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Assessing the Effectiveness of PTFE versus Traditional Retraction Cord Incorporated with Aluminium Chloride in Terms of Gingival Displacement, Bleeding Control and Application Convenience: A Clinical Study

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Abstract

Purpose: To assess the effectiveness of Polytetrafluoroethylene (PTFE) tape versus traditional retraction cord incorporated with aluminum chloride in terms of gingival displacement, bleeding control, and application convenience.

Materials and Methods: This clinical study involved 10 subjects requiring full coverage restoration on endodontically treated maxillary anterior teeth. The subjects served as their own controls for the two groups: Group I: Conventional retraction cord incorporated with aluminum chloride; Group II: PTFE tape incorporated with aluminum chloride. Gingival displacement and impression procedures were performed and evaluated on days 1 and 14. The displacement was measured using a stereomicroscope and Cat-Cam software, ease of application was assessed by placement attempts, and bleeding after cord removal was recorded.

Results: Mean gingival displacement was significantly greater in Group II (188.7 ± 0.022 µm) compared to Group I (184.2 ± 0.017 µm) ($p \leq 0.001$). Ease of application was similar between the groups, with 50% of Group II and 40% of Group I finding the procedure difficult ($p > 0.05$). Post-displacement bleeding was observed in 60% of Group II and 30% of Group I, with no significant difference ($p > 0.05$).

Conclusion: PTFE tape incorporated with aluminum chloride provided greater gingival displacement than the aluminum chloride impregnated traditional cord. Both materials showed similar ease of application and bleeding tendencies, but the PTFE tape caused more post-displacement bleeding and discomfort. PTFE tape needs further enhancements before it can be recommended as a substitute for traditional retraction cords.

Keywords: Gingival displacement, gingival retraction, retraction cord, aluminium chloride, Polytetrafluoroethylene

Introduction

In contemporary dental practice, esthetics have become a crucial component of treatment. Full coverage preparations may need subgingival margins because of issues like decay, aesthetic considerations, restorations, or the need for additional retention [1, 2]. Achieving an accurate fit for crowns requires precise capture of preparation details in the impression, which must then be accurately transferred to the cast. Therefore, gingival displacement is essential for recording subgingival preparation details [3].

Gingival displacement refers to the process of moving the marginal soft tissues surrounding a tooth, causing the marginal gingiva to be pushed away from the tooth. This displacement is primarily to facilitate access during tooth preparation, impression taking and cementation procedures [4]. Effective gingival tissue management consists of two main parts: gingival margin retraction and moisture control in the sulcus. Retraction/displacement provides temporary access to and beyond the abutment preparation margin by creating space between the tooth and gingival tissue, allowing for the injection of sufficient impression material into the expanded sulcus. Managing moisture is essential when using hydrophobic impression materials because factors like saliva, gingival bleeding flow, and sulcular fluid contamination can negatively affect the impression of the critical finish line.

Numerous techniques and materials have been developed to displace gingival tissue before recording the finish line in dental procedures. These methods are broadly categorized into mechanical, electrosurgical, chemicomechanical, rotary curettage, and combinations of these techniques[5, 6]. Mechanical techniques for gingival displacement involve employing rubber dams, copper bands, and retraction cords. Despite their widespread use, retraction cords have several disadvantages, including technique sensitivity, potential trauma to the junctional epithelium, inflammation, gingival recession, patient discomfort, and bleeding [7]. Chemicomechanical methods combine mechanical displacement with chemical agents to enhance tissue retraction and control bleeding. This approach is often employed with retraction cords impregnated with hemostatic agents. Chemicals employed in retraction cords (gingival displacement medicaments) fall into two categories: vasoconstrictors, and astringents, which encompass aluminum sulfate compounds, aluminum potassium sulfate (alum), aluminum chloride, and ferric sulfate [8]. Electrosurgical techniques use electrical currents to precisely remove or displace gingival tissues, while rotary curettage involves the use of rotating instruments to achieve similar results. Both methods offer precise tissue management but require significant skill to avoid damaging surrounding tissues. Alternative techniques and materials have been introduced to replace retraction cords with cordless methods such as pastes, gels, foams, lasers, and surgery [7]. These innovations aim to minimize patient discomfort and tissue trauma. While retraction cords remain the gold standard for soft tissue retraction due to their cost-effectiveness and reliability, advancements in cordless techniques and laser applications are promising alternatives.

The synthetic fluoropolymer known as Polytetrafluoroethylene (PTFE) tape is heat stable, non-reactive, has non-adherent property and low coefficient of friction. Plumber's tape, also referred as Teflon or PTFE tape, is widely used in clinical dentistry. PTFE is comparatively inert and has the capacity to withstand oral cavity fluids as well as acids and solvents used in dentistry. Naseem H *et al.*found that both PTFE cord and non-impregnated gingival retraction cord had comparable results in terms of gingival displacement effectiveness, ease of application, and bleeding post-removal of the cord. However, the PTFE cord was associated with higher incidences of post-displacement bleeding and discomfort during placement, indicating the potential for refinement in this technique [9].

So, the purpose of this study was to assess the effectiveness of PTFE versus traditional retraction cord incorporated with aluminium chloride in terms of gingival displacement, bleeding control and application convenience. Null hypothesis for this study was that the gingival retraction and displacement, ease of placement and bleeding tendency will be similar for conventional gingival retraction cord and PTFE incorporated with aluminium chloride.

Materials and Methods

Ethical Considerations

The study was approved by ethical committee of the Sankalchand Patel University, Visnagar, Gujarat, India. Study subjects having indication for full coverage restoration on permanent maxillary anterior teeth were evaluated for fulfillment of eligibility criteria by the principal investigator. Subjects who qualified for the selection criteria were verbally informed about the procedure and associated risks and benefits. Subjects willing to participate in the study completed a written consent and patients had the option to withdraw from the study at any time throughout the trial without facing any repercussions.

The study was performed at the Sankalchand Patel University, Visnagar, Gujarat, India. Samples were collected from June 2024 to July 2024.The participants included in the study were having greater than 18 year of age, requiring full coverage restoration, sound gingival and periodontal health of the abutment teeth, abutment teeth of normal size and contour (no developmental anomaly), Maxillary anterior teeth, and no signs of bleeding on probing.

Participants with Class V restorations, gingival pathology, bleeding disorders, tilted or rotated teeth, developmental anomaly, periodontal surgery and crown lengthening, smokers, tobacco users, pregnant women, history of systemic diseases like diabetes, hypertension and immune-compromised patients, history of prolonged use of steroids/immunosuppressive agents/aspirin, allergic to aluminium chloride were excluded.

Total of 10 subjects were selected requiring full coverage restoration in the endodontically treated maxillary anterior teeth. All the subjects served for both the groups based on the material used for retraction (Table 1). All subjects selected were having same gingiva biotype. Normal gingival condition was assessed with flexible measuring strip with 0.5 mm grading.

TABLE 1: GROUPS WHICH WERE USED FOR THE STUDY

Group I(n=10)	Conventional retraction cord incorporated with aluminium chloride
Group II(n=10)	Polytetrafluroethylene tape incorporated with aluminium chloride

The standard prosthodontic principles were followed to prepare the equi-gingival tooth preparation margin.

Gingival Retraction using cord incorporated with aluminium chloride and impression making

Tooth isolation was done. Retraction cord was dipped in aluminium chloride and was looped around the tooth. Cord was placed in the sulcus by gently pushing it with gingival cord packer instrument from the mesial interproximal area using single cord technique. Retraction cord was kept in place for 10 minutes and then gently removed. A Dual step impression was made first using putty consistency addition silicone with spacer followed by removal of cord and then making impression with light body impression material.

Fabrication of Polytetrafluoroethylene cord

A piece of commercially available PTFE tape was placed on a glass slab, onto which a 3-0 silk suture was positioned. The tape was carefully folded over the suture to encase it. Using another glass slab, gentle and uniform pressure was applied to roll the tape into a cord (Fig. 1). The ends of the cord were cut to achieve a length of 10 cm using scissors. This process was repeated to prepare a total of ten cords by a single operator. The diameter of each cord was measured at its midpoint using a stereomicroscope, and the measurements were recorded. Each PTFE cord was subsequently immersed in aluminum chloride before being used for gingival retraction, following the procedures outlined for Group I.

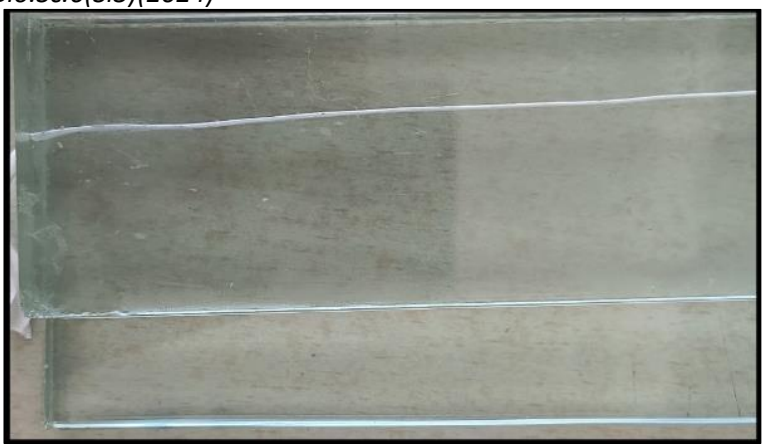


FIG 1: ROLLED UP PTFE CORD

Gingival retraction and impression making: The schedule for gingival displacement and impression making wererandomly assigned the order in which each subject receives the treatments to counterbalance any potential order effects. On day 1 and day 14, impressions were made after retraction with anyone of two displacement agents (Fig. 2, Fig. 3).

FIG 2: GINGIVAL RETRACTION WITH CONVENTIONAL RETRACTION CORD INCORPORATED WITH ALUMINIUM CHLORIDE

FIG 3: GINGIVAL RETRACTION WITH PTFE TAPE INCORPORATED WITH ALUMINIUM CHLORIDE

After removing gingival retraction material from the gingival sulcus, a single calibrated examiner assessed the presence or absence of gingival bleeding in each patient. All the surfaces were assessed. Presence was defined as visible gingival bleeding after the removal of cord, whereas absence was defined as no visible bleeding after cord removal [10].

Ease of Application: Ease of cord placement into the gingival sulcus was characterized by the ability to insert the retraction cord smoothly into the crevice on the first attempt, avoiding any need for repositioning. Conversely, instances where multiple attempts were necessary due to dislocation from the gingival crevice were classified as "difficult application [10]."

Evaluation of Gingival Displacement: Disinfection of recorded impressions was done with glutaraldehyde and then they were poured in type IV dental stone. Models were trimmed to an equal height using model trimmer and were then labeled. Crest of buccal gingiva was marked on all samples using a fine lead tip. Additionally, three specific points were identified: the mesial line angle, the mid-buccal point, and the distal line angle. The mid-buccal point served as a reference for assessing horizontal displacement under a stereomicroscope at 10x magnification [11]. The Cat-Cam software was used to process and measure the distance between the crest of the gingival margin and the uncut tooth surface (Fig. 5).

FIG 5: DISPLACEMENT UNDER 10X MAGNIFICATION OF STEREOMICROSCOPE

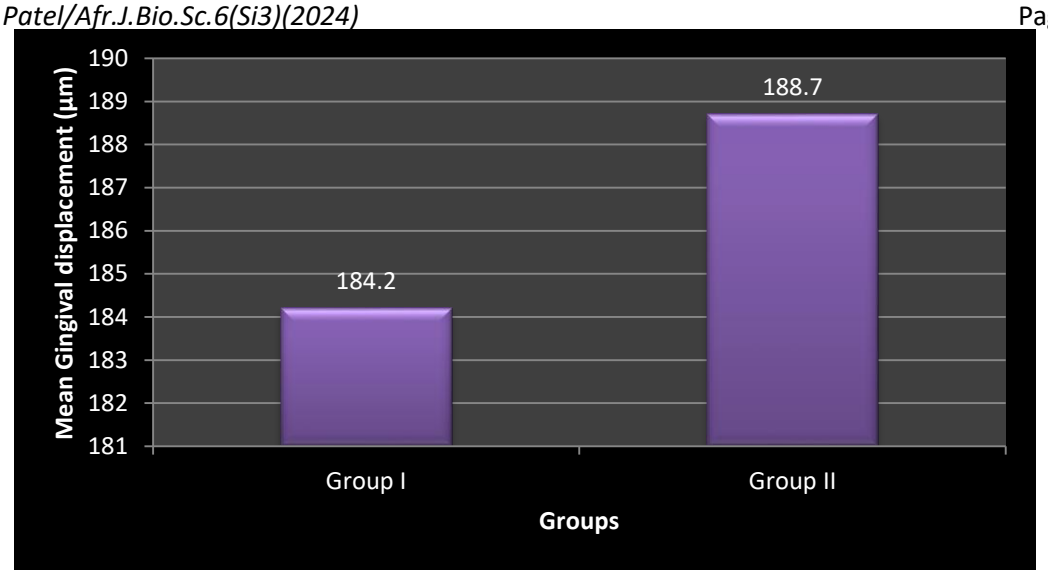
Statistical analysis: SPSS Version 20.0 was used. Mean and standard deviations (SD) were calculated and by applying paired t-test, their comparison for gingival displacement was assessed. Comparison of ease of cord application and bleeding after cord removal between the two groups was identified using Chi square test. ($P \leq 0.05$)

Results

TABLE 2: GINGIVAL DISPLACEMENT WISE DISTRIBUTION

Parameters	**Groups**	**Number**	**Gingival displacement (µm)**		**P Value**
			Mean	**SD**	
Gingival displacement	Group I	10	184.2	0.017	≤ 0.001*
	Group II	10	188.7	0.022	

Level of Significance $P \leq 0.05$, * Significant, ** Non-Significant

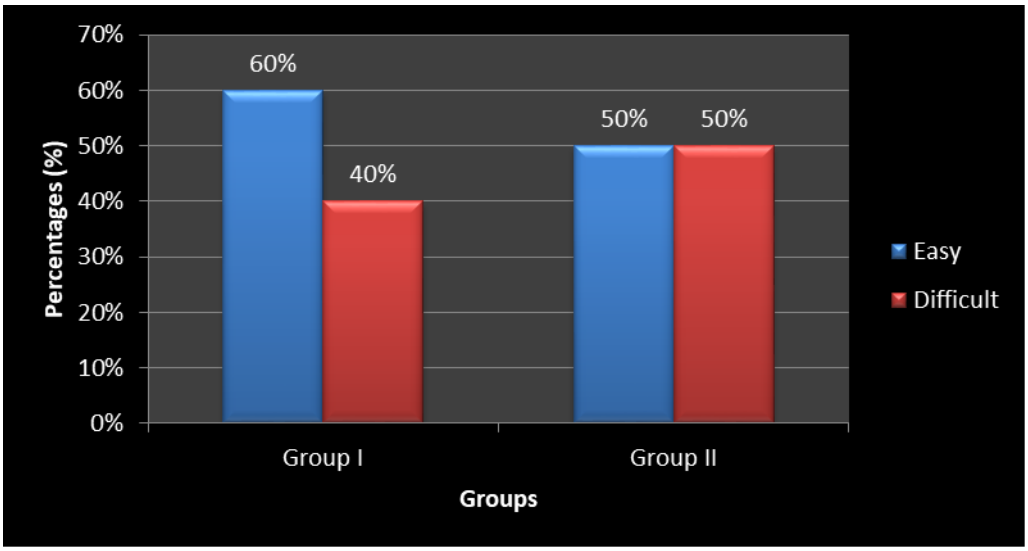


Graph 1: MEAN GINGIVAL DISPLACEMENT

TABLE 3: EASE OF APPLICATION

Ease of application	N (%)		P Value
	Group I	Group II	
Easy	6(60%)	5(50%)	0.653**
Difficult	4(40%)	5(50%)	
Total	10	10	

Level of Significance P ≤ 0.05, * Significant, ** Non-Significant



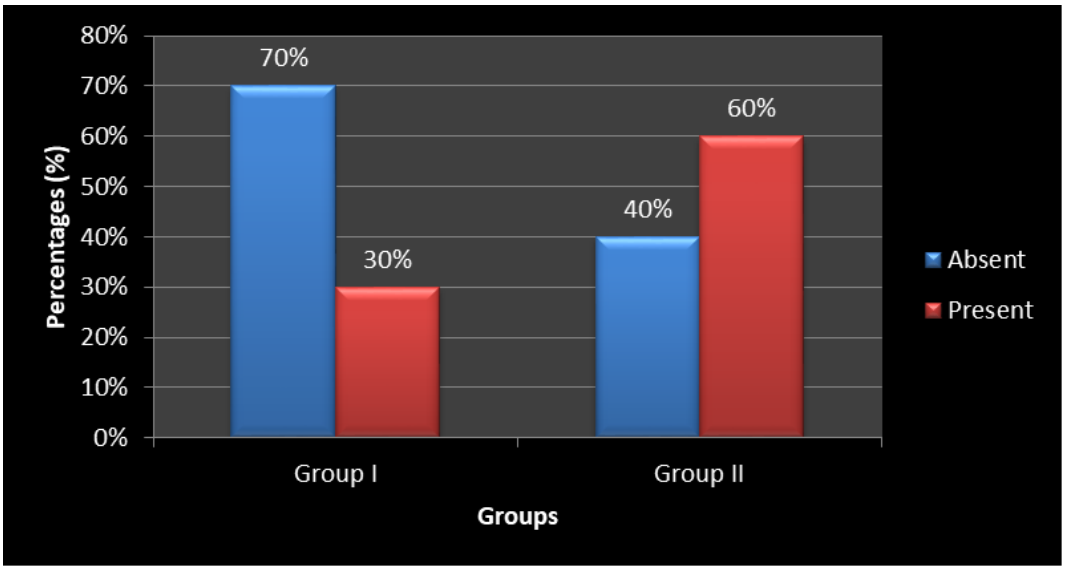
GRAPH 2: EASE OF APPLICATION

TABLE 4: GINGIVAL BLEEDING

Gingival bleeding	N (%)		P Value
	Group I	Group II	

Absent	7(70%)	4(40%)	0.178**
Present	3(30%)	6(60%)	
Total	10	10	

Level of Significance P ≤ 0.05, * Significant, ** Non-Significant



GRAPH 3: GINGIVAL BLEEDING

Mean gingival displacement was more in Group II (188.7 ± 0.022 µm) as compared to Group I (184.2 ± 0.017 µm). Statistically, significant difference was observed in gingival displacement between Group I and Group II. (Table 2, Graph 1).50% (n=10) of subjects in Group II showed difficulty of cord placement and 40% (n=10) cases in Group I demonstrated difficulty in cord placement ($p > 0.05$). (Table 3)60% (n=10) of the patients experienced bleeding in Group II after cord removal as compared to 30% (n=10) cases in group I. (Table 4)Statistically, no significant difference was observed in Ease of application (Table 3, Graph 2) and gingival bleeding (Table 4, Graph 3) between Group I and Group II.

Discussion

The null hypothesis was partially accepted as there was no significant difference in ease of placement and bleeding tendency for conventional gingival retraction cord and PTFE incorporated with aluminium chloride. But significant difference was observed in gingival displacement using conventional gingival retraction cord and PTFE incorporated with aluminium chloride.

The gingival displacement technique for impressions in fixed prosthodontics often varies based on the practitioner's personal preference. However, research indicates that most practitioners favor using retraction cords, either plain or impregnated with chemical agents. Among these, chemically impregnated cords are the most popular for gingival displacement. The use of cords impregnated with 5-10% aluminum chloride is considered both safe and effective.Aluminum chloride solution (10%) acts as a hemostatic agent and astringent by causing protein precipitation, constriction of blood vessels, and removing fluid from tissues. When used in lower concentrations, aluminum chloride has no contraindications and exhibits minimal side effects. These prompted us to include aluminum chloride as the first experimental group in the study.

Randomization was employed in the sequence of gingival displacement in this study to prevent tissue fatigue. It is reasonable to assume that the extent of displacement achieved during the initial attempt might be the smallest compared to the final attempt, or the opposite could be true. This suggests that the results for the first and last agents might be influenced by the degree of tissue fatigue experienced during the displacement process. The sequence of displacement was not similar for each subject, thus eliminating the bias.

The result of the current clinical trial showed significant difference in mean horizontal gingival displacement among both the groups as mean displacement produced was 188.7 µm by PTFE group and 184.2 µm by conventional retraction cord incorporated with aluminium chloride ($p > 0.05$). It is consistent with the study by Naseem H *et al.* where PTFE cord exhibited slightly greater displacement than the conventional plain retraction cord [9].

The ease of application of both cords was almost similar.The application challenges of PTFE cord might be attributed to its flexibility and tendency to unravel. A survey result showed that using small diameter cord is the primary mistake dentist make during gingival displacement in restorative procedures.

Further the results of a study by Runyan *et al.* found that an aluminum chloride solution can be effective for controlling hemorrhage, suggesting that pre-soaking retraction cords in this solution might be a helpful additional method [12]. In this study, the retraction cords were immersed in aluminum chloride. Post-displacement bleeding can negatively impact the quality of impressions, particularly when using hydrophobic elastomeric materials. It was also noted that the use of a retraction cord system might cause epithelial attachment injuries, which can be uncomfortable for patients and may require local anesthesia. This can also lead to bleeding and oozing from the gingival margin, complicating the treatment process. In the present study, 60% of the patients experienced bleeding in PTFE group after cord removal as compared to 30% cases in conventional group. But it was not statistically significant.

Thus, on the basis of these findings it can be indicated that PTFE cord needs further improvement prior to be recommended as a potential clinical alternative to traditional retraction cord system.

Limitations

The impact of varied sulcus depth can influence the gingival displacement; however, this could not be controlled among the study patients. In addition, all the parameters are influenced by the inherent tooth anatomy. However, only maxillary anteriors were only included for assessment in the present study. Gingival displacement was assessed on the buccal surface of the tooth only, which could have influenced the overall study outcomes. Therefore, further studies comparing the gingival displacement using contemporary and conventional retraction agents with standardized protocol and conditions are further warranted.

Conclusions

PTFE cord incorporated with aluminium chloride displayed greater gingival displacement compared to conventional cord incorporated with aluminium chloride. Although conventional gingival retraction cord and PTFE cord incorporated with aluminium chloride displayed similar outcomes of ease of placement and bleeding after cord removal. Nonetheless, the post displacement bleeding and discomfort of PTFE cord placement suggests that this technique needs improvement. Therefore further studies are warranted to improve and investigate the physical and biological response to PTFE retraction cord.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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