Clinical Surgery Journal

Review Article | Vol 3 Iss 1

Hemostasis in Dental Practice - A Review Article

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Abstract

Management of bleeding is one of the key component while performing a surgical or any other dental procedures. This review article emphasizes on the prevention of bleeding and also focuses on the available hemostatic agents and its usefulness in routine dental procedures.

Keywords: ***Hemostasis; Dental Practice; Coagulation***

Received Date: September 14, 2019; **Accepted Date:** October 14, 2019; **Published Date:** October 21, 2019

Introduction

Hemostasis refers to arrest of bleeding, whether it be by normal vasoconstriction, by an abnormal obstruction or by coagulation or surgical means. The term comes from the Greek roots heme, blood + stasis, halt = halt of blood.

Good hemostasis can provide multiple advantages to the patient and surgical team.

1. Fewer transfusions
2. Better visualization of surgical field
3. Reduced surgical time
4. Decreased morbidity and mortality

Biology of Hemostasis

Maintaining hemostasis requires a complex interaction of the vessel wall, platelets, coagulation and fibrinolytic systems [1,2]. There are two main phases of hemostasis: primary (the cellular phase) and secondary (the humoral phase). Primary hemostasis begins immediately after endothelial disruption and is characterized by vasoconstriction, platelet adhesion, and formation of a soft aggregate plug. When an injury occurs, there is a temporary local contraction of vascular smooth muscle and the blood flow slows, promoting platelet adhesion and activation. Within 20 seconds of the injury, circulating von Wille brand factor attaches to the sub endothelium at the site of injury and adheres to the glycoproteins on the surface of platelets. As platelets adhere to the injured surface, they are activated by contact with collagen-exposing receptors that bind circulating fibrinogen. A soft plug of aggregated platelets and fibrinogen is formed. This phase of hemostasis is short lived, and the soft plug can easily be sheared from the injured surface. The soft platelet plug is stabilized during secondary hemostasis (initiation of coagulation cascade) to form a clot.

Citation: Anubhav Jannu, Hemostasis in Dental Practice - A Review Article. Clin Surg J 3(1): 25-31.

The coagulation cascade is a series of dependent reactions involving several plasma proteins, calcium ions, and blood platelets that lead to the conversion of fibrinogen to fibrin. Coagulation factors are produced by the liver and circulate in an inactive form until the coagulation cascade is initiated. Then each step of the cascade is initiated and completed via a series of sequential and dependent coagulation factor activation reactions.

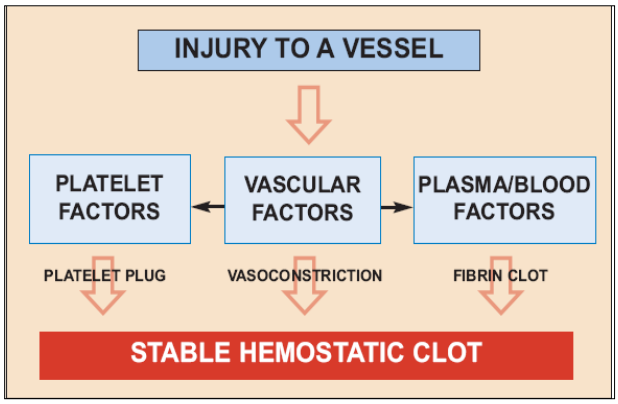

Figure 1: Stable hemostatic clot.

In the final steps, thrombin converts the soluble plasma protein fibrinogen to the insoluble protein fibrin, while simultaneously converting factor XIII to factor XIIIa. This factor conversion stabilizes the fibrin and results in cross-linking of the fibrin monomers, producing a stable clot.

Prevention

The prevention of hemorrhage includes proper clinical evaluation & certain investigations.

History Taking: A thorough case history is essential to prevent hemorrhage. Emphasis should be given particularly on drug history & past medical history. The specific drug, dose, route of administration , and duration of use should be recorded for each medication (Table 1). Any Previous history of liver disorders should be noted.

Aspirin	Interferes with platelet formation, prolongs bleeding due to decreased platelet aggregation and platelet plug formation
Anticoagulants	Prevent intra vascular coagulation
Antibiotics-(Broad spectrum)	Causes changes in intestinal flora which decease vitamin k production
Anticancer drugs	Interferes with hematopoietic system and reduces the number of circulatory platelets
Alcohol	Causes cirrhosis of the liver leading to decreased production of coagulation factors

Table 1: Medications that interfere with hemostasis.

Investigations

Several laboratory tests are commonly used to evaluate haemostasis prior to invasive procedures which include bleeding time, clotting time, prothrombin time (Table 2).

Bleeding time (BT) is sensitive measure of platelet function. There are several methods of measuring bleeding time, example Ivy, Duke, etc. Patients with bleeding time of more than 10 mins have increased risk of bleeding. BT is prolonged in thrombocytopenia, Von willi brand disease etc.

Investigations	Normal values	Interpretation
Bleeding time	Ivy method: 3-10 minutes Duke method: 2-5 minutes	Increased in thrombocytopenia, von Willebrands disease, Aspirin
Clotting time	5-8 minutes	Prolonged in patients on anticoagulants
Platelet count	1.5-4.0 lakhs/mm^3	Decreased in Bleeding disorders and coagulopathies
Prothrombin time	12-14 sec	Prolonged in patients on warfarin, vitamin K deficiency

Table 2: Investigations required for evaluation of patient.

Clotting Time (CT) is the time required for blood to coagulate in vitro under standard conditions. There are various methods for determining the clotting time, the most common being the capillary tube method. Normal value is 5 to 8 minutes. It is prolonged in patients on anticoagulants like LMW heparin, warfarin etc.

Classification of hemostatic techniques used in surgery	
Mechanical techniques	• Direct pressure • Sutures & ligatures • Hemostats • Embolization of vessels
Thermal techniques	• Electrocautery • Electrocautery • Laser • Argon gas coagulator
Chemical techniques	• Pharmacotherapy a. Epsilon amino caproic acid b. Tranxaemic acid c. Epinephrine d. Desmopressin e. Vitamin K • Topical haemostats a. Passive haemostats i. Styptics ii. Collagen iii. Cellulose iv. Gelfoam v. Bone wax b. Active haemostats i. Bothrops jararaca venom ii. Botropause iii. Fibrin glue iv. Systemic agents v. Chitosan

Table 3: Hemostatic techniques used in surgery.

Platelets, or thrombocytes circulate in the blood of mammals and are involved in hemostasis, leading to the formation of blood clots. Normal platelet count is 1.5 lacs/mm^3 - 4 lacs/mm^3.If the number of platelets is too low (less than 20,000/mm^3) excessive bleeding can occur; if it is in the range of 50,000-1,00,000 then there will be mild prolongation of bleeding time.

Prothrombin time (PT) assesses the extrinsic and final common pathway of the coagulation cascade, thus can detect factor I, II, V, VII or X deficiency or the effects of warfarin. Prothrombin time suggests the presence of an inhibitor to, or a deficiency of, one or more coagulation factors, the presence of warfarin, the existence of vitamin K deficiency or liver dysfunction.

International standardized ratio (INR) a comparative rating of a patient's prothrombin time (PT) ratio, used as a standard for monitoring the effects of warfarin. In healthy people, the INR is about 0.9-1.3. For patients on anticoagulants, the INR should be between 2.0 and 3.0 INR greater than 4.0 may indicate that blood is clotting too slowly, creating a risk of uncontrolled bleeding.

Management of bleeding

Step 1: Don't Panic; reassure the pt.
Step 2: Apply pressure
Step 3: Identify the source of bleeding (soft tissue or bony bleed)
Step 4: Suture wound margins in case of soft tissue bleed
Step 5: If bony bleed; apply hemostatic agents (bone wax, gel foam etc.)

Techniques to achieve hemostasis

There are several conventional hemostatic techniques to minimize blood loss [3,4] (Table 3).

Mechanical means: These include manual pressure, ligature, embolization of vessels and the application of a tourniquet. However, these methods can be labour intensive and add time to the operative procedure.

1. Pressure: Application of direct pressure or compression at a bleeding site is often the surgeon's first choice to assist in the control of bleeding. Pressure with gauze swab on the wound and with digital pressure should be maintained for 10 minutes. To decrease infection a ribbon gauze soaked in White heads varnish can be applied.

2. Use of hemostats: Also Mosquito Artery-straight & curved can be used to clamp moderate sized artery. After clamping the cut ends are tied with 3-0 catgut to hold the bleeding points [5].

3. Sutures & ligatures: Transected blood vessels need to be tied with ligatures. For large pulsating artery non absorbable 3-0 black silk is used & for small artery 3-0 catgut or polyglatin is preferred.

4. Embolization of vessels is usually done using agents like gelfoam, alcohol foam, methylmethacrylate

Thermal means: These comprise of electro surgery, cautery, argon gas coagulators and lasers.

1. Cautery: In this heat is transmitted to tissues from instrument by conduction. Heat achieves hemostasis by denaturation of proteins for coagulation of large tissues electro cautery or ball burnisher is used [6].

2. Electrosurgery: Heating occurs by induction from alternating current source. The bleeding point is held either directly or with haemostat & touched to achieve hemostasis and sealing of vessel [7]. Burning smell indicates tissue destruction.

3. Argon beam coagulator: Monopolar current is passed to tissues through flow of argon gas. New form of electrocautery tip of coagulator is held 1cm away from the tissue .The flow of argon gas cleans the surgical field.

4. Lasers: lasers are generally used for bloodless surgeries to effectively coagulate small blood vessels.

Chemical means

1. Pharmacotherapy

i) Epsilon-aminocaproic acid (EACA) and tranexamic acid (TA) are synthetic lysine analogs which binds reversibly to plasminogen, blocking the binding of plasminogen to fibrin, inhibiting the binding of plasminogen to fibrin, inhibiting the activation of plasminogen to plasmin thus inhibiting fibrinolysis consequently resulting in clot stabilization [8]. TA is 10 times more potent than EACA. Usually, it is available in concentration of 5% ampoules for iv (intravenous) use.

ii) Desmopressin is used for the prevention and treatment of bleeding in patients with von Willebrand disease (VWD) or mild hemophilia A and further in patients with an impaired function of primary hemostasis, such as in patients with uremia, liver cirrhosis, or aspirin associated bleeding [9].

iii) Adrenaline can also be used for hemostasis as it induces vasoconstriction6. Drug is applied in gauze pack in concentration of 1:1000 over oozing sites.

iv) **Vitamin K:** Phylloquinone (K1) or menaquinone (K2) are capable of reversing the anticoagulant activity of the powerful anticoagulant warfarin (Coumadin). Warfarin works by blocking recycling of vitamin K, so that the body and tissues have lower levels of active vitamin K, and thus a deficiency of the active vitamin [9]. Supplemental vitamin K (for which oral dosing is often more active than inject-able dosing in human adults) reverses the vitamin K deficiency caused by warfarin, and therefore modulates or reverses the intended anticoagulant action of warfarin and related drugs.

2. Topical haemostats

They can be divided into two categories: those that provide their mechanism of action on the clotting cascade in a biologically active manner and those that act passively through contact activation and promotion of platelet aggregation [4].

(a) Passive Hemostasis: The basic mechanism of action of passive hemostatic agents is to provide a physical structure around which platelets can aggregate so a clot can form [10]. These come in multiple forms and methods of application is important factors in determining their effectiveness. Gauze, sheets, sponges, and fleece are most popular among surgeons.

i) Certain styptics like tannic acid, silver nitrate & ferric chloride are used.

ii) Collagen-based products (eg. Avitene, Etik collagen) provide hemostasis through contact activation and the promotion of platelet aggregation, which occur as a direct result of contact between blood and the collagen [11]. The

collagen may be applied to the site of bleeding as a powder, paste, or sponge. As with any product of animal origin, bovine derived collagen has the potential to cause allergic or immune reactions to develop. Between 2% and 4% of the total population has an allergy to collagen.

iii) Cellulose-based products (Oxycel, Surgicel) contain regenerated oxidized cellulose. They initiate clotting via contact activation; however, the exact mechanism is not completely understood. It is believed that on application these release cellulosic acid which has affinity for haemoglobin, thus leading to formation of artificial clot [3]. Cellulose products may be cut to size to fit the wound, and when cut into small pieces, the knitted strips of material conform well to different shapes, are easily manipulated, and do not stick to instruments. It should be applied dry as acid produced by wetting inactivates thrombin.

iv) Gelfoam is made from gelatine. The properties of gelatin can allow it to conform to irregular wound geometries [12]. When held in place at the site of bleeding, gelatine will conform to the wound and swell, providing a tamponade effect in confined spaces. The swollen gelatin particles restrict blood flow and provide a stable matrix around which a clot can form. Clotting is initiated via contact activation Gelatin-based products are available in granular or sponge forms from bovine or porcine sources. Gelatin-based products also can have their drawbacks; blood-soaked gelatin tends to stick to surgical instruments, making handling difficult. Furthermore, gelatine sponges are easily dislodged because they do not form a tight bond with the bleeding source.

v) Bone wax is used to control bleeding from bony canal. It is available as sponge form & is applied in small quantity to bleeding bone8. Bone wax comprises of beeswax-7 parts, olive oil-2 parts & phenol-1 part. It acts by mechanical occlusion of bony canal. Large quantity can cause granuloma & infection.

b) Active Hemostasis: Active topical hemostatic agents have biological activity and directly participate at the end of the coagulation cascade to induce a clot at the site of bleeding. Active agents used in surgery include thrombin and combination products containing thrombin [4].

i) Bothrops jararaca is a venomous pit viper species. Haemocoagulase enzyme derived from the venom is used as antihemorrhagic drug [13].

ii) Fibrin glue is a biological adhesive containing thrombin, fibrinogen, factor XII & aprotinin. Thrombin is an enzyme and converts the fibrinogen into fibrin between 10 secs and 60 secs, factor XIII stabilises clot & aprotinin prevents its degradation [14]. Commercially prepared fibrin sealants, Tisseel (Immuno, Vienna, Austria), Beriplast (BehringwerkeAG, Marburg/Lahn, FRG), and Biocol (CRTS, Lille, France) have been used extensively for almost 15 years [15].

iii) Systemic agents such as whole blood, FFP, PRP & Ethamsylate & monosemicarbazon are used as replacement therapy in cases of massive bleeding.

iv) Botro Pause is hemocoagulase containing injection. It Can be given by IV, IM, SC or by local applications Adults-1 ml of heamocoagulase SC or IM, in severe cases IV Surgery: 1ml SC or IM, 1/2 to1 hour before the operation, or 1 ml IV immediately before the surgery. Children: 0.3 ml to 0.5 ml depending on Age.

v) Recent years sees the use of Chitosan (poly-N-acetyl glucosamine) which is a biodegradable, nontoxic, complex carbohydrate derivative of chitin [16]. Specifically, chitosan appears to function independently of platelets and normal clotting mechanisms. It has remarkable capacity to induce clot formation in absence of clotting factors [17].

Conclusion

Intraoperative bleeding can be life threatening in some cases; therefore, a fast and effective blood management plan incorporating topical hemostatic agents may be essential for achieving optimal patient outcomes. Appropriate and correct use of these hemostatic agents has the potential to improve outcomes for patients, the surgical team, and health care facilities.

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