

Use of RANDOM SUBDERMAL FLAPS to Repair Extensive Skin Defects

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In veterinary medicine, many surgical problems, including **tumor resection and trauma**, can result in **skin defects** that can be extensive and require **additional repair techniques** beyond undermining (separating the skin from the underlying tissue) and simple suture closure.



When wide surgical margins are created in an effort to achieve clean surgical margins after tumor resection, skin defects often cannot be closed due to excessive tension. Several different techniques have been described to address these types of extensive wounds, such as:¹⁻¹²

- **Vascularized Flaps:** Local or subdermal, axial pattern, myocutaneous, and distant flaps
- **Free Grafts.**

Since a **skin flap** has a tethered vascular attachment, this limits transfer of donor skin to a local adjacent skin defect unlike **grafts**, which do not contain a vascular supply.^{1,2,5-7} Distant flaps and free grafts can be transferred to remote areas, such as those on the lower limbs.^{1,2,5,7,12}

Due to the extensive nature of this topic, this article will provide an overview of the use of random subdermal flaps (local flaps). For skin defects that require axial pattern flaps, myocutaneous flaps, or skin grafts, we recommend referral to a surgical specialty clinic or more advanced training.

RANDOM SUBDERMAL FLAPS

Random subdermal flaps do not contain a direct cutaneous artery and vein and are reliant on the subdermal plexus located at their base.^{1,2,5-7,9,12} This plexus is

maintained by small subdermal branches from nearby direct cutaneous arteries, and care must be exercised to ensure that this plexus is maintained during flap elevation since flap survival is dependent on its intact circulation.^{1,2,9,12} Because of this circulation, random subdermal flaps can be used for immediate coverage of exposed musculature, tendons, vessels, and nerves.¹

FLAP CREATION Donor Sites

Skin tension lines and pliability are important when considering a donor site to ensure that the donor site is amenable to primary closure.^{1,2,5} Ideally, a donor bed should have adequate skin available to close the recipient bed without creating a significant defect at the donor site that cannot be closed.^{1,5,7} Common areas with ample redundant skin for donation include the neck, axilla, and flank fold.

Local flaps created in distal limb areas are not recommended because there is little donor skin to use without causing difficulty closing the donor defect. Additionally, donor sites susceptible to excessive motion and stress can result in dehiscence after closure.^{1,2,5-7} In essence, donor sites allow closure of one defect but create another skin defect, which is less than ideal; in

some instances, further reconstructive techniques or second intention healing is required.^{1,5}

Flap Template

A template created with cloth, surgical glove wrapper, or foam rubber is beneficial for planning flap dimensions.^{1,5}

1. The template can be held over the defect; then the proposed flap base is held stationary as the template is rotated to the donor site.^{1,5}
2. After the flap dimensions have been established, a felt-tip pen can be used to outline the flap boundaries, providing a guide for skin incision.^{1,5}
3. Plan on creating flaps at least 20% larger than the defect to avoid excess tension on the repair edges.

Flap Formation

When creating flaps, it is imperative that:

1. The base be slightly wider than the body of the flap to avoid narrowing the pedicle and damaging the cutaneous vessels.^{1,2,5-7}
2. The flap length be as long as, or preferably longer, than the defect to prevent production of excessive tension during closure.^{1,2,5-7}
3. When undermining underneath the panniculus muscle layer, such as the cutaneous trunci, the plexus, along with any branches from nearby direct cutaneous vessels, must be maintained.¹
 - Flaps created from sites lacking subdermal mus-

cle, such as the extremities, are undermined just superficial to the muscle fascia.¹

- In areas where skin is intimately associated with underlying muscle fascia, a portion of this fascia may need to be included in elevation of the flap, such as with the skin overlying the superficial pectoral muscle.¹
4. When skin edges are manipulated, instruments (skin hooks or DeBakey thumb forceps) only should be used if absolutely necessary to avoid compromising circulation.⁵ In addition, avoid use of electrosurgical instruments to cut flap margins or coagulate bleeding vessels along the flap edge.
 5. Local skin perfusion should be allowed to return by, ideally, waiting several days or more after the initial injury before considering flap closure. Immediate creation of flaps in the local area of trauma could devitalize more skin if an effort is made to quickly close the defect.

Recipient Bed

It is very important that the recipient bed be healthy and not contain debris, necrotic tissue, or active infection.^{1,2} If a chronic granulation bed, indicated by excessive granulation tissue overlying the wound, is present, it should be excised or freshened before flap transfer to allow a healthy granulation bed to form.^{1,2} In addition, inverted epithelialized borders of the skin defect should be excised to create a fresh perpendicular sharp edge.¹

Most Versatile Local Flaps for the General Practitioner

Flap Type	Definition & Indications	Indications for Specific Flaps
Rotational Flaps	<ul style="list-style-type: none"> • Flaps located adjacent to the recipient bed that rotate around a pivot point • Rotational flaps can be used for defects located along the trunk, facial region, neck, and proximal limbs. • Examples include: <ul style="list-style-type: none"> » Rotation flap (Figure 1): Semicircle created adjacent to the border of the defect and rotated to cover wound » Transposition flap (Figure 2): Rectangular pedicle graft located 45° to 90° to the long axis of the defect » Interpolation flap (Figure 3): Similar to a transposition flap but does not share a common border with the defect 	<ul style="list-style-type: none"> • A rotation flap is indicated when a triangular defect is present and there is only mobile skin on one side of the defect. • A transposition flap is used to close square and rectangular defects when there is mobile skin along only one side of the defect. The skin used for the flap is in a different plane from the defect, requiring rotation. • An interpolation flap is utilized when there is available skin for closure not immediately adjacent to the defect, requiring a portion of the flap to pass over intact skin.
Advancement Flaps	<ul style="list-style-type: none"> • Flaps advanced forward without lateral displacement • Advancement flaps, in general, can be used for defects located on the trunk, proximal limbs, face, and forehead. • Examples include: <ul style="list-style-type: none"> » Single pedicle advancement flap (Figure 4): Two skin incisions equal to the width of the defect created with the distant edge of the flap bordering the defect » H-plasty (Figure 5): Paired single pedicle advancement flaps » Bipedicle advancement flap (Figure 6): Incision created parallel to the long axis of the defect, allowing skin to be advanced over the defect 	<ul style="list-style-type: none"> • A single pedicle advancement flap can be employed to cover a square or rectangular wound when there is available skin adjacent to and in the same plane as the defect. • Two single pedicle advancement flaps are used to close large square or rectangular defects when there is mobile skin on two sides of the wound. • A bipedicle advancement flap is used when there is a defect located in an area where there is loose skin.

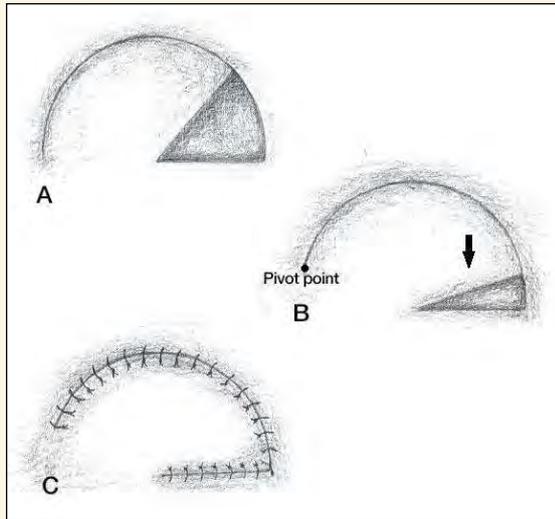


Figure 1. A rotating flap is fashioned by creating a semicircle incision; then progressively lengthening the incision until the flap is long enough to cover the defect (A). It is important to note that the flap base must be widened as the arc of the flap is increased to accommodate for flap shrinkage secondary to rotation. The flap is then rotated about a pivot point (B) allowing it to cover the defect (C).

TYPES OF SUBDERMAL PLEXUS GRAFTS

Rotation Flaps

When a triangular skin defect is present, a rotation flap can be used effectively.^{1,5} This rotating flap is created when a semicircle is fashioned adjacent to the border of the defect (Figure 1).^{1,2,5-7}

The creation of the semicircle incision occurs in a step-wise fashion:^{1,2,5-7}

1. The curved incision begins next to the shortest side of a triangular wound.
2. The incision is then progressively lengthened until the flap is long enough to cover the defect.
3. The general guideline when creating this flap is to

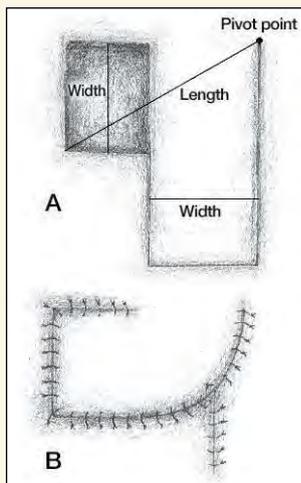


Figure 2. A transposition flap is a rectangular pedicle graft that is 45° to 90° to the long axis of the defect. The width of the flap is normally equivalent to the recipient bed width, while the length is equal to the distance from the pivot point to the farthest point of the defect (A). The flap is then undermined and rotated to cover the recipient bed (B).

make the arc 4× the length required to rotate the flap sufficiently to close the defect.¹

Wider or rectangular defects can be repaired by using paired rotation flaps; however, this type of flap is not commonly used.^{1,2,5,7} Any dog ears (slight elevations of the skin at either end of the suture line) created are left intact because they typically resolve within several weeks without intervention.¹

Transposition Flaps

A transposition flap is a “tongue-shaped” rectangular pedicle graft that is adjacent to and created 45° to 90° in relation to the long axis of the defect (Figure 2).^{1,2,5,7} The width of the flap is normally equivalent to the recipient bed width,

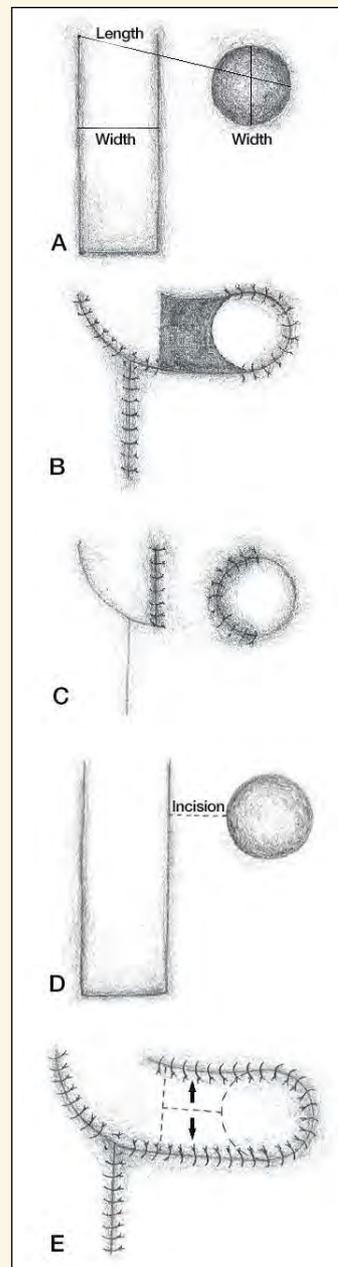


Figure 3. An interpolation flap is created by rotating a rectangular flap across intact skin to cover a defect. The width of the flap is equal to that of the defect, and the length is calculated by measuring from the pivot point to the most distant aspect of the wound, including the length of the intact skin the flap must bridge (A). This figure depicts the excessive skin covering the intact skin (the darker shaded portion) that is to be excised after the incision has healed (B); the remaining edges are then sutured to finish closing the defect (C). Alternatively, a “bridge incision” can be created: An incision is created (dashed line), extending from the defect to the incised edge of the flap (D). The skin edges along this incision are elevated, allowing the flap to be laid down (black arrows) (E). The incision and flap edges are then sutured together.

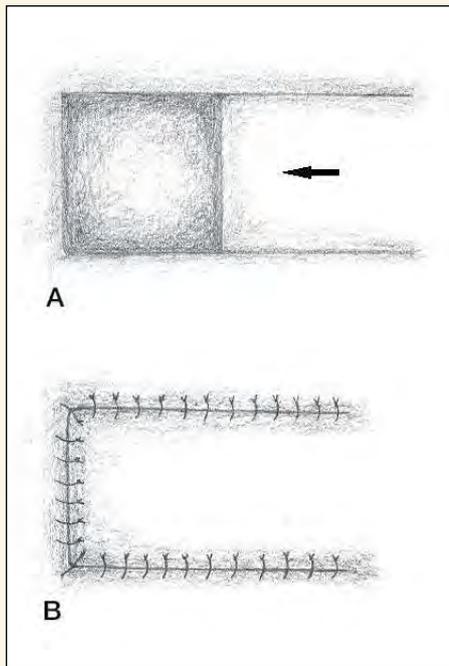


Figure 4. A single pedicle advancement flap is created when 2 skin incisions equal to the width of the defect are created bordering the defect (A). The flap is then undermined and advanced, allowing it to cover the area of interest (B).

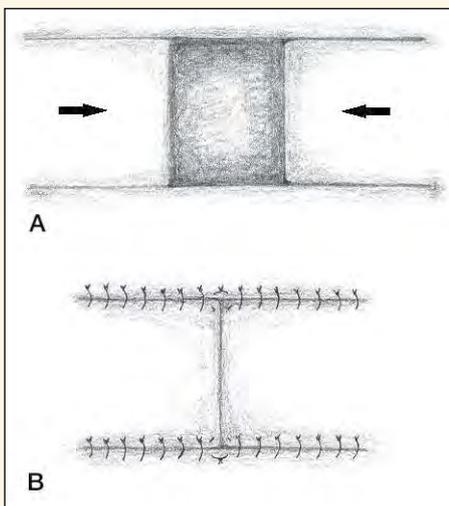


Figure 5. Two single pedicle advancement flaps, also known as an H-plasty, can be used to close larger wounds. The flap width is equal to the width of the defect, and length is determined by the length necessary to close the defect (A). The flap is then undermined and advanced over the wound (B).

while the length is determined by measuring the distance from the pivot point to the farthest point of the defect.^{1,2,5,7}

When using this flap, it is important to be aware that the length of the flap will decrease as the arc of the rotation increases; however, increasing the angle the flap is rotated results in less tension on the repaired defect.^{1,2,6} As mentioned earlier, as the flap is rotated, there is a tendency for a dog ear to develop, but this will regress with time.^{1,2,6} This type of flap allows loose skin from a region not adjacent to the defect to be transferred to the defect, allowing closure.

Interpolation Flaps

The difference between a transposition flap and an interpolation flap is that the latter does not share a common border with the defect (Figure 3, page 23).^{1,2,5,6}

- These flaps are created by rotating a rectangular flap across intact skin to cover a defect.
- The width of the flap is equal to that of the defect.⁵
- Length is calculated by measuring from the pivot point to the most distant aspect of the wound, including the length of the intact skin the flap must bridge.^{5,6}

The excessive skin covering the intact skin can be excised 14 to 21 days post surgery and the remaining edges sutured.^{5,6} Alternatively, a “bridge incision” between the donor site and recipient bed can be performed to allow the incision edges to be sutured to the flap.^{1,2,5,6}

Advancement Flaps

This type of flap moves skin parallel to the lines of least tension in order to cover the defect.^{1,2,5,7}

- A **single pedicle advancement flap** is created when 2 skin incisions equal to the width of the defect are created with the distant edge of the flap bordering the defect (Figure 4).^{1,2,5}

- An **H-plasty**, or **two single pedicle advancement flaps**, can be used to close larger square or rectangular defects (Figure 5).^{1,2,5,7}

» H-plasties have a wider base:length ratio, improving blood supply when compared to a single pedicle advancement flap.²

» The length of the flap is determined by the length necessary to close the defect without tension.¹

- A **bipedicle advancement flap** is created by making an incision parallel to the long axis of the defect.^{1,2,5} This flap can be used to close adjacent defects; however, the main drawback is the elastic retraction and tension that is transferred to the suture line.^{2,5,6}

» The width of the flap is equal to the width of the defect and length is equal to the length of the defect (Figure 6).^{1,2,5}

» The total length should not exceed twice the width of the flap base.²

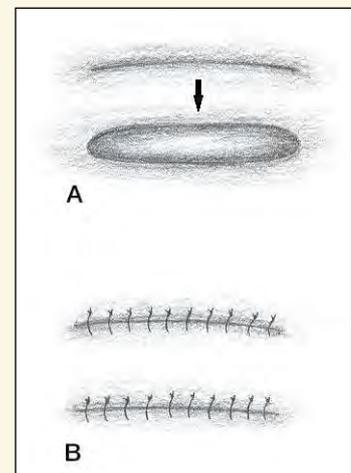


Figure 6. A bipedicle advancement flap is made by performing an incision parallel to the long axis of the defect. The width of the flap is equal to the width of the defect, and length is equal to the length of the defect (A). The flap is then cautiously undermined and advanced to facilitate closure (B).



CASE PRESENTATION: DOG BITE WOUND REPAIRED WITH ROTATING FLAP

A 10-year-old, 20-kg neutered male mixed-breed dog presented to Mississippi State University Surgical Service 10 days after being attacked by another dog.

Figure 1. Extensive wounds were located just to the left of dorsal midline and extending from the tail base cranially. The wounds were managed with daily bandage changes until they were free of infection and had a healthy granulation bed.

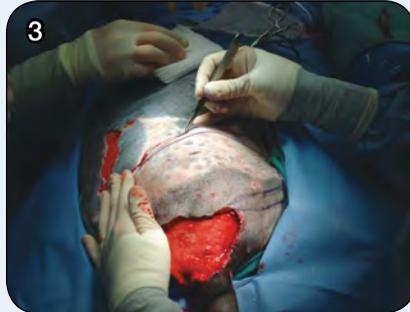


Figure 2. A template is created with a surgical glove wrapper, allowing flap dimensions to be established. The template base is held stationary as it is rotated to the donor site (proximal to tail base). Note the presence of a healthy granulation bed within the defect.

Figure 3. A surgical marker is used to outline the flap boundaries, providing a guide for the skin incision.

Figure 4. The skin edges are undermined, allowing flap elevation.

Figure 5. The flap is further undermined, allowing manipulation and rotation over the defect. Note the use of needles in the flap corners, which are acting as skin hooks to avoid compromising circulation.

Figure 6. The flap is rotated to cover the defect and held in place to assess tension.

Figure 7. The flap is sutured into place and the donor site is closed primarily.

- » Tension can be relieved by making the incision curved with the concave side facing the defect border.^{1,5}
- » Two pedicles allow for longer flaps, but necrosis can occur at the interface between the pedicles if vascularity is compromised.¹

FLAP VIABILITY

During the healing process, flaps are nourished from the pedicle vascular supply. Flap viability can be assessed by:¹

- Color

- Warmth
- Pain sensation
- Bleeding.

However, using pain sensation as a guideline for viability may not be accurate because some flaps are denervated during elevation. In addition, bleeding along the flap edges does not provide any information on venous return and vasospasm may result in a transient decline in circulation.¹

Flaps that suffer from arterial or venous obstruction change color from red (due to inflammation) to lavender

to dark purple to black over 1 to 6 days, ultimately leading to necrosis.^{1,2,6,7} When necrotic skin is observed, evidenced by either the presence of a demarcation line between viable and nonviable skin, liquefactive necrosis, or eschar, the necrotic skin should be debrided as soon as possible to encourage wound healing.² It is also important to recognize that regional plexus variations affect flap survival.¹

COMPLICATIONS

Complications associated with these procedures include:^{2,7}

- Infection
- Seromas
- Dehiscence
- Necrosis.

Seromas

Seroma formation is more likely to occur if there is loose skin or dead space present, particularly in high-motion areas, such as the flank or axilla.² The use of closed suction drains, bandages, and exercise restriction for 2 to 3 weeks post surgery decreases the risk of seroma formation.^{2,7}

Dehiscence

Some causes of dehiscence include excessive tension on the flap edges (due to inappropriate planning), infection, surgical trauma, or inadequate blood supply which causes necrosis.^{2,5,7}

The risk of complications can be decreased by using good surgical technique and planning appropriately before performing surgery.⁷

CONCLUSION

Skin defects can be difficult to correct without the aid of ancillary techniques, such as skin flaps. Local subdermal flaps can be performed in general practice if extreme care is used during the performance of the procedure and appropriate aftercare is instituted.

More extensive wounds may benefit from advanced flaps, such as distant, axial pattern, and myocutaneous flaps, or free skin grafts; for these procedures, referral to a specialist is recommended. These types of wounds include those:

- Located over bone, tendons/ligaments, or large arteries and veins
- Involved with body cavities
- Covering more than 30% of the body surface
- Located circumferentially around extremities.

Another indication for referral is if the patient requires 24-hour care either due to its health status or a tendency to interfere with the bandage protecting the flap. ■

FIGURE CREDIT

Figures 1 through 6 adapted from Pavletic MM. Atlas of Small Animal Reconstructive Surgery. Philadelphia: WB Saunders, 1999.

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