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"Solvency Capacity of Gutta Percha Using Chloroform and Eucalyptol: A Scanning Electron Microscopic Study"

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Abstract:
Aim: *To evaluate the solvency of chloroform and eucalyptol for gutta percha removal in re-treatment.*
Methodology- A total of 40 extracted human maxillary single rooted teeth were selected. Canal preparation was carried out by the sequential use of K- files up to size 30 at working length and then divided into one control group(n=10)that is group I and three experimental groups II,III,IV (n=10 each).The experimental groups were obturated by lateral compaction of gutta percha using zinc oxide eugenol sealer. During re-treatment chloroform and eucalyptol severed as solvent in all groups. In group II no solvent ,group III chloroform and group IV eucalyptol, were used for gutta percha removal. Scanning electron microscopy was done to check the efficacy and statistically analysed.
Results: *Among the three experimental groups SEM analysis showed greatest efficacy of group IV at coronal and apical sections and statistically significant result at middle section.*
Conclusion: *eucalyptol showed superior gutta percha removal efficacy at coronal and apical thirds and similar efficacy for both at middle third.*
Keywords: *Re-treatment,Solvent,Obturation.*

I. Introduction

Persistent or secondary intra-radicular infection is a major cause of endodontic failures.[1,2] Therefore, endodontic retreatment is indicated when initial procedure has failed and the problem can be corrected by improving root canal debridement and filling.[3,4]
The most commonly used root canal filling material is gutta-percha in conjunction with a sealer. The proper removal of these materials from inadequately prepared and filled canals is the major part of most root canal re-treatments.

Removing filling materials can be time consuming and challenging but has an important clinical impact so that instruments and irrigants may gain access to the entire root canal system, thus promoting better cleaning.[5,6]
There are several techniques for removing gutta-percha and sealer from filled root canals using manual files, burs, and automated devices, generally preceded by the softening of the filling material with different solvents or heat.[7-12] However, all retreatment techniques leave residual debris in the canal walls after reinstrumentation.[13]

Hence this study was conducted to evaluate which solvent is more efficient for gutta percha removal from root canal during re-treatment.

II. Methods And Materials

Selection of samples-

Fourty freshly extracted human anterior teeth with straight roots and single canal were used in this study. The selected samples were randomly divided into four groups with 10 samples in each group.

Inclusion criteria-

1)Freshly extracted 2)Intact 3)Non carious 4)Unrestored human anterior teeth within 19-21mm length range were selected for this study.

Exclusion criteria-

1)Extracted teeth with crown fracture 2)Previous history of root canal treatment and restoration 3)Severe attrision 4)Teeth having root caries 5)Evidence of external root resorption 6)Roots having crack,hypercementosis 7)Teeth having open apices over ISO size 20 k-file in diameter were excluded from the study.

Specimen preparation-

Immediately after extraction , the teeth were washed in running tap water ,cleaned of any attached tissue ,autoclaved in hot air oven (Coslab laboratory product, India)and stored in 0.2% thymol in normal saline solution until use. 40 extracted human permanent single rooted teeth were divided into four groups with 10 teeth in each. Radiographic evaluation revealed patency of canals.

Canal preparation-

Standard access cavities were made using high speed burs and water spray and the orifices were flared using Gates glidden drill # 2 -3 (Mani Co. India).Root canal were prepared using K-files (Mani Co. India) and Protaper file (Dentsply,Tulsa Dent)and 3%sodium hypochlorite with Glyde (Dentsply Tulsa Dent, India) in a crown down technique. All teeth were prepared upto F3 master apical file #30 followed by final irrigation with 15mL of 3%sodium hypochlorite and 15 mL of 17% EDTA.

All canals were dried using paper points. The working length were determined using radiograph. The working length was kept 1mm short of radiographic length. All samples were randomly divided into four groups .The roots in group 1(control group) remained unfilled.

Canal filling-

The root canal from group 2-4 were filled by lateral compaction of gutta percha. A master gutta percha cone selected and tug back was checked. The master cone were coated with the sealer ZOE sealer and positioned into the canal . Accessory gutta percha cones sizes 20 were laterally compacted using nickel titanium finger spreader. After filling the roots were radiographed in buccolingual and mesiodistal directions in order to confirm adequacy of the root canal filling. All teeth were stored in a humidor at 37° C and 100% humidity for 2 weeks to allow complete setting of sealer.

Retreatment technique-

In groups 2-4, 6mm of root filling materials were removed from cervical part of canal using gates glidden drill #2-3(Mani Co. India).In the middle and apical part, hedstrom files were used sizes #25-50(Mani Co. India).

Table no.3: group of samples.

Group	N	Solvent
Group I	10	Unfilled
Group II	10	No solvent
Group III	10	Chloroform
Group IV	10	Eucalyptol

During re-instrumentation, 3% sodium hypochlorite was used as irrigant. After gutta percha removal the canals were irrigated for 1min with 17% EDTA (15mL), followed by 3%sodium hypochlorite(15mL) using the irrigation needle 1-2mm short of working length. Finally, all canals would be dried with paper points.

Sample analysis-

All roots were sectioned longitudinally in half with fracture line passing through the root canals. To facilitate fracture, two longitudinal grooves, parallel to the long axis of tooth were made on the buccal and lingual surfaces of each specimen using a diamond disk (Brasseler USA, Savannah,GA) on low speed contra-angle handpeice (NSK,Japan) and split longitudinally with a chisel and mallet into two halves. Root surfaces were grooved to three levels at 4,8,12mm from the root apices using diamond bur. The sections were dehydrated by a series of graded ethanol solutions and then coated with a gold layer in an Auto fine sputter coater (JEOL-JFC 1600) after drying. The selected dentinal surfaces of cervical, middle, and apical thirds(12mm,8 mm and 4 mm from the apex, respectively),equidistant from lateral walls , were observed by SEM (JEOL-JSM-6380A.) at 2000x magnification. Five independent examiners analyzed in a blind manner, the removal of gutta percha and was graded using a 4 grade scale. The standard for worst and best results of cleanliness were negative and positive groups, respectively. Statistical analysis was performed using Kruskal-Wallis at 5% significance level.

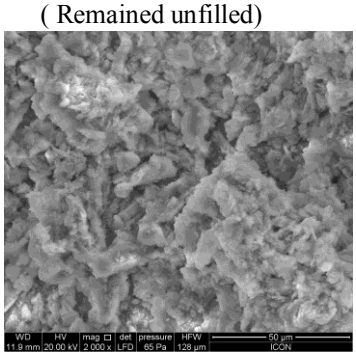
Table no:4 Criteria for degree of cleanliness and gutta percha removal.

Score	Criteria
1	0-25% removal of gutta percha – none / slight
2	25-50% removal of gutta percha- mild / moderate
3	50-75% removal of gutta percha – moderate / severe
4	75-100% removal of gutta percha – severe / complete.

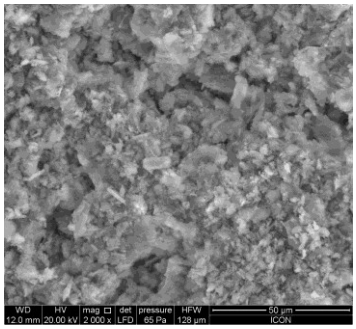
Observation and results– five blind observers were subjected to view the images.

Representative sample of each group SEM Images of the Coronal, Middle and Apical areas of representative samples(Original Magnification 2000x)

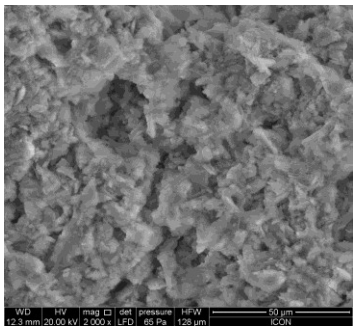
GROUP-I
(Remained unfilled)



Coronal

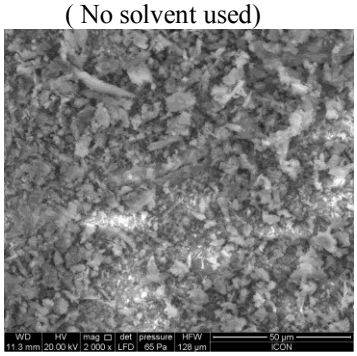


Middle

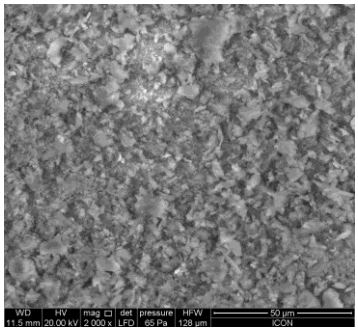


Apical

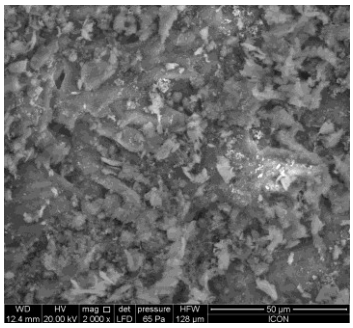
GROUP-II
(No solvent used)



Coronal



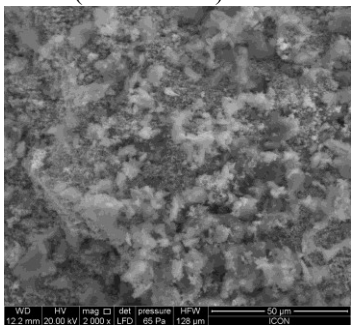
Middle



Apical

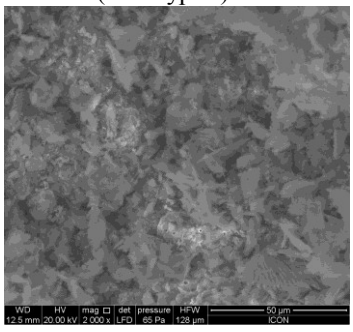
SEM Images of the Coronal, Middle and Apical areas of representative samples (Original Magnification 2000x)

GROUP-III
(Chloroform)

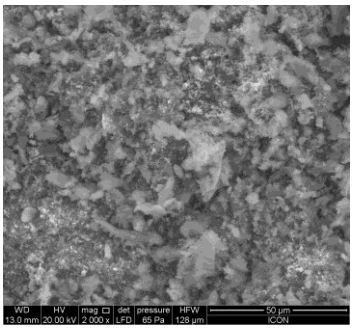


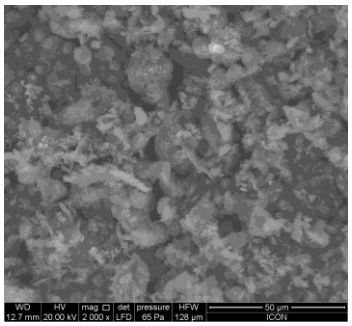
Coronal

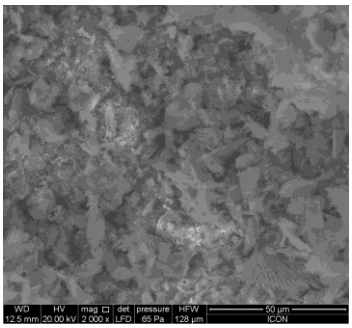
GROUP-IV
(Eucalyptol)

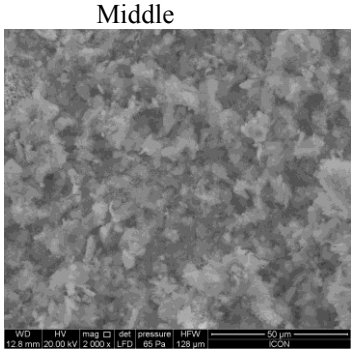


Coronal


Middle

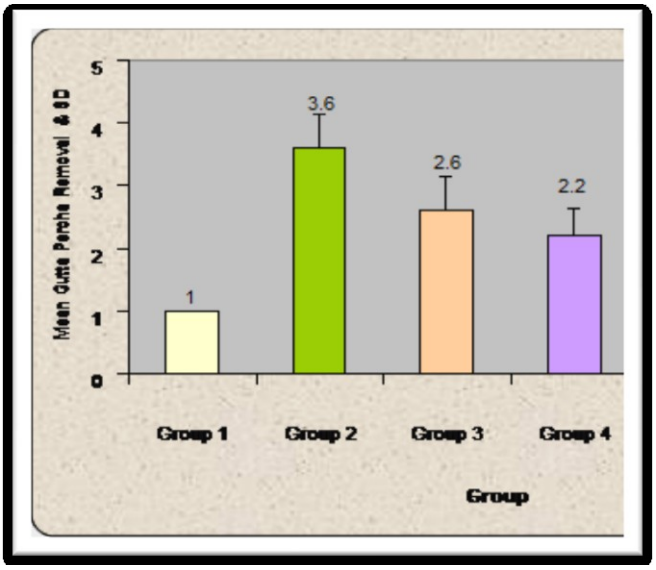

Middle


Apical


Apical

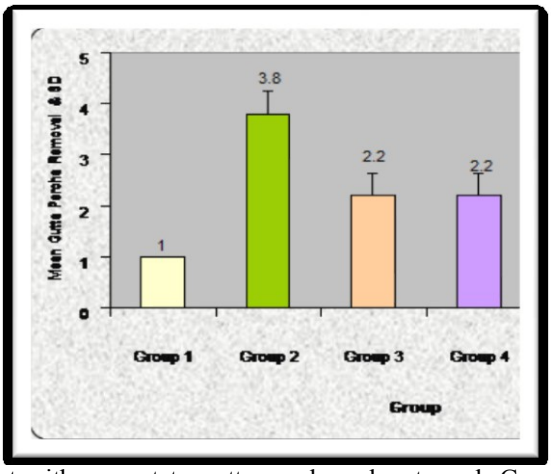
The statistical tests used for the analysis of the result were:Krushkal Wallis Test. And following graphs were obtained using all the obsever's findings.

Graph 1: Comparison of Gutta Percha removal by chloroform
And eucalyptol in the root
canal walls at apical 3rd



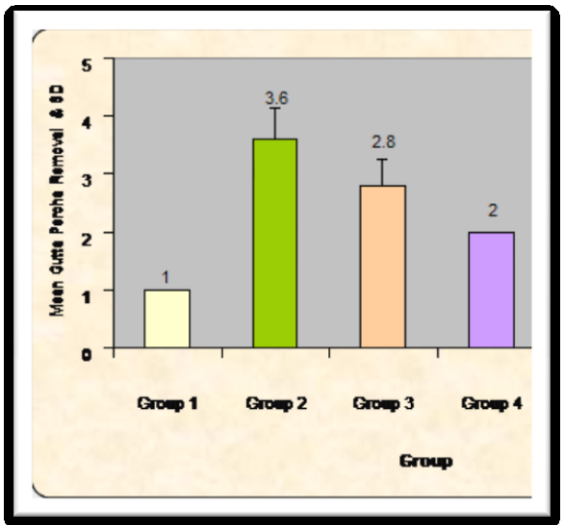
This bar diagram illustrates that with respect to gutta-percha solvent used, group IV that is eucalyptol shows maximum cleaning efficacy in removal of gutta-percha from root canal walls at the apical third however group III shows less canal cleanliness than group IV.

Graph 2: Comparison of Gutta Percha removal by chloroform and eucalyptol in the root canal walls at middle 3rd



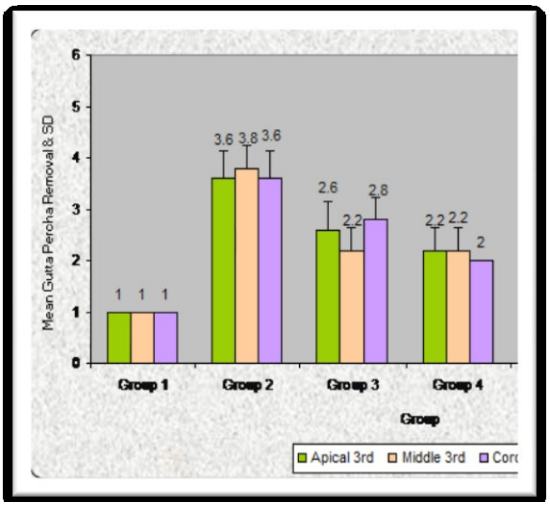
This bar diagram illustrates that with respect to gutta percha solvent used, Group III and IV are statistically significant.

Graph 3: Comparison of Gutta Percha removal by chloroform and eucalyptol in the root canal walls at coronal 3rd



This bar diagram illustrates that with respect to gutta percha solvent used, group IV that is eucalyptol shows maximum cleaning efficacy in removal of gutta-percha from root canal walls at the apical third however group III shows less canal cleanliness than group IV

Graph 4: Comparison of Gutta Percha removal by chloroform eucalyptol orange oil and xylene in the root canal walls at apical, middle and coronal 3rd



This bar diagram illustrates that with respect the gutta percha solvent used, group IV more efficient than group III in all thirds of the canal.

III. Results

Efficacy of solvents at the coronal third :

All the solvents used for gutta percha removal does not achieve complete removal with maximum removal seen with group IV (Eucalyptol) [mean value 2.00±0.00] ,then by group III(Chloroform) [mean value 2.80±0.44]. These result suggest that in coronal third area of canal walls removal with Eucalyptol was most efficient and achieves more canal cleanliness which is statistically significant with a p value of 0.000 ($p < 0.05$) which is highly significant when compared to chloroform. Removal with no solvent was least efficient in canal cleanliness which is statistically significant with a p value of 0.000 ($p<0.05$) which is highly significant when compared to all other solvents (chloroform,eucalyptol)

Efficacy of solvents at middle third:

All the solvents used for gutta percha removal does not achieve complete removal with removal similar with group IV (Eucalyptol) [mean value 2.20±0.44] and group III(Chloroform) [mean value 2.20±0.44] . These result suggest that in middle third area of canal walls removal with chloroform and eucalyptol was similar which is statistically significant with a p value of 0.000 ($p < 0.05$).

Efficacy of solvent at apical third:

All the solvents used for gutta percha removal does not achieve complete removal with maximum removal seen with IV (Eucalyptol) [mean value 2.20±0.44] ,then by group III(Chloroform) [mean value 2.60±0.54] . These result suggest that in apical third area of canal walls removal with eucalyptol was most efficient and achieves more canal cleanliness which is statistically significant with a p value of 0.000 ($p < 0.05$) which is highly significant when compared to all chloroform.

IV. Discussion

A number of studies have assuredly shown that most endodontic treatments yield a success rate of nearly 90%[14]. Failures occur despite meticulous treatment methods that meet high and stringent standards[2]. Besides iatrogenic factors such as inadequate canal preparation/obturation and procedural errors, other several causes are responsible for these occasional failures. For example, residual post-treatment root canal infection may be inevitable in some cases due to the complexity of root canal anatomy. Re-infection resulting from coronal leakage is also regarded as a major contributing cause[15]. In these cases, non-surgical root canal retreatment may be required to re-disinfect the canals and re-establish healthy periapical tissues[16].

When group II(no solvent) was compared with group IV(eucalyptol) mean values of Group II was greater as compared to group IV with a P-value 0.000($P<0.05$) which was significant in all the thirds (i.e coronal, middle, apical thirds).

The result of the present study are not in agreement with **Horvath et al. 2009**[17].

Horvath et al. 2009[23] suggested that open tubules were more prevalent in the control group, followed by the nonsolvent group, the eucalyptol group and the chloroform group . Less surface was covered by root filling remnants in the non solvent group than in the eucalyptol group and the chloroform group.

When group II(no solvent) was compared with group III(chloroform) mean values of Group II was greater as compared to group III with a P-value 0.000(P<0.05) which was significant in all the thirds (i.e coronal, middle, apical thirds).

When group III(chloroform) was compared with group IV(eucalyptol) mean values of Group III was greater as compared to group IV in apical and coronal third and was equal to in middle third with a P-value 0.000(P<0.05) but the values were statistically not in all the thirds (i.e coronal, middle, apical thirds).

The result of the present study are in agreement with **Horvath et al. 2009** [17] and **K. Rick Hunter et al 1991** [18].

Horvath et al. 2009 [17] suggested that open tubules were more prevalent in the control group, followed by the nonsolvent group, the eucalyptol group and the chloroform group . Less surface was covered by root filling remnants in the nonsolvent group than in the eucalyptol group and the chloroform group.

K. Rick Hunter et al. 1991 [18] suggested that although halothane was significantly less effective than chloroform in softening gutta-percha, the difference between halothane and eucalyptol or between eucalyptol and chloroform was not significant.

The result of present study were not in agreement with **Gary J. Kaplowitz et al.1990** [19].

Gary J. Kaplowitz et al.1990 [19] compared five solvents (rectified white turpentine, oil of melaleuca, eucalyptol, white pine oil, and pine needle oil)with chloroform for their ability to dissolve gutta-percha. All solvents dissolved at least 50% of the gutta-percha in 15 min at 37~ with chloroform and rectified white turpentine dissolving the gutta-percha completely.

The present in vitro study suggest that although none of the solvents are able to remove gutta percha completely from root canal but eucalyptol can provide satisfactory results as compared to chloroform. In the majority of the in-vitro study experimental studies, the results cannot be directly transposed to in vitro situation. Yet, they provide a more easily reproducible and reliable means for comparison and testing of newer materials for establishing international standards.

Although these are in vitro results, these are of significance because these factors cannot be quantitatively determined in vivo. Nevertheless, further long term clinical studies are necessary to confirm these results and evaluate their relevance to treatment outcome.

Based on the results obtained and discussed, following conclusions were drawn from the present study:

1. Gutta percha residues were observed in all the samples i.e none of the solvents could eliminate gutta percha residues completely from root canal
2. Efficacy of chloroform in gutta percha removal was greater to non solvent group and less as compared to eucalyptol with a statistically significant difference ($p< 0.05$).
3. Efficacy of eucalyptol in gutta percha removal was greater to chloroform with a statistically significant difference ($p< 0.05$).
4. Among all the thirds of the root canal irrespective of the solvent used maximum amount of cleanliness was observed in coronal third followed by middle third and least amount of cleanliness was observed in apical third.

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