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IN VITRO EVALUATION OF THE PRESENCE OF APICAL DEVIATION WITH EMPLOYMENT OF AUTOMATED HANDPIECES WITH CONTINUOUS AND ALTERNATE MOTION FOR ROOT CANAL PREPARATION

AVALIAÇÃO, IN VITRO*, DA PRESENÇA DE DESVIO APICAL QUANDO DO USO DE PEÇAS AUTOMATIZADAS DE GIRO CONTÍNUO E ALTERNADO NO PREPARO DO CANAL RADICULAR*

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ABSTRACT

The present study conducted an *in vitro* evaluation of the presence of apical deviation on the root canal preparation of the mesiobuccal roots of human maxillary molars employing automated handpieces with continuous motion, the Pow R system (Moyco Union Broach), and alternate motion, the M4 system (Kerr). Analysis of the presence of apical deviation was carried out by means of radiographs obtained on a radiographic desk fabricated for the study. The results demonstrated the lack of statistically significant differences between the two systems as to the evaluation of the presence of apical deviation. There was no correlation between the degree of curvature of the roots and the degree of apical deviation for the continuous motion system. However, there was a statistic difference for the alternate motion system, with a direct correlation of moderate degree.
Uniterms: Root canal preparation; Apical deviation; Rotary instruments.

RESUMO

O presente trabalho avaliou, *in vitro*, a presença de desvio apical no preparo de canais radiculares em raízes mésio-vestibulares de molares superiores humanos utilizando-se de peças automatizadas de giro contínuo, sistema Pow R (Moyco Union Broach) e giro alternado, sistema M4 (Kerr - USA). A análise da presença de desvios apicais foi realizada por meio de radiografias obtidas na plataforma radiográfica confeccionada para o experimento. Os resultados mostraram não haver diferença estatisticamente significante quanto à avaliação da presença de desvio entre os dois sistemas. Não houve correlação entre o grau de curvatura das raízes e o grau de desvio apical, no sistema de giro contínuo. No entanto, o sistema de giro alternado apresentou diferença estatística de correlação direta e grau médio.
Unitermos: Preparo de canal radicular; Desvio apical; Instrumentos rotatórios.

INTRODUCTION

The aim of root canal preparation is to clean and shape the root canal system in order to achieve a hermetic and tridimensional sealing after filling.

The important role played by root canal preparation led to the creation of techniques and instruments that allow accuracy and less chair time, avoiding or reducing the risk of accidents such as irregularities, perforations, obstructions and fracture of instruments. Thus, in addition to the evolution of endodontic technique, the technological industry has been making efforts to develop instruments to

help in the accomplishment of root canal preparation.

Currently, two types of automated devices commercially available for root canal preparation should be highlighted: the alternate motion systems, M4 (Kerr – USA), Endo Gripper (Moyco Union Broach) and Handpiece 2962 Duratec (Kavo); and the continuous motion systems, Quantec Series 2000 system (Analytic Endodontics), Profile .04/.06 system (Dentsply/Maillefer), Pow R system (Moyco Union Broach), Lightspeed system (Lightspeed), Hero 642 system (Micro Mega), Pro Taper system (Dentsply/Maillefer) and K^3 system (Kerr - USA).

The alternate motion system comprises a handpiece with a speed reducer, to which a stainless steel or nickel-titanium (NiTi) file is attached and accomplishes alternate motion movements in both clockwise and counterclockwise directions, with an amplitude of 30 degrees, as on the M4, or 45 degrees, as on the Endo Gripper and on the Duratec system[12].

On the other hand, the continuous motion system works by means of an electric engine that, according to Leonardo and Leonardo[6], has been submitted to modifications and may be classified in three generations: first – high torque, second – torque limiters, and third –torque control. These systems require nickel-titanium (NiTi) files.

Some studies have evaluated the ability and effectiveness of shaping of root canals provided by continuous rotary instrumentation with NiTi files, alternate rotary instrumentation with NiTi files, and comparison between the automated systems and the manual techniques with NiTi files.

Esposito and Cunningham[2] analyzed alterations in the original shape of root canals instrumented with NiTi and stainless steel (K-Flex) files, manually or with an engine. The authors concluded that the stainless steel instruments yielded larger deviations in the original shape of the root canal when compared to the NiTi files. They further observed that the larger the instrument, the higher the amount of deviations.

Sydney[11] compared the occurrence of apical deviation in root canals prepared with NiTi files, applied manually or with the ProFile .04 system on 24 mesiobuccal roots of human maxillary molars. There was a higher incidence of apical deviation with the manual technique, however with no significant statistical difference. Moreover, the ProFile .04 system demonstrated to be effective up to file #35, however some deviations were produced after this file up to file #45.

On the other hand, Lloyd, et al.[7] evaluated the effectiveness of the M4 handpiece and Safety Hedströen files inserted in an incorrect manner in simulated canals. There was a high number of apical zips, irregularities and excessive wear of the inner wall of the curvature of the root canals. Under the conditions of this study, the M4 handpiece and the Hedströen files improperly employed yielded many disturbances, however such defects were considerably influenced by the anatomy of the root canal.

Campos and Pastora[1] made use of conventional K files #15 to 25 with a M4 handpiece and found the occurrence of deviation of the root canal on the coronal and middle portion in distal direction, and on the middle-apical and apical portions in mesial direction.

In 1999, Kosa, et al.[4] evaluated the canal deviation with employment of the Profile series 29 and Quantec 2000 systems with Flex R files on an Endo Gripper handpiece, and Safety Hedströen files on the M4 system. The results demonstrated the occurrence of deviation in all systems. The Quantec 2000 exhibited a higher incidence of deviation than the Profile series 29, with no significant differences when compared to the others.

Griffiths, et al.[3] evaluated the effectiveness of NiTi rotary instruments with the Quantec LX systems in simulated canals and found that the Quantec LX tended to remove excess material at the curvature of the root canals, and the prevalence and severity of the wear increased with the employment of larger instruments.

Kum, et al.[5] conducted a study on the effectiveness of preparation of the ProFile .04, ProFile .04 combined to .06 and orifice openers, and ProFile GT combined to ProFile .04, in simulated canals. This study revealed that the ProFile .04 instrument removed significantly less coronal structure than the other three groups. Moreover, the additional employment of the ProFile .06 and orifice openers or ProFile GT enhanced the root canal shape and did not increase the deformations in the simulated canals.

Concerning the alternate motion systems, Sydney, et al.[13] conducted an *in vitro* analysis of the occurrence of apical deviation on the preparation of mesiobuccal root canals of human maxillary first molars with the alternate motion systems M4 (Kerr), Endo Gripper (Moyco Union Broach) and Kavo handpiece. The results revealed an incidence of apical deviations of 14.28% for the three alternate motion systems and 7.14% for the manual preparation.

Some doubts still remain about the real effectiveness and safety of the automated systems. However, its employment seems likely to become a daily routine in endodontic practice. Thus, the aim of this study was to conduct an *in vitro* evaluation of the presence of apical deviations after root canal preparation of the mesiobuccal roots of 40 human maxillary molars with the continuous motion Pow R system and the alternate motion M4 system, both by means of an electric engine.

MATERIAL AND METHODS

Forty human molars with different degrees of curvature extracted for periodontal reasons at the clinics of Ulbra University were included in the present study. The teeth were stored in 1% sodium hypochlorite solution (University Pharmacy of Ulbra) in covered plastic recipients. The specimens had not been submitted to endodontic treatment and did not present internal resorption or calcifications, as demonstrated on the radiographic examination.

The crowns were ground at 1 to 2mm from the cervical area with a carborundum disc (Dentorium), the palatal and distobuccal roots were sectioned and discarded and the

mesiobuccal roots were employed in the study. The buccal aspect of the mesiobuccal roots was marked for posterior identification.

The curvatures of the roots were determined by means of the method suggested by Schneider.[9] According to the curvature, the roots were divided in four segments from 0º to 10º, 11º to 20º, 21° to 30° and finally more than 31º of curvature. Afterwards, the roots of all segments were randomly divided in two groups, A and B, with 20 specimens each.

The root canals were initially explored with stainless steel hand files #10 (Dentsply/Maillefer) under thorough irrigation with 1% sodium hypochlorite. When the file tip was juxtaposed to the tooth apex, 1mm was subtracted from the value and the result was measured on the endodontic ruler, thus providing the working length.

A wax pellet was placed on the tooth apex of all specimens to avoid penetration of acrylic inside the root canal, and then the specimens were embedded in transparent self-curing acrylic resin (Auto Jet) in plastic molds for ice. After curing of the resin, the cubes were removed from the mold and the number of the specimen and the buccal aspect of the root were recorded. The same plastic molds were employed for fabrication of a radiographic platform as proposed by Sydney, Batista and Melo[10] for achievement of the radiographic recordings, and root canal preparation was then initiated.

The two study groups were divided for root canal preparation as follows:

Group A – Root canal preparation – Pow R system

Before preparation, a stainless steel hand file #15 was introduced up to the working length and the resin block was attached to the radiographic platform for achievement of the first radiograph, with Kodak Ultraspeed film and 0.5-sec exposure.

After thorough irrigation, shaping was initiated with a Pow R NiTi file (Moyco Union Broach) taper 0.02mm #40 with an electric engine TC 3000 and NOUVAG AG handpiece with 16:1 of reduction at a speed of 180 rpm. The file was inserted in the root canal while rotating without force until resistance was felt. Then, smaller files were employed in the same manner until the working length was reached and the apical preparation was initiated with files up to #30.

After completion of the apical preparation, the step-back technique was employed with files #35 and 40 alternating with file #30 up to completion of the root canal preparation. Irrigation was performed at every change of file, as well as checking of the canal opening with a stainless steel hand file #15.

Then, the working length file was once again inserted in the root canal and the resin block was placed in the same position on the radiographic platform. Another radiograph with 0.5-sec exposure was achieved on the same film, which had been kept on the platform.

Group B – Root canal preparation – M4

Root canal preparation was accomplished with a M4 handpiece with 4:1 reducer, with NiTi hand files Onyx R (Moyco Union Broach) with an electric engine TC 3000 at a speed of 2500 rpm.

The methods employed for root canal preparation and achievement of the radiographs were the same as described for Group A and were always performed by the same operator. The files were used at most four times in both groups.

All radiographs were developed in an automatic processor. The presence or absence of deviation was observed in a dark room through projection of the radiographs with a slide projector (Kodak) on a smooth and white screen at a 2 m distance.

The presence of perfect superimposition of both instruments on the projected image was regarded as no deviation, and the lack of superimposition of the instruments was regarded as presence of deviation. This deviation constituted an angle that was measured with a protractor (Faber Castel). The results are presented in Tables 1 and 2.

Data were submitted to statistical analysis by means of the Mann Whitney test and Pearson's Coefficient of Correlation.

RESULTS

The results achieved are presented in Table 1.

The results were submitted to statistical analysis, which revealed the lack of significant difference between the groups as to the apical deviation, according to the non-parametric Mann-Whitney test (p=0.883).

The Pearson's coefficient of correlation demonstrated a significant direct correlation of moderate degree between the curvature and the deviation for the alternate motion system (M4) (p=0.005; r=0.597). However, the correlation between the degree of deviation and the curvature of the root was not significant for the continuous motion system (p=0.562).

DISCUSSION

The introduction of nickel-titanium files was based awes on the initial studies of the Naval Ordinance Laboratory Silver Springer, USA. However, nickel-titanium endodontic instruments were just introduced in 1988 by Walia, Brantley and Gerstein[14]. The instruments fabricated with this alloy present two remarkable properties, elasticity and the shape memory effect. These properties provide them a better means to deal with the curvatures of the root canal, improving the shaping ability without yielding deformations.

Even though the nickel-titanium files are characterized by superelasticity, they present are less resistance to fracture than stainless steel files[6]. Therefore, the employment of automated handpieces with nickel-titanium files requires preparation of the root canal by means of the Crown down

technique suggested by Marshall and Pappin[8] and used in this study, in order to allow free action of the instrument at the most apical area of the root canal with a reduced possibility of fracture. For that purpose, as mentioned by Sydney, et al.[13], the instrument must be allowed to work freely at the apical portion, which is a very critical area.

One of the great advantages of the rotary systems is the faster preparation of the root canal, especially concerning root canals with atresia and curvatures. Therefore, the selection of the mesiobuccal roots of maxillary molars in the present study was due to the presence of curvatures and atresia, i.e. in an attempt to reproduce difficult situations for root canal preparation. Determination of the degree of curvature of the roots was accomplished by means of the method of Schneider[9],which is widely employed for this type of study[11,13].

The continuous motion rotary systems require the employment of an electric engine. On the other hand, the alternate motion systems may be attached to the conventional low-speed dental handpiece. In the present study, the electric engine was used for both systems, with a view to keep a constant speed, which may be adjusted on the electric engine but not on the conventional handpiece, because of the inconstant flow of the compressed air, as reported by Leonardo and Leonardo[6]. Moreover, they provide more comfort to both dentist and patient due to the significant reduction in noise.

The lack of literature on the occurrence of apical deviation comparing the alternate and continuous motion systems led us to analyze the frequency of apical deviation yielded by the automated systems employing nickel-titanium files. For that purpose, a very effective radiographic platform proposed by Sydney, Batista and Melo[10] was employed, since it is easy to fabricate and is reliable for positioning of the instrument before and after the root canal preparation on a same radiographic film.

Regarding our results, in Group A, which employed a continuous motion system, the degree of deviations observed were 1, 6, 5, 4, 1 and 4, respectively, for roots with original curvatures of 10, 10, 18, 25, 30 and 33 degrees. For Group B, which made use of an alternate motion system (M4), the degrees observed were 1, 1, 1, 4, 2 and 5 degrees, respectively, for original curvatures of 10, 19, 23, 35, 37 and 40 degrees.

Thus, the lack of correlation between the degree of curvature of the root and the degree of apical deviation was statistically demonstrated for the continuous motion system. However, on the M4 system a statistical difference of direct relationship was found, yet of a moderate degree. That is to say, roots with larger curvatures exhibited the larger degrees of deviation, even though not all specimens presented this proportionality.

The correlation between the degree of curvature and the apical deviation is an important aspect to think about. The results achieved with the alternate system (M4) seem to have influenced the original shape of the root canal. This finding is in agreement with Lloyd, et al.[7] However, the moderate degree of proportionality on the correlation between the curvature of the root and the apical deviation on the alternate motion system (M4) and the lack of such correlation on the continuous motion systems lead us to assume that these factors might be assigned to the type of motion or even to the variables related to the operator.

Currently, the endodontists and dental practitioners who carry out endodontic procedures have access to several options of automated systems for root canal preparation. Many difficulties existing in the endodontic practice were reduced, making it faster and reducing the operator's fatigue. Despite of that, the technical skill of the professional is still highly important for an effective endodontic treatment.

Thus, more studies are required in order to clarify all questions about root canal preparation.

TABLE 1- Group A, degree of curvature of the roots, presence and degree of apical deviation for the automated system with continuous motion (Pow R); Group B, degree of curvature of the roots, presence and degree of apical deviation for the automated system with alternate motion (M4)

SAMPLE	DEGREE OF CURVATURE		DEVIATION		DEGREE OF DEVIATION	
	A	*B*	*A*	*B*	A	B
01	10º	10º	YES	NO	1º	0º
02	10º	10º	YES	YES	6º	1º
03	13º	11º	NO	NO	0º	0º
04	15º	15º	NO	NO	0º	0º
05	16º	15º	NO	NO	0º	0º
06	18º	15º	YES	NO	5º	0º
07	19º	16º	NO	NO	0º	0º
08	19º	19º	NO	YES	0º	1º
09	20º	20º	NO	NO	0º	0º
10	20º	20º	NO	NO	0º	0º
11	22º	23º	NO	YES	0º	1º
12	23º	27º	NO	NO	0º	0º
13	23º	27º	NO	NO	0º	0º
14	25º	28º	YES	NO	4º	0º
15	26º	28º	NO	NO	0º	0º
16	28º	28º	NO	NO	0º	0º
17	30º	28º	YES	NO	1º	0º
18	33º	35º	YES	YES	4º	4º
19	33º	37º	NO	YES	0º	2º
20	35º	40º	NO	YES	0º	5º

CONCLUSIONS

The present results allowed the following conclusions:

· The systems with alternate and continuous motion employed did not present statistically significant differences to each other as to the presence of apical deviation.

· For the continuous motion system (Pow R), there was no significant correlation between the degree of curvature of the roots and the degree of apical deviation.

· For the alternate motion system (M4), there was a significant direct correlation of moderate degree between the curvature of the roots and the degree of apical deviation.

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