

AXIAL PATTERN FLAPS: WHICH ONE DO I CHOOSE AND HOW DO I PERFORM THEM TO REDUCE MY COMPLICATIONS?

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According to the literature, the risk of complications with the use of axial flaps is around 89% when all flaps are considered together, and major and minor complications are grouped together (Field et al). The most common complications are necrosis, dehiscence, infection, seroma, exudate, and flap edema. However, the final result is excellent or good in 64% of cases, and we obtain a poor result in 7%.

Axial pattern flaps are skin flaps that are developed using a direct cutaneous artery as a blood supply. The direct cutaneous artery is responsible for the blood supply to a specific area of skin called the angiosome. Axial flaps allow the transfer of large areas of skin, including the subcutaneous muscle, based on the anatomical limits of the angiosome. It is essential to know the anatomical origin of the artery and its angiosome to avoid flap failure.

Advantages of an axial flap:

- High survival rate of between 95-100% of the flap.
- Can be performed in a single procedure.
- Greater mobility.
- Larger flaps can be used compared to subdermal flaps, around 50% larger.
- Can be performed on suboptimal wounds where there is still no granulation tissue, presence of bone, nerves, tendons in the wound, and even in contaminated wounds, but it is always best to use it on clean wounds free of contamination and infection.

We have many flaps and there is usually more than one option for each area of the body. Probably the most commonly used flaps are:

- Axial flap based on the thoracodorsal artery
- Axial flap based on the superficial caudal epigastric artery
- Axial flap based on the ventral branch of the deep iliac circumflex artery

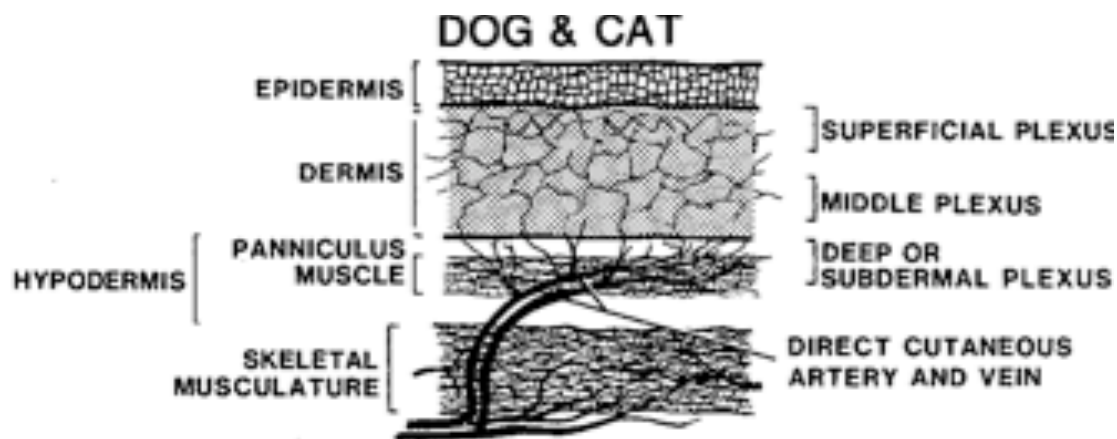
However, depending on the area of the body where the wound is located, we will have different options, and these are some examples:

- **Head, maxillofacial region:**
 - Superficial temporal

- Auricular caudal
- Angularis oris
- **Anterior extremity:**
 - **Proximal portion (shoulder, axilla, elbow):**
 - Thoracodorsal
 - Superficial cervical (omotransverse)
 - Lateral thoracic
 - Superficial brachial
 - **Distal portion (below the elbow)** use is limited since in most patients it is difficult to reach very distally.
 - Thoracodorsal (cats can reach the carpus)
 - Superficial cervical (omotransverse)
 - Superficial brachial
- **Trunk:**
 - Thoracodorsal
 - Superficial cervical
 - Lateral thoracic
- **Gluteal region:**
 - Deep iliac circumflex, dorsal and ventral branches
 - Lateral caudal (tail)
 - Caudal epigastric
- **Sacrum, dorsal pelvis:**
 - Lateral flow
 - Dorsal and ventral iliac circumflex
- **Perineum:**
 - Caudal epigastric
 - Lateral caudal
- **Proximal posterior extremity:**
 - **Knee:**
 - Lateral genicular
 - Caudal epigastric
 - **Tarsus:**
 - Reverse saphenous

Blood supply from axial pattern flaps

The main blood supply to the skin comes from the direct cutaneous arteries, which branch out to form the deep or subdermal plexus and, in turn, the middle and superficial plexuses. The direct cutaneous arteries and veins run parallel to the skin between the subcutaneous fat and the cutaneous musculature, providing vascular supply to a large area of skin. There are no direct cutaneous arteries in the distal extremity.



Slatter, Textbook of Small Animal Surgery, Third Ed.

Axial pattern flaps are based on direct cutaneous arteries and veins. The area of the flap that can be raised depends on the vascular territory of the direct cutaneous artery, called the angiosome.

To minimize distal flap necrosis, some authors do not recommend the routine use of long flaps, particularly those that extend beyond the limits of the angiosoma. To prevent necrosis, it is necessary to preserve the flap vasculature. The four main cutaneous arteries (thoracodorsal, superficial caudal epigastric, superficial circumflex iliac, and deep) are relatively large, so flap survival is relatively predictable. Other smaller vessels, such as the superficial brachial artery and the genicular artery, are smaller and at greater risk of damage during surgical manipulation. To protect the subdermal plexus, the flap should always be lifted below the cutaneous musculature, taking care not to damage the direct cutaneous artery.

Flap selection:

The decision to close a wound with an axial pattern flap is based on several factors, such as the location and size of the wound. If more than one axial pattern flap can be used, preference may be given to flaps supplied by medium or large arteries, as these flaps are larger and have more predictable survival. The viability of the arteries should

be verified prior to surgery in cases where the wound or previous surgical procedures may have damaged them; this can be done using ultrasound or Doppler.

Preoperative planning:

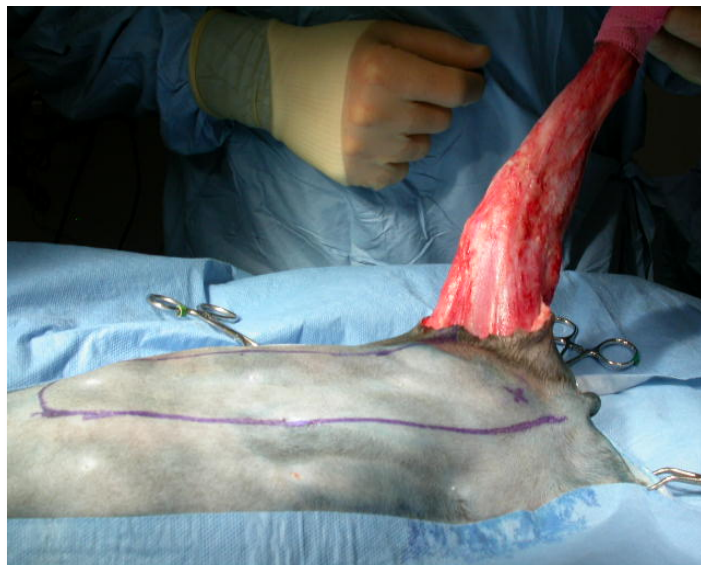
Careful preoperative planning is required to ensure that a flap of sufficient size is raised to reach and fill the defect without causing excessive rotation that could occlude the cutaneous artery. The ability of the flap to reach the defects may be affected by the species, skin elasticity, and body conformation. The width of the flap is limited by the ability to close the donor site.

Surgical technique:

A wide surgical clip is applied to include the area around the wound, the flap surface, and the skin between the flap and the wound. In some cases, it is important to include other areas in the shaving that can be used for other reconstructive techniques, if necessary.

Before surgical preparation, a permanent marker is used to draw on the skin:

- The anatomical landmarks of the flap (angiosoma)
- The origin of the direct cutaneous artery and vein
- The pivot point of the flap
- A bridge incision if there is skin between the flap and the defect



Once this is done, the skin is brought together along the edges of the flap to check that the donor site can be closed with little tension.

1. An incision is made through the skin and subcutaneous musculature following the drawn contour.

2. Retention sutures are placed at the distal end of the flap, beyond the origin of the blood supply. These are used to manipulate the flap, avoiding excessive manipulation, which reduces trauma that could cause vasospasm and decrease flap survival.
3. A combination of blunt and sharp dissection is used to lift the flap, starting at the distal end. It is very important to ensure that it is lifted from beneath the subcutaneous musculature. In extremities without skin muscle, the flap is lifted beneath the subcutaneous fat, deep to the dermis or fascia. Dissection is continued toward the base of the flap, taking care not to damage the artery. Moistened gauze is used to cover the donor site and wound while working on the flap to minimize tissue desiccation.
4. Rotate the flap away from the pivot point toward the defect. Generally, a maximum rotation of 180 degrees can be performed on the most resistant flaps, but it is suggested to limit rotation to 90 degrees to minimize flap failure, especially in flaps with small vessels, due to artery occlusion.
5. If the flap and defect are not adjacent, a bridge incision is made between the base of the flap and the defect, and the edges are separated.



6. If there is a lot of dead space, a surgical drain can be placed under the flap, exiting through the adjacent skin.
7. Suture the edges of the flap to the edges of the wound. Absorbable, interrupted, or continuous sutures may be used in the subcutaneous tissues. The skin may be closed with sutures, staples, or a combination of both. It is important not to place sutures through the center of the flap to avoid damaging blood vessels.
8. The donor site is routinely closed.



Postoperative care:

- Wounds may be covered with a dressing, but if possible, they should not be bandaged, as there is a risk of compromising blood flow.
- Strict hygiene practices are maintained when handling the patient and the wound to reduce the risk of postoperative infection.
- Analgesia should be considered, especially in extensive reconstructions.
- Antibiotics are administered preoperatively, but not after the procedure unless there are clinical signs of infection.
- Animals are housed in padded beds.
- The wound should be monitored for postoperative complications such as seroma, dehiscence, or infection.

Complications:

1. **Dehiscence:** This is the most common complication. It occurs most frequently at the interface between the flap and the defect, but usually only affects a small area. Causes include wound tension and movement. Dehiscence may also occur in the donor site, but this can be minimized with good planning. Dehiscence can be reduced by using tension-reducing sutures and restricting postoperative exercise. In most cases, small dehiscences are allowed to heal by secondary intention without additional intervention.

2. **Exudate** is usually associated with dehiscence or complications with drains.

3. **Seroma:** due to drainage failure or failure to insert a drain.

4. **Flap necrosis:** color changes and edema in the flap are commonly observed during the first few days. This can sometimes progress to flap necrosis. The initial signs of necrosis are observed within the first 24 hours and include a reddish or purplish discoloration of the skin and a decrease in surface temperature. This will lead to full-thickness skin necrosis, which occurs between the second and sixth postoperative day.

The necrotic tissue should be debrided and the wound treated; if it is not too extensive, it should be left to heal by secondary intention. If the area is extensive, a second reconstructive procedure may be required.

5. Infection: occurs in 15-30% of cases and does not normally affect the viability or survival of the flap. Infection should be treated with antibiotics and local wound care. The use of prophylactic antibiotics does not affect infection rates.

Recommended reading:

- Pavletic, M. Atlas of Small Animal Wound Management and Reconstructive Surgery.^{3rd}Ed.
- Williams, J; Moores, A. BSAVA Manual of Canine and Feline Wound Management and Reconstruction.^{2nd}Edition
- Slatter. Textbook of Small Animal Surgery. 3rdEdition.
- Tobias K.M. Johnston S.A. Veterinary Surgery Small Animal. Elsevier

- Field, E.J., Kelly. G., Pleuvry, D. *et al.* (2015) Indications, outcome and complications with axial pattern skin flaps in dogs and cats: 73 cases. *Journal of Small Animal Practice* 56, 698-706
- Proot, J.L.J., Jeffery N., Culp W.T.N. *et al.* (2019) Is the caudal auricular axial pattern flap robust? A multi-centre cohort study of 16 dogs and 12 cats (2005 to 2016). *Journal of Small Animal Practice* 60, 102-106
- Forster K., de la Puerta, B., *et al.* (2021) Outcome of caudal superficial epigastric axial pattern flaps in dogs and cats 70 cases. (2007-2020). *Journal of Small Animal Practice* 63, 128-135
- Villedieu E, Nolff MC, Del Magno S, Emmerson T, Field E, Hattersley R, De La Puerta B, Ragni RA, Baines SJ. (2022). Outcome of superficial brachial axial pattern flaps used to close skin defects in cats and dogs: 16 Cases (1196-2019). *Journal of Small Animal Practice* 60, 136-141
- Emmerson T, de la Puerta, Polton, G. (2019). Genicular axial pattern flap for reconstruction of skin defects in 22 dogs. *Journal of Small Animal Practice* 60, 529-533
- De La Puerta, B. Buracco P, Ladlow J, Emmerson T, del Magno S, Field E, Baines S, (2021) Superficial temporal axial pattern flap for facial reconstruction in dogs and cats. *Journal of Small Animal Practice* 62, 984-991