



Comparison of Rotary Files System During Root Canal Preparation

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Abstract: Background: This study was conducted to compare the rotary files during root canal preparation. **Material and methods:** A total of one hundred mandibular premolars that were newly extracted were categorized into five groups, each containing twenty teeth, for the purpose of biomechanical preparation. Group I included untreated teeth, while Group II employed manual files. Group III utilized ProTaper rotary instruments, Group IV incorporated K3 rotary instruments, and Group V made use of Easy RaCe rotary instruments. Subsequently, the roots were horizontally sectioned at 3, 6, and 9 mm from the apex for microscopic examination. Flaws were identified in the dentin. The analysis of the groups was conducted using a chi-square test. **Results:** A statistically significant difference was observed between the groups ($P = 0.006$). Group I exhibited no defective roots. The rotary groups, including the Hand K-file, ProTaper, K3 SybronEndo, and Easy RaCe, all displayed imperfections in the dentin. Nevertheless, the variations among the different rotary systems evaluated in this study were not statistically significant. Furthermore, the occurrence of dentinal defects did not show a significant difference among the groups. **Conclusion:** When compared to hand instrumentation, there may be a higher risk of dentinal abnormalities when using rotational tools.

Keywords: Endodontics, Rotary, Manual, Dentin, Dentinal defects.

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INTRODUCTION

The ultimate goal of endodontics is to achieve a flawless three-dimensional seal of the root canal system, which is realized through the meticulous design of the canal's diameter and shape.¹ One of the critical phases in this process is biomechanical preparation, which plays a significant role in eliminating bacteria and debris from the root canal, thereby facilitating successful endodontic treatment.^{2,3} However, during the instrumentation of the root canal, various complications may arise, including perforations, ledge formation, canal transportation, and the development of cracks in the root dentin.^{4,5}

In the pursuit of effective biomechanical preparation, there are instances where we inadvertently compromise the integrity of the root dentin, leading to the emergence of dentinal cracks and subtle fractures, ultimately resulting in treatment failure.⁶

Due to the presence of craze lines or microcracks, root fractures may occur, which can propagate as a result of the repeated application of stress from occlusal forces. Various procedures, including biomechanical preparation, obturation, and retreatment, can lead to varying degrees of dentinal damage.⁷

Consequently, this study was undertaken to evaluate the comparison of different rotary files and the associated dentinal damage observed during root canal treatment as seen through a stereomicroscope.

Material and methods

A total of one hundred mandibular premolars, recently extracted, were selected, cleaned using a periodontal scaler, and subsequently stored in pure filtered water until further analysis. Following the application of a diamond disk to excise the coronal portions of each tooth, the measured remaining root length was found to be sixteen millimeters. To eliminate the potential for cracks on any of the root surfaces, a stereomicroscope with a magnification of 12 was employed.

Group I: Left unprepared and served as Group 1.

Group II: Prepared using stainless steel K-files up to apical size 25 at the working length and step-back technique was used till file no. 60.

The canal's patency was assessed in each of the subsequent three groups utilizing a #10 K-file. Subsequently, a K-file with a width of fifteen millimeters was introduced into the canal until it became visible through the apical foramen. By subtracting one millimeter from this measurement, we were able to determine the working length.

Group III: Prepared using ProTaper rotary system sequentially at the speed of 300 rpm using a crown-down technique. Canal preparation was finished with F2 (25/.08) till working length.

Group IV: K3 rotary system sequentially at the speed of 300 rpm using a crown-down technique. Canal preparation was done with file 25/.06 till working length.

Group V: Easy RaCe rotary system sequentially at the speed of 300 rpm. Canal preparation was done with file 25/.06 till working length.

In the canal preparation process, each canal was irrigated with three percent sodium hypochlorite between the use of each instrument. This procedure was consistently applied across all groups. Dolo Endogel, which comprises seventeen percent EDTA and ten percent carbamide peroxide, was employed between each successive instrument in the groups that utilized a rotating system for preparation. Furthermore, in all groups, the EndoActivator equipped with a no. 25 tip was operated for thirty seconds to vigorously agitate the solution, ensuring thorough cleaning of the canals. Throughout the experimental procedures, all roots were maintained in a damp state using filtered and purified water.

The analysis of the collected data was conducted using the statistical software SPSS 17.0. To assess whether there was a statistically significant difference among the experimental groups concerning the presence of defective roots, a Chi-square test was performed.

Additionally, a chi-square test was executed to ascertain the number of defects present in each group at various horizontal sections. The criterion for

statistical significance was set at P less than 0.05.

Results

Table 1: Comparison of number and percentage of teeth showing defects

Defect	Control group	Hand K-file	ProTaper-rotary	K3- rotary	Easy RaCe rotary	Total
Absent	05	06	11	21	41	84
Present	00	02	07	03	04	16
Total	05	08	18	24	45	100

It was concluded that a statistically significant difference existed between the groups ($P = 0.006$). In Group I, no abnormal roots were identified. The investigation revealed that the Hand K-file, ProTaper, K3 SybronEndo, and Easy RaCe rotary groups exhibited dentinal imperfections. Nevertheless, the differences observed were not statistically significant for all rotary systems examined in this study. The results suggested that while there were variations in the occurrence of dentinal abnormalities, these variations did not reach statistical significance.

DISCUSSION

The main objective of chemomechanical root canal preparation is to maintain the original pathway of the canal while thoroughly cleaning the entire root canal system. A frequent complication linked to mechanical canal preparation is vertical root fracture (VRF), which often results in the loss of the tooth.⁸ Various NiTi instruments with distinct designs have been developed, yet all tend to cause incomplete cracks or even VRF.

Therefore, it is crucial to prevent such defects. Bier et al.⁹ indicated that craze lines appeared in 4% to 16% of cases, which could progress to fractures during retreatment or after prolonged functional stresses, such as those from chewing. This evidence suggests that root canal preparation using NiTi rotary systems, along with any subsequent procedures in endodontics, such as obturation and retreatment with rotary systems, can lead to the formation of fractures or craze lines.

According to our research, the occurrence of cracks in root dentin was higher following instrumentation with OneShape compared to HEDM and ProTaper Next. Liu et al. also reported similar findings, noting cracks in 35% of roots treated with OneShape.

The configuration of the file can influence the shaping forces exerted on root dentin; such forces have the potential to induce root fractures. ProTaper Next features a rectangular cross-section design with variations in tapering throughout its length. The off-centered rectangular design of ProTaper Next may have resulted in a lower incidence of cracks compared to OneShape.¹⁰

This particular design produces a swaggering motion, which mitigates the screw effect, reduces the risk of taper lock, and lessens the torque applied to the file. In contrast, OneShape possesses an asymmetrical

cross-section along its entire length and features a variable pitch, along with a noncutting safety tip.¹¹ In this specific study, a statistically significant

difference was observed between the groups ($P = 0.007$). In Group I, no abnormal roots were identified. It was found that the Hand K-file, ProTaper, K3 SybronEndo, and Easy RaCe rotary groups exhibited dentinal imperfections. Nevertheless, the differences among all the rotary systems examined in this research were not statistically significant. The results suggested that while there were variations in the occurrence of dentinal abnormalities, these variations did not reach statistical significance.

Wilcox et al.¹² claimed that the amount of tooth structure removed was associated with vertical root fractures. A previous study reported that the ProTaper Next X2 instrument removed similar amounts of dentin compared with other instruments with larger taper sizes. The design features of the ProTaper Next might be related with the greater crack formation at the 3- and 9-mm levels than with the K3XF and RECIPROC.

Furthermore, Bier et al.⁹ stated that the instrument taper affected the incidence of microcracks in root dentine. In this study, the apical preparation size was standardized to the size of #25 instrument. Nevertheless, for the final apical taper there were two different sets: 0.06 for K3XF and ProTaper Next and 0.08 for RECIPROC and TF Adaptive system. The larger apical taper in the TF Adaptive group may have contributed to the greater crack formation at the 3-mm level.

Abou El Nasr¹³ and Abd El Kader¹³ stated that the alloy of the instrument affects the number and percentage of dentinal cracks. Root canal instruments with greater flexibility were associated with fewer microcracks in the root structure. The total frequency

(percentage) of microcracks in the groups was 3 (3%) for K3XF, 13 (14%) for ProTaper Next, 3 (3%) for RECIPROC, and 16 (17%) for TF Adaptive. In the present study, the results revealed a significant difference in the incidence of microcracks among the experimental groups at the 3- and 9-mm levels. Hence, the null hypothesis is rejected.

CONCLUSION

Although Ni-Ti rotary instruments offer numerous benefits compared to hand tools, the process of preparing root canals may lead to varying levels of dentinal damage, contingent upon the intensity of the device's application. Increased taper, higher rotational speeds, and aggressive cutting techniques can elevate the stresses exerted on the dentin wall, potentially contributing to this issue. Such factors may lead to the emergence of dentinal irregularities. The results of this study indicate that the ProTaper rotary system inflicts greater harm on the dentin than alternative rotary systems such as K3 and Easy RaCe.

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