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Evaluation of apical filling using different obturation techniques

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Abstract

The aim of this study was to compare the quality regarding imperfections, voids in root canals of extracted single rooted tooth filled with gutapercha and sealer by different techniques. For this study we selected 200 extracted single rooted teeth, with fully formed apices and a single and permeable canal, the canals were prepared using the ProTaper Next system (Dentsply, Ballaigues, Switzerland).Canals preparation were performed by a single operator, in accordance with the manufacturer's instructions, at the end of instrumentation, each root canal was irrigated with 5 ml 17% EDTA (MD Cleanser, META BIOMED) and 5 ml 2% NaOCl (Chloraxid 2% Cerkamed). Root canals of group 1 were filled by cold lateral condensation technique the Group 2 of teeth was filled by warm vertical condensation, continuous wave technique. The Group 3 of teeth was filled by a single cone and sealer using single cone technique, four Group 4 of the teeth we filled only by squirt technique with heated gutta-percha, after application of the AH Plus sealer. Furthermore, the entire root canal was backfilled with gutta-percha using a cartridge with gutta-percha 23-gauge, heated at 200 ° C.
Voids were observed particularly in the case of teeth obstructed by monocone technique and by the cold side condensation technique. The gaps were identified within the sealing sections of the filling, especially in the apical segment. The following deficiencies have also been highlighted: over-extension of the sealer, guttapercha, under the obturation of the root canal, fissures, restant dentinal chips.
These defects were identified by stereo microscopy on extracted teeth, making sections in the median third coronary and in the apical coronary segment by shooting with the camera digital determining issues, thus establishing the total number of errors as well as the percentages of errors in each obturation technique used.
As for conclusions, the presence of intercanalar isthmuses may be a factor favoring the retention of dentin fragments produced during mechanical treatment of the channels. Most of the errors were encountered in the monocone technique. Practically half of the post-treatment stereomicroscopically investigated teeth were found to be mistakes, among which the most frequent were the voids found in the sealer (24% of the cases). The second place in the number of errors is the cold side condensation technique, with 46% errors in the total number of investigated teeth cases. For this technique, the maximum number of errors is related to the formation of voids in the sealer, which is found in 18% of the investigated cases.

Key words : root canal obturation , void, cold lateral side condensation, warm vertical condensation, intercanalar isthmuses.

1. Introduction

To achieve an optimal three-dimensional obturation of the endodontic system, there have been introduced a number of techniques for preparation of shaping and cleaning of the root canals. For research purposes single-rooted teeth ar commonly used to compare different

feeling techniques (8) to check the adaptation of the feeling materials to the canal walls in order to facilitate the interpretation of results, in order to identify any eventual flaws in the purpose of improving the statistical analyzes.
The conclusion of studies refers to the fact that apical or coronar leakage adversly affects the long time out comme of root canal therapy [1,3,5] .Leakage in filled root canals se produce de-a lungul sealer- dentin and sealer – root filling material interfaces or via voids and other type of other types of imperfections in canal obturation.
Am large variety of techniques have been used to evaluate to coliting of root fiilings-leakagetes radiographic and microscopic evaluation.[2,6]

2. Material and Methods

- **Samples preparation**

For this study we selected 200 extracted single rooted teeth, with fully formed apices and a single and permeable canal, radiologically verified. They were kept in saline until ready to use.The access openings were made using a high speed dimond round bur and cooling water. Working lengths were determined with a size 10 K-file (Dentsply, Ballaigues, Switzerland) inserted passively until its tip was visible at the apical foramen. Then, using an operating microscope (Seliga SmartOptic microscopes, Poland), the true length of the canal was registered, the working length been calculated by subtracting a millimeter of this measurement. For uniformity evidence all crowns were shortened with a diamond disc in order to obtain a final 18mm working length for each tooth.

- **Canal preparation**

The canals were prepared using the ProTaper Next system (Dentsply, Ballaigues, Switzerland). The glide path was obtained by using the ProGlider instrument (Dentsply, Ballaigues, Switzerland). An endodontic motor X-Smart (Dentsply Tulsa Dental, Tulsa, OK) was used for rotary systems. Canals preparation were performed by a single operator, in accordance with the manufacturer's instructions. All ProTaper Next instruments were used at a speed of 300 rpm and a torque of 2.0 Ncm. Each instrument was used by brushing motion. They were placed on the entire working length of the root canals. Instrumentation sequence was as follows: X1 (0.17 mm diameter at the top, 4% taper), X2 (0,26mm diameter at the top, 6% taper) and X3 (0.30mm diameter at the top, 8% taper). Each instrument was cleaned after three brushing movements and the canall was irrigated with 2.5ml of 3% sodium hypoclorite using a luer-lock syringe (Roeko) and 30-gauge needle introduced up to 3 mm from the apex but not fixed there. The permeability of each root canal was checked with a size 10 K-file. When the instrument touched reached the working lenght and moved without difficulty, he was removed and replaced by the following one. Each instrument was used to prepare only 5 root canals.

At the end of instrumentation, each root canal was irrigated with 5 ml 17% EDTA (MD Cleanser, META BIOMED) and 5 ml 2% NaOCl (Chloraxid 2% Cerkamed) and dried with paper points (Diadent, USA).

- **Filling of the root canals**

Root canals of group 1 were filled by cold lateral condensation technique [1]. Before drying the root canals, we selected a size 35 master gutta-percha cone (Diadent, USA), adapted by cutting to obtain tug-back. We prepared the AH Plus sealer (Dentsply, Maillefer) according to the manufacturer' instructions. Master cone was passed through the sealer and inserted into the canal. Medium-fine accessory cones (Dentsply, Maillefer) were condensed with a finger spreader (VDW, Germany) until they could not be placed in the canal more than 4 mm. A heated plugger was used for sectioning the bundle of cones in the orifices of the emergence of the root canal, followed by the vertical condensation with a cold plugger . Each tooth was radiographed from 2 incidence to verify the accuracy of root canal fillings. If the canal fillings were incomplete or heterogeneous condensations were restored.

The Group 2 of teeth was filled by warm vertical condensation, continuous wave technique. A gutta-percha cone Protaper Next X3 (VDW, Germany) was used as a master cone, AH Plus (Dentsply, Maillefer) as a sealer and BeeFill system 2 in 1 (VDW, Munich, Germany) for performing the vertical condensation technique. From master cone were cut 0.5 mm from the top to provide tug-back. The electric plugger was selected with a similar taper as the master cone, inserted into the root canal to confirm reaching of the working length minus 4 mm by adjusting the stopper's and at the reference point.

The master cone was passed through the sealer, gently inserted into the canal and cut with the previously selected heated plugger from the emergence of the root canal orifices. A 3/4 manual plugger (Dentsply, Maillefer) was used to laterally and vertically compact the gutta-percha. The BeeFill electric plugger was again heated to 200° C and in a single continuous movement was inserted in the gutta-percha mass by up to 4 mm of working length. This stage was limited to 2-4 seconds. The plugger was disabled while firm pressure continued to be applied to cold instrument. Then the plugger was again activated for one second and then removed from the canal with gutta-percha excess. A cold hand plugger (Dentsply, Maillefer) was used for the gutta-percha vertical compaction that remained in the canal. The rest of the root canal has been backfilled with gutta-percha using a 23-gauge cartridge gutta-percha heated to 200 ° C. Again the heated gutta-percha was condensed with a 3/4 cold plugger (Dentsply, Maillefer).

The Group 3 of teeth was filled by a single cone and sealer using single cone technique. Protaper Next X3 cone was chosen (Dentsply, Maillefer) and previously tested in the root canal. The AH Plus sealer was inserted with a Lentullo, then the gutta-percha cone and severed from the emergence of the root canal.

The Group 4 of the teeth was filled only by squirt technique with heated gutta-percha, after application of the AH Plus sealer. Furthermore, the entire root canal was backfilled with gutta-percha using a cartridge with gutta-percha 23-gauge, heated at 200 ° C.

All access cavities were sealed with Coltosol (Roeko) and the teeth were kept in100% humidity conditions, at a temperature of 37 ° C for 48 hours to allow complete set of the sealer.

3. Results and Discussions

The errors of endodontic obturation technique were observed post-surgically by stereomicroscopy. For this, each tooth was initially divided into three places: i) at the crown-root limit; ii) at third root coronary limit - two thirds of apical root and iii) at the limit of two thirds of coronary root canal - apical third root. Sectional surfaces and root canal contents at these levels were inspected with the stereomicroscope. Considering the frequency of obturation techniques in the apical third in some cases for a better detection of imperfections, the apical third has been further sliced once again. This additional section was followed either by the detachment of the apical quarter or by dividing the apical third into two. These additional cuts were also followed by a stereomicroscopic analysis of the new sectional areas.

With the digital camera of the stereomicroscope, photos were taken for the aspects considered significant. In order to determine the types of errors and the most likely ways to produce them, the members of the team of authors consulted by analyzing each part of the fragments of the stereomicroscope and not by simply reviewing the digital images taken.

Type of stereoscopy used: ***Leica EZ4 HD*** ***with built- in photodigital camera***

To obtain images with magnification over 50x a Zeiss Jena calcographic microscope was used. Calcographic microscopy was applied only in some cases to detect aspects requiring greater magnification order than those that can be obtained with the stereomicroscope.

Tables with identified errors (expressed as total number of errors and percentage of errors on the clogging technique)

	Obturation technique	Number of errors identified by stereomicroscopy							
		Voids	Heterogeneous Sealer	Fissures	Restant dentine Chips	Exceedings	Subobturations	Lack of filling	Number total errors per technique
Lot1 (50 teeth)	Lateral side cold condensation	9	2	5	4	2	1	0	2. 3
Lot2 (50 teeth)	Vertical side warm condensation	2	0	7	1	0	0	0	10
Lot3 (50 teeth)	Monocone technique (Protaper preperation)	12	0	0	6	1	4	2	25
Lot4 (50 teeth)	Injection technique for guttapercha	1	0	0	1	2	0	0	4
	Obturation technique	Percentages of errors identified by stereomicroscopy							
		Voids	Heterogeneous Sealer	Fissures	Restant dentine Chips	Exceedings	Subobturations	Lack of filling	Percentage of total errors per technique
Lot1 (50 teeth)	Lateral side cold	18 %	4 %	10 %	8 %	4 %	2 %	0 %	46 %

	condensation								
Lot2 (50 teeth)	Vertical warm condensation	4 %	0 %	14 %	2 %	0 %	0 %	0 %	20 %
Lot3 (50 teeth)	Monocone technique (Protaper preperation)	24 %	0 %	0 %	12 %	2 %	8 %	4 %	50 %
Lot4 (50 teeth)	Injection technique for guttapercha	2 %	0 %	0 %	2 %	4 %	0 %	0 %	8 %

a. Voids

The gaps (voids) have been observed in particular in the case of the teeth that were filled using the monocone technique and the lateral side cold condensation technique. The gaps were identified within the sealer sections of the filling, especially in the apical segment. On a surface given by the section of the root can be unique or multiple . The multiple ones were most commonly observed as being locally grouped.

The stereomicroscopy investigation provides three-dimensional images and allows a check to be made to extend the lack of sealing material to the depth of the studied root fragments. Thus, there were considered voids from technical errors, those that saw an extension within the canal portion of the root fragment studied. Obviously, we did not fit as obturation techniques errors, the small sealer depressions on the analyzed surface area that appeared almost without exception when the root was cut.

(1) " Heterogeneous Sealing"

We have encountered in this error the situations in which we have found the presence of two types of sealer in the root canal between the guttapercha cones and between them and the walls of the root canal. In these cases, we have found that a type of sealer is present in smaller amounts on the walls of the root canal and a second type of sealer which is recognized by color more or less different is present in the central zone of the canal partially surrounding or totally the guttapercha cones. In such circumstances, we consider it unlikely that the junction between the two sealers that were placed in the canal at different times to be perfect and to provide a proper closure of the endodontic space. These situations have been included in possible treatment retreats.

(2) Fissures

In the present study the cracks have been encountered especially in the case of teeth obstructed by warm vertical and cold condensation technique. The following types of cracks have been encountered: ***open*** (those that partially or totally detach a root fragment) and ***closed*** (those that do not detach the root fragment). These cracks may also be classified into ***radiar*** (those extending from the root canal to the root surface or up to it) and ***paracanallation*** (those that pass next to the root canal without intersecting it at the level of the surface section analysed).

(3) Restant dentinal chips

The remaining dentinal fragments identified have been particularly surprised to be locked in interradicular isthmus areas. We have found that the dimensions of these fragments are generally relatively large, namely that they hold 10-15% of the small diameters of the root canal at the sectional area where they were observed.

(4) Exceedings

We have overturned them by stereomicroscopic analysis of the root apex. In these situations, the gutta-percha, and sometimes even the sealer, passed through the apical constriction and came out through the apical foramen by overcoming it in diverging degrees.

(5) Subobturations

Under extesion of obturation is a permited because it facilitates apical infiltration and correct adaptation of obturation to apical anatomy.

(6) Lack of filling

Although it seems an almost impossible error to occur, we have also seen such errors. In these situations, on the walls of the root canal there were traces of sealer in the form of very stratiform and static stratiform depositions in other cases, although it is obvious that a mechanical canal treatment was not found in the respective channel at no level of root cuts, neither sealer nor guttapercha.

The single-cone technique did not use compaction forces so this technique in our barrel experiment did not fill the last millimeters of root canal preventing leakage as effective as vertical and lateral compaction techniques.

In concordance with other sudies the area of the carrier in the Thermafil group was included in the filled area, but this technique had a higher incidence of appical extrusion, just like the warm injection of guttapercha technique.

Images supporting the identified errors

a. Under extension of the obturation.
It can be seen that the "C" shaped root canal [Fig1], where sealer and dentinal chips are detected in the apical portion of the root canal, and the presence of voits [Fig.1 and 2]

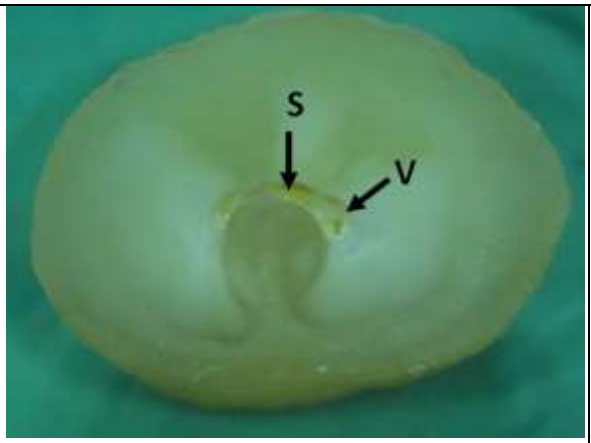

Fig.1 C-shaped channel; only the sealer (S) is present in the apical third of the root. Gaps (V) are also observed in the present sealer (25x)

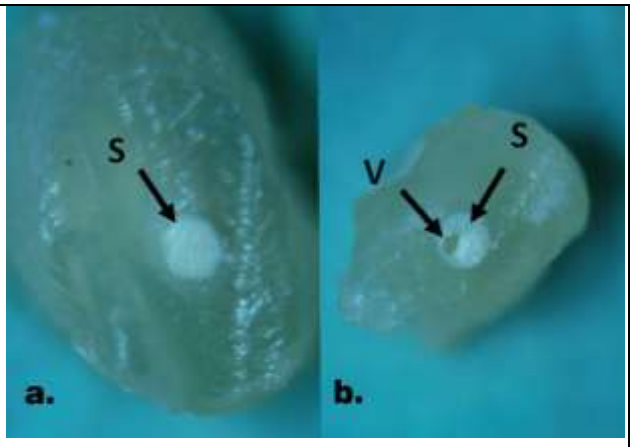

Fig.2
a) Obturation but with sealer at the third apical root limit - two thirds of the coronary root (40x).
b) In the case of the same tooth, at the half of the third apical radiculus (In this case the apical root third was resected into two parts of approximately equal length) it is observed that filling with sealer only is unsatisfactory by the presence of voids (V) - V 40x)

In the case of cold lateral conjugation [Fig. 3], two non-confluent voits are observed and [Fig. 4] in the proximity of the vestibular canal is formed void in the sealer and in the vicinity of the palatal canal is distinguished uninterrupted dentinal detritus.

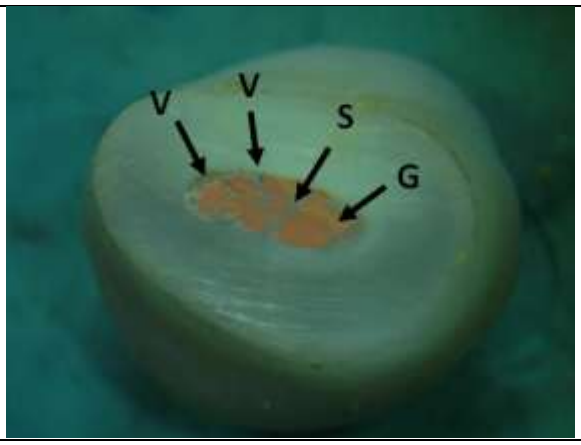

Fig.3 Small voids (V) in the sealer used to fill the remaining spaces between the cones and the root canal walls in cold lateral condensation (12.5x)

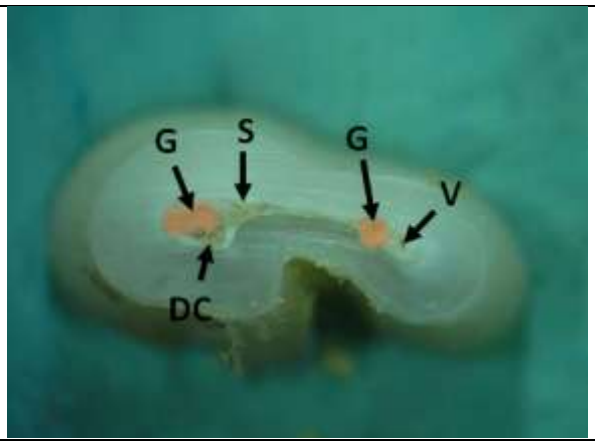

Fig.4 Fragments of dentine (DC) and gills (Voids -V) in the sealer (S) used to procure this endodontic system (16x)

We notice the presence of two micro voits [fig. 5] in the sealer, one in the diverticula of the main canal by not preparing the oval prolongation of the canal.

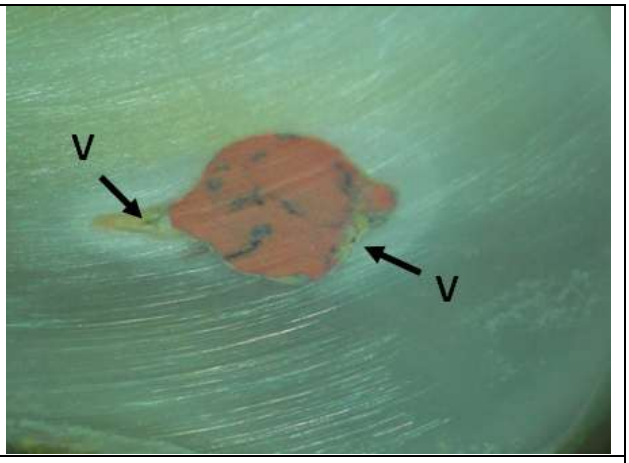

Fig . 5 Small voids in the sealer used in cold lateral condensation; it is noticed that perhaps the section passes through the oval prolongation of the canal that has not been instrumental. (25x)

b. Excessive dentine fragments in the endodontic space [Figures 6 and 7] resulting from inappropriate preparation of the endodontic system.

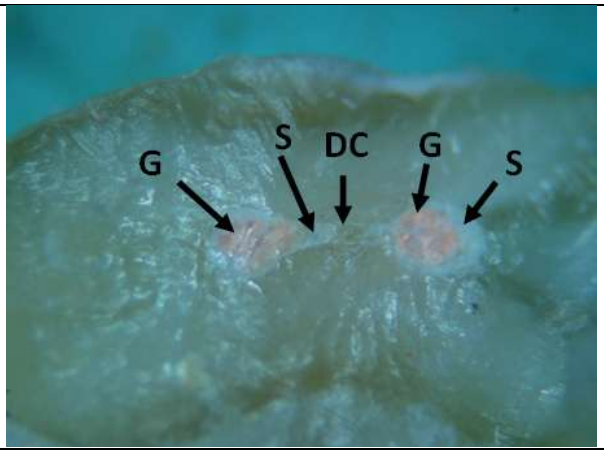

Fig. 6 Dentine chips (DC) trapped in the intercanalicular isthmus (40x)

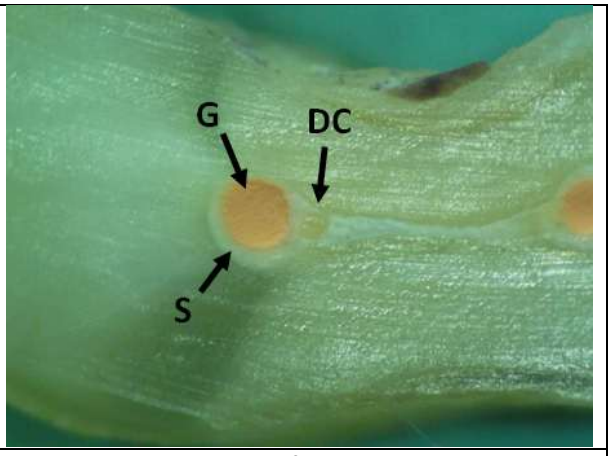

Fig. 7 Dentine chips (DC) fragments surprised at the boundary between one of the two root canals of a premolar and intercanalicular instinct. It is observed in this case that the endodontic seal also entered the inter- canal isthmus (35x)

c. Voids

In Figures 8 and 9, micro voits are visible at the guttapercha sealer interface and the sealer and the side wall of the root canal.

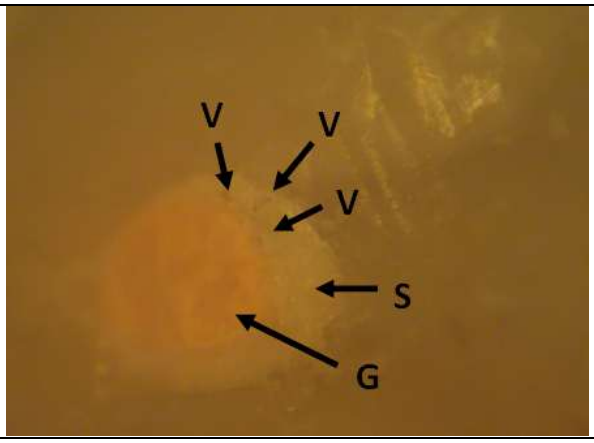

Fig . 8 Group of voids (V) (cluster of voids) in the sealer (S) around the guttapercha cone (G) (100x)

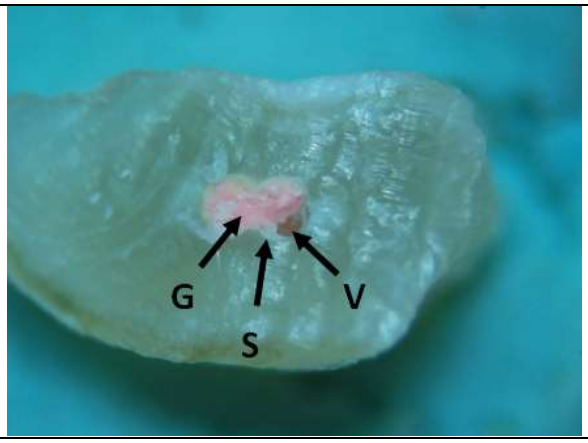

Fig . 9 Void (V) present between a guttapercha cone and the root canal wall at the limit of 2/3 coronary root and 1/3 apical radicle, this level being the place where the two root canals join together (Endodontic We II) (20x)

c. Exceedings

In Figures 10 and 11 there is evidence of over extransion with guttapercha through the apical formen.

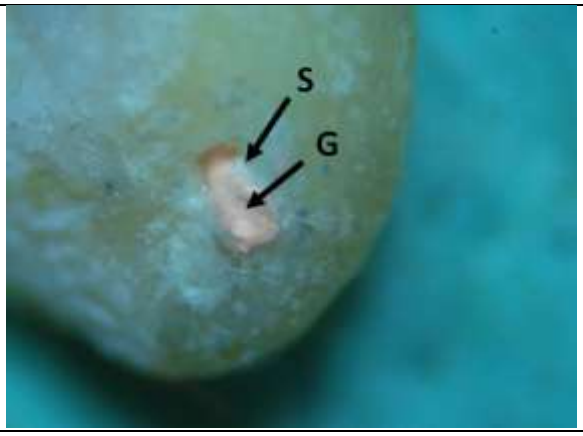

Fig . 10 Apex of a front tooth: Exceeding apex with guttapercha (G) and sealer (S) (40x)

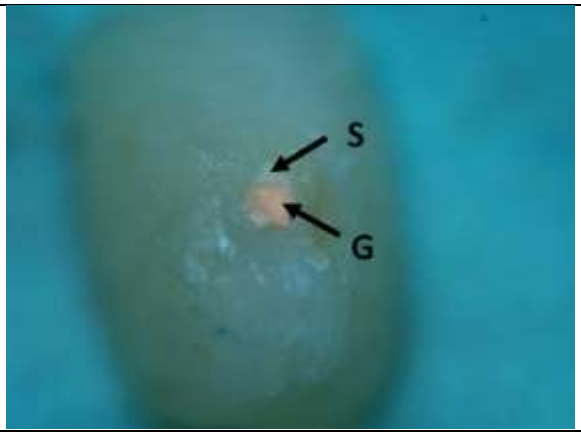

Fig . 11 The apex of a front tooth: Exceeding apex with guttapercha (G) and sealer (S); the gutta – percha cone has passed the apical constriction as a result of its excessive widening by over-working and non-observance of the working length (40x)

e. Cracks

In Figure 12 it is evident on the apical segment, the apical root that contains two channels are united by isthmus visualizing the dentin debris located in the isthmus, also relatively frequently identified cracks [fig.12 and fig.13].

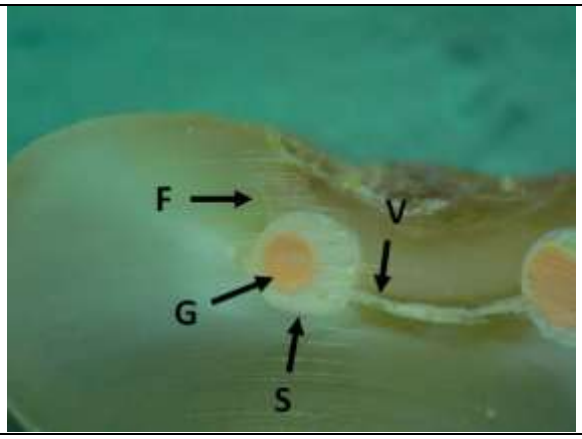

Fig . 12 Crack that starts from the root canal to the external face of the root (the crack does not detach a dental fragment); an intercanalicular isthm is only partially filled with sealer (V voids have been identified) (30x)

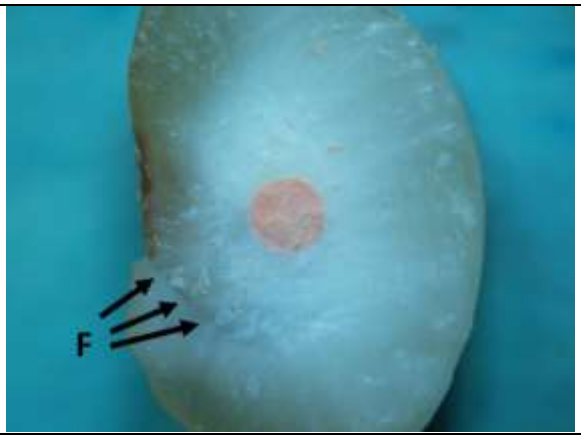

Fig. 13 A crack at this level (the play of the coronal root to the middle root) does not intersect the root canal, but it is the extension of a crack that starts from the floor of the pulp chamber, so that we can assume that through it the endodontic spindle was opened there are no color changes suggestive of infiltration (20x)

d. Complete missing of the canal filling

An omission of obstruction has been identified in the canals contained in the partially extracted obturated root using the Thermafil technique , in the digital image on the section it is observed that the palatal canal is not covered in the presence of sealer traces

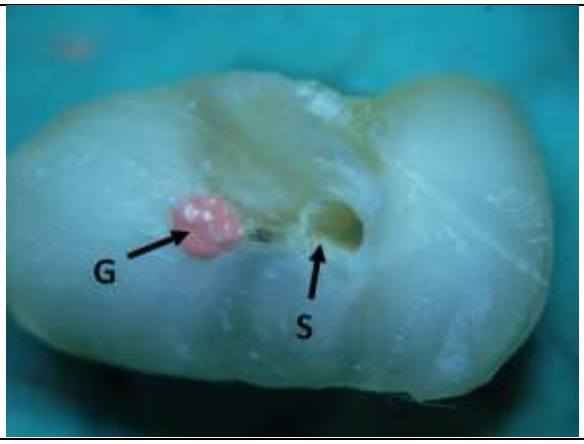

Fig.14 Omission of obstruction of one of the two root canals to a maxillary premolar; the stereomicroscopic investigation on the vestibular canal only found the presence of sealer (S) residues on the walls of this channel (20x)

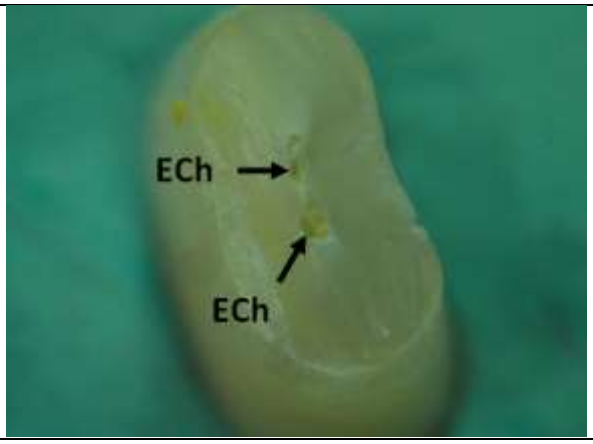

Fig.15 In the case of this premolar, although at the level of the section effect at the boundary between the crown and the median third the canal obstruction with sealer and cones was found, at the level of the section between the apical root and the middle one, obturation is no longer present and the level of mechanical preparation of the channels is appreciably weak or non-existent. In the central area of the root there are two hollow canal shaped sections (empty channel - ECh) (20x)

e. Lack of the homogeneity of the sealer

The presence of two materials where one of the sealing which - resumed endodontic treatment [Figure 16].

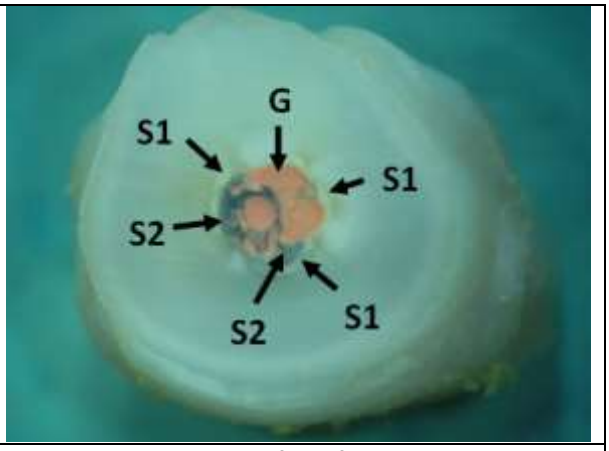

Fig.16 In the root canal of this front tooth there is a residual sealer (S1) that sticks to its canal walls and a second sealer (S2) which is located centrally and which is found among the guttapercha cones used in the cold lateral condensation and even surrounds some of these cones (16x)

4. Conclusions

1. The imperfections of the final obturation ar conected with the quality of the canal-filling technique , voids are frecvently found in the last milimeters of the root canal and the isthmus area.
2 . With the limits of this study the lack of homogeneity of the material filling referring - we the sealer were identified when replays endodontic treatment when the first sealer probably was not completely removed from the walls of the root canal in order to identify its presence in proximity sealant used resumption of treatment.
3. Cracks were found in the case of the warm and cold lateral side condensation technique, putting on account of excessive pressure application and the side of the spreader (the condensation in the cold side) of the pressure is excessive and the plugger to the apical (the vertical condensation) and sometimes the choices of inadecqute choosing of the spreader/ plugger segment relative to that root.
4. If under extesion of obturation material were encountered situations in which - made probably unwise canal preparation and sealer is currently one only certain segments of the apical third of the root canal.
5. The presence of inter-canal isthmuses may be a factor favoring the retention of dentin fragments produced during the mechanical treatment of the canals.
6. Most errors were encountered with the monocone technique. Practically half of the post-treatment stereomicroscopically investigated teeth were found to be mistakes, among which the most frequent were the voids found in the sealer (24% of the cases). The second place in

the number of errors is the cold lateral side condensation technique, with 46% errors in the total number of investigated tooth cases. For this technique, the maximum number of errors is related to the formation of voids in the sealer, which is found in 18% of the investigated cases.

7. A notable error, which, as can be seen from the tables, appears specifically in this technique of cold lateral side concealment and the warm vertical condensation technique is the root cracks. According to our study, they occurred more frequently in the case of warm vertical condensation than in cold lateral side condensation (14% of cases in comparison to 10% of cases).

5. Acknowledgements

In this article, all the authors have equal contributions to the first author.

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