Achieving hemostasis in dermatology – Part 1: Preoperative, intraoperative, and postoperative management

Ravneet Ruby Kaur, Jaimie B. Glick, Daniel Siegel

Department of Dermatology, SUNY Downstate Medical Center, 450 Clarkson Avenue Brooklyn, NY 11203, USA

ABSTRACT

As dermatological procedures continue to become increasingly complex, improved methods and tools to achieve appropriate hemostasis become necessary. The methods for achieving adequate hemostasis are variable and depend greatly on the type of procedure performed and the unique characteristics of the individual patient. In Part 1 of this review, we discuss the preoperative, intraoperative, and postoperative management of patients undergoing dermatologic surgery. We address oral medications and supplements that affect hemostasis, hemostatic anesthesia, and intraoperative interventions such as suture ligation and heat-generating cautery devices. In Part 2 of this review, we will discuss topical hemostats. The authors conducted an extensive literature review using the following keywords: "hemostasis," "dermatology," "dermatological surgery," "dermatologic sutures," "electrosurgery," "hemostatic anesthesia," and "laser surgery." Sources for this article were identified by searching the English literature in the Pubmed database for the time period from 1940 to March 2012. A thorough bibliography search was also conducted and key references were examined.

Key words: Dermatological surgery, dermatologic sutures, electrosurgery, hemostasis, hemostatic anesthesia and laser surgery

Access this article online

Website: www.idoj.in

DOI: 10.4103/2229-5178.110575

Quick Response Code:

Address for correspondence:
Dr. Ravneet Ruby Kaur, Department of Dermatology, SUNY Downstate Medical Center, 450 Clarkson Avenue, Brooklyn, NY 11203, USA.
E-mail: rubykaurmd@gmail.com

INTRODUCTION

Over the years, dermatological procedures have become increasingly complex requiring improved methods and tools to achieve appropriate hemostasis.[1] Methods for achieving adequate hemostasis in dermatological procedures are variable and depend greatly on the type of procedure performed and the unique characteristics of the individual patient. In this review, we discuss the preoperative, intraoperative, and postoperative management of patients undergoing dermatologic surgery. We will also address hemostatic anesthesia, laser surgery, electrosurgery, and suture ligation used in dermatologic surgery. The authors conducted an extensive literature review using the following keywords: "hemostasis," "dermatology," "dermatological surgery," "dermatologic sutures," "electrosurgery," "hemostatic anesthesia," and "laser surgery." Sources for this article were identified by searching the English literature by Pubmed for the time period from 1940 to March 2012. A thorough bibliography search was also conducted and important references examined.

PRE-PROCEDURE PLANNING

Proper hemostasis is imperative to successful dermatologic surgery and begins with pre-procedure planning. Obtaining a thorough history is the key to avoiding a bleeding complication. It is important to concentrate on identifying underlying disorders and medications that may increase surgical bleeding. Specific questions are more informative such as: Is the bleeding excessive for the injury, prolonged, or recurrent? Up to one-third of patients with von Willebrand disease (VWD) deny a bleeding diathesis.[2] Interestingly, more women are diagnosed with VWD than men because the bleeding symptoms associated with VWD are more readily apparent during menstruation and childbirth.[3] Patients with VWD have platelet abnormalities that cause them to bleed from mucocutaneous surfaces. See Table 1 for a list of useful questions while eliciting a bleeding history.[1] Table 2 lists a variety of disorders that may impair hemostasis.[1] Patients with hemophilia, a coagulation factor disorder, are more easily identified because they often have an established personal or family history. They may experience

Table 1: Interview questions for bleeding history

General questions	Have you ever had prolonged bleeding after surgery?
	Have you required transfusions after surgery?
Women	Do your periods last longer than 7 days?
	Is your menstrual flow heavy for 3 days or more?
	Have you ever had anemia or required iron supplementation as a result of menstrual bleeding?
Coagulation factor abnormalities (delayed bleeding and deep hemorrhage into muscles)	Have you ever had delayed bleeding after surgery (>3 days postoperatively)?
	Do you have a family history of bleeding problems?
	Have you ever bled into joints or muscles? (coagulation factor deficiency)
Platelet type bleeding (mucocutaneous bleeding)	Have you had bleeding after dental surgery? Did the bleeding require stitching or packing? Did the bleeding occur immediately or the next day?
	Have you ever had a nosebleed? If so, how frequent are they and do they ever require emergency or hospital care?
	Do you have excessive bruising (>5 cm, truncal locations, absence of injury)?

This table is adapted with permission from: Nguygen, TH. Chapter 17: Hemostasis. In: Surgery of the Skin: Procedural Dermatology. Edited by Robinson JK, Hanke CW, Sengelmann RD, Siegel DM. New York and London: Elsevier Mosby, 2005; 245-258

prolonged surgical bleeding and hemorrhage deeply into muscles and joints.[4] These patients should be referred to hematology for management in the preoperative period.

On the other hand, thrombocytopenia is rarely an issue in cutaneous surgery. Platelets aggregate to form a hemostatic plug and secrete chemicals that promote the invasion of fibroblasts from surrounding connective tissue into the wounded area to completely heal the wound. Platelet abnormalities may be quantitative or qualitative. Medications such as vitamin E often impair platelet function [Table 3]. Thrombocytopenia does not affect hemostasis in cutaneous surgery unless there is clinically excessive bleeding such as petechiae or gingival bleeding (regardless of levels) or platelet levels drop below 20,000. In this case, a hematologist should be consulted. Caution in patients with thrombocytopenia is also warranted if a complex reconstruction such as a flap, wide undermining, or bone/cartilage grafting is anticipated as more significant bleeding may occur.

Anticoagulation

Patients often present on complex anticoagulation regimens which sometimes include nonprescription drugs, ethanol, herbal medications, and vitamin supplements, many of which may impair hemostasis.[5] Table 3 reviews these agents and their potential effects. It is important to ask the patient about their use of any over-the-counter medications such as aspirin and/or nonsteroidal anti-inflammatory drugs. Recreational alcohol, garlic,[6] ginseng, ginkgo and vitamin E, among others, can also lead to impaired hemostasis.[5] Furthermore, other natural or herbal products such as various fungi[7,8] can also disrupt the coagulation process. If a patient with no history of thrombotic events is consuming such substances and is taking aspirin or supplements for primary rather than secondary prevention, the clinician should consider delaying an elective procedure for a few days or weeks to allow the substance to be cleared from the body.

In contrast, if the patient is taking anticoagulation for therapeutic purposes such as thrombotic prophylaxis, it is important to allow them to continue their anticoagulation in order to avoid devastating consequences.[9] A study of thrombotic complications in patients who stopped warfarin peri-operatively found a higher incidence of stroke, transient ischemic attacks (TIA), myocardial infarction, cerebral embolism, death, deep vein thrombosis (DVT), pulmonary embolus, blindness and death. In patients who stopped aspirin, there was an increase in the above complications but no increase in DVT or pulmonary embolus.[9] For the skilled surgeon, excessive bleeding is easily handled without significant sequelae when compared to events resulting from failed anticoagulation.

When deciding whether to discontinue anticoagulation, it is important to remember that in dermatologic surgery it is extremely rare to have a life-threatening bleed such as an expanding cervical hematoma related to neck liposuction or bleeding severe enough to require transfusion.[1,7] In addition, major bleeding or complications with dermatologic surgery are not increased in patients who are taking aspirin or warfarin.[10-13] In fact, patients who discontinue their anticoagulation are at a significant risk of severe complications[9,14] from thrombotic events, which greatly outweigh any risk of bleeding from dermatologic surgery.[15] Although warfarin and aspirin impair the coagulation process, the increased bleeding during cutaneous surgery is insignificant and easily limited with standard measures such as electrocoagulation and ligation. Thus, if a patient on warfarin is to have a surgical procedure performed the warfarin may be continued. However, the International Normalized Ratio (INR), a serum lab test that is used for monitoring the impact of anticoagulant medicines such as warfarin, should be checked. In healthy people, the INR is about 1.0. For patients on anticoagulants, the INR typically should be between 2.0 and 3.0, but should not exceed 3.0 pre-procedure if possible.[16] For many smaller procedures it is not necessary to check INRs just before surgery, especially if the patient has a history of stable values and no other significant risk factors. It is important to note that each patient requires an individualized approach when deciding whether to continue anticoagulation and patients on warfarin or aspirin should be made aware preoperatively

Table 2: Disorders that may impair hemostasis[1]

Common disorders affecting hemostasis[2,3]	Comment
Hypertension	May be due to situational anxiety or a medical condition
Disorders affecting platelets	Comment
	Bleeding time is not predictive of bleeding risk for any condition; some disorders may affect both platelets and coagulation factors
Severe renal disease	Uremia may impair platelet function, heparin considerations with dialysis
Immune thrombocytopenia	Antibody-mediated platelet destruction
Splenomegaly	Platelet sequestration
Bone marrow failure	Platelet synthesis problem
VWD	Type 1 (70–80%)
	Low levels of vWF and Factor VIII
	Type 2a
	Abnormal vWF protein, levels normal
	Type 2b
	vWF "hyperactivity," causing platelet aggregation without endothelial injury
	Mild thrombocytopenia
	Type 3
	Homozygous deletion
	Zero levels of vWF and Factor VIII
	Deep joint bleeding similar to hemophilia
Disorders affecting clotting factors	Comment
Severe hepatic insufficiency	Impaired synthesis of vitamin K-dependent clotting factors
Alcoholism (liver, vasodilation)	Hepatic insufficiency
	Direct vasodilator
Vitamin K deficiency	Clotting factors II, VII, IX, X
Hemophilia A	Factor VIII deficiency
Hemophilia B	Factor IX deficiency

This table is adapted with permission from: Nguygen, TH. Chapter 17: Hemostasis. In: Surgery of the Skin: Procedural Dermatology. Edited by Robinson JK, Hanke CW, Sengelmann RD, Siegel DM. New York and London: Elsevier Mosby, 2005; 245-258

of the small but significant risk of postoperative bleeding complications.[1,3]

Hypertension and anxiety

Many patients experience situational anxiety surrounding surgical procedures. Prior to starting the procedure, it is important to help the patient relax. Placing the patient in a calm and quiet room and using soft, reassuring voices and distraction can all help alleviate anxiety, lessen the chance of hypertension and tachycardia, and thus decrease the risk of intra- and postoperative bleeding. In addition, some patients may have undiagnosed hypertension or uncontrolled hypertension which elevates intravascular pressure and can aggravate surgical bleeding. It is important to take a blood pressure reading prior to any surgical procedure; a systolic blood pressure of 180 mmHg or greater or untreated hypertension should be stabilized before any surgery, especially any elective procedure. Sustained systolic hypertension above 180 mmHg is dangerous and carries the risk of myocardial infarction or stroke as well as bleeding, as does a diastolic pressure above 100 mm Hg.[1] Situational hypertension in an anxious patient can effectively be treated with clonidine 0.1 mg orally if the physician is comfortable with its side effects. This medication acts as an antihypertensive, sedative and anxiolytic.[17] Clonidine has a prolonged antihypertensive effect of 12 h, making it advantageous to use, as the effect will last through the postoperative period when the risk of bleeding is greatest. It should be administered 60 min prior to surgery and avoided in patients with a preoperative systolic blood pressure less than 100 mmHg or pulse rate less than 60/min. If solely anxiolysis is required, sublingual diazepam 5-10 mg or alprazolam 0.5 mg is a consideration.[18-20] As an alternative, oral midazolam 5-10 mg works well as it provides rapid anxiolysis within 20 min.[21,22] Moreover, its short half-life of 2 h and rapid onset are beneficial in elderly patients. Midazolam also offers the advantages of amnesia, and reduced alertness. Given the risk of excess sedation, initial doses of these medications should be low, especially in elderly patients.

Hemostatic anesthesia

Epinephrine and cocaine are potent physiologic hemostatic

Table 3: Oral medications and supplements affecting hemostasis (for most dermatologic procedures the risk of discontinuing therapeutic anticoagulation greatly outweighs any risk of excess bleeding from dermatologic surgery)

Medication	Mechanism of action	Comment
Aspirin	Irreversible inhibition of cyclooxygenase, affecting platelet release of clotting cofactors	May discontinue 10-14 days pre-op
Nonsteroidal anti-inflammatory drugs	Reversible inhibition of cyclooxygenase	Variable, depending on specific drug (usually 2-3 days pre-op)
Clopidogrel (Plavix)	Oral inhibitor of platelet aggregation	May discontinue 5 days preoperatively
Ticlopidine (Ticlid)	Oral inhibitor of platelet aggregation and adhesion. Also inhibits fibrinogen binding to platelets	May discontinue 10-14 days preoperatively
Dipyridamole (Persantin)	Phosphodiesterase inhibitor with mild vasodilatory and anti-platelet activity	Dipyridamole alone has no clinical effects on hemostasis. Aggrenox is dipyridamole with 25 mg aspirin and does impair hemostasis as a result of the aspirin component
Prasugrel	ADP receptor blocker	Often prescribed with aspirin
Ticagrelor	ADP receptor blocker	More potent platelet inhibitor
	Coagulation factor inhibition	
Warfarin	Oral vitamin K antagonist (inhibits clotting factors II, VII, IX, and X)	May discontinue 3-4 days preoperatively (lowers the International Normalized Ratio (INR) to near normal)
Herbs and supplements–all enhance anticoagulation effects of warfarin; garlic and vitamin E have additional effects		
Feverfew		For migraines headaches, arthritis, rheumatic disease
Garlic	Inhibits platelet aggregation and thromboxane B2 *in vitro*. Enhances fibrinolysis *in vivo*	For lowering cholesterol, triglycerides, and blood pressure
Ginger		For reducing nausea, vomiting, vertigo
Ginkgo		For increasing blood circulation and oxygenation, memory
Ginseng		For increasing physical stamina and mental concentration, immune function
Vitamin E	Decreases platelet adhesion Impairs platelet aggregation only in patients with abnormal platelets	Mild anticoagulant effect may be significantly increased when taken with aspirin, garlic
Dong Quai root		For antispasmodic, anticlotting, laxative, and analgesic effects
Bilberry		For diuretic, astringent effects
Chondroitin		For arthritis

This table is adapted with permission from: Nguygen, TH. Chapter 17: Hemostasis. In: Surgery of the Skin: Procedural Dermatology. Edited by Robinson JK, Hanke CW, Sengelmann RD, Siegel DM. New York and London: Elsevier Mosby, 2005; 245-258

agents. They work by promoting a strong physiologic response of vasoconstriction or by mimicking the later stages of the coagulation cascade.

Epinephrine

Local anesthetic, most commonly lidocaine with epinephrine (adrenaline) in dilutions of 1:100,000 or 1:200,000 is the default mixture for most cutaneous surgical procedures.[23] When used properly in cutaneous surgery, systemic effects are extremely rare. It is contraindicated in patients with primary cardiac arrhythmias, narrow angle glaucoma, or a subclinical metabolic disorder (e.g., hyperthyroidism, carcinoid, and pheochromocytoma). The normal maximum dose is restricted to about 0.5-1 mg. Epinephrine overdose may induce severe or fatal hypertension, tachycardia, other arrhythmias, and vasoconstriction. Treatment can be aimed at blocking the marked pressor effects with rapidly acting vasodilators such as the nitrites and alpha-adrenergic blockers. Treatment of arrhythmias can be accomplished with the administration of a beta-adrenergic blocking drug such as propranolol.

Topical epinephrine, available in concentrations of 1:2000 dilution, is useful for mucosal procedures. Topical lidocaine with epinephrine (TLE–lidocaine 5% plus epinephrine 1:2000)

can be soaked on a dental roll for intranasal hemostasis.[24] Epinephrine may also be used alone in concentrations of 1:1000 to 1:1,000,000;[23,24] it is packaged as Adrenalin and may be diluted and injected to improve hemostasis, though this is rarely done in this century. Patients with severe coronary artery disease must be monitored carefully because they may develop cardiac ischemia as a result of significant systemic absorption. If the surgeon is mixing epinephrine into an anesthetic, the mixing should be done in the bottle, not in the syringe, to avoid the risk of incomplete mixing and placement of concentrated epinephrine where it is not intended.

A more dilute concentration of epinephrine (1:1,000,000) in 0.1% lidocaine tumescent anesthesia (which consists of a combination of lidocaine, epinephrine, and sodium bicarbonate in normal saline), will provide pronounced and prolonged vasoconstriction. The maximum dose of lidocaine given with epinephrine is 7 mg/kg, not to exceed 500 mg. By temporarily compressing vessels, the tumescent effect (tissue swelling) aids hemostasis.[25-28] Tumescent anesthesia is ideal for large excisions, reconstruction, liposuction, hair transplantation, and full face laser resurfacing.[1] For maximum vasoconstriction of the anesthetic, the surgeon should wait at least 15 min before the first incision. The skin will have a diffuse blanched appearance when effective hemostasis is achieved.

Moreover, a wealth of information can be gained from the initial injections of local anesthetic. Does the patient actively bleed from each stick of the needle? Does the patient bruise almost immediately? If so, it is likely the patient forgot to mention some important information that the surgeon should be aware of prior to performing the procedure. If a patient bleeds more than expected, it is possible he failed to mention the use of aspirin or some other agents listed in Table 3.

In the past, distal and acral sites such as the nose, digits, penis, or ear have often been avoided when injecting epinephrine given concerns for ischemic necrosis or injury. These concerns have been lessened by the rarity of adverse vascoconstrictive events during the common use of dilute epinephrine concentrations in conventionally used local anesthetics.[29] Additionally, several studies now refute this belief and epinephrine appears to be safe, at least as a digital block, for fingers and toes.[30-34] To enhance the safety of epinephrine use in the digits, epinephrine dilutions should be ≥1:200,000 and 1.5 mL or less should be used per side, circumferential ring blocks should also be avoided. Additionally, epinephrine should not be used for digital blocks in patients with conditions like diabetes mellitus, peripheral vascular disease, Raynaud's or other vasospastic/thrombotic conditions.[1,34] It is important to note that reports of gangrene formation after digital blocks have been associated with excessive tourniquet pressure, ring block technique, injection of excessive volume, and burn from hot soaks to anesthetized fingers.[31] There have been very rare reports of necrosis of the eyelid after local anesthesia using 2% lidocaine with epinephrine.[28] It is important to keep this in mind, especially when performing any peri-ocular surgical procedures. Necrosis in these cases is presumed to be due to prolonged vasoconstriction of arteries and is observed most commonly in patients at increased risk for vascular complications including those with arteritis, Raynaud's phenomenon, and severe microvascular disease.[35] We are unaware of any reports or studies demonstrating necrosis of the nose[29] in extensive and prolonged Mohs or other procedures. Additionally, the safety of epinephrine containing anesthetic in the penis is well established.[36]

Hemostasis as well as anesthesia may also be obtained via intravenous regional anesthesia (IVRA) or the Bier's block; this is rarely used in dermatology practice. IVRA utilizes a specialized tourniquet as well as local injections of lidocaine and/or opioids;[37] it may be used to anesthetize complete regions on extremities, such as from the elbow to the fingers or from the knee to the toes. This technique is particularly useful for surgery on extremity lesions or those with a strong vascular component. It has been used to create a bloodless field for performing procedures such as excisions, carbon dioxide laser destruction, and botulinum toxin injections.[38] Appropriate monitoring should be available when this technique is used.

PREPARING THE SURGICAL FIELD

Proper visibility, including ample bright light and easy accessibility to instruments and supplies is imperative for effective management of intraoperative bleeding. Gauze, Q-tips, and the electrosurgery unit should all be prepared prior to surgery and be readily available. In addition, a hemostat and vascular clamps can be kept on hand. Proper patient positioning can assist in surgical hemostasis as well as execution of technique. A useful technique involves lying patients as flat as possible (while still maintaining patient comfort) and placing the surgical plane at a slight incline of 15°. The mild incline directs any bleeding to drain inferiorly toward a gauze, reducing blood pooling at the superior end. The surgeon can then concentrate on hemostasis at the more visible portion of the field.[1] Avoid too steep (>15°) of an incline in order to prevent the wrist or neck bending in a non-ergonomic position. Advanced preparation of equipment for sites that are more prone to bleeding such as the scalp, nose, ears, lips, and digits is helpful.[1] The vessels that might be transected during the surgical procedure should also be marked before the surgery to plan for ligation or cautery later.

Intraoperative bleeding

Despite all precautions, some amount of intraoperative bleeding will occur with any surgery. After injury, vessels initially spasm and then constrict. This sequence is rapidly followed by vasodilation unless epinephrine (adrenaline) has been used.[1] If

there is profuse bleeding, compression by an assistant proximal to the bleeding vessels will reduce hemorrhage. During this time, the surgeon and assistant have time to collect supplies and rethink strategies. Pressure may then be released slowly to identify the offending vessel(s).[1]

When bleeding occurs at multiple sites, it can be overwhelming. A systematic approach is best: by mentally dividing the bleeding area into several segments or sectors, it can become more manageable. While compressing individual segments, the surgeon may achieve hemostasis one section at a time. In general, hemostatic efforts should be directed from arteries to veins, from larger to smaller vessels, and from superior to inferior sections of the wound.[1]

Compression

Direct pressure is a reflexive method of initial hemostasis for most dermatologic surgeons. Firm pressure over a bleeding wound for 15-20 min compresses capillaries allowing platelet aggregation and commencement of the coagulation cascade for most wounds.[39] For small wounds, one to several minutes of uninterrupted, direct pressure can result in complete hemostasis without further intervention. Larger vessels may require more time and/or further intervention. Pressure is necessary when topical hemostatic agents are applied, or to facilitate electrosurgery. Compression is usually applied downward, but when attempting to tamponade vessels near hollow openings, an upward pressure may be necessary. Incisions near the nasal ala, for instance, may require upward pressure from within the nasal vestibule.[1] Moistened Q-tips, a dental roll, or an inflated Foley catheter can all be used to apply upward pressure for nasal stabilization and compression of bleeding vessels.[40] A chalazion clamp may also provide stabilization and help isolate small vessels for hemostasis in surgery on the mucosal lip,[1] nose, and external ear [Figure 1a and 1b]. Compressing with the ring of a scissor or other metal ring can achieve a similar effect[41] [Figure 2].

Tourniquets can carefully be used, especially on the fingers and toes, to provide compression to greatly decrease intraoperative bleeding and improve the control of bleeding vessels. They may be fashioned from the cut finger of a surgical glove or a Penrose drain.[42-45] Proximal tourniquets at the forearm or distal thigh are generally safe for up to 2 h,[46] but the pain with prolonged compression is usually intolerable without sedation after a few minutes. We recommend limiting tourniquet use without sedation to 60 min or less. The extremity or digit may be elevated for 10 min before tourniquet placement to encourage venous exsanguination with the aid of gravity which may improve hemostasis.[1] Active exsanguination with a Penrose drain can increase the likelihood of a dry operative field [Figures 3a, 3b and 4a-c].

Figure 1a: The chalazion clamp can be used for lip stabilization and hemostasis

Figure 1b: The chalazion clamp can be used for lip stabilization and hemostasis

Figure 2: Compression using a metal ring

Figure 3a: Surgical glove tourniquet: A finger from the surgical glove is cut using scissors at both its base and its tip

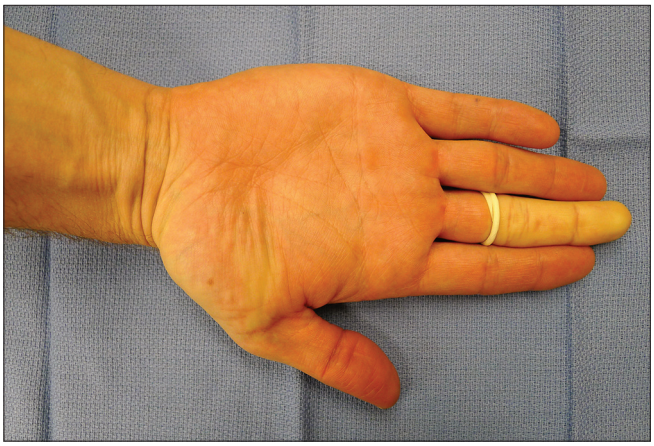

Figure 3b: The cut finger glove is then placed over the digit to be treated and rolled back proximally, forming the tourniquet

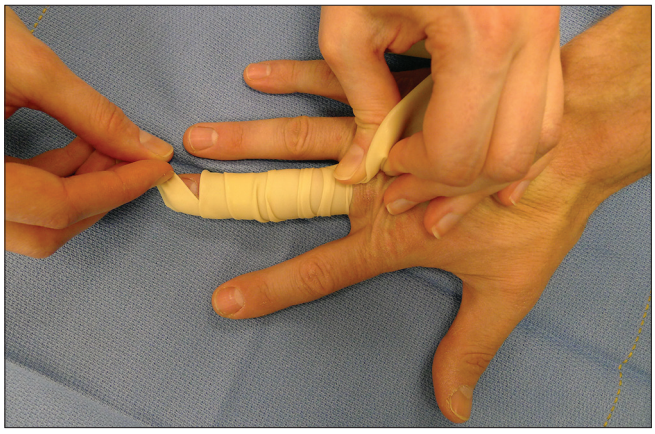

Figure 4a: Exsanguinating tourniquet: A Penrose drain is wrapped around the distal fingertip with a length exposed and then the drain is wrapped proximally under tension with overlapping layers (the wrap should extend beyond the surgical site leaving an exposed end proximally as well as distally)

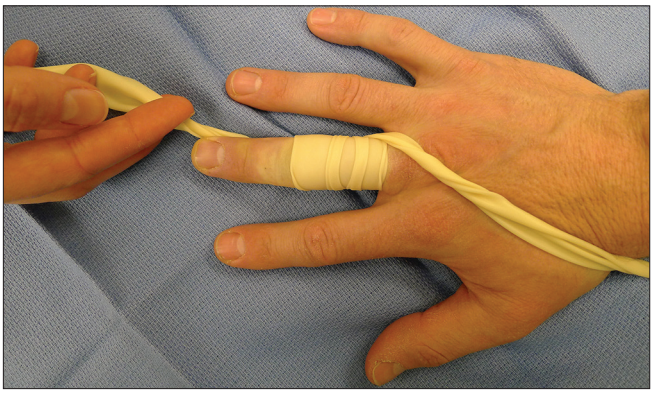

Figure 4b: Exsanguinating tourniquet: The distal end is then unwound slowly until it reaches the proximal exposed end

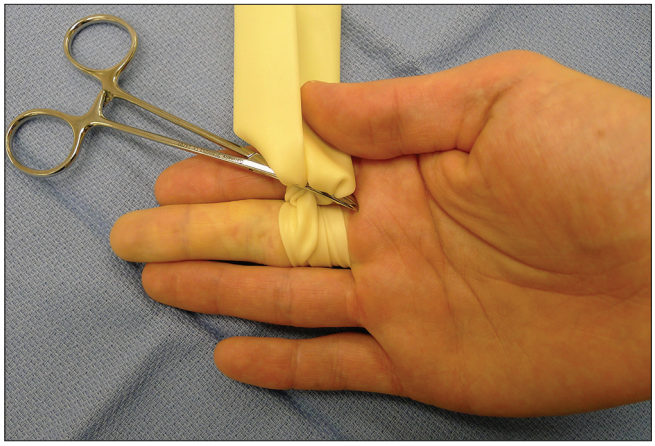

Figure 4c: A hemostat secures both ends to form the tourniquet

Laser surgery

The continuous wave carbon dioxide (CO_2) laser is a valuable tool in surgical procedures. The laser utilizes selective photo-thermolysis with a wavelength of 10, 600 nm; the chromophore is water (which makes up most biological tissue). It may be used in a focused (tissue incision) or defocused (tissue vaporization) mode while also sealing blood vessels of 0.5 mm in diameter.[47] Compared to scalpel surgery, use of the laser reduces bleeding. This incisional hemostasis is valuable in procedures like blepharoplasties, where meticulous hemostasis in mandatory.[48] The CO_2 laser does not work well in a wet field because blood or moisture will absorb the laser energy and prevent effective coagulation. Thus, this laser is most often used to control slow capillary bleeding. It is not routinely used as a primary method of hemostasis due to the significant investment in equipment, safety, and training that is required.

The continuous wave neodymium: Yttrium aluminum garnet (Nd: YAG) laser (1064 nm wavelength) can also

be used for hemostasis.[49,50] This laser targets melanin, hemoglobin, and water. It can generate diffuse thermal damage when used in the continuous wave mode. With a sapphire tip, it can cut with direct tissue contact, simulating a scalpel.[51] The Nd: YAG penetrates to a depth of 4–6 mm and diffuses widely, permitting significant thermal coagulation peripherally.[52] It is generally not used as the sole instrument for hemostasis and is uncommon in most dermatologic surgery practices.

Electrosurgery

Electrosurgery is an easy and effective method for surgical hemostasis. It can be monoterminal or biterminal. Monoterminal electrosurgery includes electrofulguration or electrodessication and provides adequate hemostasis for superficial procedures. Both electrofulguration and electrodessication utilize high voltage passed through a single electrode to desiccate tissue and thrombose small blood vessels (<2 mm diameter).[53] When using the electrofulguration technique, the electrode is held at a slight distance from the tissue and a spark is formed between the electrode and the tissue. This achieves very superficial destruction because the surface carbonization it produces insulates the underlying tissues from thermal heat spread.

Biterminal electrosurgery is known as electrocoagulation. Electrocoagulation uses a low-voltage current and has two electrodes that may be applied in a unipolar or bipolar fashion. Hemostasis may be achieved by touching the electrode directly to the bleeding vessel, or by using biterminal forceps or clamps that grasp the vessel. The field must be dry for optimal efficacy. It also causes a third less tissue necrosis than an equivalent current through a unipolar electrode.[54]

Radiofrequency devices such as a Valley Lab or Ellman Surgitron use high-frequency/low-temperature radio waves to allow cutting, coagulation, and the use of bipolar coagulation. These devices allow one to perform an excision in a bloodless field while causing minimal tissue trauma and collateral tissue damage. Vessels <1 mm will be seared away by a blended cutting and coagulation current. In contrast, cutting with one of these devices on pure coagulation mode leads to a large amount of plume with a significant amount of thermal damage, but minimal to no bleeding.

Electrosurgical methods may lead to collateral thermal damages and charring. These negative effects are more common with electrodessication and electrofulguration than with electrocoagulation. To minimize the sequelae of excess tissue charring, precise application of the current can help prevent poor wound healing and risk for infection. Periorbital skin and perichondrium are more vulnerable and require precision to prevent necrosis, inflammation, or damage to deeper structures due to excessive voltages. A controlled and precise technique using the lowest effective current setting should be used. Care should be taken to avoid applying the current to the edges of the wound. Adequate skin retraction and vertical positioning of the device can help prevent inadvertent wound edge necrosis.[1]

In a “wet” field with copious blood, the electric current will be dispersed and this can lead to excess charring. Maintaining a dry field is critical and can be achieved using either Q-tips or a dental roll. The “roll back” rather than “dabbing” method is best for precise electrocoagulation. In the roll back method, a Q-tip is used to compress the bleeding area and then slowly rolled back toward the surgeon. As the Q-tip is rolled back, bleeding vessels should be immediately coagulated and sealed.[1] When grasping a bleeding vessel (either with forceps or a mosquito clamp), it is important to minimize the amount of tissue that is secured in order to decrease tissue trauma when electrosurgery is subsequently applied. Two forceps may be used; the first is placed in the general area of bleeding and the second localizes the hemorrhaging vessel to be electrocoagulated.[1]

Electrosurgery and implantable devices

Implantable devices have become increasingly common over the last two decades. In regards to patients with pacemakers, there is no need for concern as all pacemakers have override electronics that prevent disruption of their transmission during electrocautery. It is not advisable to use prolonged hyfrecation directly over the pacemaker or lead wires. For patients with a defibrillator, the safest option is to use a hand-held battery operated thermal cautery device. Electrocautery seals the blood vessels using a heated wire and does not produce high-frequency electromagnetic interference or electrical currents. However, it may cause more of a burn injury than does true electrosurgery. This is effective only for the most minimal of bleeding and is generally used for small vessels. Wall-powered units (medical soldering irons) may be used for larger vessels.

Bipolar electrocoagulation is another option for patients with implantable defibrillators because the current is concentrated across the two tips, minimizing the chance of distal dispersion of electricity and interference with implanted devices. If conventional electrosurgery must be used, the active tip should not be applied to an area within 15 cm (6 inches) of the implanted device whenever possible.[55]

Another option for patients with defibrillators is temporary deactivation of the device in order to avoid accidental firing of the defibrillator.[55] Patients with implanted defibrillators are routinely cautioned regarding exposure to environmental magnetic fields because such exposure may interfere with device function. Medtronic manufactures a permanent ferrous magnet that, when placed directly over any implanted Medtronic ICD/CRT-D

device, will result in temporary suspension of tachyarrhythmia detection and therapy. This magnet has minimum field strength 90 G. The defibrillator will not interpret the Electro-Magnetic Interference (EMI) from electrosurgery as an arrhythmia since detection is suspended while the magnet is in place. The manufacturer suggests that during the use of the magnet, external monitoring be performed but is not necessary for brief periods of use when pacing and a defibrillator are immediately available. One author, DMS, has been told by the manufacturers' representatives that such monitoring is not necessary for brief periods of use of up to a minute unless the patient has no natural rhythm. If an arrhythmia is detected, the magnet should be removed to restore permanently programmed detection and therapy to the defibrillator, or external rescues can be performed. The magnet is placed over the chest at the site of the defibrillator. It is not recommended that the electrocautery or electrosurgery be performed any closer than 15cm (6 inches) from the defibrillator. The magnet is removed once the electrosurgery is complete.[56]

Suture ligation

Hemorrhaging vessels of all sizes may be ligated with appropriate suture techniques. Several different suture techniques are available for hemostasis. Generally, any vessel greater than 2 mm in diameter should be ligated because other methods of hemostasis are not as secure. In the case of transection of a vessel, each end may be clamped and ligated individually. Larger vessels are best secured with a curved mosquito clamp or Halsted clamp. It is important to clamp and ligate only the minimum amount of tissue. Buried sutures should be absorbable [i.e., polyglactin 910 (Vicryl, Ethicon, Inc., Johnson and Johnson Co, Somerville, NJ, USA)].

A bleeding vessel that cannot be visualized can be one of the most challenging situations. This may be a result of a blood vessel spasm leading to retraction of the vessel beneath the wound edge. It may also occur when punch biopsies are performed in highly vascular areas such as the scalp and bleeding develops deep to the wound surface.[1] In either case, more undermining may help reveal the retracted vessel for ligation or electrocoagulation. If further undermining is not possible, then blind ligation may be used. A figure-of-eight suture or square stitch is often effective and should be used around the bleeding site. The figure of eight provides a crisscross configuration that tampondes the underlying bleeding vessel. The suture can be non-absorbable or slowly absorbed. The horizontal mattress suture is an epidermal suture that is useful for non-specific epidermal oozing along the wound edge,[1,57] in addition to stopping most bleeding from the deep dermis and subcutis region. Running locked surface sutures can also be useful for stopping bleeding from oozing wound edges. Compression applied proximal to the area of hemorrhage will temporarily reduce bleeding sufficiently to allow for suture intervention.

Scalp biopsies can be particularly challenging due to the high vascularity of the region. A new technique for achieving hemostasis during scalp punch biopsies has recently been described.[58] The technique recommends first placing a horizontal mattress suture, using a 3-0 or 4-0 nonabsorbable suture, around the area to be excised. The horizontal mattress suture should be placed wide enough to allow the punch tool to enter the area without cutting the suture. Once the suture has been placed, an assistant holds the suture out of the surgical field and a standard punch biopsy is done and the specimen collected. Immediately after the specimen is obtained, the suture is drawn tight and tied off, obtaining rapid and complete hemostasis. This technique may also be used for tongue biopsies.[58]

Excisions of vascular lesions such as hemangiomas and port-wine stains are inherently complex. Visibility may be limited by diffuse bleeding. A useful technique to control this type of bleeding is a double imbricating suture.[59] This method consists of two modified vertical purse-string sutures placed peripheral to the area of excision. The tension is adjusted by pulling on either end of the suture, constricting the central area of surgery, and tamponading the vessels peripheral to the centrally excised lesion.[1] A 3-0 prolene (Ethicon, Inc., Johnson and Johnson Co.) suture with PS-2 needle is most useful for this technique. In order to avoid dead space, closing with a buried suture such as vertical mattress can be helpful.[57] In case of severe hemorrhage, over sew the wound in any way that you can. Use any combination of horizontal mattress, purse-string suture, and multiple figure of eights until it is controlled and then close the wound with your preference of mattress sutures to tamponade against further bleeding. In order to enable drainage of the potential postoperative hematoma, it may be advisable to avoid continuous intradermal sutures.

POSTOPERATIVE BLEEDING AND HEMATOMA

It is imperative that patients receive detailed instructions on activity restrictions and postoperative wound care. The risk of postoperative bleeding is greatest in the first 48 h. Trauma or rebound vasodilation after epinephrine is the most common cause for acute bleeding. This can be minimized with cold packs and elevation. Compression dressings can also be used to close vessels and immobilize the wound, protecting it from trauma. In Part 2 of this paper, we will address hemostatic agents that can be applied to assist in achieving hemostasis. In spite of all precautions, bleeding complications may still occur. An expanding hematoma can occur with continued bleeding within a closed wound. To decrease the chance of hematoma, it is best to minimize dead space. Complications arising from hematomas include compression injury to adjacent tissues, wound necrosis, dehiscence, and infection. Hematomas in the neck and periorbital region can be the most hazardous due to risk of vision

loss or airway compromise. Patients should be given emergency phone numbers and be aware of warning signs and symptoms, especially any new painful swelling at the site of the wound. Hematomas evolve through several stages; early hematomas may require suture removal to open part of or the entire wound. Hemostasis can then be obtained with electrosurgery, ligation, or fibrin sealants/other topical hemostatic agents. A check for further bleeding can be carried out with an irrigation of normal saline before resuturing the wound if it is not contaminated. If the wound is infected, antibiotics should be administered and healing by secondary intention is recommended. The wound may be revised in the future.

Later, a hematoma may become gelatinous; if it is small and asymptomatic, it can be observed. However, evacuation may be necessary if it is threatening viable tissues. After several days, a hematoma may become rubbery and the wound may feel firm. This stage of a hematoma is difficult to remove and may be deferred until 7-10 days post procedure. Hematomas in the liquefaction stage begin to liquefy at 7 to 10 days along with fibrinolysis and are eventually resorbed. In this stage, the wound may feel fluctuant and can be easily aspirated with a 16- or 18-guage needle without needing to re-open the wound.[1]

CONCLUSION

Achieving hemostasis successfully can be accomplished with careful pre-procedure planning, intraoperative techniques, and post-procedure aids. It is important for surgeons to communicate well with their patients to determine if there is an underlying hematologic disorder or medications that may complicate hemostasis. Anticoagulated patients may continue their anticoagulation regimen with dermatologic surgery with only a few exceptions.

ACKNOWLEDGMENT

Doctors Andrea Hui and Michael Jacobson are thanked for their assistance with obtaining images for this project.

REFERENCES

1. Nguygen TH. Chapter 17: Hemostasis. In: Robinson JK, Hanke CW, Sengelmann RD, Siegel DM, editors. Surgery of the Skin: Procedural Dermatology. 1st ed. New York and London: Elsevier Mosby; 2005. p. 245-58.
2. Miller CH, Graham JB, Goldin LR, Elston RC. Genetics of classic von Willebrand's disease I. Phenotypic variation within families. Blood 1979;54:117-36.
3. James AH. Von Willebrand disease in women: Awareness and diagnosis. Thromb Res 2009;124(Suppl 1):S7-10.
4. Beyer R, Ingerslev J, Sorensen B. Current practice in the management of muscle haematomas in patients with severe haemophlia. Haemophilia 2010;16:926-31.
5. Chang L, Whitaker D. The impact of herbal medicines on dermatologic surgery. Dermatol Surg 2001;27:759-63.
6. Makheja A, Vanderboek J, Bailey J. Inhibition of platelet aggregation and thromboxane synthesis by onion and garlic. Lancet 1979;1:781.
7. Hammerschmidt D. Szechwan purpura. N Engl J Med 1980;302:1191-3.
8. Makheja A, Bailey J. Identification of the antiplatelet substance in Chinese black tree fungus. N Eng J Med 1981;304:175.
9. Kovich O, Otley C. Thrombotic complications related to discontinuation of warfarin and aspirin therapy perioperatively for cutaneous operation. J Am Acad Dermatol 2003;48:233-7.
10. Billingsley E, Maloney M. Intraoperative and postoperative bleeding problems in patients taking warfarin, aspirin and nonsteroidal anti-inflammatory agents: A prospective study. Dermatol Surg 1997;23:381-3.
11. Shalom A, Wong L. Outcome of aspirin use during excision of cutaneous lesions. Ann Plast Surg 2003;50:296-8.
12. Stables G, Lawrence C. Management of patients taking anticoagulant, aspirin, non-steroidal anti-inflammatory, and other anti-platelet drugs undergoing dermatologic surgery. Clin Exp Dermatol 2002;27:432-5.
13. Blasdale C, Lawrence C. Perioperative international normalized ratio level is a poor predictor of postoperative bleeding complications in dermatological surgery patients taking warfarin. Br J Dermatol 2008;158:522-6.
14. Kearon C, Hirsh J. Current concepts: Management of anticoagulation before and after elective surgery. N Eng J Med 1997;336:1506-11.
15. Otley C. Continuation of medically necessary aspirin and warfarin during cutaneous surgery. Mayo Clin Proc 2002;78:1392-6.
16. Ah-Weng A, Natarjan S, Velangi S, Langtry JA. Preoperative monitoring of warfarin in cutaneous surgery. Br J Dermatol 2003;149:386-9.
17. Klein J. Ancillary pharmacology. In Klein, J, ed. Tumescent liposuction. St Louis: Mosby; 2000.
18. Gatti J. Oral sedation allows for comfort and amnesia during office surgery. Ann Plast Surg 2000;44:502-7.
19. Tromovitch T, Stegman S. Microscopic-controlled excision of cutaneous tumors: Chemosurgery, fresh tissue technique. Cancer 1978;41:653-8.
20. Tromovitch T, Stegman S. Microscopically controlled excision of skin tumors. Arch Dermatol 1974;110:231-2.
21. Otley C, Nguyen T, Phillips P. Anxioysis with oral midazolam in pediatric patients undergoing dermatologic surgical procedures. J Am Acad Dermatol 2001;45:105-8.
22. Ravitskiy L, Phillips P, Roenig R, Weaver AL, Killian JM, Hoverson Schott A, *et al*. The use of oral midazolam for perioperative anxiolysis of healthy patients undergoing Mohs surgery: Conclusions from randomized controlled and prospective studies. J Am Acad Dermatol 2011;64:310-22.
23. Naftalin L, Yagiela J. Vasoconstrictors: Indications and precautions. Dent Clin N Am 2002;46:733-46.
24. Glasson D. Topical adrenaline as a hemostatic agent. Plast Reconstr Surg 1984;74:451-2.
25. Vaughan R. Ventricular arrhythmias after topical vasoconstrictors. Anesth Analg 1973;52:161-5.
26. Klein J. Anesthesia for liposuction in dermatologic surgery. J Dermatol Surg Oncol 1988;14:1124-32.
27. Hunstad J. Tumescent and syringe liposculpture: A logical partnership. Aesthetic Plast Surg 1995;19:321-33.
28. Habbema L. Safety of liposuction using exclusively tumescent local anesthesia in 3,240 consecutive cases. Dermatol Surg 2009;35:1728-35.
29. Häfner H, Röcken M, Breuninger H. Epinephrine-supplemented local anesthetics for ear and nose surgery: Clinical use without complications in more than 10,000 surgical procedures. J Dtsch Dermatol Ges 2005;3:195-9.
30. Denkler K. A comprehensive review of epinephrine in the finger; to do or not to do. Plast Reconstr Surg 2001;108:114-24.
31. Wilhelmi B, Blackwell S, Miller J, Mancoll JS, Dardano T, Tran A, *et al*. Do not use epinephrine in digital blocks: Myth or truth? Plast Reconstr Surg 2001;107:397-9.

32. Chowdry S, Seidenstricker L, Cooney D, Hazani R, Wilhelmi BJ. Do not use epinephrine in digital blocks: Myth or truth? Part II. A retrospective review of 1111 cases. Plast Reconstr Surg 2010;126:2031-4.
33. Fitzcharles-Bowe C, Denkler K, Lalonde D. Finger injection with high-dose (1:1,000) epinephrine: Does it cause finger necrosis and should it be treated? Hand 2007;2:5-11.
34. Firoz B, Davis N, Goldberg L. Local anesthesia using buffered 0.5% lidocaine with 1:200,000 epinephrine for tumors of the digits treated with Mohs micrographic surgery. J Am Acad Dermatol 2009;61:639-43.
35. Yakoubi S, Knani L, Touzani F, Ben Rayana N, Krifa F, Mahjoub H, *et al*. Eyelid necrosis after injection of lidocaine with epinephrine. J Fr Ophtalmol 2012;35:113-6.
36. Mohs FE, Snow SN, Messing EM, Kuglitsch ME. Microscopically controlled surgery in the treatment of carcinoma of the penis. J Urol 1985;133:961-6.
37. Bansal A, Gupta S, Sood D, Kathuria S, Tewari A. Bier's block using lignocaine and butorphanol. J Anaesthesiol Clin Pharmacol 2011;27:465-9.
38. Blaheta HJ, Vollert B, Zuder D, Rassner G. Intravenous regional anesthesia (Bier's block) for botulinum toxin therapy of palmar hyperhidrosis is safe and effective. Dermatol Surg 2002;28:666-72.
39. Larson P. Topical hemostatic agents for dermatologic surgery. J Dermatol Surg Oncol 1988;14:623-32.
40. Alcaly J, Goldberg L. Intraoperative nasal ala stabilization using the foley catheter. J Dermatol Surg Oncol 1991;17:957-8.
41. Alinovi A, Allegra F. A technique for the biopsy of oral lesions. J Dermatol Surg Oncol 1994;20:769-70.
42. Smith I, Austin O, Knight S. A simple and fail safe method for digital tourniquet. J Hand Surg 2002;27:363-4.
43. Tucker S, Harris P. The unforgettable finger tourniquet. Injury 2002;33:76-7.
44. Salasche S. Nails: Therapy, diagnosis, surgery, 2nd ed. Philadelphia: WB Saunders; 1997.
45. Harrington AC, Cheyney JM, Kinsley-Scott T, Willard RJ. A novel digital tourniquet using a sterile glove and hemostat. Dermatol Surg 2004;30:1065-7.
46. Wakai A, Winter D, Street JT, Redmond HP. Pneumatic tourniquets in extremity surgery J Am Acad Orthop Surg 2001;9:345-51.
47. Dover J, Arndt K, Geronemous R, Alora M. Continuous and pulsed carbon dioxide laser surgery. In: Illustrated cutaneous and aesthetic laser surgery, 2nd ed. Stamford: Appleton and Lagne; 2000.
48. Glassberg E, Babapour R, Lask G. Current trends in laser blepharoplasty. Results of a survey. Dermatol Surg 1995;21:1060-3.
49. Fincher E, Gladstone H. Use of a dual-mode erbium: YAG laser for the surgical correction of rhinophyma. Arch Facial Plast Surg 2004;6:267-71.
50. Iwasaki M, Sasako M, Konishi T, Maruyama Y, Wada T. Nd-YAG laser for general surgery. Lasers Surg Med 1985;5:429-38.
51. Apfelberg D, Maser M, Lash H, White DN. Sapphire tip technology for YAG laser excisions in plastic surgery. Plast Reconstr Surg 1989;84:273-9.
52. Zachary C. Modulating the Er: YAG laser. Laser Surg Med 2000;26:223-6.
53. Khouri S, Lodha R, Nouri K. Electrosurgery. In: Khouri, S, Nouri K. editors. Techniques in dermatologic surgery. Philadelphia: Elsevier; 2003.
54. Edlich R, Reddy V. 5th Annual David R Boyd, MD lecture: Revolutionary advances in wound repair in emergency medicine during the last three decades. A view toward the new millennium. J Emerg Med 2001;20:167-93.
55. Porres JM, Laviñeta E, Reviejo C, Brugada J. Application of a clinical magnet over implantable cardioverter defibrillators: Is it safe and useful? Pacing Clin Electrophysiol 2008;31:1641-5.
56. Medtronic. Mounds View: Implantable Pacemaker and Defibrillator Information. Available from: http://cacgas.com/uploads/Medtronic_Magnet_use_and_ICD.pdf. [Last updated on 2007 Dec 18; cited on 2012 May 25].
57. Alam M, Goldberg L. Utility of fully buried horizontal mattress sutures. J Am Acad Dermatol 2004;50:73-6.
58. Ingraffea A. Use of a preliminary horizontal mattress suture on scalp biopsies to achieve rapid hemostasis. Dermatol Surg 2010;36:1312.
59. Harahap M, Siregar A. Method of minimizing hemorrhage in excising hemangiomas. J Dermatol Surg Oncol 1989;15:1077-80.

Cite this article as: Kaur RR, Glick JB, Siegel D. Achieving hemostasis in dermatology - Part 1: Preoperative, intraoperative, and postoperative management. Indian Dermatol Online J 2013;4:71-81.

Source of Support: Nil, **Conflict of Interest:** No.

This article is the first of a 2-part series. The second part focusing on Topical Hemostatic Agents will appear in the next issue of IDOJ