REVIEW ARTICLE

Evaluation of Effectiveness and Adverse Effects of Retraction Cord vs Retraction Paste: A Systematic Review

Vincent Bennani[1], Y-S Chuang[2], John M Aarts[3], Paul Brunton[4]

Abstract

Aim and objective: The practitioner's assumptions with regards to the ideal gingival retraction technique are not well supported in the literature and contradictions still exist. Therefore, the objective of this review is to determine the effectiveness and adverse effects, of using a retraction cord compared with a retraction paste.

Materials and methods: The "Preferred reporting items for systematic review and meta-analysis protocols" (PRISMA-P) 2015 guidelines were followed. Studies, published between 2010 and 2020, involving retraction cords and retraction pastes were searched for in multiple databases. Inclusion and exclusion criteria were applied and the studies were evaluated using the GRADE system. The studies were analyzed and the quantity of gingival retraction and periodontal health are reported.

Results: Of the selected 10 studies, nine were randomized, and one was quasi-randomized. Five studies compared the horizontal displacement of retraction cords and retraction pastes. Eight studies described the influence of retraction materials on periodontal health. Seven studies recorded Bleeding Index (BI) scores, with five studies finding higher BI value following removal of retraction cords. According to the GRADE scoring system, the quality of research was ranked from +1 to +3 with the majority of the studies being in the +2 range.

Conclusion: Astringents used with retraction cords can achieve wider and longer gingival displacement. Retraction pastes can avoid disrupting the junctional epithelium attachment and damaging the supracrestal tissue height, and produce less gingival inflammation due to the lower application forces.

Keywords: Cord, Displacement, Gingival, Paste, Retraction.

International Journal of Prosthodontics & Restorative Dentistry (2021): 10.5005/jp-journals-10019-1344

Introduction

The accuracy of clinical impressions is dependent on their ability to reproduce the prepared abutments, especially when the margins are placed equigingivally or subgingivally. Evidence-based studies have shown that a minimum of 0.2 mm horizontal gingival retraction is required to capture the margins of a tooth preparation precisely without distortion or tearing of the impression material.[1,2] Clinically, dentists utilize gingival retraction techniques to displace the gingival margin away from the tooth before taking a final impression for fixed prosthodontics.[3,4]

Although various materials and methods can be utilized for gingival retraction, retraction cord and retraction paste systems are the most commonly used techniques. The retraction cord method is more traditional, which can be impregnated with an astringent that induces shrinkage of the gingival tissue and hemostasis. Some chemicals like aluminum chloride have been shown to control the seepage of the gingival fluid.[5] The retraction paste system works by absorbing gingival fluids to achieve the desired mechanical displacement of the gingiva.[6] A gingival retraction material needs to be predictable, effective, reversible, and leave no permanent tissue injuries. However, an improper technique can result in inadvertent damage to the periodontium, especially when dealing with a thin gingival biotype.[7,8]

A common adverse effect of retraction techniques is damage to the attachment epithelium within the sulcular gingival complex with a violation of the biological width. The impingement of the biological width during gingival retraction can result in gingival recession, gingival pockets, and localized alveolar bone loss.[9] It is recommended, to avoid the violation of the supracrestal tissue height, that the subgingival margin placement, when required, and operators should follow strict guidelines.[10]

[1–3]Department of Oral Rehabilitation, Faculty of Dentistry, University of Otago, Dunedin, Otago, New Zealand

[4]Department of Health Sciences, University of Otago, Dunedin, Otago, New Zealand

Corresponding Author: Vincent Bennani, Department of Oral Rehabilitation, Faculty of Dentistry, University of Otago, Dunedin, Otago, New Zealand, Phone: +64 3 479 7061, e-mail: vincent.bennani@otago.ac.nz

How to cite this article: Bennani V, Chuang Y-S, Aarts JM, *et al.* Evaluation of Effectiveness and Adverse Effects of Retraction Cord vs Retraction Paste: A Systematic Review. Int J Prosthodont Restor Dent 2021;11(4):183–190.

Source of support: Nil

Conflict of interest: None

There are still inconsistent results with regards to the effectiveness and periodontal irritation associated with different retraction techniques and contradiction in the literature with regards to the best techniques that should be used to achieve gingival retraction. Therefore, the purpose of this systematic review is to compare the effectiveness and subsequent post-retraction adverse effects on periodontal health when gingival retraction is achieved using a retraction cord vs the use of a retraction paste technique.

Materials and Methods

This systematic review conformed to the "Preferred reporting items for systematic review and meta-analysis protocols" (PRISMA-P) statement published in 2015. The PICO questions were defined as; Population (P) is the healthy gingival tissue surrounding human

teeth, Intervention (I) is the retraction paste technique, Comparison (C) is the retraction cord technique, Outcomes (O) is the successful gingival displacement and the resulting gingival health after gingival retraction. The databases utilized for the electronic search of the literature were Medline (Ovid), Embase, PubMed, Web of Science, Scopus, and Cochrane Library. Publications between 2010 and 2020 were searched with the following search strategy, syntax for each search were modified in accordance with the respective databases: [(gingival displacement OR gingival retraction OR cord OR cordless OR gingival retraction paste) AND (periodontal health OR periodontal tissue OR gingiva OR gum* OR biological width) AND (gingival recession OR attachment loss OR probing depth OR gingival index OR periodontal index OR bleeding on probing OR plaque index)].

The inclusion criteria were; studies that are done *in vivo*, studies that are clinical research or randomized clinical trials, studies that include both retraction cords and retraction pastes, studies that include patients with healthy periodontal status, and studies published in English. The exclusion criteria were; studies that are *in vitro*, studies that were done on an animal model, studies published before 2010, publications that described a case report, technique-based report or review, and studies in a language other than English.

The initial search was followed by the removal of duplicates, then those studies abstracts were screened with the inclusion and exclusion criteria applied. The remaining individual studies were selected as full-text studies. The bibliographies of the selected full-text studies and related reviews were conducted to complement the electronic search. The hand search was performed by the author and another researcher and further studies were identified for final review.

The quality of the studies included in this systematic review was rated using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system. GRADE is a well-developed formal process to rate the quality of scientific evidence in systematic reviews. It provides guidelines to develop recommendations that are as evidence-based as possible. The scoring was done by two reviewers and the Cohen's Kappa coefficient between the two reviewers was 0.8 which was calculated by the online counter.[11] The reviewers reached an agreement after discussion or by consulting the third reviewer. In the GRADE approach, randomized controlled trials are categorized as high-quality evidence and observational studies as low-quality evidence to support estimates of intervention effects.[12] The factors taken into consideration in this scoring system are type of evidence, quality, consistency, directness, and effect size. The final GRADE score was determined by the sum of the individual scores in the aforementioned categories and summarized as: high (at least 4 points overall), moderate (3 points), low (2 points), and very low (1 point or less). A schematic view of GRADE scoring is summarized in Table 1.[12]

The basic information of the studies included in this systematic review, such as the authors, study types, assessed teeth, and gingival condition were captured and presented in the results. To determine the effectiveness of each retraction method the included studies were analyzed. The gingival retraction materials, sampling methods, measurement designs, and statistical strategies of each study were analyzed and reported. The process of analysis also involved the conclusions being considered, along with the quality of the studies, with the higher-quality studies ultimately being a key contributing factor.

Results

As shown in the PRISMA flowchart in Flowchart 1, a total of ten studies were included in this systematic review.[13–22] The selected ten studies were published between 2010 and 2020, and nine studies were randomized, and one was quasi-randomized. Most studies evaluated the amount of gingival retraction and periodontal parameters, except for two studies. One study reported the clinical and immunologic factors related to two gingival retraction techniques, and the other the histological analysis on orthodontically-extracted premolars after gingival retraction. A total of 788 teeth were included in the systematic review, with 210 unprepared teeth in three studies and 578 prepared teeth in seven studies. According to the GRADE scoring system, the

Table 1: GRADE scoring system used for reviews

Type of evidence		
Initial score based on type of evidence	+4	randomized controlled trials/SR of randomized controlled trials, +/– other types of evidence
	+2	Observational evidence (e.g., cohort, case-control)
Quality		
Based on	Blinding and allocation process	
	Follow-up and withdrawals	
	Sparse data	
	Other methodological concerns (e.g., incomplete reporting, subjective outcomes)	
Score	0	No problems
	–1	Problem with 1 element
	–2	Problem with 2 elements
	–3	Problem with 3 or more elements
Consistency		
Based on	Degree of consistency of effect between or within studies	
Score	+1	Evidence of dose-response across or within studies (or inconsistency across studies is explained by a dose-response); also 1 point added if adjustment for confounders would have increased the effect size
	0	All/most studies show similar results
	–1	Lack of agreement between studies (e.g., statistical heterogeneity between studies, conflicting results)
Directness		
Based on	The generalizability of population and outcomes from each study to our population of interest	
Score	0	Population and outcomes broadly generalizable
	–1	Problem with 1 element
	–2	Problem with 2 or more elements
Effect size		
Based on	The reported OR/RR/HR for comparison	
Score	0	Not all effect sizes >2 or <0.5 and significant; or if OR/RR/HR not significant
	+1	Effect size >2 or <0.5 for all studies/meta-analyses included in comparison and significant
	+2	Effect size >5 or <0.2 for all studies/meta-analyses included in comparison and significant

assessment of the quality of research and the ranking outcomes are presented in Table 2.

A summary of the reviewed studies materials and methods is presented in Table 3 and includes a summary of the operators involved, various sample groups, measurement method, and follow-up times if described. The results were analyzed and reported in two parts. Five studies are included in the first part evaluating the quantity of gingival retraction (Table 4). The second part includes eight studies focusing on periodontal health after gingival displacement (Table 5).

Effectiveness of Gingival Retraction Techniques

Five of the reviewed studies compared the horizontal displacement abilities between retraction cords and retraction pastes.[13–17] Beleidy and Elddien's[13] study failed to obtain the minimum required horizontal gingival displacement (0.2 mm sulcular width) with all retraction materials used.[2] According to their data collection, the horizontal retraction achieved with Ultrapak, GingiTrac, Traxodent, and NoCord was 0.111 mm, 0.116 mm, 0.078 mm, and 0.072 mm, respectively.[13] Two studies (Gupta et al.[14] and Bennani et al.[15]) reported that retraction cords achieved significantly better horizontal gingival displacement. In the study of Bennani et al.,[15] the average amount of the horizontal gingival displacement was 0.282 mm in the retraction cord group and 0.213 mm in the retraction paste group. Gupta et al.[14] reported the achieved horizontal retractions of Stay-put, Expasyl, and Magic foam cords were 0.233 ± 0.082 mm, 0.151 ± 0.069 mm, and 0.199 ± 0.085 mm, respectively. Both of them assessed the vertical gingival displacement as well. Gupta et al.'s study reported significantly better vertical displacement was attained by the retraction cord, which was 1.0655 ± 0.3851 mm, than the retraction pastes, which were 0.484 ± 0.195 mm for Expasyl and 0.8645 ± 0.3029 mm for Magic foam cord. Bennani et al.[15] reported similar vertical displacement within the retraction cord and retraction paste groups, which were 0.06 mm and 0.013 mm, respectively. In contrast, statistically more significant horizontal displacement in the retraction paste group (0.26 ± 0.02 mm) than that in the retraction cord group (0.21 ± 0.01 mm) was recorded by Prasanna et al.[16] Jain and

Flowchart 1: PRISMA flowchart of the study selection

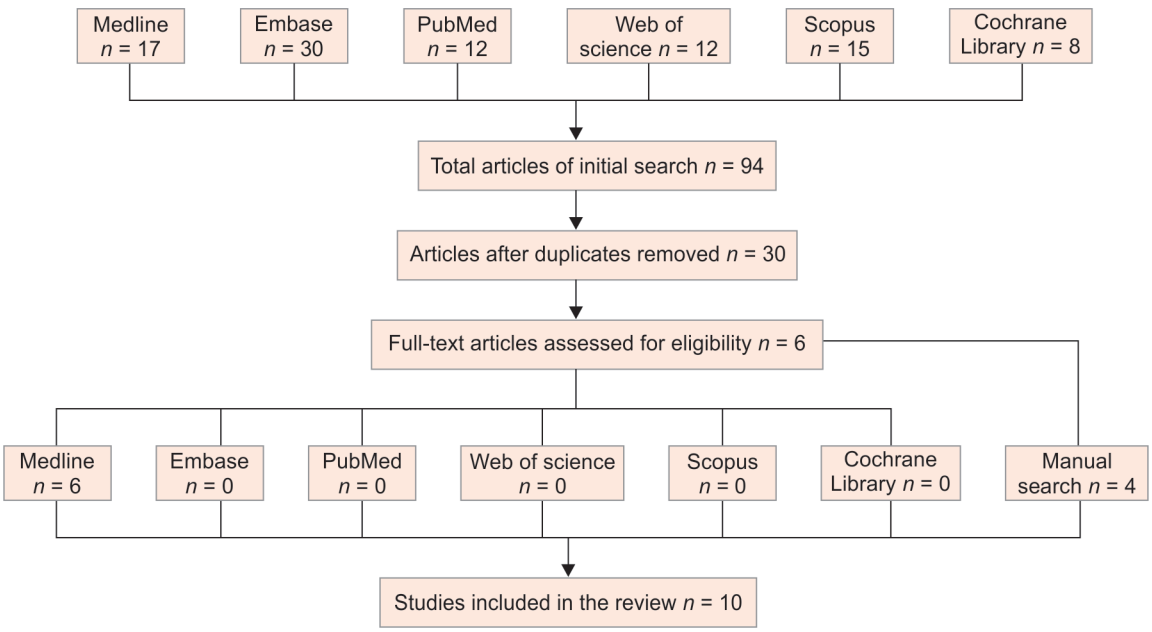

Table 2: Results of the GRADE scoring of the included studies

Study	*Type of evidence (+2 to +4)*	*Quality (0 to −3)*	*Consistency (+1 to −1)*	*Directness (0 to −2)*	*Effect size (0 to +2)*	*GRADE score*
Sarmento et al. (2014)	+4	−1	0	0	0	+3
Bennani et al. 2020)	+4	−1	0	0	0	+3
Phatale et al. (2010)	+4	−2	0	0	0	+2
Gupta et al. (2013)	+4	−2	0	0	0	+2
Prasanna et al. (2013)	+4	−2	0	0	0	+2
Chandra et al. (2016)	+4	−2	0	0	0	+2
Jain and Nallaswamy (2018)	+4	−2	0	0	0	+2
Einarsdottir et al. (2018)	+4	−2	0	0	0	+2
Beleidy and Serag Elddien (2020)	+4	−1	−1	0	0	+2
Acar et al. (2014)	+4	−3	0	0	0	+1

Table 3: Overview of the reviewed studies materials and methods

	Operator information							
Study	*No.*	*Qualification*	*Calibrated*	*Study groups*	*Applied time*	*Sampling*	*Measurement*	*Follow-up*
Sarmento et al. (2014)	1	N/S	NO	I) Group A: 25% AlCl3 gel+Ultrapak / ~10 days~ / Group B: Expasyl II) Group A: Expasyl / ~10 days~ / Group B: 25% AlCl3 gel+ Ultrapak	I) Ultrapak: 10 min Expasyl: 2 min II) Ultrapak: 10 min Expasyl: 2 min	Absorbent paper strip (Periopaper)	Gingival crevice fluid / cytokine-specific enzyme-linked immunosorbent assays	1 & 10 days
Phatale et al. (2010)	1	Prosthodontist	NO	I) Expasyl → 14#; II) Magic foam cord → 34# III) Ultrapak+5% AlCl3 → 24#	I) 1 min (thin biotype); 2 min (thick biotype) II) 5 min on all teeth III) 10 min on all teeth	Surgical removal	Histological specimen	2 days
Chandra et al. (2016)	N/S	N/S	N/S	I) U: Ultrapak+epinephrine (1:1000) S: SilTrax AS+aluminum sulfate II) E: Expasyl, 15% AlCl3, T: Traxodent, 15% AlCl3	I) 5 min II) 2 min	Photos after removal of retraction every 20 sec for 180 sec.	Photographs / Adobe photoshop	1 & 7 days
Bennani et al. (2020)	1	Prosthodontist	Yes	I) Expasyl / KnitTrax size 0+AlCl3 II) KnitTrax size 0+AlCl3 / Expasyl	N/S	Impression taken with custom tray (Polyvinyl, 3M imprint)	On casts / Microscope	1 & 14 days
Gupta et al. (2013)	1	N/S	Yes	I) Stay-put+Expasyl II) Stay-put and magic foam III) Expasyl and magic foam	I) 4 min II) 4 min III) 4 min	Impression taken with custom tray (Polyether, Impregum)	On impressions / Microscope	N/S
Prasanna et al. (2013)	N/S	N/S	N/S	I) Ultrapak+15.5% ferric sulphate / Expasyl II) Expasyl / Ultrapak+15.5% ferric sulphate	I) Ultrapak: 10min Expasyl: N/S II) Ultrapak: 10min Expasyl: N/S	Impression taken without custom tray (Polyvinyl, 3M ESPE)	On impression / Microscope	N/S
Acar et al. (2014)	4	N/S	Yes	I) Knit-Pak II) Knit-Pak+AlCl3 III) Traxodent+displacement cap IV) Knit-Pak+AlCl3+Traxodent+displacement cap	I) 15 min II) 15 min III) N/S IV) 15 min	Impression taken without custom tray (Polyether, Impregum)	On impressions / Microscope	N/S
Jain et al. (2018)	N/S	N/S	N/S	I) Expasyl II) Ultrapak	I) 2 min II) 5 min	Impression taken without custom tray (Polyvinyl, Aquasil)	On casts / Microscope & Caliper	1 & 3 months
Einarsdottir et al. (2018)	N/S	Prosthodontist, general dentist, dental student	Yes	I) AlCl3 paste II) Ultrapak+AlCl3 paste III) Ultrapak with 14% AlCl3 or Ultrapak+20% ferric sulfate	N/S	Impression taken without custom tray (Alginate)	Photographs / Adobe photoshop	30±10 days
Beleidy et al. (2020)	1	N/S	Yes	I) Ultrapak (U) II) GingiTrac (G) III) Traxodent (T) IV) No Cord (NC)	I) 10 min II) 5 min III) 2 min IV) 4 min 45 sec	Impression taken with custom tray (Polyether, Impregum)	Impression / Microscope	1 & 7 days

N/S, not specified

Table 4: Summary effectiveness of gingival retraction (cord vs paste)

		Retraction achieved (mm)	
Study	*Placement time requested (sec)*	*Vertical*	*Horizontal*
Bennani et al. (2020)	N/A	KnitTrax: 0.06 Expasyl: 0.013	KnitTrax: 0.282Expasyl: 0.213
Gupta et al. (2013)	Stay-put: 215.1±37.44Expasyl: 75.15±17.95Magic foam: 79.75±18.36	Stay-put: 1.06550±0.3851Expasyl: 0.484±0.195Magic foam: 0.8645±0.3029	Stay-put: 0.233±0.082Expasyl: 0.151±0.069Magic foam: 0.199±0.085
Prasanna et al. (2013)	N/A	N/A	Ultrapak: 0.21±0.01(max. ~0.2, mand. ~0.22) Expasyl: 0.26±0.02(max. 0.27, mand. 0.26)
Jain and Nallaswamy (2018)	Ultrapak: ant. ~109.38 post. ~112.06Expasyl: ant. ~42.25 post. ~57.09	N/A	Ultrapak: 0.254–0.407 Expasyl: 0.285–0.479
Beleidy and Serag Elddien (2020)	Ultrapak (U): 52.6 secGingiTrac (G): 6.4 secTraxodent (T): 8.4 secNoCord (NC): —	N/A	Ultrapak (U): 0.111mmGingiTrac (G): 0.116mmTraxodent (T): 0.078mmNoCord (NC): 0.072 mm

Table 5: Summary of adverse effects on periodontal health (clinical indices)

	Periodontal health		
Study	*Parameters assessed*	*Toothsensitivity*	*Gingival recession*
Sarmento et al. (2014)	BI→ No significant change GI→ N/A PI→ No significant change PD→ No significant change BOP→ N/A CAL → No significant change	No significant change	N/A
Bennani et al. (2020)	BI→KnitTrax~removal 0–0.9%; 24 hr 0% Expasyl~removal 0–1.8%; 24 hr 0% GI→ unchanged PI→ unchanged PD→ unchanged BOP→ N/A	No significant change	No
Gupta et al. (2013)	BI→ Stay-put with higher GI→ N/A PI→ N/A PD→ N/A BOP→ N/A	N/A	N/A
Chandra et al. (2016)	BI→ Day 0: Ultrapak~ highest, Expasyl~0; Day 7: All~0 GI→ Day 0: Ultrapak~ highest, Expasyl~ lowest; Day 7: All~0 PI→ N/A PD→ N/S BOP→ N/S	N/A	N/A
Jain and Nallaswamy (2018)	BI→ Ultrapak: 74.4%; Expasyl: 5.1% GI→ N/S PI→ Ultrapak group with higher value PD→ N/A BOP→ Ultrapak: 1M~64.1%; 3M~74.3%Expasyl: 1M~35.9%; 3M~25.6%	N/S	Ultrapak: 1M~0.229mm3M~0.476mm Expasyl:1M~0.093mm3M~0.146mm
Einarsdottir et al. (2018)	BI→ N/A GI→ N/A PI→ N/A PD→ N/A BOP→ N/A	N/S	Ultrapak: –0.087mmUltrapak & Paste: –0.011mmPaste: 0.111mm

Contd...

Contd...

	Periodontal health		
Study	*Parameters assessed*	*Toothsensitivity*	*Gingival recession*
Beleidy and Serag Elddien (2020)	BI→ U: 50%; G: 10%; T: 30%; NC: 0%; GI→ baseline~U:1 G:1 T:1 NC:1 1 day~U:2 G:2 T:3 NC:27 day~U:1 G:2 T:2.5 NC:1; PI→ unchanged PD→ baseline~ U:1.03±0.25 G:1.03±0.25 T:1.08±0.25 NC:1.48±0.38 1 day~ U:1±0.32 G:1.25±0.45 T:1.62±0.32 NC:1.88±0.347 day~ U:0.85±0.18 G:1.03±0.26 T:1.37±0.27 NC:1.43±0.24 BOP→ N/S	N/S	N/A
Acar et al. (2014)	BI→ NIC-85.7%; IC-28.6%; PC-4.8%; ICPC-12.7% GI→ N/A PI→ N/A PD→ N/A BOP→ N/A	N/A	N/A

N/A, not available; N/S, not specified; NIC, non-impregnated cord; IC, impregnated cord; PC, paste with cap application; ICPC, impregnated cord + paste with cap application
U, Ultrapak; G, GingiTrac; T, Traxodent; NC, no cord

Nallaswamy[17] indicated both techniques obtained a similar amount of horizontal retraction. The mean horizontal retraction amount was found to be from 0.254 mm to 0.407 mm in the retraction cord group and between 0.285 mm and 0.479 mm in the retraction paste group at different locations of the teeth.

Other than measuring the amount of gingival displacement, Chandra et al.[18] recorded the displaced marginal gingiva's closure rate and concluded a faster closure rate at the transitional line angle than at the mid-buccal area for the retraction paste compared to the retraction cord.

In consideration of chair-time saving, three studies, Beleidy et al.,[13] Gupta et al.,[14] and Jain et al.[17] consistently showed that the retraction paste system needed less time in placement and was easier to manipulate. In both retraction cord and retraction paste techniques, the anterior region required less placing time than the posterior areas. These findings can easily be associated with the difficulty of accessibility and visibility in the posterior areas of the oral cavity.

Adverse Effects on Periodontal Health (Clinical Findings)

Eight studies described the influence of retraction materials on periodontal health after gingival displacement.[13-20] Five studies[13,14,17,18,20] found higher BI value following the removal of retraction cords. Acar et al.[20] compared retraction cord with and without astringent and indicated the propensity for bleeding with a retraction cord without astringent (85.7%) were three times when compared to the retraction cord used with astringent (28.6%). Three studies[13,14,17] used nonmedicated retraction cords and revealed a high prevalence of bleeding after retraction cord removal. Beleidy and Serag Elddien[13] reported 50% and Jain and Nallaswamy[17] reported 74.4% prevalence of bleeding after nonmedicated retraction cord removal. The study by Chandra et al.[18] reported cords had a higher BI score compared to retraction pastes after removal and at Day 1, with no bleeding observed on Day 7.

On the contrary, Bennani et al.[15] and Sarmento et al.[21] indicated that slight gingival bleeding was recorded after retraction cord and retraction paste removal with no apparent difference between each other. No bleeding was observed after 24 hours and 10 days, respectively.

Beleidy and Serag Elddien,[13] Bennani et al.,[15] and Chandra et al.[18] recorded the GI value. Bennani et al.[15] found no significant change after gingival displacement. Chandra et al.[18] reported a higher GI value after retraction cords gingival displacement and full recovery after 7 days. Beleidy and Serag Elddien[13] indicated an increase in GI values in all groups after removal; however, all groups, except the retraction paste group, recovered after 7 days.

Bennani et al.[15] indicated no gingival recession occurred at the 2-week follow-up, while Jain and Nallaswamy[17] and Einarsdottir et al.[19] reported minor to moderate recession occurred in the retraction cord group after 1-month follow-up. Einarsdottir et al.[19] reported 0.087 mm gingival recession in the retraction cord group after 1-month follow-up. Jain and Nallaswamy[17] recorded 0.229 mm gingival recession in the retraction cord group and 0.093 mm in the retraction paste group after 1-month follow-up. Furthermore, Sarmento et al.[21] and Bennani et al.[15] noted that gingival retraction might cause tooth sensitivity. Sarmento et al.[21] reported no tooth sensitivity to cold in all groups throughout the experimental period. The study by Bennani et al.[15] described that tooth sensitivity occurred as a short-term problem and was resolved by applying Sensodyne toothpaste for a few days.

Adverse Effects on Periodontal Health (Laboratory Findings)

Two studies[21,22] assessed the soft tissue injury from gingival retraction using laboratory evidence evaluating either cytokine concentration or histological examination. According to Sarmento et al.,[21] the mean concentration of three inflammatory cytokines, IL-1β, IL-6, TNF-α, increased after gingival displacement. They detected that the highest concentration was associated with the retraction cord technique. The study by Phatale et al.[22] observed the histology of gingival samples after retraction. They described that both retraction cord and retraction paste caused injury to the gingival sulcus epithelium, with the retraction cord causing more destruction.

Discussion

This systematic review compares the effectiveness and adverse effects of retraction cords and retraction pastes. All the included studies were randomized or quasi-randomized and start as

high-quality evidence.[23] The limited number of randomized controlled trials and the heterogeneity of study designs, interventions, and survival assessment methods, constitute the main limitations of the present systematic review. Furthermore, different kinds of retraction paste with various textures and diverse research strategies make a meta-analysis not viable and direct comparisons between studies difficult.

It is agreed that horizontal gingival displacement is essential for precise impression and a sulcular width of 0.2 mm at the finish line level is recommended.[2,24] Among the reviewed studies, almost all retraction cords used could achieve the required 0.2 mm horizontal displacement and most of the retraction paste systems. Gupta et al.[14] was the only study that reported that Expasyl failed to get the required gingival displacement, and Magic foam displacement was borderline; however, that study had missing key information making the conclusions less reliable. Gupta et al.[14] and Bennani et al.[15] both reported that retraction cord achieves significantly greater horizontal gingival displacement compared to retraction paste systems. Bennani et al.[15] focused on gingival retraction without tooth preparation and specified the position and gingival condition of the participant's teeth. In contrast, Prasanna et al.[16] described retraction paste systems produced significantly wider mean displacement of the sulcus than retraction cords. Jain and Nallaswamy[17] in their study found that the retraction cord and the retraction paste achieved adequate gingival displacement; however, both these studies were not highly ranked due to the poor research scheme.

Chandra et al.[18] investigated the sulcus closure rates for retraction cord and retraction paste materials and reported all groups showed a sulcular width greater than 0.22 mm up to 1 minute after retraction at the mid-buccal area and up to 40 seconds at the transitional line angle. When considering Chandra et al.'s[18] results it is important to consider that the gingiva at the interproximal area is thicker and richer in collagen fibers; thus, a greater relapse tendency occurs due to better gingival elasticity.[26] These findings were constant with Laufer et al.'s[25] findings, which indicated the mid-buccal sulcus remained open longer than the transitional line angle.

Gupta et al.[14] described the mean vertical displacement of Stay-put, Magic foam cord with comprecap, and Expasyl groups to be 1.0655 mm, 0.8645 mm, and 0.484 mm, respectively. Bennani et al.[15] reported retraction cords produced significantly more vertical displacement than retraction pastes. The minimal vertical displacement (paste; 0.016 mm, cord; 0.06 mm) and significant horizontal displacement (paste; 0.213 mm, cord; 0.282 mm) indicate the gingival retraction mainly pushes the gingival tissue away from teeth with minimal downward displacement. Despite the identified reviewed studies' limitations, it still can be concluded that retraction cords can achieve better horizontal displacement and gingival retraction lasts longer when the retraction material used incorporates astringent medication. It also appears that with regards to vertical gingival retraction, retraction cords provide more effective retraction than retraction pastes.

Bleeding index (BI) is used to evaluate gingival inflammation because bleeding is the first sign of inflammation. Five studies[13,14,17,18,20] reported that retraction cords, with or without astringent, had a higher prevalence of gingival bleeding after material removal. Three studies[13,17,20] reported a high percentage (74.4%, 50%, and 85.7%), of bleeding tendency after plain retraction cord removal. Acar et al.[20] described the prevalence of gingival bleeding after impregnated retraction cord removal as 28.6%, only one-third compared with non-impregnated retraction cords, but still significantly higher than the percentage of the retraction paste group, which was 4.8%. Jain and Nallaswamy[17] also reported an extremely low BI after retraction paste removal of 5.1%. Acar et al.,[20] Beleidy and Serag Elddien,[13] Gupta et al.,[14] and Jain and Nallaswamy[17] studies prepared teeth with either equi- or sub-gingival margin (not specified in Acar et al.[20]), which could have confounded their results as the gingival bleeding could have been due to tooth preparation. Within the methodology of Acar et al.,[20] Beleidy and Serag Elddien,[13] Chandra et al.,[18] Gupta et al.,[14] and Jain and Nallaswamy,[17] the operators' qualifications were not mentioned, and the studies by Chandra et al.[18] and Jain and Nallaswamy[17] also did not report the number of operators. Acar et al.'s[20] study reported on the number of operators; however, they did not specify their qualifications.

As gingival retraction is a technique-sensitive procedure, the experienced operator can reduce the amount of invasion into the sulcular epithelium and therefore, reduce possible gingival bleeding. The missing information means we need to cautiously interpret the results of these studies. Bennani et al.[15] and Sarmento et al.[21] reported no significant difference in bleeding tendency after retraction between the impregnated retraction cord and retraction paste groups. These two studies received a moderate ranking because the randomized clinical trials provided more complete methodological information. Sarmento et al.[21] was the only study identified for review which evaluated histological samples. The study recorded the concentration of the three inflammatory cytokines, IL-1β, IL-6, and TNF-α, in the gingival crevice fluid. They found that significantly higher concentrations of the cytokines were related to the retraction cord technique compared to the retraction paste. While this study was well-designed alone it is insufficient to draw a strong conclusion.

Only three studies[13,15,18] recorded and compared the gingival index (GI) values of retraction cords and retraction pastes after gingival retraction. Bennani et al.[15] and Chandra et al.[18] experimented on unprepared teeth that excluded the factor of epithelial harm from preparation. Bennani et al.[15] revealed unchanged GI values for both retraction techniques during the entire process. Chandra et al.[18] reported that the retraction cord Ultrapack group had the maximum GI at day 0 and day 1. The study by Beleidy and Serag Elddien[13] found that GingiTrac containing 15% ammonium aluminum sulfate showed significantly lower GI values than Traxodent, which consists of 15% aluminum chloride, at day 1 and day 7. Beleidy and Serag Elddien[13] described that retraction paste groups had higher GI and longer healing time. This finding was comparable with a previous study by Al Hamad et al.,[3] who reported Expasyl had a higher GI compared with retraction cords after the first day and showed slower healing. The probing depth was monitored in three studies (Beleidy and Serag Elddien,[13] Bennani et al.,[15] and Sarmento et al.[21]); however, only Beleidy and Serag Elddien[13] found that the Ultrapack group had a probing depth reduction after 1 day and further reduction after 7 days. This slight reduction could be due to low-grade trauma through foreign body impaction. Jain and Nallaswamy[17] and Einarsdottir et al.[19] monitored the gingival recession and noticed that it occurred after 1-month and 3-month follow-up, after gingival displacement. Jain and Nallaswamy[17] had a number of weaknesses in the study design, but a key concern was the baseline impression was made immediately after cementation of the prosthesis. Therefore, the surrounding soft tissue inflammation could be multifactorial. Einarsdottir et al.[19] study reported that mean changes in gingival height were statistically significant between the groups. The retraction cord group recorded 0.087 mm gingival recession,

and the retraction paste group recorded 0.111 mm increased gingival height. Both studies described the retraction cord group to have significantly more gingival recession than the retraction paste group. However, further research is needed, as both studies had weak methodologies. Sarmento et al.[21] and Bennani et al.[15] monitored the post-retraction sensitivity. Sarmento et al. reported no difference in sensitivity between groups, while Bennani et al. found that tooth sensitivity for some participants was a short-term problem.

There appears there is no significant change in periodontal health if retraction cords and retraction pastes are placed carefully. However, if soft tissue damage is caused by tooth preparation or gingival retraction, then the gingival parameters, such as BI, GI, and probing depth, can be significantly changed, and gingival recession may occur.

Many other factors may influence gingival health after retraction. Different gingival biotypes may have varied reactions after gingival retraction. The authors recommend that future studies investigate the gingival response of thick vs thin gingival biotypes to better select the appropriate retraction technique for each scenario.

Conclusion

Within the limitations of this study, it was concluded that; Retraction cords and retraction pastes achieve the required gingival retraction; however, retraction cords achieve a larger horizontal and vertical gingival displacement for a longer period of time compared to retraction pastes. In addition, when astringents are used with retraction cords, the amount of gingival retraction, time of sulcus opening, and moisture control are improved. Careful use of retraction cords and retraction pastes led to no significant changes in periodontal health. However, gingival retraction with retraction cords is a technique-sensitive procedure and may cause damage to the junctional epithelium attachment.

References

1. Sikri VK. Color: implications in dentistry. J Conserv Dent 2010;13(4):249. DOI: 10.4103/0972-0707.73381
2. Laufer BZ, Baharav H, Ganor Y, et al. The effect of marginal thickness on the distortion of different impression materials. J Prosthet Dent 1996;76(5):466–471. DOI: 10.1016/s0022-3913(96)90002-5
3. Al Hamad KQ, Azar WZ, Alwaeli HA, et al. A clinical study on the effects of cordless and conventional retraction techniques on the gingival and periodontal health. J Clin Periodontol 2008;35(12):1053–1058. DOI: 10.1111/j.1600-051X.2008.01335.x
4. The glossary of prosthodontic terms. J Prosthet Dent 2005;94(1):10–92. DOI: 10.1016/j.prosdent.2005.03.013
5. Donovan T, Gandara B, Nemetz H. Review and survey of medicaments used with gingival retraction cords J Prosthet Dent 1985;53(4):525–531. DOI: 10.1016/0022-3913(85)90640-7
6. Ferrari M, Cagidiaco MC, Ercoli C. Tissue management with a new gingival retraction material: a preliminary clinical report. J Prosthet Dent 1996;75(3):242–247. DOI: 10.1016/s0022-3913(96)90479-5
7. Bennani V, Schwass D, Chandler N. Gingival retraction techniques for implants versus teeth: current status. J Am Dent Assoc 2008;139(10):1354–1363. DOI: 10.14219/jada.archive.2008.0047
8. Jokstad A. Clinical trial of gingival retraction cords. J Prosthet Dent 1999;81(3):258–261. DOI: 10.1016/s0022-3913(99)70266-0
9. La Forgia A. Mechanical-chemical and electrosurgical tissue retraction for fixed prosthesis. J Prosthet Dent 1964;14(6):1107–1114. DOI: 10.1016/0022-3913(64)90180-5
10. Jain A. Gingival retraction in prosthodontics-a review. J Pharm Res 2017;11:1454–1461.
11. Blackman NJM, Koval JJ. Interval estimation for Cohen's kappa as a measure of agreement. Stat Med 2000;19(5):723–741. DOI: 10.1002/(SICI)1097-0258(20000315)19:5<723::AID-SIM379>3.0.CO;2-a
12. Dijkers M. Introducing GRADE: a systematic approach to rating evidence in systematic reviews and to guideline development. KT Update 2013;1(5):1–9. https://ktdrr.org/products/update/v1n5
13. Beleidy M, Serag Elddien A. Clinical comparative evaluation of different retraction systems in gingival displacement and their influence on periodontal health: a randomized clinical trial. Egypt Dental J 2020;66(3):1667–1678. DOI: 10.21608/edj.2020.26079.1076
14. Gupta A, Prithviraj DR, Gupta D, et al. Clinical evaluation of three new gingival retraction systems: a research report. J Indian Prosthodont Soc 2013;13(1):36–42. DOI: 10.1007/s13191-012-0140-y
15. Bennani V, Aarts JM, Brunton P. A randomized controlled clinical trial comparing the use of displacement cords and aluminum chloride paste. J Esthet Restor Dent 2020;32(4):410–415. DOI: 10.1111/jerd.12581
16. Prasanna GR, Reddy K, Kumar RN, et al. Evaluation of efficacy of different gingival displacement materials on gingival sulcus width. J Contemp Dent Pract 2013;14(2):217. DOI: 10.5005/jp-journals-10024-1302
17. Jain AR, Nallaswamy D. Comparison of gingival retraction produced by retraction cord and expasyl retraction systems - an in vivo study. Drug Invent Today 2018;10(1):35–41. Corpus ID: 212535409.
18. Chandra S, Singh A, Gupta KK, et al. Effect of gingival displacement cord and cordless systems on the closure, displacement, and inflammation of the gingival crevice. J Prosthet Dent 2016;115(2):177–182. DOI: 10.1016/j.prosdent.2015.06.023
19. Einarsdottir ER, Lang NP, Aspelund T, et al. A multicenter randomized, controlled clinical trial comparing the use of displacement cords, an aluminum chloride paste, and a combination of paste and cords for tissue displacement. J Prosthet Dent 2018;119(1):82–88. DOI: 10.1016/j.prosdent.2017.03.010
20. Acar O, Erkut S, Ozcelik TB, et al. A clinical comparison of cordless and conventional displacement systems regarding clinical performance and impression quality. J Prosthet Dent 2014;111(5):388–394. DOI: 10.1016/j.prosdent.2013.08.009
21. Sarmento HR, Leite FR, Dantas RV, et al. A double-blind randomised clinical trial of two techniques for gingival displacement. J Oral Rehabil 2014;41(4):306–313. DOI: 10.1111/joor.12142
22. Phatale S, Marawar PP, Byakod G, et al. Effect of retraction materials on gingival health: a histopathological study. J Indian Soc Periodontol 2010;14(1):35–39. DOI: 10.4103/0972-124X.65436
23. Schulz KF, Chalmers I, Grimes DA, et al. Assessing the quality of randomization from reports of controlled trials published in obstetrics and gynecology journals. JAMA 1994;272(2):125–128. PMID: 8015122.
24. Anupam P, Namratha N, Vibha S, et al. Efficacy of two gingival retraction systems on lateral gingival displacement: a prospective clinical study. J Oral Biol Craniofac Res 2013;3(2):68–72. DOI: 10.1016/j.jobcr.2013.05.006
25. Laufer BZ, Baharav H, Langer Y, et al. The closure of the gingival crevice following gingival retraction for impression making. J Oral Rehabil 1997;24(9):629–635. DOI: 10.1046/j.1365-2842.1997.00558.x
26. Livaditis GJ. The matrix impression system for fixed prosthodontics. J Prosthet Dent 1998;79(2):208–216. DOI: 10.1016/s0022-3913(98)70217-3