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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF SEALING ABILITY OF DIFFERENT SEALERS USING DIFFERENT FILE SYSTEM: A CONFOCAL MICROSCOPIC STUDY

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ABSTRACT

Background: Sealers are necessary along with solid core material. The sealers exert their effect more effectively when they tend to penetrate the dentinal tubules. The latter is enhance by preparation with a rotary file system. In clinical practice numerous file system and sealers are available commercially. This study was an attempt to evaluate the effective of single and multiple rotary file system in preparing a tooth surface more conductive to sealer penetration. Different category of sealer were also evaluated for comparative penetration

Objective: To compare the penetration of different sealers after biomechanical preparation with different file systems.

Material and Method: 90 freshly extracted human permanent mandibular premolar were selected on the basis of predetermined inclusion and exclusion criteria, and equally divided into three groups.In Group 1 teeth were prepared with Hand K files using step back technique, In Group 2 teeth were prepared with HeroShaper using crown down technique, In Group 3 teeth were prepared with OneShape rotary file using crown down technique and samples were sectioned at coronal, middle, apical third. The prepared samples were analyzed for depth of penetration of sealer using confocal scanning microscope. The data obtained was subjected to statistical analysis using One-way ANOVA, Repeated measures ANOVA and LSD Post Hoc test.

Result: Depth of penetration of different sealers was found to be significantly higher in samples prepared with OneShape than the HeroShaper and Hand K file. Depth of penetration in coronal third was found to be significantly higher than middle and apical third. Depth of penetration with AH Plus was found to be significantly higher than that of EndoREZ and RoekoSeal.

Conclusion: AH Plus displays highest penetration amongst the tested sealers and preparing the canal with OneShape leads to higher sealer penetration.

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INTRODUCTION

Success of endodontic treatment primarily depends upon effective removal of the necrotic issue and the bacteria along with their byproducts. This is achieved by judicious use of endodontic instruments along with chemical irritants (Hülsmann, 2005 and Silva, 2015). In the recent past various rotary NiTi (Nickel titanium) instrument have been advocated over the conventional stainless steel instruments. Multiple file systems have further evolved into one file systems (Kumar, 2015 and Dhingra, 2014). The design characteristics of the rotary instrumentshas been modified considerably by each manufacturer, as per their research finding, advancing the view that they lead to more effective canal preparation and debris removal (Kumar, 2015). This two characteristics lead to a surface that is more conductive to a enhanced seal with the obturating material. The second most important aspect of endodontic treatment is obtaining a hermetic seal between the dentinal surface and obturating core material (Silva, 2015).

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Numerous studies have established the fact that the root canals have a complex shape and structure which is non cylindrical. The entire pulpal space cannot be adequately instrumented (Mauger, 1998 and Usman, 2004). Thus the use of sealer becomes an important adjunct towards achieving a three dimensional seal. Various sealer propagate their individual superiority over the others (De-Deus, 2012). Hence, this study was conceived and carried out to evaluate the comparative seal obtained with the three category of contemporary sealers viz Methacrylate based sealer - EndoREZ (UltraDent), Epoxy resin sealer - AH Plus (Dentsply) and Silicon based sealer - RoekoSeal (Coltene). This study also evaluated the comparative effectiveness of cleaning achieved with the different file systems and their role in enhancing the sealing ability of the tested sealers. The null hypothesis for this study was that there is no difference in the cleaning ability of different file system leading to similar penetration of sealers and there is no difference in depth of penetration of different sealers.

MATERIALS AND METHODS

Freshly extracted permanent mandibular first premolars were collected from the outpatient department of Oral and Maxillofacial Surgery, RKDF Dental College& Research Centre, Bhopal. They were rinsed under running water, cleaned with ultrasonicscaler and were disinfected. All the teeth were individually examined clinically under surgical endodontic microscope at 5X magnification and radiographic ally with the help of radiovisiography. 90 of these teeth were selected on the basis of predetermined inclusion and exclusion criteria. Inclusion criteria were freshly extracted permanent mandibular first premolar with fully formed root and free of defects. Exclusion criteria were teeth with calcified canals, more than one canal, severely curved root, external or internal resorption, developmental anomalies, fractured or crazed root, root with restoration, previously endodontically treated teeth and excessively wide canal. The selected teeth were decoronated, preserving the root length at 12 mm. The roots were randomly distributed into three groups, comprising of 30 sample each (Table 1).

Table 1. Group distribution

Group	Instrument
Group 1	K file
Group 2	HeroShaper
Group 3	OneShape

In all the samples canal patency was checked and working length was established at 0.5 mm from the apex. In group 1, canal preparation was carried out with the help of K file using step back technique. The apical preparation was carried out till no. 25 k file. In group 2, HeroShaper rotary file system was used as per manufacturer instruction; red protocol was followed thus the canal preparation was carried out till no. 25/4% file. In Group 3, canal preparation was carried out by OneShape rotary file, using crown down technique and apical preparation was carried out till 25/6%. During the Biomechanical preparation, 2.5 % Sodium hypochloride was used for irrigation. Penultimate irrigation was carried out with 17% EDTA for 1 minute and the final irrigation with normal saline. For Obturation, across the three groups along with guttapercha cone, sealer used were –EndoREZ, AH Plus and Roekoseal in subgroup A, subgroup B and subgroup C respectively. Obturation was carried out by lateral condensation technique in group 1 whereas single cone obturation technique was used for group 2 and 3. (Table-2) With all the three sealers, Rhodamine B dye was mixed, in a concentration of 0.1%. The sealers was placed into the canal with a 1 ml tuberculin syringe and ultrasonic endodontic tips kept 1 mm short of working length were activated for 5 sec for dispersing the sealer. Postobturation restoration was carried out with glass ionomer cement and each restored sample was placed in a separate container at 100% humidity and 37% temperature for 7 days. After 7 days each root was sectioned at 3,6,9 mm level from the apex with a diamond disc under continuous water spray. Each sectionwas examined under confocal microscope at 10 x magnification for observing the depth of sealer penetration. Depth and Percentage of sealer penetration was measured using ZEN blue software.

Table 2. Subgroup distribution

Subgroup	Sealer
Subgroup A	EndoREZ
Subgroup B	AH Plus
Subgroup C	Roekoseal

Statistical Analysis

The comparison of depth of penetration between different sealers at apical, middle and coronal third in each group was made with the help of repeated measures ANOVA and LSD post hoc test. Intragroup comparison was performed using one-way ANOVA test and LSD post hoc test for pairwise comparison. Intergroup comparison was conducted by using the One-way ANOVA test and LSD post hoc test.

RESULTS

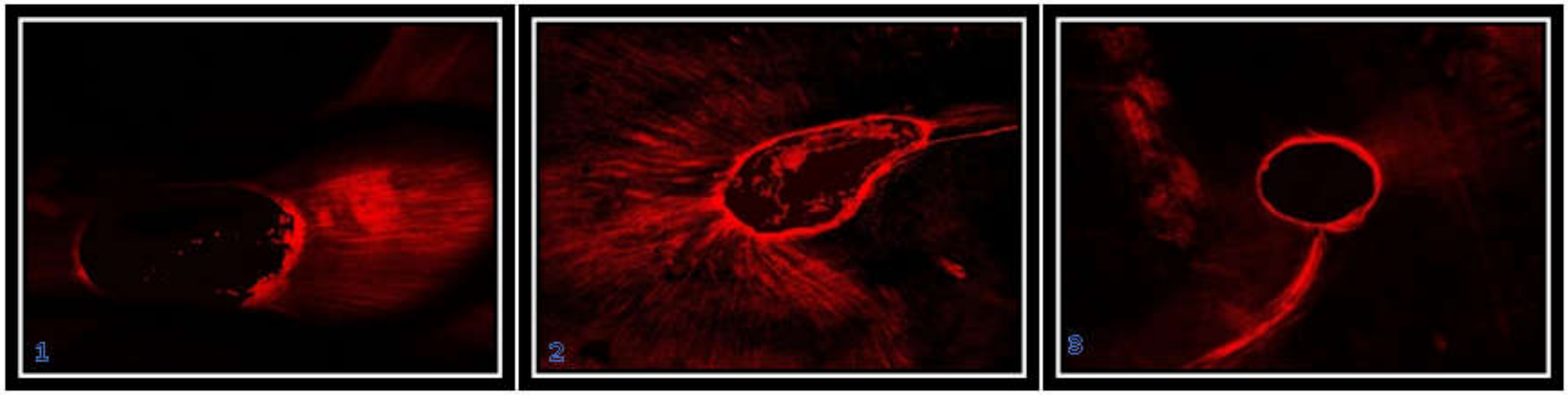
In Group 1, average mean depth of penetration of EndoREZ was found to be 2195.795. In apical, middle and coronal third it was found to be 276.93 ± 12.13 µm, 450.35 ± 7.87 µm and 506.58 ± 11.87 µm, respectively. Average mean depth of penetration of AH Plus was found to be 2096.124. In apical, middle and coronal third it was found to be 287.10 ± 8.20 µm, 461.73±9.52 µm and 518.23 ± 10.55 µm, respectively. Average mean depth of penetration of RoekoSeal was found to be 3351.971µm. In apical, middle and coronal third it was found to be 266.80 ± 8.86 µm, 437.33 ± 10.95 µm and 494. 70 ± 9.67 µm, respectively (Table 3). In Group 2, average mean depth of penetration of EndoREZ was found to be 2210.553. In apical, middle and coronal third it was found to be 290.80 ± 10.46 µm, 476.58 ± 10.84 µm and 537.10 ± 11.43 µm, respectively. Average mean depth of penetration of AH Plus was found to be 1554.370. In apical, middle and coronal third it was found to be 309.45 ± 11.23 µm, 487.53 ± 11.01 µm and 550.45 ± 11.49 µm, respectively. Average mean depth of penetration of RoekoSeal was found to be 1483.832. In apical, middle and coronal third it was found to be 278.40 ± 11.65 µm, 459.10 ± 10.99 µm and 525.95 ± 11.90 µm, respectively. (Table 3). In Group 3 where samples were prepared with OneShape, average mean depth of penetration of EndoREZ was found to be 1429.589. In apical, middle and coronal third it was found to be340.55 ± 10.34 µm, 519.60 ± 11.74 µm and 579.08 ± 11.48 µm, respectively. Average mean depth of penetration of AH Plus was found to be2295.777. In apical, middle and coronal third it was found to be 355.40 ± 9.84 µm, 544.18 ± 10.54 µm and 675.33 ± 12.43 µm, respectively.

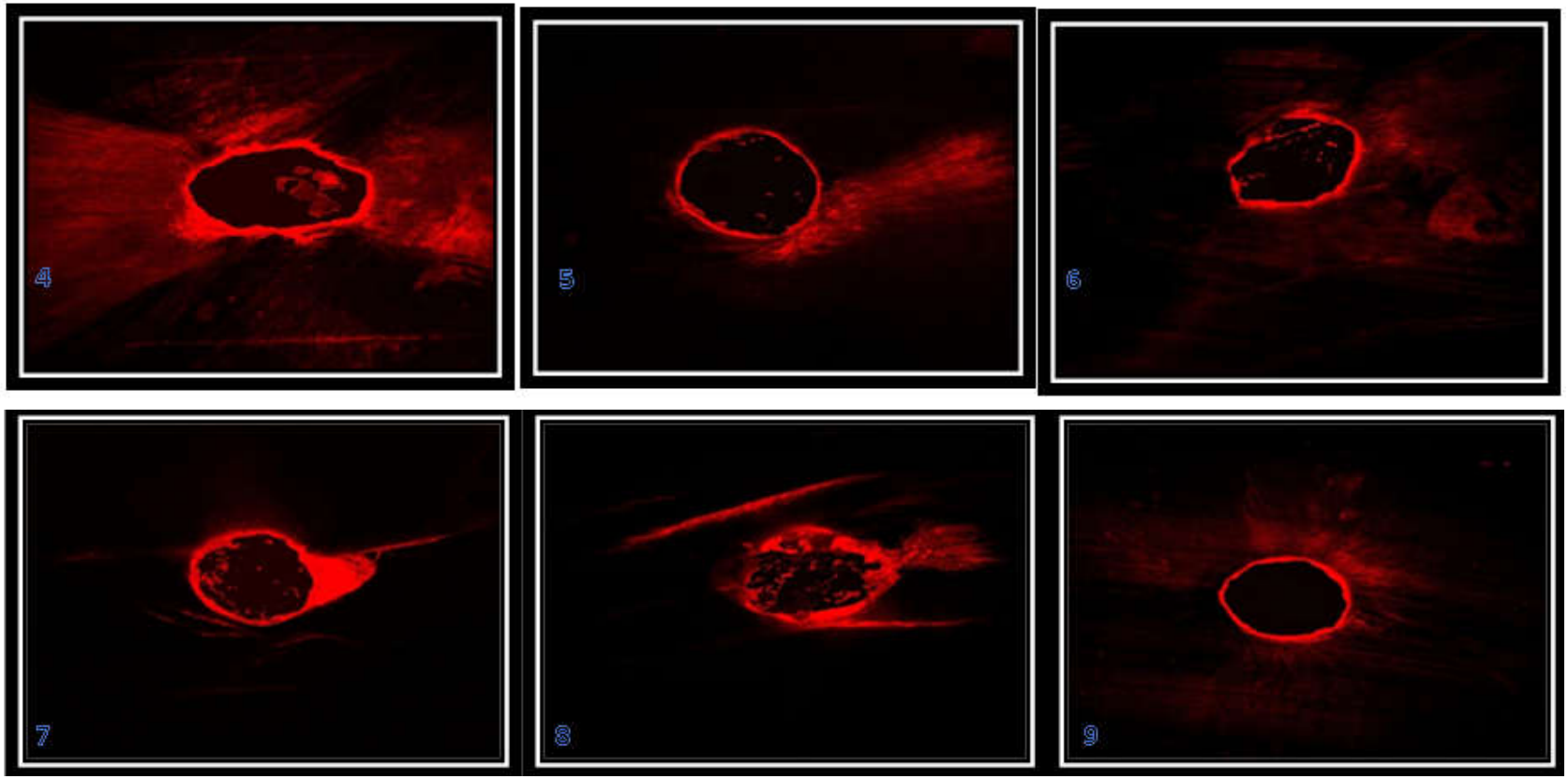
Table 3. Comparison of depth of penetration between different levels in sealers in different file system

	Sealers	Depth of penetration at different levels (Mean ± SD, µm)			Repeated measures ANOVA	LSD post hoc test
		Apical (3 mm)	Middle (6 mm)	Coronal (9 mm)		
Hand K file	Endorez	276.93 ± 12.13	450.35 ± 7.87	506.58 ± 11.87	F = 2195.795, P = 0.000 (<0.001), VHS	Coronal> Middle> Apical
	AH plus	287.10 ± 8.20	461.73 ± 9.52	518.23 ± 10.55	F = 2096.124, P = 0.000 (<0.001), VHS	Coronal> Middle> Apical
	Roekoseal	266.80 ± 8.86	437.33 ± 10.95	494. 70 ± 9.67	F = 3351.971, P = 0.000 (<0.001), VHS	Coronal> Middle> Apical
HeroShaper	Endorez	290.80 ± 10.46	476.58 ± 10.84	537.10 ± 11.43	F = 2210.553, P = 0.000 (<0.001), VHS	Coronal> Middle> Apical
	AH plus	309.45 ± 11.23	487.53 ± 11.01	550.45 ± 11.49	F = 1554.370, P = 0.000 (<0.001), VHS	Coronal> Middle> Apical
	Roekoseal	278.40 ± 11.65	459.10 ± 10.99	525.95 ± 11.90	F = 1483.832, P = 0.000 (<0.001), VHS	Coronal> Middle> Apical
OneShape	Endorez	340.55 ± 10.34	519.60 ± 11.74	579.08 ± 11.48	F = 1429.589, P = 0.000 (<0.001), VHS	Coronal> Middle> Apical
	AH plus	355.40 ± 9.84	544.18 ± 10.54	675.33 ± 12.43	F = 2295.777, P = 0.000 (<0.001), VHS	Coronal> Middle> Apical
	Roekoseal	327.83 ± 8.91	488.15 ± 9.70	542.75 ± 10.90	F = 1637.160, P = 0.000 (<0.001), VHS	Coronal> Middle> Apical

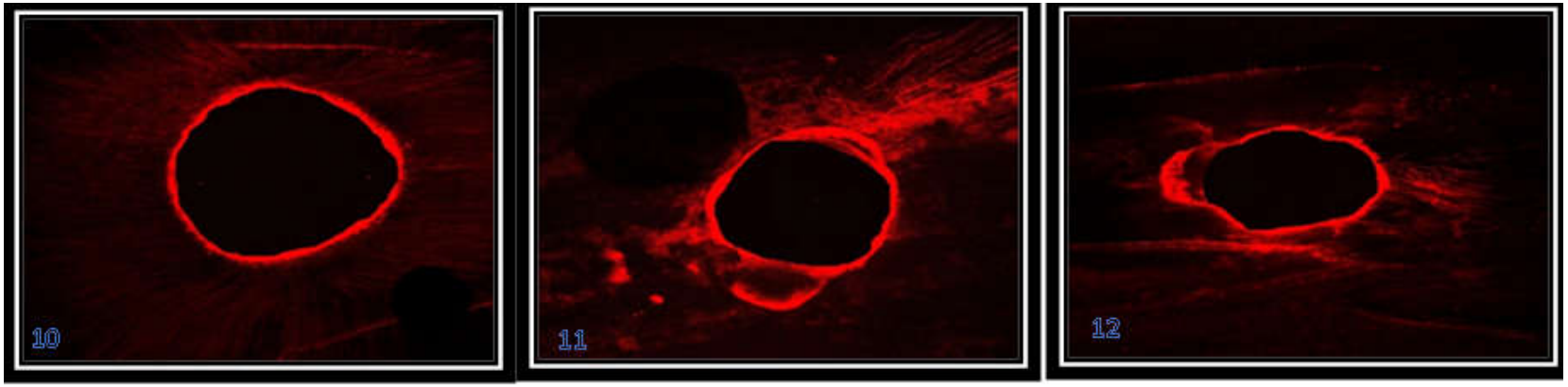
Table 4. Comparison of depth of penetration between different sealers at different levels in different file system

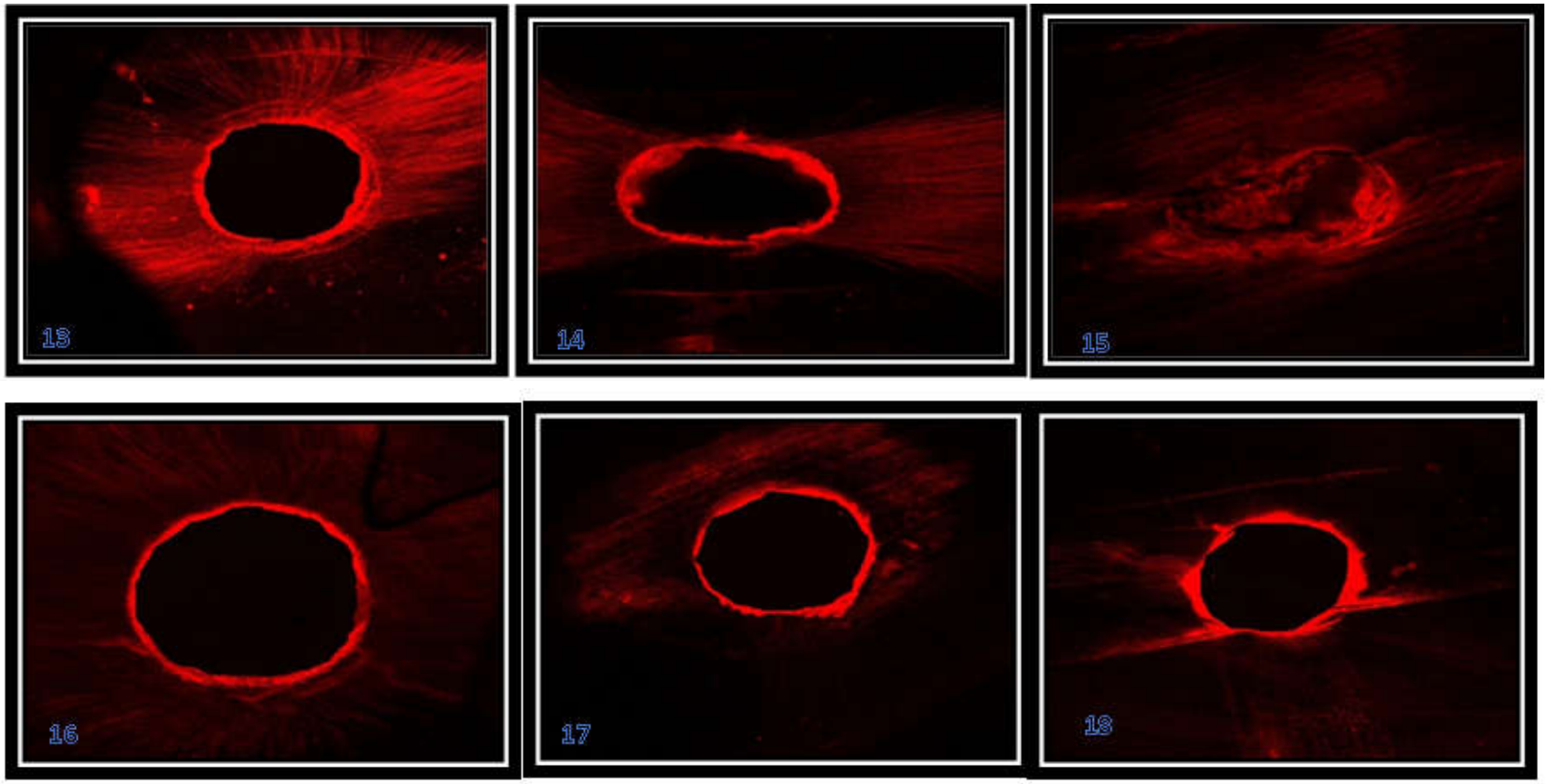
	Hand K file			HeroShaper			OneShape		
Sealers	Depth of penetration at different levels (Mean ± SD, µm)			Depth of penetration at different levels (Mean ± SD, µm)			Depth of penetration at different levels (Mean ± SD, µm)		
	Apical (3 mm)	Middle (6 mm)	Coronal (9 mm)	Apical (3 mm)	Middle (6 mm)	Coronal (9 mm)	Apical (3 mm)	Middle (6 mm)	Coronal (9 mm)
EndoREZ	276.93 ± 12.13	450.35 ± 7.87	506.58 ± 11.87	290.80 ± 10.46	476.58 ± 10.84	537.10 ± 11.43	340.55 ± 10.34	519.60 ± 11.74	579.08 ± 11.48
AH Plus	287.10 ± 8.20	461.73 ± 9.52	518.23 ± 10.55	309.45 ± 11.23	487.53 ± 11.01	550.45 ± 11.49	355.40 ± 9.84	544.18 ± 10.54	675.33 ± 12.43
Roekoseal	266.80 ± 8.86	437.33 ± 10.95	494.70 ± 9.67	278.40 ± 11.65	459.10 ± 10.99	525.95 ± 11.90	327.83 ± 8.91	488.15 ± 9.70	542.75 ± 10.90
One-way ANOVA	F = 10.554, P = 0.000 (<0.001), VHS	F = 16.410, P = 0.000 (<0.001), VHS	F = 12.005, P = 0.000 (<0.001), VHS	F = 19.729, P = 0.000 (<0.001), VHS	F = 17.151, P = 0.000 (<0.001), VHS	F = 11.169, P = 0.000 (<0.001), VHS	F = 20.193, P = 0.000 (<0.001), VHS	F = 68.968, P = 0.000 (<0.001), VHS	F = 347.542, P = 0.000 (<0.001), VHS
LSD post hoc test	AH plus>Endorez> Roekoseal	AH plus>Endorez> Roekoseal	AH plus>Endorez> Roekoseal	AH plus>Endorez> Roekoseal	AH plus>Endorez> Roekoseal	AH plus>Endorez> Roekoseal	AH plus>Endorez> Roekoseal	AH plus>Endorez> Roekoseal	AH plus>Endorez> Roekoseal



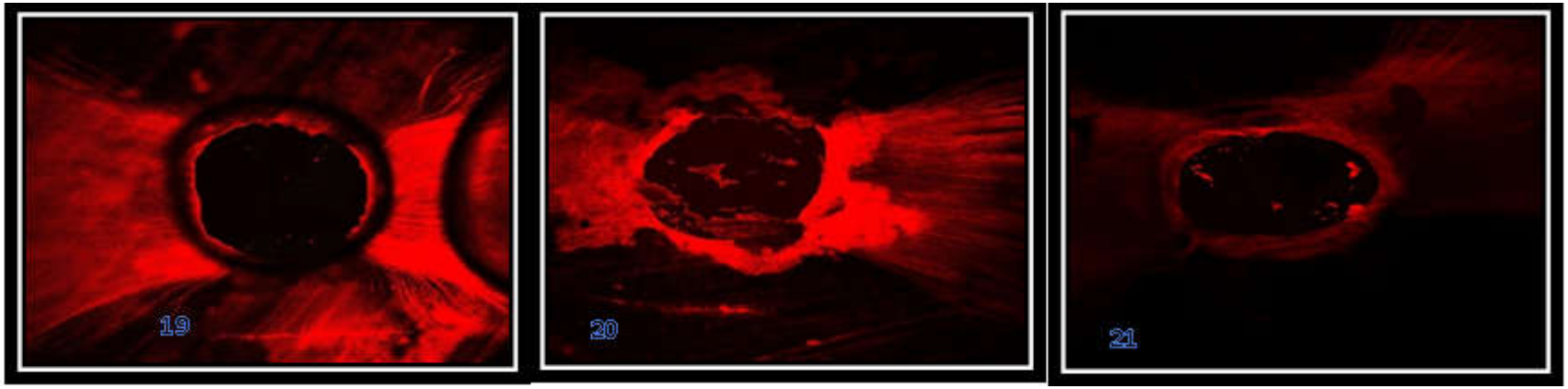


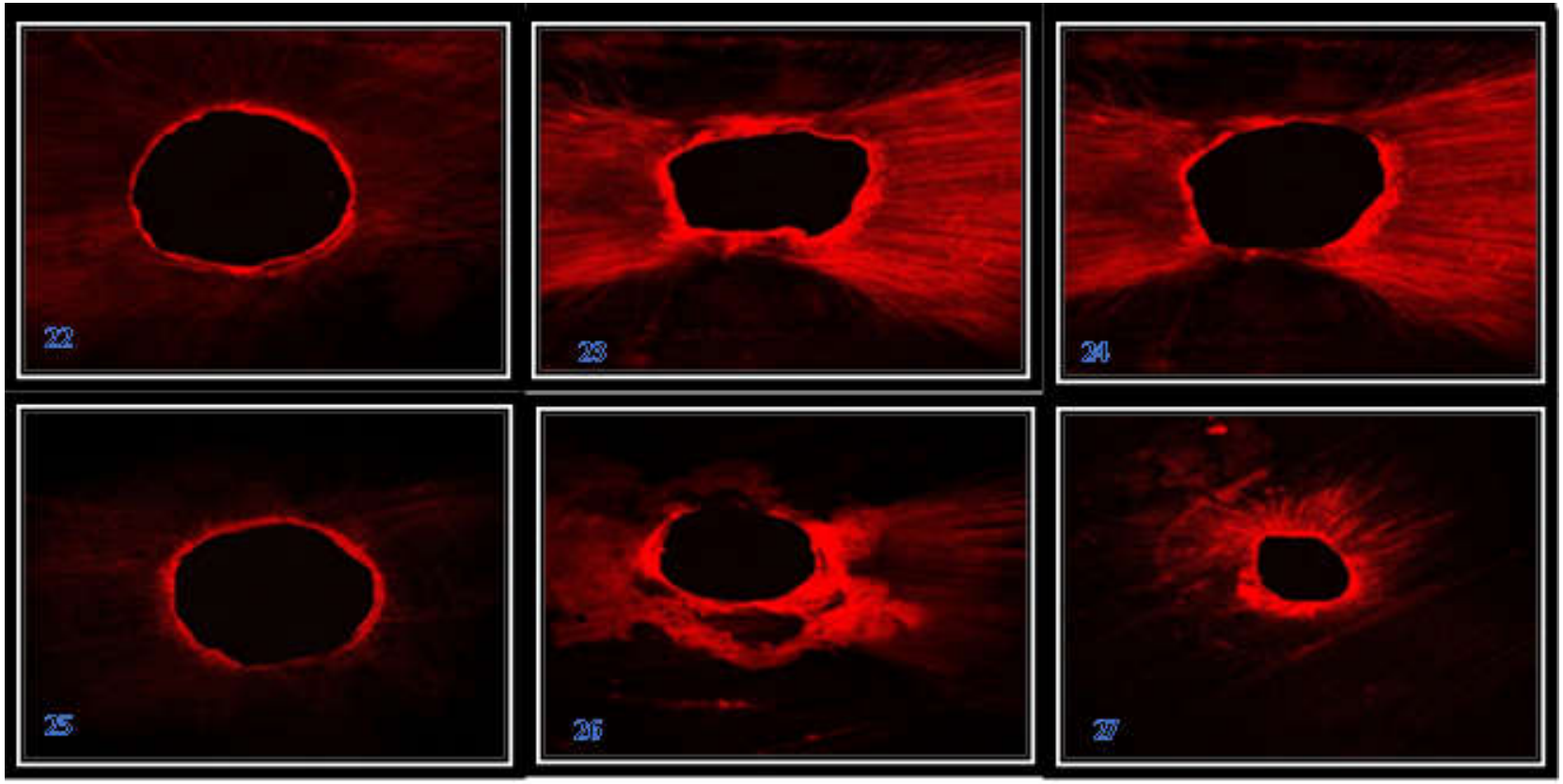
(Fig.1-9) With K file system; Depth of penetration of Endorez at 1. Coronal, 2. Middle, 3. Apical level, respectively, Depth of penetration of AH plus at 4. Coronal, 5. Middle, 6. Apical level, respectively, Depth of penetration of Roekoseal at 7. Coronal, 8. Middle , 9. Apical level, respectively





(Fig.10-18) With HeroShaper file system; Depth of penetration of Endorez at 10. Coronal, 11. Middle, 12. Apical level, respectively, Depth of penetration of AH plus at 13. Coronal, 14. Middle, 15. Apical level, respectively, Depth of penetration of Roekoseal at 16. Coronal, 17. Middle, 18. Apical level, respectively





(Fig.19-27) With OneShape file system; Depth of penetration of Endorez at 19. Coronal, 20. Middle, 21. Apical level, respectively, Depth of penetration of AH plus at 22. Coronal, 23. Middle,24. Apical level, respectively, Depth of penetration of Roekoseal at 25. Coronal, 26. Middle, 27. Apical level, respectively

Average mean depth of penetration of RoekoSeal group was found to be 1637.160. In apical, middle and coronal third it was found to be 327.83 ± 8.91 µm, 488.15 ± 9.70 µm and 542.75 ± 10.90 µm, respectively. (Table 3) On comparison between the different subgroup in group 1, the average depth of penetration at apical, middle and coronal level was found to be 10.554,16.410 and 12.005µm, in group 2, the average depth of penetration at apical, middle and coronal level was found to be19.729, 17.151 and 11.169 µm, in group 3, the average depth of penetration at apical, middle and coronal level was found to be 20.193, 68.968 and 347.542µm. (Table-4) On statistical analysis using LSD post hoc test, depth of penetration of sealers across the groups following finding were observed

- Depth of penetration of different sealers was found to be significantly higher in samples prepared with OneShape than the HeroShaper and Hand K file. (Table-3)
- Depth of penetration in coronal third was found to be significantly higher than middle and apical third. (Table-3)
- Depth of penetration with AH Plus was found to be significantly higher than that of EndoREZ and RoekoSeal. (Table-4)

DISCUSSION

During obturation, earlier zinc oxide eugenol sealer was used quite widely but it has certain drawbacks (Garg, 2014), which have been overcome by resin based sealers, The latter present better sealing ability and less chance of micro leakage and infection (D'souza, 2014). Hence comparison was made between different resin based sealers in the terms of their sealing ability and the efficacy of different type of instruments in aiding depth of penetration of different sealer in this study.

Confocal laser scanning microscopy technology (CLSM) was used for the estimation of depth of penetration of sealer because it offers several advantages over scanning electron microscopy, It does not require special specimen processing, observations can be made under near normal conditions and visualization of the resin-dentin adhesive interface can be made using fluorescence (Morgan, 1984). Irrespective of the type of sealer and file system highest sealer penetration was observed in the coronal third followed by middle and apical third respectively. This finding is obvious since number and diameter of dentinal tubules increases from the apical third to the coronal third. The number of tubule varies from 46, 798 ± 10, 644 in coronal third 30, 940 ± 7, 651 in middle third45, 192 ± 10, 888 in apical third, whereas the diameter tends to vary from 4.32 μm in coronal third to 3.74 μm in middle and 1.73 μm in apical third (Lo Giudice, 2015). Canals prepared with One Shape provided greater depth of penetration than the HeroShapers & Hand K files in coronal third and least in apical third. This finding can be explained on the basis of design, characteristics. OneShape possess different cross sections along the active length of the file, which offers an optimal and improved cutting action in the three zones of root canal, producing better and cleaner root canal surface, since more dentinal tubule are opened to a greater degree.

Both the rotary systems produced better depth of penetration than manual k file, which was found to be constant throughout the root canal. Similar to our study Bandekar et al found OneShape file to produce better root canal cleaning than other rotary file systems. The reason they assigned to this finding was the variable pitch and the helicle angle, possessing a uniform taper (Bandekar, 2016). Koçak et al also found single rotary file system to result in better debris removal from the canals than multiple rotary file systems (Koçak, 2014). In our study, HeroShaper was found to be more effective than Hand K file. Fariniuk et al. also found HeroShaper system to possess better ability of cleaning the canal as compared to manual Hand file (Fariniuk, 2011). Contrary to our finding Tomer et al found multiple file system to remove greater dentine than the single file system but the size and number of open dentinal tubule was greater with the later than former (Tomer, 2017). Amongest all the tested sealers highest penetration was found with AH Plus followed by EndoREZ and Roekoseal respectively. The variable factors affecting penetration of sealer were the different file system used for preparation and the size of different sealers used in this study. On assessing all the groups and subgroups the difference amongst the used file system and sealer produces substantial variation. This finding is in keeping with the results obtained by Kumar NS et al, who found that the adaptation and penetration of AH Plus is better. The reason they assigned for this finding was that the lateral force applied during the condensation was less in the apical third (Kumar, 2013). Balguerie E et al found that AH Plus produced better penetration in coronal third. They reasoned that the factors influencing the sealer penetration were the diameter of the dentinal tubule and the type of sealer used (Balguerie, 2007). Sevimay et al also found that resin based sealer show greater penetration in the coronal third than middle and apical due to smear layer removal which is similar to our study. The difference in the depth of penetration of different sealers tend to arises as a result of certain inherent characteristics viz. particle size, flow, dimensional change, film thickness, contact angle and pressure application (Yigit, 2012). The mean values of flow of AH Plus sealer is 9.50 mm while with EndoREZ it is 7.00 mm and with RoekoSeal 6.31 mm. The mean value of dimensional change of AH Plus sealer is 18%, EndoREZ is 21.32%, with RoekoSeal is 0.3%. (Versiani, 2006). The mean value of film thickness of AH Plus is 10.0–11.0 um, RoekoSeal is 24.9 um and EndoREZ it was found 22.9 um (Lacey, 2006 and Gambarini, 2006). The mean value of viscosity of AH Plus sealer is 320.73 (Gambarini, 2006). The contact angle value of AH Plus, RoekoSeal and EndoREZ are 87.2,87.5 and 93.2 respectively (Lacey, 2006). Singh CV et al also found that AH Plus produced maximum penetration into the dentinal tubules due to their structure and coherence of the sealers' matrix into the dentinal tubules (Singh, 2012), Schäfer E et al found that AH Plus has less solubility and better properties than EndoREZ (Schäfer, 2015). Contrary to our study Chadha et al. found the penetration depth of EndoREZ into the dentinal tubules to be significantly greater than that of AH Plus. This difference in depth of penetration might be because of application of sealer was carried out with master cone in their study, while in our study ultrasonics was employed (Chadha, 2015). Thus the null hypothesis that there is no difference in the cleaning ability of different file system leading to similar depth of penetration of different sealer stands rejected, Moreover the second hypothesis that different sealer have similar depth of penetration also stands rejected.

Conclusion

Within the limitation of this study it can be concluded that depth of penetration of AH Plus is greater than Endorez& Roekoseal respectively. Hence AH Plus should be the preferred sealer. Depth of sealer penetration is greater in the coronal third than middle and apical third of the root canal. OneShape is a better and useful tool for preparation of the canal in single visit as compared to other rotary file system. Its design allows faster preparation of the canal and has greater fracture resistance. Moreover preparations with OneShape leads to better penetration of sealers. But to draw more conclusive results a wider study needs to be undertaken.

Conflict of Interest: No

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