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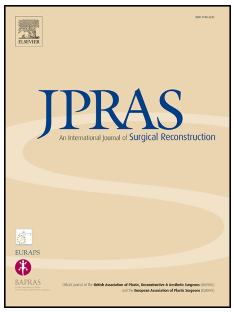

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Two-stage treatment of ischial pressure ulcers in spinal cord injury patients: Technique and outcomes over 8-years

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SUMMARY

Background: Reconstruction of ischial pressure ulcers remains a difficult problem with high reported failure rates, despite newly introduced techniques.

Methods: A retrospective chart review was performed on all spinal cord injury (SCI) patients who underwent ischial pressure ulcer reconstruction by the senior author (V.L.) between 2004 and 2012. The two-stage procedure consisted of debridement and bone biopsy, followed by bursectomy, partial ischiectomy, fascial release, and gluteus maximus and hamstring advancement flaps. Post-operative care included 2-weeks supine bed rest on an air-fluidized bed, sitting tolerance rehabilitation, and thorough behavioral training.

Results: Sixty-five patients (74 flaps) were identified. 45.9 per cent had a previous attempt at reconstruction. Median follow-up was 622 days. Overall, 67.6 per cent of flaps were intact at last follow-up. Superficial and deep dehiscence rates were 16.2 and 28.4 per cent, respectively. Seven out of 35 flaps suffered late recurrence after being well-healed for greater than one year. A history of previous reconstruction was found to be associated with increased odds of superficial (OR 6.02, 95% CI 1.55-23.3) and deep dehiscence (OR 12.3, 95% CI 1.99-76.9).

Conclusions: It has been the evolution of the senior author's practice towards a simpler repair, which relies on plane-by-plane release of scarred tissues to improve mobility of muscle and skin flaps without large tissue movements, even in the setting of apparent extensive tissue loss. This technique is a reliable option, particularly for the primary ischial pressure ulcer.

Keywords: ischial pressure ulcer, muscle flap

INTRODUCTION

The prevalence of spinal cord injury (SCI) in the United States is estimated to be 282,000, with an incidence of 17,000 new cases yearly[1]. In the United Kingdom, over 40,000 people are affected with SCI, with an annual incidence of approximately 16 new cases per million in Western Europe[2,3]. Globally, the prevalence of traumatic SCI has been estimated to be between 236 and 4,187 per million[2]. Pressure sores in SCI patients represent significant physical and financial burdens and are a leading cause of unplanned hospitalization in this population[4]. An Australian study found that 11 per cent of SCI patients were readmitted to the hospital within 2 years of initial injury for the primary diagnosis of pressure ulcer, second only to urinary tract infection (UTI). Moreover, the group reported that readmissions due to pressure ulcers were 59 per cent more costly than readmissions due to UTI[5]. In a Canadian study of 1137 traumatic SCI individuals (381 with pressure ulcers within the last 12 months), individuals with pressure ulcers were significantly more dissatisfied with their ability to participate in their main activity than SCI individuals without pressure ulcers. Additionally, pressure ulcers adversely impacted participation in 19 of 26 daily and community activities when compared to SCI without pressure ulcers. By contrast, the same study revealed no differences in community participation in 22 of 26 activities based on SCI level[6]. Despite advances in prevention, including regular examination of susceptible bony prominences, frequent positional changes, pressure releases, and pressure relief adjuncts such as wheelchair cushions and air mattresses, over one-third of SCI patients have a pressure ulcer at any point in time, and 70 per cent of these have more than one ulcer[7]. Several risk factors for developing pressure sores specific to SCI have been identified and include completeness of injury, time since SCI, urinary and fecal incontinence, spasticity, contractures, and change in health status such as major infection[8,9]. Moreover, these factors have

important implications for reconstruction. Specifically, fecal diversion has been recommended in select patients, and medical management of spasticity should be optimized[10]. Superficial wounds often close with local wound care and pressure relief, while deeper, more extensive wounds, Shea Stage III and IV,[11] may require operative repair. Briefly, European Pressure Ulcer Advisory Panel (EPUAP) and Shea classification staging are summarized in Table 1[11,12]. Various methods for reconstruction of ischial pressure ulcers have been described since Davis et al. in 1938[13], yet recurrence rates remain high[14,15]. Factors contributing to poor outcomes include poor nutrition, poorly controlled diabetes, anemia, underlying osteomyelitis, peripheral vascular disease, and other inherent complications associated with prolonged immobility[14].

In the early 1980s, myocutaneous flaps were applied to the ischial sore, including the biceps femoris advancement flap described by Tobin et al.[16] and the V-Y hamstring advancement flap published by Hurteau et al.[17]. These mainstays of ischial reconstruction share the advantages of muscle bulk to fill the defect and pad the ischium as well as the ability to be re-advanced, but often resist ischemia poorly. Gluteus maximus-based myocutaneous flaps included large rotational and advancement flaps as well as the inferior gluteal island flap[18,19]. Hurwitz et al. introduced the fasciocutaneous gluteal thigh flap based on the descending branch of the inferior gluteal artery[20]. The strategy of fasciocutaneous flaps raised on parasacral perforators for pressure ulcer reconstruction was introduced by Koshima et al. in 1993[21], followed by descriptions of superior gluteal artery perforator (SGAP)[22] and inferior gluteal artery perforator (IGAP)[23] flaps at the turn of the century. Other published techniques include the pedicled anterolateral thigh (pALT) flap with or without the vastus lateralis[24,25] and the gracilis myocutaneous flap[26,27]. Finally, for the limited application, free flap pressure ulcer

reconstructions have been reported and include the latissimus dorsi, gastrocnemius, and fillet of leg flaps to superior gluteal, inferior gluteal, deep femoral, and intercostal recipient vessels[28,29].

Herein we aim to report our outcomes with a single technique for repair of ischial pressure ulcers utilizing plane-by-plane dissection to mobilize muscle and skin flaps. A first stage operative debridement and bone biopsy is performed followed by the reconstructive procedure in a second stage.

PATIENTS AND METHODS

Patient selection

A retrospective chart review of 65 consecutive SCI patients (74 flaps) treated for Shea Stage IV ischial pressure ulcers with the described technique between 2004 and 2012 was performed with approval from the Northwestern University Institutional Review Board. No patients operated on within this time period were excluded. Demographic and pre-reconstructive variables tracked included age, sex, race, level of spinal cord injury, smoking status, diabetes mellitus, body mass index (BMI), pre-operative hemoglobin (Hb), albumin, Shea stage, previous reconstruction, presence of a concurrent ischial or sacral ulcer, and the presence of acute osteomyelitis at the time of bone biopsy and debridement. Appropriateness for surgery was demonstrated by albumin >3.0 g/dL and Hb >10 g/dL. If a previous reconstruction had been performed, the quality of the scar was clinically evaluated by the senior author prior to reattempting reconstruction. Only one ulcer was reconstructed at a time to minimize the healing burden. All reconstructive procedures were performed by the senior author (V.L.L.) with the assistance of a surgical resident or physician assistant. Follow-up assessments were performed through the Rehabilitation Institute of Chicago (RIC) outpatient SCI program or by the plastic surgery inpatient service. Post-operative outcomes were categorized as no breakdown, superficial dehiscence, deep dehiscence, and late recurrence. *Superficial dehiscence* was defined as separation of skin or subcutaneous tissues only; *deep dehiscence* was defined as separation of the muscular layer prior to 1-year post-operative; *late recurrence* was defined as separation of tissues occurring after 1-year post-operative.

Logistic regression analysis was performed to examine the effect of demographics, smoking status, diabetes mellitus, body mass index (BMI), pre-operative hemoglobin (Hb),

albumin, previous reconstruction, presence of a concurrent ulcer, and the presence of acute osteomyelitis on ulcer recurrence. Statistical analyses were conducted using SPSS 20.0 (IBM Corp., Armonk, NY).

Operative technique

All patients were treated in two stages. The first stage consisted of operative debridement and bone biopsy performed as an outpatient surgery[30,31]. Patients with a bone biopsy positive for osteomyelitis were treated medically with 6-weeks of best choice intravenous antibiotics in an outpatient setting prior to reconstruction. Patients with concomitant ulcers were treated one ulcer at a time to minimize healing burden.

The reconstructive stage is illustrated photographically in Figure 1. The operation was performed under general anesthesia or intravenous sedation based on the level of spinal cord injury and at the discretion of the anesthesiology service. The patient was placed in the prone jackknife position with appropriate protective padding. The margins of the pressure sore were excised to the level of the ischium (Figure 1b). Particular care was taken to remove all fibrotic tissue. An incision was made in the granulation tissue over the ischium and excised with a Cobb elevator to complete the bursectomy. An osteotome was used to blunt the ischial tuberosity conservatively, and bone contouring was completed with a rasp. The bone was submitted for permanent histology. The argon beam coagulator was used for bone hemostasis. The gluteus maximus was freed on both the superficial and deep surfaces to separate the muscle flap from the subcutaneous flap and pelvis, respectively. The extent of dissection was dependent on the degree of advancement achieved towards the goal of a minimal tension repair (Figure 1c). Reasonable effort was made to preserve gluteal perforators as they were encountered. The inferior gluteal

artery was identified and preserved. The hamstring origin was then detached and separated from the ischium and elevated along its deep surface to the level of the medial circumflex perforators. The subcutaneous flap was again elevated until skin and muscle layers were freely mobile. Horizontal mattress sutures of 2-0 monofilament polyglyconate synthetic absorbable sutures (Maxon, Covidien, Mansfield, MA) were used to approximate the hamstring origin to the gluteal plate (Figure 1d). Two closed suction drains were placed—one deep and one superficial to the muscle repair. The subcutaneous tissues were closed in two layers (Figure 1e). Three-month follow-up is shown in Figure 1f.

Post-operative care

All patients were placed on supine bed rest on an air-fluidized bed (Clinitron, Hill-Rom, Batesville, IN) for 13 days post-operatively. Anti-spasm agents such as diazepam and baclofen were continued and adjusted as needed. Routine skin care with lotion was provided to address anhidrosis common in SCI patients. On post-operative day 13, they were transferred to a low air loss mattress (Flexicare, Hill-Rom, Batesville, IN), and a limited sitting protocol, beginning with 30-minutes three times a day, was initiated and overseen by physical medicine and rehabilitation. The majority of patients were then transferred to acute inpatient rehabilitation for an additional 2 to 4 weeks of sitting tolerance therapy. Surgical drains were removed prior to transfer to inpatient rehabilitation or discharge.

During rehabilitation, patients were progressed to 1-hour three times a day for one week, to 1.5-hours three times a day for one week, and then finally 2-hours three times a day prior to discharge. Skin evaluation by the therapist was performed together with the patient before and after sitting sessions, and patients were encouraged to perform such skin checks independently.

Lifting transfer techniques to minimize shear were reinforced. Patients were given appropriate education with regard to frequent pressure relief and maintenance of wheelchair cushions.

RESULTS

Descriptive statistics are summarized in Table 2. The study population was predominantly male (85.1 per cent) with a mean age of 41.3±13.8 years. Thirty-six per cent were smokers; 6.8 per cent were diabetic. All wounds were Shea stage IV. Wound size ranged from 6 by 8-cm to 10 by 15-cm with significant undermining. Notably, approximately half of the ulcers (45.9 per cent) had a previous reconstruction. Forty-three per cent of patients had a concurrent sacral or contralateral ischial ulcer, which were treated separately. Fourteen ulcers (18.9 per cent) were found to have acute osteomyelitis by bone biopsy. Follow-up time was bimodal with a median of 622 days and an interquartile range of 148 days to 5.4 years. No hematomas or seromas were observed. Superficial and deep dehiscence rates were 16.2 and 23.0 per cent, respectively (Figure 2a). Seven out of 35 patients (20.0 per cent) developed late recurrence. All cases of superficial dehiscence were noted within the 2-week inpatient stay, and all of these cases went on to heal by secondary intention. The most common association with deep dehiscence was wound infection. Three cases successfully underwent secondary closure following wound irrigation and debridement. The majority of deep dehiscence was noted within one month, with the exception of two cases attributed to mechanical falls, which occurred at 3 and 6 months, respectively. Five cases of late recurrence occurred during prolonged admission for pneumonia or urosepsis, one case secondary to a chronic seroma, and one case 7 years after reconstruction during induction chemotherapy. Overall, 67.6 per cent of flaps were healed at the time of last follow-up (Figure 2b).

Logistic regression identified a history of previous reconstruction as a significant predictor of both superficial and deep dehiscence with odds ratios (OR) of 6.02 (95% confidence interval [CI] 1.55-23.3, p=.009) and 12.3 (95% CI 1.99-76.9, p=.007), respectively. The

remaining variables listed in Table 2 were not associated with increased risk of superficial or deep dehiscence. Small sample size did not allow for logistic regression analysis of late recurrence.

DISCUSSION

Our muscle flap technique for ischial pressure ulcer coverage relies on the fundamental plastic surgery principles of excision of scar to pliable tissue, preservation of perforator blood supply, and plane-by-plane elevation of skin and muscle flaps to allow for mobility of tissues. Notably, our two-stage approach not only provides the opportunity to prepare an appropriate wound bed characterized by supple tissues, but also serves to identify and address any fistulous tracts or underlying osteomyelitis prior to reconstruction. Notably, the muscle repair is treated distinctly from the skin repair, although muscle release often facilitates skin closure. The myocutaneous flap eliminates dead space and provides bulk to cushion the sitting surface. Interestingly, Constantian advocated a similar procedure for the primary ischial ulcer in 1980; however, in contrast to the biceps femoris and V-Y hamstring advancement flaps being described at the time, the Constantian technique never gained wide acceptance [16,17,32].

Apparent gluteus maximus loss under the ischial tuberosity is often overestimated preoperatively due to tissue retraction and malpositioning in the sitting-induced pressure ulcer. The hamstrings may be displaced from their origin, but are almost always attached by scar to the ischium inferiorly. Magnetic resonance biomechanical studies have demonstrated that gluteal muscle thickness under the ischial tuberosity during non-loaded 90-degree hip flexion decreases significantly by 59 per cent compared to supine positioning. This finding is secondary to the muscle sliding away from the ischial tuberosity[33]. In our series, we have observed adequate muscle bulk once the overlying bursa and scar are released and the muscle is allowed to unfurl, even in the deep tunneling wound.

We have previously demonstrated in a series of 108 patients that deep abscess or sinus tract formation after pressure ulcer reconstruction may often be attributed to underlying

osteomyelitis[30]. In contrast, a recent study by Larson et al. [34] showed no difference in recurrence or complication rates with a radiographic diagnosis of osteomyelitis. The authors did note, however, that patients with no bone culture performed were significantly more likely to experience a complication. We believe this discrepancy may have been due to overdiagnosis of osteomyelitis by radiographic techniques without histologic or microbiologic confirmation. Histopathologic analysis of Jamshidi core needle biopsy specimens has been shown to be 96 per cent specific for the diagnosis of osteomyelitis, while plain pelvic x-ray in combination with white cell count and erythrocyte sedimentation rate was found to be only 88 per cent specific[35]. Thus it has been the senior author's practice to obtain routine Jamshidi core needle bone biopsies followed by 6-weeks of antibiotic therapy, if indicated, prior to scheduling flap reconstruction. Using this two-stage algorithm, we believe complication rates have been significantly reduced. Subsequently, few patients had evidence of acute osteomyelitis at the time of reconstruction, and while acute osteomyelitis trended towards risk association, it did not reach statistical significance in the current series.

Flap surgery for the SCI patient must always be cognizant of the "next flap". Compared to the elderly debilitated patient, young, traumatic SCI males have fewer chronic, comorbid conditions such as diabetes, but are at increased risk of recurrence due to longer life expectancy as well as behavioral and social risk factors[36]. It is therefore important to note that the presented technique may be re-advanced and furthermore does not violate future flap territories. Our overall failure rate was 32 per cent with a median follow-up of 622 days, comparable to other large series. Disa et al.[37] reported a 61 per cent recurrence rate in their series of 66 ischial pressure ulcer reconstructions. Follow-up ranged from 1 to 71 months. Foster et al.[38] published a superficial wound edge separation rate of 14 per cent and an overall failure rate of 17 per cent

with an average follow-up time of 11.8 months. More recently, Keys et al.[14] recorded 122 ischial flaps, with a follow-up range between 7.7 months and 12 years, and a failure rate of 46.7 per cent. They noted ischial location as an independent risk factor for pressure ulcer recurrence. Larson et al.[34] reported a series of 179 mixed ischial, sacral, and trochanteric flaps with a mean follow-up of 629 days and an overall recurrence rate of 16.8 per cent but did not discriminate between location or type of flap used.

Our series was predominantly comprised of young, male, urban trauma patients, who are associated with varying degrees of drug and alcohol use, compliance, and follow-up as well as increased recurrence rates[37]. In multivariate regression analysis, Keys et al.[14] found age <45-years to be associated with a 13-fold risk of reconstructive failure. However, we did not find a significant correlation between age and flap failure. Additional patient factors including nutrition and anemia have been shown to increase risk of development and recurrence of pressure ulcers[14,36,37]. Recently, some authors have advocated that nutritional protocols are unnecessary[34]. However, in the cited study, the average preoperative nutritional status was adequate as measured by albumin and prealbumin levels of 2.99 g/dL and 11.6 mg/dL, respectively. While our regression analysis did not identify preoperative nutritional status or anemia as risk factors, the patients in this series were pre-selected for surgery appropriateness based on laboratory criteria, i.e. albumin>3.0 g/dL, hemoglobin>10 g/dL. Based on all available data and first principles of wound healing, we will continue to stress nutritional optimization within the limits of practicality prior to reconstruction.

Nearly half of the ischial ulcers in this series were recurrent ulcers. Some authors have reported up to 3.8-fold increased risk of reconstructive failure compared to primary ulcers[14], while others have found no correlation [38,39]. We found a strong association between previous

same-site reconstruction and both superficial and deep dehiscence. We postulate that this is due to more extensive scar in the recurrent setting and thus recommend liberally excision of fibrotic, scarred tissues during preparation of the wound for flap closure.

Most operative complications (i.e. seroma, hematoma, superficial dehiscence) occurred within the 2-week bed rest period. Following this 2-week inpatient stay, the majority of our patients were sent for continued sitting tolerance therapy with physiatrist supervision and skin assessment and follow-up (including multidisciplinary management of comorbid conditions and custom wheelchair cushions) at the Rehabilitation Institute of Chicago. Because we release our patients from bed rest at 2 weeks, significantly earlier than some institutions which report bed rest for 6 weeks, daily assessment by a physiatrist during rehabilitation can identify threatened wound healing. Anecdotally, four out of five cases of non-compliance, e.g. early sitting, leaving against medical advice, resulted in deep dehiscence. Rehabilitative sitting protocols and proper education of transfers and off-loading are essential for reducing preventable late recurrence.

We believe that the advantages of our approach is in limited incisions to heal, potentially violating fewer territories which may be needed for other areas, lower healing burden, and its relative ease of execution. While this may appear somewhat conservative, we perform aggressive excision of stiff fibrotic and poorly healing tissues to allow the muscle to unfurl and to achieve sufficient mobilization of tissues without large tissue movements.

Our retrospective study is not without limitations. Follow-up time was highly variable, with the longest term follow-up skewed towards those who presented with comorbid complications of SCI such as urosepsis and pneumonia. Of 45 flaps (61 per cent of study population) with greater than one-year follow-up, only 35 intact flaps were available for late recurrence analysis and thus rigorous statistical analyses could not be performed. Given the

predominantly urban trauma patient population, one-year follow-up was difficult to achieve, although our follow-up time was comparable to other studies in the literature.

CONCLUSIONS

It has been the evolution of the senior author's decades of experience towards two-stage treatment of ischial ulcers with debridement and bone biopsy followed by bilateral muscle advancement flap repair. We have demonstrated reliable and durable outcomes in an urban SCI population, particularly for the primary ischial pressure ulcer.

Conflict of Interest: None

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Figure Legends

Figure 1. (a) Pre-operative appearance of recurrent ischial ulcer; (b) Gluteus maximus and hamstrings freed from ischium following bursectomy and ostectomy; (c) Advancement of gluteus maximus and hamstring following plane-by-plane release from fascial and subcutaneous tissues; (d) Muscular repair; (e) Skin closure; (f) 3-month post-operative appearance.

Figure 2. (a) Flowchart of post-operative outcome; (b) Outcome stratified by available follow-up.

Table 1. European Pressure Ulcer Advisory Panel-National Pressure Ulcer Advisory Panel (EPUAP-NPUAP) and Shea Stage Classification of Pressure Ulcers

EPUAP-NPUAP[11]	Shea[12]
I: Non-blanchable redness of intact skin	I: Limited to epidermis, exposing dermis; includes a red area
II: Partial thickness skin loss or blister	II: Full-thickness of dermis to the junction of subcutaneous fat
III: Full thickness skin loss involving damage or necrosis of subcutaneous tissue which may extend down to, but not through, underlying fascia	III: Fat obliterated limited by the deep fascia undermining of skin
IV: Full thickness skin loss with extensive destruction, tissue necrosis or damage to muscle, bone or supporting structures	IV: Bone at the base of ulceration
(US) Unstageable/ Unclassified: Full thickness skin or tissue loss – depth unknown	Closed large cavity through a small sinus
(US) Suspected Deep Tissue Injury-depth unknown	

Table 2. Descriptive statistics

Variable	n=74 (%)
Age (mean ± S.D.)	41.3 ± 13.8
Sex	
Male	63 (85.1%)
Female	11 (14.9%)
Smoking	27 (36.5%)
Diabetes mellitus	5 (6.8%)
Body mass index (mean ± S.D.)	24.1 ± 4.8
Preoperative laboratory values	
Hemoglobin (g/dL, mean ± S.D.)	11.7 ± 1.8
Albumin (g/dL, mean ± S.D.)	3.1 ± 0.6
Previous reconstruction	34 (45.9%)
Concurrent pressure ulcer	32 (43.2%)
Acute osteomyelitis by bone biopsy	14 (18.9%)
Follow-up period (days)	
Median	622
Interquartile range	148-1989
Post-operative outcome	
No breakdown	38 (51.4%)
Superficial dehiscence	12 (16.2%)

Deep dehiscence	17 (23.0%)
Late recurrence (>1 year)	7/35 (20.0%)
Healed at last follow-up	50 (67.6%)