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COMPARATIVE EVALUATION OF THE PREPARATION TIME OF A NEW NON INTERRUPTED FLAT SIDED DESIGN VERSUS PROTAPER HAND INSTRUMENTS AND CONVENTIONAL INSTRUMENTS: AN IN VITRO STUDY

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ABSTRACT

Modern endodontics is characterized by a quest for more efficient methods of canal instrumentation. A new addition to the endodontic instruments is the EZ-fill safesiders. These instruments have shown promising results decreasing the preparation time when compared to the stainless steel files. The aim of this study was to check the time required for preparation of root canal using the various manual instruments.

Objective: To determine and compare the time needed for instrumentation of the root canal system when different instruments are used.

Methodology: Thirty extracted upper anterior teeth were selected for the study. Standard access cavities were prepared and they were randomly divided into three groups (n= 10). The groups were according to the instruments used for root canal preparation

Group 1 – Stainless steel K-reamers

Group 2 - ProTaper manual instruments

Group 3 – EZ-fill safesiders reamers

The same operator according to the manufacturer's instructions instrumented all the root canals. The time for instrumentation was recorded using a stop watch in seconds. Sodium hypochlorite was used as irrigation

Results: The results with regards to the preparation time showed that the group 1 instrumented with the K-reamers required the least time for preparation followed by the EZ-fill safesider reamers and then the ProTaper manual instruments.

KEYWORDS Preparation time,

INTRODUCTION

Modern endodontics is characterized by a quest for more efficient methods of canal instrumentation. From the initial manual instrumentation to the present day rotary and Ni-Ti instrumentation, endodontics has undergone sea change, thus reducing the time required for canal preparation and at the same time alleviating fatigue and reducing distortions[1] .

Presently, endodontic instruments come in two basic configurations: reamers and files. Files are fabricated from wire that is square in cross-section and then twisted. Reamers are made from wire that is triangular in cross-section and then twisted. Consequently reamers have three point contact, where as files have four. The larger the number of contacts, the greater the dentinal engagement and the more resistance the instrument encounters. An in vitro study on resin blocks has demonstrated that the conventional reamers to be more efficient when compared to the conventional files in terms of cutting efficiency[1] .

The ProTaper instrumentation system represents a significant development in root canal preparation procedures. The convex triangular cross section of ProTaper instruments reduces the contact area between the file and the dentin resulting in greater cutting efficiency and lesser instrumentation time. Other rotary systems focus on one taper within a file and tend to combine a series of reamers to achieve the necessary effect. In contrast the ProTaper has varying tapers within one reamer ranging from 3.5% to 19%, which makes it possible to shape specific sections of a root canal with one reamer or instrument[2, 3, 4].

A new addition to the endodontic instruments is the EZ-fill safesiders. (Essential Dental systems, South Hackenseck, NJ). The EZ fill safesider hand instrumentation system incorporates a noninterrupted flat sided design for both reamers and files including NiTi i.e. these instruments are "D" shaped in cross section. This reduces dentinal engagement and, consequently, the resistance of the instrument within the canal, shortening the time for canal preparation. This new hand instrumentation system uses a no. 2 peeso reamer to straighten the coronal one half to one thirds of the root canal space, performing approximately 85% of the shaping procedure. The last 2 instruments in these series are made of NiTi which are used for apical shaping[1]. At present there are no studies comparing the preparation time of these new instruments.

Thus the aim of this study was to compare the time required for instrumentation and the cleaning efficiency of root canal using the EZ safesiders, the ProTaper manual instruments and the conventional reamers.

Objectives of the study: To determine and compare the time needed for instrumentation of the root canal system when different instruments were used.

Materials and Methods

Thirty single rooted, extracted upper anterior teeth were used in this study. Teeth collected were extracted due to periodontal reasons. These teeth had an initial apical foramen size corresponding to no. 15 K reamer. Any teeth with a crack, root fracture, caries or any regressive alterations were excluded from the samples.

Methodology:

Coronal access was made using the Endo access bur and the Endo Zee bur

(DENTSPLY). The teeth were then divided randomly into three groups. (n = 10).

The groups were

Group 1: Instrumented using stainless steel K-reamers No 15-40 (Mani)

Group 2: Instrumented using the ProTaper manual instrumentation system. (DENTSPLY Maileffer U.S.A)

Group 3: Instrumented using EZ-fill safesider reamer (Essential dental systems (. U. S.A)

Working length was determined by means of a No 15 reamer which was observed at the apex and then withdrawn 1mm. All instrumentation was confined to this working length.

Specimens in Group 1 were instrumented with the standard method as described by Ingle[5]. Reamers were inserted into the canal twisted clockwise half a

turn to engage their blades in to the dentin and then withdrawn – penetration, rotation and retraction. The process was then repeated, penetrating deeper and deeper into the canal. When working length was reached, the next size instrument was used and so on. Root canals were enlarged to a master apical file ISO size 30.

Group 2 was instrumented in the following manner.S1 shaping file was used first and moved apically to 2 mm short of the working length. SX files were then used until resistance was encountered (4-5 mm from the working length), followed sequentially by S1 and S2 to the working length for the shaping of the coronal two thirds of the canal. The apical one third was finished using F1, F2 and F3 sequentially to the working length. Method of use was to insert the ProTaper instrument, rotate 3/4 turns clockwise till the instrument locks, de-rotate anticlockwise to disengage the file and rotate clockwise again to cut at that level, withdraw the file clean the flutes and repeat until the desired length is reached[2, 5].

The specimens in group 3 were instrumented using the following sequence[1]:

a) Instrumented to the working length with a stainless steel reamer no. 15

b) Instrumented to the working length with a stainless steel reamer no.20

c) Using a no. 2 peeso (Essential dental systems) to prepare the coronal one half to two thirds of the canal space

d) Instrumented 1mm short of the working length with a stainless steel reamer no. 25 (performing a step back procedure)

e) Instrumented 2 mm short of the working length with a stainless steel reamer no.30

f) Instrumented 3 mm short of the working length with a stainless steel reamer no. 35

g) Instrumented 4 mm short of the working length with a stainless steel reamer no. 40

h) Using the no. 2 peeso to deepen the flare further.

i) Instrumented to the working length with a NiTi reamer 30/0.04

j) Instrumented to the working length with a NiTi reamer 25/0.08.

The same operator instrumented all the root canals. Copious irrigation was performed after each instrumentation using 2ml of 1% sodium hypochlorite solution through a 27 gauge needle[5]. The root canals were kept flooded with irrigation solution throughout the entire instrumentation procedure. The instrumentation of each canal was timed with a stopwatch to evaluate the time effectiveness of each instrument. The time required for instrumentation was recorded in seconds.

Statistical analysis:

For analysis of preparation time

Descriptive (Mean ± SD) and comparative statistics were used to illustrate and compare the results. One Way ANOVA was performed for multiple group comparisons followed by Newman-Keuls multiple comparison test procedure to determine whether significant differences were present.

The difference was considered statistically significant when P-value was 0.05 or less.

Results:

Table 1 show the mean preparation time and the standard deviation of root canal preparation which was recorded in seconds. Group 1 instrumented with the k-reamers required the least time for preparation i.e. 129.6 sec followed by group 3 which required 145.7 seconds while group 2 required 152.2 seconds.

Comparison of the three groups was done using the one-way analysis of variance (ANOVA) (Table 2). On finding a statistically significant value between the groups the data was further subjected to Newman Kuels multiple comparison test.

The results showed a statistically significant finding between groups 1 and 2 and groups 1 and 3 ($p<0.05$). However there was no statistically significant difference between the group 2 and group3. (Table 3) Thus from the above findings it can be concluded that the Group 1 instrumented by the K-reamers required the least time for preparation followed by the Group 3 and Group 2 which required the maximum time. Graph 1 shows the graphical representation of the preparation time and standard deviations of the three groups.

Discussion

"One thing you cannot recycle is wasted time"

This proverbial saying is the most apt for modern endodontics. Not only is the time factor important for the dentists but also for the patients as well. In order to make the biomechanical preparation of the root canals faster, many innovations have been done in the field of endodontics. From stainless steel hand instruments to the present day NiTi rotary instruments and from multi visit to single visit, endodontics has grown by leaps and bounds. This leap can be attributed to the development of newer instruments, materials and procedures which all aim to reduce the time factor for treatment.

In the present study, all root canals were uniformly prepared to size 30; this was because the instrument diameters at apex limited by the greatest file of the ProTaper system[6]. Results showed that the K-reamers used in the reaming motion required the

least time for preparation, the mean time required being 129.6 seconds followed by the EZ-fill safesider instrumentation system requiring 145.7 seconds and the ProTaper group required 152.2 seconds which was the highest. K-reamers were used in the present study instead of files because it has been reported in previous studies [1, 7, 8, 9] that K-reamers have achieved faster instrumentation when compared with K-files. This result can be attributed to the fact that lesser number of instruments was required to prepare the canal to three sizes larger than the initial apical file and the final taper achieved was 2%. This result is in agreement with earlier studies which showed similar results 4, 5, 15 . The EZ-fill safesider reamers showed the second best

results requiring 145.7 seconds. This system is a combination of the conventional stainless steel and nickel-titanium instruments. Instruments are "D" shaped in cross-section. This was done to reduce the contact area of the instruments so that cutting efficiency is increased. In a previous study it was found that they required less time for instrumentation in acrylic resin blocks when compared with the EZ-fill files, conventional files and reamers [1]

But similar results were not obtained in this study which was carried out in extracted teeth. The most probable reason for this is that the number of instruments is more in the EZ-fill safesider reamer system when compared to group I and the final taper achieved is 8%. The number of instruments used is 10 i.e. reamers 15 – 40, No 2 peeso reamer which was used twice and two nickel-titanium instruments that were used to achieve the apical preparation.

The Pro Taper instrumentation system ranked a poor third. These instruments are made of nickel-titanium alloy and are progressively tapered from 3.5% to 19%. These instruments are used in a crown down sequence for preparation of the root canal system. The shaping files in this series i.e. SX and S1 are used for enlarging the coronal thirds, while S2 shapes the middle third of the root canal. The finishing files in this series have tip diameters corresponding to ISO size 20 for F1, 25 for F2 and 30 for F3 and tapers of 7%, 8% and 9% respectively. So the final shape of the root canal is that having a master apical size of ISO 30 and a taper of 9%. It is this shaping that requires more time since the final taper achieved with K-reamers is 2% while that achieved with the Ez-fill safesider reamers is 8%. The initial coronal enlargement is done with SX which has cutting blades of 14mm and a tip diameter of 0.19mm. SX has the highest increase of taper. At D6, D7, D8 and D9, the cross-sectional diameter

increases from 0.50mm, 0.70mm, 0.90mm and 1.10mm, according to a taper of 11%, 14%, 17% and 19% respectively. The total increase of taper in SX from D0 to D9 is defined with nine different tapers from 3.5% to 19%. Thus achieving such a larger percentage of taper will require removal of more amount of dentin and consequently more time for instrumentation. The number of instruments in group 3 was more, but still it was able to achieve faster instrumentatation when compared with group 2. This can be said to be because of the coronal pre-enlargement which was carried out by means of a No 2 peeso reamer in a contra-angle micromotor handpiece. The use of the peeso reamer does almost 85% of the shaping procedure in the coronal and the middle thirds leaving only the apical third to be instrumented with the hand instruments.

Another aspect which could have a bearing on the cutting efficiency of the instruments is the alloy from which it is made[10]. K-reamers are manufactured form stainless steel; ProTaper instruments are made from nickel-titanium, whereas the EZ-fill safesider reamers are a combination of stainless steel and NiTi i.e. instrument nos 10 – 40 are made of stainless steel and the last two instruments are made of NiTi which are of ISO size 30 and 25 with a taper of 4% and 8% respectively. These are used for instrumentation of the apical areas. The Vickers hardness values of stainless steel & NiTi are 530 and 300 to 350 respectively. The VHN of crown dentin is 70 and 30-35 for the root dentin. NiTi alloys have properties of super-elasticity and shape memory where as the stainless steel has greater hardness and higher cutting efficiency. The surface of NiTi instruments is not homogenous and the cutting edges are softer than the core of the instruments. This finding means a lower cutting efficiency and a higher wear than for stainless steel files .

The cutting efficiency of stainless steel reamers and files has been found to be higher when compared to the NiTi K-files in a previous study[11, 12]. NiTi K-files were found to have least cutting efficiency when compared with the stainless steel reamers and files and flexible stainless steel instruments . Though the stainless steel has higher cutting efficiency[13], but is has a lower flexibility. The EZ-fill safesider system can be described as a hybrid system has been developed to take advantages of both the stainless steel alloys as well as the NiTi alloys. The instrumentation in the coronal and middle parts is achieved by means of stainless steel flat sided reamers and No 2 peeso reamer where as the apical part is shaped by means of NiTi reamers.

Conclusion

In the present study evaluation of new non-interrupted flat sided designed endodontic instruments was carried out and compared with ProTaper hand instruments and conventional K-reamers to check for their efficiency in terms of time required for root canal instrumentation measured in seconds The study concludes that the fastest instrumentation was achieved by the conventional K-reamers followed by the EZ-fill safesider reamers and then the ProTaper hand instrumentation. But speed is not the only thing. The quality of the preparation is also important. Further in-vitro and in-vivo studies are required to confirm the results obtained in the present study. Though speed is important but it cannot be the only criteria for judgment, other parameters like maintenance of canal curvature, canal centering ability etc need to be investigated.

GRAPH 1: COMPARISON OF THE MEAN AND SD VALUES OF PREPARATION TIME BY GROUPS

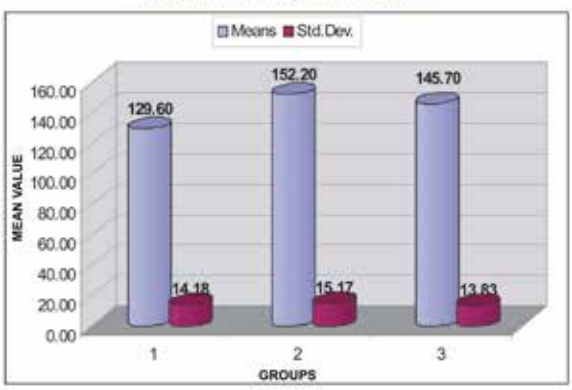

Table 1: Mean and SD values of preparation time in seconds by groups

Groups	Means	Std. Dev
1	129.6000	14.1751
2	152.2000	15.1716
3	145.7000	13.8327

Table 2: Comparison of three groups with respect to mean preparation time by one way analysis of variance (ANOVA)

SV	DF	SS	MSS	F-value	P-value	Signi
Between Groups	2	2707.4000	1353.7000	6.5243	0.0049	S
Within Groups	27	5602.1000	207.4852			
Total	29	8309.5000				

Table 3: Pair wise comparison of groups by Newman Kuels multiple comparison test procedure

Group	I	II	III
Means	129.600	152.2000	145.7000
I	-		
II	0.0045*		
III	0.0190*	0.3220	

*indicates significant at 5% level of significance (p<0.05)

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