ECRONICON OPEN ACCESS

EC DENTAL SCIENCE
Review Article

A Review on Hemostatic Gingival Retraction Agents and their Effect on Prosthodontic Treatment Procedures

Shaykhah Othman AlOthman[1]*, Taher Jamal Sandokah[2], Gadah Abdullah Alturki[3] and Faisal A Alkhayyal[4]

[1]General Dentist, Riyadh Specialized Dental Center, Riyadh, Saudi Arabia

[2]General Dentist, Imam Abdurrahman Bin Faisal University, Riyadh, Saudi Arabia

[3]General Dentist, Riyadh Elm University, Riyadh, Saudi Arabia

[4]Orthodontist, Riyadh Specialized Dental Center, Riyadh, Saudi Arabia

***Corresponding Author:** Shaykhah Othman AlOthman, General Dentist, Riyadh Specialized Dental Center, Riyadh, Saudi Arabia.

Received: May 29, 2019; **Published:** June 20, 2019

Abstract

The oral cavity is a challenging region to treat in prosthetic dentistry because of the restrictions of the lips, tongue, and cheeks, the difficulty in visualizing the area, the difficulty in controlling the use of dental instruments, and finally the site of the gingival tissue relative to the tooth.

These factors affect the appropriate management of bleeding and isolation during the process. Gingival tissue's retraction achieved by placing the tissues away from the cervical margins combined with providing hemostatic gingival retraction agents will result in proper treatment.

Hemostatic agents are vital for effective gingival retraction and hemostasis. However, these agents can be confusing and challenging to the dentist due to the variability in use and the negative impacts. These impacts include ineffective bonding, discoloration, or decalcification of the tooth when misused. Therefore, this article aims to review and summarize the literature of the application, the advantages, and disadvantages of different gingival retraction agents utilized by dentists during the treatments.

Keywords: *Gingival Retraction; Adhesion; Astringent; Hemorrhage Control; Hemostatic Agent; Isolation; Prosthodontics*

Introduction

Gingival retraction is defined as the deflection of marginal gingiva away from the tooth [GPT 2005]. In the field of prosthodontic treatment, exposing the gingival margin around the prepared tooth to aid an accurate impression is considered one of the most challenging phases in gingival tissue management [1,2]. Gingival tissue management defined as "The procedure of temporary retraction of gingiva far from the tooth surface or extending of gingival sulcus to uncover the cervical part of a tooth with the end goal to have legitimately negligible complete to the rebuilding or by building up a decent cervical cavosurface edge to the tooth preparation. "Poor tissue management during the final impression of full coverage restorations may result in an inadequate, marginal fit of these restorations, especially when margins are placed subgingivally [3].

Gingival bleeding can occur as a result of soft tissue trauma during tooth preparation at the cervical margin.

Consequently, this has the potential to compromise the accuracy of impressions due to moisture sensitivity and the hydrophobic nature of impression materials. Therefore, maintaining good moisture control is essential for optimal restoration [4]. Using hemostatic agents is the most common procedure to control blood contamination when the use of rubber-dam is not feasible. Commonly used hemostatic agents differ regarding their chemical composition and active pharmaceutical ingredients for precipitating proteins, coagulating blood, and constricting blood vessels [2].

Different hemostatic agents, which produce various degrees of tissue healing response, have been used in clinical practice. Aluminum chloride ($AlCl_3$) and ferric sulfate [$Fe_2(SO_4)_3$] are the most commonly used hemostatic agents, in concentrations ranging from 5% to 25% for impregnating retraction cords [5]. Since concerns still exist on hemostatic agents' interference with bonding [6] and impression taking, it is wise to remove the residues by water spray or surfactant-containing mouthwashes, such as Plax (Colgate), Consepsis Scrub (a chlorhexidine slurry; Ultradent products) or cleansing agents such as prep-quick (2% glycolic acid; Ultradent). Water irrigation for at least 10 seconds [5] also eliminates the staining and discoloration effect of ferric (iron) compounds on gingival and esthetic restorations [7] and it has been reported that chlorhexidine gluconate helps hemostasis happen in a shorter time due to its surfactant effect [5].

This paper reviews different hemostatic gingival retraction agents and their impact on prosthodontic treatment steps.

Hemostasis pathway overview

Hemostasis is the physiological process that maintains the fluidity of blood and upon injury, limits blood loss yet preserves tissue perfusion and stimulates the local repair process. Hence, hemostasis is an intricate balance between clot formation and clot dissolution and any derangement of this balance leads to either hypercoagulation and thrombosis or hypercoagulation and hemorrhage. As minor injuries occur frequently, it is crucial that procoagulant reactions remain localized to the injured site and are not disseminated throughout the vascular system [8]. Thrombosis occurs when an aggregation of platelets and fibrin forms within the vessel lumen. In either hemostasis or thrombosis, the coagulation process results in the conversion of prothrombin to thrombin that in turn converts circulating fibrinogen to insoluble fibrin [8].

Primary hemostasis

In primary hemostasis, which includes the vascular phase and platelet phase, the vascular system and platelets respond to limit the loss of blood. The vascular system is a network of vessels comprised of muscular and elastic arteries which decrease in diameter and branch progressively into arterioles at the entrances to capillaries-the sites of nutrient, metabolite, and blood gas exchange-and post-capillary venules and veins. Capillary ECs are surrounded by a basal lamina and occasionally pericytes, which have a contractile function in regulating blood flow through the capillary. Following injury, pericytes can proliferate and differentiate into endothelial and smooth muscle cells. In general, veins conform to the three-layer anatomy of arteries, but veins have thinner walls, and larger lumens than arteries and medium-sized veins contain valves to prevent blood backflow [9].

Secondary hemostasis and the coagulation system

The Waterfall Cascade Model of clotting was developed independently by MacFarlane [10] and Davie and Ratnoff [11]. The Waterfall Cascade Model (Figure 1) comprises the distinct 'Y'-shaped pathways of the intrinsic and extrinsic pathways that both generate activated factor X (FXa) and converge into the common pathway.

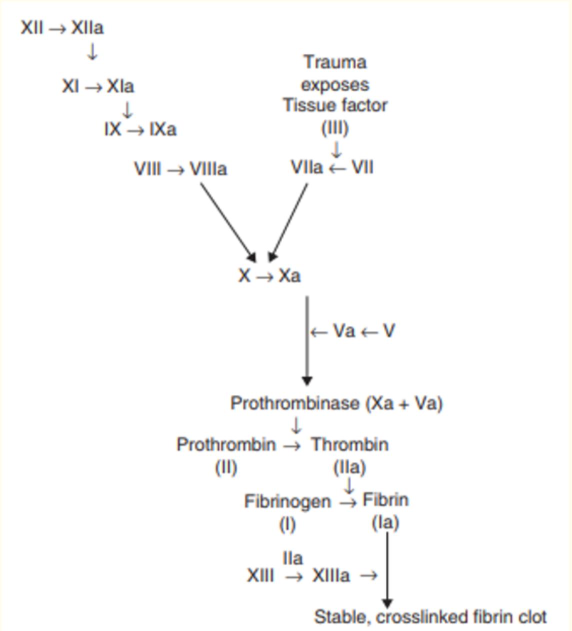

Figure 1: *The Waterfall Cascade Model of clotting. In the intrinsic pathway, a negatively charged surface initiates factor XII cleavage, while in the extrinsic pathway, the tissue factor initiates factor VII cleavage. Both pathways lead to factor X activation and continue in a common pathway leading to fibrin clot formation.*

Predictable gingival retraction and hemostasis

When deciding which method to use with the gingival retraction cord, it is important to investigate the gingiva health and the depth of the gingival sulcus. When there is minimal sulcus depth, the dentist is limited in several cases to placing only a single cord. When possible, recommendations for enhanced gingival retraction with cord involve the use of a double cord method where a thin cord is inserted flush in the sulcus, followed by a wider diameter cord. Both braided and knitted cords can be used with this method. It is recommended to use a chemical astringent-hemostatic agent in combination with the gingival retraction cord [12].

The medicaments (hemostatic agents) that are used alone or in conjunction with a retraction cord in any gingival displacement procedure should fulfill three basic criteria. First, the agent should be effective, resulting in sufficient lateral and vertical displacement of gingival tissues, and at the same time should provide control of hemorrhage and sulcular fluid seepage. Second, its usage should not cause any significant irreversible tissue damage. Even though it was shown that all techniques of finish line exposure might result in some minor tissue injury, complete healing should be accomplished within two weeks [13,14] and third, the used material should not cause any potentially harmful systemic effects. The dentist always has to keep in mind that the medicament may pass via the gingival tissues into the systemic circulation and therefore might pose a risk for undesired, harmful, systemic effects following overdosing [14].

Classification of hemostatic gingival retraction agents

Chemically, active gingival retraction agents are classified as either Class I which include vasoconstrictor agents (or called adrenergic), or Class II of astringent agents (or called haemostatics) [15].

A description of each along with advantages and disadvantages is described below.

Class I (vasoconstrictors, adrenergic): Epinephrine is the most widely used agent, it acts as a vasoconstrictor and a hemostatic agent [16]. In practice, epinephrine can be used in a concentration of 0.01% and 8%. 0.01% concentrations of epinephrine found to be useful in maintaining the gingival sulcus dry during the impression process [Csillag., *et al.* 2007] whilst the high concentration (8%) is preferred over the astringents as they cause adverse tissue reactions such as zinc chloride and alum [Donaldson., *et al.* 2016].

There have been concerns with the overutilization of racemic epinephrine-impregnated cords. a rise of blood pressure and elevation in heart pulses can be observed by the absorption of the local epinephrine into the circulation [17,18]. Jokstad and colleagues found that no advantages have been perceived over other non-impregnated cords [19].

When administering epinephrine as a gingival retraction agent, a possible cumulative effect of epinephrine from other sources, such as anesthesia and endogenous epinephrine, should be taken into consideration [14].

If the patient has comorbid conditions as cardiovascular diseases, hypertension, diabetes mellitus, or hyperthyroidism exist or if hypersensitivity to epinephrine is known, a cord impregnated with some other agent must be utilized [20]. Also, epinephrine shouldn't be used on patients taking monoamine oxidase or tricyclic antidepressants, rauwolfia compounds, ganglionic blockers, or cocaine. Patients without the abovementioned contraindications can also exhibit "epinephrine syndrome" (tachycardia, rapid respiration, elevated blood pressure, anxiety, and postoperative depression) [21-23].

In dental practice, adverse drug interactions with epinephrine based vasoconstrictors were observed and fatality associated with a combined use of halothane and epinephrine impregnated gingival retraction cords were observed [24]. Local unfavorable effects such as hyperaemic response, the trauma of crevicular and junctional epithelium were estimated, with complete wound healing after the period from 7 to 10 days [25].

Class II (hemostatic agents, astringents)

Astringents, like alum or aluminum potassium sulfate ($KAl(SO_4)_2$), $AlCl_3$ and zinc chloride ($ZnCl_2$), are substances which their mechanism of action is depending mainly on the precipitation of protein molecules on the external layer of mucosa and make it mechanically stronger. Styptics such as ferric chloride and ferric sulfate $Fe_2(SO_4)_3$ are concentrated forms of astringents, which cause superficial and local coagulation [26].

$Al_2(SO_4)_3$ compounds ($Kal(SO_4)_2$ [Alum]

- **Alum**: When the Alum was used in 100% concentration, it is effective in shrinking the gingival tissues were slightly fewer than epinephrine, and it shows good tissue recovery. Although its tissue retraction and hemostatic capacities are limited [Fischer, 1981] alum has been suggested for use as a hemostatic substance as a substitute for epinephrine since it is safer and has less systemic effects [16].
- **$Al_2(SO_4)_3$:** It is considered to be an effective agent in managing a hemorrhage, and it is accepted to be used in the biological fields. The mode of action of sulfate compounds in controlling hemorrhage is it able to suppress the setting reaction of additional-reaction impression materials [16].
- **$AlCl_3$:** It is one of the most known astringents used in controlling gingival hemorrhage [27]. It is a mode of action depending on vasoconstriction and absorption of fluid out of tissues. The optimal concentration of $AlCl_3$ in this application is 5 - 25% which has minimal systemic side-effects [16]. The advantage of $AlCl_3$ over the other agents is having the least irritating among hemostatic agents utilized with cords, but it disrupts the setting of polyvinyl siloxane impression materials. Even though, rinsing thoroughly with water resolves its inhibitory effect [Gupta., *et al.* 2013]. It causes less vasoconstriction than epinephrine [28].

Ferric sub-sulfate ($Fe_4(OH)_2(SO_4)_5$): It is also known as Monsel's solution; it has been widely utilized in gingival displacement [Fischer, 1981 and Gupta., *et al*. 2012]. It is action is slightly more effective than epinephrine in gingival displacement. Recovering of tissue is good, and it is recommended to be used for 3 min. Unfortunately, the corrosive effects of ferric or ferrous salts can cause injury to enamel and soft-tissues and causing tooth staining. These properties are attributed to the high acidity (72%, pH < 1) of the solution [Gupta., *et al*. 2012].

$Fe_2(SO_4)_3$: By comparing the ferric sulfate with aluminum chloride, the researchers reported that $Fe_2(SO_4)_3$ Is causing trauma to the tissue and the injury healing is rapidly more than with $AlCl_3$. When the concentrations of $Fe_2(SO_4)_3$ solutions are above 15%, the solution became very acidic and can cause considerable tissue inflammation and post-operative root sensitivity. It coagulates blood so rapidly that it must be set directly against the cut tissue. It is prescribed to be applied for 1 - 3 minutes [29].

Ferric sulfate disturbs the setting reaction of polyvinylsiloxanes and polyether impression materials, so use for gingival displacement in implants is questionable [30]. All traces of medicament must be carefully removed before the impressions are recorded [31].

It stains gingival tissues a yellow-brown to black color for several days after being used as a retraction agent. The aesthetics of the anterior all-ceramic crowns may also be compromised due to the use of ferric sulfate since it has shown to produce the internalized color change of the tooth structure [32].

In an *in vitro* study, dentinal exposure to highly acidic ferric sulfate for 30 seconds can result in superficial smear layer removal. Removal of smear layer by hemostatic agents negatively affects the bonding mechanism of self-etching adhesive which may further self-etching adhesive which may further discoloration [33].

$ZnCl_2$(bitartrate): This substance has been used in concentrations of 8% and 40%. Because these two concentrations are escharotic and leading to long-term soft-tissue injury and probably to the bone, their use has not been advised [Gupta., *et al*. 2012].

Tannic acid (20% and 100%): Although this substance shows less effectiveness than epinephrine, it is a very good tissue recovery. The advised time of application is 10 minutes [34]. The tannic acid has minimum hemostatic efficacy [30].

Negatol solution

It is a 45% condensation material made of metacresol sulfonic acid and formaldehyde. It gives better retraction than epinephrine. But it shows poor tissue recovery. It is highly acidic and leads the teeth to decalcify in concentrations of 10% and 100% [30,35].

Type of agent	Advantages	Disadvantages
Vasoconstrictors (epinephrine)	• Hemostatics • Vasoconstrictive	• Systemic effect and epinephrine syndrome • Risk of inflammation gingival cuff • Rebound hyperemia • Risk of tissue necrosis.
Alum	• Safer than epinephrine • Has a less systemic effect	• Its tissue retraction and hemostatic capacities are limited
$Al_2(SO_4)_3$	• Least inflammatory of all agents used with cords • Hemostasis • Little sulcus collapse after cord removal	• Offensive taste • Risk of necrosis if in high concentration. Even by using a 100% Alum solution, it has been shown to be less effective in shrinking the gingival tissues than epinephrine, and it gives good tissue response. Alum is safer and has fewer side effects than epinephrine cords saturated with 100% alum. It can be safely left in the sulcus for as long as 20 mins without any adverse effects [30].
$AlCl_3$	• No systemic effects • Least irritating of all Chemicals • Hemostasis • Little sulcus collapse after cord removal	• Less vasoconstriction than Epinephrine • Risk of sulcus Contamination • Modifies surface detail Reproduction • Inhibits sets of polyvinylsiloxane and polyether impressions
Ferric sub-sulfate ($Fe_4(OH)_2(SO_4)_5$)	• Slightly more effective than Epinephrine • Hemostasis • Good tissue recovery	• Cause injury to soft-tissues • Enamel injury • Staining teeth • High acidity
$Fe_2(SO_4)_3$	• Hemostasis	• Tissue discoloration • Acidic taste • Risk of sulcus contamination • Inhibits set of polyvinylsiloxane and polyether impressions
$ZnCl_2$ (bitartrate)	• Hemostasis	• Permanent injury to the soft-tissue • Injury of teeth bone
Tannic acid (20% and 100%)	• Very good tissue recovery	• Epinephrine • Minimal hemostatic efficacy
Negatol solution	• Better retraction than epinephrine • Hemostasis	• Poor tissue recovery • Highly acidic • Decalcifies teeth

Table 1: *Summarization of advantages and disadvantages of different gingival retraction agents.*

Conclusion

Since gingival retraction is an integral part of clinical practice, the dentist should make an effort to utilize different methods and products available for retraction of gingival tissues in various clinical scenarios. The dentist prefers to perform gingival retraction before tooth preparation. The choice of method and material depends on the operator's judgment of the clinical situation apart from the availability and cost of the materials. Sometimes the combination of the methods may be needed, and some things may work for one dentist and not for another. The effort put into the appropriate retraction of gingival tissues pays off regarding the longevity of restorations, better margins, and aesthetics.

Bibliography

1. La Forgia Anthony. "Tissue retraction for fixed prosthesis". *The Journal of Prosthetic Dentistry* 11.3 (1961): 480-486.
2. Nemetz EH and W Seibly. "The use of chemical agents in gingival retraction". *General Dentistry* 38.2 (1990): 104-108.
3. Gracis Stefano., *et al*. "Biological integration of aesthetic restorations: factors influencing appearance and long-term success". *Periodontology* 2000 27.1 (2001): 29-44.
4. Al Hamad Khaled Q., *et al*. "A clinical study on the effects of cordless and conventional retraction techniques on the gingival and periodontal health". *Journal of Clinical Periodontology* 35.12 (2008): 1053-1058.
5. Tarighi Pardis and Maryam Khoroushi. "A review on common chemical hemostatic agents in restorative dentistry". *Dental Research Journal* 11.4 (2014): 423-428.
6. Fathpour Kamyar and Maryam Khoroushi. "Effect of trichloroacetic acid hydrogel on self-etch adhesive bond strength to dental tissues". *The Journal Of Contemporary Dental Practice* 14.3 (2013): 375-380.
7. Prasad Krishna D., *et al*. "Gingival displacement in prosthodontics: A critical review of existing methods". *Journal of Interdisciplinary Dentistry* 1.2 (2011): 80-86.
8. Dahlbäck Björn. "Blood coagulation and its regulation by anticoagulant pathways: genetic pathogenesis of bleeding and thrombotic diseases". *Journal of Internal Medicine* 257.3 (2005): 209-223.
9. Atkinson Martin E and Frank H White. "Principles of anatomy and oral anatomy for dental students". *Churchill Livingstone* (1992).
10. Macfarlane RG. "An enzyme cascade in the blood clotting mechanism, and its function as a biochemical amplifier". *Nature* 202.4931 (1964): 498-499.
11. Davie Earl W and Oscar D Ratnoff. "Waterfall sequence for intrinsic blood clotting". *Science* 145.3638 (1964): 1310-1312.
12. Strassler Howard E and Leendert Boksman. "Tissue management, gingival retraction and hemostasis". *Oral Health* 101.7 (2011): 35.
13. Harrison P and E Martin Cramer. "Platelet α-granules". *Blood Reviews* 7.1 (1993): 52-62.
14. Donovan TE., *et al*. "Review and survey of medicaments used with gingival retraction cords". *Journal of Prosthetic Dentistry* 53.4 (1985): 525-531.
15. Nowakowska D., *et al*. "Dynamic oxidoreductive potential of astringent retraction agents". *Folia Biologica* 56.6 (2010): 263-268.
16. Weir Dennis J and Brian H Williams. "Clinical effectiveness of mechanical-chemical tissue displacement methods". *Journal of Prosthetic Dentistry* 51.3 (1984): 326-329.

17. Tyas M. "Cotton pellets and gingival retraction cords. Clinical notes No. 2". *Australian Dental Journal* 29.4 (1984): 279.

18. Shillingburg Herbert T., *et al*. "Fundamentals of fixed prosthodontics". Quintessence Publishing Company (2012).

19. Jokstad Asbjørn. "Clinical trial of gingival retraction cords". *The Journal of Prosthetic Dentistry* 81.3 (1999): 258-261.

20. Houston John B., *et al*. "Effect of r-epinephrine-impregnated retraction cord on the cardiovascular system". *The Journal of Prosthetic Dentistry* 24.4 (1970): 373-376.

21. Bowles WH., *et al*. "Evaluation of new gingival retraction agents". *Journal of Dental Research* 70.11 (1991): 1447-1449.

22. Stark Marvin M., *et al*. "Clinical and Materials Sciences: The Effects of Retraction Cords and Electrosurgery upon Blood Pressure and Tissue Regeneration in Rhesus Monkeys". *Journal of Dental Research* 56.8 (1977): 881-888.

23. Forsyth Ralph P., *et al*. "Blood pressure responses to epinephrine-treated gingival retraction strings in the rhesus monkey". *The Journal of the American Dental Association* 78.6 (1969): 1315-1319.

24. Hilley MD., *et al*. "Fatality associated with the combined use of halothane and gingival retraction cord". *Anesthesiology: The Journal of The American Society of Anesthesiologist*s 60.6 (1984): 587-587.

25. Harrison James D. "Effect of retraction materials on the gingival sulcus epithelium". *Journal of Prosthetic Dentistry* 11.3 (1961): 514-521.

26. Mohan Mandakini., *et al*. "Pharmacological agents in dentistry: a review". *British Journal of Pharmaceutical Research* 1.3 (2011): 66-87.

27. Shaw David H., *et al*. "Retraction cords with aluminum chloride: effect on the gingiva". *Oper Dent* 5.4 (1980): 138-141.

28. Polat N Tülin., *et al*. "Effects of gingival retraction materials on gingival blood flow". *International Journal of Prosthodontics* 20.1 (2007): 57-62.

29. Thomas Manuel S., *et al*. "Nonsurgical gingival displacement in restorative dentistry". *Compendium of Continuing Education in Dentistry* 32.5 (2011): 26-34.

30. Benson BW., *et al*. "Tissue displacement methods in fixed prosthodontics". *The Journal of Prosthetic Dentistry* 55.2 (1986): 175-181.

31. O'Mahony Aisling., *et al*. "Effect of 3 medicaments on the dimensional accuracy and surface detail reproduction of polyvinyl siloxane impressions". *Quintessence International* 31.3 (2000): 201-206.

32. Conrad Heather J and James R Holtan. "Internalized discoloration of dentin under porcelain crowns: a clinical report". *The Journal of Prosthetic Dentistry* 101.3 (2009): 153-157.

33. Kuphasuk Watcharaporn., *et al*. "Bond strengths of two adhesive systems to dentin contaminated with a hemostatic agent". *Operative Dentistry* 32.4 (2007): 399-405.

34. Johnston John F., *et al*. "Modern practice in crown and bridge prosthodontics". WB Saunders Company (1971).

35. Maischberger Christian., *et al*. "Hemostatic gingival retraction agents and their impact on prosthodontic treatment steps: A narrative review". *Quintessence International* 49.9 (2018): 719-732.

Volume 18 Issue 7 July 2019