CHAPTER **34**

SURGICAL WOUND DEHISCENCE PREVENTION

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Surgical wound dehiscence is a postsurgical complication that involves the breakdown of the surgical incision site. This can range from simple to complex depending on what tissue layers are involved (Figures 1, 2). Wound healing involves a complex series of interactions among cells and cell mediators, and the wound healing stages that have been described are hemostasis, inflammation, proliferative, and maturation and remodeling phases (1, 2). Many factors can disrupt the physiologic responses and cellular functions leading to a wound dehiscence. Preventive measures during the preoperative, intraoperative, and postoperative phases can help.

PREOPERATIVE CONSIDERATIONS

Preoperatively, the patient needs to be medically optimized. This involves determining the patient's nutritional status, managing their medications and comorbidities, and educating them on smoking cessation. Taking a thorough history and actively communicating with the patient's primary care physician about patient medical care is important during the preoperative phase to help prevent wound dehiscence.

Nutritional Status

Surgery and trauma increase the patient's metabolic demand, and this makes marginal deficiencies more substantial. Preoperatively, patients should be encouraged to eat a well-balanced diet consisting of increased amounts of calories, protein, vitamins A and C, and sometimes the mineral zinc to provide adequate nutrients for proper surgical healing (Table 1). There are also vitamins, fatty acids, and herbal supplements that can adversely affect wound healing (Table 2). Having an understanding of the benefits and risks of a patient's nutrition can help in promoting successful surgical wound healing.

Proteins are essential for wound healing, and preoperative laboratory values that can be tested include albumin (>3.5 mg/dl), pre-albumin (>15 mg/dl), and transferrin (>200 mg/dl) (3). Albumin has a long half-life and may be normal

Figure 1A. Superficial wound dehiscence (second week postoperative visit).

Figure 1B. Superficial wound dehiscence healed (sixth week postoperative visit).

Figure 2A. Complex wound dehiscence (third week postoperative visit).

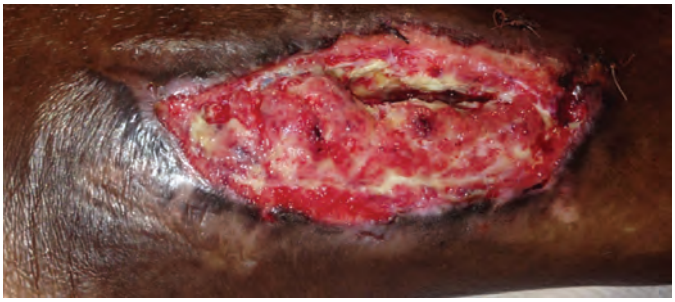

Figure 2B. Complex wound dehiscence after debridement and hardware removal (12 weeks).

Figure 2C. Complex wound dehiscence healed (7 month follow-up).

in a malnourished patient. The patient's hydration status can also affect the measured level of albumin, making it less accurate in assessing nutrition than pre-albumin, which has a shorter half-life (4). The amino acid arginine has been shown to enhance nitric oxide synthesis, which increases angiogenesis and collagen synthesis. Daily supplements of 30 gm arginine aspartate for 14 days have shown to result in greater collagen and total protein deposition at the wound site (5).

Vitamins A and C can benefit surgical wound healing. Vitamin A increases the inflammatory response in wounds, reverses anti-inflammatory effects of corticosteroids, and can enhance wound healing even in non-deficient states. Vitamin A doses as high as 25,000 IU/day (five times the recommended daily dose) have been suggested without side effects. (3, 6, 7). Vitamin C deficiency can cause impaired synthesis of collagen and connective tissue, and has historical significance in its relation to scurvy. The recommended daily allowance is 60 mg/day. There is no evidence to recommend mass doses of vitamin C, but there is also no evidence showing excess vitamin C is toxic (3, 8).

Zinc is essential in wound healing, and is involved in DNA synthesis, protein synthesis, and cellular proliferation. Decreased fibroblast proliferation and collagen synthesis has been noted when zinc levels are less than 100 µg/dl. Severe stress and long-term steroid use can deplete zinc levels. The current recommendation for zinc is a daily allowance of 15 mg (3).

Table 1. Foods to help wound healing

	HealingFoods
Protein	Eggs, Meat, Beans, Milk, Tofu, Nuts and Seeds
Vitamin C	Citrus Fruits, Guava, Kiwi, Tomatoes, Strawberries, Peppers, Cantaloupe, Brussel Sprouts
Vitamin A	Carrots, Sweet Potatoes, Spinach, Beef, Collards, Kale, Winter Squash
Zinc	Beef, Lamb, Sesame/Pumpkin Seeds, Garbanzo Beans, Cashews

Table 2. Supplements that interfere with would healing

Herbs/Vitamins That Can Interfere With Surgery	
• Any Diet Pills	• Echinacea
• Aspirin/Blood Thinners	• Licorice
• Vitamin E	• Saw Palmetto
• Chromium	• Ephedra
• Garlic	• Ginseng
• Ginger	• Feverfew
• Ginkgo	• Kava-Kava
• Goldenseal	• St. John's Wort
• Fish Oil	• Valerian Root

Medical Comorbidities

Characteristics that increase wound complications are obesity, cardiovascular disease affecting tissue perfusion, respiratory disease affecting sufficient blood oxygenation, steroid treatment, metabolic disease, endocrine disease, and renal and hepatic failure (2). Diabetes mellitus can cause slow wound maturation and decreased numbers of dermal fibroblasts. Hemoglobin A1c levels greater than 7% have been shown to be associated with bone healing complications (9). According to the 2009 Standards of Medical Care in Diabetes, lowering the hemoglobin A1c to below or around 7% can reduce microvascular and neuropathic complications of type 1 and type 2 diabetes (10). Hepatic failure can contribute to soft tissue wound failure secondary to decreased clotting factors, low plasma proteins, and decreased bactericidal activity. Renal failure can lead to wound issues because of protein malnutrition and dialysis causing an increased susceptibility of developing infections due to deficient responses of both B and T lymphocytes (2).

Smoking

Cigarette smoking has been shown to cause adverse effects on wound healing. Nicotine is a vasoconstrictor that decreases the production of erythrocytes, macrophages, and fibroblasts. Carbon monoxide competitively inhibits oxygen binding of hemoglobin, and hydrogen cyanide inhibits oxidative metabolism enzymes (2). In a study involving flaps, and full-thickness grafts it was noted that 1 pack-per-day smokers had three times the frequency of necrosis, and 2 pack-per-day smokers had six times the frequency of necrosis in comparison to nonsmokers (11). No uniform guidelines

for smoking cessation have been made, but a period of 4 weeks before and after surgery has been advocated for cosmetic and reconstructive surgery (12).

INTRAOPERATIVE CONSIDERATIONS

Infection control, incision placement, tissue handling, hemostasis, suture technique, and dressings are factors that surgeons need to consider intraoperatively. Whole body Hibiclens baths before surgery can result in a sustained antibacterial effect with multiple uses, and prepping the surgical site with 4% chlorhexidine gluconate scrub followed by 70% isopropyl alcohol paint has been shown to be most effective at eliminating bacterial contamination of the skin (13.).

Prophylactic preoperative antibiotics against Staphylococcus aureus and Staphylococcus epidermidis are recommended since these are the most common pathogenic bacteria in clean surgeries. Cefazolin, clindamycin (if penicillin allergic), or vancomycin (if the patient has a history of Methicillin-resistant S. aureus) is typically administered. General guidelines recommend that antibiotics be given within 30 minutes to 1 hour of the incision (14), and during long procedures the antibiotic should be administered again based on their half-life. An example would be giving a repeat dose of cefazolin at 4 hours intraoperatively (15). Antibiotics should be discontinued at the end of the procedure or by 24 hours postoperatively. Prolonging antibiotics postoperatively does not decrease the risk of infection, but can increase the risk of adverse consequences (16).

Angiosomes need to be considered during incision placement. Attinger provided four considerations to making any incision: an incision should provide adequate exposure of target tissues, it should allow blood supply from both sides of incision, an incision should spare motor and sensory nerves, and an incision should be parallel to resting skin tension lines (17). The safest incisions, according to Attinger, are shorter and located at the junction of adjacent angiosomes (17). Surgical retraction should be released on occasion to allow for tissue perfusion, and wounds should be kept moist throughout the procedure because dry wounds lose perfusion (18). Adequate hemostasis must be maintained to decrease chances of postsurgical hematoma formation. When a surgical tourniquet is utilized it should be released before skin closure so all active bleeding vessels are controlled before skin closure. Clarke et al noted that when using a tourniquet, it should be inflated at low pressure (225 mm Hg) to decrease the chance of postoperative wound hypoxia (19).

There are a variety of sutures and suture techniques for skin closure. Monofilament sutures are preferable for skin closure, and sutures should not be tight to allow for expected swelling of tissues without causing ischemia (18). Sagi et al compared suture techniques on cutaneous blood flow (CBF) at wound edges and noted that the Allgower-Donati suture pattern had the least effect on CBF with increasing tension (20).

Postoperative edema can be controlled with application of proper surgical dressings. Use of a Jones compression dressing with or without a cast can be utilized depending on the type of surgery performed. Proper dressings can result in decreased pain, peri-operative complications, and a protective environment for patient healing and recovery (21).

POSTOPERATIVE CONSIDERATIONS

Incision healing during the postoperative period is dependent upon vasoconstriction prevention, edema control, immobilization, and a clean environment (22). The most vulnerable time for wounds postoperatively is during the early hours after surgery. Pain, decreased body temperature, and inadequate hydration can lead to vasoconstriction. Pain control can be achieved by an adequate intraoperative regional block, and following surgery with patient controlled analgesia or close attention and monitoring by nursing. Warming of the patient should be continued postoperatively until the patient is thoroughly awake and can maintain their own thermal balance. Warming the patient helps prevent vasoconstriction and minimizes caloric losses. Vasoconstrictive drugs should be avoided to minimize wound hypoxia. Beta blockers, unless clearly medically indicated, should not be administered because they reduce wound/tissue partial pressure of oxygen (23). An alternative for heart rate control is clonidine because it also induces vasodilation and can possibly increase wound partial pressure of oxygen (24). Smoking must be avoided as noted in the preoperative considerations section.

Edema control is an important factor to control postoperatively. Edema can be limited with continuous lower limb elevation above heart level with a maximum of 30 minutes of dependency at a time for meals. Applying ice for 15 to 20 minutes per hour behind the knee and on the anterior aspect of the ankle while the patient is awake can decrease edema, which will reduce tension on the wound edges. Proper dressings and immobilization are important to minimize surgical wound irritation. The time between dressing changes depends on the extent of the surgery. If increased edema is anticipated post-surgical dressings should be changed more frequently for better edema control. Patients need to keep their dressings clean, dry, and intact to avoid condensation underneath the surgical bandages that could lead to maceration and wound breakdown. Sutures/staples should be maintained until the incision is fully healed, which sometimes can take 4 weeks or longer, and steri-strips can be used to decrease wound

Figure 3A. Postoperative surgical wound healing at 2 weeks following pilon fracture repair.
Figure 3B. Wound healing at 4 weeks.
Figure 3C. Wound healing at 3 months.

tension (Figure 3). Patients need proper postoperative care instructions, and must be educated on signs and symptoms of postsurgical complications.

In summary, postoperative wound complications can be very challenging and difficult to manage. Many preventive measures can be performed throughout the perioperative phase to minimize the chances of wound dehiscence. If postsurgical wound complications occur, it is imperative that possible risk factors be reassessed and properly addressed. Infections, when present should be managed appropriately and patients educated on the treatment protocol.

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