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CLINICAL COMPARATIVE EVALUATION OF DIFFERENT RETRACTION SYSTEMS IN GINGIVAL DISPLACEMENT AND THEIR INFLUENCE ON PERIODONTAL HEALTH: A RANDOMIZED CLINICAL TRIAL

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ABSTRACT

Purpose: This randomized clinical study was to assess cordless techniques compared to conventional cords in gingival displacement and effect on periodontal health.

Material and Methods: Forty participants having a premolar abutment were elected following inclusion criteria and allocated by using parallel randomization into four groups (n=10) for gingival retraction either with Ultrapak, GingiTrac, Traxodent or NoCord. By single-blinded operator, the horizontal gingival displacement as a primary outcome was measured on pre- and post-retraction polyether impressions utilizing a stereomicroscope. As secondary outcomes, the placement time and bleeding after removal were noted. The periodontal parameters; plaque index, gingival index (GI), and probing depth (PD) were recorded pre-operative, 1- and 7-days post-operative.

Results: There was a non-significant gingival displacement difference among groups (P=.282) and a significant difference within each group. GI elevated in all groups after one day as Traxodent exhibited the highest value (p<.001). After seven days, it returned to a non-significant value compared to the baseline except for GingiTrac and Traxodent which were significantly higher (p<.001). PD of Ultrapak and GingiTrac were non-significant in all-time hiatuses, while Traxodent and NoCord revealed a significance. After seven days, Traxodent showed higher PD than the baseline (p<.001). Ultrapak induced maximal bleeding (50%), while NoCord showed no bleeding.

Conclusion: Cordless retraction systems showed similar horizontal gingival displacement compared to conventional cords. NoCord can be considered an alternative retraction system, providing an effortless placement, good gingival displacement and no bleeding. All techniques induced an interim gingival inflammation; Traxodent showed the highest level. GingiTrac and Traxodent demonstrated delaying recovery.

KEYWORDS: Horizontal gingival displacement, Cordless technique, NoCord, Periodontal health.

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INTRODUCTION

The correlation of restorative dentistry and periodontics is influential and has been well-reported both clinically and histologically.[1] This interconnection is launched at many aspects, including restorative margin locations, crown contours, and gingival tissues' response to restorative preparations.[2]

Marginal adaptation performs a predominant role in the long-term success of the restoration, and its failure may be a result in ill-fitted crowns, hypersensitivity, marginal leakage, periodontal tissue inflammation, and increased recurrent caries risk.[3,4] Marginal details corresponding to the apical tooth structure in relation to the restorative margin are crucial for an accurate detailed impression,[5] so handling of gingival tissues around margins, management of crevicular fluids and minimizing of bleeding are essential.[6-8] The process of gingival displacement allows the exposure of differently located finish lines, along with the unprepared tooth parts.[9]

There are various methods of gingival tissue management such as a mechanical method (retraction cords), a chemo-mechanical method (chemicals impregnated in cords), and a surgical method (electrosurgery, rotary curettage, and lasers), of which gingival retraction cords are most commonly used.[10,11] The retraction cords can generate a decent retraction, but clinicians usually report a long time taken in placement, pain, bleeding, and acute gingival injury induction.[12] In addition, cord packing into the sulcus may lead to potential junctional epithelium damage and biological width violation,[13] which results in bone resorption and gingival recession or even infection.[13,15,16] However, the retraction material should not only displace the gingival tissue laterally and vertically but also control the bleeding.[3,17-19]

Cordless displacement techniques have been recently popularized. Utmost systems involve injectable paste into the gingival sulcus to accomplish a chemo-mechanical dilatation. These techniques offer time-saving, better gingival retraction, less related crevicular fluid flow, better maintenance of gingival health, less patient discomfort and less application-generated pressure.[9, 20-22]

Recently, a one-step, self-retracting impression material was introduced and claimed that it delivers an accurate impression providing dimensional stability and gingival displacement with completely capture marginal details without gingival trauma. On the other hand, there are no evidence-based studies in the literature investigating the efficacy of newly introduced retracting impression system on tissue displacement; therefore, the current study was designed to assess the amount of horizontal gingival displacement produced by four different retraction systems and to compare their ease of use, bleeding control and effects on soft tissue health. The null hypothesis was that no significant change would be settled in horizontal gingival displacement, or effect on periodontal health among tested systems throughout the study.

MATERIAL AND METHODS

Study design

This study was conducted as a randomized clinical trial with a registered Clinical Trials no. (NCT03892109) of parallel design and approved by the Research Ethics Committee, Faculty of Dentistry, October 6th University (O6U) (approval no. RECO6U/2-2019). Written informed consent was obtained from those who agreed to participate voluntarily in this clinical trial.

Patient selection

Patients requiring full coverage restorations for restoring or replacing missing maxillary first or second premolars were elected from those patients being present in the Fixed Prosthodontics Postgraduate Clinic, Faculty of Dentistry, O6U following inclusion criteria: ages >18 years, non-smokers, or quit smoking before the study for at least 6 months. The selected teeth were screened for gingiva with a minimum 2 mm of keratinized tissues,

<3 mm probing depths, no significant attachment loss or recession as well as gingiva not manifesting highly scalloped margins or fibrotic tissues, no bleeding on probing, and 0 or 1 score for plaque and gingival indices.[23, 24] However, subjects with signs of gingival or periodontal disease, grossly decayed, tipped, tilted or rotated abutments, medically compromised illnesses (diabetes, hyperthyroidism, hypertension and other cardiovascular disorders), pregnancy, lactation, alcohol-abusing or specific drugs consumption were excluded.

Sample size calculation and allocation

In this study, the power analysis used the amount of horizontal gingival retraction as the prime outcome. The effect size (f = 0.621) was obtained based upon the results of Thimmappa M et al.[25] Utilizing alpha (α) level of (5%) and Beta (β) level of (20%) i.e., power = 80%; the minimum estimated sample size was 9 abutment teeth per group. The sample size was increased to a total of 40 abutments (10 abutments per group) to compensate for a drop-out rate of 10%. Sample size calculation was performed utilizing power analysis software (G*Power; Version 3.1.9.2, Heinrich-Heine-Universität Düsseldorf, Germany). Forty abutment teeth were randomly allocated equally with a 1:1 allocation ratio by using random allocation software (SourceForge; Slashdot Media, La Jolla, CA, USA) performing a block randomization into four groups by one of the operators as seen in Figure 1. Sealed envelopes were used to implement the random allocation sequence until interventions were assigned by the other single-blinded operator who assessed the outcomes for the selected retraction systems (Table 1).

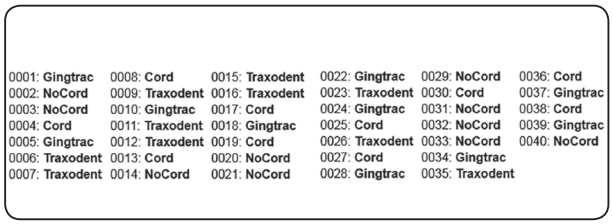

Fig. (1) Performed random allocation for abutment teeth.

Clinical procedures

A pre-operative impression was taken utilizing irreversible hydrocolloid impression material (tropicalgin; Zhermack SpA, Badia Polesine (RO), Italy) and a stock tray (position tray; 3M ESPE, St. Paul, MN, USA) to obtain a diagnostic cast for construction two special methacrylate trays to serve as impression material carriers in pre- and post-retraction impression.

All abutments were prepared for full coverage all-ceramic restoration with equigingival shoulder finish line to prevent risk of violating biological width.[26]

TABLE (1) Tested gingival retraction systems.

Retraction system	Composition	Company
Ultrapak (U)	100% cotton, knitted cord	Ultradent Products Inc., South Jordan, UT, USA
GingiTrac (G)	A medium-viscosity, vinyl polysiloxane (VPS) gingival retraction paste with 15% ammonium aluminum sulfate (alum)	Centrix, Inc., Shelton, CT, USA
Traxodent (T)	Hemodent Paste Retraction System with 15% aluminium chloride	Premier Dental, PA, USA
NoCord (NC)	VPS containing15% alum	Centrix, Inc., Shelton, CT, USA

Before gingival retraction initiation, plaque index (PI), gingival index (GI) were documented for each elected abutment based on Lo¨e & Silness method modification.[27] Probing depth (PD) was assessed through the placement of a periodontal probe (Williams; Carl Martin GmbH, Solingen, Germany) to the base of the gingival sulcus on the buccal and palatal aspects of each tooth. The probe was grasped lightly parallel to the tooth's long axis and pointed towards the apex.

Two impressions were taken for each tested group utilizing constructed special trays which were loaded by a monophase medium consistency polyether impression material (Impregum Penta Soft; 3M ESPE, St. Paul, MN, USA): the first one that would act as a control for the sulcus width baseline measurement.[28] The other one was taken after gingival displacement for microscopic examination.

Gingival retraction methods

Ultrapak cord (U group)

The gingiva was retracted choosing the smallest retraction cord diameter (#000) (Ultrapak; Ultradent Products Inc., South Jordan, UT, USA) Cord was wetted by a saline solution for 20 min.,[29] cut to a 1-inch length and inserted in the sulcus with a serrated circular head cord packer (Fischers Ultrapak Packer; Ultradent Products Inc., South Jordan, UT, USA) from mesio-palatal to the mesio-buccal tooth surface to facilitate its insertion into the sulcus and left for 10 min. as seen in Figure 2, then it was slowly retrieved.

GingiTrac (G group) and Traxodent (T group)

The gingiva was retracted with either GingiTrac which is a medium-viscosity, vinyl polysiloxane (VPS) gingival retraction paste with 15% ammonium aluminum sulfate (alum) (Centrix, Inc., Shelton, CT, USA) or Traxodent which is a Hemodent Paste Retraction System with 15% aluminium chloride (Premier Dental, PA, USA). Either GingiTrac or Traxodent , in an abundant amount, was gradually injected into the sulcus from mesio-buccal to the mesio-palatal with the tip parallel to the tooth long axis as seen in Figure 3A and 4A, and followed by the suitable size anatomic retraction cap (GingiTrac: GingiCap; Centrix, Inc., Shelton, CT, USA or Traxodent: ROEKO Comprecap anatomic; COLTENE Group, Altstätten, Switzerland) that were filled with retraction material and placed back over the preparation and then the patient was instructed to bite on the cap with a medium force for 5 min. for GingiTrac or 2 min. for Traxodent as seen in Figure 3B and 4B. Both the retraction material/Cap were then removed in one piece and the sulcus was cleared away with an air/water spray to eliminate any retraction material remnant.

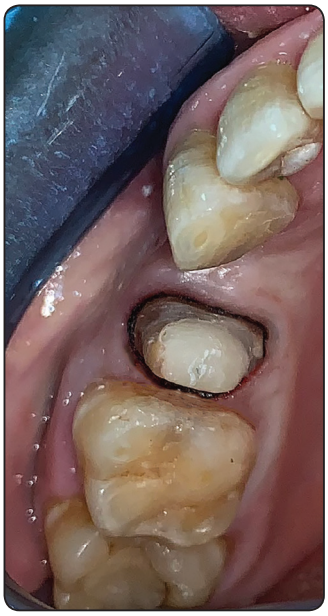

Fig. (2) Retraction cord placement in the gingival sulcus.

NoCord (NC group)

NoCord, which is a one-step, self-retracting impression system and a VPS containing 15% alum (Centrix, Inc., Shelton, CT, USA) was used following the manufacturer manual. NoCord Mega-Body was loaded in the impression tray, as seen in

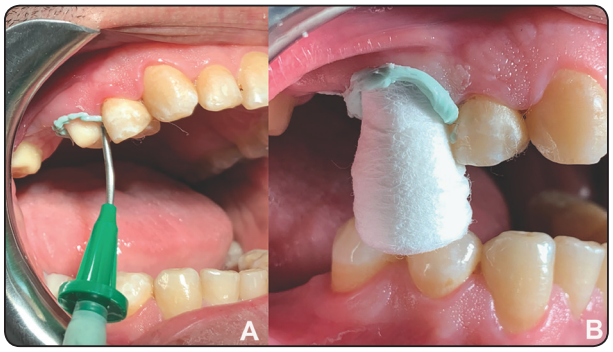

Fig. (3) GingiTrac retraction system application; a) GingiTrac retraction material injected into the gingival sulcus. b) GingiCap placed with biting force to push GingiTrac into the gingival sulcus.

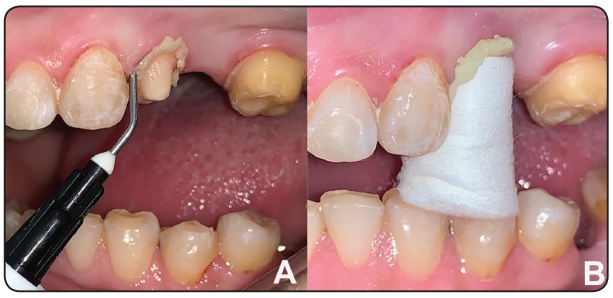

Fig. (4) Traxodent retraction system application; A) Traxodent retraction material injected into the gingival sulcus. B) Comprecap placed with biting force to push Traxodent into the sulcus.

Figure 5A, followed by syringing copious amounts of NoCord wash material into the gingival sulcus and around the preparation and adjacent teeth as seen in Figure 5B. The material was left to set for 4:45 min., then was removed from the mouth as seen in Figure 5C.

The placement time was recorded in seconds for each retraction system and the ease of placement was assessed subjectively. Immediately after retraction system removal and before post-retraction impression taking, bleeding was assessed according to the bleeding scores (Table 2).[28] PI, GI and PD were measured at various follow-up intervals (1 day and 7 days) similarly to the baseline periodontal assessment.

TABLE (2) Bleeding scores.

Score	Significance
0	No bleeding
1	Bleeding controlled within 1 min
2	Bleeding not controlled within 1 min

Microscopic Examination

Pre- and post-retraction polyether impressions as seen in Figure 6, were evaluated for horizontal gingival displacement by using a stereomicroscope (Leica MZ 6 stereomicroscope; Leica Microsystems, Wetzlar, Germany) and photographed by an attached camera of ×60 magnification (Leica MC 190 HD; Leica Microsystems) as seen in Figure 7. The stereomicroscopic images were analyzed utilizing a software (Leica Application Suite; V 3.3.0, Leica Microsystems Wetzlar, Germany) where a perpendicular line was drawn from the most dominant point of the gingival margin crest to the mid-buccal tooth surface as seen in Figure 8. The image analysis measurements were in micrometer scale, then converted into millimeter grading.

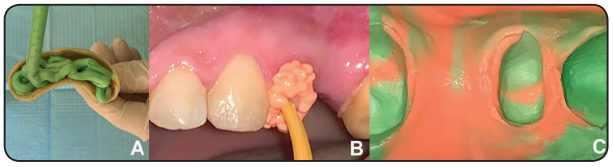

Fig. (5) NoCord retraction system application; A) NoCord MegaBody loading in the impression tray. B) NoCord wash material syringing into the gingival sulcus and around the preparation. C) The obtained set impression after removal. .

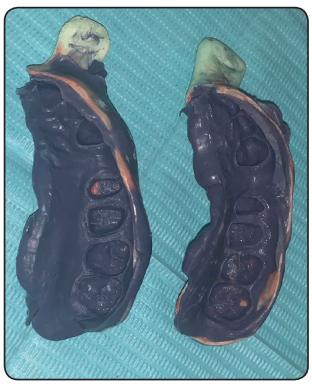

Fig. (6) Pre-retraction and post-retraction polyether impressions.

Fig. (7) Polyether impression analysis under the stereomicros cope and photographing with an attached camera of x60 magnification power.

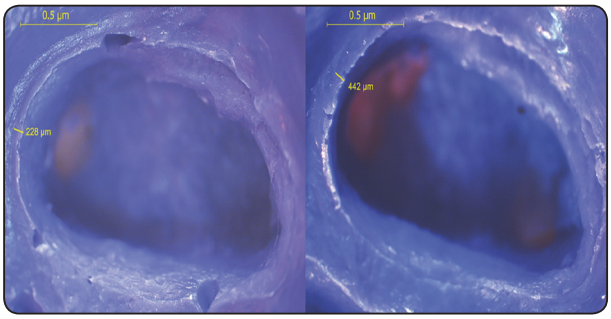

Fig. (8) Stereomicroscopic image-analysis of impressions made before retraction and after retraction to measure horizontal gingival displacement (in one-tenth of microns)..

Statistical Analysis

One-way ANOVA test was used to compare age and PD values in four groups as well as to study the changes by time within each group. Kruskal-Wallis and Friedman's tests were used to compare the displacement, PI, GI and bleeding among groups and to study the changes by the time within a group respectively. Bonferroni's post-hoc and Dunn's test was used for pair-wise comparisons. Fisher's Exact test was used for comparisons of bleeding scores regarding qualitative data. The significance level was set at $P \leq 0.05$. Statistical analysis was performed utilizing statistics software (IBM SPSS Statistics for Windows; Version 20.0, IBM Corporation, Armonk, NY, USA).

RESULTS

The participants in the four groups (n=10) were between 28 and 54 years old with statistically a non-significant difference between mean age values and gender distribution (Table 3).

Regarding the time of placement (Table 4), there was a statistically significant change among placement times in U, G and T groups (*P*-value <0.001, Effect size = 0.668). U group showed the longest median time (52.6 sec.), while there was no significant lower difference between the G group (6.4 sec.) and T group (8.4 sec.). The shortest time was observed in the NC group as it acts as retraction and impression in one step. Based on the author's subjective analysis, the NC group was relatively the easiest placement method.

Fisher's Exact test showed a non-significant diversity among four groups in bleeding after removal (*P*-value = 0.204, Effect size = 0.356) (Table 5). U group induced maximal bleeding on removal, while the NC group showed no bleeding.

Regarding the amount of horizontal gingival displacement (Table 4), there was statistically a non-significant difference among four groups (*P*-value = 0.282, Effect size = 0.023). Wilcoxon signed-rank test showed a significant diversity between post and pre-displacement in U group (*P*-value = 0.009, Effect size = 0.822) as well as in G, T and NC groups (*P*-value = 0.005, Effect size = 0.887).

The PI values (Table 4) at the baseline measurements were consistent and non-significant among groups in all time intervals. In all groups, Kruskal-Wallis tests demonstrated a significant increase in GI means after 1 day compared with baseline (*P*-value = 0.034, Effect size = 0.338). The significantly highest value was induced by the T group. Furthermore, after 7 days, the GI decreased

TABLE (3) Mean, standard deviation (SD), frequencies (n), percentages and results of one-way ANOVA test and Fisher's Exact test for comparisons of demographic data in the four groups. .

	Ultrapak (U) (n = 10)	**GingiTrac (G) (n = 10)**	**Traxodent (T) (n = 10)**	**NoCord (NC) (n = 10)**	***P*-value**
Age (Years)					
Mean (SD)	51.6 (4.1)	47.2 (12.9)	51 (5.2)	49.4 (8.4)	
Gender [n (%)]					
Man	2 (20%)	0 (0%)	2 (20%)	0 (0%)	
Woman	8 (80%)	10 (100%)	8 (80%)	10 (100%)	

: Significant at P ≤ 0.05.

TABLE (4) Descriptive statistics (Median/Range) and results of Kruskal-Wallis test for comparison among placement times, horizontal gingival measurements, PI and GI scores in the four groups and Friedman's test for the changes by time within each group.

Measurement	**Ultrapak (U) (n = 10)**	**GingiTrac (G) (n = 10)**	**Traxodent (T) (n = 10)**	**NoCord (NC) (n = 10)**	***P*-value (Among groups)**	***Effect size (Eta Squared)***
Placement time (Seconds)	52.6 (30.9-108.1) ^{A}	6.4 (1.6-12.9) ^{B}	8.4 (5.3-18.2) ^{B}		<0.001*	0.668
Sulcus width (mm)	0.239	0.300	0.232	0.209	0.739	0.048
Before retraction	(0.149-0.373)	(0.148-0.603)	(0.148-0.375)	(0.148-0.373)		
After retraction	0.365 (0.235-0.554)	0.405 (0.182-0.718)	0.360 (0.208-0.411)	0.302 (0.215-0.437)	0.310	0.016
Displacement amount (mm)	0.111 (0.057-0.304)	0.116 (0.016-0.271)	0.078 (0.015-0.171)	0.072 (0.026-0.146)	0.282	0.023
***P*-value (Within group)**	0.009*	0.005*	0.005*	0.005*		
Effect size (r)	0.822	0.887	0.887	0.887		
PI						
Before retraction	1 (0-1) ^{C}	1 (0-1) ^{C}	1 (0-1) ^{C}	1 (0-1) ^{C}	0.881	0.065
After 1 day	1 (0-1) ^{C}	1 (0-1) ^{C}	1 (0-1) ^{C}	0.5 (0-1) ^{C}	0.960	0.075
After 7 days	0 (0-1) ^{D}	0 (0-1) ^{D}	0 (0-1) ^{D}	0 (0-1) ^{D}	0.947	0.073
***P*-value (Within group)**	0.034*	0.034*	0.034*	0.034*		
Effect size (Partial Eta Squared)	0.338	0.338	0.338	0.338		
GI						
Before retraction	1(1-2) ^{D}	1 (1-2) ^{D}	1 (0-2) ^{D}	1 (0-1) ^{D}	.4710	0.013
After 1 day	2 (1-2) ^{BC}	2 (2-3) ^{BC}	3 (2-3) ^{AC}	2 (1-2) ^{BC}	<0.001*	0.444
After 7 days	1 (1-2) ^{BD}	2 (1-3) ^{AC}	2.5 (2-3) ^{AC}	1 (1-2) ^{BD}	<0.001*	0.409
***P*-value (Within group)**	0.034*	0.034*	0.034*	0.034*		
Effect size (Partial Eta Squared)	0.338	0.338	0.338	0.338		

: Significant at P ≤ 0.05.

A, B superscripts in the same row indicate statistically significant difference among groups.

C, D superscripts in the same column indicate statistically significant change by time.

to a non-significant level compared to the baseline except for T and G groups that showed significantly higher values than baseline measurements.

T and NC groups showed the highest PD values, while U and G groups showed lower values after 1 day (*P*-value <0.001, Effect size = 0.493) and 7 days (*P*-value <0.001, Effect size = 0.525) (Table 6). As regards the changes by time, there was no significant change in PD in Ultrapak (*P*-value = 0.105, Effect size = 0.121) and GingiTrac (*P*-value = 0.055, Effect size = 0.153). While PD of Traxodent (*P*-value <0.001, Effect size = 0.408) and NoCord (*P*-value <0.001, Effect size = 0.422) increased significantly after 1 day. However; Traxodent showed significantly higher values than baseline measurements after 7 days.

TABLE (5) Frequencies, percentages (%) and results of for comparison of bleeding in the four groups.

Bleeding	**Ultrapak (U) (n = 10)**	**GingiTrac (G) (n = 10)**	**Traxodent (T) (n = 10)**	**NoCord (NC)**	***P*-value**	***Effect size (v)***
No bleeding	5 (50%)	9 (90%)	7 (70%)	10(100%)	0.204	0.356
Bleeding controlled within 1 minute	5 (50%)	1 (10%)	3 (30%)	0 (0%)		

****: Significant at P ≤ 0.05.***

TABLE (6) Descriptive statistics and results of repeated measures ANOVA test for comparison among probing depth (PD) measurements in the four groups as well as the changes by time within each group.

PD (mm)		**Ultrapak (U) (n = 10)**	**GingiTrac (G) (n = 10)**	**Traxodent (T) (n = 10)**	**NoCord (NC) (n = 10)**	***P*-value (Among groups)**	***Effect size (Partial Eta Squared)***
Before retraction	**Mean (SD)**	1.03 (0.25) ^{B}	1.03 (0.25) ^{B}	1.08 (0.25) ^{BE}	1.48 (0.38) ^{AD}	0.003*	0.324
	95% CI	0.87-1.2	0.87-1.2	0.92-1.25	1.21-1.76		
1 day	**Mean (SD)**	1 (0.32) ^{B}	1.25 (0.45) ^{B}	1.62 (0.32) ^{AC}	1.88 (0.34) ^{AC}	<0.001*	0.493
	95% CI	0.76-1.24	1.01-1.49	1.38-1.86	1.64-2.13		
7 days	**Mean (SD)**	0.85 (0.18) ^{B}	1.03 (0.26) ^{B}	1.37 (0.27) ^{AD}	1.43 (0.24) ^{AD}	<0.001*	0.525
	95% CI	0.69-1.01	0.88-1.19	1.21-1.53	1.26-1.6		
***P*-value (Within group)**		0.105	0.055	<0.001*	<0.001*		
Effect size (Partial Eta Squared)		0.121	0.153	0.408	0.422		

****: Significant at P ≤ 0.05.***

A, B superscripts in the same row indicate statistically significant difference among groups.

C,D,E superscripts in the same column indicate statistically significant change by time.

DISCUSSION

A limited age range was considered and teeth were equally disbursed in maxilla either first or second premolars, which defeated age/gender effect and confirmed little difference in gingival tissue thicknesses and accessibility. All measurements were made by a single operator to eliminate an operator's variability. The abutments were prepared for full coverage restoration with equigingival margins, to avoid surrounding gingival tissues' impairment which results in gingival recession and leads to inadequate gingival displacement.[26] Polyether impression materials were utilized due to accurate capture of fine details in a narrow sulcus.[30,31] The mid buccal point was considered suitable for sulcus width measurement that was agreed by Baharav et al. who reported that the sulcus remains open for longer periods at the mid buccal point.[30]

The approach used in the current study for evaluation of tissue displacement efficiency of differently tested gingival retraction systems by taking two impressions (pre-/post-retraction) has been proclaimed.[28,33-35] Where both impressions were directly examined for tissue displacement.[28] However, some authors investigated the tissue displacing efficiency directly on the impression after its sectioning,[33] while others evaluated it on the cast after sectioning.[34,35] Such measurements on the cast can be affected by the distortions due to the pouring and setting of the stone die.

Based on the data collected, Ultrapak showed the longest placement time, while NoCord was the shortest one; that may be due to different application techniques. As well as, the U group showed the highest bleeding after removal (50%), this might be due to 0% concentration of aluminum chloride, cord filament remnants, improper cord packing force that might be associated with sulcular inflammation and marginal gingiva contraction.[13] It could also be due to clot disturbance during the cord removal. T group (30%) and G group (10%) were potentially less traumatic as a controlled pressure exerted through gingival retraction caps. Both Traxodent and GingiTrac induced minimal bleeding as they contain aluminum chloride and alum, respectively as an astringent. While the NC group induced no bleeding to be the least traumatic that might be due to passive retraction application and an astringent effect of alum incorporated in its composition.

The study findings were in agreement with Chandra et al., and Weir and Williams who reported Ultrapak had the maximum bleeding o removal.[9,36] Also, Feng et al. revealed that tumor necrosis factor-alpha (TNF-α) level increased after cord packing caused sulcular epithelium injury and connective tissue attachment damage which might induce bleeding on removal.[37] This was coinciding with the documented results by Yang et al. who reported that cordless techniques demonstrated less bleeding and pain in comparison to the traditional retraction cord.[38]

Horizontal gingival displacement is a chiefly fundamental step for precise impression making to attain the desired emergence profile of fixed prosthesis, especially when the finish line is equi/subgingival.[39] Accordingly, the essential sulcular width has been recommended to be 0.15- 0.2 mm at the finish line level and is essential for a good impression material flow around the finish line.[40] Otherwise, impressions with less sulcular widths associate with tearing of impression materials, higher incidence of impression voids and marginal inaccuracy.[41]

The null hypothesis for horizontal gingival displacement was approved as there was no significant diversity in gingival displacement among the groups. This result was in accordance with an earlier study result that reported a sulcus width increase after displacement with a plain retraction cord and cordless material containing 15% aluminum chloride.[38] This may be attributed to the action of the plain retraction cord which is mechanical by the placement of materials within the sulcus to gain a maximal gingival retraction.[28] In the present study, the cord was soaked in saline solution to enhance the mechanical effect and cord wetting.[29]

Whereas, GingiTrac and Traxodent are cordless ''mechanico-chemical'' methods of gingival

displacement, depending on alum/aluminum chloride that enhances hemostatic action, which also shrinks epithelial tissue further expanding the sulcus and leads to protein coagulation on the surface of the tissue as having astringent properties.[42] In addition to the counter pressure of retraction caps, to perform gingival displacement in about 2-5 minutes.

However, NoCord is a one-step self-retracting impression material, as suggested by the manufacturer, invented for an effortless and quick retraction and impression to attain a wide-open sulcus without traumatic techniques or to rinse to be more efficient when applied on multiple teeth. However, few relevant studies in the literature were found, this may be due to differently used gingival retraction materials and horizontal displacement assessment methods.

The current study results are contrary to other studies that documented that Ultrapak achieved significantly higher horizontal retraction than Traxodent [28,43] and another study reported that gingival displacement paste (Expasyl) showed better gingival sulcus widening than the retraction cord.[33] This might be due to different cord sizes, cordless material and evaluation methods.

Clinical diagnostic indicators, including PI, GI, and PD have been used to evaluate the gingival and periodontal disease severity by analyzing the gingival inflammation and connective tissue destruction. Clinical probing is the frequently utilized evaluation criteria for documentation of attachment loss and diagnosis of periodontitis.

The GI is a convenient parameter in assessing the gingival condition and widely used in clinical trials.[27,44] All systems showed a reversible change as GI revealed a significant increase after one day suggesting injury to the periodontium.[45-48] This might be attributed to the inflammatory cells' reaction to the mechanical or chemical trauma.[46] However, after the first day, the highest significant increase was observed in the T group that contains 15% aluminium chloride. Previous studies reported that when aluminium chloride concentrations are higher than 10%, it will lead to transient ischemia and tissue damage locally.[41,49,50] All groups exhibited tissue recovery after 7 days where Ultrapak and NoCord showed the best healing due to plain cord usage and application technique. Traxodent, in agreement with Al Hamad et al.,[51] and GingiTrac demonstrated slower healing and was still significantly diverse from the baseline measurements. This might be due to the chemical composition (aluminum chloride/alum) and application method that needs to clarify. U group results were comparable to those documented by Feng et al. where GI was the highest in the first and second days after retraction cord placement, but it recovered clinically in 2 weeks.[37] In contrast to other studies that found GI was more sever in cords than pastes.[45-48]

Probing depth was evaluated to the nearest millimeter.[52] Application of Ultrapak cord caused PD reduction (1 ± 0.32 mm) after 1 day and further reduction (0.85 ± 0.18 mm) after 7 days. This might refer to the gingival recession that has occurred due to low-grade trauma through foreign bodies (retraction cord) impaction in the gingival tissue.[51] The results were in agreement with Landesman HM et al. [46] and Feng [37] who reported that there was a direct gingival injury through mechanical procedures which resulted in immediate changes. Previous studies revealed that crevicular epithelium necrosis occurred when a retraction cord placed for a long time (>10 min.) and junctional epithelium destruction that took 8 days to heal that resulted in gingival recession.[13,27] However, Yang et al., who reported that epinephrine-impregnated cord usage resulted in the greatest gingival recession, while the cordless techniques lead to clinically insignificant recession.[38]

Regarding the change by time, tested retraction systems caused no significant difference in PD mean values after 1 or 7 days, except for Traxodent which is significant and in agreement with the previous study.[51] NoCord showed a significantly higher value than the baseline PD after 1 day that decreased to a non-significant level after 7 days. This might be due to the chemical composition that needs further investigations.

Within the limitation of the present study, more studies are needed with an expanded sample size to assess the same parameters in various population groups and clinical situations (maxillary/mandibular arches and prepared/unprepared teeth) and subgingival margin preparations. The behavior of retraction systems in the existence of inflamed soft tissues should also be inspected, as well as different gingival thicknesses. In addition, the use of other cord systems (impregnated cords) are needed for future comparison studies.

CONCLUSIONS

Cordless retraction systems showed similar horizontal gingival displacement compared to conventional cord. The periodontal criteria were statistically non-significant among groups in all time hiatuses except for the GI, which increased for all groups after 1 day and increased for Traxodent group after 7 days. NoCord can be considered an effective retraction system used, as it consumed less time and was placed easily, achieved an acceptable amount of retraction and induced no bleeding on removal compared to other retraction systems.

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