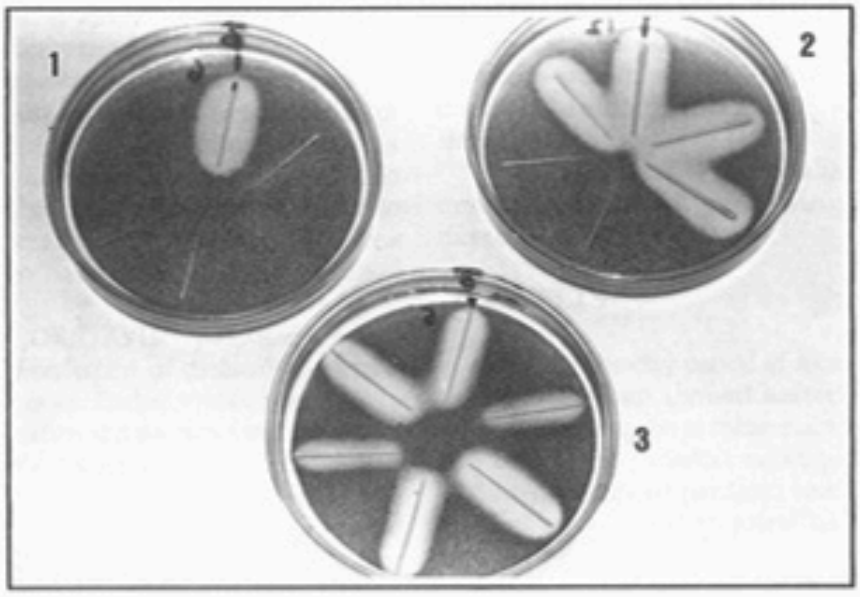

Figure 1. Antibacterial activity against *Micrococcus luteus* ATCC 9341. 1 - one cone with and five zone of inhibition; 2 - four with and two cones without inhibition and 3 - two cones with narrow haloes and four gutta-percha cones with wide one.

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DENTINAL TUBULE DISINFECTION BY CHLORHEXIDINE SOLUTIONS: AN *IN VITRO* STUDY.

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The antibacterial effectiveness of three chlorhexidine solutions (0.12, 0.2 and 2%) was evalueted inside dentinal tubules. Dentine cylinders prepared from bovine incisors and infected with *Streptococcus sanguis* were immersed in chlorhexidine solutions for 1 minute, 1 day or 1 week. The results showed that all solutions were effective in disinfecting dentinal tubules after 1 day of exposure.

Key words: Chlorhexidine; dentinal tubules; disinfection; *Streptococcus sanguis*.

INTRODUCTION

The microbiota of the infected root canal is dominated by anaerobic bacteria[4,10,25]. Gram-negative bacilli are the most prevalent; however, Gram-positive cocci such as *Streptococcus sanguis* can be isolated from root canal infections,[3,15] and also from lesions of recurrent dentinal caries.[7] *S. sanguis* has ability to adhere to the hard tissue[24] and can grow under anaerobic conditions inside dentinal tubules[15,16], and therefore be able to act as a causative factor of persistent infectious processes. Previous studies have suggested that antimicrobial agents can be used to eliminate intratubular infection as a coadjuvant measure to chemomechanical treatment[2,8,9,17,20-22]. Chlorhexidine is one of the most effective on bacteria located into dentinal tubules[22].

HAAPASALO AND ORSTAVIK[8] proposed a model to study infection and disinfection of dentinal specimens prepared from bovine incisors. Earlier studies attempted to demonstrate the contamination and decontamination of root dentin after application of medicaments[2,8,9,17,20-22] for various periods of time. Therefore, the purpose of this study was to evaluate the antibacterial effectiveness of three concentrations of chlorhexidine when used for different periods of time in contact with dentine infected by *S. sanguis*.

MATERIAL AND METHODS

wenty freshly extracted bovine incisors were selected for this study. The teeth were kept overnight in 1% NaOCl for surface decontamination. The crown and the root end of the teeth were removed. Pulp remnants and the cementum were also removed in order to obtain dentinal cylinders, as described previously[19].

The specimens were placed into glass flasks containing 10% citric acid AND were agitated for 3 minutes to remove the smear layer. Specimens were then autoclaved for 20 minutes at 121°C. They were then placed in tubes containing brain heart infusion (BHI) broth (Difco, Detroit, MI, USA) and incubated at 37°C for 1 week to verify sterilization. Each tube contained 15 dentinal specimens. This procedure allowed dentinal tubule penetration by the broth.

After incubation, each tube was inoculated with 0.2 ml of a recent culture of *Streptococcus sanguis* (ATCC 10586) which was renewed every three days for one.

The specimens were then randomly divided into four groups of 15 specimens each. Dentinal cylinders were placed in tubes containing 10 ml of 0.12, 0.2 or 2% chlorhexidine digluconate solution. Saline solution was used as the control group. Each group was equally subdivided according to the different periods of time (5 min, 1 day and 1 week).

After each period, the specimens were removed from the chlorhexidine solutions, washed twice in phosphate-buffer saline solution (pH = 7.4) to eliminate the carry-over effect of the antimicrobial solutions. Afterwards, each specimen was then placed into tubes containing fresh thioglycolate broth (BIOBRÁS, Montes Claros, MG, Brazil).

The specimens were incubated at 37°C and the evaluation of bacterial growth was carried out daily for one month.

RESULTS

After the one-day period of incubation, all cylinders of the control group showed bacterial growth. After five minutes of immersion in chlorhexidine solutions, 80%, 20% and 80% of the cylinders submitted to 0.12%, 0.2% and 2.0% concentrations remained contaminated, respectively. Regardless of the concentration of the chlorhexidine solutions, all dentinal cylinders were disinfected after 1 day and 1 week of exposure. The results are summarized in Table 1.

DISCUSSION

Several studies have demonstrated that several bacterial strains penetrate into dentinal tubules.[1,8,9,11,15-20,22] *S. sanguis* is one of the microorganisms frequently isolated from both infected root canals and recurrent dentinal caries[7,15,16]. Studies have revealed that this species can invade and consequently colonize dentinal tubules.

PEREZ et al.[15] reported that the bacterial penetration inside tubules depends on morphological factors and cellular

arrangement. In addition, Calas et al.[3] justified the choice of *S. sanguis* for their study due to its tendency to form chains and, after a long period of incubation, to form clusters, enhancing its penetration into dentinal tubules.

S. sanguis can remain in tubules growing under anaerobic conditions and low availability of nutrients, which suggests a possibility of reinfection. This bacterial species has a low Ks (saturation constant) in relation to nutrients, a condition that allows it to survive and multiply in this microenvironment. In this case, the use of antimicrobial agents as an adjuvant to chemomechanical treatment has been proposed. Chlorhexidine is important because it can prevent bacterial adhesion, disorganize clusters and maintain antibacterial activity for a long time[14].

This chemical agent has a large spectrum of antimicrobial activity, being effective against fungi and Gram-positive and Gram-negative bacteria. The susceptibility to the drug varies among microorganisms, with the Gram-positive species being more susceptible than others.[6,14] Emilson[6] related that the MIC (Minimal Inhibitory Concentration) value for chlorhexidine ranged between 8 mg to 132 mg/ml against *S. sanguis* .

In the present study, we evaluated the effects of chlorhexidine solutions (0.12, 0.2, and 2%) in the disinfection of dentinal tubules contaminated with *S. sanguis* . The specimens were prepared from bovine incisors that show similar morphologic features when compared to human teeth.[12] The effectiveness of chlorhexidine solutions in eliminating *S. sanguis* inside dentinal tubules was observed after one day or more of contact. After 5 minutes, it was observed that the most effective solution was 0.2%. However, it was also verified that 20% of the specimens were disinfected with the 0.12 and 2% concentrations. Two phenomena may have occurred. First, it is possible that the 0.12% solution after 5 minutes of exposure could not reach the lethal concentration deeper in the tubules, since *S. sanguis* has been observed at a depth of 792 mm in dentinal tubules; second, it is likely that the strongest concentration of chlorhexidine solution (2%) used in this study reacted with some ingredients of the culture medium in the tubules or with some dentinal surface components forming complexes, which may have decreased the activity of this substance. In the other periods examined, we did not observe this phenomena, probably due to the greater time of contact and the diffusion of the complex assuring antimicrobial action in the dentinal tubules.

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Table 1

Number of specimens that remained contaminated after treatment with the chlorhexidine solutions.

Time	0.12%	0.2%	2%	Control
5 min	4*/5**	1/5	4/5	5/5
1 day	0/5	0/5	0/5	5/5
1 week	0/5	0/5	0/5	5/5

* Number of specimens contaminated.
** Number of specimens tested.

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* They must be submitted in duplicate.
* They must be arranged in two separate sets.
* They must be labeled on the back in pencil, including the figure number and the word "top" at the top of the edge.
* Figure legends must be typed double-spaced on a separate page.
5. Color illustrations are not acceptable for publication at this time.

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NEWS AND ANNOUNCEMENTS

On December 05, 1996, Dr. JAP Figueiredo obtained his PhD degree, after presenting a thesis entittled *Evaluation of four endodontic sealers, inserted in rabbits' oral mucosa, by submucous injection or implant in polyethilene tubes, considering the presence of pigmentation and the histological effects.* The examining commitee consisted of the following members: Dr. Antonio Carlos Bombana, Dr. Gilberto Marcucci, Dr. Maria Antonieta Lopes de Souza, Dr. Hildeberto Francisco Pesce (advisor of the study) and Dr. Roberto Holland. The members considered the study valid and worth a grade 10 with distinction and honor.

Last December, 1996, Professor Gilson Blitzkow Sydney got his PhD. degree at the University of São Paulo - Brazil, after submeting his these entitled: *"Ecological changes of the root canal after endodontic therapy with and without the use of calcium hydroxide paste at different times"* to the examining board composed with the following members: Professors Luciano Melo (Federal University of Paraná) João Humberto Antoniazzi, Hideberto Francisco Pesce and Cesário Duarte (University os São Paulo) and Carlos Estrela (Federal University of Goiás). Professor Pesce was the advisor and the candidate was aproved with grade 10 with Distinction and Honnor.

from Left to right: Professor Sydney, Antoniazzi, Melo, Pesce, Duarte and Estrela

On April, 1997, Prof. Sydney was promoted to a Chair in Endodontics at the Federal University of paraná after being examined by the following Chairmen: Professors Atmen Marques de Sampaio and Luciano Loureiro de Melo (Federal University of Paraná), João Humberto Antoniazzi and Hildeberto Francisco Pesce (University of São Paulo) and Roberto Holland (University of São Paulo - Araçatuba Campus). We wish Prof. Sydney success in conducting the Chair of Endodontic at his School.

from left right: Professor Pesce, Sampaio, Sydney, Melo and Antoniazzi

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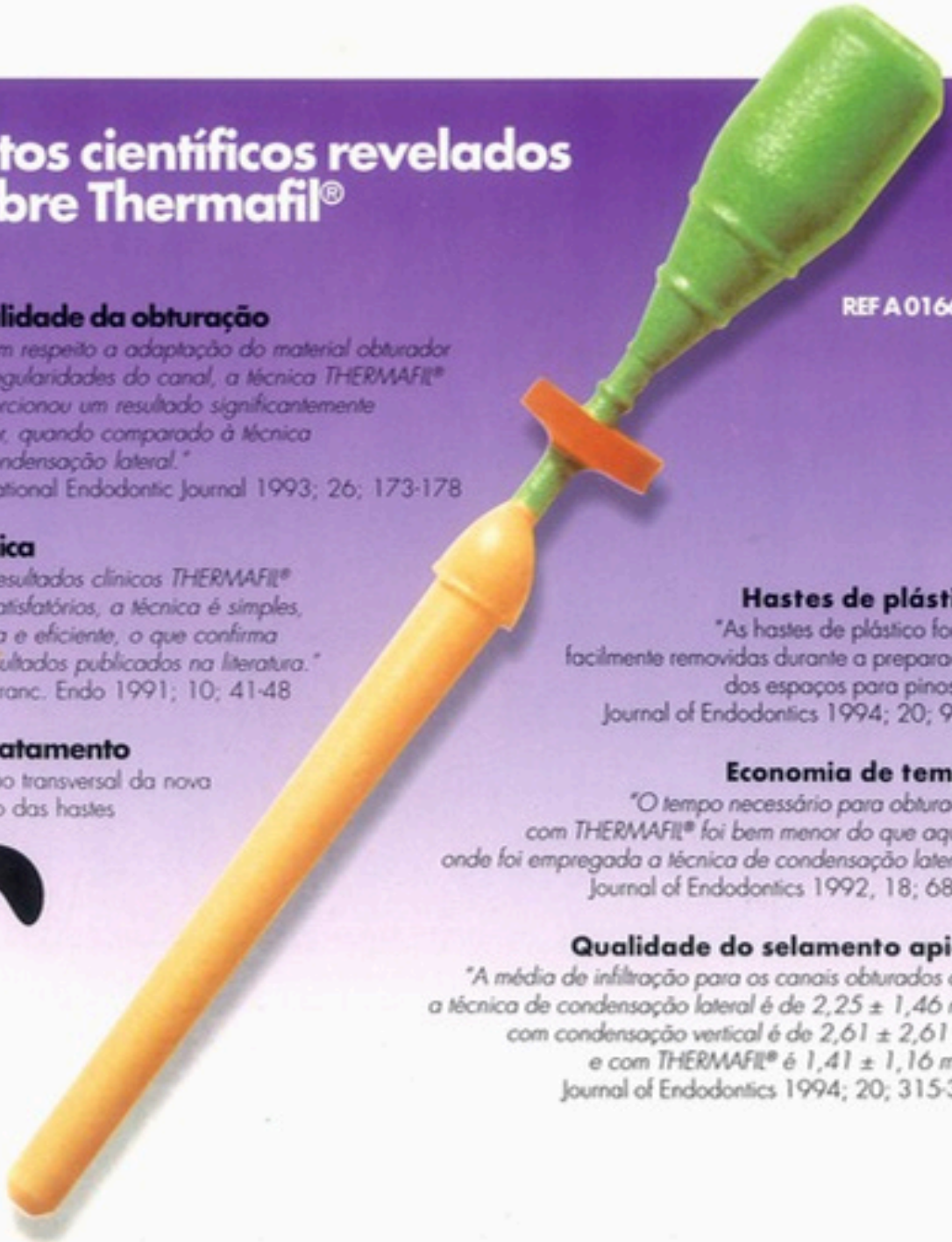

Qualidade da obturação

"...com respeito a adaptação do material obturador às irregularidades do canal, a técnica THERMAFIL® proporcionou um resultado significantemente melhor, quando comparado à técnica de condensação lateral."
International Endodontic Journal 1993; 26; 173-178

Técnica

"Os resultados clínicos THERMAFIL® são satisfatórios, a técnica é simples, rápida e eficiente, o que confirma os resultados publicados na literatura."
Rev. Franc. Endo 1991; 10; 41-48

Retratamento

Secção transversal da nova versão das hastes

Hastes de plástico

"As hastes de plástico foram facilmente removidas durante a preparação dos espaços para pinos..."
Journal of Endodontics 1994; 20; 9-12

Economia de tempo

"O tempo necessário para obturação com THERMAFIL® foi bem menor do que aquele onde foi empregada a técnica de condensação lateral."
Journal of Endodontics 1992, 18; 68-71

Qualidade do selamento apical

"A média de infiltração para os canais obturados com a técnica de condensação lateral é de 2,25 ± 1,46 mm, com condensação vertical é de 2,61 ± 2,61 mm e com THERMAFIL® é 1,41 ± 1,16 mm."
Journal of Endodontics 1994; 20; 315-319

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