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The Effect of Automated Rotational Canal Preparation System Compared to the Reciprocal System on the Volume of Coronary-Regressed Smear Layer: *In Vitro* Study

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ABSTRACT

Determining the effect of the type of preparation system on the volume of coronally-regressed smear layer. The research sample consisted of 22 newly extracted teeth, single-rooted and with a single canal, their lengths have been standardized to be 16 mm from the apex, then randomly divided into 2 equal groups (11 teeth for each group) according to the preparation system adopted as follows: (Group I: Reciproc blue) (Group II: ProTaper Gold), the apex was sealed with red baseplate wax, and fixed with a mixture of acryl, sawdust and gypsum in a plastic mold until completely solidified. 1 ml of distilled water has been used for irrigation during preparation with the use of U File for Irrigation activation after each preparation and the entire product of the preparation process has been collected into the sample tubes. Spectrophotometer has been used to calculate the volume of the smear layer. Results were analyzed using Student (T) test for independent samples. The results showed that the two systems produced the same volume of smear layer during preparation. The results showed that the two systems produced the same volume of smear layer during preparation.

1. INTRODUCTION

The scientific development in the field of dentistry has created automated tools that have made it easier for the practitioner to work, reduced the effort and time required to complete the treatment, and the complications that may be encountered.

The primary goal of endodontic treatment is to remove the contents of the canal in order to ensure an hermetic filling of the root canal system. During the preparation of the canal (canals), the practitioner must make sure to remove debris.

The correct endodontic treatment requires knowledge with the anatomical characteristics of the root canal

system of the various dental units, and knowledge of the different characteristics of the Root canal instrument in terms of the formal design, and the nature of each tool and the characteristics of the manufacturing material, in addition to the experience and scientific knowledge of the different preparation movements specific to each tool within the root system.

Manufacturers seek to design automatic file systems with rotating or reciprocating motions, so that they are made of materials that achieve greater resistance to shear stresses applied to the file and are more flexible, with greater removal of organic and inorganic materials that regresses coronally, and reduction of apically-flowing materials.

So Root Canal Treatment: Dental pulp as defined by the [1]: It is a specialized connective tissue highly innervated and vascular, of mesenchymal origin, located within a central space in the tooth, surrounded by dentin, and has many functions (induction, formation, sensation, nutrition, defense.) [1].

Automated endodontic tools can be classified according to the nature of movement into:
1) Reciprocal Systems: Reciprocating systems are characterized by the clockwise rotation of the file followed by counterclockwise rotation.

Reciproc Blue System
Heat treatment of NiTi tools provides increased resistance to cyclic fatigue and greater tool flexibility resulting in an improved version of the original Reciproc tool, which has increased resistance to cyclic fatigue and greater flexibility [21].
2) Rotational Systems: Continuous rotary tools are more efficient at cutting compared to manual files.

ProTaper Gold System
ProTaper Gold provides resistance to cyclic fatigue twice that of the ProTaper Universal system and this is a very important feature and the main cause of tool separation.

Smear Layer
Smear layer: A layer present on the walls of the canal after preparing the canal system that consists of debris of micro-crystalline organic particles.

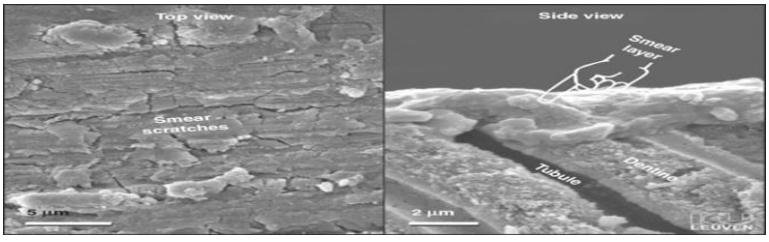

Fig. 1.1 Smear layer

Removal of the smear layer may contribute to improving disinfection and enhancing the sealability of the canal system. (2016) Morago A, Ordinola-Zapata R Shahravan A (2007).

It was first described in 1975 by Macomb and Smith and research has been carried out since then to evaluate its importance in bacterial penetration into the dentinal tubules and its effects on endodontic treatment on a larger scale.
Contents of Smear Layer:

1) Residual vital pulp tissue,2) Residual dead pulp tissue,3) Red blood cells
4)Saliva,5) Bacterial components.

Smear Layer Removal:
The smear layer can affect bonding, disinfection, and in addition to the tight sealing of the canal filling thus, it is important to remove it as its removal opens the dentinal tubules that were closed after mechanical preparation of the teeth.
Failure to remove the smear layer may result in a failure to secure the marginal seal contributing to the following microleakage. McCabe, J (2008)

2. Aim

The research aims to compare the two automated preparation systems, Rotary (ProTaper Gold) Versus Reciproc Blue (Reciproc Blue) in terms of:
The volume of coronally-regressed smear layer (after sealing the apex of the teeth with baseplate red wax) resulting from the automated preparation of the rotational (ProTaper Gold) and Reciprocal (Reciproc Blue) systems.

3. Materials and Methods

Insertion Standards:

- Teeth with a single straight root canal, length of 20 mm or more, and not endodontically treated.

Expulsion Standards:

- The root includes fractures, necrosis, or developmental defects.
- The apex tip is open or absorbed.
- The presence of internal or external absorption in the root.
- Apex size at initial probing is less than or equal to size 20.

Study Performance Method:

- Cutting the teeth to a 16 mm length.
- The sample is fixed -after sealing the dental apex with red baseplate wax- with cold acryl mixed with sawdust and within a plastic mesh to preserve the sample position. (Fig. 2)
- Assigning numbers to the teeth within the mold.
- Opening of pulp chamber using diamond burrs.
- Establishing a glidepath with manual files (10) according to the working length.

Fig. 2 Sample after fixation.

Preparing the first group with the ProTaper Gold system (n=11) as follows:
The manufacturer's instructions were adhered to in terms of the tool sequence and the device's speed and torque settings according to the following table:

- Using ProTaper Gold according manufactures instructions

Preparing the second group with the Reciproc Blue system (n=11) as follows:

- Using ProTaper Gold according manufactures instructions

Studying the smear layer volume using a spectrophotometer:
Blank: The solution that contains all the substances involved in the reaction except for the substance to be measured.

- Using a spectrophotometer according manufactures instructions.

Statistical Analytical Study:
Sample Description:
The research sample consisted of 22 root canals that were divided into two equal main groups according to the preparation system used (ProTaper Gold Automated Reciprocating Preparation System RECIPROC blue). The amount of light absorbed by the smear layer was measured after the spectrophotometer was zeroed to a wavelength of 510 nm for each root canal in the research sample.

Descriptive statistics:
Table.4.1 shows the arithmetic average, standard deviation, standard error, minimum and maximum values of the amount of light absorbed by the smear layer in the research sample according to the preparation system used.

The Used Preparation System	Number of Root Canals	Arithmetic Average	Standard Deviation	Standard Error	Minimum Value	Maximum Value
Automated Rotational Preparation System ProTaper Gold	11	1.18	0.48	0.15	0.2	1.73
Automated Reciprocal Preparation System Reciproc Blue	11	0.99	0.45	0.13	0.5	1.82

Student T Test Results for independent Samples:
Table. 4.2 shows the results of the Student T test for independent samples to study the significance of the differences in the average of values for the amount of light absorbed by the smear layer between the group of root canals in the research sample according to the preparation system used.

Studied Variable = The Amount of Light Absorbed by the Smear Layer				
The Used Preparation System	**The Difference between the two Averages**	**Calculated T Value**	**Significance Level Value**	**The Significance of the Differences**
Automated Rotational Preparation System ProTaper Gold	0.26	1.440	0.165	No significant differences
Automated Reciprocal Preparation System Reciproc Blue	0.13	0.681	0.503	No significant differences

It is noted in the table above that the significance level value is much greater than the value 0.05 regardless of the preparation system used. That is, at the 95% confidence level, there are no statistically significant differences in the average of values for the amount of light absorbed by the smear layer amount between the group of root canals regardless of the preparation system used in the research sample.

Under the circumstances of our research, we reached the following conclusions:
At the 95% confidence level, there are no statistically significant differences in the average of values of the amount of light absorbed by the smear layer between the group of root canals regardless of the preparation system used in the research sample.

This result can be explained that both systems are have cross-sections with cutting edges and a variable taper along the incisive part of the file.

Thus, we agree with Ricardo et al. 2018 and with the research done by Mudita et al. 2017, and we disagree with [19] and colleagues in the volume of smear resulting from Reciproc Blue files that is superior when compared to the smear volume resulting from ProTaper Gold files. The difference is due to researchers using lower teeth and calculating the percentage of dentin removed. In addition to our disagreement with the results of the research carried out by Sebastian Bürklein and Edgar Schäfer 2012, where the reciprocating systems produced much more smear volume compared to the rotational system.

In light of the completion of the two researches, the difference in results is due to the difference in the files. As the researchers used ProTaper and Reciproc in their research, while we used ProTaper gold and Reciproc blue in our research. And the researchers used the Meiser method to calculate the amount of apically-thrusted smear.

4. Discussion

The stage of preparing the root canal system is often more difficult compared to the stage of canal filling, and in this context, the techniques and tools of automated intervention have developed to accomplish the stages of endodontic treatment in terms of form, composition, method of manufacture and the series of use in order to achieve effective and at the same time safe canal preparation [23].

Morago A and colleagues reported in 2016 that removing the smear layer may contribute to improved disinfection and enhanced sealability of the canal system. Morago A, Ordinola-Zapata R (2016.)

All in-vitro studies that were carried out to calculate the volume of smear layer were directed towards measuring the amount of an apically-thrusted smear, as in the research carried out by Bürklein et al., 2014, Üstün et al., 2015, Koçak et aI (2015.) while we did not find any completed study to measure the entire volume of a coronary- regressed smear layer.

Most of the studies carried out in this context used pre-weighted glass vials using the Myers and Montgomery method after drying and did not measure the volume of smear layer using a spectrophotometer.

So we set out to conduct an in-vitro study to measure the volume of the coronally-regressed smear layer after sealing the apex of the teeth so that the seal achieves a pressure greater than the pressure applied from pushing the dentin chips and irrigation fluids. Using a spectrophotometer, the lower premolars were chosen because they have one root with one straight canal, and similar anatomical appearances allowing better control of the study variables (Dadresanfar, et al. 2012).

The crowns were cut using a diamond disc to standardize the lengths of the roots and eliminate the effect of the tooth length factor on the effectiveness of the preparation systems used. (Vale et al. 2013, Guiottiet al. 2013, Queirózet al. 2012)

The unit of apex preparation volume (0.25) mm is the same as the measurement of the apex diameter of the preparation files studied in the research. Because the lack of uniformity of this parameter of the studied parameters could act as a variable that affects the amount of smear more than the preparation system.

(Tanalp and Güngör 2014) Used distilled water for irrigation instead of 5,25% hypochloride to avoid crystal formation of sodium hypochloride.

(Sebastian Bürklein, Edgar Schäfer 2012, 2007 (Huang et al) Used demineralized water instead of 5,25% hypochloride so that the coronally-regressed smear does not dissolve, as part of the sodium crystals can remain attached to the walls of the canal, and these crystals may change the results, we used double side vented irrigation tips because regular tips push a large amount of irrigation fluids out of the apex. Whereas single side vented irrigation tips have less effect on the apical thrust of irrigation fluids.

(Altundasar et al 2011) sealed the apex of the teeth with red baseplate wax to measure the entire volume of smear resulting from the preparation after activating the irrigation with U Fill files. We used a spectrophotometer to measure the volume of smear as it is more accurate and faster than the method of drying and weighing, and in one session to simulate the same conditions for all samples in terms of the spectral photometer capacity.

Reciproc Blue files from the reciprocal preparation system and Protaper Gold files from the rotational system

were used. They are heat-treated files with precise shape memory, efficiency and more resistance to breakage. [21], [16].

5. Conclusions

The single-file reciprocal preparation system produced a coronally-regressed smear volume similar to that produced by the multi-file continuous rotational preparation system.

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