Review Article

Hemostatic agents - A review

Sivapriyah Kuppusamy[1], Mebin George Mathew[1]*, Deepa Gurunathan[2]

ABSTRACT

Hemostasis is the normal physiological response that prevents significant blood loss following vascular injury. The process depends on an intricate series of events involving platelets, other cells, and the activation of specific blood proteins, known as coagulation factors. When blood vessel injury occurs, physiological hemostasis is triggered and the coagulation process occurs. Hemostasis serves to maintain the integrity of the circulatory system; however, the process can become imbalanced, leading to significant morbidity and mortality. The knowledge of the process of hemostasis is therefore important to understand the major disease states associated with thrombosis. As any surgeon would agree, hemostasis is of critical importance during all surgical procedures. A fundamental principle of good surgical technique is the minimization of blood loss, and present-day surgeons have a wide variety of agents and tools to aid them in this endeavor. Few urologic surgeons would be eager to undertake renal procedures without the ubiquitous electrosurgical unit. Although used less frequently than simple electrocautery, topical hemostatic agents are useful in minimizing blood loss and in turn surgical morbidity. Although no aid in hemostasis can negate the importance of good surgical technique, even the most talented surgeon has encountered persistent bleeding, which has required focused attention. Often a topical hemostatic agent is helpful in these situations, and the evolution of these agents is an interesting topic in surgical history.

KEY WORDS: Circulatory system, Hemostatic, Knowledge, Thrombosis

INTRODUCTION

Hemostatic is the act of restricting or stopping blood flow from a damaged flow from a damaged vessel or organ. Adjunct hemostatic is essential during surgery or other invasive procedures to provide hemostasis when the normal coagulation process may be unable to function. Maintaining hemostasis during surgery is essential to preserve physiologic functions for the patient, provides the surgeon with the ability to see the operative field, and promotes successful wound management and patient outcomes.[1,2] In addition, effective surgical hemostasis also results in fewer blood transfusions, decrease operating time and reduced morbidity and mortality for patients. In oral surgery, pressure is commonly used to control bleeding. In major oral and maxillofacial surgical procedures, electrocautery and suture ligatures are most commonly used to control bleeding from small and major vessels. Having a general knowledge of coagulation process will allow the clinician to better understand how the hemostatic agents work and when they should be applied.[1]

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FACTORS THAT CONTRIBUTE TO SURGICAL BLEEDING

Procedure Factors

Type of procedure, patient position, exposed bone, large surfaces of exposing capillaries, unseen sources of bleeding, and tissue that cannot be sutured or low-pressure suture lines, and adhesions stripped during surgery.[3]

Patient Factors

Specific anatomical considerations, medications, coagulopathies-platelet dysfunction or deficiency, fibrinolytic activity, coagulation factor deficiency, medical conditions, and nutritional status.[4]

[1]Department of Research, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India, [2]Department of Pedodontics, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India

***Corresponding author:** Dr. Mebin George Mathew, Department of Research, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, 162, Poonamallee High Road, Chennai - 600 077, Tamil Nadu, India. Phone: +91-9884156513. E-mail: drgdeepa@yahoo.co.in

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METHODS TO ACHIEVE SURGICAL HEMOSTASIS

Mechanical methods	Direct pressure
	Fabric pads / gauze sponges /sponges
	Sutures /staples /ligating clips
Thermal/energy based method	Electrosurgery (Bipolar,Monopolar,Bipolar vessel sealing device,argon enhanced coagulation)
	Ultrasonic device
	Laser
Chemical methods	
>Pharmacological method	Epinephrine
	vitamin K
	Protamine
	Desmopressin
	Lysine analogues
>Topical hemostatic agent	Passive agents
	*collagen based products
	*cellulose
	*gelatin
	*polysaccharides spheres
	Active agent
	*thrombin products
	Flowables
	Sealants
	*fibrin sealant
	*polyethylene glycol polymers
	*albumin and glutaraldehyde
	*cynoacrylates

Mechanical Methods

Direct pressure

The use of direct pressure or compression with one or more fingers at a bleeding site is typically a surgeon's first choice to attempt to control bleeding, as this may be the simplest and fastest method. Arterial bleeding is more easily controlled with direct pressure than venous bleeding.

Fabric pad/gauzes/sponges

These materials may also be used in applying direct pressure and packing a body cavity. Sponge sticks often used to apply pressure in deep body cavity recesses.

Sutures/staples/ligating clips

Sutures and ties are used during operative procedures as ligatures to tie off blood vessels and control bleeding. Disposable stapling devices place staggered rows of titanium staples and then divided the tissue located between the rows of staples. These devices used in both open and minimally invasive procedures. Ligating clips used to ligate blood vessels. They reduce the risk of foreign body reactions that may occur with suture material.[5]

THERMAL ENERGY BASED METHODS

Electrosurgery

It delivered in two modes which are monopolar and bipolar. The potential risk of electrosurgery use includes patient injuries, user injuries, fires, and electromagnetic interference with other medical equipment and an internal electronic device.

Ultrasonic Device

An ultrasonic device converts electrical energy to mechanical energy, it simultaneously cuts and coagulates and seal vessels up to 5 mm in diameter.

Lasers

Laser energy delivered to a targeted site can be reflected, scattered, transmitted, or absorbed. The extent of the tissue reaction depends on the "laser wavelength, power setting, spot size, and length of contact time with the targeted tissue and tissue characteristics."[3,5]

CHEMICAL METHOD

Pharmacological Method

Epinephrine

Epinephrine causes direct vasoconstriction and acts on the heart by increasing the heart rate. The addition of epinephrine to local anesthetics has many advantages such as reduced bleeding at the site along with slow absorption of the local anesthetic allowing the anesthetic effect to be prolonged.[6]

Vitamin K

Vitamin K plays a role in the coagulation process and administered preoperatively to reverse the effects of warfarin and to potentially avoid the need for transfusion of fresh frozen plasma.[1,2,5]

Protamine

Protamine is the only current agent that is able to reverse heparin anticoagulation. Patients at risk for protamine reactions include diabetic patients, patients who have undergone a vasectomy or those who have multiple drug allergies or have had previous protamine exposure.[6]

Desmopressin

Desmopressin is a synthetic analog of arginine vasopressin. It stimulates the release of von Willebrand factor (vWF) from endothelial cells which lead to increase in plasma level of vWF and enhances primary hemostasis.[7]

Lysine analogs

It is antifibrinolytic agents that competitively inhibit activation of plasminogen, thereby reducing the conversion of plasminogen to plasmin, the enzymes that degrade a fibrin clot. These agents have variable effects in the reduction of bleeding.[8]

Styptics

Coagulants are drugs that promote coagulation and control bleeding. They are called hemostatics. They may be used locally or systematically. Local hemostatics are called styptics. Styptics are local hemostatics that are used on bleeding sites such as tooth socket and wounds. Absorbable materials such as fibrin (prepared from human plasma and dried as sheet or foam), gelatin foam, and oxidized cellulose (as strips which can cut and place in the wound) provide a meshwork which activates the clotting mechanism and checks bleeding. Left *in situ,* these materials are absorbed in 1–4 weeks and generally cause no foreign body reaction. Thrombin obtained from bovine plasma may be applied as a dry powder or freshly prepared solution to the bleeding surface in hemophiliacs. Vasoconstrictors such as 0.1% adrenaline may be soaked in sterile cotton gauze and packed in the bleeding tooth socket or nose in case of epistaxis to check bleeding, when spontaneous vasoconstriction is inadequate. Astringents such as tannic acid or metallic salts are occasionally applied for bleeding gums and bleeding piles.[6]

TOPICAL HEMOSTATIC PRODUCTS

Passive Agents

Hemostatic collagen

They are fabricated from bovine collagen and are nontoxic and nonpyrogenic. The products are highly absorbent and able to hold many times their own weight of fluid. Their indications are for wound protection and for control of oozing or bleeding from clean oral fluids.[5]

Gelatin

Gelatin is an agent which has been used for controlling minor bleeding. It is made from dried and sterilized porcine skin gelatin. It acts by forming a mechanical matrix which facilitates clotting without affecting the blood clotting mechanism. Various adverse reactions have been reported with the use of gelatin such as giant cell granuloma and hematoma formation, foreign body reactions, excessive fibrosis, toxic shock syndrome, fever, and failure of absorption.[9]

Bone wax

It is sterile mixture of beeswax, paraffin, and isopropyl palmitate that are packaged in individual foil envelopes. It is useful when bleeding is from a visualized local vascular channel within bone commonly referred to as a bone bleeder at the surgical site (occurs commonly during the extraction of mandibular third molars). Adverse effect mild inflammatory reactions in tissue adjacent to the site of bone wax implantation, and this agent can prevent the clearing of bacteria from infected sites.

Cellulose

Surgical is a resorbable oxidized cellulose material and prepared as a sterile fabric meshwork. Specific dental indications include use as an adjunct to control bleeding in exodontia and other surgical procedures. This material used in soft tissue procedures due to its shape, consistency, and interference with osteogenesis. Avoid its use in contaminated wounds, where persistent drainage is desired. It is bacteriostatic properties. This is especially important in contaminated wounds or in body cavities, in which it is difficult or impossible to maintain a sterile field.[10]

Hemostats

Periodontal dressings (periodontal packs)

After surgical procedures are completed, the area is covered with surgical packs. They assist in healing by protecting the tissue rather than providing healing factors. The pack minimizes the likelihood of post-operative infection and hemorrhage, facilitates healing by preventing surface trauma during mastication, and protects against pain induced by contact of the wound with the food or tongue during mastication.[8]

Zinc oxide eugenol pack

Used modified forms of Ward's original formula, the addition of accelerators such as zinc acetate gives dressing a better working time. It induced an allergic reaction.[9]

Non-eugenol pack

Periodontal dressings are usually kept in place mechanically by interlocking in interdental spaces and joining the lingual and facial portions of the pack.[10]

Antibacterial properties of packs

Incorporation of tetracycline powder in Coe-Pak is generally recommended, particularly when long and traumatic surgeries are performed.[11]

Active Agents

Active agents contain thrombin. Thrombin is a naturally derived enzyme that plays a role in hemostasis, inflammation, and cell signaling. Thrombin requires no intermediate physiological agent for its actions, but it does require the presence of circulating fibrinogen to actively convert fibrinogen to fibrin at the bleeding site to produce a clot.[12]

CONCLUSION

Bleeding during surgery is a serious clinical problem that can be very disconcerting to the patient and could have serious consequences. During the course of nearly all types of surgery, blood vessels will be disrupted, causing some bleeding, but in a dental setting, this is usually easily controlled. In oral surgery, pressure is commonly used to control bleeding, and this successful in most cases. In major oral and maxillofacial surgical procedures, electrocautery and suture ligatures are most commonly used to control bleeding from small and major vessels. The most important step to always remember in bleeding control is direct pressure, and hemostatic agents should always considered secondarily.

REFERENCES

1. Achneck HE, Sileshi B, Jamiolkowski RM, Albala DM, Shapiro ML, Lawson JH. A comprehensive review of topical hemostatic agents: Efficacy and recommendations for use. Ann Surg 2010;251:217.
2. Galanakis I, Vasdev N, Soomro N. A review of current hemostatic agents and tissue sealants used in laparoscopic partial nephrectomy. Rev Urol 2011;13:131-8.
3. Fathima F, Mathew MG. Awareness of medical emergency management in pediatric dentistry among dental undergraduates and postgraduates. Drug Invent Today 2019;11:59-62.
4. Sundaram CP, Keenan AC. Evolution of hemostatic agents in surgical practice. Indian J Urol 2010;26:374-8.
5. Tripathi KD. Essentials of Medical Pharmacology. 6th ed. New Delhi: Jaypee Brothers; 2008.
6. Udaykumar P. Textbook of Pharmacology for Dental and Allied Health Sciences. 2nd ed. New Delhi: Jaypee Brothers; 2002.
7. Carranza FA. Carranza Clinical Periodontology. 10th ed. St. Louis: Saunders; 2006.
8. Samuel DS. Mathew MG. Methods of delivering drugs across blood brain barrier. Drug Invent Today 2019;12:170-2.
9. Review Hemostatic Agent Used In Dentistry. Available from: http://www.dentistrytoday.com/oral-medicine/oralsurgery/1538. [Last accessed on 2019 Dec 24].
10. Ogle OE, Swantek J, Kamoh A. Hemostatic agents. Dent Clin North Am 2011;55:433-9.
11. Tarighi P, Khoroushi M. A review on common chemical hemostatic agents in restorative dentistry. Dent Res J (Isfahan) 2014;11:423-8.
12. Flanagan D. Hemostatic agents. J Am Dent Assoc 2015;146:220.

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