The use of tubular subdermal and axial flaps in the correction of four cases of extensive lesions

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ABSTRACT: The most common skin lesions in small animals result from trauma, burns, or surgical resection of large tumors. Given the high importance of reconstructive surgery associated with tumors in small animals, this study reports four cases of reconstructive surgery using subcutaneous and axial tubular flaps in animals with neoplastic lesions. Subdermal and axial tubular flaps are healthy alternatives for reconstructing wounds caused by large tumor resection in areas with poor tissue elasticity.

Key words: reconstructive surgery, axial flap, subdermal flap, cancer, canine.

INTRODUCTION

Skin defects in small animals are caused by traumatic injuries, burns, or surgical resection of large tumors (MAYHEW, 2009). Importantly, oncologic diseases are the primary cause of death in canines and felines (VAIL, 2008); thus, reconstructive surgery is necessary for correcting defects resulting from extensive injuries.

Surgery is the oldest and most successful method for treating neoplasms, and may also be used to facilitate prevention, diagnosis, and palliative care (DUPRE, 2008). Tumoral excisions, with margins wide enough to avoid residual disease, commonly result in the formation of large skin defects that represent challenges to surgeons (FISHER, 2008).

A thorough knowledge of species anatomy and physiology, command of excision and reconstruction techniques, understanding of tumoral biology, and competent use of adjuvant or alternative therapies are all essential for surgical success (HEDLUND, 2007).

Reconstruction of large skin defects after trauma or radical excision of neoplastic masses may be problematic, especially when wounds are located on extremities where there is insufficient skin for primary closure. For such cases, options include the creation of axial or local subdermal flaps, skin grafts, or secondary wound healing (MAYHEW, 2009). We currently understand the importance of surgery for reconstructing defects resulting from neoplastic injuries, but prior knowledge of neoplasms during surgery is mandatory (DUPRE, 2008).

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Skin blood flow is similar in canines and felines; a series of well-documented direct cutaneous arteries transport blood to the subdermal plexus, which in turn supplies blood to the dermis and epidermis. When skin dissection is needed, dissection below the subdermal plexus is essential to maintain blood flow and avoid necrosis (MAYHEW, 2009).

Pedicle flaps are defined as portions of skin and subcutaneous tissue, partially separated from underlying tissues, which are transferred from one location of the body to another. The base, or pedicle, maintains blood flow, ensuring flap survival (PAVELTIC, 1999; HEDLUND, 2007).

Flaps are classified as subdermal or axial, according to the blood flow configuration in the pedicle (VASCONCELLOS et al., 2005). Subdermal flaps do not include direct cutaneous vessels in the pedicle, but depend on the (usually small) subdermal plexus to ensure blood flow to the entire area (STANLEY, 2007; HEDLUND, 2007). Therefore, this study reports four cases in which tubular subdermal and axial skin flaps were used to treat animals with neoplastic wounds.

MATERIALS AND METHODS

Animals attending the veterinary hospital oncology sector, diagnosed with neurofibrosarcoma carcinoma solid mammary or neurofibrosarcoma hemangiopericytoma, underwent surgical tumor removal together with skin reconstruction. Table 1 provides data for each case.

Complete blood tests, kidney and liver biochemical assessments, ultrasounds, chest x-rays, and cardiologic assessments were carried out for all animals. X-rays and ultrasounds revealed no evidence of metastasis in the lungs or other abdominal organs, and blood, biochemical, and cardiological tests did not reveal alterations.

In case one, we made two parallel skin incisions in the flank, 6 cm apart. We then carried out an in-depth dissection, preserving the subdermal plexus, and created marginal tube sutures (3-0 non-absorbable thread) in a simple, continuous pattern. We subsequently repaired the donor area, reducing the dead space using a simple interrupted running suture (3-0 absorbable thread). Fifteen days later, we performed tumor resection and removed the dorsal extremity of the tube, implanting it on the defect caused by tumor removal. During this time, we observed small cyanosites, controlled by local application of a diethyl ammonium salicylate solution (Reparil® Gel). Only one cyanosite progressed to superficial necrosis, which was treated by cleaning the region with a physiological solution and applying 2.5% silver sulfadiazine ointment that did not compromise tube viability. During implantation, the tube’s free extremity was cut with a scalpel to open the lumen and increase coverage in the receiving area. The donor area was repaired with simple running interrupted sutures (3-0 absorbable thread) whilst skin sutures (3-0 non-absorbable thread) were applied in a simple interrupted pattern.

Table 1 - Accurate information on the four cases presented.

<table>
<thead>
<tr>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>Female</td>
<td>Female</td>
</tr>
<tr>
<td>Age</td>
<td>12 years</td>
<td>10 years</td>
<td>8 years</td>
</tr>
<tr>
<td>Neoplasms of the location</td>
<td>Skin tumors in the pelvic member, knee region</td>
<td>Inguinal near the vulva</td>
<td>Nodule in the region of the left elbow</td>
</tr>
<tr>
<td>Neoplasia type</td>
<td>Neurofibrosarcoma</td>
<td>Solid mammary carcinoma</td>
<td>Neurofibrosarcoma</td>
</tr>
<tr>
<td>Type of surgery</td>
<td>Subdermal tube near the flank region. Tumor resection and removal of the dorsal extremity of the tube and implantation on the defect created by the tumor removal.</td>
<td>Subdermal tube near the inguinal region (in the lateral region of the flank).</td>
<td>Thoracodorsal axial flap.</td>
</tr>
<tr>
<td>Complication</td>
<td>Cyanosite progressed into superficial necrosis</td>
<td>Small cyanosites</td>
<td>Not present</td>
</tr>
</tbody>
</table>
The animal returned for a follow-up examination 10 days post surgery, and no necrotic areas were observed in the healing process. The stitches were removed after 15 days, and the animal was released with no evidence of local recurrence one year postoperatively.

In case two, we made two parallel skin incisions in the flank, 5cm apart. We then carried out a deep dissection preserving the subdermal plexus and created marginal tube sutures (3-0 non-absorbable thread) in a simple, continuous pattern (Figure 1). We subsequently repaired the donor area, reducing the dead space (102) using a simple interrupted running suture (3-0 non-absorbable thread). Fifteen days later, we performed the tumor resection and removed the dorsal extremity of the tube, implanting it on the defect caused by tumor deletion. During this time, we observed small cyanosites, controlled by local application of a diethyl ammonium salicylate solution (Reparil® Gel). In the second procedure, which consisted of removing and implanting the tube, the free extremity was relocated to cover the receiving location. The donor area was repaired with simple running interrupted sutures (3-0 absorbable thread) whilst skin sutures (3-0 non-absorbable thread) were applied in a simple interrupted pattern.

The animal returned for follow-up examination 10 days post surgery, and no necrotic areas were observed in the healing process. The stitches were removed after 15 days, and the animal

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**Figure 1** - (A) Two parallel total thickness incisions were performed to create the tube. (B) The donor site was surgical dressed. (C) The tube was inserted and the donor site sutured. (D) A clamp showing cutaneous metastasis. (E) Metastasis resection. (F) A tube was implanted into the receptor site. (G) The tubular flap donor site. (H) The tube implantation site and cicatrice aspect post removal.
was released with complete healing of the wound and no evidence of local recurrence two years postoperatively. In this case, we opted not to remove the tube in a third procedure (described in the pre-surgery plan), but this did not compromise the animal’s deamellation.

In case three, we opted for reconstructive surgery to ensure adequate surgical margins. A thoracodorsal axial flap was chosen to repair the defect. We used the flap to create a thoracodorsal tube over the receiving area. The surgical technique required the animal to be positioned in lateral decubitus, with the leg slightly raised. After marking the incision points, we created the flap with two parallel incision lines over the scapular spine, at lengths twice the distance from the acromion to the caudal scapular depression. When the incisions were complete, creating a rectangle, we made a deep dissection up to the myocutaneous muscle, careful not to traumatize the thoracodorsal artery and accessory vessels. Once the flap was released, it was rotated distally to the member. We then created the resulting thoracodorsal defect, using sutures (3-0 non-absorbable thread) in a simple interrupted pattern, starting from the defect margins and advancing towards the center until total reduction of the wound was achieved. Skin sutures were then applied in the same pattern. With the aid of the flap, we created a communicant tube between the donor and receiving areas using simple continuous sutures (3-0 non-absorbable thread), leaving an unsutured section for implantation into the new bed, in the elbow region. During the synthesis of the tubular flap, we reduced the dead space using sutures (3-0 absorbable thread) in a simple interrupted pattern, and the skin was synthesized using sutures (3-0 non-absorbable thread) in a simple interrupted pattern.

The animal returned for a follow-up examination 10 days post surgery, and no necrotic areas were observed in the healing process. Stitches were removed after 15 days, and the animal was discharged once the wound completely healed and if no local recurrence was noted for one year post operation.

In case four, we conducted surgical resection with a safety margin of approximately 2cm around the tumor, and chose a tubular indirect pedicle flap to close the wound using skin tissue from the scapular region around the thoracodorsal vascular plexus. Sutures were removed from the flap 15 days post surgery, revealing proper healing in the margins and only a small necrotic area near the center, where there was inadequate muscular coverage to prevent friction between the bone and skin. Thirty days after the procedure, a resection of the tube loop was indicated, due to the remaining ulcerated area caused by friction, despite complete healing of the flap. We conducted local cleaning, applied softer protection with cotton and bandages, and left the animal in an area with delicate flooring. Upon removing the second procedure sutures, all areas of the wound had already healed. No recurrence was observed two years post operation.

RESULTS AND DISCUSSION

Subdermal and axial flaps are classified as local when transferred from an area adjacent to the defect, and distant when further away from the donor site (HEDLUND, 2007). In the cases reported, we employed distant tubular flaps, due to the location of the tumors, and obtained favorable results. Therefore, techniques used were in accordance with those described in the literature (PAVLETIC, 1999; HEDLUND, 2007).

Distant flaps (tubes) are often used to repair wounds formed after tumor resection, causing extensive defects in the extremities or sites where skin has poor elasticity. Flaps are subdivided into direct or indirect (PAVLETIC, 2003). In the cases presented, we used subdermal; and therefore, indirect flaps in two animals and direct axial flaps in two animals.

To avoid necrosis in subdermal tubular flaps, we conducted the procedures in two phases. Whilst, this approach was favorable for relocating the flap to the receiving site (HEDLUND, 2007), it can be complicated and time-consuming (PAVLETIC, 1999; PARGANA, 2009), as well as, uncomfortable for animal due to the necessity of multiple surgical procedures. Moreover, axial tubular flaps may be relocated during tumor resection (HEDLUND, 2007). Tubular subdermal and axial flaps were created as recommended in the literature (PAVLETIC, 1999; PARGANA, 2009). According to the authors, the major benefit of tubular axial flaps, compared with that of tubular subdermal flaps, is flap relocation during tumor resection, eradicating the need for tube creation in the first procedure, but necessitating time for healing and subsequent flap relocation to the receiving site. However, one of the problems with axial flaps is that the technique requires an angiosome, containing an artery and a vein, while subdermal flaps may be created from any cutaneous region of the skin.

The use of tubular skin flaps is limited to the distal portion of members. A bipedicular flap is prepared from a piece of skin with two parallel incisions, after deep dissection of the plexus, by suturing the margins to each other (PAVLETIC, 1999). The tube is made 2 or 3cm larger than the receiving
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PAVLETIC (1999), HEDLUND (2007), and DE NARDI et al. (2015). Use of this suture is necessary to avoid necrosis; it inflicts fewer wounds on the tissue and thus does not compromise local flow and angiogenesis. Axial flap transference success (i.e. avoidance of excessive tension, rotation (over 180 degrees), and vascular impairment) depends on precise and non-traumatic surgical technique, as described by PAVLETIC (1999), VASCONCELLOS et al. (2005), HUPPES et al. (2015) and DE NARDI et al. (2015). Therefore, the technique was conducted carefully, without excessive tension or sutures for dead space reduction on the implant site. Vascular impairment was avoided, but in two cases, cyanosite progression into superficial necrosis was observed. This situation can progress to necrosis and death of the flap, but in this case, only a minor impairment of the flap was observed. Therefore, the procedures were successful.

The use of subdermal and axial tubular flaps are good alternatives for the reconstruction of wounds created by large tumor resections in areas with low tissue elasticity. However, to ensure success, subdermal flap procedures must be conducted in several phases. For procedures employing axial flaps, vascularization must be preserved.

**BIOETHICS AND BIOSECURITY COMMITTEE APPROVAL**

The authors of the current article, titled “The use of tubular subdermal and axial flaps in the correction of four cases of extensive lesions” declare, for all due purposes, that the project giving rise to the present data has not been submitted for evaluation to the Ethics Committee of Faculdade de Ciências Agrárias e Veterinárias (FCAV), Universidade Estadual Paulista (UNESP), Jaboticabal, SP. However, we are aware of the content of the Brazilian resolutions of the Conselho Nacional de Controle de Experimentação Animal (CONCEA).

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