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Treatment of Trochanteric Ulcers with Cranial Sartorius and Rectus Femoris Muscle Flaps

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Five dogs with pressure ulcers over the greater trochanter were treated by debridement and transposition of the cranial part of the sartorius or the rectus femoris muscle. Both muscles had vascular anatomy that allowed transposition based on a major vascular pedicle. All wounds healed promptly by primary intention and no ulcer recurred. The cranial sartorius flap technique was easier to perform than the rectus femoris technique.

ANIMALS that are recumbent for long periods as a result of bilateral pelvic limb or spinal cord injury are predisposed to developing deep wounds over the greater trochanter pressure points, and some patients develop these lesions despite exhaustive attempts at prevention. Bilateral surgical wounds in this region are particularly prone to dehiscence because the animal has no unaffected side to lie on. Regardless of the cause, healing of these wounds is slow, often incomplete, and frequently complicated by infection. The area of skin necrosis may appear relatively minor, but the damage to underlying tissues is often deep and extensive. Granulation tissue and epithelium form slowly and poorly over exposed fascia, tendon, bone, or metallic implants. The best end result of open wound healing is often a deeply scarred and adhered base covered by thin fragile epithelium that is susceptible to reinjury and ulceration. The common worst result is a permanent draining ulcer. In animals with fractures, any underlying internal fixation is at risk of failure due to chronic osteomyelitis.

The skin defect may be small, and surrounding skin abundant for primary closure or random or axial pattern flap coverage; however, even well vascularized skin alone lacks the resiliency to survive the continuous pressure that created the original dehiscence and ulcer. Attempts at primary closure even after excision of the trochanter invariably fail. Vascularized muscle flaps have been used to cover pressure sores in humans for nearly 40 years, and muscle or myocutaneous transfers have become a standard method of management. Muscle is more sensitive to pressure than skin, and the advantages of covering the ulcer with muscle and skin over skin alone are controversial and lack a comprehensive explanation. One theory is that in addition to replacing the ischemic or necrotic subcutaneous tissues, the vascularized muscle aids in dispersing pressure. Regardless of the reasons for improved healing, the efficacy of the technique has been documented clinically and experimentally. The purpose of this report is to describe the use of the cranial part of the sartorius muscle or the rectus femoris muscle as transposition flaps for treatment of pressure ulcers over the greater trochanter in five dogs and report the results.

Anatomy of the Muscle Flaps

The cranial part of the sartorius and the rectus femoris muscles fulfill the major requirements for transposition flaps. They are of adequate size to reach and cover most defects, are relatively superficial and accessible, and are functionally expendable. One dominant vascular pedicle supplies most of each muscle, and the base of either pedicle is far enough from the greater trochanter to assure that it would not be involved in the primary lesion. Most of the blood supply to the cranial part of the sartorius is a branch

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of the superficial circumflex iliac artery 3 cm long that splits into ascending and descending limbs before entering the proximal one-third of the muscle along its caudal border (Fig. 1). Small pedicles from the iliolumbar and descending genicular arteries supply the extreme proximal and distal tips, respectively. Most of the blood supply to the rectus femoris is through a pedicle of the lateral circumflex femoral artery, which enters the caudal border of the proximal one-fourth and traverses the length of the muscle distally as one or two intramuscular branches (Fig. 2). An inconsistent small pedicle of the descending genicular artery may supply the extreme distal tip.

**Surgical Procedure**

*Cranial Part of the Sartorius Muscle*

A curved skin incision is made from the trochanteric ulcer toward the ventral border of the wing of the ilium, and then distally along the craniomedial aspect of the thigh to the stifle (Fig. 3A). The skin bordering the ulcer is dissected from underlying scar tissue, and the distal skin margins are reflected to expose the cranial part of the sartorius. All abnormal tissue associated with the ulcer is aggressively debrided, including granulation tissue, dense scar tissue, necrotic fascia, muscle, tendon, and sometimes bone. The proximal segment of the cranial part of the sartorius is isolated by blunt dissection and the origin is elevated subperiosteally from the ilium (Fig. 3B). This maximizes the proximal extent of the transposed graft and minimizes hemorrhage from the muscle. Care is taken to protect the dominant pedicle that enters the caudal border at the junction of the proximal and middle one thirds. A Doppler blood flow detector* can be used to help identify the arterial pedicle, and is useful in ascertaining a strong pulse in the muscle flap during and after transposition. The muscle is transected somewhere within its distal one third. The in-

* Ultrasonic Doppler Flow Detector, Parks Medical Electronic, Inc., Aloha, OR.
MUSCLE FLAPS FOR TROCHANTERIC ULCERS

Fig. 3. Transposition of cranial part of the sartorius muscle to cover the greater trochanter. A. Positioning of the skin incision. B. Dissection of the cranial part of the sartorius muscle. C. Transposition of the flap by inversion and placement of the proximal end over the ulcer. D. Securing the muscle flap over the ulcer with simple interrupted stitches.

Tramuscular descending branch of the dominant pedicle requires ligation at the transection site. The remainder of the muscle belly is freed of surrounding areolar tissue and the dominant pedicle is dissected toward the superficial circumflex iliac artery. Small branches of the ascending vessel going to the tensor fasciae latae muscle are ligated and divided to maximize the pedicle freedom and length. The proximal or distal end of the muscle is placed over the debrided trochanter by simple rotational transposition or inversion (Fig. 3C). A tunnel can be created beneath the cranial portion of the tensor fasciae latae muscle through which to pass the sartorius muscle and pedicle. The edge of the muscle is secured to the fascia at the periphery of the deep wound with simple interrupted sutures (Fig. 3D). The skin is undermined further and then apposed. Alternatively, a skin flap with a random pattern blood supply (rotation, Z-plasty, or transposition) may be devised to assure closure without tension.

Rectus Femoris Flap

Transposition of the rectus femoris muscle is much the same as for the cranial part of the sartorius, except that
the distal extent of the skin incision is made on the cranial aspect of the thigh directly over the muscle. The flap is based on the dominant lateral circumflex femoral pedicle, which must be isolated and protected. The rectus femoris muscle is dissected from the surrounding members of the quadriceps femoris and transected at its distal one fourth. The distal end is rotated to cover the trochanter. Elevation of the muscle origin from the ilium may be necessary to provide adequate pedicle freedom and length.

Results

Five dogs with trochanteric ulcers were treated with muscle flaps, four by transposition of the cranial sartorius muscle and one by transposition of the rectus femoris muscle (Table 1). The only complication encountered was a seroma in dog 4 that resolved promptly with dependent drainage. All surgical wounds healed by primary intention, with a normal full thickness of freely mobile, resilient skin over the trochanter. The skin sutures were removed by day 8. None of the ulcers had recurred at the time of follow-up, which was 18 to 36 months.

Discussion

It is sometimes tempting to procrastinate with ulcerative lesions in the hope that they will respond to conservative measures and heal without complication. However, the morbidity and cost of prolonged hospitalization, intense nursing care, bandages, and topical medication must be weighed against the cost and potential complications of a relatively simple surgical procedure. Exposed bone may develop osteomyelitis, which is particularly ominous if a fracture and internal fixation devices are involved. Early wound coverage and closure with vascularized muscle not only helps prevent infection, but is thought to clear infection by normalizing body defense systems via increased perfusion.11 Infection after wound dehiscence that undoubtedly contributed to failure of the treatment of the left hip fracture in dog 1 might have been averted by early muscle flap transposition.

We initially tried the rectus femoris flap because of reported successes in humans. We now prefer transposition of the cranial sartorius muscle because it is easier to dissect and mobilize, and its shape and arc of rotation are more conducive to placement over the greater trochanter. Pass-

### Table 1. Clinical Data in Five Dogs Undergoing Muscle Flaps for Trochanteric Ulcers

<table>
<thead>
<tr>
<th>Dog No.</th>
<th>Breed</th>
<th>Age (yrs)</th>
<th>Original Trauma</th>
<th>Surgical Repair</th>
<th>Ulcer (Dehiscence) Side</th>
<th>Duration of Ulcer</th>
<th>Procedure</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Collie</td>
<td>2</td>
<td>Right acetabular fracture with coxofemoral luxation. Right sacroiliac separation</td>
<td>Plate fixation with toggle pin and capsulorrhaphy</td>
<td>Right</td>
<td>2 days</td>
<td>Cranial sartorius flap</td>
<td>18 mo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Left acetabular, ilial, ischial fractures</td>
<td>Trochanteric osteotomy with plate fixation → wound dehiscence → articular infection → femoral head and neck excision</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Pointer</td>
<td>2</td>
<td>Left acetabular-ischial fractures</td>
<td>Trochanteric osteotomy and plate fixation</td>
<td>Left</td>
<td>3 wk</td>
<td>Cranial sartorius flap through tensor fasciae latae tunnel</td>
<td>36 mo</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Right sacroiliac separation</td>
<td>Lag screw and transilial bolt fixation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Border Collie</td>
<td>2</td>
<td>Right open comminuted subtrochanteric fracture with coxofemoral luxation</td>
<td>Plate fixation with open reduction of luxation and capsulorrhaphy</td>
<td>Right</td>
<td>2 wk</td>
<td>Cranial sartorius flap</td>
<td>26 mo</td>
</tr>
<tr>
<td>4</td>
<td>Labrador Retriever</td>
<td>7</td>
<td>Right coxofemoral luxation with sacroiliac separation</td>
<td>Trochanteric osteotomy and capsulorrhaphy → failure → femoral head and neck excision</td>
<td>Right</td>
<td>12 wk</td>
<td>Cranial sartorius flap</td>
<td>24 mo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Left sacroiliac separation</td>
<td>Lag screw and transilial bolt fixation</td>
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</tr>
<tr>
<td>5</td>
<td>Saint Bernard</td>
<td>9</td>
<td>Left subtrochanteric fracture</td>
<td>Plate fixation</td>
<td>Left</td>
<td>4 wk</td>
<td>Rectus femoris flap</td>
<td>18 mo</td>
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<td></td>
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<td></td>
<td>Right coxofemoral luxation</td>
<td>Open reduction and capsulorrhaphy → failure → femoral head and neck excision</td>
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</tbody>
</table>
ing the sartorius under the tensor fasciae latae maximizes the arc of rotation, but it should be done with caution because constriction of a vascular pedicle within a tunnel is one of the common causes of flap failure. Although the proximal one half of the semitendinosus muscle may also be transferred to the hip or perineum, the cranial part of the sartorius appears to be the most utilitarian muscle flap for reconstruction in the region of the hip because it is easily accessible and is expendable.

References

Abstract of Current Literature
A BIOMECHANICAL STUDY OF SUTURE PULLOUT IN LINEA ALBA
Campbell JA, Temple WJ, Frank CB, Hutchcroft SA
Surgery 1989;106:888-892

The relationship of suture bite size, suture diameter, and fascial thickness to strength of wound closure was studied in cadaveric linea alba. All soft tissue was removed from the fascia of 12 abdominal walls that were cut into 346 test sections. A single suture loop was placed in each section, simulating laparotomy closure with interrupted technique. Suture bite size (0.3, 0.6, 0.9, 1.2, 1.5, and 2.8 cm) and gauge (00, 0, 1, and 2) were randomly assigned. The force and energy required to pull out suture loops were measured. Mean linea alba thickness was greater above the linea semicircularis than below (1.19 vs 0.77 mm; p < 0.001). Similarly, mean pullout force was greater above the linea semicircularis (58.2 vs 31.6 N; p < 0.001). By regression analysis, it was determined that fascial thickness and bite size accounted for 68% of observed variability in pullout force. Suture diameter was unrelated to pullout force. Optimum security was obtained with bites of at least 1.2 to 1.5 cm.