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RECONSTRUCTIVE SURGERY IN VETERINARY CANCER TREATMENT

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Forward

Reconstructive surgery becomes very important in the management of cancer patients where there is a need to address large defects after removal of neoplastic disease. I have had the opportunity to use many reconstructive techniques frequently during my career as a surgical oncologist. I hope I can share my experience in this area of surgery with you and that this information will help you manage cancer patients, trauma patients and others.
I have drawn heavily from the textbook written by Dr Michael Pavletic in the preparation of these notes. His textbook entitled, "Atlas of Small Animal Reconstructive Surgery", second edition is published by WB Saunders Co, Philadelphia, 1999, and makes a valuable addition to anybody's library especially for surgeons involved in soft tissue and reconstructive surgery of small animals. I highly recommend this textbook.

Introduction

Like many other cancer therapies, curative surgery for patients with solid tumours is achieved at the risk of normal tissues. Where the advantage gained by aggressive, wide surgical margins outweighs the disadvantages there is “therapeutic gain”. The surgical oncologist must consider this in a global sense before embarking on “radical” surgical exercises. There are, however, many settings where complete surgical excision may be curative and it is paramount that surgical margins are not compromised for the sake of ease of closure.

Soft tissue defects may be managed in several ways and it is the prepared surgeon who will be able to offer his or her patients the best opportunity for low morbidity, rapid recovery and return to function after excisional surgery for cancer.

Besides being familiar with the technology of plastic and reconstructive surgery (the “nuts and bolts”), I cannot overemphasise the importance of solid knowledge of wound healing, wound management and atraumatic surgical technique.

Although a thorough review of wound healing and wound management is beyond the scope of this particular seminar series, I will take time at the start of these seminars to present some principles of good tissue handling. “Poor tissue handling can defeat the best surgical plans.” (Mike Pavletic)

An understanding of the blood supply to the skin of dogs and cats is essential. The subdermal plexus is the major vascular network supporting the skin. The vessels of this plexus are in the fatty subcutaneous tissue sometimes called areolar tissue on the deep surface of the dermis in the middle to lower portions of the limbs. Where there is a panniculus muscle (cutaneous muscle) the subcutaneous plexus lies deep and superficial to this muscle. So it is clear, surgeons must take care not to disrupt this crucial element of vascular support to the skin. Skin must be elevated deep to the subdermal plexus if the vascular

supply to the elevated section is to be preserved. If the tissue between the panniculus muscle and the skin is severed there will be complete necrosis of the overlying skin. The skin should always be undermined in the fascial plane beneath the cutaneous musculature or, where there is no panniculus muscle, undermine in the fascial plane well below the dermal surface.

Another important element of canine and feline cutaneous vascular anatomy is the location of the primary cutaneous arteries. These are reliable large vessels that provide blood to the subdermal plexus. They can be manipulated to provide vascular pedicle grafts very useful in reconstructive surgery. Several of these will be discussed with case examples in the seminar.

I have found several things helpful for successful reconstruction of large skin defects:

1. Prepare a wide area of skin so you can “change your mind” and go with plan b.
2. Position the animal so the skin is relaxed and not “twisted” under the weight of the recumbent patient (particularly for large dogs).
3. Use a sterile skin-marking pen.
4. Use skin hooks and pointed towel clamps to hold, move and temporarily stretch and secure skin.
5. Keep exposed dermis and cutaneous musculature moist with saline
6. Test skin tension of recipient and donor sites by “pinching” skin with your fingers prior to making skin incisions.
7. Use opened surgical sponges as templates to help design flaps.
8. Use analgesics! Have the animal comfortable in post op so as to minimize the risk of self-trauma.
9. Use closed suction drains.
10. Keep animals under close, in hospital, supervision for up to 5 days post op for involved, larger defect reconstructions so adequate analgesics can be given and strict rest enforced.
11. Minimally bandage flaps and observe them for signs of complications frequently.

Skin Tension

Wound tension is one of the major enemies of skin closure. Excessive tension during wound closure often results in circulatory compromise to the wound resulting in skin necrosis and wound breakdown. There is considerable variability of skin mobility between breeds of dogs, cats and dogs, and individuals pending on the degree of obesity and so on. With experience, the surgeon can determine whether there is excessive tension for a wound to be closed directly. In the face of excessive tension choices can be made:

1. Undermining skin edges
2. Suture patterns to help offset and distribute tension
3. Releasing incisions
4. V-Y advancement
5. Z.-plasty
6. Skin stretchers
7. Tissue expands
8. Using skin flaps or grafts

Tension Lines
Lines of tension have been determined by studies using canine cadaver skin and stab incisions. Separation of the wound edges indicated the direction of tension "bands". The anatomical maps derived serve as the general guidelines to the small animal surgeon when closing skin. Wounds should be closed parallel to these tension lines however moderate-sized skin defects can often be closed perpendicular to these tension lines where ample loose skin is available for wound closure. For example, tension lines of the limbs would suggest that wound apposition be performed parallel to these bands to facilitate closure. However, there is more loose skin around the circumference of the limbs compared with the proximal-distal direction.

Patient Positioning Techniques
When defects on the back, ventral abdomen, or lateral surface of the trunk of a large animal are closed, undermining and advancement of the skin may be impaired by the animal's weight, which can pin mobile skin against the surgery table. Sandbags, beaded "vacuum" bags, or rolled-up towels can be placed in front of and behind the surgical region, to elevate the skin "trapped" against the table.

There can be and dramatic improvement in the ability to mobilise skin using the appropriate positioning of the patient. This is most commonly noted in larger dogs during unilateral or bilateral mastectomy. The surgeon can further reduce skin tension in the inguinal, axillary and sternal regions by loosening rope ties used to secure the respective hind limbs or fore limbs.

Undermining Skin
The loose skin over the neck and trunk of the dog and cat permits the surgeon to close many skin defects by undermining alone. The key to successful elevation of skin is preserving its blood supply. This requires preservation of the direct cutaneous vessels and associated subdermal plexus. The following guidelines will help successful undermining of the skin in small animals:

1. Skin should be undermined below the panniculus muscle layer, when present, to preserve the subdermal plexus and associated direct cutaneous vessels.
2. Skin without an underlying panniculus muscle (middle and distal portion of the extremities) should be undermined in the loose areolar fascia beneath the dermis to preserve the subdermal plexus.
3. Direct cutaneous arteries and veins should be preserved whenever possible during undermining.
4. Skin closely associated with an underlying muscle should be elevated by including a portion of the outer muscle fascia with the dermis rather than undermining between these structures. This may help minimise injury to the subdermal plexus.

Local Flaps

Transposition Flap
This is a rotating flap with many uses I have found helpful where direct closure or skin tension relieving techniques just won't work. It is applicable to most body regions. It is based on the subdermal plexus not a direct cutaneous artery

so to ensure the blood supply to the flap is adequate, adherence to the geometry and relative measurements of the skin flap is important.
Using a technique of grasping skin adjacent to the defect the surgeon can find areas of accessible movable skin to transpose into a defect ("borrow form Peter to pay Paul"). The width of the flap equals the width of the defect so a line is drawn with sterile marking pen parallel to the base of the flap. Where this line finishes away from the defect is the pivot point. The flap length is the distance from the pivot point to the most distant part of the defect. A line is drawn from the pivot point at 90 degrees to the baseline for a distance equal to that measured from the pivot point to the most distant part of the defect (flap length). The flap is elevated in the standard way taking care not to amputate the blood supply either at the level of the subdermal plexus or by making the base of the flap too narrow. The flap is rotated into the defect then sutured with simple interrupted sutures. The donor site should be able to be closed directly without tension in a similar fashion.

Axial Pattern Flaps
For the ***large*** defects created after wide excision of tumours such as soft tissue sarcomas and mast cell tumours, I commonly use axial pattern flaps which are flaps utilising the primary cutaneous arteries supplying the subdermal plexus. The following is an overview of the flaps I use and the information is paraphrased from Mike Pavletic's Textbook:

Cervical Cutaneous Branch of the Omocervical Artery:
Potential uses: Facial defects, ear reconstruction, cervical defect, shoulder defect and axillary defect.
Reference incisions: Caudal incision is spine of scapula in a dorsal direction; cranial incision is parallel to the caudal incision equal to the distance between the scapular spine and the cranial scapular edge (cranial shoulder depression);Flap length is variable but may extend to the contralateral scapulohumeral joint.

Thoracodorsal Artery:
Potential uses: Thoracic defects, shoulder defects, forelimb defects axillary defects.
Reference incisions: Cranial incision is spine of the scapula in a dorsal direction; Caudal incision is parallel to the cranial incision equal to the distance between the scapula and the scapular spine and the caudal scapular edge (caudal shoulder depression); Flap length is variable and can survive ventral to the contralateral scapulohumeral joint.

Superficial Brachial Artery
Potential uses: Antebrachial defects, elbow defects.
Reference incisions: Incision lines are so the flap base includes the cranial one third of the flexor surface of the elbow and the lateral and medial incisions are parallel to the humeral shaft. The flap is progressively tapered approaching the greater tubercle. The flap length can be variable up to one ending at the level of the greater tubercle.

Caudal Superficial Epigastric
This is my favourite axial pattern flap!

Potential uses: Inner thigh defects, flank defects, stifle area, perineal area, prepucial area and even up as far as the dorsal lumbar skin.
Reference incisions: Medial incision is made on the abdominal midline, in the male dog; the base of the prepuce is included in the midline incision to preserve the adjacent epigastric vasculature. The lateral incision is parallel to the medial incision and at an equal distance from the mammary teats. The flap length is variable and may include the last four glands and adjacent skin in the dog and the last three in the cat.

Genicular Artery
Potential uses: Lateral or medial aspect of the lower limb from the stifle to the tibiotarsal joint.
Reference Incisions: Base of the flap is 1 cm proximal to the patella and 1.5 cm distal to the tibial tuberosity laterally. The flap borders extend caudodorsally parallel to the femoral shaft. The flap terminates maximally at the level of the greater trochanter.

There are other useful axial pattern flaps including the cranial superficial epigastric, the caudal auricular, the reverse saphenous (an axial pattern variant), the deep circumflex iliac (dorsal and ventral branches) and the lateral and caudal arteries but the ones I have described are the most commonly used in my practice.