

Aesth Plast Surg (2011) 35:1133–1136  
DOI 10.1007/s00266-011-9721-0

## INNOVATIVE TECHNIQUES

# Tip Anchor Flap in Decubital Surgery

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Received: 25 January 2011 / Accepted: 25 March 2011 / Published online: 22 April 2011  
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**Abstract** Anchoring a flap remains a key procedure in decubital surgery because a flap needs to be stable against shearing forces. This allows an early mobilization and undisturbed primary wound healing. This study evaluated a uniform group of eight paraplegic patients with sacral decubital ulcers and covered the lesions using gluteal rotation flaps with a deepithelialized tip to anchor the flap subcutaneously on the contralateral ischial tuber. Initial wound healing and recurrence after one year were evaluated. All but one flap showed uneventful wound healing, and all the flaps presented without any signs of recurrence or instability. The authors suggest that sufficient anchoring using a deepithelialized part of the flap helps to integrate and stabilize sacral rotation flaps.

**Keywords** Deepithelialized flaps · Gluteal flap · Paraplegics · Pressure sore

The human body is constantly affected by mechanical forces. These forces can have a positive effect on living tissues, stimulating tissue growth and regeneration similar to those observed during tissue expansion or micromechanical wound therapies [3, 6]. Mechanical forces exceeding a certain level or duration also can lead to cell death and tissue necrosis either through direct interaction

with living cells or indirectly through impaired tissue perfusion and oxygenation.

A surface pressure of 32 mmHg, the dermal transcapillary pressure, once was recognized as the critical level above which tissue perfusion starts to be impaired and pressure ulcers may occur. However, this value is not universally valid because different tissues respond variously to pressure forces and also because tissue resistance to mechanical stress is influenced by several factors including tissue edema, nutritional status, and the like. In this regard, studies have demonstrated that muscle tissue is more rapidly prone to develop a decubital ulcer than the overlying skin [3, 6].

Pressure sores have a multifactorial pathology in which, despite the misleading term “pressure ulcer,” not only vertical pressure forces, but more importantly shear forces, play a determinant role [9, 10]. Shear forces result from the horizontal movement between bony prominences and overlying tissues including skin that comes into play during translational movements of the patients (e.g., during mobilization from bed to wheel chair).

The treatment of pressure ulcers is a time- and cost-consuming interdisciplinary process, which to provide long-lasting and stable results, should consider several etiologic factors. Despite better understanding of the pathophysiology underlying pressure ulcers and optimization of surgical techniques and postoperative protocols, pressure sore recurrence remains the most frequent and most feared postoperative complication [12].

With this study, we aimed to evaluate the long-term effectiveness of fixing the deepithelialized tip of gluteal rotational flaps to the presacral fascia. We hypothesized a reduced ulcer recurrence thanks to improved dead space filling due to reduced shear stress.

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## Patients and Methods

All patients presenting at our institutions from January 2005 to December 2007 with a decubital stage 3 or 4 sacral ulcer (Daniel's classification) [2] after paraplegy were considered for this prospective clinical study. Daniel's classification divides decubital ulcers into four stages depending on the depth of tissue injury. Stage 1 comprises erythema of intact skin. Stage 2 exhibits partial-thickness skin loss involving the epidermis and dermis. Stage 3 consists of full-thickness skin loss including damage or necrosis of subcutaneous tissue up to the underlying fascia. Stage 4 is characterized by extensive destruction and tissue necrosis including underlying muscle and bones.

The patients included in the study were hospitalized at a university institution with modern facilities providing full postoperative rehabilitation including nutritional supplementation, pressure-distributive mattresses, and daily physiotherapeutic training. The study followed the ethical guidelines of the Swiss Academy of Medical Sciences.

### Study Groups

To study the effectiveness of flap anchoring in decubital flap surgery, patients were assigned by randomization to either a control group or a study group. Age, gender, and size of the decubital sores were preoperatively assessed. After wound debridement and a 2-week-long wound conditioning with wet dressings, tissue defects were covered in both groups with a fasciocutaneous gluteal rotational flap as described later.

In the study group, the mediocaudal tip of the flap was deepithelialized and anchored to the presacral fascia to achieve more stable wound closure and to minimize the effect of shearing forces. In the control group, flap fixation was performed as usual with simple subcutaneous and cutaneous sutures.

### Operative Technique

After optimization of the patient's nutritional status and application of prophylactic measures to diminish the risk of decubital ulcer recurrence, the patient was scheduled for surgery. Pressure sores were operatively debrided 2 weeks before flap surgery.

After initial wound conditioning, the soft tissue defects were covered with a gluteal fasciocutaneous rotational flap. Epifascial dissection was performed, and the flaps then were rotated to cover the tissue defect and sutured without tension using subcutaneous resorbable 2/0 sutures and interrupted Donati cutaneous nonresorbable 3/0 sutures. Blake suction drains (Ethicon, Johnson & Johnson,

Somerville, NJ, USA) were placed and then removed if the 24 h output was less than 30 ml.

Additionally, in the study group, the mediocaudal tip of the flap was deepithelialized and fixed to the presacral fascia with 70 day resorbable 2/0 sutures. At the tip base, a full-thickness incision was made to allow a normal skin-to-skin suture. Viability of the fasciocutaneous flap's apical portion was controlled intraoperatively by peripheral bleeding.

After one week of empirical antibiotic treatment, specific long-term treatment was performed if osteomyelitis was confirmed via bacteriologic examination of three intraoperatively performed bone biopsies. The postoperative period was characterized by four weeks of immobilization on pressure-distributive mattresses and daily physiotherapeutic training. Low-molecular-weight heparin was given according to patient weight during the entire hospital stay.

### Analyzed Parameters

During the hospital stay, early postoperative complications such as wound infection, wound dehiscence, hematoma, and seroma formation were assessed. Patients were evaluated 12 months after surgery for late complications, particularly decubital ulcer recurrence.

### Statistical Analysis

Statistical analyses were performed using an unpaired *t* test. A *P* value less than 0.05 indicated significance.

## Results

The study enrolled 16 patients (8 women and 8 men) with a mean age of  $50 \pm 13$  years. Four patients presented with a stage 3 and 12 patients with a stage 4 sacral pressure ulcer (Table 1). In two cases (one case in each group), intraoperative bone biopsies showed chronic osteomyelitis of the sacral bone, which was treated according to antibiogram for a three month period. The analyzed groups were comparable in terms of patient demographics and ulcer size (Figs 1, 2).

The control group of 8 patients (5 women and 3 men) with a mean age of  $52 \pm 10$  years) presented with a large  $34 \pm 10$  cm<sup>2</sup> sacral ulcer. The study group of 8 patients (3 women and 5 men) with a mean age of  $48 \pm 15$  years had large  $32 \pm 8$  cm<sup>2</sup> sacral ulcers. For all the patients, ulcer debridement was performed en bloc without perforation into the decubital cavity, as previously described [5]. After 2 weeks of wound conditioning, reconstruction was

**Table 1** Pressure sore coverage by gluteal rotational flap with (tip anchor group) and without (control group) deepithelialized tip flap fixation to the pre-sacral fascia: patient features, early postoperative complications, and late complications recorded at the 1 year follow-up assessment

	Control group	Tip anchor group
Patients features		
<i>n</i>	8 (3M/5F)	8 (5M/3F)
Age (years)	52 ± 10	48 ± 15
Defect size (cm <sup>2</sup> )	34 ± 10	32 ± 8
Daniel's classification		
Stage 3	2	1
Stage 4	6	7
Early postoperative complications: <i>n</i> (%)		
Wound dehiscence	2 (25)	1 (12.5)
Infection, hematoma, seroma	0	0
Late complications (1 year): <i>n</i> (%)		
Recurrence	1 (12.5)	0
Late infection, fistula	0	0

*M* male, *F* female

performed using a fasciocutaneous gluteal rotational flap with or without anchor fixation.

#### Postoperative Complications

In the immediate postoperative period, one patient in the study group and two patients in the sham group experienced a wound dehiscence needing operative revision. One of these patients had diabetes mellitus. No flap necrosis, wound infections, hematoma, or seroma was experienced by the analyzed patients. No tip sufferance or flap necrosis was detected in any of the patients treated by flap anchoring.

At the one year follow-up assessment, one patient in the sham group but none in the study group presented with a decubital ulcer recurrence. Osteomyelitis was not associated with any early or late postoperative complication. No late infection of the soft tissues or fistula formation was observed (Table 1).

#### Discussion

Deepithelialized flaps have been used primarily in reconstructive and aesthetic plastic surgery with good results [7, 8, 13]. Although they are used mainly to provide intrinsic stability or volume, their application for the treatment of chronic bone osteomyelitis also has well been validated [13].

After examining the different steps of the surgical treatment of pressure sores to identify possible weaknesses,

we concluded that pressure sore debridement and flap fixation are the most crucial steps, which if incorrectly performed, may predispose to recurrence. A thorough wound debridement is essential to minimize the risk of infections.

We recently proposed an innovative modification of the pseudotumor technique that involves injecting fluid silicone into the decubital cavity primarily to enable better identification of ulcer extension and to allow complete excision without capsular lesion or contamination of healthy tissues [5]. For a limited number of patients, this technique has shown promising results.

Shear forces acting on the performed flaps may lead to pseudo-bursa formation and ulcer recurrence. To minimize shear forces between the performed flap and the underlying bony prominences, flaps should be fixed to the underlying tissues, and dead spaces should be avoided. To address this issue, we previously proposed the use of fibrin glue [4]. This technique has the advantage of providing a homogeneous fixation of the flap to the underlying tissues but also has the disadvantage of associated costs and possible premature clotting of fibrin, which is difficult to recognize intraoperatively and will result in pseudo-bursa formation. Also it is not clear what amount of shear stress flap fixation provided by fibrin glue will sustain. For this reason, we considered the possibility of improving flap fixation and optimizing dead space filling as a possible alternative approach.

In seeking a more stable flap fixation, bone anchors have been used by other groups [1, 11]. This technique presents a major problem related to the fact that it needs the insertion of anchors in a predrilled bony hole, thereby increasing the risk of bacterial contamination and osteomyelitis [1].

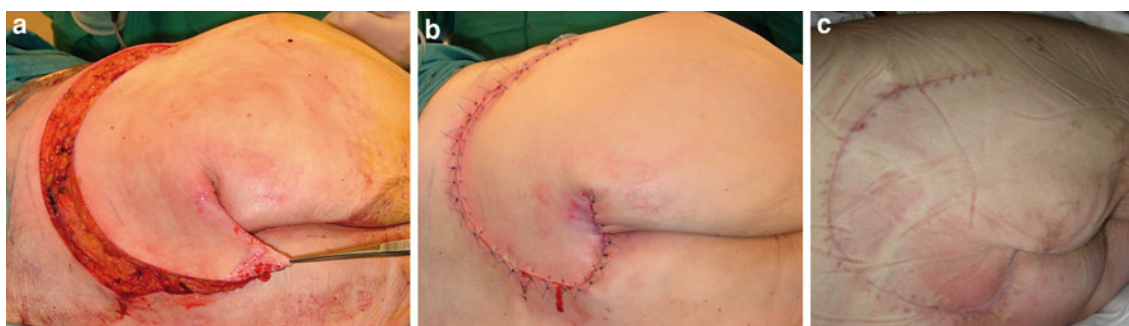
Despite the limited number of analyzed patients, we were able to show that deepithelialization of the tip of sacral rotational flaps and their subsequent fixation to the presacral fascia and contralateral ischial tuberosity does not preclude tip survival. On the contrary, this approach provides a well-vascularized tissue bulk to obliterate dead space, which is adequate for the treatment of an underlying sacral bone osteomyelitis site. At the same time, it allows stable anchoring of the flap to the underlying tissues, thereby diminishing the tension on subcutaneous sutures and minimizing shear stress on the flap.

Altogether, we were able to demonstrate promising results in the tip anchor flap group. This group had no increased early postoperative complications and no cases of recurrence one year after surgery. A larger study is needed to confirm these preliminary results.

Deepithelialization can be applied to provide cutaneous tissues for fixation of a flap to the underlying tissues. Moreover, this tip of the flap provides an additional stable tissue bulk to cover the sacral bony prominences, which



**Fig. 1** Sacral pressure sore and small flap



**Fig. 2** Sacral pressure sore and large flap

may prevent ulcer recurrence, especially in malnourished elderly patients, who often present with little adipose tissue, sharp bony prominences, and gluteal dermatochalasis.

This technique is inexpensive and has only the disadvantage of needing a stable fascial or ligamentary structure to anchor the flap effectively. This is easily possible for sacral or occipital decubital ulcers because the flaps can be anchored respectively to the presacral fascia or ischal tuberosities. However, this is not always possible for the treatment of ulcers located on the ischal tuberosities due to the small and distant fixation point at the ischiopubic ramus.

In conclusion, we propose the tip-anchoring flap technique for the treatment of sacral pressure ulcers. This flap modification provides an effective method for minimizing shear forces on the flap, reducing tension on the subcutaneous and cutaneous flap sutures and providing well-vascularized tissue for dead space obliteration.

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