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Determining the Optimal Length of The Tooth's Root Canal Obturation.

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ABSTRACT

The aim of this paper is to determine, which of the techniques and used materials reaches the ideal level of obturation of the tooth's root canal, by using micro CT. 80 human extracted frontal teeth were decrowned 1mm under the cement-dentin junction and were divided in four groups. Group 1,1 (n=20) were obturated with GuttaFlow®2 system (Coltene/Whaledent GMBh+Co.KG, Langenau, Germany), group 1,2 (n=20) with Thermafill system (Densplay DeTrey GmbH, Konstanz, Germany), group 2,1 (n=20) with AH-Plus® JET™ (Densplay DeTrey GmbH, Kostanz, Germany) and a single cone technique and group 2,2 with AH-Plus® JET™ (Densplay DeTrey GmbH, Kostanz, Germany) and a technique of lateral condensation. The samples are measured in a commercially available clinic for the cone beam micro CT (35, SCANCO Medical AG, Brüttisellen, Switzerland). Results: Although the Single cone technique has the best final values of filling, the tested difference between the four groups in relation to the average value of filling, for p>0,05 did not show a statistically significant difference (Kruskal-Wallis ANOVA test: H=4,0383 p=0,2574). The data in this paper show that with all four techniques of obturation an ideal length of obturation may be achieved. The material and the techniques of obturation have no influence on the length of the obturation.

Keywords: root canal, obturation length, micro-CT, Gutta-Flow, Thermafill

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INTRODUCTION

The success of endodontic therapy depends on the complete chemical and mechanical treatment of the canal system of the root of the tooth, followed by obturation of the root canal. The main aim of the endodontic therapy is the tridimensional obturation of the endodontic space. The efforts for an ideally treated and sterilized root canal are in question if the same is not completely obturated. The obturation of the root canal is performed to the site where recovery process of the pulp and periodontal tissue is expected. The determining of the optimal length of the biomechanical preparation and obturation of the root canal are the best antimicrobial strategies for the removal of the biofilm (1).

One question still remaining controversial in endodoncy is the length of the canal obturation. The apical constriction is often described as a referential point to where the canal obturation should be. (2) The topography of the apical part of the root canal is not standard and often shows variations. (3).

Ponce & Fernandez histologically evaluated the setting of the cement-dentin border and the diameter of the apical foramen. Their results showed that the cement-dentin border is the point where two histologically different tissues merge in the interior of the root canal and this point is submissive to changes depending on the different canal variations. (4) The length of the canal obturation may influence the success of the endodontic treatment, the prognosis is bad if the root canal is obturated under or over a certain border.

The importance of determining the level of preparation and obturation of the root canal inspired the usage of different methods for accuracy during work on this endodontic treatment (5,6)

Ricucci stated that for a more successful treatment, the preparation of the root canal should be completed 0,5mm under the radiological apex, i.e. on the apical constriction where the cement-dentin border is set. (7)

The per-apical RTG is most commonly used for setting diagnosis, planning and treatment, but its benefits and limitations are well known. The RTG is a two dimensional picture of a 3 dimensional structure (8,9), Other models have been used in dentistry as digital radiography, densitometry, CT, MRI and etc. (8,11,9,) In the early 1990 the researchers Tachibana et al. and Nielasen et al. (1995) used micro CT system to research the area of endodoncy.

The use of micro CT in endodoncy includes analyses of the inner anatomy of teeth (5,10), instrumentation of the root canal (8), obturation (12), retreatment of the obturation (12), physical and biological features of the obturation materials etc.

The aim of this paper is to determine, by using micro CT, which of the techniques and used materials reaches the ideal level of obturation of the tooth's root canal.

MATERIAL AND WORKING METHOD

This paper includes 80 frontal human extracted teeth. The teeth included are teeth which have curves of the root canal smaller than 10 (degrees) selected according the technique of Schnider. The experiment does not include teeth with under developed roots, obturated root canals and caries on the root of the tooth.

After the extraction, the teeth were washed in saline to remove the blood and were kept artificial saliva.
The teeth were decrowned 1mm under the cement-dentin border and were divided in two groups i.e. four subgroups.

Group 1(n=40) root canals root canals of teeth treated with a standard technique of treatment.

After determining the exact length of the root canals the teeth from this group were treated according the technique described by Ingle 1961. A basic apical file was set in the root canal (K-file, Densplay, Maillefer, Swiss). The file is set at a certain length of the canal. This procedure was performed in all canal walls. The canals were irrigated with 2ml of NaOCL 5% (Produites Dentares SA, Vevey, Switzerland) and dried with

paper points. (PRESIDENT DENTAL, Duisburg,Germany). This procedure is performed until the root canal gets a certain form and has no smell and remains from the pulp tissue.

Group1.1(n=20): root canals of teeth treated with a standard technique of treatment of root canals and obturated with GuttaFlow ®2.

After the treatment and the irrigation of the teeth's root canals the same were dried and prepared for obturation. For obturation a GuttaFlow ®2 was used. (Coltene/Whaledent GMBh+Co.KG,Langenau, Germany), according the instructions of the manufacturer.

Group1.2(n=20): teeth root canals treated according to standard technique of root canals treatment and obturated with Termafill system.

After preparing the root canals for obturation, in the canal a verificator was set. According the number on the verificator the size/number of the transporter is determined to use for the canal obturation. The chosen transporter (Denplay Maillefer, Ballague, Swiss) is disinfected with NaOCL 5% for one minute and rinsed with 70% alcohol. The root canal is laid with AH-Plus ®JET™ paste (Densplay De Trey GmbH, Kostanz, Germany) by the help of a lentulus. The transporter is set in the heating system TermaprepPlus® (Densplay).

Group 2 (n=40): teeth root canal treated according an ultrasonic technique for root canal treatment.

The root canals from this group were treated by using an ultrasonic crown-down technique according to Grecca et al (2007). The treatment was started by a hand widener size 40K-file adjusted to an ultrasound appliance (Zhengzhou Smile Dental Equipment Co.Ltd.China), in the period of 1 minute. From this point on, smaller widener are used till a certain working length is achieved. Circle, slow and short movements are applied during the work with the appliance. During the use of each instrument the root canals were rinsed with 5% of NaOCl and dried with paper schtifts.

Group2.1(n=20): teeth root canals treated with ultrasound technique for root canal treatment and obturated with AH-Plus® JET™ and single cone technique. The root canal was obturated with the paste AH-Plus® JET™(Densplay De Tray GmbH, Kostanz, Germany) with the help of the lentulus spiral and in the rott canal only one gutta-percha was set (Coltene/ Whaledent GmbH+Co.KG Langenau, Germany) with a certain size and length of the root canal.

Group2.2(n=20): teeth root canals treated with an ultrasonic technique for root canals treatment and obturated with the technique for lateral condensation. The root canals from this group were treated by using an ultrasound crown-down technique. The walls of the root canals were laid with AH-Plus® JET™ paste. (Densplay De Tray GmbH, Kostanz, Germany) with the help of the lentulus spiral. The gutta-percha spikes are set according the technique of lateral condensation.

The entrance of the root canal after the canal filling in all teeth was obturated with a glass ion cement (Ketac™Molar Easymix, 3M Deutchland Gmbh, Germany).

Micro-CT evaluation

The samples were measured in a commercial clinic for cone beam micro-CT (µCT 35, SCANCO Medical AG, Brüttisellen, Switzerland). The samples are wrapped with a piece of sponge with dimensions 2x3cm and set in special tubes with artificial saliva. The chosen size is 20µm in all three space dimensions. The Rtg voltage is 70kVp intensity 114 µA. For each sample 700 layers were made. To evaluate the apical part the number of layers was counted from the apex of the tooth till the layer where the canal obturation appears. The same are multiplied with 0,02mm which was the width of one layer and the exact space was calculated from the end of the obturation to the apex.

RESULTS

The descriptive analyses of the final values of each of the four techniques after filling is given in Table 1. Each technique analyzed 20 samples. The average of the final value of filling of the Gutta-Flow technique is

0,56±0,99mm with a minimal value of -0,26mm and a maximal value of 2,84mm. In this group 50% of the samples have a final value of filling of 0,17mm. The analyses of the final values of filling got by using the technique Therma fill pointed out an average value of 0,58±1,2mm and a minimal i.e. maximal value of -0,46mm v.s. 3,32mm. Fifty percent of the samples in this group have a final value of filling over 0,07mm. The average of the final value of filling of the Single cone technique is -0,05±0,37mm with a minimal value from -0,38mm and a maximal value from 0,58mm.

Table 1: Descriptive analyses of the final values according the filling techniques

Technique	Number	(Means)	(Std.Dev.)	(Median)	(Min)	(Max)
Gutta-Flow	20	0,56	0,99	0,17	-0,26	2,84
Thermafill	20	0,58	1,20	0,07	-0,46	3,32
Single cone	20	-0,05	0,37	-0,19	-0,38	0,58
Lateral cond	20	0,03	0,45	-0,07	-0,44	1,08

Kruskal-Wallis ANOVA test: H=4,0383 p=0,2574 *significant for p<0,

In this group 50% of the samples have a final value of filling over -0,19mm. By applying the technique of Lateral condensation, the average of the final values of filling is 0,03±0,45mm with a minimal value from -0,44mm and a maximal value of 1,08mm. Although the Single cone technique has the best final value of filling, the tested difference between the four groups in relation to the average value of filling, for p>0,05 did not show a statistically significant difference (Kruskal-Wallis ANOVA test: H=4,0383 p=0,2574). The results are presented in tab.1.

DISCUSSION

The canal obturation represents a stage in the endodontic treatment which is finished with a good coronary restoration. The increasing failures of the endodontic treatment is connected with an unsuitable canal preparation and obturation (9,13). The best strategy for reduction of microorganisms is a suitable preparation, intra-canal medication and a 3d obturation (14).

The choice of a proper length of the canal preparation and obturation is controversial and complicated as a result of a limited periapical radiography. The exact length of the canal preparation is hard to be determined with a two dimensional radiography which can have an impact on the further course of the condition of the periapical region. In the last years the number of laboratory studies in the area of endodontic research is increasing.

The reason for this is the fact that they are easier and more objective for evaluation especially in determining the capability for obturation, the length of the canal obturation, the adaptation of the gutta-percha, the spaces and voids in the canal obturation compared to the root canals in the mouth. From the other side the clinical studies ask for more time and energy, longer following period and marking of success is more complicated (15).

The micro-CT is a system for in-vivo studies which can supply a high resolution picture in one quality and quantity analyses of the tooth and obturation (17).

This technology is used to analyses the dental anatomy, endodontic instruments and methods of irrigation. It enables an analyses of the volume changes pre and post operation changes of the volume of the canal (17).

In our paper micro-CT is used to determine the exact length of the canal obturation. The obturation is done with different techniques of obturation.

In this study the level of apical obturation 0,3-0,6mm under the apical foramen. Our results comply with the results from previous studies.(18).

The data from many studies show that when using Gutta-Flow system there is an expansion of the material used, while at Thermafill system a tendency to contract. This data was not confirmed in our study. According to the results the canal obturation in all groups is to the ideal level of obturation.

According to the large number of papers realized in vitro the usage of a warm gutta-percha gives bigger possibilities for extrusion of the material for obturation over foramen apicale. Other authors determine a smaller rate of overextension in the root canals obturated with the technique of cold lateral condensation (1,5.20).

Frajlich (21) and Abarca (22) in their papers stated that there has not been a registered statistically significant difference in the apical extrusion of the material between the treatm,ent with warm and cold gutta-percha.

The results in this paper comply with the results of Frajlich and Abarca. In our paper the statistical analyses showed that the material for obturation has no impact on the length of the canal obturation. No significant difference has been detected between the researched groups. The analyzed values are under the level of apical foramen. This data do not comply with Gutmann cop, which in there paper state that the material for obturation has a tendency to extrude on the apical foramen in root canals obturated with Thermafill system (13).

On the other side many authors state that the results from the simulation models and the extracted teeth are completely different from the results in vivo.

The authors conclude that there is no doubt that the results from clinical trials are more relevant in the clinical practice. When comparing the studies which were analyzed , many inconsistencies were observed. Not only were the defined lengths different, but also location of the teeth. Different intracanal medicaments were used, the type of obturation material was not the same.

In the analyses of ten clinical studies the results showed an overextension in the root canals obturated with warm gutta-percha compared to the groups treatde with cold gutta-percha. Results which do not comply with our results.

CONCLUSION

The data which came out from this paper showed that all four techniques of obturation may achieve an obturation with an ideal length. The material and techniques of obturation have no influence on the length of obturation. The same remains to be proven in clinical studies.

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