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Comparison Of the Rotary and Reciprocating File Systems Using the CBCT: An Original Study

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Abstract

Introduction: In endodontics, the use of rotary file systems has made canal preparation easier and safer. There are numerous commercially availassble file systems that work with continuous and reciprocating motions.

Aim: Using "cone beam computed tomography (CBCT)," we examined the "Canal transportation (CT), Canal centering ability (CA), touched (TS), and untouched surfaces (UT)" of dentin after instrumentation in various file systems.

Materials and Procedures: With 100 removed human teeth, we launched an in vitro investigation. We compared continuous rotation ProTaper Gold (PG) and TruNatomy (TN) to reciprocating motion Reciproc blue (RB) and MicroMega One RECI (MR). These were sorted into four groups of equal size. The manufacturer's instructions were followed, and the teeth were prepared as directed. Before and after the preparations, CBCT imaging was performed on all of the teeth at lengths of "8 mm, 5 mm, and 2 mm" from the apex. For the CT, CA, TS, and US following instrumentation, we compared all of the groups pre and after operatively. Using the ANOVA statistical test, the obtained data was analysed for variation, with p0.05 being considered significant.

Results: The CT, CA, TS, and US showed a significant difference at all levels from the apex for all of the groups. We found substantial differences in the CT and CA at all three levels from apex. MR revealed the least amount of CT and CA compared to other methods. At all three levels, MR revealed the least US and the most TS surface. The PG noticed a higher CA.

Conclusion: PG exhibited better CA while MG showed lesser CT, and had better contact with the dentin surface which is essential for the removal of the infected canal surface. Hence it can be recommended for the clinical endodontic application.

Keywords: Cone-beam computed tomography, rotary, TruNatomy, MicroMega One RECI and Reciproc blue, reciprocating, ProTaper Gold, canal centration, and canal transportation.

INTRODUCTION

Root canal therapy is the most common clinical procedure performed in dental clinics (RCT). The RCT has largely replaced the extraction of decaying teeth (that can be repaired within certain parameters), which was the most common technique in the past. The RCT consists of three main steps, the first of which is a comprehensive diagnosis, the second of which

is correct preparation, and the third of which is restoration. The dentist's clinical skill is required for these steps.[1-3] In former years, manual approaches were used to prepare the canal for the RCT, using files made of various metals. The apical enlargement is a vital stage in the instrumentation process that will determine the RCT's effectiveness. This process enables full watering and a perfect seal to be achieved. To receive the rehabilitation, the canal must be consistently tapered. This stage, however, is prone to a number of issues, including "apical conveyance, zip, elbow, and ledge development."[4-6] The main disadvantages of the manual method were instrument breakage and clinician tiredness, among other things. The clinician's tactile sensitivity was also a factor in the manual approach.[7] The rotary system was developed to overcome these drawbacks. This approach uses fewer files, is simple to use, easy to learn, saves time, and file breakage is less common. The "Nickel-Titanium" metal, which is more elastic and less prone to breakage even in curved canals, is the most prominent advantage of rotary file systems. Continuous rotation- ProTaper Gold and TruNatomy are examples of continuous rotation file NiTi rotary systems. Reciprocating motion—examples are Reciproc blue and the MicroMega One RECI.[5-10] The "ProTaper Gold" file system is long-lasting, cyclically fatigue-resistant, and extremely adaptable. These are thought to be effective in the dentin cutting process. In the RCT, these can do both the shaping and the canal finishing.[3] "TruNatomy (TN; Dentsply Sirona, Maillefer, Ballaigu/es, Switzerland)" is a new file system. It is made of NiTi metal with a thickness of 0.8 mm, which is thinner than prior file systems. This method is also more flexible, and it has been found to have the fewest instrument separations.[4] "Reciproc® blue" (VDW GmbH, Munich, Germany) is a NiTi file system that has been heat treated. The "Reciproc®" has been improvised in this system. 3 This system is also more flexible and has less cycle fatigue than the reciprocal.[5] The "MicroMega One RECI" is a single-use reciprocating tool for root canal contouring. It's made of NiTi metal that's been heat treated using the unique C.Wire method. This demonstrates excellent cutting talents as well as flexibility. This file system has an advantage over others since it is more user-friendly.[6] Previous research has shown that reciprocation file systems reduce root dentin wall engagement, reduce file stress, and reduce file breakage.[11-15] However, several studies have found that the constant motion of rotary files is beneficial to their efficiency. We used CBCT imaging to compare the CT, CA, TS, and US of dentin following instrumentation in continuous rotary and reciprocating motion.

MATERIAL AND METHODS

With 100 removed human mandibular and maxillary molars, we performed an in vitro observational investigation. The study was approved by the institution's ethical committee. The research took place between 2020 and 2021. The teeth were collected, disinfected, and kept in saline at 4°C. Teeth with clearly discernible canals and no additional diseases such as internal resorption and/or underdeveloped apex were included. The teeth were chosen using Schneider's method of selection.[7] The canalised mesial root was chosen, and the distal roots were cut out and eliminated. The canal was widened to 25 number file and irrigated with 5.25 percent sodium hypochlorite and saline, as per normal protocol for the access cavity. For each file system, the teeth chosen for the study were divided into four batches, each with 25 teeth. The following groups were formed:

Continuous rotary system
Group I ProTaper Gold
Group II TruNatomy
Reciprocating system
Group III Reciproc blue
Group IV MicroMega One RECI

We compared all the groups before and after the preperation for the “Canal transportation, Canal centering ability, touched and untouched surfaces of dentin” after instrumentation

- The canal transportation was calculated as “(x1 − x2) − (y1 − y2)”
- The CA ratio was calculated as “(x1 − x2)/(y1 − y2) or (y1 − y2)/(x1 − x2)”

“x1 is the short distance measured from the mesial end of the root to the mesial end of the unprepared canal, x2 is the short distance from the mesial end of the root to the mesial end of the prepared canal, y1 is measured from the distal end of the root to the distal end of the unprepared canal, and y2 is measured from the distal end of the root to the distal end of the prepared canal” The specimen was placed in wax for CBCT "CS9000 3D, Carestream

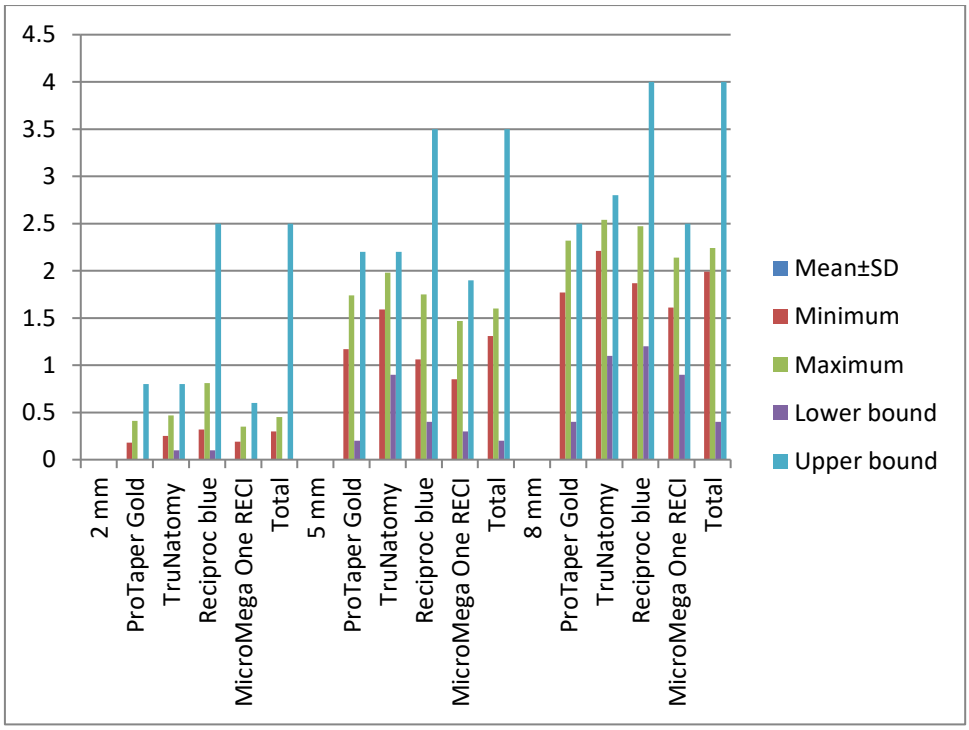
Imaging" imaging. Before and after the preparation, the photos were recorded. The scans were done in three areas: 2 mm, 5 mm, and 8 mm from the root's apex. Using the software "AutoCAD 2012-CDW," the touched and unaffected surfaces of dentin were computed by superimposing photographs acquired before and after the treatment. The findings were recorded and statistically compared, with a significance level of p0.05 considered significant. To compare the values, the statistical tests "ANOVA and post hoc" were used. The study was conducted using SPSS version 20.

RESULTS

Using the "ANOVA test," we discovered a statistically significant variation for the CT in all four groups at all three levels of the root. We found a statistically significant difference at 2mm, 5mm, and 8mm from the apex, with p =0.021,0.023, and 0.032, respectively. The MR file system had the lowest CT, followed by PG and TN, and RB had the highest CT. Graph 1

By using the "ANOVA test," we discovered that there was statistically significant variation for all four groups at all three levels of the root for the CA. We found a statistically significant difference at 2mm, 5mm, and 8mm from the apex, with p =0.045,0.04, and 0.037, respectively. Among the file systems, the MR had the lowest CA, while the PG had the most. Graph 2. We noticed something interesting when we looked at the US of the dentine in the canal, that the MR had the lowest mean percentage at the level 2mm from the apex, whereas the TN had the highest. At the other two levels of 5, 8mm, similar observations were made. When all four file systems for the US were analysed, we found a statistically significant difference between the different locations from the apex (p0.001). Table 1. When the TS of the dentine in the canal was investigated, we found that the MR had the highest mean percentage at 2mm from the apex, while TN and RB had the lowest. At the other two levels of 5, 8mm, similar observations were made. When all four file systems for the TS were evaluated, we found a statistically significant difference in the different regions from the apex (p0.001). Table 2

Graph 1: Comparison of the observed values for CT.



Graph 2: Comparison of the canal cantering for the various levels of the canal.

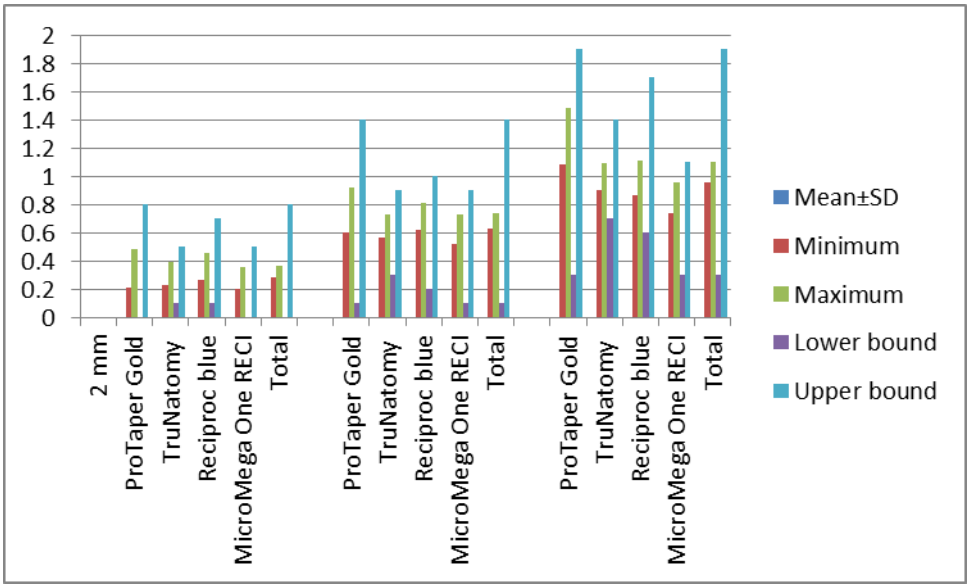


TABLE 1: Comparison of the untouched surface of dentine for the various levels of the canal

Level from apex	File system	Mean%±SD	p
2mm	MicroMega One RECI ProTaper Gold	20±2.17	0.001
	TruNatomy	25±2.88	
	Reciproc blue	22±1.1	
	ProTaper Gold	23±2.10	
5mm	MicroMega One RECI ProTaper Gold	34±1.16	0.001
	TruNatomy	41±1.48	
	Reciproc blue	36±1.38	
	ProTaper Gold	35±2.73	
8mm	MicroMega One RECI ProTaper Gold	21±2.00	0.001
	TruNatomy	29±1.56	
	Reciproc blue	24±2.47	
	ProTaper Gold	28±2.12	

TABLE 2: Comparison of the touched surface of dentine for the various levels of the canal

Level from apex	File system	Mean%±SD	p
2mm	MicroMega One RECI ProTaper Gold	45±2.17	0.001
	TruNatomy	37±2.88	
	Reciproc blue	39±1.1	
	ProTaper Gold	40±2.10	
5mm	MicroMega One RECI ProTaper Gold	49±1.16	0.001
	TruNatomy	40±1.48	
	Reciproc blue	41±1.38	
	ProTaper Gold	42±2.73	

8mm	MicroMega One RECI ProTaper Gold	55±2.00	0.001
	TruNatomy	49±1.56	
	Reciproc blue	54±2.47	
	ProTaper Gold	48±2.12	

DISCUSSION

Root canal treatment is a difficult and technique-dependent procedure. The therapy's outcome is affected by a number of factors.[15,16] On the market, there are a variety of file systems to choose from. Continuous or reciprocating motions are used in these. There are benefits and drawbacks to each file system.[17-20] As a result; we compared the CT, CA, TS, and US of dentin following instrumentation using CBCT images in our study. The MicroMega One RECI had the least amount of canal transportation and the CA. Due of the newness of this file system, there were only a few research to which we could compare our findings.[6] The MicroMega One RECI offers a more uniform cross-section and better cutting efficiency. This finding is similar to that of Alrahabi et al.,[9] who examined reciprocating and continuous rotary systems and discovered that the reciprocating file produced better results. Our findings contradict those of Arruda EDS et al.,[2] who evaluated reciprocating and continuous rotary systems but found no significant differences. By reciproc blue, the maximal canal transportation was seen. In contrast, Hage et al.,[14] showed substantial variance for the CA and CT when the Glidepath was utilised in their CBCT investigation. They claimed that RB had improved properties because it employs the M-Wire alloy, which is believed to be a significant advance in terms of flexibility over conventional NiTi alloys.[5,14,20] Keskin et al.,[20] found a similar observation in their RB investigation, but they employed resin blocks with S-shaped canals. The MicroMega One RECI had the lowest canal centering ability, while ProTaper Gold had the highest. The ability to focus the canal is linked to a better RCT result. Our findings contrast those of Saleh et al.,[21] who reported that the continuous rotary system had greater centering ability than the reciprocating system. In contrast to the current investigation, Arruda et al.,[2] found no variance for the reciprocating and rotary continuous systems. The centering ability is better because the file systems utilized in continuous motion contain files with a uniform taper. As a result, we observed a similar result in our research. De Carvalho GM et al.,[16] discovered that neither the reciprocating nor the Glidepath file systems had optimal canal transfer or centering ability. The majority of research support canal transportation in a mesial direction. Our study was comparable to the others, except that it was a microCT investigation.[11,17,18] The file should make contact with all of the canal's surfaces, removing the dentine in the process. As observed in a prior study, the manual as well as a few file systems had the disadvantage of undisturbed dentine.[21-27] For the untouched surface of dentine the least mean percentage was seen for the MicroMega One RECI. The maximum untouched walls were seen for the pro taper gold. While for the same file system touched surface was maximum. The remaining dentin after the preparation is crucial for the fracture resistance of the canal. There are no studies to compare our results. Zuolo ML et al.,[27] stated that BioRace shows more untouched canal areas. BioRace is a continuous rotary file system that is comparable to Protaper gold used in our study. The dentine surfaces that are not touched may lodge the bacterial biofilms. This may relapse of the infection in the RCT treated and failure. The untouched dentinal surfaces in our study ranged from 20-41% at different regions of the canal. The reciprocating file systems has a file design that better adopts to the canal walls.[26-29] In our investigation, the TN method produced low median dentine outcomes in the United States. This is in line with Zuolo ML et al. findings.[27]

Hand files have a better taper than the reciprocating system. This will make it easier to feel the canal's walls. Previous research, on the other hand, contradicts this attribute of files.[17,20,26-29] The volume of the canal's contacted surface is determined by the tooth anatomy as well as the cross section, taper, metal characteristics, and file size of the instrument. The outcome is also influenced by the file system's movement. Due to the increased taper of the reciprocating system files, they touch the majority of the canal surface.[11,27,29] Üstün Y et al. found no significant difference between the two file systems in their investigation, which contradicts our findings.[13] Our study had some

limitations, for example, the canal forms of the specimen teeth were not homogeneous, even if severe bent canals were avoided. The results of our investigation could have been influenced by the dexterity of the participants.

CONCLUSION

Within the study's parameters, PG had a higher CA than MG and had greater contact with the dentin surface, which is necessary for the eradication of the infected canal surface. As a result, it can be recommended for clinical endodontic use. In comparison to the other file systems, the newly announced MicroMega One RECI displayed better properties. Nonetheless, more research is needed to back up the conclusions of our study.

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