

CLINICAL RESEARCH

# Comparison of four cordless gingival displacement systems: A clinical study



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Clinically acceptable impressions are essential for the success of definitive restorations. Both marginal details and tooth structure apical to the restorative margin are important for a reliable definitive impression.<sup>1</sup> The clinical management of the marginal gingival tissues, crevicular fluids, and localized bleeding is imperative to create a clean and visible operating field.<sup>2-4</sup> Gingival displacement involves surgical, mechanical, and chemical techniques.<sup>5-9</sup>

Mechanical displacement involves placing a cotton cord into the gingival sulcus for temporary tissue displacement,<sup>10</sup> but non-medicated cords have limited effect in controlling hemorrhage.<sup>11</sup> Therefore, the chemical-mechanical method became the most frequently used one for gingival displacement.<sup>12</sup> The

## ABSTRACT

**Statement of problem.** Although the conventional chemicomechanical cord technique is widely used, packing the cord into the sulcus may cause pain and bleeding. Cordless displacement techniques have been introduced, but a comparison of these systems is lacking.

**Purpose.** The purpose of this clinical study was to evaluate the efficiency and gingival response of 4 cordless gingival displacement systems.

**Material and methods.** One hundred twenty teeth in 30 participants were allocated to 4 groups according to the material used: Tr (Traxodent; Premier Dental Products Co), Es (Expasyl; Acteon UK), Ez (Expazen; Acteon UK), and Mr (3M Retraction; 3M ESPE). Baseline measurements of periodontal indices and a digital scan were acquired. The cordless displacement pastes were applied according to the manufacturer's instructions. After removal, a second scan was acquired. Participants were recalled on the 2nd and 14th day to measure periodontal indices and for scans. Screenshots were superimposed to measure changes in the gingiva. Statistical differences among the different materials in achieving lingual and buccal vertical gingival displacement were tested using the related-samples Friedman 2-way ANOVA test by ranks at 3 time points such as immediate, at 2 days, and at 14 days ( $\alpha=.05$ ).

**Results.** Immediate gingival displacement varied with the system used. For horizontal displacement, median values ranged between 150  $\mu\text{m}$  (Tr) and 725  $\mu\text{m}$  (Ez) for buccal displacement and between 93  $\mu\text{m}$  (Tr) and 550  $\mu\text{m}$  (Ez) for lingual displacement. Minimum and maximum displacements also varied and followed a similar trend, with Traxodent providing the lowest displacement. The plaque index and attachment level did not statistically differ before and after the treatment. The periodontal parameters were not statistically significant among the groups at all time intervals, except for the gingival index that increased for all the groups after 2 days.

**Conclusions.** Significant differences were found among the 4 tested systems in both vertical and horizontal gingival displacement. Expasyl, Expazen, and 3M Retraction exceeded the 200- $\mu\text{m}$  requirements for horizontal displacement. Traxodent provided the least displacement in both vertical and horizontal dimensions. (J Prosthet Dent 2019;121:265-70)

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## Clinical Implications

Cordless gingival displacement systems are suitable for routine use in restorative dentistry. They provide the required horizontal displacement for the gingival tissues away from the finish line, making them a suitable alternative to the conventional cord. They can provide hemostasis and preserve gingival and periodontal health.

procedure involves medicated cords placed by a single-cord<sup>13</sup> or double-cord<sup>14</sup> technique.

A variety of medicaments have been used in combination with displacement cords<sup>14</sup> to temporarily shrink the gingiva by constricting the peripheral blood vessels.<sup>15,16</sup> Currently, aluminum chloride is the most commonly used medicament because it is not associated with contraindications or systemic side effects.<sup>17</sup>

Both vertical displacement, which exposes the unprepared portion of the tooth apical to the finish line,<sup>18</sup> and horizontal displacement, which moves the tissue so that an adequate bulk of impression material can contact the prepared tooth, are necessary. A minimum horizontal displacement of 200  $\mu\text{m}$  is required for the impression material to flow into the gingival sulcus and be removed without distortion.<sup>19</sup>

Although the chemical-mechanical cord technique is widely used, packing the cord into the sulcus may cause pain and bleeding. Other problems include potential damage to junctional epithelium and violation of biological width,<sup>6</sup> which might lead to bone loss and recession<sup>6,20</sup> or even infection.<sup>21,22</sup>

Cordless displacement techniques have recently been introduced. Most of these systems involve injection of a paste into the sulcus of the prepared tooth to accomplish a chemical-mechanical displacement. These products have similar methods of application. Cordless displacement techniques have advantages over conventional cord techniques, including saving time, less discomfort to the patient, better gingival displacement, less associated crevicular fluid flow, less application-generated pressure, and better maintenance of gingival health.<sup>23-26</sup>

Digital scans have advantages over conventional elastomeric impressions.<sup>27-30</sup> They have excellent accuracy and can be manipulated on the screen for viewing preparation margins and details. In addition, factors such as patient movement, swallowing, tray distortion, and moisture may negatively affect conventional impressions but not digital scans.<sup>31,32</sup>

The authors are unaware of studies that evaluated the clinical efficiency of cordless systems and gingival and periodontal indices over time. The purpose of the present clinical study was to evaluate the effects of the 4 cordless

displacement systems on the amount of gingival displacement and on the changes in the periodontal tissues, as monitored by recording the plaque index (PI), gingival index (GI), and attachment level. The null hypothesis was that no significant difference would be found in efficiency, gingival recession, or gingival health among tested systems over the time of the study.

## MATERIAL AND METHODS

Thirty participants of both sexes in need of tooth-supported crowns were recruited for the controlled clinical trial. The study took place at the Department of Oral Rehabilitation clinics, Faculty of Dentistry, Beirut Arab University, Beirut, Lebanon, after Institutional Review board (IRB) approval (2015H-0029-D-R-99). Participants were selected according to the following inclusion criteria: aged 25 to 35 years; first premolars present; in need of complete coverage restoration; abutment teeth of normal size, contour, and position; nonsmoker for at least 6 months before the study; systemically healthy with no medical history that could affect their periodontal condition; clinically and radiographically healthy gingiva and periodontium around the abutments; good oral hygiene with pocket depths  $\leq 3$  mm; no evidence of attachment loss, bleeding on probing, or plaque accumulation; and thick gingival biotype.

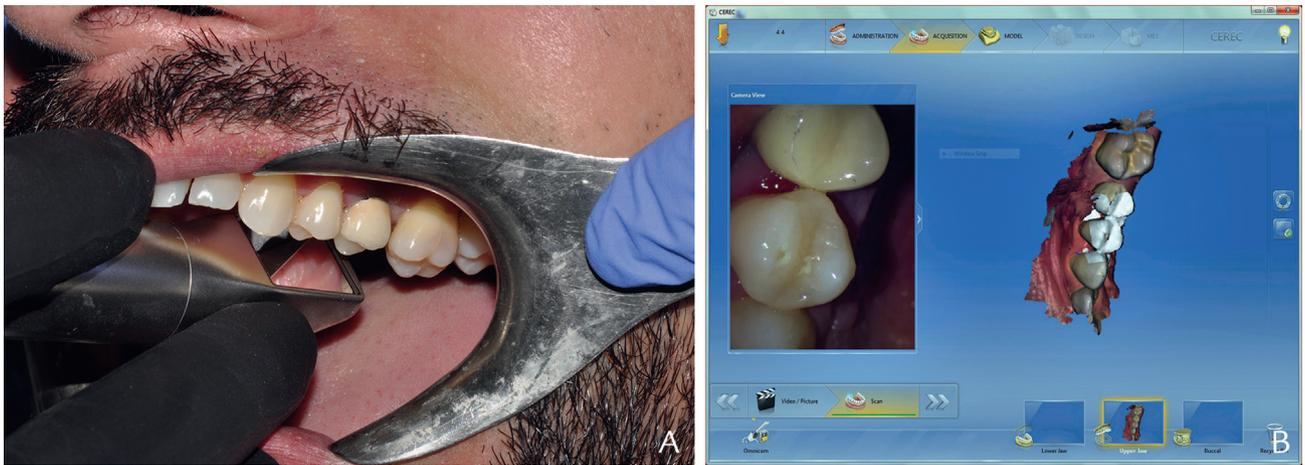
All procedures were explained thoroughly before participation. Two weeks before the clinical procedure, each participant received an oral prophylaxis, and oral hygiene was reinforced. The next week, measurements of periodontal indices were made, including PI and GI, according to the study by Silness and Loe.<sup>33</sup> Pocket depth and attachment level were also measured to the nearest millimeter on 6 sites per abutment tooth using a periodontal probe (UNC15 Color-Coded Expro; Hu-Friedy).

In the 30 participants who met the selection criteria, 120 premolar teeth were allocated to 4 groups ( $n=30$ ): group Tr (Traxodent; Premier Dental Products Co), group Es (Expasyl; Acteon UK), group Ez (Expazen; Acteon UK), and group Mr (3M Retraction; 3M ESPE) (Table 1). Before displacement cord application, cheek retractors were placed, and the maxillary and mandibular first premolars were cleaned and polished using polishing paste in a rotary cup (Disposable Contra Prophy Angle, Firm Cup; Hu-Friedy). Baseline measurements of the periodontal indices were made by the periodontist N.A.E.S. who was unaware of the material used in each tooth.

After measuring the periodontal indices, each tooth was dried using an air spray, and a digital scan was acquired for each premolar using an intraoral scanner (CEREC Omnicam; Dentsply Sirona) (Fig. 1). Each displacement cord material was assigned to a premolar in all participants ( $n=30$ ): maxillary right first premolar,

**Table 1.** Materials tested

Trade Name	Composition	Presentation	Application Time	Removal	Manufacturer
3M ESPE Astringent Retraction Paste	15% aluminum chloride hexahydrate (AlCl <sub>3</sub> , 6H <sub>2</sub> O)	Unit-dose capsules fit in any composite-dispensing gun	2 min	Air-water syringe	3M ESPE
Expasyl	15% Aluminum chloride hexahydrate (AlCl <sub>3</sub> , 6H <sub>2</sub> O)	Special dispensing gun, cartridge, and dispensing tip	1-2 min	Air-water syringe	Acteon UK
Expazen	15% Aluminum chloride hexahydrate (AlCl <sub>3</sub> , 6H <sub>2</sub> O)	Unit-dose capsules fit in any composite-dispensing gun	1-2 min	Spatula and air-water syringe	Acteon UK
Traxodent	15% Aluminum chloride hexahydrate (AlCl <sub>3</sub> , 6H <sub>2</sub> O)	Syringe with changeable needle tip	2 min	Air-water syringe	Premier Dental Products Co



**Figure 1.** A, Digital scanning with CEREC Omnicam intraoral scanner. B, Screenshot during digital scan acquisition.

Traxodent (Tr); maxillary left first premolar, Expasyl (Es); mandibular left first premolar, Expazen (Ez); and mandibular right first premolar, 3M Retraction (Mr). The intraoral scanner was calibrated before each acquisition.

Before application of the cordless displacement system, the tooth was rinsed and dried. The paste was applied slowly into the sulcus, in sufficient quantity and without pressure (Fig. 2). Following the manufacturer instructions, for all groups except Mr, the end of the capsule tip created a closed space between the tooth and the gingival margin. For the Mr group, the capsule tip was inserted into the sulcus. All materials were left in place for 2 minutes. Then all materials except Expazen were removed using air-water spray and suction. For the Ez group, the material was removed using the flat end of a spatula and air spray. Any residual material from the Ez groups was rinsed using an air-water spray. Measurements of periodontal indices were recorded again for the target teeth. Each tooth was again dried using air spray, and a second digital scan was acquired for each premolar (Fig. 3). The participants were dismissed and recalled at the 2nd and 14th day for measuring periodontal indices and for digital scans.

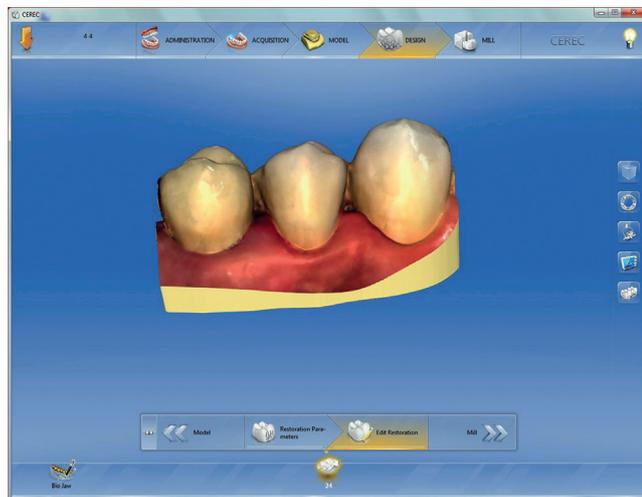
The digital scans were manipulated on the Omnicam computer screen, and screenshots were made.



**Figure 2.** Gingival blanching during application of Expazen displacement paste into sulcus.

Screenshots were superimposed and magnified using a graphics software program (Adobe Photoshop CS4 Extended v11; Adobe Systems Inc) (Fig. 4); changes in the gingival position were measured in micrometers. The location of the gingival margin for each tooth was determined and marked with dots.

For measuring vertical displacement, a line was drawn between 2 reference points (the cusp tip and a point on



**Figure 3.** Second digital scan immediately after displacement paste removal.

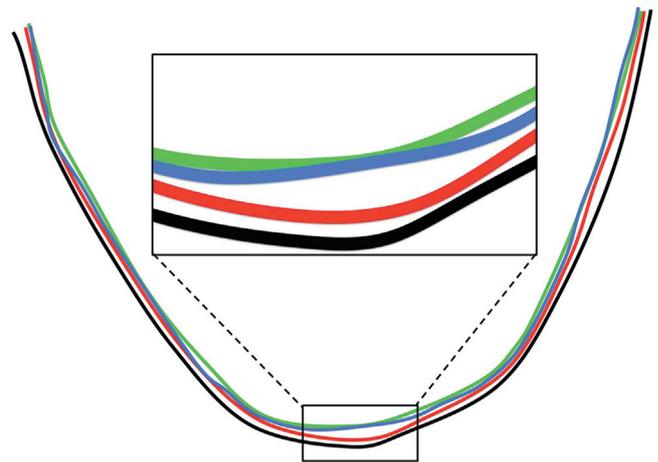
the deepest middle part of the facial marginal gingiva) on the screenshots on the selected tooth. The distance between the 2 reference points was measured in micrometers. For horizontal displacement, a line was drawn from the most prominent point of the crest of the marginal gingiva to a point perpendicular to the tooth surface. The digital scan was then sectioned mesiodistally at that point to measure horizontal displacement (Fig. 5). The gingival displacement ( $\mu\text{m}$ ) is calculated as post-displacement measurement ( $\mu\text{m}$ ) minus predisplacement measurement ( $\mu\text{m}$ ).

A statistical analysis was performed using Friedman 2-way ANOVA. Repeated measures of probing depths and PI were similarly assessed using the related-samples Friedman test. Statistical software (IBM SPSS Statistics, v20.0; IBM Corp) was used to carry out all statistical analyses ( $\alpha=.05$ ).

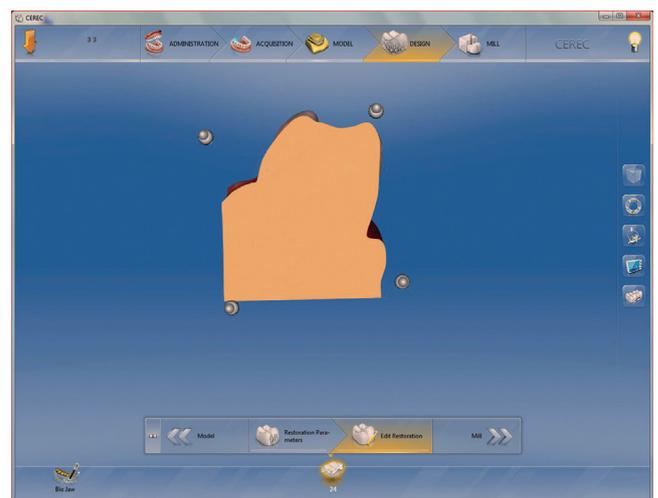
## RESULTS

Thirty participants (12 women and 18 men) were recruited, and no one was lost to follow-up; therefore, 120 sites were analyzed. Immediate gingival displacement varied with the type of displacement material used. The most notable variation was found in horizontal displacement, with median values ranging between 150 (*Tr*) and 725  $\mu\text{m}$  (*Ez*) for buccal displacement and between 93 (*Tr*) and 550  $\mu\text{m}$  (*Ez*) for lingual displacement.

Results of the Friedman 2-way ANOVA showed a statistically significant difference in gingival displacement among the 4 groups ( $P<.001$ ) (Table 2). Traxodent resulted in significantly lower buccal and lingual vertical displacements than the other displacement materials investigated ( $P<.001$ ). The long-term follow-up observations of vertical gingival displacement at 2nd and 14th days were generally similar to those found for immediate displacement (Table 3). The displacement at both the time



**Figure 4.** Traced location of gingival margin. *Green*: Gingival level before displacement. *Black*: Immediate gingival displacement. *Red*: Gingival displacement on second day. *Blue*: gingival displacement on 14th day.



**Figure 5.** Screenshot of mesiodistally sectioned digital scan to measure horizontal displacement.

points was significantly associated with the displacement material ( $P<.05$ ). Periodontal parameters (average probing depth and PI) were not statistically significant among the groups at all time intervals, except for the GI, which increased for all groups after 2 days ( $P<.05$ ).

## DISCUSSION

In the present study, digital scans were recorded and used to measure the linear gingival changes caused by displacement material to micrometer accuracy. This might have eliminated possible human errors generated from laboratory steps. All measurements were made by a prosthodontist (M.M.R.) before impression, abutment preparation, interim restoration, and cementation procedures to avoid possible causes of gingival inflammation or recession aside from the tissue displacement mechanism itself.

**Table 2.** Distribution of immediate gingival displacement (N=30)

Displacement	Traxodent		Expasyl		Expazen		3M Retraction		Friedman Test	
	Median	Mean ±SD	Median	Mean ±SD	Median	Mean ±SD	Median	Mean ±SD	Test Statistic $\chi^2(3)^a$	P
Vertical ( $\mu\text{m}$ )										
Buccal	100	80 ±24.9	300	290 ±54.8	200	200 ±32.2	200	210 ±49.8	77.32	<.001*
Lingual	50	60 ±20.3	200	220 ±40.7	200	180 ±24.9	200	210 ±38.1	73.17	<.001*
Horizontal ( $\mu\text{m}$ )										
Buccal	150	143 ±36.5	555	557.5 ±60.2	725	725 ±52.1	400	382.5 ±42.6	89.18	<.001*
Lingual	93	99 ±17.7	375	376 ±55.6	550	540 ±61.5	425	435 ±64.5	80.23	<.001*

SD, standard deviation. \*Statistically significant at  $P<.01$ . <sup>a</sup>Related-Samples Friedman Two-Way ANOVA by Ranks evaluated at 3 degrees of freedom.

**Table 3.** Distribution of vertical gingival displacement at 2 days and 14 days (N=30)

Follow-up	Traxodent		Expasyl		Expazen		3M Retraction		Friedman Test	
	Median	Mean ±SD	Median	Mean ±SD	Median	Mean ±SD	Median	Mean ±SD	Test Statistic $\chi^2(3)^a$	P
2 days										
Buccal ( $\mu\text{m}$ )	50	50 ±16.1	150	160 ±30.5	75	70 ±19.0	100	110 ±30.5	74.59	<.001*
Lingual ( $\mu\text{m}$ )	50	50 ±11.4	50	70 ±24.9	50	50 ±16.1	50	60 ±20.3	9.58	.022**
14 days										
Buccal ( $\mu\text{m}$ )	25	30 ±10.2	100	85 ±23.3	50	40 ±12.5	50	55 ±15.3	66.94	<.001*
Lingual ( $\mu\text{m}$ )	25	25 ±9.9	25	35 ±12.5	25	30 ±10.2	25	32.5 ±11.7	14.68	.002*

SD, standard deviation. \*Statistically significant at  $P<.01$ . \*\*Statistically significant at  $P<.05$ . <sup>a</sup>Related-Samples Friedman Two-Way ANOVA by Ranks evaluated at 3 degrees of freedom.

For measuring gingival displacement on buccolingually sectioned stone, digital Vernier calipers, Boley gauge, flexible scales, or low-power microscope<sup>34</sup> were not used in the present study. The Boley gauge and flexible scales could have led to errors,<sup>18</sup> and a low-power microscope and flexible scales are only accurate to 0.25 mm and 0.5 mm, which is insufficient to record difference in gingival levels with the necessary precision. Factors that could have affected the accuracy of the impression included flow properties, mixing method/ratio, time,<sup>35</sup> the 0.10% to 0.34% setting expansion of the gypsum,<sup>23,35</sup> and the possible fracture of thin marginal areas during sawing of the gypsum cast.

Horizontal displacement was not measured on the 2nd and 14th days because it was expected to subside after the removal of the displacement material, unlike vertical displacement that lasts longer because of the effect of aluminum chloride.

Three materials provided the 200- $\mu\text{m}$  requirement needed for minimum horizontal displacement. Only Traxodent did not meet the minimum displacement requirement. This may be attributed to its low viscosity and large-diameter needle tip, which might hinder material penetration into the gingival sulcus. Expasyl produced the best vertical displacement. This might be because its kaolin component can confine aluminum chloride within the sulcus long enough to perform its action.

Expazen produced the greatest horizontal displacement possibly because its thick consistency upon setting resembles displacement cord. However, its average vertical displacement may be because of its resinous consistency that might have limited the effect of the aluminum chloride.

In all the groups, residual vertical displacement was apparent on the second day and decreased, but present, after 14 days, demonstrating that it took more than 14 days for the effect of the aluminum chloride to subside. The present study is not consistent with a study that reported that Expasyl increased temporary gingival inflammation more than other materials.<sup>36</sup>

To expose the sulcular area efficiently, the magnitude of the displacement force should be sufficient to overcome the resistance offered by the gingival tissues and, at the same time, to prevent tissue collapse. Gingival resistance varies according to tissue anatomy, biotype, and tissue health. Interproximal gingiva is thicker and richer in collagen fibers.<sup>37</sup> Thick interproximal bone supports thick dentogingival fibers, which might resist displacing forces.<sup>37</sup> Unhealthy, inflamed, or swollen tissues are prone to collapse during impression making.

Limitations of the present study include comparing the materials only around healthy teeth. Further studies are needed with an increased sample size to evaluate the same parameters in different population groups and longer durations. The performance of the material in the presence of gingivitis and periodontitis should also be examined, as well as different gingival thickness groups.

## CONCLUSIONS

Within the limitations of this clinical study, the following conclusions were drawn:

1. Significant differences were found among the 4 tested materials in both vertical and horizontal gingival displacement.

2. Expasyl, Expazen, and 3M Retraction displacement exceeded the 200- $\mu$ m requirements for horizontal displacement.
3. Traxodent resulted in the least vertical and horizontal displacement.
4. The periodontal parameters were not statistically significant among the groups at all time intervals except for the GI, which increased for all groups after 2 days.

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