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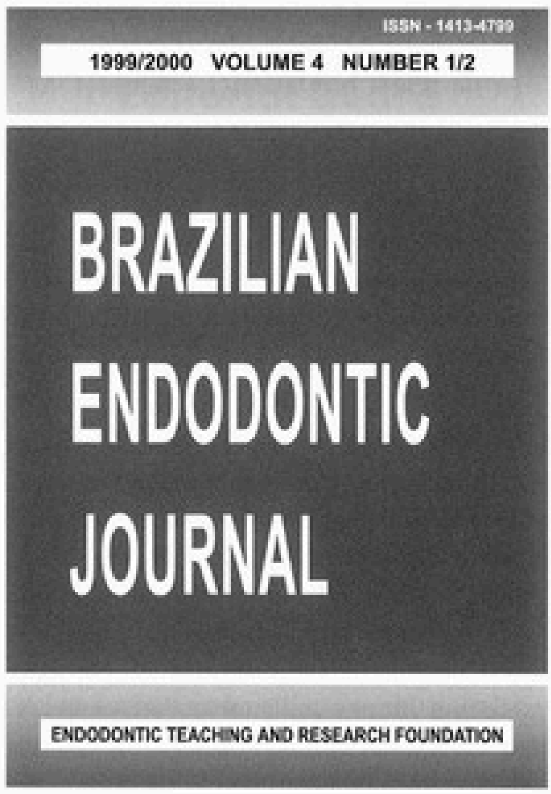

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Editorial

THE ENDODONTIC THERAPY FOR THE NEW MILLENNIUM

The practice of endodontic therapy has gone through astonishing changes in the past few years. The design of instruments, the various ways to use irrigants and pastes, the speed for the completion of treatment, the means for diagnosing the pulpal status... how far can we go?

If we consider these changes, a question can be brought up: have the principles of endodontic therapy really changed? The paradigm of opening the pulpal chamber, cleaning, shaping and filling the root canal has been unaltered for more than a century. Our instruments cut faster, but we still suffer with the risk of separation. They are more flexible, can prepare curved canals more predictably, but there are still many challenges to go through, especially in retreatments. In addition, the advances in the implant dentistry have encouraged some adventurers to proceed with root extraction in any case of doubt, calling this "dental eutanasia". There are so many things to be discussed and solved during this new millennium that we understand changes ought to come and we can not expect endodontic treatments to be done in the next generations as they have been conducted so far.

There is a promising field in cellular and molecular biology that has been helping us to better understand the behavior of pulpal and periapical cells and extracellular matrix, as well as the immunological and microbiological aspects of endodontics. This may be the key for a significant change in the paradigm of endodontic therapy.

We would like to warn the endodontic community that changes can only happen after serious and well-settled research. Sometimes, new materials and engines, if not well studied, can be a step-back in dental science, and there are many two-way paths for the practitioner to choose. Lay on scientific studies, be critical with new information, do not be the first, nor the last, to make a change. Read as much as you can, and always be open to reconsider your professional attitudes. God bless our choices for the new millennium! Are you ready?

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AN EVALUATION OF CORONAL MICROLEAKAGE IN ROOT CANALS OBTURATED BY THE THERMOPLASTICIZED GUTTA-PERCHA TECHNIQUE AND BY THE LATERAL CONDENSATION TECHNIQUE AFTER POST SPACE PREPARATION: AN *IN VITRO* STUDY

Jussara **MALLMANN**, MSc, Endodontics Specialization Course, Associação Brasileira de Odontologia do Rio Grande do Sul, Brazil.

Aquiles Amaury Córdova **SANTOS**, PhD, Department of Microbiology, Universidade Federal de Santa Catarina, Brazil.

Ilson José **SOARES**, PhD, Department of Endodontics, School of Dentistry, Universidade Federal de Santa Catarina, Brazil.

Abstract

A study was carried out to evaluate in vitro the cervical apical seal of root canal fillings by the Ultrafil System, by Thermafil obturators, and by the gutta-percha lateral condensation technique in post space prepared teeth. For this purpose, root filling materials of 70 specimens were placed in contact with an artificial saliva contaminated with *Staphylococcus aureus* for a period of 90 days. It was possible to observe that at the end of the experimental period, in 50.0%, 73.4% and 66.6% of canals obturated with Ultrafil, Thermafil and lateral condensation, respectively, microorganisms had reached foramen, indicating that there was a microleakage throughout the root canal. These differences in the results, when submitted to Fisher's exact test, were not statistically significant.

Key words: root canal filling materials, root canal obturation, dental leakage.

INTRODUCTION

It is unquestionable that after root canal preparation, obturation is necessary in three dimensions. An adequately sealed root canal will prevent tissue fluids and/or bacteria (not only from the apex but also from the oral cavity) from accessing the inner canal.

The notion that one of the reasons for endodontic treatment failure could be related to bacterial penetration by the coronal via, after root filling, is not recent. In 1961, MARSHAL and MASSLER[13] pointed out the importance of sealing the access cavity during and after endodontic therapy.

It seems logical that this concern should be extended to those teeth in which root fillings will be partially removed for post space preparation.

Satisfactory post space preparation involves the removal of root canal filling material to a level that supplies maximum strength and retention, and at the same time supports integrity of the remaining root filling material. In this case, in addition to reduction of the root filling longitudinal length, it is likely that during the root filling material removal an alteration occurs in the root canal sealing quality, which is caused by vibration or heat.[15] This aspect, in addition to the possibility that the posts and cements used for attachment do not supply a root canal seal that prevents cervical apical microleakage, would place the successful endodontic therapy[1,2] at risk.

The limited number of investigations on cervical apical microleakage in root canals obturated by the Ultrafil and the Thermafill[8] systems, as well as on the influence of post space preparation on the coronal apical seal in root canals obturated by those techniques, led us to carry out this study.

MATERIAL AND METHODS

Seventy extracted human, single-rooted, mature cuspid teeth, with straight canals, were used in this study. During exploration, they showed foramen diameters equal to or lower than a # 40 K file. The length of the teeth was standardized at 19 mm, and after access preparation, the canal content was removed for the entire extension to a # 40 K file. Preparation was performed by using a step-back filing technique to a # 45 K file, placed 1 mm shorter than the actual length of the tooth, and the remainder of the canal system was shaped with # 50 to # 80 Hedströem files.

After using each instrument, a # 40 file was passed through the entire extent of the canal to assure patency.

Irrigation with approximately 2 ml of 1% NaOCl was used between the use of every two endodontic instruments to remove dentine scraps. After completing preparation, canals were filled with 15% ethylenediaminetetraacetic acid (EDTA) and, 10 minutes later, irrigated with 1% NaOCl and dried with sterile absorbent paper points.

The 70 sterile specimens were numbered and divided into three experimental groups with 20 teeth each, according to the root filling technique employed: Group I (Ultrafil System), Group II (Thermafil Obturators), Group III (Lateral Condensation), and two control groups with five teeth each (Group IV, Negative Control, and Group V, Positive Control).

All root fillings were performed with a standardized tooth length of 18 mm, and a zinc oxide-eugenol cement (Fillcanal) was used.

At the conclusion of this stage, teeth of each group were divided into the following subgroups: test (T) subgroup (15 post space prepared specimens) and control (C) subgroup (five post space unprepared teeth).

For post space preparation, root fillings of Groups I and III were immediately removed with hot pluggers for vertical condensation (subgroups 1T and 3T), and root fillings of Group II were removed with Prepi burs (subgroup 2T), leaving 5 mm of root filling material in each canal. Preparation was completed by using a # 1 Largo bur.

In the C subgroups, root fillings were kept intact and standardized at 18 mm.

To control asepsis, five teeth from Group IV were obturated by the lateral condensation technique and their access cavities were sealed.

Five other specimens from Group V were not obturated; canals were kept empty and access cavities opened to confirm the possibility of microleakage.

After these procedures, all the access openings (but from Group V) were sealed with Lumicon and stored at 37 °C and 100% humidity for 48 hours. After this period had elapsed, temporary fillings (except for Group IV) were removed.

Preparation and assembly of the device for the microbiologic test

To evaluate the possibility of bacterial microleakage, a device (Figure 1) similar to that employed by other investigators[7,9,20,22] was developed. This device allowed the most cervical portion of the root filling to be placed in contact with artificial saliva

Figure 1. Specimen positioned in the flask containing a selective culture medium

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contaminated with *Staphylococcus aureus*, while the dental apex stayed immersed in Mannitol Salt Agar,[3] a selective culture medium for this bacterium.

Preparation of teeth for the test

Except for the specimens belonging to Group IV, which were totally waterproofed, all root surfaces were coated with Ultra-Speed Araldite,[12] leaving only 2 mm of the apical part free.

After that, the cervical portion of the tooth was inserted and bonded to the extremity of the latex tubing with the same bonding agent, so that the dental apex stayed suspended approximately 3 mm from the bottom of the flask. Teeth already coupled to the latex tubes (specimens) were sterilized in 5% NaOCl for 30 min and then rinsed with approximately 300 ml of sterile water for 30 min. Canals were dried with sterile absorbent paper points, and specimens were positioned in the interior of the flask, so that the apical third was placed in contact with the Mannitol Salt Agar.

Inoculation of the bacterial suspension plus saliva

Approximately 0.3 ml of bacterial suspension in Brain Heart Infusion (BHI) and 0.1 ml of sterile artificial saliva[18] were mixed and inoculated in the interior of the latex tubing. Flasks containing specimens were stored in a bacterial incubator for 90 days at 37 °C. Every 7 days, the remainder of the bacterial suspension was aspirated, and a fresh bacterial suspension plus sterile saliva was placed in contact with the pulp cavity in the interior of the tubing.

To monitor results, the following criteria were adopted: *absence of microleakage*: when the medium color remained unaltered; *presence of microleakage*: when the medium changed from its original pink color to a yellowish color, indicating bacterial microleakage in the entire extent of the canal.

RESULTS

The observations recorded at the end of the experimental period for the several experimental groups and subgroups are summarized in Table 1.

In Group I, no microleakage was observed in 12 teeth (seven from the T subgroup and five from the C subgroup). Microleakage was present in seven roots; at 63 days, it was observed in two teeth; at 76 days, in two other teeth; and at four and three days from the end of the experimental period, in the remainder of the teeth.

In the group of teeth in which Thermafil obturators were used (Group II), microleakage was not observed in nine teeth (four from the T subgroup and five from the C subgroup). At 63 days, microleakage was present in seven specimens, and at 67 days, in four other specimens.

In Group II, there was no microleakage in 10 teeth (five from the T subgroup and five from the C subgroup). From a total of 10 specimens presenting microleakage, one showed a change in color at 16 days; another one at 59 days; two at 63 days, and the remainder of the teeth at 21 days from the end of the experimental period.

Table 1. Results from specimens inoculated with *Staphylococcus aureus* during a 90-day incubation period

	Groups							
	I		II		III		IV	V
Microleakage	1T*	1C	2T	2C	3T	3C	C-	C+
Absent	7 (50%)	5 (100%)	4 (26.6%)	5 (100%)	5 (33.4%)	5 (100%)	5	0
Present	7 (50%)	0	11 (73.4%)	0	10 (66.6%)	0	0	5
Total number of specimens	14	5	15	5	15	5	5	5

* One unit was eliminated in this subgroup.

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In the five teeth that served as negative controls, the original medium color remained unchanged during the experimental period, characterizing the absence of microleakage.

From the five specimens serving as positive controls, the presence of microleakage was observed at 1 day in two teeth, and at 3 days in the remainder of the teeth.

Statistical significance was set at 0.05, and a 2 x 2 Table that allowed application of Fisher's exact test was selected. Results were not statistically significant, with p=0.428 for subgroups 1T and 2T, p=0.695 for subgroups 1T and 3T, and p=1 for subgroups 2T and 3T.

DISCUSSION

At 90 days, the absence of contamination in the specimens pertaining to the negative control group demonstrated that it was possible to maintain asepsis during the investigation period. On the contrary, in the positive control teeth, the presence of microleakage in the entire extent of the canal in two specimens at 24 h, and in the remainder of the teeth at 3 days confirmed the real possibility of microorganisms reaching the apical foramen.

The lowest index of microleakage, although not statistically significant, was found in the canals obturated by the Ultrafil System (50%) (Group I) with post space preparation.

In the canals obturated by the Thermafil technique with post space preparation (Group II), microleakage was present at 63 days, and at the end of the study, it was observed in 73.4% of the specimens. This could suggest, according to SAUNDERS et al.,[17] that dental exposure to dye for shorter periods (e.g. fewer than 63 days) would not be sufficient to allow microleakage. The deleterious action of saliva as time went by, partially dissolving the filling cement,[5,10,11,21] could help explain the microleakage indices observed in our study.

According to RICCI and KESSLER,[15] it is still possible to suppose that in the canals obturated with the Thermafil system, the high-speed instruments used to remove the plastic carrier (Prepi burs) could adhere to its surface, causing excessive vibration and impairing the quality of the remaining root filling.

The 66.6% of microleakage observed in the canals obturated by the gutta-percha lateral condensation technique with post space preparation does not seem to be in agreement with the findings of other investigators.[1,4,6,14,16,19]

In this analysis, results from the study of GISH et al.[6] deserve attention. That study shows that 21 days after placing artificial contaminated saliva in post space prepared teeth by the coronal via, no microleakage was found. In spite of being significant in our experiment, only one contaminated specimen permitted microorganism passage at 21 days – not very different from the results observed by GISH et al.[6] This led us to believe that microleakage is time-dependent. Therefore, it is likely that the reduced time of specimen exposure to dye in some studies[1,14,16] was not sufficient for microleakage to occur.

TORABINEJAD et al.[20] and KHAYAT et al.[9] have employed similar methodologies and noted a significant incidence of bacterial microleakage throughout the canal obturated by the lateral condensation technique. A more reasonable explanation to justify the greater number of contaminated specimens found in these studies is the fact that investigators employed incisor obturations measuring 10 mm, while in our experiment, canines standardized at 18 mm in length were used. Shorter obturations (10 mm) used in other investigations[9,20] must be considered as a probable factor for the difference in results.

It is likely that none of the factors mentioned above was individually responsible for the results obtained, but the interaction between them caused difficulties in the interpretation and prevented definitive conclusions.

Thus, in view of the microleakage indices observed, we conclude that it is very important to warn of the importance of prosthetically restoring post space prepared teeth as early as possible.

CONCLUSIONS

With the methodology used and the results obtained, we observed that microleakage started at 16 days and was present in all dental canals of the experimental groups, irrespective of the root filling technique used.

These findings suggest that in post space prepared teeth, dental prosthesis must be immediately and properly cemented.

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Correspondence:
Profa. Jussara Mallmann
Av. Carlos Gomes, 815/209
90480-003
Porto Alegre, RS - Brazil

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THE INFLUENCE OF APICAL PREPARATION ON MASTER CONE ADAPTATION IN STRAIGHT AND CURVED CANALS

Anelize Muraro **BORDIN**, Dental surgeon, Specialist in Endodontics, Universidade Luterana do Brasil (ULBRA).

José Antônio Poli de **FIGUEIREDO**, MSc, PhD; Coordinator, Graduate Program in Endodontics, ULBRA; Senior Lecturer in Histology, Universidade Federal do Rio Grande do Sul (UFRGS).

Abstract

An in vitro study was carried out in order to assess the influence of apical preparation by different memory-files on master cone adaptation in straight and curved root canals. Thirty human teeth were selected: 15 upper canines and 15 upper first and second molars (mesiobuccal root with curves of approximately 30°). Both the serial and step-back preparations were used in both types of roots according to the anatomical configuration of each canal. The cone master adaptation obtained after preparation was directly associated with the size of memory-files. The results revealed that cone master adaptation occurred first in the curved canals and then in the straight ones, with a statistically significant difference. Our findings allowed for a greater enlargement of the straight canals.

Key words: root canal, apical preparation, master cone.

INTRODUCTION

Many efforts have been made to improve chemical and mechanical preparation and root canal filling techniques, which are essential for a successful endodontic treatment. With these techniques, it is possible to have a hermetic seal, creating appropriate conditions for the cure and biological repair.

According to INGLE and BEVERIDGE[10], 60% of endodontic treatment failures are related to incomplete three-dimensional root canal fillings, which end up causing apical percolation.

The available literature[1,2,5,9,20,21] underscores that the correct configuration of the endodontic cavity determines the good adaptation of the master cone in the apical third of the root canal, thus contributing to a successful obturation. The careful observation of these aspects prevents the microleakage of periapical exudate into the canal and offers a favorable environment for tissue healing.

Apical preparation is a process that complements the preparation of the root canal. The objective of apical preparation is to create an apical niche into which the master cone will be fitted.

The master cone must be analyzed using three methods (visual, tactile, and radiographic) so as to ensure that it is properly fitted into the apical region.

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The visual method allows checking whether the master cone covers the whole working length established by the chemical and mechanical preparation of the root canal. The tactile method checks whether the master cone is laterally fitted by means of a resistance in the apical region at the moment the cone is removed from the canal. The radiographic method is used to check all previous stages.

Being able to adapt the master cone is an obstacle in endodontic treatment when the apical preparation is poorly defined due to inadequate technique or instruments, resulting in failures that may compromise the treatment outcome.

After modeling, the root canal walls should be smooth and flat, with an apically conical and tapered shape and should have the original shape and position of the apical foramen. The apical third should be adjusted until it assumes a round shape (the more round-shaped, the better) so as to allow for master cone adaptation.

It is important that the apical preparation and root canal obturation be always performed at dentinal level,[8,11,12] using irrigating solutions and standardized endodontic instruments.

The correct use of instruments in curved canals is another obstacle in endodontic treatment, if compared to straight canals, due to reduced apical thickness and low degree of curvature. Therefore, it is crucial that the individual anatomical characteristics of each canal be taken into consideration, since incidents caused by the use of large gauge instruments in the apical region are more frequent the higher the degree of curvature of root canals.[16]

This study aims at analyzing the influence of apical preparation by different-gauged memory-files on the adaptation of the master cone into the apical third of straight and curved canals.

MATERIALS AND METHODS

The experiment was conducted at the Laboratory of Endodontics, School of Odontology, Universidade Luterana do Brasil (ULBRA), state of Rio Grande do Sul, Brazil.

Thirty human permanent teeth that had been extracted due to dental and/or periapical complications were selected. The teeth presented fully formed apices and no root resorption. The sample consisted of 15 upper canines and 15 upper molars (upper first and second molars).

The selected teeth were cleaned with oxygen peroxide (10%) and placed in individual bottles numbered 1R to 15R (straight canals) and 1C to 15C (curved canals), and immersed in physiological solution for 72 hours.

The teeth were then divided into two groups. Group I included single-rooted teeth with straight canals (upper canines), while group II consisted of upper molars whose mesiobuccal roots were curved at approximately 30%. The remaining roots of these teeth were not included in the study. During the experiment, whenever two canals were found in the mesiobuccal root, we prepared only the canal that was closer to the buccal surface.

The angle of curvature of mesiobuccal roots was measured by x-ray, according to SCHNEIDER.[18]

The crowns of all sampled teeth were cross-sectioned with an arbor-mounted carborundum disc at low rotation. The palatine root of molar teeth was sectioned on an arbor in order to better visualize the mesiobuccal root on x-ray examination. The teeth were fixed onto a bench vise in mesiodistal direction; this way, the preparation of root canals was performed always at the same position. K-file (Maillefer) files were used.

First, the canals were explored with files #10, and the contents of the root canals were removed by a small gauge instrument and irrigating solution. Afterwards, the neck of canal was prepared with Gates-Glidden (Maillefer) #2 and #3, and irrigated with sodium hypochlorite at 1%.

The 1-mm working length beyond the root end was determined by x-ray using the bisecting angle technique. After that, we proceeded with the chemical and mechanical preparation of canals in a way that endodontic instrument #5 (at least) could be snugly introduced along the working length. For straight canals, we used the step-back technique with a programmed retraction of 1 mm, according to PAIVA and ANTONIAZZI[15]. In curved canals, we used anticurvature filling, and the instruments were prebent with Flexobend (Maillefer). Each instrument was used to prepare a maximum of three canals.

The preparation of canals was initially made with file #15. The area was abundantly irrigated with sodium hypochlorite at 1%, and the overflow was suctioned with a 5-ml disposable syringe (Plastipak - SP).

Subsequently, we proceeded with the programmed 1-mm retraction of the straight canals using three larger files, following the series of standardized instruments proposed by INGLE and BEVERIDGE.[11] The file

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sizes used were, respectively, 15, 20, 25, and 30. A 1-mm retraction was obtained after each file, giving the canal walls a cone shape.

In curved canals, retraction was performed according to the internal morphology of the canals, also taking the flexibility of the instrument into consideration. The retraction was naturally viable, and not mathematically programmed as in the preparation of straight canals.

After preparation, the Dentsply master cone was adjusted with gutta-percha adapter (Maillefer - Switzerland). The root canal was washed with 17% EDTA (ethylenediamintetraacetic acid) at 17%, pH 7.2, during 3 minutes, for the removal of the smear layer. Later, we performed a test in master cone #15 in the apical third of the root canal to check whether or not adaptation had occurred.

The presence or absence of adaptation of the master cone in the apical region was clinically confirmed by visual examination (when the master cone penetrated the whole extension of the prepared canal) and by tactile examination (when a slight resistance or fit sensation was observed at the moment the cone was removed from the canal, thus causing the cone to fit into the canal walls).

If adaptation had not been detected, we would have proceeded with the preparation, following the series of standardized instruments and the techniques mentioned above. We would have performed a new test to check whether or not the master cone was locked, as previously described.

After the clinical detection of master cone adaptation, we took some x-rays for confirmation (Figures 1 and 2). The absence of a radiolucent line between the master cone and the canal walls in the apical third confirmed that the cone was properly fitted. In the radiograph, we only analyzed the mesiodistal plane.

The instrumentation of canals was concluded as soon as the adaptation of the master cone was observed, according to the requirements above.

The experiment was examined by two calibrated verifiers for checking the presence or absence of master cone adaptation in the apical region of the straight and curved canals.

The data were submitted to statistical analysis using Student t test ($p = 0.05$) and to the analysis of variance.

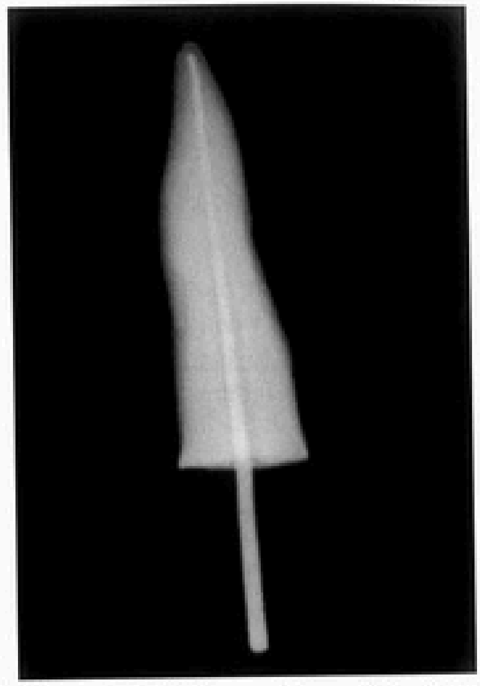

Figure 1. Radiographic confirmation of master cone adaptation in the root canal of an upper permanent canine

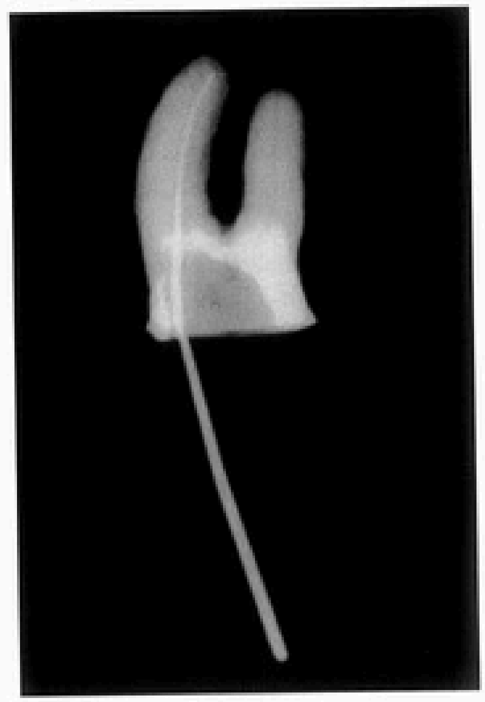

Figure 2. Radiographic confirmation of master cone adaptation in the mesiobuccal canal of the mesiobuccal root of an upper first permanent molar

RESULTS AND DISCUSSION

All the samples of straight canals (Table 1) in this study showed adaptation of the master cone.

There was no adaptation when endodontic instruments #15 and #20 were used. The first adaptation occurred with instrument #25 in only one sample (6.66%). The adaptation of master cone was more frequent when instruments #30 to #50 were used. Instrument #35 showed the highest incidence of master cone adaptation (26.66%). The master cone was adapted in only one sample (6.66%) when instrument #40 was used. The root canals prepared with instruments #30, 45 and 50 (20%) presented the same amount of adaptations.

Table 1. Presence/absence of master cone adaptation in straight canals based on different endodontic instruments

Endodontic instruments	No. of samples		
	Adaptation present	Adaptation absent	Total
15	0 (0%)	15	15
20	0 (0%)	15	15
25	1 (6.66%)	14	15
30	3 (20%)	12	15
35	4 (26.66 %)	11	15
40	1 (6.66%)	14	15
45	3 (20%)	12	15
50	3 (20%)	12	15
Total	15 (100%)	105	120

In addition, the instruments used in the first series showed adaptation in 40% of the cases, while adaptation in the instruments in the second series amounted for 60% of the cases as far as the standardization proposed by INGLE and BEVERIDGE[10] is concerned.

The master cone was adapted in all the samples of curved canals (Table 2).

Our findings revealed total absence of adaptation with instrument #15 (0%). Master cone adaptation was found with instrument #20 onwards (6.66%). In this case, only one sample showed adaptation. The master cone was more frequently adapted with instrument #25 onwards, and instrument #25 presented the highest frequency (33.33%). The same number of samples showed master cone adaptation when instruments #30, 35 and 40 were used (20%).

Table 2. Presence/absence of master cone adaptation in curved canals based on different endodontic instruments

Endodontic instruments	No. of samples		
	Adaptation present	Adaptation absent	Total
15	0 (0%)	15	15
20	1 (6.66%)	14	15
25	5 (33.33%)	10	15
30	3 (20%)	12	15
35	3 (20%)	12	15
40	3 (20%)	12	15
Total	15 (100%)	75	90

The adaptation in curved canals restricted itself to the instruments in the first standardized series only (100% of the cases)

The analysis of variance tests the statistical significance of the differences among the obtained means, while the standard deviation is the square root of the variance. The results obtained (Table 3) show that master cone adaptation is more frequent in straight canals than in curved ones, with a significance level of 0.05.

The standards for endodontic treatment show that apical preparation plays a fundamental role in instrumentation, significantly reducing failure in root canal obturations.

Table 3. Statistical analysis of the results obtained from straight and curved canals

	Straight canals	Curved canals
Mean	38.7 a*	30.7 b
Variance	69.5	42.4
Standard deviation	8.3	6.5

* Means indicated by the same letter do not differ.

Several studies[5,9,20,21] proved that step-back preparation enhances the apical preparation of the root canal, contributing to root canal adaptation.[19] The association of these important factors allows for a hermetic three-dimensional seal and prevents possible apical percolation.

The serial and step-back techniques should be complementary and essential procedures for the correct preparation of the root canal. The sole use of serial preparation gives the root canal a more cylindrical shape, allowing the master cone to fit into a larger area in the canal. This remarkably reduces the space reserved for accessory cones, which do not extend to the apical third, even after obturation by lateral condensation. This region only receives filling material, which does not incorporate physical and chemical characteristics of gutta-percha cones; therefore, it is more susceptible to microleakage.[5]

Considering that, step-back preparation allows for greater enlargement of the cervical and medial third, facilitating the insertion of irrigating syringes, aspirating cannula, and instruments for the preparation of straight and curved canals. This way, it is possible to better clean and smoothen the canal walls, eliminating the need for dental magma. Consequently, there is increased contact of the filling material with dental walls, reducing the chances of leakage between both surfaces.[9] This technique gives the neck and apex of the canal a conical and tapered preparation, offering good conditions for master cone adaptation, and more space for the insertion of accessory cones into the apical third. Also, it facilitates the use of lateral pluggers in the apical third,[1,2] allowing for the application of thicker filling material. In curved canals, step-back preparation facilitates the use of instruments and prevents iatrogenesis. The enlargement obtained through this technique favors the manufacture of prosthetic materials.

By comparing both forms of preparation, we observed that serial preparation produces a more cylindrical canal, favoring the projection of air bubbles into the periapical region when the master cone is adapted, causing painful sensitivity on the site. On the other hand, the step-back preparation gives the canal a more conical appearance, allowing air bubbles to flow back to the crown. This reduces the chances of periapical pain.

According to the results obtained in this study, we found out that the adaptation of the master cone in the apical third of straight canals commenced after the preparation with file #25, followed by step-back preparation. The adaptation occurred after preparation with file #30 to #50. In curved canals, the adaptation of the master cone occurred before, manifesting itself after preparation with file #20. It was carried out after the use of files #25 up to #40.

The instrumentation of straight canals is facilitated by their anatomical characteristics, allowing the use of larger files and greater enlargement of these canals. On the other hand, this does not occur in curved canals, since the degree of curvature and the reduced flexibility of files according to the larger size of the canal hinder instrumentation. This way, the preparation of curved canals requires greater care, because there may be iatrogenesis at a higher rate than that observed in straight canals, compromising the treatment outcome.

There was adaptation of the master cone in all samples of the present study. Possibly, the step-back technique may have contributed to that.

It is worth mentioning that all master cones used in the study were calibrated with a specific gauging instrument soon after the size of the cone to be adapted in the root canal was defined. Whenever adaptation occurred, the cone was set aside. After that, we tried to adapt a cone with a larger size according to the standardized series. In no sample was the adaptation of the master cone higher than that obtained from the previous instrumentation.

The curved canals selected for this study had a curvature of approximately 30°. In this case, file #40 was the last instrument to touch the working length. CLEM[3] and SCHILDER[17] recommend maximum enlargement of the apical third up to file #35. Studies conducted by PESCE et al.[16] show that a preparation with file #35 onwards produces an overlap in the apical foramen in 100% of the cases. FAVA and CAPUTO,[6] FAVA,[7] PAIVA and ANTONIAZZI,[15] and WEINE[22] recommend the apical preparation up to file #30. Canals with a curvature greater than 30° are not believed to offer apical enlargement up to file #40, as shown by our results.

MARTIN[14] suggests that apical enlargement goes up to file #20. LOPES and COSTA FILHO[13] recommend that, in canals with a gradual and less prominent curvature, apical enlargement should occur up to instrument #30; in cases in which the curvature is gradual but prominent, up to instrument #20 or #25; and, in canals with sharp and apical curvature, up to #15 or #10.

None of the referred authors[3,6,7,14,15,17,22] specified the degree of curvature. However, LOPES and COSTA FILHO[13] classified the three types of curvatures mentioned above; they did not specify their degree.

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Studies carried out by YARED and DAGHER[4,23-25] revealed considerable apical overextension and microleakage when canals were prepared with instruments up to #40 in comparison to canals prepared with instruments up to #25. This is due to the fact that the canals had been filled with thin, medium-sized, nonstandardized cones, originating high rates of apical overextension and microleakage.

ALLISON et al.[1,2], HABITANTE et al.[9]; and FACHIN and SILVA[5] stated that the step-back technique allowed for greater enlargement of the neck and apex of the root canal and for a more cone-shaped appearance, offering a more effective lateral condensation and thus making the obturation more compact. The combination of these factors resulted in a low rate of microleakage if compared with serial preparation. For ALLISON et al.,[1,2] the final form of root canal preparation is a more significant aspect than the adaptation or not of the master cone.

This study shows more accurately the size of the memory-file used in the preparation of root canals, based upon the anatomical configuration of straight and curved canals.

An additional study to assess the rate of apical microleakage could be conducted by performing obturation on the samples.

The use of the step-back technique, which leads to master cone adaptation, combined with the requirements encompassed by endodontic treatment, such as biosecurity rules, good quality material/instruments, correct technique, good clinical judgement, and accurate diagnosis, permits obtaining a higher success rate in the treatment of the root canal system.

CONCLUSIONS

After analyzing the results, based on the established methodology, we conclude that there is a direct relationship between apical preparation and cone master adaptation in the apical third of straight root canals and curved canals of approximately 30°.

In curved canals, the adaptation of the master cone occurred before, if compared with straight canals, and proved statistically significant. Master cone adaptation commenced after preparation with instruments #20, and was carried out after the use of instrument #25 up to #40.

In straight canals, master cone adaptation began after preparation with instrument #25, being carried out after the use of instrument #30 up to #50.

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Correspondence:
José Antonio Poli de Figueiredo
Rua Luciana de Abreu, 20/201
90570-060 Porto Alegre – RS – Brazil
Phone/Fax: + 55 51 3346.2197
Email: endofig@terra.com.br

USE OF DIRECT DIGITAL RADIOGRAPHY IN THE FOLLOW-UP OF ENDODONTIC TREATMENT

Márcio Luiz Fonseca **MENIN**, DDS, MSc, Universidade de São Paulo, SP, Brazil.

Carlos Eduardo **AUN**, DDS, MSc, Universidade de São Paulo, SP, Brazil.

Giulio **GAVANI**, DDS, MSc, PhD, Universidade de São Paulo, SP, Brazil.

Abstract

Radiographic examination is widely used in endodontics for the follow-up of periapical lesions. One of the factors that influence diagnosis accuracy is the quality of the image used for interpretation. In the past few years, direct digital radiography (DDR) has motivated the performance of studies with the aim of defining the validity and the advantages/disadvantages of the use of this type of examination as a routine in dental offices. In the present study, the usefulness of digitally processed images was assessed during the follow-up of periapical lesions. Using the Sens-A-Ray digital radiographic system, the images were analyzed by means of a histogram (optical density x number of pixels). Our study showed that DDR was effective in the follow-up of periapical lesions.

Key words: endodontics, direct digital radiography, periapical lesions.

INTRODUCTION

Radiology has been broadly used in dental medicine, especially during transoperative processes and as an auxiliary examination for diagnosis.

With the development of the direct digital radiography (DDR) technology, new areas started to be investigated in intra-oral radiology, mainly the area of endodontic treatment, which is based on radiography. Therefore, digital radiography may represent a possibility of improving diagnosis and follow-up of endodontic patients.

In order to understand the functioning of digital radiography, it is necessary to distinguish this method from the conventional one. In conventional radiography, a film is used, and the image is obtained due to the properties and processing of the film. In the digital method, the film is replaced with an electronic sensor and a computer, and the image is displayed on a monitor screen; the image is digitally stored, and it is possible to manipulate it using digital filters.[6]

Since the introduction of DDR in dental medicine, by MOUYEN,[8] different studies have shown the advantages of this method when compared to conventional radiography, especially in terms of exposure to X-rays and time of image processing, which is instantaneous in the digital process.[5,11]

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It is clear that, still in the present days, radiographic examination is the best way to detect alterations in the periapical bone, even though it presents some flaws. Many efforts have been made to improve radiographic images of the periapical bone and dental structures, so as to allow the identification and diagnosis of alterations as early as possible. Such alterations include root fractures, bone resorption and other bone pathologies, with a special focus on repair.[1,3,4]

One of the most important advantages of the digital method when compared to the conventional one is the possibility of editing an image using digital filters. HORNER,[2] WENZEL and HINTZE,[14] in their study on the use of conventional and digital images for the identification of anatomic structures, cavities and periapical bone lesions, concluded that most observers preferred a digitally processed image rather than an unprocessed image or a conventional image.

In his study about simulated periapical lesions, YAKOTA[13] reports that the digital system was efficient in the identification of the lesions, and that observers usually chose brightness- and contrast-enhanced images.

The purpose of this study was to verify the usefulness of digitally processed images in the follow-up of periapical lesions.

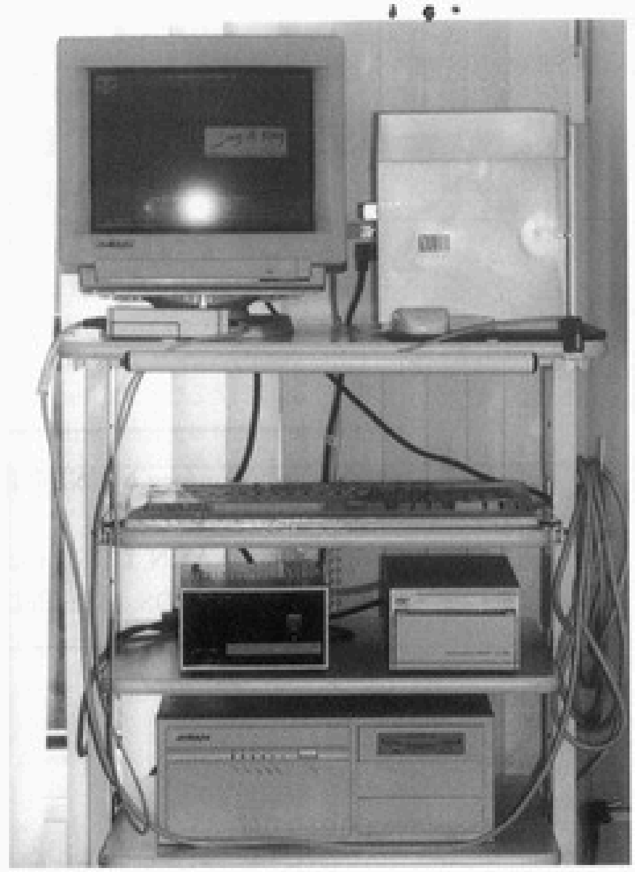

Figure 1. Sens-A-Ray system

MATERIAL AND METHODS

We used the Spectro 70X radiation unit (Dabi-Atlante, 70 kVA and 10 mA, Ribeirão Preto, SP, Brazil) as the radiation source.

DDR images were obtained through stimulation on the charge coupled device (CCD) sensor of the Sens-A-Ray system (Reagan Systems, Sweden) (Figure 1), which is in accordance with the protocol recommended by NELVIG et al.[9] Time of exposure to radiation was modulated at 0.2 seconds.

The DDR system used in this study was composed of two different parts: hardware and software. Hardware included: a personal computer (PC) with an arithmetic processor, a CCD sensor, an 8-bit digital converter, a regulating unit to amplify and regulate digital signals, an image capture and processing card, a monitor to view the image, and a printer to print the image.

Software version was 3.02, and was divided into two parts. The first part was a database for storing patient data. The second part consisted of a graphic user interface that controlled the capture, exposure, storage and selection of images.

Ten teeth with periapical lesions identified by conventional radiographic examination were selected. The teeth were endodontically treated according to the technique recommended by PAIVA and ANTONIAZZI.[10] After the end of treatment, patients' teeth were molded for the design of a personalized tooth-supported localizing appliance made of acrylic resin (Figure 2) whose aim was to place the CCD sensor always in the same position on the tooth to be examined through digital radiography. In order to do so, a small canal was created to accommodate the sensor and the Han Shin positioner. This aimed at avoiding variations in the distance and in the vertical/horizontal position of the main X-ray beam (Figures 3 and 4).

At the end of the endodontic treatment, a digital radiograph was taken as described above (Moment 0 – M0). After three months, a new radiograph was taken (Moment 1 – M1). A third digital radiographic examination was performed six months after the end of treatment (Moment 2 – M2).

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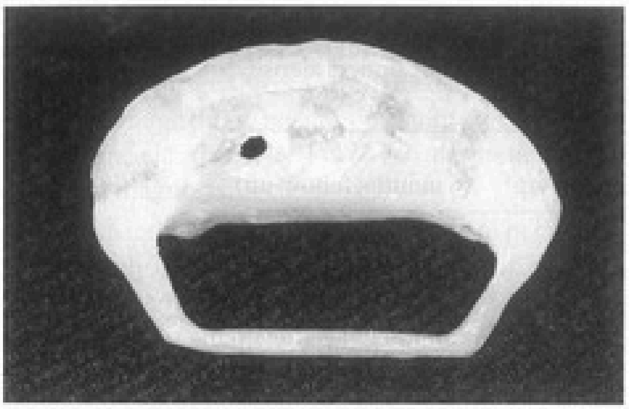

Figure 2. Personalized tooth-supported localizing appliance

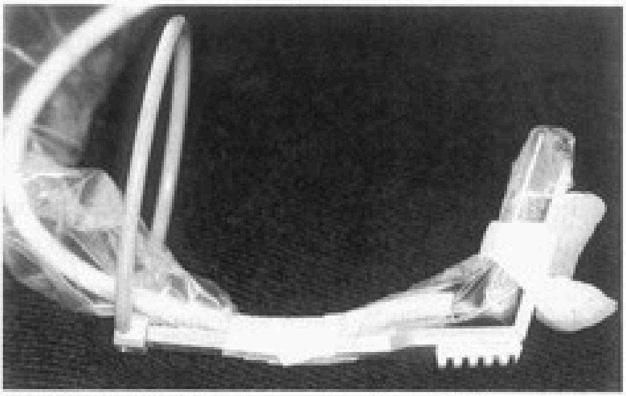

Figure 3. Localizer, sensor and Han Shin positioner

Figure 4. Appliance position during radiographic examination

The images were analyzed on the monitor. Image interpretation was carried out objectively by means of image processing using a histogram (optical density x number of pixels). Image quality values were provided by the Sens-A-Ray system software.

RESULTS

Results and mean optical densities obtained with the histogram at the three experimental moments can be observed in Table 1.

Images processed by the histogram at the three moments of the study and related to one of the cases can be observed in Figures 5, 6, and 7.

Data were statistically analyzed according to the Kruskal-Wallis test. A significant difference of a=5% was observed (H=21.53 against the chi-square critical value for two degrees of freedom, equal to 5.99).

Table 2 shows paired comparisons between the mean squares of the groups, as well as the contrast values for a significance level of 5%.

Result analysis showed that six months after the end of treatment (M2), optical density presented a significantly increase on the histogram when compared to the other two experimental moments (M0 and M1). Similarly, the comparison between M1 and M0 also showed a significant difference of 5%.

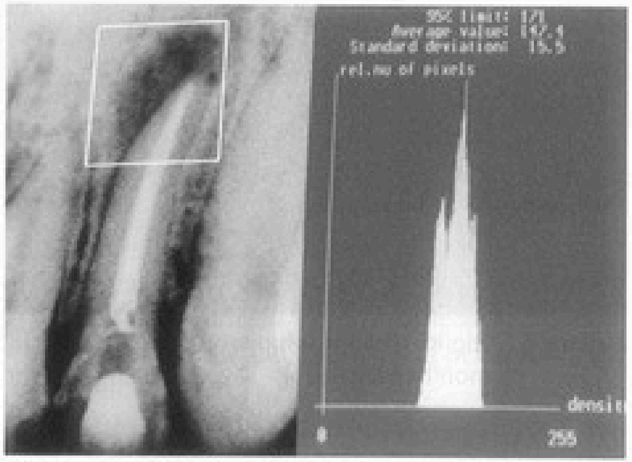

Figure 5. Digital radiographic examination at M0 (end of treatment)

DISCUSSION

The accuracy of radiographic examination is essential for the follow-up of endodontic treatment, especially in cases of teeth with periapical lesions. In spite of the limitations of radiographic examination, it remains as the only test that allows viewing periapical tissues and distinguishing between healthy or sick tissues and tissues being repaired.

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Table 1. Results obtained through the objective evaluation of optical density x number of pixels number in digital radiography

Cases	M0 (end of treatment)	M1 (3 months follow-up)	M2 (6 months follow-up)
1	76.4	99.5	137.9
2	80.3	119.7	141.8
3	80.3	119.7	141.8
4	159.5	167.6	180.1
5	110.6	126.5	149.7
6	135.0	150.9	156.1
7	118.9	142.3	164.5
8	83.7	128.3	143.3
9	147.4	163.4	172.3
10	138.5	146.1	162.4
Means	113.06	136.40	155.19

Figure 6. Digital radiographic examination at M1 (3 months follow-up)

Figure 7. Digital radiographic examination at M2 (6 months follow-up)

In the past few years, great efforts have been made in order to improve radiation units and films, making them more sensitive with no loss of quality.

In the early 1990s, a new system of radiography was created: DDR. In this method, the film is replaced with a CCD sensor (RGV[8] and Sens-A-Ray[9]), which is much more sensitive than the radiographic film. Due to this increase sensitivity, radiation exposure can be reduced in up to 80% in some cases. On the other hand, digital systems do not have the same image quality as conventional radiographs. In conventional radiography, the image is formed by twelve line-pairs/mm^2, and in digital radiography, by ten line-pairs/mm^2.[15] In our study, we observed that in spite of the loss of image quality, the system was safe enough to allow diagnosis of periapical repair after image processing with the optical density histogram. We could observe statistically significant bone repair already at the first experimental moment (M0).

Table 2. Comparison between the mean squares of the studied samples

Compared samples	Differences between means	Critical values	Significance
M0 x M1	12.7000	5.99	***
M0 x M2	17.3000	5.99	***
M1 x M2	7.900	5.99	***

*** Significance level of 5%

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Conventional radiographs produce a still image, which cannot be altered. On the other hand, in digital radiography, image filters are provided by the software, and the image may be manipulated according to specific needs; this may improve interpretation and facilitate diagnosis.

When radiographic examinations were performed in our study, there was a special interest in whether the equipment was easy to handle, especially the sensor, which is smaller than a radiographic film, rigid, and has a cable at one of the ends, which could make the examination more difficult to perform. However, the equipment proved to be easy to handle and was well tolerated by patients.

With regard to exposure time, we observed a decrease of approximately 70% when compared to the conventional method. In each case, an average of 0.6 second was spent for treatment and follow-up when digital radiographs were used; this mark reached 2.1 seconds with the conventional method. These results coincide with those presented by SOH et al.[11]

YAKOTA et al.,[13] while analyzing simulated lesions, concluded that digital images are less accurate in cases of very large lesions. In small lesions, accuracy of digital images was higher than in conventional ones. In our study, lesions had different sizes. Image accuracy was considered statistically satisfactory. We believe that the comparison between the conventional and the digital methods deserves further studies.

KULLENDORFF et al.[3,4] and WENZEL,[16] compared unprocessed digital images to processed images in terms of accuracy for the assessment of healthy and sick periapical tissues and dental cavities. Usually, processed images were more accurate. In our observations, carried out with processed images, an alteration in the optical density of the periapical region was verified at different moments.

TIRRELL et al.[12] and MISTAK et al.[7] compared images of periapical lesions obtained with the conventional and the digital method, and did not find statistical differences between them. Similar statistical results were found in our study.

When analyzing data related to the digitally processed image at the three experimental moments, an increase in the optical density of the studied areas was observed – this is a typical characteristic of bone repair, which was diagnosed by the system on the first observation, that is, 90 days after the end of treatment.

The statistical analysis of image observations confirmed that digital radiography is a safe and effective tool in the follow-up of periapical tissue repair.

On the other hand, it is important to mention that the digital system is still extremely recent, so that that advances and further development are necessary.

Since the sensor is extremely sensitive to radiation, any variation in exposure time may lead to false-negative or false-positive results in the measurement of optical density. Thus, in order to carry out consecutive radiographic examinations for the follow-up of apical tissue repair, it is necessary to calibrate the exposure time, as well as the distance and the vertical/horizontal variations of the main X-ray beam according to the tooth to be examined.

The decreased time of exposure to X-rays and the immediate processing and handling of the image are undeniable advantages of the digital system, which may help professionals to accurately distinguish between sick or healthy tissue and those being repaired.

The disadvantages of the digital method are related to its recency. Time and further studies are necessary before digital radiography may be recommended as an appropriate substitute for conventional radiography.

CONCLUSIONS

1) The system was easily manipulated and tolerated by patients.
2) Time of exposure to X-rays decreased in approximately 70%.
3) Even with an inferior image quality when compared to conventional radiography, satisfactory results were obtained with digitally processed images.
4) The system proved to be reliable as an auxiliary in the diagnosis and follow-up of periapical tissue repair.
5) Further studies, especially clinical and comparative ones, are necessary in order to obtain more accurate analyses.

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Correspondence:
Universidade de São Paulo
Faculdade de Odontologia - Disciplina de Endodontia
Av. Prof. Lineu Prestes, 2227
Cidade Universitária
05508-900
São Paulo, SP - Brazil

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ASSESSMENT OF THE DIAMETER OF GUTTA PERCHA CONES OF DIFFERENT MANUFACTURERS

José Antônio Poli de **FIGUEIREDO**, DDS, MS, PhD, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.

Aluí Oliveira **BARBISAN**, PhD, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.

João Antônio Neto **CAMINHA**, PhD, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.

Ana Paula Bellon dos **SANTOS**, DDS, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.

Fabiano Pradella **LAGES**, DDS, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.

Scheyla **WIRTTI**, DDS, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.

Viviane Barbosa **SILVESTRE**, DDS, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.

Abstract

Our objective was to measure the diameters of gutta percha cones of different manufacturers in order to assess whether the size indicated corresponded to that measured. Cones of four different manufacturers were measured using a cone adapter (Maillefer, Switzerland). Values were compared to those indicated by the manufacturers (standard values). Evaluation of the material was carried out by a professional experienced in endodontics. The evaluation was double-masked – neither the professional responsible for measurements nor the evaluator responsible for the statistical analysis were aware of manufacturer data. Our findings indicated significant variations in the sizes measured. Results suggest that, in a top-to-bottom order, the best results were those of Tanari, Dentsply, Roeko, and Alpha.

Key words: dental instruments, gutta-percha, root canal obturation.

INTRODUCTION

Endodontic treatment consists of surgical exposure of the root and preparation/obturation of the root canal with the objective of cleaning and keeping the canal free from microbial proliferation.

Root canal obturation is, thus, the final procedure in endodontic treatment. A well-obturated root canal is that one hermetically sealed with gutta percha and endodontic cement – endodontic cement bonds the gutta percha cones to one another and to the root canal wall; gutta percha cones, in turn, fill most of the endodontic space.

The apical region is the most critical one for obturation. It requires professionals to observe the adaptation of the cone to the dentin wall. One of the methods used to verify wall adaptation is testing whether the gutta percha master cone is fit. For the master cone to be fit, its diameter should correspond

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to the size of the last instrument used. Since the files have standardized diameters and their metallic structures restrict alterations during contraction and expansion, gutta percha master cones become a critical issue – cones are more flexible and can change diameter sizes more easily.

When kept at room temperature and stored under proper conditions, cones present little or no variability. However, current techniques to manufacture cones still favor differences in diameter sizes according to different manufacturers.

The most important question lies in how significant the dimensional difference or variability between different manufacturers of cones can be. Thus, our objective was to assess the diameters of gutta percha cones indicated by different manufacturers and compare them to the diameters obtained using a gutta percha cone adapter.

MATERIALS AND METHODS

Our study was carried out at the Dental School of Universidade Federal do Rio Grande do Sul (UFRGS) by second-semester undergraduate students.

Measurement of gutta percha cone diameters was carried out using standardized gutta percha cones of four different manufacturers: Alpha, Dentsply, Roeko, and Tanari (Figure 1). The cones of each manufacturer were measured according to the diameter ISO sizes 25, 30, 35, 40, 45, 50, 55, 60, 70, and 80. We carried out random measurements of 20 gutta percha cones of each diameter size, that is, a total of 200 gutta percha cones of each different manufacturer (Figure 2).

Figure 1. Manufacturers of gutta percha cones

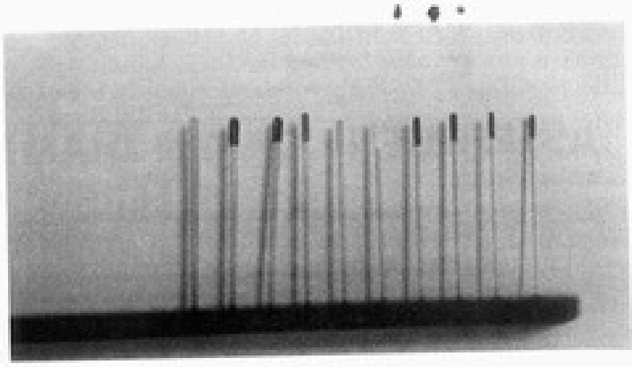
Figure 2. Measurement of gutta percha cones

Gutta percha points were inserted into a cone adapter (Maillefer, Switzerland) in order to test the different diameters found (Figures 3 and 4).

The diameter of each gutta percha cone was recorded in a spreadsheet. For example, cone ISO size 25 of manufacturer X was inserted into cells numbered 25, 30, and 35, and so on, until the correct fit was verified. Manufacturers were identified on the spreadsheet according to letters A (Tanari), B (Dentsply), C (Roeko), and D (Alpha).

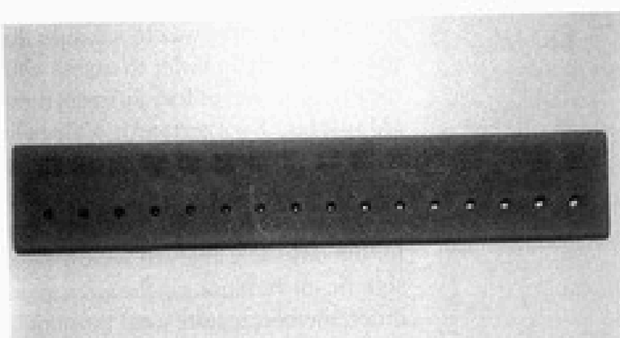
Figure 3. Gutta percha cone adapter

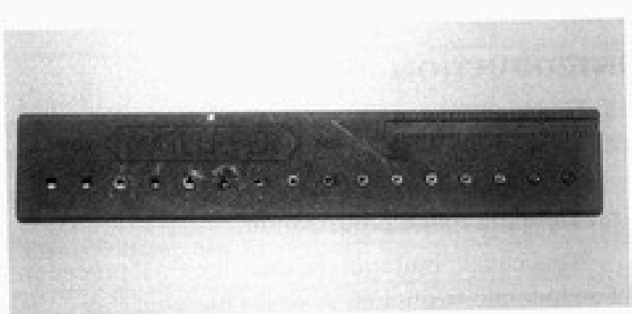
Figure 4. Maillefer (Switzerland) gutta percha cone adapter

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Cone sizes were considered correct when they did not exceed the indicated diameter and when the whole surface of the gutta percha point fit tightly into the adapter (Figures 5 and 6). All measurements were recorded; if a specific cone did not fit an exact diameter size, the corresponding measure range was recorded.

Evaluation of the material was carried out by a professional experienced in endodontics. The evaluation was double-masked, that is, neither this evaluator nor the professional responsible for the statistical analysis were aware of manufacturer data.

Results were statistically analyzed for prevalence of errors and presented as graphs. We assessed the error percentage according to each manufacturer and cone diameter ISO sizes and calculated the error percentage of diameter sizes (difference between expected and measured diameters) for each manufacturer.

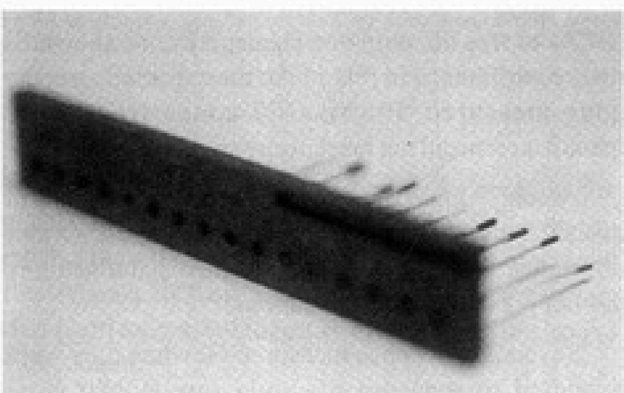

Figure 5. Gutta percha cones with correct size

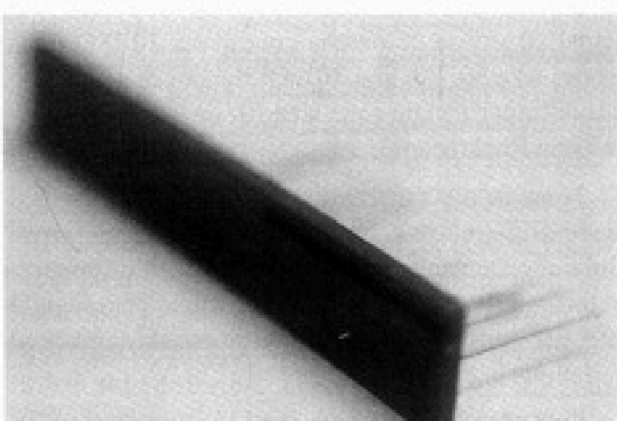

Figure 6. Gutta percha cones with incorrect size

RESULTS

As shown in Table 1, Tanari cones presented the lowest error percentage, ranging from 5% in diameter size 45 to 40% in size 60. Dentsply cones, in turn, presented a higher error percentage, varying from 5% in diameter size 70 to 60% in size 55. Roeko cones presented an error percentage from 15% in diameter size 70 to 90% in size 35. Alpha cones presented the highest error percentage, ranging from 25% in diameter size 30 up to 100% in size 80.

Table 1. Distribution of error percentage of gutta percha cone sizes according to different manufacturers, Porto Alegre, Brazil (1997)

Cone ISO size	Manufacturer Tanari	Dentsply	Roeko	Alpha
25	15%	20%	15%	40%
30	20%	20%	45%	50%
35	30%	20%	90%	30%
40	30%	35%	85%	40%
45	5%	40%	90%	80%
50	10%	50%	25%	80%
55	20%	60%	75%	55%
60	40%	15%	25%	40%
70	10%	5%	15%	30%
80	20%	10%	25%	100%

Tanari cones showed the best standardized sizes, with the lowest percentage of incorrect diameters. Final results for Tanari cones indicated that 20% of sizes were incorrect. In the case of Dentsply cones, there was a higher percentage of incorrect sizes; 60 out of the 200 cones measured presented incorrect measures according to the standard size (30% error). In Roeko cones, the amount of incorrect sizes was even more significant: 99 out of the 200 measured cones were incorrect according to the standard size (49.5% error). Finally, Alpha cones presented the highest prevalence of incorrect sizes – the diameter of most cones was not as expected. Our results indicated that 104 out of the 200 Alpha cones were incorrect according to the standard size (52% error) (Figure 7).

Assessment of all gutta percha cones independently of manufacturer indicated that the highest error percentage was related to size 45,

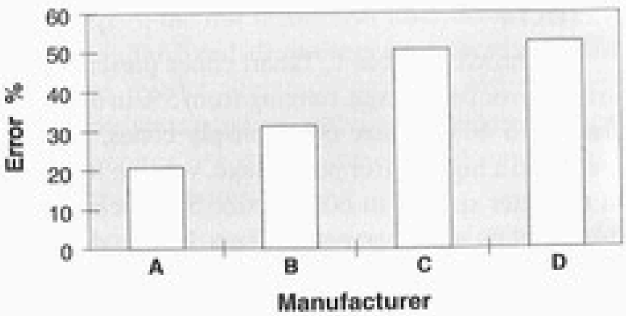

Figure 7. Error percentage according to manufacturers

followed by sizes 55 and 40, respectively. Out of the 80 cones size 45 measured, approximately 54% (43 cones) were incorrect, that is, the indicated diameters did not correspond to those observed with the adapter. Size 70 cones had the lowest error percentage, with most indicated diameters corresponding to those found with the adapter (only 15%, or 12 out of 80 cones, were incorrect); size 25 cones also presented a low error percentage (approximately 23% or 18 cones) (Figure 8).

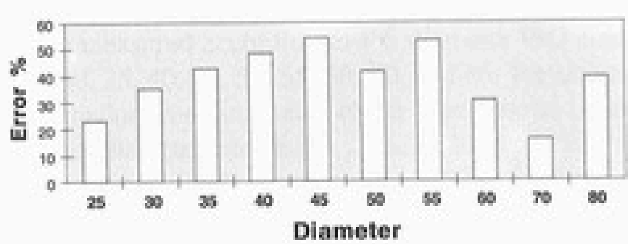

Figure 8. Error percentage according to cone diameter sizes

Gutta percha cones size 25, 30, and 45 did not present significant diameter differences among manufacturers; when these cones were not exactly the correct size, they fit values immediately above or below it or within a range between the two values.

However, in the case of size 35 cones, there were marked differences between expected and measured values (at least two values above or below the expected). Roeko cones presented four marked size differences, and Alpha cones presented one. In these two manufacturers, size 25 also presented considerable variations in diameter. These differences were not observed in Tanari and Dentsply cones.

Out of all size 40 cones measured, only two presented important differences in relation to the expected values: one Roeko cone measured 50 and one Alpha cone measured 25. These differences were not observed in Tanari and Dentsply cones.

Our findings indicated significant size variations for size 50 cones: in 14 Alpha cones and in one Roeko cone. Out of the 14 unstandardized Alpha cones, one measured 30; six measured 35; and seven were size 40. One of the Alpha cones presented a difference of 20 ISO units in relation to the expected value. The Roeko cone size 50 that presented significant variation measured 40. There were no significant differences in Tanari and Dentsply cones size 50.

The study of size 55 cones showed that there were four Alpha cones and one Roeko cone with significant variations in size. All these five cones measured 45. There were no significant differences in Tanari and Dentsply cones size 55.

As to size 60, only one Dentsplay cone showed a marked difference in relation to the expected size; the cone measured 50. Size 60 cones from other manufacturers did not present any significant variation.

Among Alpha cones size 70, two measured 55 and one measured 50; the latter presented a 20-ISO unit difference. Size 70 cones from other manufacturers did not present marked variations.

Seven Alpha cones measured 60 when they were expected to measure 80; only one Roeko cone presented this same variation of 20 ISO units. There were no significant differences in Tanari and Dentsply cones size 80.

The greatest difference between expected and actual size of gutta percha cones was 20 ISO units (cones size 50, 70, and 80). Of the cones presenting this difference, eight were size 70 (seven Alpha cones and one Roeko cone).

None of the Tanari gutta percha cones presented marked differences between expected and actual sizes. Only one Dentsplay cone presented such difference. In turn, in the case of Roeko and Alpha cones, eight and 30 cones, respectively, presented marked variations in diameter.

Table 2 shows the results of the statistical analysis for prevalence of correct and incorrect cone sizes.

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Table 2. Prevalence of correct and incorrect cone sizes according to manufacturer, Porto Alegre, Brazil (1997)

	Manufacturer				
Prevalence	**Tanari**	**Dentsply**	**Roeko**	**Alpha**	**Total**
Correct	160	140	101	96	497
Incorrect	40	60	99	104	303
Total	200	200	200	200	800

The chi-square value calculated for the prevalence of correct and incorrect cone sizes resulted 60.875 and was compared to the critical chi-square value found at 0.1%, which yielded 16.266 with six degrees of freedom. The comparison indicated that the prevalence of incorrect cone sizes of different manufacturers is significantly different at the 0.1% level.

DISCUSSION

Due to the importance of the master cone for the apical placement of obturation, it becomes necessary to leave the smallest space possible for the cement, so that it will act only as a cementing medium. Metaphorically speaking, it is similar to laying bricks with cement.

Considering that the above metaphor can serve as an actual example, the precision of master cone sizes is of the utmost importance. As a rule, standardized instruments (files, tapers) could be used in the preparation of root canals. Such instruments would ensure a constant diameter for gutta percha cones, independently of the manufacturer. However, sharp instruments usually present some sort of irregularity. Thus, the use of these instruments in the preparation of root canals should be an exception to the rule.

The literature suggests that gutta percha points should be manufactured with the diameter that best corresponds to that of the last instrument used in the preparation of the apical region. Our findings did not confirm this criterion. The evaluation of the four different manufacturers showed differences in indicated and measured sizes of all brands. Although the sizes varied at different rates among manufacturers, our results may serve as a warning to professionals who perform endodontic procedures and treatments. It is necessary to verify the correct diameter of cones at the time of purchase; if this is not possible, the professional should test the material before obturating a root canal.

In our study, Tanari cones presented the most reliable sizes, followed by Dentsply. Both are well-known manufacturers, and our results suggest that they follow strict manufacturing standards. Nonetheless, in some sizes, such as size 60 for Tanari cones and 55 for Dentsply cones, we observed error percentages of 40 and 60%, respectively, thus indicating significant incorrect sizes for these manufacturers as well. In turn, Alpha and Roeko cones showed poorer results: Alpha cones size 80 and Roeko cones size 35 showed 100 and 90% error percentages, respectively. In Alpha cones, incorrect sizes were almost a rule.

Cones might have suffered variations due to temperature changes. However, in that case, the error percentage should have been high for all manufacturers. Moreover, cones were stored in boxes with sizes 15 to 40 and 45 to 80, and there were significant variations in cones stored in the same boxes.

Another aspect that could be questioned is the reliability of the cone adapter. However, we did not assess the adapter as a variable, since it constitutes a precision equipment, yielding minimal or no risks for variations. Before the verification of cones, we used files to test the cone adapter and verified an agreement between the file size and the result obtained with the adapter. Finally, if the differences observed were caused by the adapter, there would be no differences between gutta percha cones of the same size.

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This study corroborates the findings of LEONARDO and LEAL,[1] PAIVA and ANTONIAZZI,[2] and WALTON and TORABINEJAD[3] concerning imprecision in gutta percha cone diameters.

We understand that the problem of cone standardization is related to their manufacturing process. Cones are hand-made products, so it is difficult to attain total precision. The better standardization found among Tanari cones may be the result of a strict quality control.

Our findings underscore the importance of testing whether the master cone is fit. Relying on the diameters indicated by manufacturers does not ensure proper placement of the master cone, and may result in empty spaces or spaces filled only with cement in the apical region.

CONCLUSIONS

Our findings suggest that:

1) All manufacturers studied presented variable levels and statistically significant size differences in the comparison with the cone adapter.
2) In a top-to-bottom order, the better results were those of the Tanari, Dentsply, Roeko, and Alpha cones.

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FUSED GUTTA-PERCHA TECHNIQUE: ROOT CANAL FILLING PROCEDURE WITH THERMOPLASTICIZED LOW-TEMPERATURE GUTTA-PERCHA

Abilio Albuquerque Maranhão de **MOURA**, DMD, MDSc, PhD, School of Dentistry, Universidade de São Paulo, Brazil.

Alex Yoshiharu **OTANI**, DMD, MDSc, School of Dentistry, Universidade de São Paulo, Brazil.

Harry **DAVIDOWICZ**, DDS, MDSc, PhD, School of Dentistry, Universidade de São Paulo, Brazil.

Abstract

The authors suggest a modification in the thermoplasticized low-temperature gutta-percha technique (Ultrafil system) to fill the root canal system. This new procedure improves control of apical extrusion and a allows better apical sealing. In addition, it makes gutta-percha more homogeneous and increases its adaptation to the root canal walls.

Key words: gutta-percha, root canal obturation, root canal filling materials.

INTRODUCTION

One of the main objectives in endodontic treatment is to fill the root canal system in a uniform and tridimensional way. In the few past years, a variety of techniques and sealing materials have been extensively analyzed.

A study performed at Washington University demonstrated that 59% of endodontic failures were caused by an incomplete filling of the root canal system.[8]

WEINE et al.[18] showed that, after instrumentation, root canal preparation was not round in shape in order to allow the perfect adaptation of gutta-percha cones to the root canal walls.

YEE et al.,[19] in an attempt to obtain a better filling, developed a technique that used a pressure syringe to inject warm gutta-percha inside the root canal. Several studies have been performed with this technique, assessing aspects such as marginal microleakage,[2,3,4,5,13] histopathological observations under light microscopy,[14] gutta-percha adaptation analyzed under scanning electron microscopy (SEM),[7,12] and clinical radiographic evaluations in human teeth.[11]

These studies presented favorable results so as to the adaptation of the sealing material to the root canal walls[12] and also in relation to biocompatibility.[16] However, it is difficult to control the extension of the filling. Apical extrusion of the material may also occur, with a consequent injury to the periapical region.

In order to better control apical extrusion, GEORGE et al.[6] suggested root canal filing without reaching the apical foramen, using a # 15 file. Results proved to be favorable.

Later on, MOURA[12] proposed an alteration in the thermoplasticized low-temperature gutta-percha technique using a gutta-percha cone cut at the apical portion. As the cone was locked, the warm material could not suffer extrusion when the remaining part of the root canal was filled through the Ultrafil system. When using SEM, it was possible to see that the tip of the gutta-percha cone was fused to the thermoplasticized material.

OTANI et al.[14] compared the above mentioned technique to other two filling procedures. Under histological examination, it was possible to observe that this technique provided improved periapical repair in dogs.

The present study aims at detailing this new technique in order to facilitate its use in clinical applications. We also show the advantages and limitations of the procedure.

DESCRIPTION OF THE TECHNIQUE

Root canal preparation

Root canal instrumentation is fundamental when using thermoplasticized gutta-percha, and should allow a continuous tapered shape. Gates-Glidden burs facilitate the surgical procedure, as does the use of Endo-PTC* with 1% sodium hypochlorite.† The enlargement of the cervical portion aims at a better root canal tapering.

Root canal filling

After final irrigation with Tergentol,‡ a standardized master cone is selected. It is measured with a gutta-percha cone scaled gauge (Maillefer) (Figure 1).

When fitting the cone, it is fundamental to lock it at the apical part[17] (Figure 2). Locking is verified, and clinical radiographic tests are performed.

The root canal is first dried with aspirating needles and absorbing paper cones.

The heater of the Ultrafil system§ should be activated at least 15 minutes before use, as this is the time required for the gutta-percha to become plasticized inside the irrigating needle[17] (Figure 3).

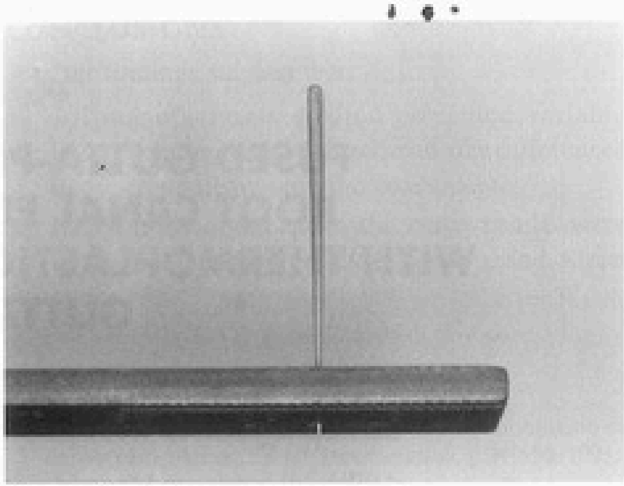

Figure 1. Cone measurement

The irrigating needle, coupled to the pressure syringe, is used to extrude the plasticized gutta-percha into the root canal and involve the master cone from the cervical to the apical portion. The material should completely cover the cone (Figure 4). The irrigating needle for this technique can be white (regular set) or blue (firm set), since both present an excellent flow.

The master cone, involved by thermoplasticized gutta-percha, is slowly introduced into the root canal until working length is achieved.

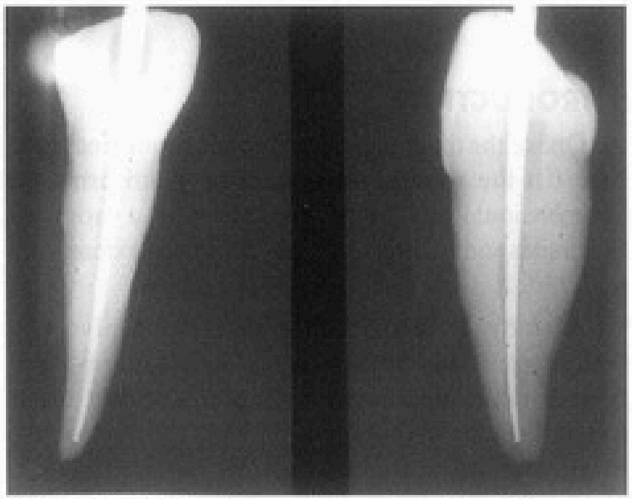

Figure 2. Fitting the cone (buccal and proximal view)

* Endo-PTC (Ao Pharmacêutico, São Paulo, Brazil). Formula:[15] Urea peroxide: 10%; Tween 80: 15%; Carbowax (vehicle): 75%.
† Milton's solution: 1% sodium hypochlorite solution, stabilized with sodium chloride. Ao Pharmacêutico: Farmácia de Manipulação. São Paulo. Brazil.
‡ Tergentol (Laboratório Searle Sintético Ltda., São Paulo, Brazil): lauryl diethylene glycol ether sodium sulphate.
§ Ultrafil (The Hygenic Corporation, Akron, OH, USA): thermoplasticized low-temperature gutta-percha (70 °C).

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Figure 3. Ultrafil system

A radiograph is taken to observe the quality of the filling and analyze extension, adaptation and extrusion of the material into the periapical region (Figure 5).

The excess material is removed, and vertical condensation is performed with cold pluggers.

The thermoplasticized gutta-percha technique, associated with vertical condensation, pushes the filling material to the sides and towards accessory root canals, and also eliminates irregular voids from the root canal wall. A final radiograph is taken to verify the quality of the filling (Figure 6).

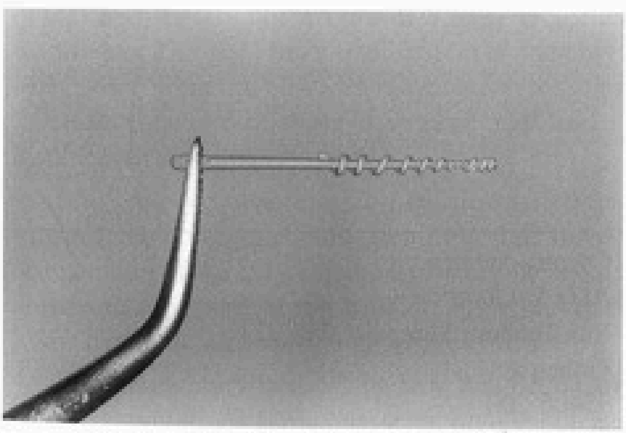

Figure 4. Cone involved by thermoplasticized gutta-percha

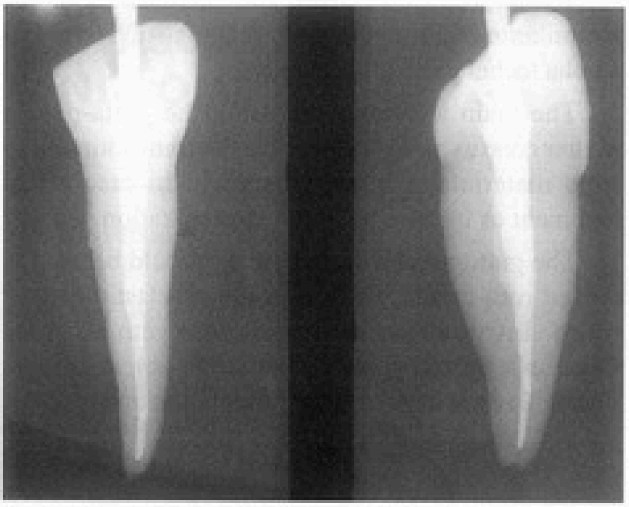

Figure 5. Quality of the filling (buccal and proximal view)

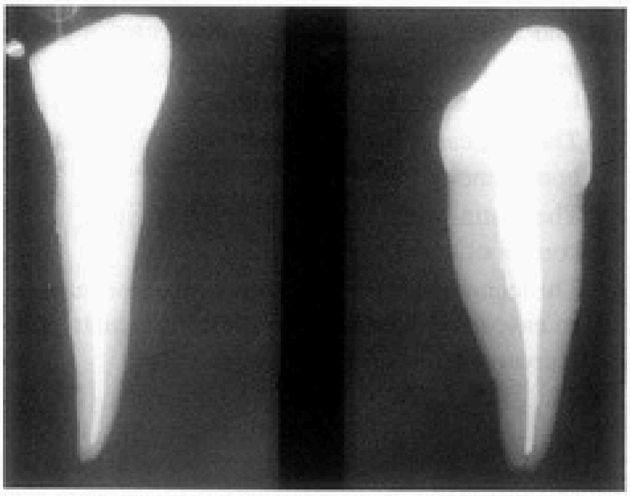

Figure 6. Final radiograph (buccal and proximal view)

OBSERVATIONS

The fused gutta-percha technique, compared to the thermoplasticized low-temperature gutta-percha technique,[19] allows better control of the filling extension. This is possible because the gutta-percha master cone represents a constitutes a good instrument for the transportation of solid materials. As a consequence, the sealing material is controlled and apical extrusion is improved, which results in an adequate adaptation of the material to the root canal

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walls. In addition, the gutta-percha mass remains homogeneous, with no leakage or voids.

In root canals that present isthmi, thermoplasticized gutta-percha tends to fill these voids[15] and penetrate dentinal tubules.[7]

The time spent with filling in the fused technique is similar to that spent in the thermoplasticized gutta-percha technique[10] (30 seconds).

The main advantage of using the gutta-percha master cone as an instrument for the transportation of solid materials is its easy removal in case of re-treatment or intra-radicular post-preparation.

The gutta-percha master cones should be used in curved root canals, since metallic or plastic cones,[9] when introduced into the root canal, lose thermoplasticized gutta-percha at the apical portion. This will result in poor filling adaptation and leakage.

CONCLUSIONS

Based on the observations above, it is possible to conclude that:

1) The fused gutta-percha technique uses a gutta-percha master cone fused to thermoplasticized low-temperature gutta-percha.
2) The root canal filling shows good adaptation and homogeneity.
3) The gutta-percha master cone provides better control of under- or overfilling.
4) The technique favors easy removal of the material in case of re-treatment and intra-radicular post-preparation.

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Correspondence:
Alex Y. Otani
Rua Teodoro Sampaio, 2550/73
Pinheiros
05406-200
São Paulo, SP - Brazil

USE OF 2% LIDOCAINE HYDROCHLORIDE WITHOUT VASOCONSTRICTOR IN THE TREATMENT OF POSTTRAUMATIC MYOFASCIAL PAIN DYSFUNCTION SYNDROME

Eduardo **GROSSMANN**, DDS, MS, PhD, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.

Mirian **MARTELETE**, MD, PhD, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.

José Antônio Poli de **FIGUEIREDO**, DDS, MS, PhD, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.

Eduardo **GONÇALVES**, DDS, MS, Private practitioner, Araraquara, SP, Brazil.

Abstract

The authors present the case of a patient with a posttraumatic myofascial trigger point located in the anterior belly of the left digastric muscle and suggestive of odontalgia. Once diagnosis was established, 2% lidocaine hydrochloride without vasoconstrictor was used as treatment. After six infiltrations, pain ceased completely. The patient remains asymptomatic after 60 months of follow-up.

Key words: trigger points, myofascial pain syndromes, trauma, drug therapy, odontalgia.

INTRODUCTION

Problems related to the temporomandibular joint (TMJ) and its structures present a high incidence worldwide. The TMJ functional system is composed of bilateral joints, teeth, and masticatory muscles. Alterations in one of these structures may lead to disorders in the whole system.[12]

Masticatory muscles act on the downward and upward movements of the mandible and on the stabilization of the cervical and hyoid region, so that an adequate posture of the structures is achieved to allow the harmonic functioning of the system.

The masticatory muscles include the medial and lateral pterygoid, digastric, masseter, mylohyoid, and geniohyoid muscles. The role of other muscles of the head and neck, such as the trapezius and sternocleidomastoid muscles, is also interesting, due to their involvement in the myofascial pain dysfunction syndrome.[10]

The digastric muscle is divided into two bellies (anterior and posterior). The anterior belly inserts into the inferior border of the mandible, near the midline, in the digastric fossa[5]; the posterior belly inserts into the mastoid cavity. The intermediate tendon of the bellies of the digastric muscle adheres to the hyoid muscle by means of a fibrous band.

The mylohyoid branch of the trigeminal nerve (mandibular division) innervates the anterior belly, while the digastric branch of the facial nerve innervates the posterior belly. The digastric muscle contributes to the movements of mandibular opening, retrusion, and protrusion.[2]

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Anatomical variations in the masticatory muscles may lead to mandibular deviations due to alterations in force properties during mouth opening. This type of alteration has been shown to occur at the mandibular insertion of the digastric muscle.[17]

Muscular and/or myofascial pain is the most common cause of temporomandibular disorders.[13] Myofascial pain presupposes the presence of a trigger point, which consists of a hypersensitive, small, circumscribed area of the muscle that sends a great quantity of impulses to the central nervous system and causes local and/or referred pain.[7,8,11,13,15]

Myofascial trigger points are classified as active (symptomatic points of irritability in the muscle or fascia presenting referred pain), diffuse (usually developing in the muscle pertaining to the referred pain zone of another trigger point), and latent (similar to the active trigger points, but asymptomatic in terms of spontaneous pain).[8,10]

The etiology of myofascial pain dysfunction syndrome is frequently complex and multifactorial. Scientific evidence suggests that muscular hyperactivity may be the most important cause of the perpetuation of this disorder.[12]

Diagnosis is based on clinical examination, which aims at verifying the presence of trigger points in the muscle structure by means of digital palpation. When trigger points are found, patients usually report chronic local or referred pain and eventual resistance to palpation. The use of a local anesthetic block for the diagnosis of trigger points is uncommon.[16]

There are several options for the treatment of myofascial trigger points. The literature reports warm compresses and muscular exercises,[9] local anesthetic injection (2% lidocaine hydrochloride without vasocontrictor), ischemic compression for 30 to 60 seconds, acupuncture, drug therapy (including analgesics, muscular relaxants, nonsteroid antidepressive and anti-inflammatory agents), posture correction, management of tension, stabilization of nutritional and metabolic factors, and occlusal adjustments.[13]

The use of local anesthetics has shown to be effective in the treatment of myofascial pain dysfunction syndrome. The mechanism of action of this treatment consists in preventing the generation of nervous impulses and their conduction through the cellular membrane with the application of an anesthetic injection right at the trigger point.[6,13] Some authors have reported relief of pain following intramuscular injection in regions not anatomically associated with the painful area.[15]

The use of other drugs, such as sumatriptan (a peripheral agonist of 5-HT_{1D} receptors,[8] botulinum toxin,[1,7] 0.025% topical capsaicin,[11] and clonazepam[12]) has shown important effects on the reduction of orofacial and cervical pain. However, since these drugs may present severe side effects, they should not be the treatment of choice for myofascial pain dysfunction syndrome.

We suggest that infiltration of 2% lidocaine hydrochloride without vasoconstrictor be the gold standard for the treatment of myofascial pain dysfunction syndrome. Vasoconctrictors should not be used, since they may cause muscle spasm.[13]

The application of anesthetic block to a muscle reduces pain in one of the following ways: the needle disintegrates contractile elements, the neural feedback that maintains dysfunction is interrupted, or vasodilatation results in increased local circulation by removing catabolites that are present.[3]

CASE REPORT

A 14 year-old black male patient (T.S.B.) sought assistance at a private clinic in Porto Alegre, Brazil. His main complaint was pain for approximately 6 months in the inferior labial segment (score 8 on a Visual Analog Scale), more precisely on teeth 31, 32 and their respective alveolar processes.

Patient history revealed a bike accident prior to the beginning of pain episodes. Mandibular trauma occurred, with no clinical/radiographic signs of fracture. Pain was continuous, constant, pulsatile, and got worse during the performance of functional acts, such as yawning, speaking, chewing, and also when the weather was cold.

During the first months after establishment of pain, the patient consecutively sought a total of nine different practitioners, including neurosurgeons, psychiatrists, dental surgeons, and bucomaxillofacial surgeons. None of them was effective in diagnosing and treating the problem.

Panoramic, mandibular occlusal, and periapical radiographs had been previously requested by different professionals. In addition, the Clark technique had been used. These examinations evidenced the presence of an inferior canine tooth transversally positioned on the right side of the mouth (Figure 1). The tooth was surgically removed, but pain did not cease. All mandibular teeth that had erupted presented pulp vitality. Acetylsalicylic acid, paracetamol, piroxicam, and diclofenac sodium were the drugs that had already been used, with no success.

Figure 1. Inferior canine tooth transversally positioned (right side)

Clinical examination revealed the absence of parafunctional habits. Mouth opening measured 4.52 cm, with no pain, deviations, or articular pain. Mandibular movements were normal, with no interference with the work and balance sides.

Palpation of the anterior belly of the left digastric muscle was performed with cervical hyperextension and digital pressure on the muscle insertion into the mandible. It revealed referred pain in the mandible, more precisely at teeth 31, 32 and their respective alveolar processes.

The presence of an active trigger point was diagnosed in the anterior belly of the left digastric muscle. Local infiltration of 2% lidocaine hydrochloride without vasoconstrictor directly at the trigger point was carried out, with previous cutaneous asepsis using 70º alcohol. A total of six infiltrations were performed with seven-day intervals – a 0.9 ml dose was used at each infiltration. After six weeks, the patient reported complete resolution of pain (score 0 on a Visual Analog Scale). The patient remains asymptomatic until the present moment (60 months of clinical follow-up).

DISCUSSION

According to MCMILLIAN and BLASBERG,[15] the occurrence of trauma in craniofacial tissues seems to be the most frequent cause of myofascial pain dysfunction syndrome. This disease may be caused by either a macrotrauma (acute trauma, such as in a car accident) or a microtrauma (insidious, low-intensity, long-lasting trauma, such as bruxism). Macrotraumas may lead to painful muscular contraction, due to poor regulation of the muscular tone.

Trauma-related alterations in the mandible position may cause damage to articulations and to periarticular tissues, with ligament rupture and inflammation. In addition, masticatory muscles may be injured due to excessive stretching, resulting in the myotatic reflex with prolonged contraction.[4]

Accurate and early diagnosis is the best way to achieve good results in the treatment of myofascial pain dysfunction syndrome.

The use of local anesthetics, mainly of 2% lidocaine hydrochloride for the treatment of myofascial pain has been shown to be effective, leading to a decrease in the number of symptomatic cases. Local anesthetics have a peripheral effect on the site of pain and on the central nervous system activity, especially at points where pain is maintained.[15] They also seem to decrease the input of nervous impulses at the posterior spinal horn, which acts as a barrier and inhibits the reverberant activity of neural circuits.[14]

The difficulty shown by several practitioners in effectively diagnosing myofascial pain dysfunction syndrome suggests the existence of a gap between the medical and the odontological areas. Professionals concentrate on the bone involvement observed in traumas, and little attention is given to the effects of the lesions on muscles.

Diagnosis of myofascial pain dysfunction syndrome based on clinical examination (palpation) showed to be effective, since it evidenced the location of the trigger point and its pattern of pain. Once diagnosis was confirmed, local anesthetic blocks were used to eradicate pain and proved effective.

CONCLUSIONS

1) Traumas in the craniofacial area play an important role in the etiology of myofascial pain dysfunction syndrome.
2) Health professionals lack experience in diagnosing and treating myofascial pain dysfunction syndrome.
3) Although the use of local anesthetics in the treatment of myofascial pain dysfunction syndrome is effective, further studies are necessary in order to establish its mechanism of action.

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Correspondence:
Prof. Eduardo Grossmann
Rua São Luís, 700/801
90620-170
Porto Alegre, RS - Brazil
E-mail: edugrmnn@zaz.com.br

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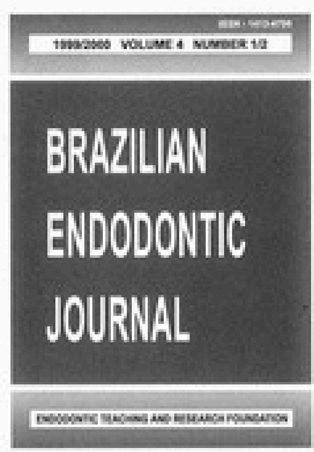

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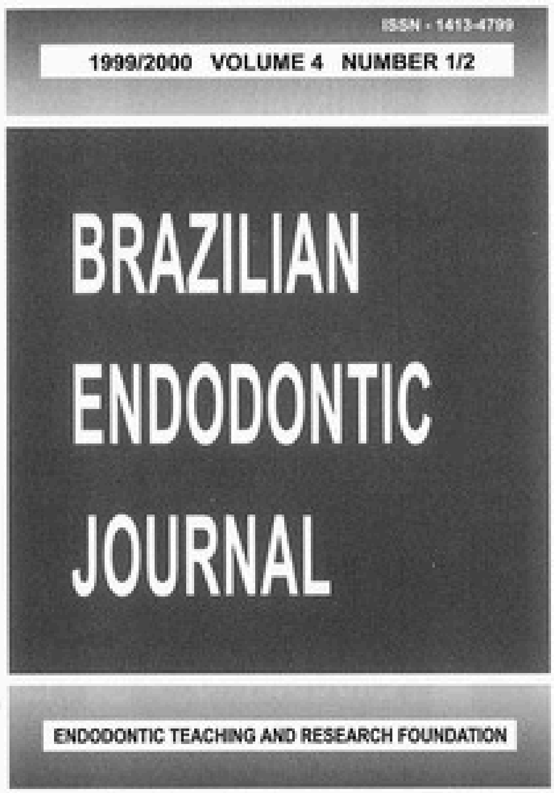

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