Intraoperative Hemostasis in Dermatologic Surgery: A Review and Discussion of Varied Approaches

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Abstract

One of the most frustrating challenges in surgical dermatology is achieving effective hemostasis. Basic techniques such as taking a proper medical history and providing pre-operative patient education, as well as proper techniques during surgery have been the mainstays of achieving hemostasis. We intend to review these historical methods of hemostasis and discuss the various approaches intended to minimize surgical bleeding in order to achieve the best results.

Introduction

Dermatology is a diverse field that requires a physician to be competent clinically, histopathologically and surgically. Cutaneous surgery has allowed dermatologists to cure skin cancers such as basal cell carcinoma, squamous cell carcinoma and melanoma. One of the greatest challenges in surgery is the control of hemostasis, finding the balance between preventing extensive blood loss and maintaining sufficient blood flow to the surrounding tissue.[1] The goal during most dermatological surgeries is to not only keep the surgical field clear but also prevent potential postoperative complications like infection, hematoma, tissue necrosis, delayed wound healing and dehiscence.[2] Various techniques can be used to achieve hemostasis pre-operatively, intra-operatively and post-operatively in order to avoid complications and yield the best surgical results. We intend to provide a comprehensive review of hemostasis methods.

Medical History and Patient Education

One of the most important aspects in any surgical preparation is obtaining a complete patient history. An individual's medical history and social habits might render the task of achieving hemostasis difficult. A history of bleeding disorders, immune suppression, renal or liver failure, diabetes, hypertension, inflammatory skin disease, radiation therapy, and tobacco or alcohol use strongly influence hemostasis and the patient's overall surgical outcome.

Tobacco use has proven to have damaging effects on dermatological surgeries by affecting cutaneous blood flow. The nicotine in cigarettes decreases blood flow perfusion, and the carbon monoxide decreases oxygenation of the skin. As noted by Delaney et al., a study by Goldminz showed that those who smoke one pack of cigarettes or more per day have a three-fold higher risk of developing necrotic complications compared to those who never smoke. It is recommended that patients stop smoking for a minimum of two days before surgery and at least a week after surgery.[2]

In addition, alcohol use significantly affects hemostasis. Acutely, alcohol directly impacts platelets, leading to prolonged bleeding time, and predisposes to hematoma formations, further compromising blood supply to the surgical site.[2] Chronic alcoholism often results in hepatic insufficiency and associated coagulation dysfunction. A general surgery review noted that patients who consume three to four alcoholic beverages per day have a 50% higher complication risk compared to those who consume two or fewer drinks per day. Patients who have five or more drinks per day increase their risk by an average of 300%.[2]

Patients with a history of jaundice or hepatitis unrelated to alcohol may also have coagulopathies, which can be screened for by routine PT, PTT, and INR blood testing. In addition, patients with easy or unexplained bruising, bleeding gums, or unexplained hemorrhage stand a high chance for intraoperative bleeding and should be worked up accordingly. Beneficial questions to ask patients include whether they have unexplained nose bleeds, prolonged bleeding after injury or, if female, prolonged menstrual cycles or multiple heavy-bleeding days, as well as whether there is any history of blood transfusions after a surgical procedure.

A medication history is also imperative to the success of the procedure and must first emphasize the medications that directly increase intraoperative bleeding. These include warfarin, aspirin, NSAIDs, clopidogrel, heparin, and dabigatran. Current thought favors the continuation of warfarin during surgery because the risk of a thrombotic event from cessation far outweighs the potential intraoperative bleeding complications.[3] All superfluous aspirin and NSAIDs should be stopped one to two weeks prior to surgery and resumed one day after surgery. A meta-analysis revealed that patients taking aspirin or NSAIDs were

Table 1. Dietary supplement influencing anticoagulant activity[5]

Supplement	Mechanism	Notes
Ginkgo	Platelet aggregation inhibitor	Clinical significance documented at ~120 mg to 240 mg.[6]
Ginseng	Fibrin formation and platelet aggregation inhibitor	Interacts with warfarin at a dose of ~2 g.[7]
Ginger	Platelet aggregation inhibitor	Dose dependent between 250 mg and 1 g.[8]
Vitamin E	Platelet aggregation inhibitor	At high doses (~671 mg or higher), can add to warfarin effects.[9]
Willow Bark	Platelet aggregation inhibitor	Clinical significance not yet documented but may occur anywhere between 120 mg and 240 mg.[10]
Licorice	Platelet aggregation inhibitor	Presence of 3-arylcoumarin derivatives has significance at high doses (~30 mg/ml).[11]
Celery	Platelet aggregation inhibitor	Clinical significance at ~500 mg.[12]

Table 2: Dietary supplements influencing pro-coagulant activity[5]

Supplement	Mechanism of Coagulation	Notes
Alfalfa	High vitamin K content	High vitamin K antagonizes coumarins in alfalfa at anywhere from 500 mg to 1,000 mg.[13]
Green tea	High vitamin K content	Presence of theanine inhibits platelet effects of warfarin at anywhere from 400 mg to 716 mg.[14]

Table 3. Chemical hemostasis[1,19]

Chemical Agent	Mechanism of Action	Side Effects	Benefits	Disadvantages	Indication
Aluminum Chloride	Vasoconstriction Activation of extrinsic coagulation pathway	May cause irritation	Clear color avoids staining Avoids tissue necrosis Safe for surrounding normal tissue	Delays healing Adds scarring in deeper wounds	Preferred agent for hemostasis secondary to efficacy, speed of hemostasis, and cost.
Monsel's Solution (ferric subsulfate)	Acidic and oxidizing qualities	Increase in inflammation Dermal fibrosis	Bacteriotoxic	Temporarily stains the skin via iron deposition	Safe to use on mucosa Ideal for small wounds
Silver Nitrate Sticks	Free silver ions form eschar by binding to tissue	Stinging sensation	Preformed sticks Bacteriostatic properties	Temporarily stains the skin Slower onset of action	Intended for small wounds (if used in large areas, can lead to argyria)

more than twice as likely to have moderate-to-severe bleeding complications in comparison to controls.[4] Screening patients regarding their use of vitamins, herbals, or over-the counter supplements can also attenuate the risk of intraoperative bleeding. Dietary supplements known to have anticoagulant activity include gingko, ginseng, ginger, Vitamin E, willow bark, licorice, and celery (**Table 1,** p. 10). Alfalfa and green tea, on the other hand, have procoagulant activity (**Table 2**).[5]

Preparing the Surgical Field

After a patient's surgical risk for bleeding is addressed, a surgical field must be optimized to best procure hemostasis. The objectives are accessibility and visualization of the surgical field. In additions, a cool ambient temperature will ameliorate intraoperative bleeding by promoting cutaneous vasoconstriction.[15] To decreasing surgical risk factors, the operating room should be open and uncluttered, allowing for easy attainment of hemostatic supplies such as gauze, Q-tips, and chemical and electrical cautery.[16] Additionally, positioning the patient at a 15-degree incline will allow gravity to reduce superior blood pooling.

Once the area is best visualized, the surgical site may be infiltrated with lidocaine and epinephrine to locally constrict blood vessels, which takes three to five minutes. This will be the first sign of how the patient responds to puncture and whether their history is accurate. In the case of any prolonged bleeding or bruising after the injection, extra caution should be taken to reach hemostasis. Ice compression is another valuable tool to utilize prior to anesthetizing. It serves the dual purpose of locally constricting blood vessels in a surgical site and blunting any patient discomfort during the injection.

Hemostasis Agents

Topical Hemostasis

Topical hemostasis agents are usually used in conjunction with additional hemostasis methods, which typically leads to more efficient and cosmetically sound results. Two of the more common topical agents include gel foam and a topical powder composed of hydrophilic polymer and potassium ferrate. Gel foam is a topical agent packaged as a sterile compressed sponge. It is derived from porcine-skin gelatin and works by creating a matrix that facilitates artificial clotting.[1] A prospective study showed that deep-excision procedures had improved hemostasis and cosmesis with gel foam and secondary intention healing.[17]

Another useful topical agent is a hydrophilic polymer mixed with potassium ferrate powder. The hydrophilic component absorbs blood, while the potassium salts form an artificial scab, both leading to successful and efficient hemostasis better tolerated than gel foam due to its non-biological properties. Additionally, an individual's coagulation ability does not affect the ability to reach hemostasis with this product, making it ideal for patients who have prolonged bleeding disorders or take blood-thinning medications.[1]

A study by Kircik et al. compared topical powders to sponges (gel foam) to see which topical agent is more effective in reaching hemostasis. Overall, both agents were effective, but they concluded that the topical powder caused significant hemostasis at a faster rate than the sponge, with the added benefits of less scarring and a reduction in wound size.[18]

Chemical Hemostasis

There are three common chemical hemostatic agents to consider: aluminum chloride, Monsel's solution, and silver nitrate sticks (**Table 3**). Chemical agents cause protein precipitation that helps achieve superficial bleeding cessation. These methods work best in a dry field, where the blood itself does not dilute their contents.

Physical Hemostasis

Physical interventions are paramount in controlling hemorrhage. The simplest physical modality involves placing firm pressure over a bleeding wound for 15 uninterrupted minutes. During this time, a physician and assistant should avoid the temptation to interrupt manual compression to check if bleeding has stopped and instead allow the appropriate time to pass. Manual compression is often sufficient in promoting the formation of a clot. Compression is typically applied downward and directly on the suspected source of the bleed; however, upward pressure may assist in tamponading vessels located near hollow openings where bleeding may be brisk, such as the nasal vestibule.[16] In addition to manual compression, pressure hemostasis may also be obtained by using Q-tips, dental rolls or inflated Foley catheters.[20]

One physical method for hemostasis includes using ring loops. Ring loops in surgical scissors and forceps can mechanically compress blood vessels to visualize a surgical site. This method is often used in areas such as the trunk, scalp, tongue or lips. Chalazion ring forceps are placed around the lesion and screwed into position, immobilizing the lesion to both stabilize and apply circumferential pressure to cause hemostasis.[19,21] Additionally, using two skin hooks concomitantly can decrease blood pooling to promote a clear visual field.[22] In this method, two skin hooks are placed on the edge of the skin and rotated toward the wound to both exert tension on the surrounding skin flaps and apply pressure to bleeding vessels. Once this is done, the surgical assistant can use electrodessication to control any additional hemorrhage. Aside from the surgical benefits, this method also improves coordination between surgeon and assistant.

Suturing Techniques

Overall, any suturing technique can obtain hemostasis, but certain approaches achieve the best results. A vertical mattress is a simple method of everting, closing any dead space of a defect, and also minimizing hemorrhage. Another valuable suturing technique involves the purse-string suture. The purse string not only enhances hemostasis but also reduces the size of the defect. This technique is done by placing multiple intradermal sutures in a sequence until a "purse-string" is created.[23] This method is geared toward patients on anticoagulation or for patients who lead more sedentary lifestyles, where excessive physical activity will not potentially open the purse string.

In certain locations of the body, specific suture techniques can also reduce bleeding during a procedure. For punch biopsies of the scalp, which are notorious for bleeding, a horizontal suture

can be placed prior to punching the lesion. A 3-0 or 4-0 non-absorbable suture should be placed wide enough that it does not interfere with the punch biopsy. As the dermatologist removes the lesion using a punch, the surgical assistant can quickly pull in the sutures and tie them so as to preemptively stop any bleeding. This process creates immediate and complete hemostasis. For excisions of vascular lesions (for example, port wine stains), a double imbricating suture is indicated. A 3-0 polypropylene suture with a PS-2 needle is recommended for this method.[16]

Lasers/Radiofrequency

Lasers are a newer physical modality for achieving hemostasis. Rather than scalpels and other surgical blades, lasers can be used to incise a lesion. The CO2 laser with a wavelength of 10,600 nanometers (nm) can be used for tissue incision, because it not only cuts but also simultaneously seals blood vessels that are 0.5 mm in diameter. Recent literature supports the use of lasers instead of scalpels in order to reduce both intraoperative and postoperative bleeding.[16] With many papular, pedunculated skin lesions, CO2 lasers have achieved better hemostasis results compared to the traditional method of removal with a cold scalpel. CO2 laser is a safe, efficient and precise incision option that simultaneously achieves hemostasis.[24]

In a similar manner, radiofrequency can be used for surgical, hemostatic and aesthetic purposes while removing benign cutaneous lesions. The most favorable radiosurgery wave is set at a frequency of 4.0 MHz for a consistency of 90% cutting and 10% coagulation. This setting causes the least lateral damage, ultimately producing an aesthetically pleasing result. The recommended technique is described as a light paint-brush motion moving laterally from one end of the lesion to the other, followed by a firm wipe with dry gauze; this process is done as many times as necessary to reach the base of the lesion.[25]

Wound Dressings

Wound dressing can also play an important role in hemostasis. Alginate dresses are ideal for wounds with minimal blood loss. A study by Steenfos et al. demonstrated significantly higher levels of blood absorption after 10 minutes with alginate dressings compared to mesh gauze dressings. Mineral zeolite can also help hemostasis. It works to enhance the initiation of the clotting cascade by transforming factor XII to its activated form. Finally, chitosan and chitin have also been found to be effective dressing material. When chitin is deacylated, it forms chitosan. Both chitin and chitosan have significant hemostatic abilities in addition to demonstrating antimicrobial activity against gram negative bacteria.[26]

Conclusion

In all aspects of achieving hemostasis, efficacy, speed, and reliability have proved the most important factors when choosing an approach. We reviewed methods known to minimize operative bleeding risk and thus ensure the best possible surgical outcomes for our patients. There is no claim that one method is better than another, but rather that a combined approach can best address the issue of intraoperative hemostasis.

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