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Review Article

Haemostatic wound dressing and pharmacologic agents for management of bleeding in dentistry

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ABSTRACT

Haemostasis is a mechanism that, through different interdependent biologic processes, has the purpose of ensuring the integrity and permeability of the circulatory system. Haemostasis term means prevention the loss of blood. Interventions or treatments in the oral cavity, in particular those with a possibility of bleeding, represent a risk for patients with disorders of haemostasis. Prevention is the key to avoid bleeding complications after oral surgical procedures and therefore it is essential a detailed medical history of the patient. This paper investigates the effects of wound dressing and local pharmacologic treatments on haemostasis.

1. Introduction

The objective of oral haemostasis is to limit and control local bleeding alongwith reducing the danger of systemic thrombosis. To achieve this aim, it is necessary to first recognise that pathologic bleeding can develop as a result of a variety of reasons. Local considerations include the size and kind of wounded artery, as well as the fragility of capillaries and perivascular tissues. Bleeding disorders and drug-induced coagulopathies are also the examples of systemic causes.[1] This knowledge should aid in collecting a complete and comprehensive patient history. Ascertaining previously identified bleeding diatheses, bleeding tendencies, or disorders of organ systems intimately implicated in haemostasis—bone marrow suppression and liver disease—are important components of a hematologic history too.[2] A thorough list of drugs and supplements consumed is also an important part of the history. When appropriate, the patient's history should be clarified, and illness quantification should be reviewed with the patient's primary care physician and haematologist. The dental practitioner should then evaluate the following patient-specific difficulties based on the information garnered from the history: The aetiology of bleeding, the influence of antithrombotic medication on the risk of local bleeding and systemic thrombosis, the impact of hematologic illness on bleeding risk, and the treatment modalities available to help control bleeding are need to be comprehended.[3]

2. Types of Haemorrhage[4,5]

1. Primary Haemorrhage: When there is bleeding during surgery.
2. Reactionary Haemorrhage: Bleeding that occurs two to three hours after surgery as a result of vasoconstriction stopping.
3. Secondary Haemorrhage: Bleeding that can linger up to fourteen days after surgery. It is assumed that infection is the most likely cause of this.

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The bleeding can also be categorised according on the afflicted site: the soft tissue, Vascular, Bone.

2.1. Haemostasis process:[4–7] The steps are as follows-

1. Vasoconstriction
2. Formation of a platelet plug
3. Coagulation (secondary haemostasis).

   (a) *Step 1. Vasoconstriction:* Endothelial cells generate vasoconstrictive paracrine, which induces rapid constriction of damaged blood arteries, resulting in a transient reduction in blood flow inside the wounded artery.

   (b) *Step 2. Formation of a platelet plug:* Platelets get activated when they link to exposed collagen in the region of damaged endothelium, releasing cytokines (serotonin, thromboxane A2, and endothelin 1) into the area around the lesion, resulting in mechanical closure of the defect. Adenosine diphosphate, fibronectin, thrombospondin, fibrinogen, and platelet derived growth factor are substances generated at the site of injury that increase the vasoconstriction process by triggering more platelets to clump together (platelet aggregation) and form a platelet plug.

   (c) *Step 3. Coagulation (Secondary haemostasis):* At the same time, exposed collagen and tissue factor initiate a series of events known as the coagulation cascade, which results in the creation of fibrin polymer. The fibrin protein fibre mesh promotes the stability of platelet plugs, allowing them to form a blood clot.

Two pathways into which clotting cascade has been divided are-

1. *Intrinsic pathway* (contact activation pathway) — Collagen, which is exposed at the site of damage and binds Factor XII to start the coagulation cascade, is the primary activator.
2. *Extrinsic pathway* **(**tissue factor pathway): It is triggered by tissue factor, which is released as a result of tissue injury and is activated by Factor VII.

3. Haemostatic Agent

A haemostatic agent is a substance that promotes haemostasis. The ideal haemostatic agent should be effective, as well as biocompatible and cost-effective to the body.

Haemostatic wound dressings are materials that are put within the limits of a traumatic or surgically produced wound to help the patient's physiology stop bleeding. In the 1940s, the first two commercially marketed haemostatic wound dressings were oxidised cellulose, Oxycel (Becton Dickinson), and Gelatin, Gelfoam (Pfizer).[8] Many more wound dressings have now been available for the use in the oral cavity. The haemostatic wound dressings are divided into:

1. Oxidized cellulose
2. Gelatin
3. Collagen products
4. Chitosan products

3.1. Oxidized cellulose

Polyanhydroglucuronic acid is the main component of oxidised cellulose. The ph of the substance is low. Its pro-haemostatic features include creating a framework for clot formation, denaturing blood proteins, and contact stimulation of the clotting cascade. Bacteriostatic characteristics are most likely due to its acidic properties. The acidity may also be unpleasant and perhaps harmful if it comes into contact with critical structures such as the inferior alveolar nerve.[9] Although it has been stated that it totally resorbs in 4–8 weeks, there have been many case reports of oxidised cellulose residue (applied on the exterior surface of the mouth) being present on reoperations. The quantity utilised and the location of implantation may have an impact on biodegradability. The material is simple to deal with and may be trimmed to size and inserted into wounds.[10–12]

3.2. Gelatin

Gelatin products that are commercially accessible are derived from swine or bovine sources and come in granular or sponge form. Gelatin dressings can act as a mechanical matrix for the formation of a clot. These materials will adapt to uneven wounds and expand up to 200 percent of their original volume, resulting in a tamponade effect. They are also likely to be the ones that begin contact activation because of the coagulation. Gelatin products cause little to no tissue reactivity and totally dissolve within 4–6 weeks.[10–13]

3.3. Collagen products

Absorbable collagen products are derived from bovine sources and come in a variety of formats, including sheets, sponges, plugs (for extraction sockets), and powders. Collagen dressings aid in the promotion of haemostasis through two mechanisms: Clotting activation and platelet aggregation.[10,11]

3.4. Chitosan products

Chitosan is a chitin (N-acetyl-d-glucosamine) derivative that is a common natural bio polymer. Despite the fact that chitin makes up the majority of the exoskeleton of shellfish, there have been no known adverse effects from utilising chitosan

in shellfish-sensitive people. Chitosan is positively charged and attracts negatively charged red blood cells, resulting in the formation of a viscous clot that closes the wound and promotes haemostasis. This process operates independently of coagulation factors. Chitosan is entirely biodegradable and normally resorbs in 48 hours. Chitosan has also been proven to increase the release of PDGF and TGF, which aids in wound healing.[10–13]

3.5. Local pharmacologic agents

1. Locally applied pharmacologic agents are divided into:
2. Bone wax
3. Caustic agents
4. Antifibrinolytic agents
5. Epinephrine
6. Thrombin

3.6. Bone wax

Bone wax is largely made of beeswax, isopropyl palmitate (a wax-like material), and/or paraffin wax. The mechanism of action of bone wax is to create a physical barrier in the region of bleeding bone, resulting in a tamponade effect. Platelets and coagulation factors have no interaction. Its primary use is in locations with low-flow bleeding bone. High-flow bleeding (from an artery) may displace the bone wax, rendering it useless. Bone wax is very bendable and moldable, allowing it to be easily shaped and tailored to the target region.

The drawback of using bone wax is that it inhibits new bone formation. Bone wax is insoluble in bone and hence persists permanently. Its presence hinders soft tissue and bone in growth. It can also induce a foreign body granuloma become infected, and induce local inflammation and pain.[14]

A synthetic substance with similar handling properties to bone wax is now available which does not inhibit osteogenesis. The product is an alkylene oxide copolymer which is applied to the bleeding bone in the same manner as bone wax. However, this polymer is water-soluble, absorbed within approximately 48 h, and has no adverse tissue interactions. Since the material is resorbed, bone growth and normal healing progress. One product commercially available is Ostene® (Baxter International Inc.)[15]

3.7. Caustic agents

Caustic agents induce local haemostasis by causing a degree of superficial destruction of the tissue it contacts and interacting with the proteins at the site of bleeding. These substances have also been classified as styptics and astringents. There effect is best seen in minor, superficial bleeding.

The caustic agents are divided into:

1. Silver nitrate
2. Ferric compounds
3. Aluminium compounds

3.8. Silver nitrate

Silver nitrate has a haemostatic action by releasing free silver ions topically, which bind to and precipitate tissue proteins, producing small artery blockage. Although a solution is available, silver nitrate is most often applied with sticks. Light pressure should be applied to the region of minimal bleeding. The tissue first has a brief black colouring that fades. Local tissue irritation, tattoo creation owing to the infused silver particles, and pain during application are all possible side effects.[16]

3.9. Ferric compounds

Ferric substances such as ferric chloride, ferric sulphate, and ferric subsulfate have been utilised in topical haemostasis. The iron-containing solutions are black and can discolour tissues and teeth. When ferric chloride combines with blood proteins, they coagulate. This response closes tiny vessel and capillary holes. This impact takes place independently of the haemostatic system.[17]

Monsel's salt and Monsel's solution are other names for ferric subsulfate when coupled with distilled water. It has traditionally been used in dermatology and surgery, particularly oral surgery and dentistry, for topical haemostasis of small wounds. The subsulfate group works as an oxidant in this molecule, which is acidic. Both of these features catalyse protein precipitation, resulting in tiny artery blockage.[16,17] Because of its acidity, commercially available dental products typically comprise a mix of ferric sulphate with and without subsulfate, as well as a buffer.[18] Ferric local haemostatics have been proven to be irritating to tissues, causing osseous and soft tissue healing to be delayed. When employed, they should be entirely eliminated from the tissue through curettage and bleeding bone re-establishment. It is not recommended to utilise them in close proximity to brain structures, as well as the sinus and nasal cavities.[17]

3.10. Aluminium compounds

In dentistry, three aluminium compounds are available: aluminium chloride, aluminium potassium sulphate, and aluminium sulphate. Aluminium chloride has been utilised as a topical haemostatic agent in medicine and surgery.

Aluminium chloride is considered to hydrolyse hydrogen chloride, which has haemostatic properties via protein coagulation, vasoconstriction, and/or activation of the extrinsic coagulation pathway. Tissue irritation

and dysesthesias can be caused by aluminium chloride. Aluminium chloride is accessible in solution in dentistry and is present in some kinds of gingival retraction cord. Aluminium chloride has also been reported to be effective in periapical surgery for haemostasis. Aluminium chloride can cause tissue irritation and slow bone repair. When used for haemostasis during periapical surgery, all of the product should be withdrawn and the bone margins should be refreshed before wound closure. Aluminium potassium sulphate and aluminium sulphate have been used in prosthetic dentistry for gingival retraction. The term alum, which is marketed to dentists, refers to aluminium potassium sulphate.[10,18]

4. Conclusion

Understanding haemostasis is essential for the safe management of patients undergoing dental treatment. The dental literature has consistently reviewed topics in haemostasis, particularly in management of patients with pathology of haemostasis and on medications altering haemostasis. This literature has detailed time-tested protocols to help with decision-making in the perioperative period.

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6. Conflict of Interest

None.

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