5 Skin Closure Techniques That You Should Really Be Using in Practice
Christopher Adin, DVM, DACVS
North Carolina University
Raleigh, NC

Classification of Skin Flaps
There is no such thing as a “standard wound”; there are always variables like the location and size of the defect, the vascularity of the wound bed, the degree of contamination, the age of the patient, concurrent administration of chemotherapeutic agents. As a result, reconstructive surgery requires that the surgeon has extensive knowledge of basic principles and is able to adapt them with creativity to each problematic wound. This need for variability in closure techniques has led to skin flaps that are often created “on the spot” and may not have specific names. Rather, they are classified using general descriptive terminology. The following classification schemes are commonly used in the veterinary literature and should be learned:

1) Classification by blood supply:
Vascularized skin flaps:
- Subdermal plexus flap (random pedicle flap)- a flap that depends upon terminal branches of direct cutaneous arteries in the subcutaneous tissue and panniculus muscle.
- Axial pattern flap - a flap that is supplied by a named direct cutaneous artery and vein.

Non-vascularized skin grafts:
Subtypes
- Full thickness vs partial thickness skin grafts
- Meshed versus non-meshed skin grafts
- In small animals, meshed, full-thickness grafts are preferred

2) Classification by composition
- Cutaneous flaps- flaps that are composed of skin only
- Composite flaps- flaps that are composed of combinations of tissue types may be used in complex reconstructive procedures for defects that involve more than just skin
- Myocutaneous flaps are composed of muscle and skin
- Osteomyocutaneous flaps contain bone, muscle and skin

3) Classification by location
Local flaps are based on tissue that is adjacent to the defect
Subtypes:
- Advancement flaps- subdermal plexus flaps that are elevated and pulled directly over a defect, single or bipedicle
- Rotational/transposition flaps- subdermal plexus flaps that involve rotation of a piece of skin that is continuous with one portion of the defect.
- Distal flaps are subdermal plexus flaps that are based on tissue that is obtained from a site that is not continuous with the recipient be. This tissue can be “tubed” and slowly advanced to a distant site. They are rarely used today, due to development of axial pattern flaps and free skin grafts.

Principles of Advanced Reconstructive Surgery
1. KNOW YOUR ANATOMY
2. Use the simplest technique possible to close any tissue defect.
3. Have multiple plans available for wound closure and be prepared to use all of them
4. Warn clients of the frequent need for revision surgeries
5. Shave and aseptically prepare LARGE areas of skin before reconstructive surgery. You will be very sad if you are pulling haired skin into your surgical site to close a large wound.

Local Tissue Advancement:
Local advancement techniques are based on tissue that is adjacent to the defect and include:
Axial Pattern Flaps
Axial pattern flaps have several advantages for use in wound closure. Due to their robust blood supply through a large vascular pedicle, axial pattern flaps can be much longer than subdermal plexus flaps and still maintain viability. This direct blood supply makes axial pattern flaps preferable for tumor resection sites that may require radiation therapy, which would cause rapid necrosis of a non-vascularized skin graft. Since they are full thickness flaps, axial pattern flaps maintain hair growth and cosmesis and provide relatively durable skin covering. One of the greatest advantages of axial pattern flaps is that they allow instant, complete closure of large defects without the laborious bandage changes required for free skin grafts.

The primary disadvantage of axial pattern flaps is that they do not reach the distal extremities in dogs or cats. Another disadvantage of axial pattern flaps is the large donor site incision which increases surgical time and patient morbidity.

Axial pattern flaps are harvested using described anatomic landmarks and the flaps are named for their nutrient artery and vein. It is important to elevate the flap deep to the subcutis and panniculus muscle to preserve blood supply. I find trans-illumination of the flap helpful in locating the vascular pedicle. The flap may be elevated and rotated up to 180 degrees to cover the adjacent skin defect if the cutaneous pedicle is divided, leaving only the vascular pedicle attachment (an island flap). Flaps that are not directly adjacent to the recipient site may be “tubed” (sutured upon themselves) or a bridging incision may be made to connect the donor and recipient sites. Flaps are typically sutured only at the periphery. I avoid placing many sutures to tack down the flap to the underlying tissue due to fear of compromising blood supply to the flap. Instead, I place a closed suction drain to remove fluid and eliminate dead space.

The two most commonly utilized axial pattern flaps in clinical practice are the thoracodorsal flap and the caudal superficial epigastric flap. The thoracodorsal flap is based on the thoracodorsal artery and vein, arising from the caudal shoulder depression palpable at the level of the point of the acromion. The skin boundaries for flap elevation are:

- cranial- spine of scapula
- caudal- a line parallel to the spine of the scapula and double the distance from the spine of the scapula to the caudal shoulder depression.
- dorsal- extends to dorsal midline. The thoracodorsal flap will rotate to cover the shoulder, cranial thorax and axilla, but is used most often to cover skin defects over the elbow- an area that is not amenable to skin grafting due to the high degree of motion and low vascularity of the donor bed. The thoracodorsal flap extends maximally to the mid antebrachium and is not helpful for defects of the carpus or distal thoracic limb.

The caudal superficial epigastric flap is based on the caudal superficial epigastric artery and vein which arise from the inguinal ring. The flap length includes the caudal 4 mammary glands and associated skin in dogs, but only the caudal 3 glands in cats. The medial border is the abdominal midline, the lateral border is parallel to midline and is an equal distance from the teats. The caudal superficial epigastric flap can be used to cover defects in the flank, perineal area, lateral thigh, inguinal area, stifle, hip and prepuce. Owners should be warned about the cosmetic appearance of this flap, as the skin over the mammary glands is thin and sparsely haired, not to mention the fact that the dog will have teats on it’s knee...

Skin Grafts
Skin grafting is a long utilized technique to provide epithelial coverage to skin defects. In veterinary surgery the term “skin graft” typically refers to non-vascularized autogenous (from the same animal) tissue. Skin grafts may be either partial thickness or full thickness. Partial thickness grafts are harvested using a dermatome (a moving blade) or a freehand knife which “shave” off a piece of skin that is 0.015-0.03in. . The donor site heals rapidly by a process called adnexal re-epithelialization. Advantages of partial thickness skin grafts are increased viability compared to full thickness grafts and decreased contraction of the graft during healing.
Disadvantages of partial thickness grafts are cosmesis (hair growth is minimal to absent), poor durability, loss of hair at the donor site, and the requirement for specialized equipment. Partial thickness grafts are not used in cats, because the skin is too thin to be useful with this technique. Full thickness grafts are harvested by simply removing a piece of skin from the trunk using a standard scalpel. The subcutaneous tissue is scraped off the deep surface of the graft using metzenbaum scissors so that the dermis will be in direct contact with the wound bed. Full thickness grafts have improved cosmesis and durability, with a potential for hair regrowth and may be performed without specialized equipment. Both types of grafts are typically “meshed” before application, increasing the area covered by up to 3 times the original size of the graft. The graft is sutured down to the wound bed with simple interrupted sutures at the periphery and throughout the center of the graft to prevent movement of the graft during healing. The wound is bandaged and the initial bandage is not changed for 3 days after surgery to avoid disruption of the tenuous blood supply to the graft. The recipient site is immobilized for 10-14 days.

Skin grafts become vascularized through a 4-step process:

1. **Adherence**: initial fibrin seal followed by fibroblast ingrowth
2. **Plasmatic imbibition**: blood vessels in the graft dilate and take up serum-like fluid in the wound bed by capillary action, absorbing nutrients to sustain the graft.
3. **Inosculation**: anastomosis of the graft vessels with vessels in the wound bed
4. **Penetration and ingrowth of new vessels**: vessels from the wound bed enter the graft tissue

Based on this description, it is clear that application of a non-vascularized skin graft is a “race” in which the wound bed must establish a delicate blood supply to the graft before necrosis occurs. Because of the requirement for vascular supply from the wound bed, only certain types of tissue are appropriate for application of skin grafts. The ideal wound bed is clean, uninfected and well vascularized such as granulation tissue or muscle. Skin grafts should not be applied over exposed bone, tendon, infected areas, fat, chronic ulcers, or in areas where radiation therapy is planned.

The most commonly used skin graft technique for wounds of the distal extremity is a full thickness, meshed skin graft. Because tendons or bone are often exposed in distal limb wounds, it is necessary to apply wet to dry bandages until a granulation tissue bed is established to nourish the graft.

**Free vascularized skin flaps**

With the advent of microvascular surgical techniques, it is now possible to detach a piece of skin with its vascular pedicle and transfer it to a different site where it is anastomosed to a recipient blood vessel. This process is very similar to preparing an axial pattern flap, except that the vessels are cut and the flap may be transferred to any location with a recipient blood vessel. Advantages of this technique are that full thickness, haired skin may be immediately applied to any wound bed without waiting for granulation tissue to form (even over exposed bone or tendons in the distal wound). Because vascularized flaps have a direct blood supply, they can be used to cover a site that will later require radiation therapy. The obvious disadvantage to these flaps is the specialized training and equipment required to perform the vascular surgery.