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# Comparative evaluation of fracture resistance of endodontically treated teeth, irrigated using Sodium Hypochlorite, Smear clear, and ASEP-RC as final irrigating solutions: an in-vitro study

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**ABSTRACT:** Various solutions have been used for chemo mechanical preparation during endodontic treatment. However there have been reports suggesting that there might be some detrimental effects of these irrigants on the fracture resistance of root canal treated dentin.

**Aims:** The aim of this study is to compare and evaluate the effects of different irrigants, on the fracture resistance of endodontically treated teeth.

**Methods:**Eighty freshly extracted, single rooted human mandibular premolars were selected. Access cavities were prepared, working lengths weremeasured and root canals were prepared till #45 K-file(MANI, INC., Japan). 5ml Normal Saline was used for irrigation during preparation. After preparation, they were divided into following groups: Group I-Normal Saline, Group II- ASEP-RC(Anabond Stedman pvt. ltd. Chennai, India), Group III-SmearClear (Kerr Corp. CA) and Group IV- 2.5% NaOCl(Sodium Hypochlorite, PRIME Dental Products, Maharashtra, India). Obturation was done using Gutta Percha with cold lateral compaction. Teeth were incubated at 37°C and 100% humidity for a week. Fracture resistance was tested for the teeth under a Universal Testing Machine(UTM). One-way ANOVA and one-way Tukey HSD test were used for the comparative analysis of the groups and significance level was set at 0.001.

**Results:**Group III (SmearClear) showed significantly higher values of fracture resistance compared to other groups.

**Conclusion:** Roots that were irrigated using SmearClear demonstrated higher fracture resistance compared to the other groups.

**Keywords:** Irrigants,NaOCl,SmearClear, ASEP-RC, Fracture Resistance.

## I. INTRODUCTION

Success of endodontic therapy depends upon efficient chemo-mechanical preparation and subsequent obturation to provide a complete sealing of the root canal spaces.The removal of microorganisms may be achieved using various irrigants and intracanal medicaments.An irrigating solution, ideally, should debride, lubricate, dissolve the smear layer formed and eliminateall the microorganisms from the root canal systems.

NaOCl(Sodium Hypochlorite)is the traditional, most commonly used irrigant. It is, however unable to remove the smear layer which is produced during canal instrumentation.[1] Studies have also related sodium hypochlorite irrigation with dentin micro-hardness reductionand weakening by reduction of dentin flexural strength and elastic modulus.[2] For effective irrigation apart from NaOCl, new irrigating agents such as SmearClear (Kerr Corp. CA), ASEP RC (Anabond Stedman pvt. ltd. Chennai, India), have also been introduced.

ASEP-RCis a new irrigant consisting of 2% CHX (Chlorhexidine) solution, which has excellent antimicrobial activity and a unique property, called substantivity, that allows it to adsorb onto dentine

surface and prevents colonization of microbes on the dentine for some time even after the actual time period of contact.[3]

SmearClear a product containing 17% Ethylene diamine tetra aceticacid (EDTA) solution along with cetrimide and additional proprietary surfactants has been in the market since it was introduced back in 2006.[4]Action of an irrigating solution on the dentinal walls depends on the ability of the solution to wet the solid dentine, which again dependent on a low value of surface tension.[5] This can be achieved by virtue of the surfactants in SmearClear.

There is little scientific knowledge about the effects of irrigating solutions, like ASEP-RC, and SmearClear on root dentin strength of endodontically treated teeth and their comparison with NaOCl.Hence, this study was done to evaluate the effects caused by using these irrigants, on the fracture resistance of root dentin of root canal treated teeth. The null hypothesis was that there was no effect of final irrigation protocols on the fracture resistance of endodontically treated teeth.

## II. METHODS

Eighty freshly extracted, single rooted human mandibular premolars stored in normal saline after extraction, were selected. Each tooth was radiographed and examined to check for straight single canal and completed roots. They were decoronated at CEJ(Cemento Enamel Junction) with a diamond disk to obtain roots of approximately 14mm length. Access cavities were prepared and working lengths (WL) were measured using a #10 K-file (MANI, INC. Japan); root canals were prepared upto K files #45(MANI, INC. Japan). During preparation, irrigation was performed using 5ml saline solution. After this, they were divided into 4 groups, and irrigated for 1 minute each with the respective irrigating solutions:

Group I: normal saline
Group II: ASEP-RC
Group III: SmearClear
Group IV: 2.5%NaOCl

Final rinsing was done with 5ml saline in all groups. The samples were obturated using Gutta Percha (Dentsply Sirona, Canada) with cold lateral compaction technique and Sealapex (Kerr Dental Corp. USA) sealer. Excess GP was removed to 1-2 mm below CEJ. The samples were sealed and restored using temporary filling material (Orafil-G, PrevestDenpro, Digiana, Jammu, India). They were stored after wrapping in moist gauze in incubator at 37°C for 1 week. Root surfaces were covered using 0.2 to 0.3 mm baseplate wax (Carmel Industries, Canada)upto 1-2mm below CEJ (cemento enamel junction) to simulate Periodontal Ligament (PDL). Roots were mounted vertically in thick copper rings using self cured acrylic resin. They were placed on the lower plate of Universal Testing Machine (Lloyd Instruments, 50 HK, USA); upper plate included a steel spherical tip with a diameter of 5mm. Forces were applied at 1mm/min until fracture occurred; force was recorded in Newtons(N).

## III. RESULTS

The data was analysed using one-way ANOVA and one-way Tukey HSD test for the groups.

[Table 1] shows, the distribution of mean ±Standard deviation (S.D.). Fracture resistance of Saline, ASEP RC, SmearClear and NaOCl groups are 312.35 ±7.819, 350.78 ±11.857, 504.75 ±21.535 and 414.26±11.973 respectively.

[Table 2] shows, the multiple comparison of mean difference of fracture resistance between groups by Tukey's HSD test; the mean difference of fracture resistance between Saline vs ASEP RC (38.433), Salinevs SmearClear 192.398, Saline vs NaOCl (101.904), ASEP RC vs SmearClear (153.965), ASEP RC vs NaOCl (63.471), SmearClear vs NaOCl (90.495) are highly significant, ($p<0.001$).Moreover, the fracture resistance of SmearClear group is significantly higher than other groups.Also, [Figure – 1] shows a pictorial representation depicting the comparisons of the means of fracture resistances of the four groups.

## IV. DISCUSSION

Root Canal irrigantscause a change in the composition of dentin, both chemically and structurally, by altering its characteristics like permeability and solubility.[6]Moreover, preparing the root canals using any of the hand, rotary or reciprocating instruments also negatively affects the strength of the tooth and leads to a decrease in its fracture resistance , as shown by Shantiaee Y et al.[7,8]According to Voilich D R et al., as dentin is cut, the mineralised tissues are not shredded but are crushed to produce significant amounts of debris, a large part of which is composed of very tiny particles of mineralised collagenous matrix that spreadsevenly over the entire surface to form what is called the smear layer.[9] Studies like those of Prado M et al. have shown that the root canal irrigants influence the bond strength of resin sealers to dentin either by removing the smear layer or affecting the surface properties of the dentin of root canals.[10]There has been report by Johnson ME et al. that stated that endodontic sealers should bond

to the dentin to reinforce root fracture resistance.[11]The strength of the roots may increase via removal of smear layer, which allows root canal sealers to contact the root canal wall by penetration into the dentinal tubules.[12]As shown in a study done by Patil P H et al., normal Saline solution basicallyhas a flushing action. It can wash out debris generated from instrumentation. However it has no effect on the smear layer.[13]Hence as stated before, due to the action by the hand files, the smear layer produced was not removed by the saline solution.[13]Therefore, there was ineffective and inefficient wetting and bonding of the sealer to the dentin in the root canals irrigated only using normal saline. Thisled to a low fracture resistance of teeth treated with saline.CHX has also been advised as a final irrigating solution due to its antimicrobial properties as shown by Bhandari S et al. [14]. According to Prado M. et al, CHX has also shown to have a positive effect on the surface free energy of dentin.[15]This leads to a better bonding ability with the sealer. However, Mohammadi Z has shown that just like saline, it is also unable to remove the smear layer formed from instrumentation.[3]Hence roots irrigated using ASEP-RC, also had low values of fracture resistance, even though statistically more when compared to those irrigated using saline($p<0.001$).Grigoratos D et al. studied about Sodium Hypochlorite and concluded that Sodium hypochlorite is one of the most popular and probably the single most widely used irrigating solution in endodontics.[2]It has got excellent antimicrobial properties and remarkable pulp tissue dissolving abilities.However, as outlined by Grigoratos et al., it also has several drawbacks, important among them being its inability to remove the inorganic portion of the smear layer.[2] Sodium hypochlorite has also been shown to have a concentration dependent reduction of elastic modulus and flexural strength in human root dentine, though this might have played minimal role in our study.Thus the ability of NaOCl when used as a final irrigant to remove the organic portion of Smear layer leads to better bonding ability with the sealer as compared to final irrigation done using saline or ASEP-RC. This accounts for significantly higher values of fracture resistance of this group as compared to the previous two groups ($p<0.001$).SmearClear consists of 17% EDTA solution along with cetrimide and additional proprietary surfactants.Ethylenediaminetetraaceticacid(EDTA) is a chelating agent which reacts with the calcium ions of dentine and thusforms calcium chelates that dissolve easily. However there have been studies(Bezerra da Silva et al.) that have stated that this chelating effect is nearly negligible in the apical one-thirds of the root canal spaces.[16]SmearClearconsists of surfactantsthat help in enhancing the chelating action by reducing the surface tension. This leads to an increase in the dentin wettability.[16]Tay et al found out that EDTA when used as the final irrigant leaves a thin layer consisting of demineralized collagen fibrils on the surface of dentin.In the absence of an adjuvant surfactant, the presence of this residual layer of collagen fibrils is the reason for the poor wettability of root canal sealers on the dentin (especially in the apical third)when irrigated using EDTA without a surfactant. So,final irrigation usingSmearClear might have led to a stronger bonding between the sealer and root dentin, leading to significantly higher values of fracture resistance among all the groups($p<0.001$).

So, a one-minute irrigation protocol using saline had no effect on the smear layer, thereby reducing the bonding capability of sealer to root canal dentin. Thus, saline group accounted for the lowest values of fracture resistance. ASEP-RC, by virtue of its CHX content, was able to increase the surface free energy of dentin, leading to better fracture resistance values compared to Saline.However, it also had no effect on the smear layer. Final irrigation using NaOCl for one minute led to a better fracture resistance compared to saline and ASEP-RC mainly due to the fact that it was able to remove the organic portion of smear layer present on instrumented roots. SmearClear was the only irrigant able to remove the smear layer out of all the groups due to the chelating action of its main constituent i.e. EDTA. In addition, presence of surface tension lowering Surfactants like cetrimide lead to overall significantly better performance as a final root canal irrigant.

## V. CONCLUSION

The results of this study have demonstrated that the root canal preparation and subsequent final irrigation affected the root fracture resistance in endodontically treated teeth. Hence the null hypothesis was rejected.As far as irrigating solutions are concerned, roots that were irrigated using SmearClearas final irigantdemonstrated significantly higher resistance to root fracture as compared to the other groups.Further studies are required to investigate the effects of various irrigating solutions on bond strengths of different sealers and fracture resistance of roots of endodontically treated teeth.

**Conflicts of Interest**
There are no conflicts of interest.

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**Table Legends:**

**Table 1:** Distribution of mean and Standard deviation (s.d.) Fracture resistance of four groups

| Fracture Resistance | | | | | | |
|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | Standard Error | Minimum | Maximum |
| SALINE | 20 | 312.35 | 7.819 | 1.748 | 302 | 327 |
| ASEP RC | 20 | 350.78 | 11.857 | 2.651 | 330 | 373 |
| SMEARCLEAR | 20 | 504.75 | 21.535 | 4.815 | 469 | 537 |
| NaOCl | 20 | 414.26 | 11.973 | 2.677 | 390 | 435 |

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**Table 2: Multiple Comparisons** of Fracture resistance of four groups by one-way Tukey's HSD test

| Group | Group | Mean Difference | Standard Error | P value |
|---|---|---|---|---|
| SALINE vs | ASEP RC | 38.433 | 4.497 | <0.001* |
| SALINE vs | SMEARCLEAR | 192.398 | 4.497 | <0.001* |
| SALINE vs | NaOCl | 101.904 | 4.497 | <0.001* |
| ASEP RC vs | SMEARCLEAR | 153.965 | 4.497 | <0.001* |
| ASEP RC vs | NaOCl | 63.471 | 4.497 | <0.001* |
| SMEARCLEAR vs | NaOCl | 90.495 | 4.497 | <0.001* |

*Highly significant p<0.001

**Figure Legends:**

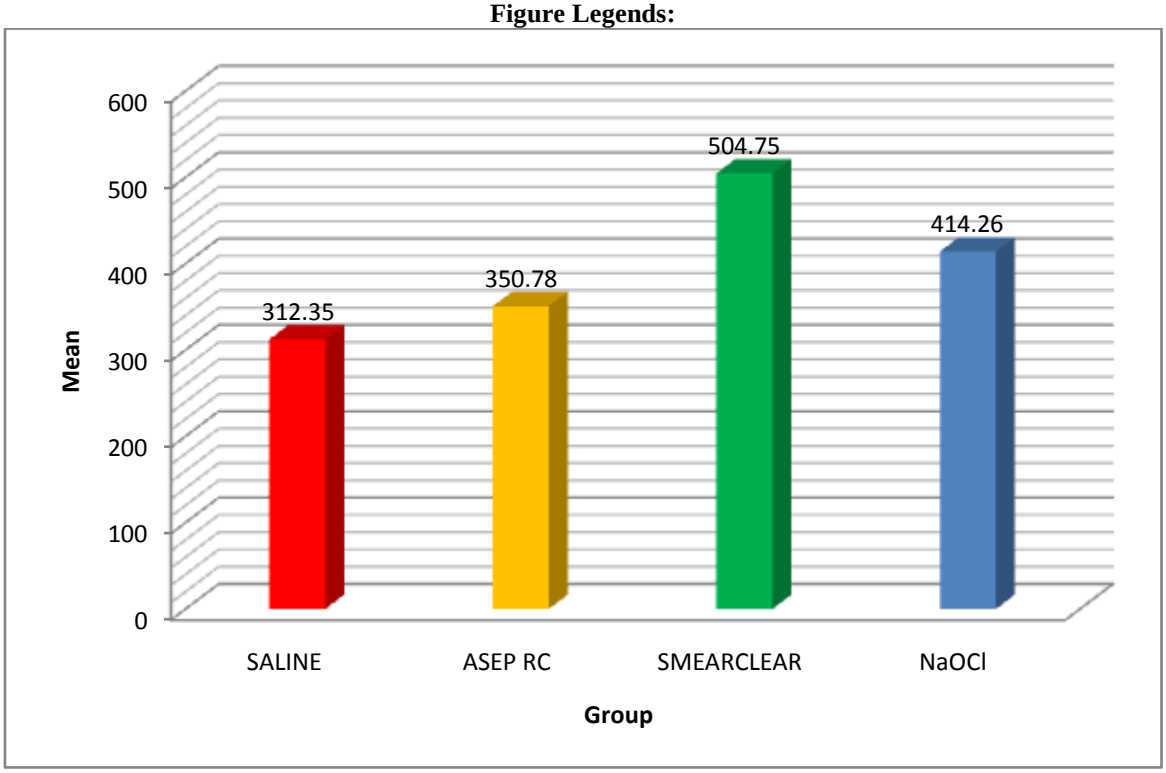


**Figure – 1: Pictorial representations depicting the comparisons of the means of fracture resistances of the four groups.**