

Update in the Surgical Management of Decubitus Ulcers

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Abstract

Decubitus ulcers remain a common and recurring problem amongst overly ill patients, especially those who are bed-bound. They are caused by unrelieved pressure over tissues, mainly over bony prominences, such as the trochanteric, ischial, and sacral areas, and are classified from stage I to IV. Many forms of management have been described, with prevention being the most important of them. For stages I and II a conservative, non-surgical approach can be used, compared to stages III and IV which normally require surgical management. Post-operative care has also been shown to play a major role in avoiding the high rate of recurrences. Because of their location, high recurrence rates and increase in mortality, pressure sores continue to be a challenge for the medical and nursing staff, and are extremely costly to treat. In this manuscript we review the literature to expose the latest non-surgical and surgical techniques for the management of Decubitus Ulcers.

Keywords: Decubitus ulcers; Osteomyelitis; Tensor fascia lata; Wound care; Surgical management pressure sore

Introduction

Pressure ulcers, also known as decubitus ulcers or bed-sores, are defined as localized injuries to the skin and/or underlying tissue, usually over a bony prominence, as a result of pressure, or pressure in combination with shear and/or friction [1]. In a Cochrane Review, an incidence of 7% to 71.6%, and a prevalence of 8.8% to 53.2% were reported [2]. In an acute care setting the incidence is between 5-9%, and reaches 21% in critical care settings [3]. Levine et al. reported that 2% to 28% of nursing home residents suffer from pressure ulcers [4,5], and almost two thirds of these occur in elders above 70 years old. They are also common in patients with spinal-cord injury and that are bed-bound [1,6], reaching a 39% incidence in these patients [7].

Pressure sores can develop anywhere on the body, but are often located in the trochanteric, ischial, heel, and sacral areas [7]. Multiple classification systems have been described, as depicted in table 1, but the one proposed by the National Pressure Sore Advisory Panel Consensus Development Conference (US-NOUAP) is the most commonly used [8]. It divides the lesions from Stage I to IV and Un-Stageable. Pressure sores, as their name implies, are caused mainly by external unrelieved pressure that exceeds the capillary pressure (33 mmHg), leading to ischemic necrosis [1]. Other factors that have been found to contribute to the formation of pressure sores are shearing (causes tearing of blood vessels), friction (may breach the epidermis), moisture (causing maceration of the skin), neurological conditions, local infection, edema, and poor nutrition [1,8,9]. Cakmak et al. found that fecal and urinary incontinence, smoking, hypoalbuminemia, alcoholism, and diabetes mellitus were other factors that contribute to pressure sore development [10].

In general, the treatment of pressure sores begins with prevention (optimizing nutrition status, preventing/eradicating infection, and relieving pressure) [4,7,11]. According to Brem and Lyder [7] an interdisciplinary approach (physician, nurse, social worker) demonstrated to be more cost-effective. Pressure sores classified as stage I and II can be treated conservatively by using optimal non-surgical ulcer treatment and by eliminating the local and general conditions that interfere with healing. However, if stage III or IV pressure ulcers are present, surgical management is normally required [12].

Pressure sores continue to be a challenge for the medical and nursing staff because they are difficult to heal and to close by surgery,

may have a tendency to recur and are extremely costly to treat. Chronic wound management however, particularly if in a wound care center, will lead to equivalent costs and may never get to the point of being a fully closed wound. They are also associated with a >2-fold increase in mortality [2,7], making them a potentially serious condition that should be treated.

The objective of this article is to expose a review of the latest techniques for the non-surgical and surgical pressure ulcers management.

Management

Management of pressure ulcers is challenging. There are many options of treatment, ranging from surgical to non-surgical. However, management should always be directed towards prevention, which is achievable by educating the patient and the medical and nursing staff about the multiple factors that contribute to the formation of pressure sores, and how to avoid them.

Nonsurgical Management

Nonsurgical management of pressure sores is typically reserved for stage I and stage II ulcers. The management can be separated into prevention of ulcer formation, optimizing local wound healing, and use of adjunctive treatments. Although multiple methods exist for each treatment category, there is generally little evidence that definitively supports one method above another.

Preventing the formation of pressure sores is the ideal treatment modality for patients [13]. Patient repositioning has long been used as a preventive method of pressure sores, whether through turning by

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Grade/stage	Shea (1975)	Yarkony-Kirk (1990)	EPUAP (1996)	US- NPUAP (2007)
I	Limited to epidermis exposing dermis	Red area	Erythema	Redness
II	Full thickness skin loss exposing fat	Involvement of epidermis and dermis, no subcutaneous fat observed	Partial thickness skin loss	Partial thickness loss of skin
III	Full thickness skin and fat defect exposing deep fascia	Exposed subcutaneous fat with no muscle observed	Full thickness skin and subcutaneous necrosis	Full thickness skin loss exposing subcutaneous fat
IV				
	Full thickness defect exposing bone	Exposed muscle without bone involvement	Extensive destruction with or without skin loss	Full thickness tissue loss exposing bone, tendon or muscle
V	-	Exposed bone	-	-
VI	-	Joint space involvement	-	-
	Closed pressure sores. Subcutaneous necrosis without skin ulceration	-	-	Suspected deep tissue injury with discolored intact skin
	-	-	-	Un-stageable: Full thickness tissue loss with base covered with slough/ eschar

Table 1: Comparative table of common classifications of pressure ulcers [8].

nursing or through the use of specialized mattresses. Physiologically, patient repositioning reduces ischemia at pressure locations allowing for increased perfusion and decreased metabolic waste accumulation. Brem and Lyder recommend patient turning at least 2-3 times a day [7]. Despite the common practice of patient turning, there is no strong evidence to suggest the best protocol [14]. In addition, there are no randomized controlled trials or strong evidence studying whether repositioning makes a difference in pressure ulcer healing [2]. The use of specialized mattresses allows more frequent redistribution of pressure and functions similarly to repositioning. While one recent Cochrane review advocated the use of specialized mattresses [15], Reddy et al. did not find specialized mattresses to be superior compared to non-powered mattresses [13]. Furthermore, specialized mattresses only reduce pressure but do not address other forces on ulcer formation such as friction, temperature, and shear.

Enzymatic debridement uses collagenase and urea amongst other enzymes over the wound. Biologic debridement uses maggots over the ulcer [16]. Optimization of local wound healing is another aspect of nonsurgical management. Wound healing techniques range from debridement of underlying tissue, dressing changes, to proper nutrition. Wound care protocols should target moisture balance, bacteria, and debridement. Many methods target the removal of dead tissue creating a proper wound bed for granulation tissues. Dressing changes control for appropriate drainage and absorption of wound debris. However, no single dressing has been found to be better than others [13]. Proper nutrition is also of paramount for wound healing. Vitamin C and Zinc are long known to be essential in the biochemical pathway for tissue regeneration. Furthermore, for patients with poor protein and albumin, restoring a proper nitrogen balance speeds up wound healing [17].

Adjuvant treatments for pressure ulcers include the use of newer technology to improve wound healing. Wound vacuum therapy, also known as negative pressure wound therapy, increases local blood supply and wound contraction. However, there is no actual strong evidence supporting the use of negative pressure wound therapy in the treatment of pressure ulcers [18,19]. Evidence for the use of hyperbaric oxygen has also been inconclusive [20]. Similarly, evidence for the use of lasers, ultrasound, electrotherapy, and electromagnetic therapy is also lacking [13].

Surgical Management

While stage I and stage II ulcers respond to conservative management, surgical intervention is usually required for stage III and stage IV ulcers. The goals of surgical management are to prevent progressive osteomyelitis, reduce protein loss, improve quality of life, improve function and hygiene, and reduce rehabilitation and wound care costs. These goals are typically achieved as patients undergoing surgical intervention have been shown to have significantly better outcomes. Singh et al. found that in spinal cord injury patients, surgical interventions led to improvements in quality of life, hemoglobin, serum albumin, and total serum protein [21]. Another study has also found improvements in hygiene as well as reduction in rehabilitation costs [1] (Figures 1 and 2).

Preoperative considerations include many factors such as history of prior ulcers, ambulatory status, motivational status, compliancy, type of injury, and other associated medical problems. Other considerations during the preoperative phase are maintaining an albumin level above 2 g/dl to ensure healing [8], radiographs to rule out pathologies like fractures, scoliosis or osteomyelitis, treatment of spasms, colostomies if the ulcers are in close proximity to the anus, and, according to the severity of the ulcer, prophylactic antibiotics one day prior to surgery and postoperative [22].

Debridement is the first process in surgical intervention. Even though recent Cochrane Reviews have not shown strong evidence of any debridement technique being the most efficacious [23], debridement can be achieved through a myriad of methods. The optimal method for debridement depends on factors such as location, perfusion status, and equipment needed [24]. Chemical debridement uses compounds such as Dakin solution. Mechanical debridement uses dressing changes along with wound cleansing. Surgical debridement should be conducted in the operating environment with proper wound cultures of exposed bones. Surgical debridement focuses on excision of ulcer, underlying bursa, surrounding calcifications, with removal of underlying heterotopic ossification that will be covered by a flap in addition to osteomyelitic bone. A combination of methods is also possible [4,25] (Figure 6).

Since pressure ulcers often penetrate to bony prominences leading to possible osteomyelitis, osteotomies are also a subject of debate in pressure ulcers. Bone debridement is typically conducted until appearance of bleeding, grossly healthy bone. Bone biopsy should be



Figure 1: a) 46 year old male with lower extremity paresis and right ischial stage IV decubitus ulcer of 3 years duration. b) Intraoperative view at time of right ischial bursectomy and ischiectomy. c) Immediate reconstruction with gluteal rotation fasciocutaneous flap reconstruction. d) 5 months postoperative healed and without recurrence.



Figure 2: a) 28 year old male with lower extremity paresis and right trochanteric ulcer in addition to sacral ulcer both Stage IV. b & c) 6 months following right vastuslateralis flap and skin graft in addition to bilateral VY gluteal fasciocutaneous flaps.



Figure 3: a) 15 year old female with spina bifida and Stage IV sacral ulcer of 2 years duration. b) Gluteal fasciocutaneous rotation flap at 3 months.

conducted to help guide in postoperative antibiotic use. The general consensus for optimal care is removal of as little bone as necessary. While some studies have shown osteotomy to be effective in reducing recurrences [26,27] and flap failures [28], others found no association between bone cultures, complications, and recurrences [29].

Many types of flaps are available as reconstructive techniques

to cover pressure sores. Musculocutaneous flaps were the first flaps introduced for pressure sores and have become the second line choice in treatment if a fasciocutaneous flap has failed or there is a defect size which warrants a larger soft tissue fill where a musculocutaneous flap is required [30]. Theoretically, muscular flaps offer the advantage of elimination of underlying dead space, rich vascular supply, tissue

cushioning, and enhanced bacterial clearing [31,32]. Studies have also shown that transferred muscle atrophies with up to 30% loss over time [33]. Muscle tissue, which is less tolerant to ischemia, may lead to earlier recurrence if it is subjected to a pressure environment once again. A systematic review by Sameem et al. reported a 18.6% complication rate, 9% necrosis rate, 7.5% infection rate, and 8.9% recurrence rate for musculocutaneous flaps. When taking musculocutaneous flaps, it is also important to remember the importance of donor morbidity, especially in non-paralyzed individuals, to preserve muscular function [34].

Fasciocutaneous flaps began gaining in popularity in the 1980s [35]. Fasciocutaneous flaps lack the muscular cushion of musculocutaneous flaps and depend on the deep fascia, subcutaneous tissue, and skin for its vascular supply. The theoretical advantage of fasciocutaneous flaps is the covering of bony pressure points only by fascia, subcutaneous fat, and skin directly, mirroring that of normal anatomy; in addition to the obvious advantage of muscle preservation. Studies of fasciocutaneous flaps have shown a reduction in donor site morbidity, minimal blood loss, decreased postoperative pain, shorter hospital stays, reduced costs, and preservation of muscle function [36,37]. When considering complications, Thiessen et al. reported no differences in infection, hematoma, seroma, dehiscence, and need for reoperation between fasciocutaneous and musculocutaneous flaps [38]. Similar findings by Sameem with 11.7% complication rate, 5.1% necrosis rate, 6.9%

infection rate, and 11.2% recurrence rate [34] are supported by several other studies [39,40].

Perforator based flaps have gained popularity since their use twenty years ago [41]. Perforator flaps contain vasculature that course from underlying vascular supply toward tissue surface. Advantages of the perforator flap include preservation of original vascular supply and longer pedicle lengths for flap advancement. However, perforator flaps are also more tedious to dissect [41,42] and are more prone to venous congestion [43]. From a performance perspective, Sameem found perforator-based flaps to have worse complication rates but improved recurrence rate compared to both musculocutaneous and fasciocutaneous flaps [34]. Based on literature, musculocutaneous, fasciocutaneous, and perforator flaps could perhaps be more appropriately selected through advantages rather than possible complication or recurrence rates of the flap.

Although less commonly used, other flaps for pressure sores include free flaps. Free flaps can be taken from parascapular region, latissimusdorsi, or as fillet flaps from the leg and have been shown to produce good results [44]. Indications for free flap coverage include absence of local flap tissue especially in the multiply recurrent pressure sores. Biplanar flaps incorporate a transposed muscle flap with a rotated fasciocutaneous flap to cover the underlying muscle flap

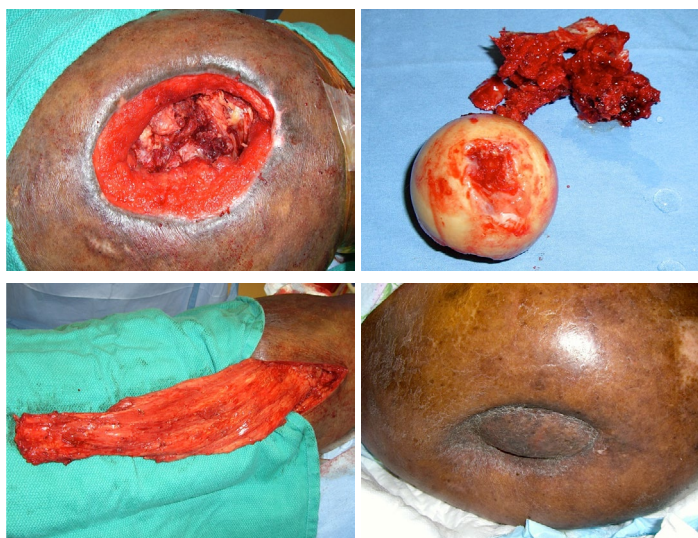


Figure 4: a) Right greater trochanter Stage IV ulcer in 60 year old patient who is non-ambulatory secondary to stroke. b) Girdlestone resection specimen. c) Vastuslateralis muscle flap at time of harvest. d) 5 months following vastuslateralis muscle flap and skin graft reconstruction.

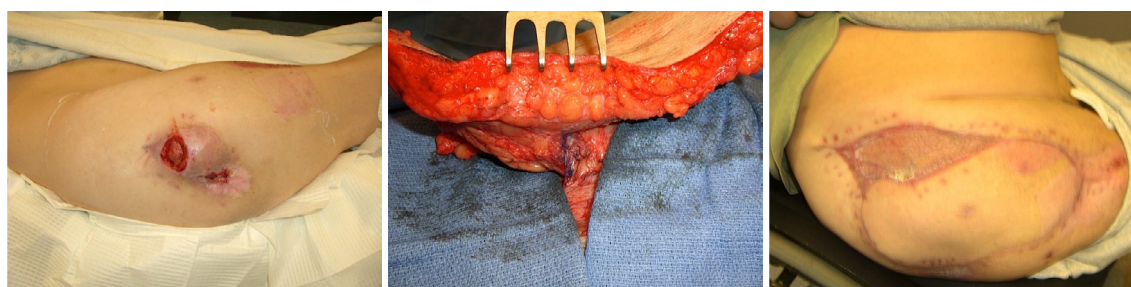


Figure 5: a) 37 year old male with history of right trochanteric decubitus ulcer occurring in previous flap reconstruction. b) Tensor fascia latae perforator flap at time of harvest. c) 4 months following reconstruction with skin graft reconstruction of donor site.



Figure 6: a) 39 year old with spinal cord lesion in past with long standing history of a sacral pressure sore and recent left femur fracture requiring Girdlestone resection. b) Xray of left femur fracture and diffuse osteomyelitis of the left hip with heterotopic ossification. c) Left lower extremity specimen. d) Anterior thigh flap used to reconstruct defect. e) 3 week postoperative view of above knee stump.

(Figure 3). Biplanar flaps have also been utilized with good results [45]. Amputations, hemicorpectomies, or salvage flaps should be reserved as a last resort for patients with recalcitrant ulcers or septic patients with uncontrollable infection. Surgery is not without risks since with any chronic wound, malignant degeneration into Marjolin's ulcer is a possibility. Biopsies are indicated in chronic wounds with changes in appearance especially when patients experience increased pain, foul discharge, or bleeding [46].

Ischial Defects

Ischial pressure sores occur in patients who remain in the sitting position for prolonged periods of time, being most of these patients paraplegic [8]. They usually have a minor skin defect accompanied by deep tissue loss and a large, penetrating ischial tuberosity [47], requiring adequate padding at the time of reconstruction. They are the most complicated pressure sore to treat and have the highest recurrence rate, between 20-75% [38,48-50], since patients almost always return to their chair-bound position [51]. If treated with non-surgical methods, the recurrence rate reaches 77% [9]. There have been various types of flaps suggested for the reconstruction of ischial defects, but among the most commonly used are the ones in the gluteal region and posterior thigh [48]. The latter present a disadvantage since their origin is in the leg, causing them to suffer shear forces with leg movement and closure of the flap under tension.

Gluteus maximusmyocutaneous flap

The gluteus maximusmyocutaneous flap, described by Minami et al. in 1977 [30], remains one of the first options in surgical management for ischial reconstruction [12,52]. It receives its vascular supply from the superior gluteal artery and can be designed as a rotational or an advancement flap. Among its advantages are that it can be revised and re-advanced if there is any recurrence, and its sutures do not lie on pressure zones [12]. It can also fill in undermined ulcers with skin removal, however if the defect is big, a combination of flaps may be needed [22,53].

To harvest this flap the incision is made just lateral to the gluteal crease, extending it superior and laterally to the defect, but remaining medial to the greater trochanter. The muscle is then elevated from its inferior border by dissecting into the areolar plane, which is below the muscle and above the sciatic nerve. The dissection should be continued until an adequate size is acquired to fully fill the defect, and then the muscle is transected. Finally the flap is placed into position by suturing the excess muscle into the depth of the wound, and closure is performed by layers [30].

Although it is one of the first options among reconstruction, it compromises muscle function and should be avoided in patients that ambulate. It is also may be prone to post-operative skin breakdown because of tension [22], and has been shown to have a recurrence rate between 0-8.3% [34,54].

Inferior gluteus maximus island flap

The gluteus muscle is divided in a superior and inferior half based on their blood supply, which in this case is the inferior gluteal artery. Then the flap is elevated, including only the inferior half of the muscle, and rotated into the defect. The donor site can be closed primarily [55]. A recurrence rate of 9.7% has been reported [34].

Variations that can be used in patients where ambulation should be conserved are:

- Split inferior gluteal muscle flap which is less debilitating [8], with an 8.3% recurrence rate [56].
- Inferior Gluteal Artery Perforator Flap, a fasciocutaneous flap, described for ischial pressure sores by Higgins et al. in 2002 [57], that takes its vascular supply from the inferior gluteal artery perforators, leaving the underlying gluteal muscle intact [58,59]. It is shaped elliptically, and then positioned parallel to the tension line [37]. It is versatile enough to allow various flap designs, allows closure without tension and preserves tissue for future flaps [58]. According to Kim et al., it has a recurrence rate of 21.7% [37].

Posterior thigh flaps

The posterior thigh flaps have been widely used in pressure sore reconstruction, mainly because they provide bulk and coverage, while maintaining tissue integrity for future flaps in case recurrence occurs [46]. Their main disadvantage is their origin in the thigh, which exposes them to friction against the ischial tuberosity when the patient extends or flexes extremities and to increased pressure when the patient remains seated [22].

V-Y hamstring advancement flap

As its name suggests, it is based on the Hamstring muscles (mainly the biceps femoris muscle, but can include the semitendinosus and semimembranosus muscles) and it receives its vascular supply from the biceps femoris perforators [22]. It is indicated in small to medium defects [8], whether primary or recurrent, and its versatility allows it to be used both in ambulatory patients and in those with spinal-cord lesions by just modifying its muscle content. It also has a bulky muscle component that protects the bony prominence and that could be used for large ischial defects [22]. It has a recurrence rate of ~18% [34].

The flap landmarks are from the gluteal to the popliteal crease, and from the gracilis muscle to the fascia lata. The flap is elevated deep from the underlying fascia, with the sciatic nerve marking the deep landmarks. The biceps femoris long head is included in the flap, by separating it from the short head, as well as the semitendinosus and semimembranosus muscles, by transecting them at their origin and insertion tendon junction. If flexion of the knee must be preserved, these last two muscles are not included in the flap. Then the proximal part of the flap is advanced into the ischial defect and closed without tension, and the distal part is closed by V-Y technique [53,60].

Medial thigh advancement fasciocutaneous flap

With its base on the posterior-medial thigh, this flap allows adequate coverage of the defect since it has a great degree of rotation [8]. As described by Homma et al., it receives its vascular supply mainly from the musculocutaneous perforators from either the adductor magnus muscle or the gracilis [61]. Its disadvantage is the amount of pressure and shear forces it endures since it is localized on the leg [58].

The flap is raised off the hamstring fascia, and then is rotated towards the ischial defect, and sutured with double layer closure. The distal part of the donor site should be skin grafted [53].

Ahluwalia et al. reported 7% recurrence rate (when combined with the biceps femoris muscle), and Homma et al. a 27.3% recurrence rate [62].

Posterior thigh fasciocutaneous flap

It is available if there is no deep scarring of the posterior thigh, and can be used with the gracilis flap to fill up the dead space [22]. Its recurrence rate has been reported to be 8 to 16% [34,63].

Inferior gluteal posterior thigh flap

This fasciocutaneous flap has been commonly used for ischial reconstruction, it is similar to the hamstring flap but does not include muscles. Its blood supply is from the descending branch of the inferior gluteal artery [53].

Gracilismyocutaneous island

The gracilis muscle flap is the most extensively used for free tissue transfer [58]. It is located in the medial thigh, and receives its vascular supply from a branch of the medial femoral circumflex artery. It is an excellent flap for small to medium defects, but should be used with caution in patients with atrophy since failure of the skin portion has been a problem. Other advantages are that transfer of the muscle leaves no functional deficit, and the donor site can be closed primarily [53]. Its recurrence rate has been reported to be between 8.3-14.3% [34].

The incision line must be planned with the patient in supine position with slight abduction, because the lax gracilis muscle might migrate when placing the patient in a lithotomy position. The skin paddle is designed posterior to this line. After the incision is made, the gracilis muscle is dissected distal to proximal, its tendon is divided and its proximal pedicle is preserved. Then a subcutaneous tunnel is created to pull the gracilis into the ischial cavity, and the donor site is closed primarily by layers [47,53,58].

Tensor fascia latae flap

Although it is mostly used for trochanteric defects, this flap is indicated in patients with spinal cord injury below L3 because it brings sensitivity to the ischial area [8,12]. It is based on the ascending branch of the lateral circumflex femoral artery. It has a reliable pedicle, however, occasionally cannot quite reach the zone of the defect, causing its distal part to undergo necrosis rather easily [63]. 21.1% recurrence rate has been reported [34].

Other flaps have been mentioned in the literature like the Adipofascial turnover fasciocutaneous flap (recurrence rate between 6.7-9.1%) [34,63], the “three muscle flap” which is for big, deep pressure sores and depends on the descending branch of the lateral femoral circumflex artery for its vascular supply [64], lateral and anterior thigh fasciocutaneous flap, rectus abdominis myocutaneous flap, adductor muscle perforator flap, and sclerotherapy, among others [8,58].

Sacral Defects

Sacral pressure sores are commonly seen in patients that remain in the supine position. They can be managed with skin grafting if the defect is small and/or secondary to acute/short-term disability. However, their recurrence rate has been as high as 70% with this method [8], demonstrating that more bulk is necessary to achieve healing. For this

reason flaps have been used. Amongst the most common flaps for this area are the ones based on the Gluteus Maximus [22], because of its proximity to the lesion. Yamamoto et al. reported a total recurrence rate of 21%, with fasciocutaneous flaps recurring 17% of the time [50]. Additionally to flaps, Wong and Ip recommend the release of flexion contractures since it facilitates passive movement and nursing care [65]. This is commonly done with botulinum toxin injections.

Gluteus maximus musculocutaneous flap

Just as in the ischial defect, the gluteus maximus musculocutaneous flap remains the first choice for sacral pressure sore reconstruction [12]. In this case it is based inferior and medially, and its vascular supply is the superior gluteal artery. When elevating this flap, the key point is the piriformis muscle since it is through there where the vascular supply emerges [30]. For more details refer to the ischial defects section. According to the review done by Sameem et al., the recurrence rate reaches 7.7% [34].

V-Y gluteus maximus flap

Since Parry and Mathes introduced the bilateral gluteal advancement flap, it has remained a popular option for sacral pressure sore management. It can be used as a musculocutaneous or fasciocutaneous flap, receives its vasculature from the gluteal artery and its innervation from the inferior gluteal nerve. Its recurrence rate approximates 6.3% [34].

When harvesting this flap, you elevate both superior and inferior arms, advance them and close in layers in a straight fashion or in “zig-zag”; the later diminishes tension and allows more healthy tissue to cover the defect [66].

Superior gluteal artery island flap

A musculocutaneous flap similar to the inferior gluteal island flap for ischial defects is the superior gluteal island flap and is a good option for sacral defects that provides adequate tissue coverage and protection, and preserves muscle function by leaving the inferior gluteal nerve intact, so it can be used in ambulant patients [55]. Korambayil et al. reported no recurrence [67].

Superior gluteal artery perforator flap

This fasciocutaneous flap is commonly used in breast reconstruction, but is also used in sacral ulcer repair, especially for small defects. Its pedicle can be rotated to fit the defect, but it is not a flap that can easily be revised [22]. According to the review published by Sameem et al., there were no reported recurrence rates with this flap [34].

Gluteal rotation flap

A fasciocutaneous flap, with an inferior base, and vascular supply from the superficial branch of the superior gluteal artery and from the inferior gluteal artery [53]. Despite this excellent blood supply, Wong et al. found a recurrence rate of 24% compared to zero percent when they used musculocutaneous flaps. The surgical technique is similar to the musculocutaneous flap, except for the fact that the muscle is spared. It also has the advantage that it can be re-advanced / rotated [65].

When there is no more available tissue, other flaps should be considered, among the most common secondary treatment flaps are the transverse back flap [9], filet leg flap, and latissimusdorsi flap [34,44].

Trochanteric Defects

Trochanteric ulcers arise secondary to direct pressure from the

greater trochanter, and are typically found in patients lying in prolonged lateral decubitus position. They are less common than ischial and sacral ulcers, but still represent 12-19% of all pressure sores [68,69]. Nonsurgical therapy is estimated to work in 41% of patients according to one study [70], while surgery is typically reserved for Stage III and IV ulcers. Because of the tension on the lateral hip tissue, direct wound closure is usually not possible. Ulcer recurrence is mainly secondary to the insensate wound site with rates as high as 80% [71]. The ulcer could extend into the trochanteric bursa causing septic destruction of the hip joint. In these situations a Girdlestone resection may be required.

Tensor Fascia Lata (TFL) musculocutaneous flap and its modifications are the most commonly used flaps in trochanteric ulcer closure [72-74]. The TFL is supplied by the ascending branch of the lateral femoral circumflex artery. Sensory innervation is by the cutaneous sensory nerve of the thigh and lateral femoral cutaneous nerve distally. Motor innervation is through branches of the superior gluteal nerve. Anteriorly, the flap is located within the boundaries of the anterior superior iliac spine axis to the lateral patella and posteriorly, the axis of the femur. The flap is lifted distal to proximal with proper identification of descending and ascending branches of the lateral circumflex femoral artery, respectively. The vascular pedicle of the lateral circumflex femoral artery is typically 10 cm below the anterior superior iliac spine. The length of the flap is determined by the distance between the pivot point of the flap and the posterior border of the ulcer.

The TFL is an ideal muscle for this flap because of its lack of use as a functional muscle and its 10 cm pedicle length. In addition, its lumbar innervation helps provide sensation for patients with spinal injuries. Good results have typically been reported with this flap and its modifications [75,76]. TFL flaps as a VY advancement flap is typically used for ulcers that are small to medium sized [74]. For larger ulcers, the TFL can be used as a rotation flap. Disadvantages of the TFL flap include necrosis of distal flap secondary to poor blood supply especially when extended to 8-10 cm proximal to knee [77-79]. In addition, excessive tension resulting in suture separation has also been reported at the donor site [80,81]. Donor defects can be closed with a split-thickness skin graft. Aesthetically, the TFL also has the disadvantage of dog-ear deformity. Attempts to alleviate these issues have led modifications to bilobed and duck flaps with good results [76,80,81].

Second line treatments for trochanteric ulcers include anterolateral thigh flap, vastus lateralis flap, rectus femoris muscle flap, and gluteus maximus flap [53,82,83]. These flaps can also be combined to form chimeric flaps [84]. The Anterolateral Thigh Flap (ALT) was first developed by Kimata et al. for perineal reconstruction with subsequent application to trochanteric defects with success [85-88]. Advantages of the ALT include a long vascular pedicle and a relatively unrestricted arc of rotation. Disadvantages include tedious and time consuming dissection. Attempts to simplify for the ALT through myocutaneous instead of pedicled flaps have been reported by Wang et al. with good results [89]. Other reported flaps include gluteus medius flap, random thigh flap, and random bipedicled flap (Figure 5).

The major complication of trochanteric ulcers is septic arthritis with joint destruction. Joint and bone debridement followed by the Girdlestone procedure and muscle flap closure is the treatment of choice [90-92]. Rectus femoris flaps can be used for small defects while a vastus lateralis muscle flap or a combined vastus TFL flap can be used for larger defects (Figure 4).

Post-Operative Care

Post-operative management for pressure sores include appropriate wound care as to reduce infection, tension, and dehiscence. Non-surgical preventive measures should still be applied to post-operative patients. Traditionally 6 weeks of immobilization is practiced, while Kierney et al. recommended 3 weeks of immobilization with air-fluid Clinitron or KinAire beds [39]. In addition, physical therapy is also important to prevent contractions, decrease DVT, and other typical post-operative complications. Progressive sitting should begin with gradual increase to pressure release maneuvers. However, special care must be taken in spinal cord patients as denervated tissue heals less efficiently [93]. Ulcer recurrence rates following flap intervention typically range between 13% to 31% [39,94] and the most vulnerable time for flap failure range from 15-22 months post operatively [71,95]. Recurrences and flap failures are due to a multitude of factors. Age < 45 years at surgery time, history of same-site failure, poor diabetes control, prealbumin less than 20 mg/dL and ischial wound location are found to be significant predictors of dehiscence and recurrence [49]. The recurrence in younger population is hypothesized to be secondary to poor compliance with long bed rests and higher incidence of traumatic denervating injuries. Interestingly, while one study suggested that poor hygiene, malnutrition, and anemia are associated with recurrences [96], Larson, however, found that preoperative albumin and prealbumin levels are not associated [29].

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