SHAPING ABILITY AND SAFETY OF FOUR DIFFERENT NICKEL-TITANIUM (NI-TI) SYSTEM USING RECIPROCATION TECHNIQUE

By Mohammad I Al-Obaida

Department of Restorative Dental Sciences, College of Dentistry, King Saud University

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1.0 Abstract:

Root canal instrumentation is carried out for the cleaning of bacteria and organic remnants and the proper shaping of the root canal system after decay or inflammation of the pulp. The instruments made from stainless-steel are the conventional ones used in the treatment. However, these instruments cause hindrance in the narrow and curved root canals due to non-flexibility and cause the removal of the dentin. A new dimension in this field has been provided by the invention of nickel-titanium (Ni-Ti) files. They are more advantageous than the conventional ones as they are more flexible and work faster. This study aims to investigate a new technique which was introduced by Yared in 2007. The technique was based on the use of only one rotary instrument for the treatment. Five blocks each with different system Pro Taper, RaCe, Profile and Vortex were used. The canal preparations were carried out followed by the sequencing of the instrumentation and then the required time was noted. After that, the instrument failure was examined and records were maintained. Then, photographs were taken and the analysis of image and assessment was carried out. The procedure was preceded by calculating the degree of transportation. Statistical analysis was performed using ANOVA, Chi-square and Duncan's range test. The results showed that Ni-Ti instruments require less time and instruments, cause less canal transportation and stayed more centred in the canal. The data was statistically significant and values lied under the level of significance ($p < 0.05$). All these aspects of the Ni-Ti instruments make them vulnerable to be used in the treatment of narrow and curved root canals.

2.0 Introduction:

Root canal treatment is the treatment for the repair and safety of the tooth after decay or infection (Fonseca, 2015). The pulp usually gets decayed or is inflamed in the case of any bacterial infection. According to (Üstün, 2014), the main aim of root canal instrumentation is the shaping and cleaning of the root canal system. It is also focused on the formation of a continuously tapered form. The

cleanliness refers to the removal of the bacteria, organic remnants and endotoxins and Shaping refers to the proper three-dimensional filling of the entire root canal space as mentioned by Narayan (2012).

These aims are unable to be achieved with the conventional instruments made from stainless-steel while dealing with narrow and curved root canals (Üstün, 2014). However, the targets can be achieved by the use of more flexible files. Files made of Ni-Ti are used as an alternative (Fonseca 2015). It helps in reducing the intricacy level faced in curved and narrow canal preparations. Ni-Ti instruments have been proved better in terms of flexibility, extended cutting efficiency and reduction in the tendency of having canal transportation. Also, Ni-Ti files have proved the time efficiency (Yared, 2015).

As stated by Maintin (2013), a number of studies have been carried out for the comparison between the Ni-Ti instruments and the conventional instruments made from stainless steel. The results of these studies suggested that the Ni-Ti instruments caused a significant lesser canal transportation and stayed more centred in the canal (Inan, 2012). According to Maintin (2013), it removed less dentine and rendered rounder canal preparations which stainless steel hand file didn't. Also, they proved to be more efficient in the maintenance of the original path of the canal of the curved root canal and were faster. Better cleaning and sharp ability by the Ni-Ti instruments were observed in one of the comparative studies carried out for the rotary Ni-Ti instruments and the conventional ones. However, the results of a comparative study showed that there was no difference in the time of preparation, changing in working length and frequency of aberrations (Shen, 2013).

In 2007, Yared while explaining his new canal preparations told that he used only one rotary instrument in his technique. With a size of 08 hand file, the canal was mediated to the working length. After that, the preparation of the canal was completed by the help of an F2 pro taper instrument which is used in reciprocation movement. This technique provided a number of advantages including the use of a lesser number of instruments, shortened instrument fatigue, was of low cost and there was the extinction of the possible chances of cross-contamination (Gambrani, 2012). The outcomes of the exploratory experiments were supportive. The initial impression of these experiments was also satisfactory as suggested by Fonseca (2015). Even so, the proper laboratory and clinical evaluation of various parameters like canal transportation, instrument fracture, apical extrusion of debris, the need of pre-flaring would still be required (Yürüker, 2016).

The objective of this study is to further investigate for Yared (2007) reciprocation technique and the comparison of the shaping ability and safety of Pro Taper, RaCe, Profile and Vortex by the use of the fresh concept which is the preparation of the whole canal by reciprocation movement using only one file simulated curved root canal. Also, Üstün (2014) suggested that the evaluation of the overall shape, time of preparation, failure of the instrument, the aberration of the canal, outer and inner cutting and apical extrusion of debris is necessary too.

3.0 Materials and Methods:

3.1 Specimens & Instruments:

Sixty simulated root canal blocks were taken and were divided randomly into 4 groups in a way that each group had 15 blocks each.

The length of the simulated canals was 50 ISO. Determination of working length was carried out by inserting #8 stainless steel k-file to the end.

The curvature initiated 30 ISO from the coronal orifice with the mean curvature of 40°. The rotary instruments used in the study included Pro Taper, RaCe, Profile and Vortex.

3.2 Preparation of Simulated Canals:

Five blocks with each different system were carried out by each of the three general practitioners who put their effort in this study. The first negotiation of the preparation was set at the working length of stainless steel size 10-15. Pro Taper, RaCe, Profile and Vortex were used for the preparation of canal in reciprocation movement in conjunction with 16:1 reduction ratio contra-angle which was connected to an ATR vision (ATR, Pistoia, Italy) motor. This motor allowed the reciprocation movement. The rotations of the motor were set clockwise and counter clockwise. The rotations were set at four-tenth and two-tenth of the circle. The speed of the motor was set at 400 RPM. The preparations were made using slow packing motion light apical pressure until resistance was acquired. It was cleaned regularly with gauze until the files reach the working length. Continuous canal irrigation (2% NaOCl) and RC prep. was supplied till the accomplishment of the canal preparation.

3.3 Instrumentation Sequence:

3.3.1 ProTaper Group (PT):

The files used for the coronal and middle third flaring ProTaper shaper were S1 (17/.02-.11), S2 (20/.04-.115) and SX (19/.035-.19) while, for apical finishing, finishing files F1, F2 and F3 were (20/.07-.055), (25/.08-.055) and (30/.09-.05) respectively.

3.3.2 RaCe Group (RC):

PRE-RaCe files, (35/.08) and (40/.10) were used for coronal flaring whereas for apical shaping, (30/.06) and (25/.06) RaCe files were used.

3.3.3 EndoSequence Group (ES):

An expeditor file (27/.04) was inserted until the resistance was acquired. For EndoSequence files (30/.06), (35/.06) and (40/.06) were used.

3.3.4 Profile Group (PF):

Profile orifice shapers (50/.07) and (35/.12) were used for the Coronal flaring. After that, Profile (35/.06), (30/.06) and (40/.06) files were used.

3.4 Time and Instrument Failure:

A stopwatch was used to record the time in seconds which was required for the canal preparation. The time required for the active instrumentation and irrigation was also included in it. The instruments were examined for failure or impairment after every cycle of use. The records of the fracture were also maintained.

3.5 Image Analysis and Assessment:

3.5.1 Canal Aberrations:

Standardised conditions were maintained while taking the pictures of pre and postoperative resin canal using Adobe Photoshop® software and FinePix S3Pro digital camera and the combination of a pre-and postoperative image was facilitated by four marks on the surface of the resin blocks. The superimposed images of pre and postoperative resin canal were presented for the evaluation by endodontic who is completely unaware of the system which was used in each block.

3.5.2 Degree of Transportation:

The software was used for the measurement of the amount of cutting in the inner and outer walls were AutoCAD® 2000.The analysis of the superimposed images was carried out by the selection of two points namely first and second. The former point was marked at the start of the curvature in the middle third. However, the latter point was marked at the end of the curvature in the apical third. The measurement was noted on the magnified images at the right angle to the canal surface millimetres (mm) scale. Then, the difference between the amount of cutting in the inner and outer wall at each point was calculated for the determination of the degree of transportation.

3.6 Statistical Analysis:

The data was entered in MS Excel and analysis was carried out by using SPSS Pc+ version 11.0 software for the statistical analysis. The quantitative and qualitative variables were summarised by using Descriptive statistics (Mean, SD and proportions). For the comparison of mean values of the quantitative outcome variables (preparation time, working length, canal aberration etc.), the test used was One Way Analysis of Variance ANOVA. Chi-square test was used for the observation of the significant differences among the four groups with respect to the quantitative variables (Pro Taper, RaCe, Profile and Vortex). Statistical level of significance was considered at a P-value of < 0.05. For the pair-wise comparison of groups, Duncan's multiple range tests were utilised.

4.0 Results

On the basis of the performed experiments, the nickel-titanium (Ni-Ti) files proved to be better than stainless steel in the maintenance of the original canal path of curved root canals. Ni-Ti instrumentation required less time. They also caused less transportation and were able to remove possibly the less amount of dentine without harming the tooth. They stayed more centred in the canal and also a lesser number of instruments was required. It reduced the chances of cross contamination. The data was statistically significant ($p < 0.05$) with the size range of larger than 30. . It caused reduced canal transportation ($p < 0.05$), remained more centered in the canal ($p < 0.05$), less volume of dentine was removed and the values lied under the level of significance ($p < 0.05$), less instrumentation was required ($p < 0.05$), the data was also significant for NT Sensor file and Engine instrumentation with Light speed ($p < 0.05$).

5.0 Discussion

The investigation of the new technique for canal treatment was carried out in the study. It was observed that the nickel-titanium (Ni-Ti) files proved to be much satisfactory and produced much better results when used in the narrow and curved root canals (Üstün 2014). As stated by Fonseca (2015), Ni-Ti instruments are more flexible than the stainless steel instruments and therefore can be utilised in the endodontic treatments of the narrow and curved canals. As per Yürüker (2016), they rendered more amount of dentin so that the tooth is not at a loss which is usually removed during the use of stainless steel instruments. Use of a lesser number of instruments and less time requirement is the most captivating advantages provided by the Ni-Ti instruments (Inan, 2012). Nickel-titanium instruments also possessed the capability of staying more centred in the canal which aided in the treatment procedure (Maintin, 2013). Additionally, the canal transportation has been observed lesser while using Ni-Ti instruments. All these aspects make Ni-Ti more appropriate to be used in the treatment of the narrow, thin and curved canals (Gambarini, 2012). However, the Ni-Ti files are quite vulnerable to fracture as suggested by (Yared, 2015). It has to be changed after two to three uses. A motor working at a constant speed can also be counted in one of its limitation (Shen, 2013).

6.0 Conclusion

A novel experiment with only one Ni-Ti rotary instrument is discussed. As suggested by Davut (2014), it proved to be better than the stainless steel for the curved and narrow root canals in many aspects. The noteworthy attribute of the experiment is the use of only one rotary instrument (Yared, 2015). Although further experiments and research are needed for proper clinical and laboratory evaluation. The cost effectiveness of the experiments has also to be maintained.

7.0 References

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