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SEM Evaluation Of Smear Layer Using Wave One Gold With Q Mix And Chlor Oquick: A Short Study

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Abstract

Introduction

Root canal treatment aims to preserve the teeth in a healthy and functional condition by removing diseased pulp tissue and cleaning of the canals by instrumentation along with irrigants and intra canal medicaments.[1,2] Several mechanical devices and techniques have been presented to make canal preparation easier. These devices can be manual or machine-assisted (including automated root canal preparation, sonic and ultrasonic preparation, laser systems, and non-instrumental techniques).[3]

During cleaning and shaping procedure, mechanical instrumentation leads to the formation smear layer that inhibits the dispersion of intra canal medicaments and sealers into the dentinal tubules. Hence, elimination of this smear layer improves the fluid tight seal during obturation of the root canal systems and ensures a successful endodontic treatment.[4]

There have been numerous concepts, strategies,

and techniques for preparing root canals from the beginning of modern day endodontics. Throughout the decades, a number of files have emerged for negotiating and shaping canals starting from the K-files to WaveOne file system.[5] Newer innovations like WaveOne Gold file systems, used in a reciprocating handpiece is used to completely prepare the canal to an adequate size and taper, even in narrow and curved canals. This specially designed NiTi files work in a reverse "balanced force" action with a "reciprocal motion". The motor is programmed such that the counter clockwise movement is greater than the clockwise movement wherein, three reciprocating cycles complete one reverse rotation.[6,7]

Mechanical instrumentation, therefore, must be enhanced by irrigation to keep the canal wall lubricated and to remove smear layer from root canals & ramification. A number of chemicals have been investigated as irrigants like sodium hypochlorite (NaOCl), ethylenediaminetetraacetic acid (EDTA), chlorhexidine (CHX), citric acid, etc.[4]However, several newer irrigation systems have been presented to increase the mechanical flushing action of irrigants for better removal of smear layer.[8]QMix is a new irrigating solution containing EDTA (decalcifying agent), CHX, cetrimide and a detergent having a pH slightly above neutral. It has both antimicrobial properties of CHX and the smear layer removing properties of EDTA. The addition of CHX to cetrimide before adding EDTA usuallyavoids any precipitation development. The surface active agent in QMix lowers the surface tension of solutions and increases their wettability. These properties render QMix to be the best solution for final irrigation of canals.[9]Recently, a new formulation of 18% etidronic acid with 5% NaOCl has been commercially available as 'ChloroQuick' is a combination solution of stabilized NaOCl solution with buffered HEDP (1-Hydroxyethane 1,1 Diphosphonic Acid) with detergent and system activator along with other excipients.[4]A combined use of contemporary files along with adequate anatomic acumen of the root canal system would empower a clinician to attain a higher quality of endodontic treatment.

Hence, this study was undertaken to evaluate the nature of Smear layer produced after cleaning of the root canals prepared by WaveOneGold in combination with newer root canal irrigants QMix 2in1 and ChlorOQuick using Scanning Electron Microscope (SEM).

Materials and Method

Thirty freshly extracted single rooted mandibular first premolars were selected and cleaned with hand scaler and stored in purified filtered water. Exclusion criteria for the study included carious tooth, tooth with periodontal diseases and those for orthodontic treatment. The coronal portions of all teeth were removed using safe sided diamond disk, leaving roots 16mm in length. The roots were pre-grooved to help in splitting the tooth for SEM study.30 teeth were prepared using WaveOne Gold files in reciprocating motion using Xsmart plus as Endomotor. The samples were subdivided into 3 groups.

SUBGROUP I CONTROL GROUP= 10 teeth	SUBGROUP II = 10 teeth	SUBGROUP III = 10 teeth
Irrigant- Normal saline	**Irrigant**- (i) 5.2% NaOCl (ii) Nomal saline (iii) QMix 2 in 1	**Irrigant**- ChlorOquick

After determination of workin length by visualizing the tip of No. 10K file at the apical foramen using dental operating microscope simultaneously determining the patency of the canal, the respective samples are instrumented. The teeth samples are instrumented with WaveOneGold file system (upto 35/0.6taper along with respective irrigants of sub groups as mentioned above.

Evaluation by SEM

The prepared teeth (pre-grooved) were split along the longitudinal axis into two halves and used for further analysis. The root was then dehydrated in the ascending alcohol series for 24 hours and then were left to dry overnight and mounted on copper stubs. The samples were then prepared, examined and photomicrographed using a SEM. The photomicrographs were taken at 1000x magnification at coronal, middle and apical thirds of the root canals (for all 3 sub-groups), using the SEM analysis software. (Figure: 1)

Criteria for Smear Layer Evaluation

The amount of smear layer remaining on the surface and dentinal tubules were scored according to the following 5 score system by Hulsmann, M *et.al*.(1997).[10]Statistical analyses were done using a Social Sciences software (SPSS version 22, USA). Statistical tests were used to find out the statistical significance of the results obtained.

Results

The mean smear layer score in WaveOne Gold - QMix were 1.7(0.48), 1.6(0.51), 1.4(0.51) in the apical, middle and coronal third of the root canal respectively and WaveOne Gold – ChlorOquick were 2.7 (0.48), 2.3(0.48) and 1.9 (0.31) in the apical, middle and coronal third of the root canal respectively in Wilcoxson signed rank test and Mann Whitney Test respectively. Wilcoxon singed rank showed statistically insignificant difference at the apical third between the groups (p value = 0.155, 0.653 and 0.433). Similarly, Mann Whitney Test showed statistically insignificant difference at the apical third between the groups (p value = 0.850, 0.556 and 0.333). Tables 1,2,3,4,5 Both results showed statistically insignificant values.

TABLES

Table 1: Distribution of smear scores (in %) in the apical, middle and coronal thirds of the root canal in the Normal Saline, WaveOne Gold group.

Smear Layer score	Apical Third	Middle third	Coronal third
1			
2			
3	2(20%)	3(30%)	
4	6(60%)	5(50%)	2(20%)
5	2(20%)	2(20%)	8(80%)

Table 2: Distribution of smear scores (in %) in the apical, middle and coronal thirds of the root canal in the QMix - WaveOne Gold group

Smear Layer score	Apical Third	Middle third	Coronal third
1	3(30%)	4(40%)	6(60%)
2	7(70%)	6(60%)	4(40%)
3			
4			
5			

Table 3: Distribution of smear scores (in %) in the apical, middle and coronal thirds of the root canal in the ChlorOQuick - WaveOne Gold group.

Smear Layer score	Apical Third	Middle third	Coronal third
1			
2	3(30%)	7(70%)	9(90%)
3	7(70%)	3(30%)	1(10%)
4			
5			

Table 4: Mean smear layer score in WaveOne Gold – QMix group and WaveOne Gold ChlorOquick

	WaveOne Gold – QMix (Mean ± SD)	WaveOne Gold – ChlorOquick (Mean ± SD)	p value
Apical	1.7 (0.48)	2.7(0.48)	0.155
Middle	1.6 (0.51)	2.3(0.48)	0.653
Coronal	1.4 (0.51)	1.9 (0.31)	0.433

Table 5: Mean smear layer score in WaveOne Gold – QMix group and WaveOne Gold ChlorOquick

	Wave One Gold – QMix (Mean ± SD)	Wave One Gold – Chlor o quick (Mean ± SD)	p value
Apical	1.7 (0.48)	2.7(0.48)	0.850
Middle	1.6 (0.51)	2.3(0.48)	0.556
Coronal	1.4 (0.51)	1.9 (0.31)	0.333

#Mann Whitney Test, *statistically significant

Discussion

Endodontic therapy encompasses treatment of diseased coronal and radicular pulp, in order to preserve natural tooth in its form, function and esthetics and to cure or prevent apical periodontitis and reduces chances of reinfection.[11]Schilder H (1967) introduced the concept of cleaning and shaping which refers to the removal of contents (including organic substrates, pulp tissue, microorganism, necrotic dentin, debris etc) of root canal system before and during mechanical instrumentation.[12,13]

The introduction and use of rotary Ni-Ti instruments brought significant contributions to clinical practice in terms of safety, speed, cleanliness and shaping of root canals.[12] WaveOne files are reciprocating files, made of a special NiTi alloy called

M wire, produced by thermal-treatment process and possesses improved flexibility and enhanced resistance to cyclic fatigue (Roane's balanced Force technique).[14,15]These newer innovations (WaveOne Gold)provides better handling of curved, narrow and deep canals compared to the conventional rotary NiTi files. However, certain controversy still exists in this regard, in relation to the decrease in the breaking of instruments, failures due to torsional or flexural fatigue.[16]

The first study with an alternating movement was done by Yared G in 2008. Later, in 2010, introduction of single file reciprocating systems (Reciproc and WaveOne) reduced the number of instruments required which assuages operator anxiety of the likelihood of instrument failure and also the preparation time.[17]

The WaveOne Gold system displays a unique alternating off-centered parallelogram-shaped cross section and a progressively decreasing percentage taper design. This design restricts engagement of the file and dentin to only 1 or 2 points of contact at any given stage of canal preparation improving the safety of the file with less taper lock and screw-in effect. The cross-sectional design of the file also allows for more debris extrusion during canal preparation. The Primary WaveOne Gold instrument (PWOG) is more resistant to cyclic fatigue and more flexible.[18]

WaveOne Gold operates at 350 rpm speed in 150CCW, 30 CW direction and complete 360 in 3 cycles. There are 3 major clinical advantages to WaveOne Gold's unique movement. (1) compared to continuous rotation, there is improved safety (CCW engaging angle is designed to be less than the elastic limit of each file). (2) opposed to equal CW/CCW angles, unequal CW/CCW angles enable a file to more readily advance toward the desired working length without using excessive and potentially dangerous inward pressure. (3) compared to equal CW/CCW angles, unequal angles strategically enhance auguring debris out of the canal.[19]

Few studies conducted by Amaral P *et al.* (2013), Surakanti JR *et al.* (2014) and Vorster M *et al.* (2018) that the cleaning ability of WaveOne Gold system was much efficient and this could extrude more amount of debris as compared to others (Reciproc, Mtwo etc).[16,20]The results of our study was found to be in accordance to these studies.

Wave One Gold file is a newly designed file with semi-active guiding tip, which enables the file to more readily to follow and safely progress along manually reproduced and secured canals.[19]

Whenever the dentin is cut, the mineralized tissue is shredded to yield substantial amount of debris which may be compressed along the surface of canal wall raising the risk for bacterial contamination. Moreover, debris may occupy part of the root canal space, preventing complete obturation of the root canal. The debris contains small particles of mineralized collagen matrix which is spread over a surface to form smear layer. The smear layer in the cavity and in the root canal are different since there is presence of dentinal tubules in the root canal there is more amount of soft debris in this zone. The smear layer may block the dentinal tubules, can harbor bacterial and their by-products and also limit the efficacy of the irrigants and intra canal medicaments. Thus, to attain efficacious clinical results in an endodontic therapy the smear layer should be efficiently removed.[2]

Irrigation has a central role in endodontic treatment after chemo-mechanical preparation. During and after instrumentation, the irrigants accelerate the flushing action by removing microorganisms, tissue remnants, and dentin chips from the root canal system. There is a wide array of irrigants and their selection is of major importance because there are differentiations in their effectiveness to act as lubricants during instrumentation to flush out debris, smear layer, and bacteria out of the canal.[21]The most widely used irrigant for root canal treatment is sodium hypochlorite (NaOCl) because of its bactericidal properties and its ability to dissolve organic tissues but NaOCl has not been shown to be effective in removing the smear layer.[22]

NaOCl acts as a solvent of organic material while EDTA acts as a chelating agent. Using a combination of the two would reproduce the most ideal irrigation protocol. However, these agents cannot be combined directly because it results in an almost instant loss of free chlorine completely, thus unfavorably affecting the antimicrobial properties of NaOCl and the structural integrity of the dentin may also be compromised.[9]

To meet these challenges in the irrigation of the root canal system, a novel irrigating solution, Qmix (DENTSPLY Tulsa Dental Specialties, Tulsa, OK, USA) has been introduced to both remove smear layer and kill bacteria. This irrigant has a proprietary formulation and method of preparation, and has been shown to remove smear layer and kill recalcitrant bacteria, such as *E. faecalis,* in one application.[22]QMix may cause an impact on the physiological healing process anticipated during and following root canal treatment. QMix is a novel endodontic irrigant for smear layer removal with added antimicrobial agents. It contains EDTA, CHX and a detergent. QMix is a clear solution, ready to use with no chair-side mixing. Mixing EDTA and CHX is known to produce a white precipitate, whereas in QMix those precipitate is not formed due to its chemical design.[23]

ChlorOquick (innovationsendo, India) is a combination of NaOCl 5.25% and HEBP 18% (1-Hydroxyethane 1,1 Bisphosphonic Acid) and is essential to be premixed with surfactant Tween 80 for a complete root canal irrigation solution. The novel ChlorOquick solution is a mix of HEBP (a soft chelating agent) and NaOCl which can disinfect root canals as well as reduce smear layer. The highlight of such combination of NaOCl and HEBP is that the NaOCl does not surrender its biological, antibacterial, and tissue dissolving properties, whereas the reduction and elimination of the inorganic element are done with the help of HEBP. This combination also has better tissue dissolution capability by keeping the hypochlorite - hypochlorous acid equilibrium toward hypochlorite. This combination is effective on the inorganic as well as organic part of smear layer at the same time.[24]

In the present study WaveOne file system was evaluated for its effectiveness in removing smear layer by using two different irrigants namely ChlorOquick and QMix. Then the smear layer removal ability was evaluated using, the criteria given by Hulssman *et al.* and their scores were given accordingly. SEM studies are necessary when comparing the efficacy of removing the smear layer using various instruments, irrigants and techniques. In the present study, the criteria proposed by Hulsmann M *et al.* (1997) were used to score the smear layer status.

The results of the present study showed Wilcoxon singed rank showed statistically insignificant

difference at the middle third between the groups (p value = 0.155, 0.653 and 0.433). Similarly, Mann Whitney Test showed statistically insignificant difference at the middle third between the groups (p value = 0.850, 0.556 and 0.333). Hence, it was observed that there was better outcome in terms of smear layer removal in case of WaveOne Gold – QMix group as compared to that with ChlorOquick group. The present study was found to be in accordance to other studies like Chia MSY *et al*. (2020) performed a systematic review and found that QMix was found to have better smear layer removal ability than mixture of tetracycline isonomer, an acid and a detergent (MTAD), sodium hypochlorite (NaOCl), and phytic acid. The authors deduced that QMix has better smear layer removal ability compared to MTAD, NaOCl, Tubulicid Plus, and Phytic acid.[25] Similar results were obtained by Dai *et al*. (2011) who reported that QMix was as effective as 17% EDTA in smear layer removal.[26,27]

There are few researches that did not prove the efficacy of QMix in debris removal. Patil PH *et al*. (2018) in their in-vitro study observed that ChlorOquick was found to be more effective in the removal of smear layer in the apical third of root canal.[4] Hegde V *et al*. (2019) in their in-vitro study also showed ChlorOquick better removal of the smear layer.[24]

Cleaning and shaping is a key step for successful root canal treatment that aids to remove all tissue debris from the root canal space and eliminating the inner layers of root canal dentin, thus, allowing the irrigant to reach the entire length of the root canal for its thorough cleaning and disinfection. Single file systems are the new asset in endodontic armamentarium. Only single rotary file is used for complete endodontic treatment. However, the root canal system often has a very complex anatomy with lateral canals, isthmuses, complex branching, and deltas that make complete debridement and disinfection impossible. Additionally, because of the vapor lock that results in trapped air in the apical third of the root canals, the effectiveness of irrigating solutions remains limited in the apical one third. Thus, irrigant activation is suggested to increase the efficacy of irrigant delivery and improve root canal cleanliness.

Conclusion

Successful endodontic treatment depends on the effective removal of smear layer from root canals through chemo-mechanical instrumentation. Smear layer removal for root canal therapy, facilitates a fluid-tight seal of the system, lessens the amount of bacteria in the root canal, empowers root canal disinfection and also improve the canal surface for better filling material adherence to bring about effective and good long term results. Hence, the present study exhibited statistically insignificant difference at the apical, middle and coronal third between the 2irrigant groups. These results revealed that WaveOne Gold–QMix group demonstrated better results than ChlorOquick group. Since the present study was an in-vitro research work the original or actual environment of the tooth structure could not be mimicked. Hence, within such limitations of the study, it can further be determined that WaveOne Gold file system could demonstrateremoval of the smear layer proficiently and dexterously for proper disinfection of the root canal when used in combination with newer irrigating solutions like QMix or ChlorOquick. This modernized endodontics enables a practitioner successful outcome by delivering countless benefits over hand instrumentation although their probability smear layer removal by these latest root canal irrigants is still

questionable. This could probably be attributed to the lack of adequate research work in the respective topic. Thus, in future, elaborate and extensive studies are necessary to establish such efficacious results.

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Fig.1