12

Distant Flap Techniques

PLATES

DISTANT FLAPS

Distant flaps are constructed at a distant location from a skin defect. They are used almost exclusively for wounds that involve the middle to lower extremities. The skin of the lateral thorax and abdomen are the most frequently used donor sites. Distant flaps are subdivided into *direct flaps* and *indirect flaps*, based on the method used to transfer the distant flap to the recipient bed.

Distant flap techniques were originally developed for use in human patients and were modified for use in the dog and cat. They provide full-thickness skin coverage for wounds and a means of successfully transplanting skin without resorting to the more exacting surgical skills and postoperative care required for successful coverage with a free graft. Like other multistaged surgical procedures, they are time-consuming and expensive to perform. In the case of direct flaps, there are some canine and feline (especially) patients who will not tolerate having a limb immobilized against their chest or abdomen for an extended period of time.

Over the past several years, new reconstructive surgical techniques have evolved that are simpler and more economical to perform. Axial pattern flaps and refinements in free graft transplantation have largely replaced the need for distant flaps. Nonetheless, there are occasional cases in which these procedures can be used effectively (see Figure 18-5.) Elevation of massive skin losses overlying the knee, for example, may be amenable to elevation to a lateral abdominal wall (direct) flap. In one reference (White 1999), an external fixator was used to maintain the hind limb in a fixed position while using this direct flap technique to close a skin defect over the stifle area.

DIRECT FLAPS

Direct flaps include the single pedicle (hinge flap) and the bipedicle (pouch flap) designs developed for using the middle to lower lateral surface of the thorax or abdomen. The affected limb is lifted and the recipient bed is sutured to the elevated flap (Fig. 12-1). The pedicles are eventually divided in stages to complete the transfer in a 2- to 3-week time frame, provided that vascularization and healing occur between the flap and the wound bed. Direct flaps are used successfully in small animals, although cats are better anatomically suited to this technique than dogs because of their size, flexible limbs, and the ample loose, elastic skin available over the trunk. However, some, cats in particular, poorly tolerate the immobilization of their limbs in an elevated position (see Plates 41 and 42).

Direct flaps have the disadvantage of requiring prolonged immobilization of the affected limb to assure flap survival and healing over the wound. The author has noticed mild muscle atrophy of the limb until normal use of the leg is regained. Dermatitis secondary to skin-to-skin contact and moisture accumulation requires the doctor's close attention. Because multiple stages and prolonged hospitalization are required to complete their transfer, the cost to the owner is moderate. The transplanted skin assumes the same hair growth characteristics despite its new location on the limb (Fig. 12-2).

> Today, direct flaps are considered for problematic extremity wounds in which other flap and grafting techniques are not feasible or in which their use is hampered by the wound's location and size.

INDIRECT FLAPS

Indirect flaps are almost entirely of the tubed-flap design, in which a bipedicle flap is sutured into a tube prior to its eventual transfer to the recipient bed after a delay procedure. (see Plate 43). Tubing the flap prevents it from healing to the donor bed, minimizes infection, and facilitates eventual transfer to the recipient bed. Most long tubed flaps require a 2- or 3-week "delay" to enhance their circulation before one pedicle can be severed and advanced toward the defect. Although tubed flaps can be "walked" great distances by periodically severing each pedicle alternately and advancing the freed end toward the recipient bed at 2-week intervals, it is both time consuming and impractical. Each successive step increases the likelihood of partial flap necrosis from an ineffective delay period, accidental kinking or twisting of the intact pedicle, trauma, or infection. As a result, tubed flaps are best developed close enough to the recipient bed to allow their immediate application to the wound after the initial delay period. Tubed flaps shrink or contract prior to their transfer and should be made larger than the recipient bed and longer than the length required to reach the defect: increasing the size by 25% of the exact measurements taken helps compensate for the shrinkage factor. Like direct flaps, the color and quality of hair growth after transplantation of the flap are maintained despite its new location (Fig 12-3).

FIG. 12-1 (A) Pressure sore over the elbow of a Labrador. Epithelialized scar tissue and the chronic granulation tissue were resected; within days, a healthy granulation bed formed, suitable for closure.

(B) Application of a single pedicle direct flap, elevated from the lateral thorax. Although successful results were obtained, the prolonged bandaging, hospitalization, and staged transfer were costly. Today, a thoracodorsal axial pattern flap likely would be the best method to close this difficult wound.

(C) By day 11, the flap has healed onto the underlying granulation surface.

(D) By day 14, the pedicle was divided in stages: one-half the pedicle, 2 days apart. Following division and closure of the donor area, the incised edge was sutured to the wound border, completing the transfer. The elbow was protected with a padded bandage for an additional 2-week period. Close follow-up assured the distant flap was not traumatized. Soft padded bedding was advised.

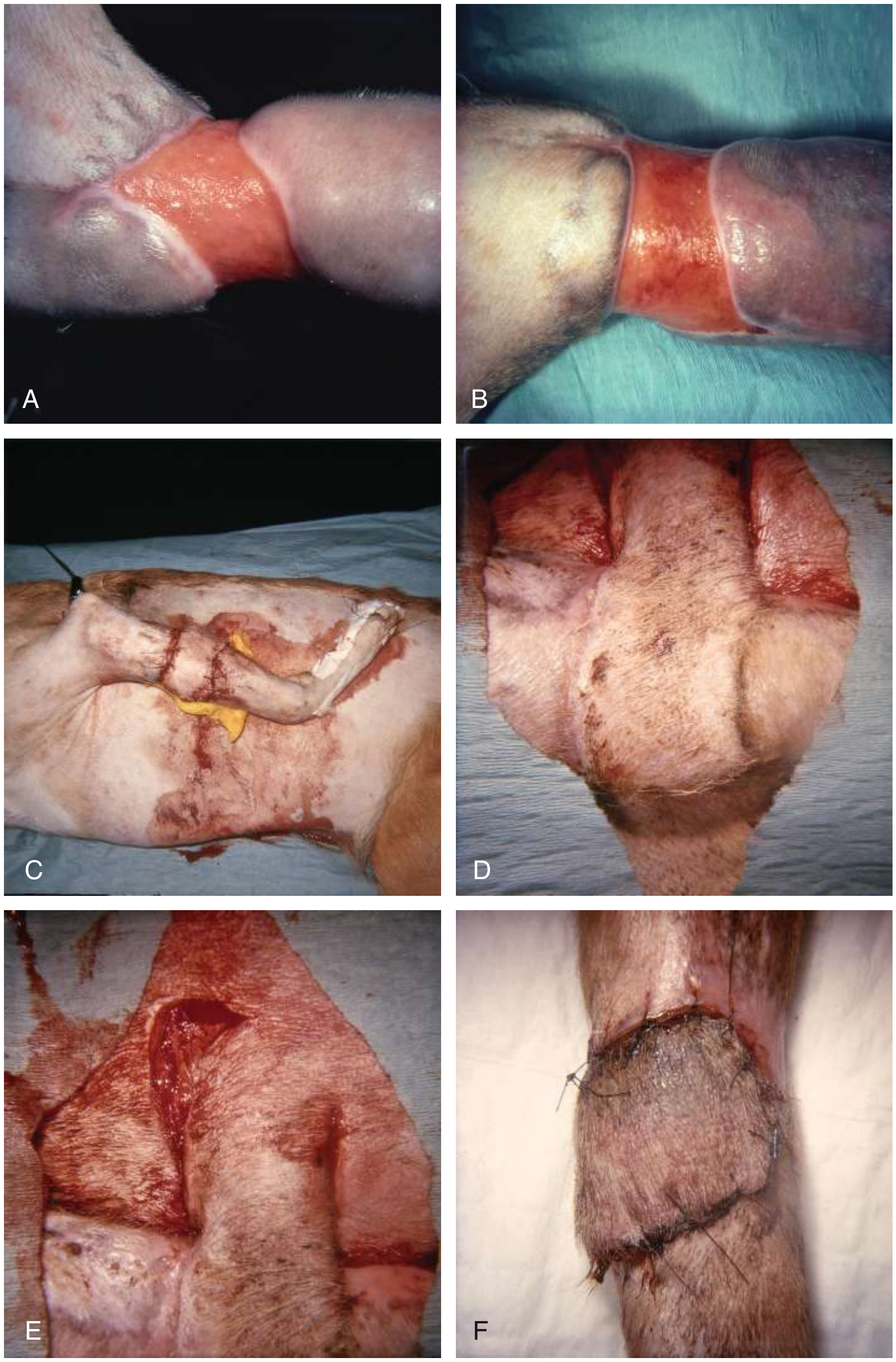

FIG. 12-2 (A, B) Circumferential degloving injury to the forelimb of a mixed-breed dog. Contracture of this chronic wound resulted in distal limb edema. Lateral (A) and medial views (B). The epithelialized border was resected prior to direct flap application.

(C) Elevation of a single pedicle direct (hinge) flap. Securing the limb to the side required an elaborate bandage, as noted in Plates 41 and 42.

(D) At 2 weeks, the hinge flap has healed to the lateral half of the wound.

(E) The pedicle is extended and partially divided.

(F) Approximately 3 days later, the remaining half of the pedicle was divided and the remaining half of the flap was sutured to the medial side of the defect. Partial necrosis of the terminal flap occurred; second intention healing of this site completed the closure. Today a mesh graft would be one of the best choices for closing this wound. (From Pavletic MM. 1985. Pedicle grafts. In: Slatter DH, ed. *Textbook of Small Animal Surgery*. Philadelphia, PA: WB Saunders.)

FIG. 12-3 (A) Forelimb defect in a mixed-breed dog, secondary to vehicular trauma.

(B) Staged elevation of an (indirect) delayed tube flap developed over the left shoulder region. At week 3 the final segment of the proximal pedicle was divided.

(C) The tubed flap was carefully incised over the "seam" of the tube.

(D) The partially contracted tube was opened.

(E) The flap was sutured into position.

(F) The end of the flap necrosed: second intention healing of this area occurred without incident. The distal tube segment of the healed flap site was resected 1 month after transfer to the recipient bed. This wound today could have been closed more easily and effectively with a mesh graft, thoracodorsal axial pattern flap, or, possibly, the brachial axial pattern flap.

THE DELAY PHENOMENON

Large flaps (without inclusion of direct cutaneous vessels) gradually developed in two or more stages prior to transfer are more likely to survive than pedicle grafts transplanted at the first operation. The physiologic mechanism(s) of augmenting flap survival is called the *delay phenomenon*. The improved circulation after a delay procedure can help offset the hazards of torsion and tension upon flap transfer. This delay effect also may contribute to skin flap survival with the use of tissue expanders: expanders in the latter phases of inflation create episodes of ischemia that may enhance neovascularization of the overlying skin.

Studies have focused on the microcirculatory mechanisms that account for delay and the optimal time for flap transfer. Selective division of the nerve, artery, and vein in neurovascular island flaps of rats has demonstrated that both denervation (sympathectomy) and ischemia play major roles in the delay phenomenon. Although the exact delay mechanism still is unclear, sustained vasodilation is currently believed to be the cause of improved flap survival. Delay is a two-phase response, the second phase being vasodilation of microcirculation from causes other than changes in the flap's sympathetic innervation.

Angiography and functional studies employed to examine the developing circulation within canine tubed flaps (8–10 cm long, 3–3.5 cm wide) as well as tubed flaps in rabbits have demonstrated that vessels in the subcutaneous tissue (corresponding to the subdermal plexus) increased in size and number with parallel reorientation or main vascular channels to the long axis of the flap. The longitudinal vascular arrangement in delayed flaps is most evident in loose-skinned research subjects (dog, rat, rabbit).

If ischemia and denervation are the stimuli for effective delay, tubed flaps of variable length, located in different regions of the body and on different animals, have variable circulatory efficiency. Flaps with adequate circulation do not benefit appreciably from a surgical delay compared with ischemic flaps. As a result, the variable tubed flaps employed clinically and experimentally suggest that the shorter delay period employed for short-tubed flaps (2 weeks or less) may be insufficient for long-tubed flaps with greater ischemia.

The optimal time for transfer varies among species; for example, the maximum delay effect in rabbits and swine occurs in 8–10 days, whereas rats required up to 6 weeks. One-week, 2-week, and 3-week time intervals have been suggested as satisfactory before flap transfer in the dog. A 3-week delay is the safest interval for the dog, based on Hofmeister's research. At 18 days, the author divides one half of the pedicle; the second half is severed 3 days later to complete the delay. Long-tubed flaps may also require staged elevation to avoid an ischemic crisis from immediately tubing the bipedicle flap.

Sphygmomanometer cuffs, rubber-padded intestinal clamps, and Penrose drain tubing have been employed to "train" a tube to rely on vascular support from one pedicle by applying these compressive devices around the opposite pedicle. Compression can be applied for progressively longer periods of time until the tubed flap circulation can survive on the unclamped pedicle. As noted, delayed tube flaps have been largely abandoned for clinical usage in veterinary and human reconstructive surgery with the advent of axial pattern flaps, myocutaneous flaps, and improvements in free-grafting techniques. However, deciphering this phenomenon may hold the key to selecting drugs that may mimic this physiologic response in order to salvage skin flaps with serious circulatory compromise. Although a variety of drugs have shown promise in improving survival of failing flaps, results have been inconsistent, and at times refuted by subsequent studies.

Suggested Readings

Pavletic MM. 1990. Skin flaps in reconstructive surgery. *Vet Clin No Am* 20:81–103.

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