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Getting it Together - Wound Management and Closure in Dogs and Cats Mini Series

Session 3: Location, Location, Location - Managing Wounds in Tricky Locations

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Axial pattern flaps

Axial pattern flaps are pedicle grafts that contain a direct cutaneous artery and vein. The regions of skin that are supplied by most of the main direct cutaneous vessels have been mapped in dogs and cats. This allows consistent identification and mobilisation of large skin flaps in one stage with confidence that there is a reliable vascular supply. These can then be used for the closure of many large adjacent defects.

Axial pattern flaps are generally rectangular in shape; although they can be modified with a right angle extension (this area of the flap is dependent on the deep subdermal plexus). **The planning and execution of an axial pattern flap must be meticulous, as if there is failure of the flap, the results can be catastrophic.** Flap failure is generally due to technical error (failure to identify perimeters correctly, failure to preserve the vascular pedicle, failure to manage dead space etc.). There will also be a significant donor site to be closed. Axial pattern flap surgery is time-consuming with consequent lengthy anaesthesia.

The elevated flap can be rotated into position with a base of skin still intact or this base can be incised to create an 'island' flap. This reduces the wastage that results in with rotation when the base is intact (when a large dog ear can develop). However the island flap is now completely dependent on its vascular pedicle for its blood supply and as there is no skin attachment there is a risk of kinking the pedicle with resultant vascular compromise. All the principles of surgical wound closure must be adhered to especially dead space management.

In the postoperative period the flap margins should always appear pink and viable. Cyanosis or excess swelling are indicators of vascular compromise and potential impending necrosis.

Axial pattern flaps provide the ability to resect large tumours and close large defects with vascularised skin. However flap failure is a castastrophic disaster so surgery should be not undertaken lightly!

These flaps have also been used for ***microvascular transfer techniques*** where the cutaneous vessels are identified; the flap is elevated and then transfered to a distant site where the vessels can be anastomosed to large local vessels. This procedure requires considerable experience and expertise and are very rarely indicated.

The following table is a summary of the landmarks of the most useful axial pattern flaps. The caudal superficial epigastric axial pattern flap is one of the most versatile flaps with clearly identified margins.

Overview of Axial Pattern Flaps

(table adapted from Pavletic M (1987) Proceedings for Wound Management and Reconstructive Surgery, 2nd ACVS Annual Surgical Forum Germany)

Cutaneous artery	Anatomical landmarks	Reference incisions	Potential uses
Omocervical	Spine of the scapula Cranial edge of the scapula (cranial shoulder depression) Vessel originates at location of the prescapular lymph node	**Caudal incision:** spine of the scapula in a dorsal direction **Cranial incision:** parallel to the caudal incision, equal to the distance between the scapula spine and cranial scapular edge. **Flap length:** variable, may survive to contralateral scapulohumeral joint.	Facial defects Ear Cranial thoracic limb Cervical defects Axillary defects
Thoracodorsal	Spine of the scapula Caudal edge of the scapula (caudal shoulder depression – take care to be caudal to long head of triceps) Vessel originates at caudal shoulder depression at a level parallel to the dorsal point of the acromion.	**Cranial incision:** Spine of the scapula in a dorsal direction **Caudal incision:** parallel to the cranial incision, equal to the distance between the scapular spine and the caudal shoulder depression **Flap length:** Variable, may survive ventral to contrlateral scapulohumeral joint.	Thoracic defects Shoulder defects Axilary defects Forelimb defects ***CARE WITH THIS FLAP: HIGH RATE OF COMPLICATIONS REPORTED***
Caudal Superficial Epigastric	Midline of abdomen Mammary teats Base of prepuce	**Medial incision:** Abdominal midline. In the male dog, the incision must curve about the base of the prepuce. **Lateral incision:** parallel to the median incision, lateral to the limits of the mammary tissue **Flap length:** In the dog, the incision may extend up to the cranial limit of mammary gland 2, though some die back may be seen. In the cat, the incision may only extend the lengths of glands 3 and 4.	Flank defects Inner thigh defects Hindlimb defects (up to the level of the hock) Perineal region
Deep Circumflex Iliac Dorsal branch	Cranial edge of wing of ilium Greater trochanter Vessel originates at a point cranioventral to the wing of the ilium	**Caudal incision:** midway between edge of the wing of the ilium and the greater trocanter **Cranial incision:** parallel to the caudal incision, equal to the distance between the caudal incision and the cranial edge of the ilial wing **Flap length:** dorsal to the contralateral flank fold	Thoracic wall defects Lateral abdominal wall defects Flank defects Lateral/Medial thigh defects Defects over the greater trocanter
Deep Circumflex Iliac Ventral branch	Cranial edge of wing of ilium Greater trochanter	**Caudal incision:** midway between edge of the wing of the ilium and the greater trocanter extending distally cranial to	Lateral abdominal wall defects

	Vessel originates at a point cranioventral to the wing of the ilium Shaft of femur	the cranial aspect of the femoral shaft **Cranial incision:** parallel to the caudal incision, equal to the distance between the caudal incision and the cranial edge of the ilial wing **Flap length:** proximal to the patella	Flank defects Pelvic defects Sacral defects
Caudal Auricular	Wing of the atlas Spine of the scapula Vessel originates between the base of the vertical ear canal and the lateral aspect of the wing of the atlas	**Cranial limit (base of flap):** Centred over the lateral wing of the atlas **Caudal incision:** Parallel to the base, as a point rostral to the spine of the scapula **Dorsal/Ventral limits:** Make parallel incisions connecting cranial and caudal limits of the flap at a width which allows closure of the donor site.	Defects of the head and neck
Genicular	Patella Tibial tuberosity Greater trochanter	**Base of flap:** 1cm proximal to the patella, and 1.5cm distal to the tibial tuberosity (laterally) **Flap borders:** extends upwards in a caudodorsal direction, running parallel to the femoral shaft. The flap terminates at the base of the greater trochanter.	Lateral or medial aspect of the lower limb from the stifle to the tibiotarsal joint

Free Skin Grafts

Free skin grafts are a versatile and accessible method of closing small to large sized wounds, usually following a period of open wound healing. In difficult areas such as the distal limbs, free skin grafts can be utilised to achieve durable epithelial cover. Full thickness grafts have the advantage of including the adnexal structures which improves cosmesis and are by far the most commonly used graft in dogs and cats.

Free skin grafts lack a vascular attachment on transfer to the wound and must depend on imbibition of wound fluid from the recipient bed for the first 48 hours. It follows therefore that having a healthy vascular bed plays a key role in the initial preparation for a free skin graft. The most common recipient bed is clean healthy granulation tissue, but healthy muscle and periosteum can also support a graft. Chronic granulation tissue (pale, poorly vascularised) is unsuitable but can be coverted back to good tissue by serial debridement and bandaging for a few days prior to grafting.

The graft is harvested from an area where there is plenty of free skin. This is then prepared by removing all subcutaneous fat or muscle. The graft is then meshed by placing small incisions at staggered intervals. This is to allow effective drainage of fluid that may collect beneath the graft. The graft is orientated in the correct direction of hair growth, secured to the recipient site with sutures, overlapping the edges by 2-5 mm.

Any accumulation of debris, blood, purulent material or foreign material between the graft and the recipient site will impair plasmatic imbibition (absorption of recipient site wound fluid) and will lead to ischaemic necrosis of the graft. Therefore the recipient bed should be smooth, clean, free of infection and have all haemorrhage controlled. For the first 48-72 hours the graft will appear swollen and slightly cyanotic. All subcutaneous fat must be removed to allow imbibition to occur. Vascularisation of the graft occurs via entry of capillaries of old vascular channels (inosculation) or creation of new vessels (revascularisation). These vessels are fragile and any movement of the graft will prevent a successful ‘take’ – therefore careful immobilisation of the graft to the recipient bed by carefully suturing in position and subsequent bandaging to immobilise the area is very important. The initial bandage (an absorbent foam, silicone dressing with absorptive secondary layer, or possibly vacuum-assisted closure to maintain moist wound conditions is recommended) is usually left in place for at least 72 hours (I usually wait 3-5 days unless concerned). Sedation is essential for the first bandage change to prevent excessive movement. Extreme care is needed when lifting off the bandage material in case there is some adherence to the graft. The bandage is then changed every 2-3 days for about 10-14 days. A light dressing is then placed and changed as required for a further 1-2 weeks to protect the initially delicate epithelium.

Should the graft appear to undergo necrosis, all may not be lost as the deeper dermal and adnexal layers may survive and epithelialisation can occur from these areas. Therefore avoid debridement of the graft even for at least 5-6 days even if it looks as if full necrosis has occurred.

There is currently research into the use of ***vacuum-assisted closure*** systems for use with the placement of free skin grafts with anecdotal reports indicating an improved and more consistent graft take

An alternative to full thickness meshed grafts is the use of punch grafts. These are harvested with a biopsy punch (usually 8mm) and placed in holes created in the granulation tissue bed with a smaller biopsy punch (6mm). Excess blood is removed from the recipient site (a cotton bud is useful for this) and the graft is maintained in position by the fibrin clot that forms and is protected by a bandage. This is a very useful and straightforward technique for closure of some open wounds, especially if more movement is anticipated as the grafts sit within the granulation tissue bed and are therefore much more tolerant to movement compared to meshed skin grafts. Once established, epithelialisation will occur from the edges of the grafts to then cover the wound. The cosmetic appearance is not as good as there are reduced adnexal structures placed compared with a meshed skin graft, but a robust epithelialised surface will be achieved

The grafts can be harvested from available skin (such as the flank) and placed into the wound under deep sedation. It is quite common for some grafts not to take or fall out

Free skin grafts are less technically demanding than axial pattern flaps and are very useful for distal limbs. Another advantage is that should failure occur regrafting of the site can be performed. Applying them to the proximal half of the limb is more difficult, but the use of vacuum-assisted closure dressings is being investigated to aid this process.

Decision-making for the Difficult Wound

Wounds can prove difficult to manage in any location of the body , but the area that can be especially challenging are in areas where there is limited available skin or where there are important local structures such as the face, perineal region and the distal limb/foot. Quite often the trickiest wounds are those that have dehisced as these often have compromised wound edges or potentially large dead space issues. A key skill for the surgeon is anticipating and avoiding dehiscence and therefore an appropriate surgical technique is essential. The basic principles of surgery were summed up by Halsted in the 19th century and remain as true today as when he elucidated them.

Halsted's Principles of Surgery

Strict asepsis
Gentle tissue handling
Accurate hemostasis
Maintenance of adequate blood supply
Careful approximation of tissues
Avoidance of tension in tissues
Obliteration of dead space

It is important to assess the difficult wound and consider the key issues affecting it which may interfere with straightforward wound healing Carefully assess the wound where a surgical closure is planned and consider the possible factors that may interfere with healing,

- Will there be excessive tension, which could lead to ischaemic necrosis of wound edges and suture pullout?
- What is the state of the skin edges? Placing sutures too close to the edge risks suture pullout and scar tissue has poor suture-holding capacity
- Avoid inappropriate suture pattern leading to vascular compromise of skin edge and subsequent necrosis. Be honest and think simple – if a fancy technique is thought necessary there is probably too much tension
- Watch out for underrun skin edges especially if second intention is required for closure. Remember contraction and epithelialisation requires the skin edges to be attached to the underlying granulation tissue.
- Look out for other issues that may make healing more challenging such as underlying infection (especially multi-resistant bacteria), foreign bodies, necrosis or neoplasia
- Anticipate and avoid poor postoperative management with patient self-trauma of the wound or lack of immobilisation, poor bandage technique and especially iatrogenic bandage injury

When assessing wounds keep asking yourself lots of questions…..

1. Is there really enough local skin to close this defect without excessive tension? If so what will be effect of movement and can the dead space be managed?

2. If not then where will the skin come from?

    (i) Can it be mobilised from the adjacent local areas? If so what is its blood supply – is it based on the subdermal plexus or based on a direct cutaneous vessel? Can the donor site be closed easily?

    (ii) If local skin can't be mobilised can it be grown into the area by second-intention healing or brought in from a distant location by a skin graft? If so what is the impact of the location on the ability to do this successfully?

Complications of wound closure

Seroma/haematoma

Fluid or blood that collects between tissue layers will significantly delay healing. Dead space management is a key element of surgical wound closure (see earlier section on drains). However if a seroma develops due to poor drain selection, failure to close dead space, premature drain removal, a high motion area (the cervical region, shoulder and inguinal region are common sites for development), then management is required as if further fluid collects in the dead space then enlargement of the area can lead to further disruption or enlargement of the wound. This can place pressure on the wound, leakage of fluid from the sutured incision and dehiscence. Should bacteria gain access to the area, then the fluid can be an ideal medium for infection to develop.

Management depends on the extent of the seroma. Monitoring of small accumulations is appropriate, with needle drainage if necessary. These will often resolve without treatment. Larger or rapidly developing accumulations can be needle drained (with strict asepsis) and then bandaged to control dead space or a new drain (active or penrose) may need to be placed. Placement of active drains can be achieved in a closed manner - the swaged-on needle drain can be placed through the skin, placed through the seroma and then manipulated to exit at a distant site. The drain can then be pulled through into the seroma cavity. The drain is secured at the distant exit site. This technique is considerably easier then having to open the wound again and place a penrose drain. With active drainage the seroma cavity (by now usually lined with granulation tissue) will be sucked into apposition and usually will rapidly close.

Wound dehiscence

Pavletic has identified 12 potential causes of dehiscence – knowledge of these before embarking on surgery helps the anticipation and avoidance of this major complication.

Remember nearly all of these causes are technical surgeon errors!

- Excessive tension leading to ischaemic necrosis of wound edges and suture pullout
- Inappropriate suture placement too close to skin edge (within 5mm there is a zone of increased collagenase activity which increases the risk of suture pullout)
- Suture placement in scar tissue which has poor suture-holding capacity
- Inappropriate suture material – size, type (especially avoid multifilament for skin), pattern, placement etc. for skin type
- Inappropriate suture pattern leading to vascular compromise of skin edge and subsequent necrosis
- Premature removal of sutures
- Premature closure of inflamed skin leading to skin necrosis

- Exudative wound leading to maceration of skin edges
- Underrun skin edges with major dead space or underlying infection, foreign bodies, necrosis, neoplasia
- Poor postoperative management with patient self-trauma of wound or lack of immobilisation, poor bandage technique, iatrogenic bandage injury
- Delayed healing due to corticosteroids (usually with long-term treatment) or other agents
- **If all the above are excluded –** suspect an underlying healing disorder

Although any wound dehiscence is disappointing and frustrating, always use it as an opportunity to identify the cause and then try to avoid repeating the same mistake on this or the next wound!

Selected Reading List:

Wound management:

Atlas of Small Animal Reconstructive Surgery 3rd Edn., Pavletic M.M., W.B Saunders ******

BSAVA Manual of Canine and FelineWound Management and Reconstruction, 2nd Edn, Williams J., Moores A

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BSAVA Manual of Canine and Feline Oncology, 3rd Edn, Dobson J.M., Lascelles B.D.X (2011)

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Veterinary Surgery: Small Animal, Tobias and Johnston, Elsevier, 2012

Textbook of Small Animal Surgery, 3rd Edn, Slatter, W.B. Saunders

Tumours in Domestic Animals, Ed Meuten D.J., Iowa State Press

http://www.vsso.org/ - website of the Veterinary Society of Surgical Oncology - follow the links for education and cancer information