

MANUSCRIPT

Essential Title page information

Title: TO COMPARE THE PURSUANCE OF ULTRASONIC ACTIVATION AT
DISTINCT PLANES OF ENODONTIC THERAPY ON FILLING SUPERIORITY OF
DIFFERENT ROOT CANAL SEALERS.

ABSTRACT

Aim: The purpose of this study was to evaluate the influence of ultrasonic activation at different levels of endodontic therapy on filling quality of various sealers.

Materials and methods: Sixty extracted human single rooted teeth were divided into 4 groups (n=15) based on the sealer used to obturate the root canal instrumented upto F4 pro taper. These groups were subsequently divided into 3 sub-groups (n=5) each depending on the activation protocol followed in the study (ie, no activation of irrigant /sealer, activation of final irrigant, activation of both irrigant and sealer). All samples were sectioned at 2, 4, 6 mm from apex. The percentage of sealer penetration of root canals were analysed.

Results: In the groups where the final irrigant & sealer was ultrasonically agitated showed statistically significant increase in sealer penetration when compared to other groups.

I Root SP (D) showed statistically significant difference in sealer penetration when compared to ZOE, AH plus, & HRS.

Conclusion: The tubular penetration depth varies with the different physical and chemical properties of the sealers used. The use of ultrasonic activation at different levels of endodontic therapy facilitated better dentinal sealer penetration with I Root SP and AH Plus. I-root SP has solely satisfied & surpassed the test of better sealer penetration even at the apical level.

Key words: Sealer Penetration, Ultrasonic Activation, AH PLUS, I ROOT SP, Bio ceramic Sealer.

INTRODUCTION

In the Root canal system, pulpal and peri apical diseases are primary ones for which microorganisms and their by products are inciters (4). A successful root canal therapy aims at complete disruption of microorganisms from the bio-frame. Biomechanical preparation, a paramount phase for infection-expulsion (1), is the germinal stage in infection-preventive manoeuvring (2). Fluid tight root canal filling and coronal restoration are the best modus-operandi for effective-sealing aiming at prevention of reinfection and is envisaged as the main objective (3).

Hence, endodontic success mainly depends on: “effective cleaning of the root canal system and effective sealing”

Irrigation, an obligatory and vital part of biomechanical preparation relies both on mechanical flushing action and chemical ability of irrigants to dissolve tissue (6, 7). An expectation that magnitudinal-increase of irrigant would facilitate their improvement of flushing action and efficacy of debris-removal is false. A satisfactory way of hastening the effect of task is by the use of ultrasonic action in conjunction with irrigant (8, 9).

Standard root canal filling is a combination of sealer cement and central core material. The core acts as a piston on the flowable-sealer, diligently spreading it, filling voids, to wet and attach to the instrumented dentinal wall. Several kinds of sealers are used in endodontic practice with each having its own flaws and merits and are basically selected during the operational purpose contemplating their sealing ability.

Regarding the quality of the seal obtained with GP and conventional ZOE sealer, it is quite imperfect (10, 2). Despite its strong traits, the GP and conventional sealer combination disfavours ability to strengthen root, un-adhering to dentin, under-control of micro leakage & solubility of sealer makes prognosis unfavourable and unassuring (11, 12, 13).

Hence several new sealers have come in vogue to substitute ZOE which will suffice in improving the root canal seal imparting more strength. Such enhanced sealers include epoxy resin-based sealers with possibility of adhesion to dentin and with lower water solubility and hybrid root

seal which is a self-etching methacrylate resin-based sealers based on hybridization and biocompatibility (10, 2). A Recently reased sealer is I Root SP, which is a bioceramic sealer and is based on formation of monoblock, being known for its low water absorption.

The activation of root canal sealer can possibly favour its penetration into dentinal tubules providing increased stability and antimicrobial effects (14). The outcome of ultrasonic activation of sealer in root canal and its filling quality are yet to be deciphered. Thus, ongoing research study aimed at comparing the influence of ultrasonic activation at different levels of endodontic therapy on the filling quality of different root canal sealers. The null hypothesis tested was that ultrasonic activation does not improve the filling quality of sealers.

OBJECTIVES:

Evaluation and comparison of the effect of ultrasonic activation of irrigant and ultrasonic activation of sealer on tubular penetration depth of different sealers.

MATERIALS AND METHODS

60 single rooted premolars extracted for the reasons other than the study with root curvature less than 5° have been selected. Ethics Committee approved the use of these teeth for the research. The calculus and debris on the roots were removed with a periodontal scaling unit. Teeth were disinfected in 0.5% chloramine solution for 48hrs and stored in distilled water until use.

The teeth were decoronated using 0.3mm low speed diamond disc standardizing the root length to 15mm. 10 K file is inserted into the canal until it is visible at the apical foramen. Then the working length is established by subtracting 1mm from it. The root canal shaping is performed using protaper rotary instruments upto F4 protaper file. Between instruments, the canals were irrigated with 2 ml of 3% NaOCl (Vishal Dentocare Pvt. Ltd, Ahmedabad, India). A final flush of 2ml of 17% EDTA (Canalarge, Ammdent, Chandigarh, India) is carried out for 3 min to eliminate the smear layer. All the irrigants were delivered using 27 gauge needle placed as far into canal as possible without binding. The canals in all groups were finally washed with 5 ml of saline solution

and dried using paper points of size 30 (6% taper) (Pearl Dent Co. LTD. Hochiminh, Vietnam).

The specimens were randomly divided into four groups [(A,B,C,D) (n=15)] according to the sealer used to obturate the root canal.

GROUP A- ZOE sealer (Vishal Dentocare, Ahmedabad, Gujarat, India)

GROUP B- AH Plus sealer (Dentsply International)

GROUP C- Hybrid root seal (sun medical, New Delhi)

GROUP D- I Root SP (Innovative BioCeramix Inc. (IBC), Canada)

Each group is further divided into 3 sub-groups depending on the activation protocol (Box -1) followed in the study.

Box -1

A1,B1,C1,D1 - No activation of either irrigant or sealer

A2,B2,C2,D2 - ultrasonic activation of final irrigant

A3,B3,C3,D3 - ultrasonic activation of both final irrigant and sealer

The sealers are manipulated according to the manufacturer's instructions. For the visualization in confocal microscopy, the sealers are mixed with Rhodamine B fluorescent dye (Chennai Chemicals, Chennai, India) to an appropriate concentration of 0.1%. The sealers are placed in each root canal by using a size 30 rotary lentulospiral maintaining the instrument 4mm from the apex. For ultrasonic activation of either irrigant or sealer the ultrasonic tip (F43807 IRR 20-21 mm, acteon

satelec) is activated for 20 sec in buccolingual and another 20 sec in mesio-distal direction of the root canal, 2mm short of working length.

All specimens are obturated using the single cone technique with matching taper to obtain standardized specimens. Specimens are sealed with provisional filling material and stored in 100% humidity at 37°C for 1 week (Yorco sales pvt. Ltd. New Delhi) to allow sealer to set.

SEGMENT OF SEALER PENETRATION:

After 1 week each specimen is sectioned perpendicular to the long axis using 0.3 mm isomet saw at low speed and water coolant. Horizontal sections were made for all the specimens at 2, 4, and 6mm levels from the apical foramen and polished with sand paper with the thickness of the specimen being 1 ± 0.1 mm.

The segments of the root canal in which the sealer penetrated into dentinal tubules were analyzed on an inverted Laica TCS-SPE confocal laser scanning microscope.

STATISTICAL ANALYSIS:

The data obtained was statistically analyzed using One Way ANOVA, and 't' – tests, whereas multiple comparisons were done using Post Hoc Tests.

RESULTS:

Comparing Dentinal Sealer Penetration -

In case of A,B,C there is no significant difference between the groups. That is no significant difference between A1,B1,C1 when compared with A2,B2,C2, but A3,B3,C3 showed statistically significant difference

In regard to D, there is a statistically significant difference between D1,D2,D3 (Table -1)

2.Comparing The Sealers At Different Activation Levels-

No Activation Of Either Irrigant / Sealer-

There is no difference Between the A1 and C1 groups, D1 showed a highest value followed by B1 which is followed by C1 which showed similar value to A1.

A1=C1 <B1 < D1 [Figure -1]

Activation Of Final Irrigant-

A2< B2= C2< D2.

Activation Of Both Final Irrigant And Sealer-

I Root SP (D) showed an overall statistically significant increase in sealer penetration when compared to ZOE, AH plus, & HRS. (A,B,C) [Table 2], [Figure-2], [Fig-4, Fig-5, Fig-6 (Pink colour indicates amount of sealer penetration)]

3.Comparing The Sealer penetration At Different Root Sections (Coronal, Middle , Apical) -

In the groups where the final irrigant & sealer was ultrasonically agitated, showed statistically significant difference between the coronal, middle and apical sections when compared to their respective non agitated groups. (Table -3), [Figure-3], [Fig-4, Fig-5, Fig-6]

DISCUSSION

Meticulous disinfection of the most apical part of any preparation remains demanding (15). Nevertheless, the finer way to clean is through manoeuvring irrigating solutions (16), as mechanical cleansing of webs and fins is intractable (17). The aim was to evaluate the effect of ultrasonic activation on the filling quality of different sealers. Null hypothesis was rejected as ultrasonic activation ameliorated the filling quality of sealers.

It has been validated that an irrigant in concomitance with ultrasonic vibration, generates an unrelenting movement of irrigant and is directly associated with effectiveness of cleaning of the root canal space (18).

In this study, EDTA was used as a final irrigant to peel-off the smear layer and is ultrasonically activated to make canals squeaky-clean (19).

In line with the results mentioned previously, the present study even showcased that ultrasonic activation at different levels favoured a greater dentinal-sealer-penetration which can promote a high contact and confinement of micro-organisms present in dentinal tubules (20).

Many factors contribute to the sealer penetrating into the dentinal tubules like smear layer removal (21), dentinal permeability (the number and the diameter of tubules), root canal dimensions, and the physio-chemical properties of the sealer (22, 23, 24). Flow is one of the prominent chemical/physical factors stresses upon determination of consistency, particle size, shear rate, temperature, time, internal diameter of the root canal, and the rate of insertion (24). It is quintessential as it reflects the ability to penetrate into small irregularities and ramifications of the root canal system and dentinal tubules and ultimately propelling into the uninstrumented accessory root canal anatomy (23).

The sealer penetration into dentinal tubules can be beneficial, that is

Preventing reinfection because of sealers antibacterial property and by locking the residual microorganisms in dentinal tubules (25, 26) and the sealer inside the tubules promotes a mechanical interlocking, improving material retention (25, 27).

Adriana Simionatto et al reported the performance of lateral condensation technique and single cone technique comparing all the typical sealer placement methods (using GP cone, K file, lentulospiral). Significant difference in the percentage-statistics filling material has not been encountered in lateral condensation technique while in single cone technique the sealer

placement method interfered the filling quality with lentulospiral being beneficial (28). Hence lentulospiral has been used in the present study.

According to Weis and Sevimay *et al*, the penetration in the dentinal tubules was significantly greater in the coronal and middle of the root canal than the apical part of the root canal and also earned the support of other studies(23, 29). In fact the reason would be that the apical root canal contains less tubules, moreover, the diameter of the merely present tubules is smaller or they are more often closed (30, 31, 32). Furthermore, the apical portion of roots show a pronounced variation in structure (32).

Previous studies claim that ultrasonic activation promoted better sealer penetration at 6mm & 4mm but did not figure out any significant difference at 2mm level, Nonetheless, according to the results obtained , the present study showed a notable sealer penetration even in the 2mm minor section.

The following explanation suffices this, i.e, EDTA which was used as a final irrigant has been ultrasonically agitated. Previous study reported that ultrasonic activation results in a better irrigation at 4mm and 2mm from working length when compared to traditional needle irrigation (33) and also the effect of ultrasonic vibrations will be more effective at the tip of the file than along its length (19).

The cornerstone-reasons for the better performance of the novel filling material I root SP are low particle size (incorporated nano particles in I Root SP), hydrophilicity, low contact angle which eases the spread of cement over the dentinal walls of root canal elegantly, gain ingress into it and fills the dentinal tubules and lateral canals (34). Next parallelly prosperous one, but little subsidiary is AH Plus, an epoxy Resin based sealer, known to have adequate flow and deeper penetrability, owing to their thin film structure (35).

CONCLUSION

The tubular penetration depth varies with the different physical and chemical properties of the sealers used. The use of ultrasonic activation at different levels facilitated

better dentinal sealer penetration with I Root SP and AH Plus. I-Root SP has solely satisfied & surpassed the test of better sealer penetration even at the apical level.

ACKNOWLEDGEMENTS

I affirm that I have no financial affiliation (Eg, Employment, direct payment, stock holdings, retainers, consultant ships, patent licensing arrangements or honoraria), or involvement with any commercial organization with direct financial interest in the subject or materials discussed in this manuscript, nor have any such arrangements existed in the past three years).

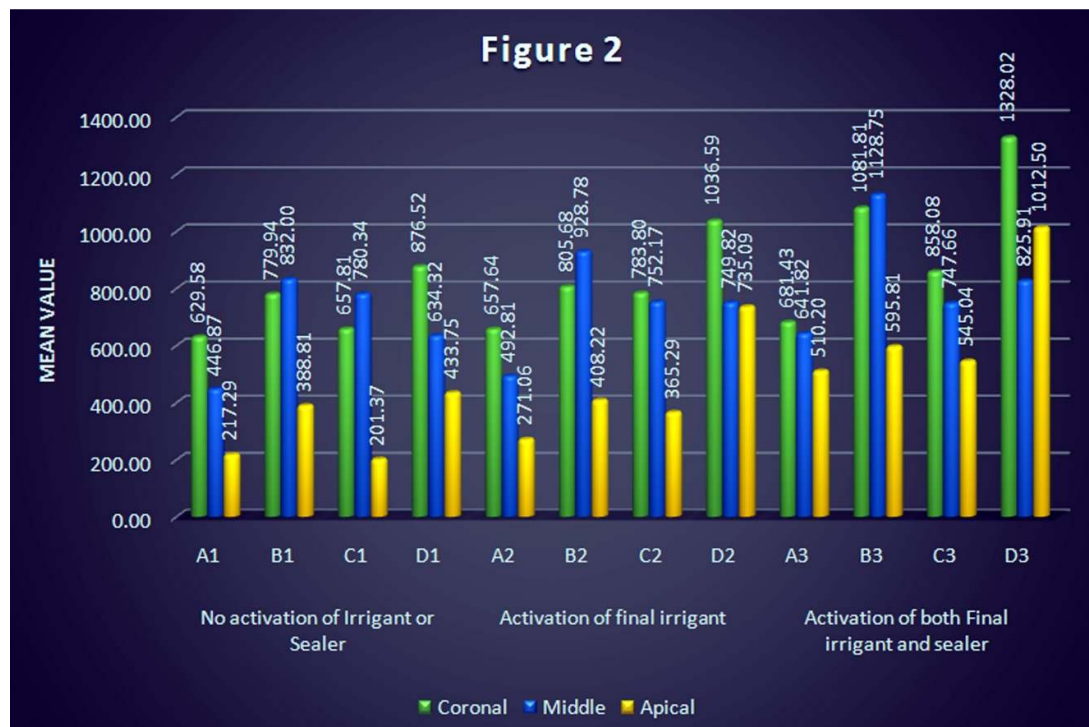
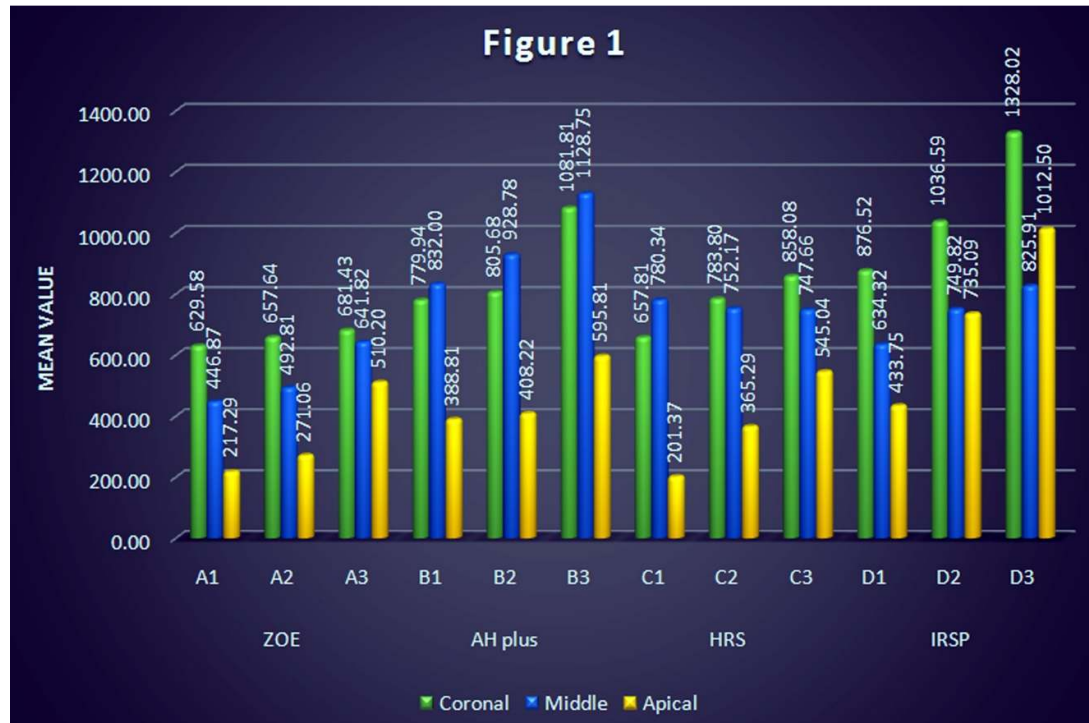
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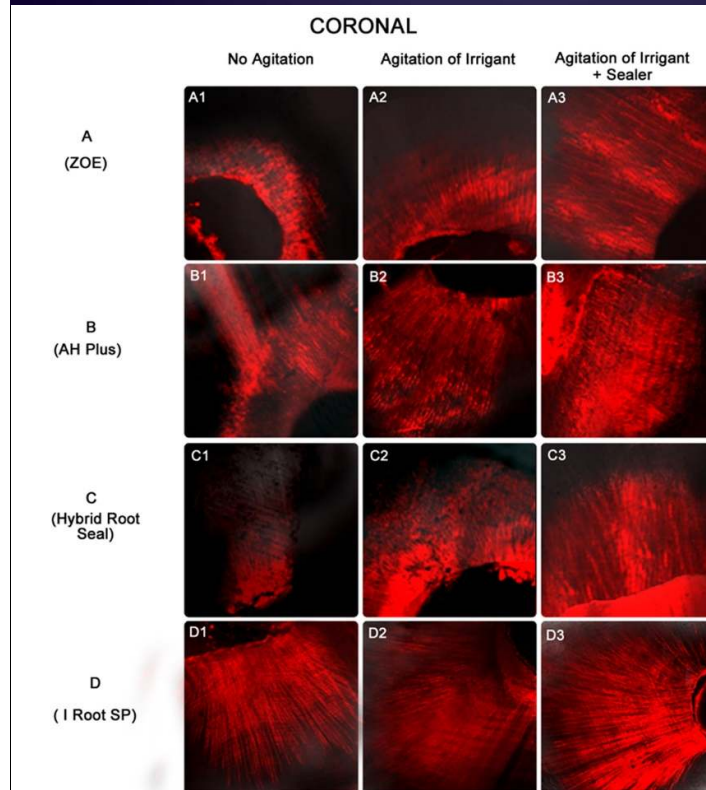
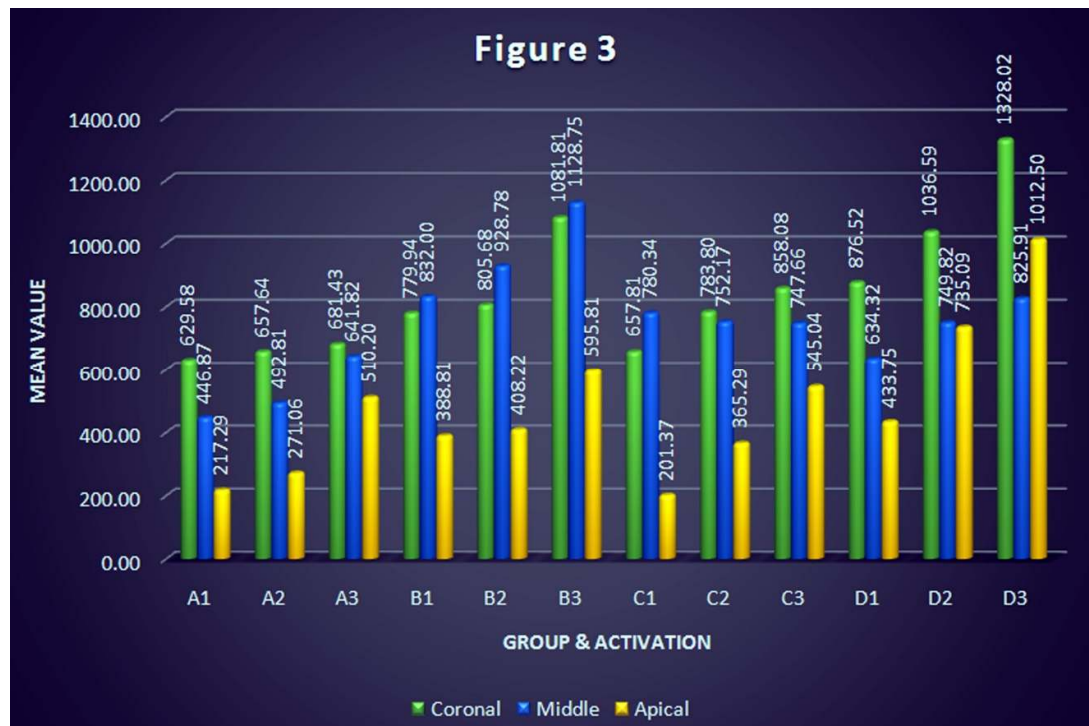


FIGURE 4

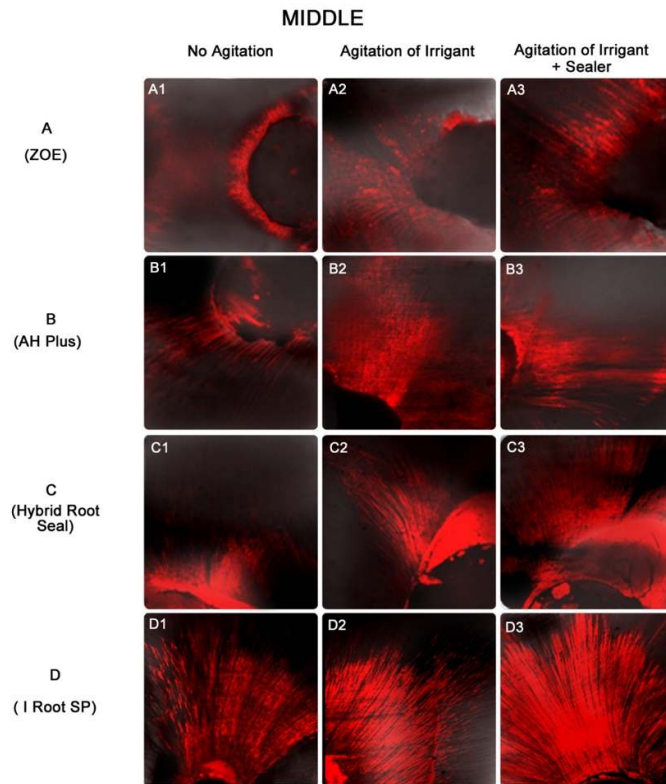


FIGURE 5

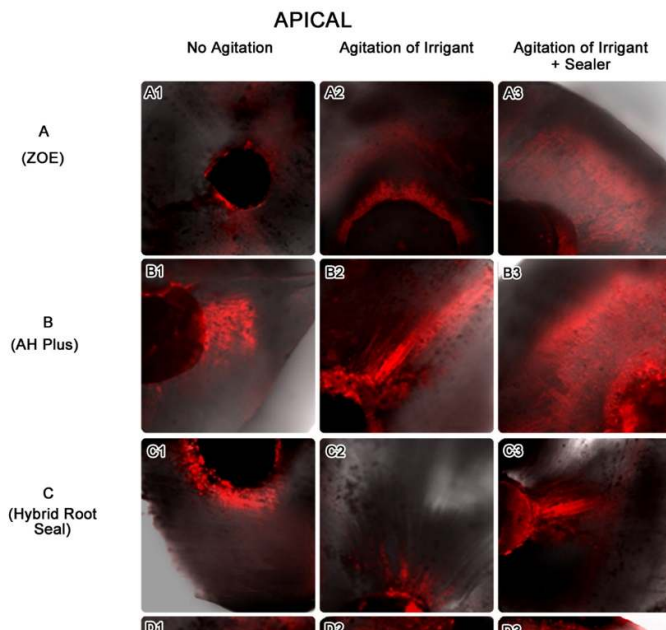


FIGURE 6

RESULTS:

TABLE : 1

Group	Activation	Coronal	Middle	Apical
ZOE	A1	629.58 ± 15.32 ^a	446.87 ± 16.24 ^a	217.29 ± 39.69 ^a
	A2	657.64 ± 15.74 ^{ab}	492.81 ± 52.27 ^a	271.06 ± 43.68 ^a
	A3	681.43 ± 16.99 ^b	641.82 ± 41.56 ^b	510.20 ± 14.52 ^b
AH plus	B1	779.94 ± 27.02 ^a	832.00 ± 45.80 ^a	388.81 ± 42.93 ^a
	B2	805.68 ± 27.97 ^a	928.78 ± 34.30 ^b	408.22 ± 26.46 ^a
	B3	1081.81 ± 21.02 ^b	1128.75 ± 45.64 ^c	595.81 ± 81.04 ^b
HRS	C1	657.81 ± 34.26 ^a	780.34 ± 43.73 ^a	201.37 ± 49.10 ^a
	C2	783.80 ± 17.91 ^b	752.17 ± 53.87 ^a	365.29 ± 25.24 ^b
	C3	858.08 ± 31.34 ^c	747.66 ± 22.71 ^a	545.04 ± 20.76 ^c
IRSP	D1	876.52 ± 19.64 ^a	634.32 ± 25.93 ^a	433.75 ± 24.96 ^a
	D2	1036.59 ± 27.79 ^b	749.82 ± 32.82 ^b	735.09 ± 24.25 ^b
	D3	1328.02 ± 15.42 ^c	825.91 ± 24.60 ^c	1012.50 ± 27.09 ^c

Different alphabets denotes significant difference among activations within group

TABLE : 2

Activation	Group	Coronal	Middle	Apical
No activation of irrigant or sealer.	A1	629.58 ± 15.32 ^a	446.87 ± 16.24 ^a	217.29 ± 39.69 ^a
	B1	779.94 ± 27.02 ^b	832.00 ± 45.80 ^b	388.81 ± 42.93 ^b
	C1	657.81 ± 34.26 ^a	780.34 ± 43.73 ^b	201.37 ± 49.10 ^a
	D1	876.52 ± 19.64 ^c	634.32 ± 25.93 ^c	433.75 ± 24.96 ^b
Activation of final irrigant.	A2	657.64 ± 15.74 ^a	492.81 ± 52.27 ^a	271.06 ± 43.68 ^a
	B2	805.68 ± 27.97 ^b	928.78 ± 34.30 ^b	408.22 ± 26.46 ^b
	C2	783.80 ± 17.91 ^{bc}	752.17 ± 53.87 ^c	365.29 ± 25.24 ^{bc}
	D2	1036.59 ± 27.79 ^d	749.82 ± 32.82 ^c	735.09 ± 24.25 ^d
Activation of both final irrigant and sealer	A3	681.43 ± 16.99 ^a	641.82 ± 41.56 ^a	510.20 ± 14.52 ^a
	B3	1081.81 ± 21.02 ^b	1128.75 ± 45.64 ^b	595.81 ± 81.04 ^a
	C3	858.08 ± 31.34 ^c	747.66 ± 22.71 ^c	545.04 ± 20.76 ^a
	D3	1328.02 ± 15.42 ^d	825.91 ± 24.60 ^d	1012.50 ± 27.09 ^b

Different alphabets denotes significant difference among groups within Activations

TABLE : 3

Group & Activation	Coronal	Middle	Apical
A1	629.58 ± 15.32 ^a	446.87 ± 16.24 ^b	217.29 ± 39.69 ^c
A2	657.64 ± 15.74 ^a	492.81 ± 52.27 ^b	271.06 ± 43.68 ^c
A3	681.43 ± 16.99 ^a	641.82 ± 41.56 ^a	510.20 ± 14.52 ^b
B1	779.94 ± 27.02 ^a	832.00 ± 45.80 ^a	388.81 ± 42.93 ^b
B2	805.68 ± 27.97 ^a	928.78 ± 34.30 ^b	408.22 ± 26.46 ^c
B3	1081.81 ± 21.02 ^a	1128.75 ± 45.64 ^b	595.81 ± 81.04 ^c
C1	657.81 ± 34.26 ^a	780.34 ± 43.73 ^a	201.37 ± 49.10 ^b
C2	783.80 ± 17.91 ^b	752.17 ± 53.87 ^a	365.29 ± 25.24 ^b
C3	858.08 ± 31.34 ^a	747.66 ± 22.71 ^b	545.04 ± 20.76 ^c
D1	876.52 ± 19.64 ^a	634.32 ± 25.93 ^b	433.75 ± 24.96 ^c
D2	1036.59 ± 27.79 ^a	749.82 ± 32.82 ^b	735.09 ± 24.25 ^b
D3	1328.02 ± 15.42 ^a	825.91 ± 24.60 ^b	1012.50 ± 27.09 ^c

Different alphabets denotes significant difference among Coronal, Middle and Apical levels

Table -1 & Figure -1: Comparing sealer penetration of different sealers.

Table – 2 & Figure - 2: Comparing the sealers at Different Activation Levels

Table – 3, & Figure 3: Comparing the sealer penetration at Different Root Sections (Coronal, Middle, Apical) –

Figure 4: Coronal sections showing the amount of sealer penetration at different agitation levels. (Pink colour indicates amount of sealer penetration)

Figure 5: Middle sections showing the amount of sealer penetration at different agitation levels. (Pink colour indicates amount of sealer penetration)

Figure 6: Apical sections showing the amount of sealer penetration at different agitation levels. (Pink colour indicates amount of sealer penetration)