

Comparative Evaluation of Lateral Displacement Produced by 3 Gingival Retraction Methods- An in Vivo Study

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Abstract : Purpose: The gingival displacement agents make it easier for the flow of the impression material into the gingival sulcus, thereby registering the prepared subgingival finish line and an area apical to it, providing the marginal integrity. Therefore, the purpose of this study was to evaluate and compare the effectiveness of 3 different gingival retraction methods like retraction cords soaked in 25% aluminium chloride gel, retraction cord soaked in 0.05% oxymetazoline hydrochloride and 15% aluminium chloride cordless retraction paste in the lateral displacement of gingival tissues. **Methods:** 66 teeth from both male and female participants needing full coverage restoration were selected for the study. They were divided into 3 groups i.e. group1: Retraction cords soaked in 25% Aluminium Chloride gel, group2: Retraction cord soaked in 0.05%W/V Oxymetazoline Hydrochloride, group3: 15% aluminium chloride Cordless retraction paste. Impressions were made before and after the retraction procedure. Die was prepared using Accu Trac precision die system and 3mm blocks were obtained out of it. These blocks were evaluated for lateral displacement under the stereomicroscope 20x using image analyser. **Results:** The median displacement values of the 3 groups of were compared and it was found that Oxymetazoline Hydrochloride had the highest displacement values followed by Aluminium Chloride gel while 3M ESPE Cordless Retraction paste had the least displacement values. A post hoc analysis was done using Mann Whitney U test. It was found that there was a statistically significant difference in displacement values between Aluminium Chloride v/s Oxymetazoline Hydrochloride ($P=0.019$) and between Oxymetazoline Hydrochloride and Cordless Retraction paste ($P = 0.011$). **Conclusion:** The amount of lateral gingival displacement produced by 0.05%W/V oxymetazoline hydrochloride >25% aluminium chloride gel > 15% aluminium chloride retraction paste.

Key Words: aluminium chloride, oxymetazoline hydrochloride, retraction paste, retraction cord, gingival displacement, stereomicroscope.

Introduction

Long-term health and stability of the surrounding periodontal structures are critical to the success of fixed prosthodontics restorations¹. There are numerous factors that influence the longevity of cast restorations, one of which is marginal integrity². An accurate impression is important and it should record the finish line of the prepared tooth as well, a portion of the unprepared tooth, to achieve a suitable emergence profile with smooth gingival margin³. The crowns with a lack of marginal adaptation, causes periodontal tissue inflammation and increases the risk of recurrent caries, especially in sub gingivally placed crown margins. The control of haemorrhage and gingival fluid seepage becomes essential for the accurate recording of the subgingival finish lines after the tooth preparation procedures thus the effective management of the gingiva before making an impression is a critical step.⁵ With a sound emergence profile, adaptation, and marginal fit, the gingival displacement agents aid in the acquisition of a superior grade prosthesis¹. The most commonly used elastomeric impression material, polyvinyl siloxane, is dimensionally stable and accurate, with excellent elastic recovery, ease of manipulation, superior electroplating qualities, and a long shelf life; however, due to its extreme hydrophobic nature, the gingival crevice should not be moist. Therefore, various soft tissue management methods have been employed to effectively dilate and dry the gingival tissues, including mechanical displacement, chemo- mechanical displacement, rotary gingival curettage and electrosurgery.

Mechanical displacement is the most conventionally used gingival retraction method wherein the cords are packed into the sulcus. Since they cause the gingiva to temporarily shrink, medicated cords are more successful in stopping bleeding. These medicaments constrict the peripheral blood vessels.⁶ The retraction cord and chemical agents are used together in the chemo - mechanical method of retraction, where the retraction cord mechanically displaces the gingival tissue and absorbs moisture contamination in the gingival sulcus, and the chemical agents control haemorrhage and shrink the gingival tissues¹. Due to the acidic nature of the gingival displacement agents, prolonged exposure causes alterations and instability in the smear layer. According to studies the recommended time for chemo-mechanical displacement is 7-10min beyond which it might lead to localised tissue necrosis¹. Based on their pharmacological actions the gingival displacement agents can be classified as conventional retraction agents (CRAs) as astringents (aluminium chloride, ferric sulphate, aluminium sulphate) and experimental retraction agents (ERAs) containing alpha and beta adrenergic (HCl-epinephrine) or only alpha adrenergic (HCl-tetrahydrozoline, HCl oxymetazoline or HCl phenyl epinephrine).⁷ The CRAs, are very effective haemostatic agents but cause cytotoxic effects on primary gingival fibroblast.⁷

The mechanical displacement of gingiva is a time-consuming process and may cause discomfort and possible periodontium harm by damaging the junctional epithelium. To overcome the limitations of the conventional cords, the cordless retraction materials were introduced and is gaining popularity.²In this technique the retraction pastes are injected into the sulcus of the prepared tooth. The cordless displacement technique is time saving, more accepted by the patient, provides better gingival displacement, lesser application generated pressure and better maintenance of gingival health.

Tetrahydrozoline and Oxymetazoline are alpha agonist sympathomimetic vasoconstrictors, which produce desired effects without adverse local or systemic effects. They are generally used as nasal decongestants and eye drops. Bowles et al. found tetrahydrozoline to have a satisfactory clinical outcome with strong local vasoconstrictive effect and minimal systemic reactions. Tardy et al. conducted a clinical study that demonstrated increased tetrahydrozoline retraction efficiency with no side effects.⁸ Oxymetazoline hydrochloride shows good acceptable displacement with negligible harm to the gingival tissues, and is most bio compatible with primary human gingival fibroblast (HGFs) and does not cause any systemic effects¹ However, studies to test clinical efficiency of this agent in gingival retraction in humans have not yet been reported.

Therefore, the purpose of this study was to evaluate and compare the effectiveness of 3 different gingival retraction methods like retraction cords soaked in 25% aluminium chloride gel, retraction cord soaked in displacement agent like 0.05% Oxymetazoline hydrochloride and 15% aluminium chloride cordless retraction paste in the lateral displacement of gingival tissues.

The null hypothesis was tested that there is no significant difference in the gingival displacement produced by the 3 gingival retraction methods.

Materials and Methods

This study was initiated after ethics committee clearance from the institutional ethics committee (REF: PROTOCOL NO: IEC/PGPROS_{20/24/V2}). The research included 66 teeth from male and female patients in need of full coverage restoration who reported to the Department of Prosthodontics and Crown and Bridge, A.J. Institute of Dental Sciences and Hospital.

The study was divided into three groups wherein:

Group1: Retraction cords soaked in 25% Aluminium Chloride gel (hemostal gel, PrevestdentproLtd. Jammu and Kashmir, India).

Group2: Retraction cord soaked in 0.05%W/V Oxymetazoline Hydrochloride (oxy spray-Zyodus Health Care Ltd; East Sikkim, India).

Group3: 15% Aluminium Chloride Cordless retraction paste (3M ESPE Astringent Retraction Paste, ESPE Platz, Seefeld,Germany).

The retraction techniques were allocated to the participants based on single blind randomization clinical trial-lottery technique. The Inclusion criteria included patient aged >18yrs of age, healthy gingiva and periodontium of the abutment teeth, abutment teeth should be of normal size and contour, devoid of any development anomaly or regressive age changes, preparation needed for full coverage restoration, patients with thick gingival biotype will be selected, teeth with optimum to ideal crown: root ratio as radiographically observed. The exclusion criteria were patients with periodontitis, gingival recession, tipped, tilted, or rotated abutment, hypertension, patients with known allergy to oxymetazoline and aluminium chloride, pregnant and lactating women. The patient received a thorough explanation of each step in a language they could comprehend prior to taking part. The patient's abutments were assessed clinically and radiographically once consent was received.

The gingival retraction protocols for the three groups were as follows: a double mix putty reline technique was used to make an impression of the prepared tooth before the gingiva was retracted. The prepared tooth was then allowed to air dry and isolated with cotton rollers to ensure a dry working environment. For group 1: The knitted non-impregnated cords (SURECORD, Sure Dent Corporation, Brussels, Belgium) were cut to the proper length and soaked in 25% aluminium chloride gel (Hemostal gel, PrevestDentPro Ltd. Jammu and Kashmir, India) for five minutes, and they were gently looped and pushed around the gingival sulcus using the Hu-Friedy gingival cord packer tool. The retraction cord was removed after ten minutes, and the tooth was air dried and sprayed with water to get rid of any residual solution. Group 2: Using Hu-Friedy gingival cord packer instrument, the knitted non-impregnated retraction cords were gently wrapped and pushed into the gingival sulcus after being immersed in 0.05%W/V oxymetazoline hydrochloride (Oxy spray-Zydus Health Care Ltd; East Sikkim, India) for five minutes. The retraction cord was removed after ten minutes, and the tooth was air dried and sprayed with water to get rid of any residual solution. Group 3: The retraction paste (3M ESPE Astringent Retraction Paste, ESPE Platz, Seefeld,Germany) was ejected directly into the sulcus via a highly innovative, easy to use, hygienic unit-dose capsule. The astringent paste was placed in the gingival sulcus for 2min and was then completely removed with air-water spray and suction. Following the removal of the cord, an impression was made for each group utilising the double mix putty reline technique using non-aqueous addition silicone impression material (Photosil SOFT, Dental Products of India, Mumbai, India). The die was fabricated using Accu Trac precision die system (Coltene/ Whaledent Ltd. U.K.). The Impression Tray was filled with Type IV die stone (prime rock, Next Dental Products, Gujarat) and the Accu Trac tray was filled with Dental stone (gold stone, rajkot, india). The die stone and dental stone were mixed, poured, and allowed to set as per the

manufacturer's recommendation. The die was measured mesio-distally using a Vernier Calliper and the centre of the tooth was marked for the primary cut. For the secondary cut, a second marking was created 3 mm apart from the previous marking. The cast was placed on the die cutter's platform and stabilised while a primary cut was made along the length of the cast's marked central portion of the incisal edge in the buccolingual direction¹. A 3 mm thick buccolingual slice was obtained by making a second incision distal to the first along the full length of the cast.

The buccolingual slice obtained was then evaluated under the stereomicroscope (Cognex, Lawrence and Mayo microscope) having a magnification of $\times 20$, to measure the amount of lateral gingival displacement. The images were then transferred to the MIC 3.0 image analyser and the amount of the gingival displacement was tabulated in micron meters (μm). The lateral displacement was measured from the crest of gingiva to the finish line of the prepared tooth. The amount of lateral gingival displacement was calculated by subtracting the measured width before retraction from the one obtained after retraction and the data obtained was subjected to statistical analysis.

Results

The data was analysed using SPSS for Windows [SPSS ver 22.0, IBM Corp., Armonk, NY].

The data was assessed for normal distribution using Shapiro Wilk test. It was found that the data had a skewed distribution and hence Kruskal Wallis test was used to compare between the groups and post hoc analysis were done using Mann Whitney U test. The level of significance was set at $P \leq 0.05$.

The median displacement values of Aluminium Chloride gel, Oxymetazoline Hydrochloride and Cordless retraction paste was compared and it was found that Oxymetazoline Hydrochloride had the highest displacement values followed by Aluminium Chloride gel while Cordless Retraction paste had the least displacement values. This difference in values was found to be statistically significant ($P = 0.017$) (Table 1).

A post hoc analysis was done using Mann Whitney U test. It was found that there was a statistically significant difference in displacement values between Aluminium Chloride v/s Oxymetazoline Hydrochloride ($P = 0.019$) (Table 2) and between Oxymetazoline Hydrochloride and Cordless Retraction paste ($P = 0.011$) (Table 4). There was no statistically significant difference in displacement values between Aluminium Chloride v/s Cordless retraction paste ($P = 0.573$) (Table 3).

This means displacement by: (statistically)

- ☑ Oxymetazoline Hydrochloride > Aluminium Chloride gel
- ☑ Oxymetazoline Hydrochloride > Cordless Retraction Paste
- ☑ Aluminium Chloride gel = Cordless Retraction Paste

Discussion

One of the most fundamental standards of the principles of tooth preparation is marginal integrity. The positioning of the finish line in respect to the gingival margin directly affects the outcome of the restoration and the condition of the periodontal tissue around the abutment teeth. The gingival finish lines of the restoration should be placed supra-gingivally or equi-gingivally from a periodontal standpoint.²The dentist may prepare them sub-gingivally for aesthetic purposes or other factors like cavities, an existing restoration, or the need for greater retention.²

The gingival retraction agents selected should have good clinical efficiency, with negligible systemic or local side effects. Many techniques like mechanical, chemo – mechanical and surgical are employed for retraction of gingiva. For many years, the mechanical method of gingival displacement via retraction cord had been the norm. It works by physically pushing the gingiva away from the finish line, but it is unable to stop the seepage of sulcular fluid, hence its usefulness is constrained.

Chemo-mechanical method being the most commonly and widely used technique uses a combination of retraction cord with chemical medicament. The retraction cord used in this study is knitted type of cord. The distinctive knitted weave reduces unravelling and fraying during cord insertion and after cutting. Knitted cords are simple to place and expand when wet, widening the sulcus by more than the cord's original width. A wide variety of medicaments are used for this purpose¹⁰. These pharmacological agents are classified into two categories: - experimental displacement agents and conventional displacement agents⁷. The experimental displacement agents contain α and β adrenergic like HCl- Tetrahydrozoline, HCl – oxymetazoline, HCl – phenylephrine and the conventional displacement agents include aluminium sulphate, ALUM, ferric sulphate, and aluminium chloride.

Astringents are metal salts that produce gingival retraction by precipitating proteins and preventing plasma proteins from moving through the capillary. They work by decreasing cell permeability and drying out the surrounding tissue, which causes the reversible recession of that tissue. Astringents are employed as haemostats because the precipitation of proteins under physiological conditions has an antihemorrhagic effect. Denatured proteins, however, can harm nearby tissues.⁸ Retraction agents made of aluminium are thought to have an astringent effect, to be safe, and be only moderately efficient at suppressing gingival tissues.⁸

Aluminium chloride is the most popular retraction agent used among the conventional astringents used¹¹. They cause haemostatic effect by effective constriction of the gingival tissues; they are also cytotoxic on the primary human gingival fibroblasts⁷. Aluminium chloride can have a negative effect on the adhesion. Due to its acidic pH of this agents, it is said to dissolve the smear layer. If the dentin of

prepared teeth is exposed to these solutions, it could cause postoperative sensitivity on the root surfaces that extend beyond the limits of the crown preparation.

Alpha-agonist like the tetrahydrozoline, oxymetazoline and phenylephrine, which are commonly used as eye and nasal decongestant drops infrequently cause any systemic reaction⁹. Oxymetazoline hydrochloride was selected for this study following the clinical study by Chaudhari et al. who reported that α adrenergic drugs like tetrahydrozoline hydrochloride or oxymetazoline hydrochloride show good acceptable displacement with negligible harm to the gingival tissues, and is most bio compatible with primary human gingival fibroblast(HGFs) and does not cause any systemic effects¹⁷. Oxymetazoline hydrochloride is a topical vasoconstrictor that is an imidazole derivative and a widely used nasal decongestant. It reduces nasal mucosal blood flow by constricting the resistance epistaxis¹³. Based on the study conducted by Bowles et al. for the evaluation of new gingival retraction agents on Mongrel dogs, inferred that the mean width of the experimental groups like Visine[®] (tetrahydrozoline HCl, 0.05%), Afrin[®] (oxymetazoline, 0.05%) showed significantly wider retraction than the other conventional agents like Alum and Epinephrine¹².

High levels of disruption occurred at the junctional epithelium due to excessive pressure applied when placing the cord into the gingival sulcus. The amount of force needed to insert the cord into the gingival sulcus determines the extent of the damage¹⁰ According to studies, using too much force when inserting retraction cords increases the risk of periodontal injury, attachment loss, and gingival recession¹⁰. A cordless retraction technique resulted in less tissue damage and were introduced into the market as an atraumatic alternative. Based on the study conducted by Bennani et al. wherein the pressure generated by 4 different cordless gingival displacement agents was measured, 3M ESPE Astringent Retraction Paste generated a pressure of 58.8kPa which was well within the normal range of pressure the epithelial attachment can withstand(2400kPa). However, based on the study conducted by Chandra S et al. the usage of cords showed a greater amount of gingival displacement than the cordless retraction techniques.

Impression techniques has a significant effect on the accuracy of the die. Based on the study conducted by Chee and Donovan, they found that the double mix two-stage impression generated the most accurate cast when comparing the double mix and single mix putty relined techniques. The failure to record the more minute information was the primary drawback of the single mix technique as observed by the researchers¹⁴. Accu Trac provides the clinical benefit of effective fabrication of dental models and dies for the creation of dental restorations. Dies were made using the die cutter and 3mm blocks were obtained¹⁵. The block was then evaluated for lateral displacement under a stereomicroscope of magnification 20 \times . The measurements were done on the image analyser, wherein the lateral displacement was calculated from the crest of the gingiva to the prepared tooth finish line. In the study conducted by Bowles

et al. and Chaudhari et al, stereomicroscope was used as the measuring tool to evaluate the effectiveness of gingival retraction agents^{1,12}.

The data was assessed for normal distribution using Shapiro Wilk test. The data was found to have a skewed distribution and hence Kruskal Wallis test was used to compare between the groups and post hoc analysis was done using Mann Whitney U test. It was found that there was a statistically significant difference in displacement values between Aluminium Chloride v/s Oxymetazoline Hydrochloride (P=0.019) and between Oxymetazoline Hydrochloride and Cordless Retraction paste (P = 0.011). There was no statistically significant difference in displacement values between Aluminium Chloride v/s Cordless retraction paste (P = 0.573). Therefore, from the result point of view the amount of lateral gingival displacement produced by 0.05%W/V oxymetazoline hydrochloride >25% aluminium chloride gel > 15% aluminium chloride retraction paste.

Conclusion

Within the limitations of the study, the following conclusions were made:

1. The lateral gingival displacement produced by 0.05% W/V Oxymetazoline Hydrochloride was significantly greater than the lateral displacement by 25%Aluminium Chloride gel. (P=0.019)
2. The lateral gingival displacement produced by 0.05% W/V Oxymetazoline Hydrochloride was significantly greater than the lateral displacement Cordless Retraction Paste. (P=0.011)
3. There was no statistically significant difference in the displacement values between 25%Aluminium Chloride gel v/s Cordless retraction paste (P = 0.573).

The amount of lateral gingival displacement produced by 0.05%W/V oxymetazoline hydrochloride >25% aluminium chloride gel > 15% aluminium chloride retraction paste.

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Groups	N	Median	IQR	Mean Rank	Chi Square	P value
Aluminium Chloride Gel	22	121	87.5 - 193.25	30.05	8.2	P = 0.017*
Oxymetazoline Hydrochloride	22	190.5	147.25 - 234.25	42.95		
Cordless Retraction Paste	22	106.5	83.75 - 166.25	27.9		

Level of significance at $P < 0.05$; N-Number; IQR-Interquartile range

*Statistically significance at $P < 0.05$ using Kruskal Wallis test

Table 1: Comparison of median displacement values of Aluminium Chloride gel, Oxymetazoline Hydrochloride and Cordless retraction paste

Groups	N	Median	Mean Rank	Sum of Ranks	Mann Whitney U	P value
Aluminium Chloride Gel	22	121	17.95	395	142	P = 0.019*
Oxymetazoline Hydrochloride	22	190.5	27.05	595		

Level of significance at $P < 0.05$; N-Number

*Statistically significance at $P < 0.05$ using Mann Whitney U test

Table 2: Comparison of median displacement values of Aluminium Chloride gel and Oxymetazoline Hydrochloride

Groups	N	Median	Mean Rank	Sum of Ranks	Mann Whitney U	P value
Aluminium Chloride Gel	22	121	23.59	519	218	P = 0.573
Cordless Retraction Paste	22	106.5	21.41	471		NS

Level of significance at $P < 0.05$; N-Number

NS-Not significant using Mann Whitney U test

Table 3: Comparison of median displacement values of Aluminium Chloride gel and Cordless retraction paste

Groups	N	Median	Mean Rank	Sum of Ranks	Mann Whitney U	P value
Oxymetazoline Hydrochloride	22	190.5	27.41	603	134	P = 0.011*
Cordless Retraction Paste	22	106.5	17.59	387		

Level of significance at $P < 0.05$; N-Number

*Statistically significance at $P < 0.05$ using Mann Whitney U test

Table 4: Comparison of median displacement values of Oxymetazoline Hydrochloride and Cordless retraction paste



Figure1: Retraction Cords Soaked in 0.05%W/V Oxymetazoline Hydrochloride packed into the Gingival Sulcus



Figure2: 15% Aluminium Chloride Retraction paste injected into the Gingival Sulcus

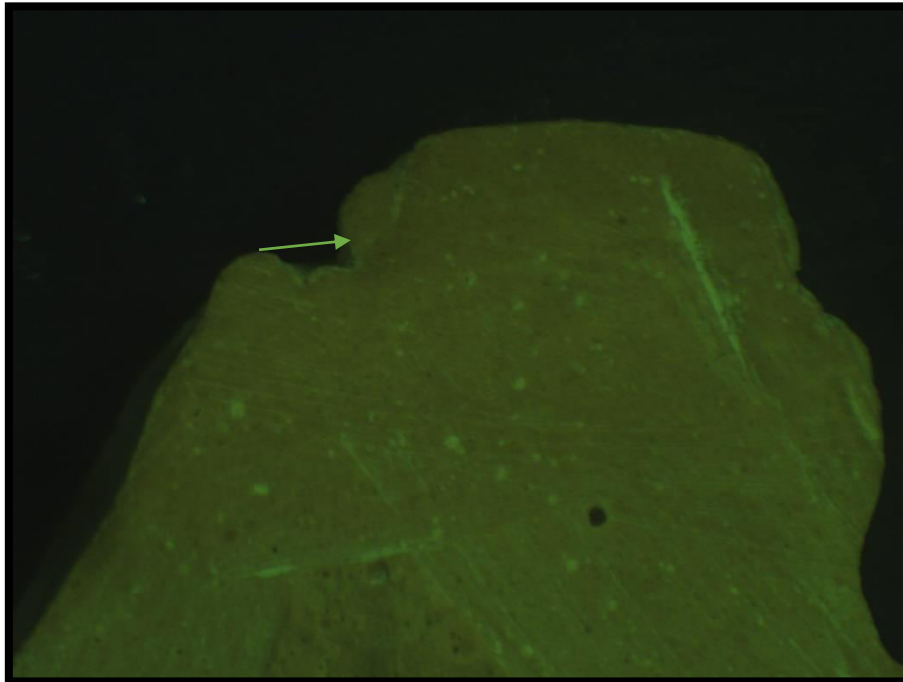


Figure3: Gingival displacement evaluated with stereomicroscope and image analyser after retraction



Figure 4: Retraction cords soaked in 25% Aluminium Chloride packed into the gingival sulcus

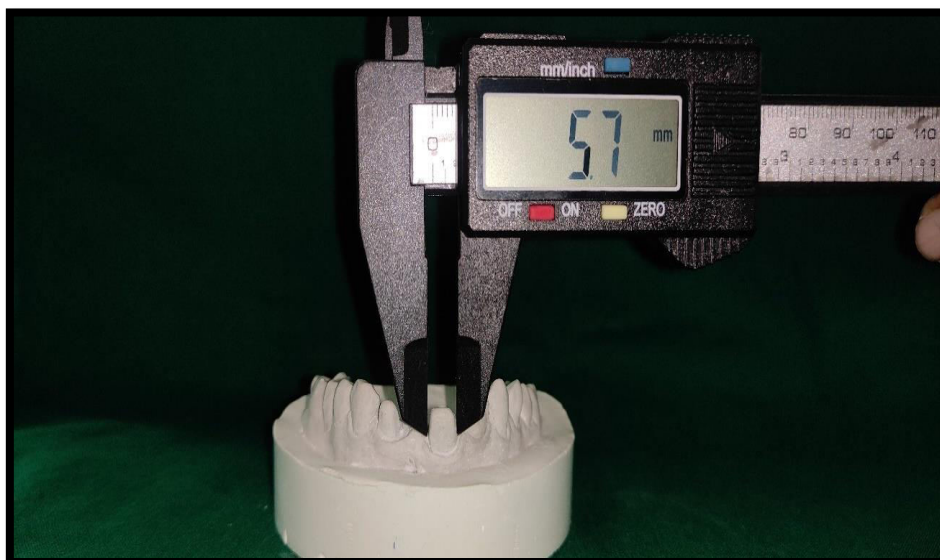


Figure5: Mesio - Distal Width of the Prepared tooth measured using digital vernier calliper

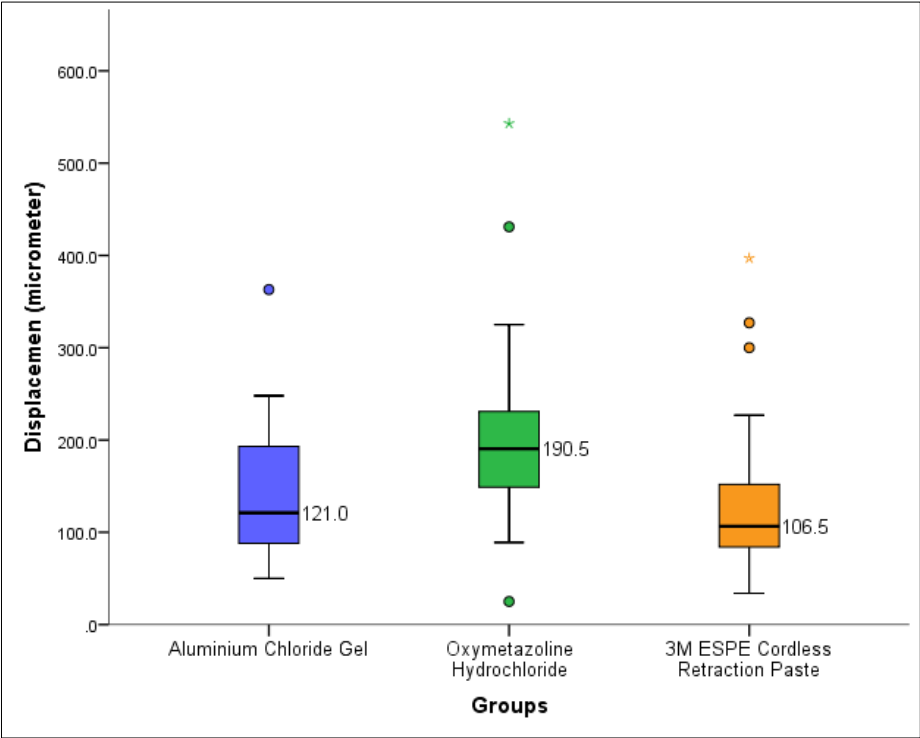


Figure 6: Graph showing median displacement values of Aluminium Chloride gel, Oxymetazoline Hydrochloride and Cordless retraction paste