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WOUND CARE AFTER INJURY (H KAAFARANI AND J GOVERMAN, SECTION EDITORS)

An Overview of Sacral Decubitus Ulcer

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Abstract

Purpose of Review Pressure injuries, known as decubitus ulcers, are a challenge to the healthcare community. One of the most common sites involved is the sacrum.

Recent Findings There are four main factors that cause pressure injuries: pressure over bony prominence, shear force, destruction of skin, and compromised blood flow.

Summary While primary prevention of pressure ulcers remains essential, sound wound care, optimization of nutrition, and secondary prevention of ulcer deterioration are the main components of management of this complex clinical entity. In addition, various novel surgical reconstruction flaps (e.g., V-Y fasciocutaneous advancement and gluteus maximus muscle rotation flaps) can help with early tissue coverage and fasten recovery.

Keywords Sacral decubitus ulcer · Pressure injury · Pressure · Risk · Prevention · Treatment

Introduction

In 2016, the National Pressure Ulcer Advisory Panel replaced the term "pressure ulcer" with the term "pressure injury" since it more accurately describes pressure injuries to both intact and ulcerated skin [1••]. Pressure injuries, also known as decubitus ulcers, are a challenge to the healthcare community as they can be difficult to manage, result in a large financial burden, and psychosocially impact the patient, family, and healthcare providers. There are four main factors that contribute to the occurrence of pressure injuries: pressure over bony prominence, shear force, destruction of skin, and compromised blood flow [2]. The body part with the highest risk for forming a pressure injury is the sacrum [3]. Critically ill, functionally dependent, or paraplegic/quadriplegic patients lying in a supine position for extended periods of time are at an especially increased risk for developing sacral decubitus ulcers [4]. Early and aggressive intervention is important to improve a patient's quality of life, decrease infection and mortality, and facilitate rehabilitation [5]. Such interventions need to aim at optimizing the patient's nutrition, managing his/her overall medical condition, and decreasing further external pressure in the sacral region [5, 6].

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Epidemiology

Approximately 62% of pressure injuries occur in three different regions: ischium, sacrum, and trochanter [7•]. The anatomical location of the sacrum at the end of the spinal column causes the sacral skin to be exposed to higher pressures as well as fecal and urine secretion, which may ultimately result in the formation of a sacral decubitus ulcer [8, 9]. A national study published in 2000 measured both the prevalence and the

incidence of pressure injuries in 17,560 patients in acute care facilities from 34 states. The study found that the most common pressure injury site was the sacrum with a prevalence of 26% and incidence of 31% [10]. In another comparative study, it was suggested that the sacrum is more prone to developing a pressure injury especially because the skin overlying the area is thinner than most other posterior areas of the body [11].

Similarly, a more recent study utilizing the Nationwide Inpatient Sample (NIS) database between 2008 and 2012 found that almost half of pressure injuries develop in the sacrum [12•].

Financial Burden and Psychosocial Impact

In the USA, the fastest growing segments of the population are those over 65 years of age [13]. In addition, there have been increased rates of obesity, diabetes, and cardiovascular disease, all leading to more people needing assistance with daily activities due to decreased mobility [13, 14]. Decreased mobility results in increased rates of pressure injury, burdening further the American healthcare system [15]. Specifically, in the USA alone, an estimated $11 billion dollars is spent on pressure injuries yearly, with up to $70,000 being spent on the care and management of one patient with a pressure injury [16]. On October 1, 2008, the Centers for Medicare and Medicaid Services announced that they will no longer pay for additional cost of care for hospital-acquired pressure ulcers [17].

In addition to the financial and clinical burden, sacral decubitus ulcers affect patients psychosocially, often severely and negatively impacting their mood and self-esteem [18]. As a result, they tend to experience loss of control of the situation and many manifest such feelings by persistently asking their healthcare providers to be more involved in decisions regarding their care and management [19].

Pathophysiology

One of the main causes of pressure injury formation is added pressure for an extended period of time that results in the obstruction of healthy capillary blood flow and resulting in local tissue necrosis [20, 21]. Friction at the skin surface, shear forces, and moisture can also damage the skin and lead to pressure injury formation [20]. The skin necrosis is typically the "tip of the iceberg," as the skin often masks larger, deeper, and more extensive ulcers, as it is more resistant to ischemia than the muscle [4].

Tissue ischemia occurs at the sacrum when the external pressure exceeds 33 mmHg [5, 22]. This prevents the delivery of oxygen and nutrients to the tissues, resulting in tissue anoxia/hypoxia, accumulation of metabolic waste products, and free radical generation [20, 23]. Obstruction of a capillary bed for more than 2 h will commonly lead to irreversible tissue damage [24]. However, it is important to note that depending on a patient's severity of illness and comorbidity, tissue damage may occur with lower external pressure [21]. Furthermore, critically ill patients are sometimes unstable and often have multiple monitoring devices and catheters attached making it difficult to routinely turn them over or reposition them, increasing further their risk of forming a pressure injury [25].

Clinical Staging

Pressure injuries are categorized into four different stages Fig. 1 (stage 1 not depicted). The most up to date clinical staging of pressure injuries, based on the 2016 National Pressure Ulcer Advisory Panel (NPUAP) guidelines, can found be in Fig. 2 [26••].

Stages 1 and 2 pressure injuries should be kept under observation, and all measures of prevention should be applied [7•]. Aging, medical conditions (such as diabetes or infection), smoking habits, or medications (such as anti-inflammatory drugs) can slow down the healing process of these pressure injuries [27•]. On the other hand, the optimal treatment method for pressure injuries in stages 3 and 4 can be difficult and most often requires surgical intervention [7•, 27•].

Risk Factors

There are multiple risk factors that contribute to the formation of a sacral decubitus ulcer: immobility, sensory loss, malnutrition, steroids, diabetes, reduced perfusion, and spinal cord injury.

Immobility Immobility, such in paraplegic or critically ill patients, is one of the most important contributing factors to the development of pressure injuries. In healthy individuals, a sensorimotor feedback system allows them to change their posture frequently which results in relief from exerted pressure [22]. This feedback system is diminished in patients with sensory deficits or motor weakness/paralysis and prevents them from changing their posture when pressure is exerted [22]. The inability to change position when excessive pressure is exerted often leads to the development of sacral decubitus ulcers. An adequate support system can help paraplegic patients to properly manage their medical care and help prevent sacral decubitus ulcers [28].

Sensory Loss The loss of sensory perception or impaired level of consciousness prevents a patient from perceiving the pain of pressure and the need to relieve it [22]. It turns out that patients affected by poliomyelitis are less prone to developing a pressure injury than paraplegic patients, suggesting that sensory loss is a key factor in the development of a pressure injury

Fig. 1 Stages of sacral decubitus ulcer. Stage 2 (*above*), stage 3 (*left bottom*), and stage 4 (*right bottom*)

[22]. As such, postoperative epidural analgesia diminishes sensation and mobility, and may be associated with the development of severe sacral decubitus ulcers in the elderly malnourished patients [29]. The ability to sense pain and pressure prevents a patient from experiencing prolonged pressure that would cause tissue ischemia, and ultimately the development of a sacral decubitus ulcer.

Malnutrition It is important that nutritional parameters and lab values are consistently evaluated by healthcare providers and that patients at risk of developing a pressure injury receive a nutritional consult. Adequate nutrition that includes fluids, adequate caloric and protein intake, vitamins, and minerals is key to prevent pressure injuries [22]. An animal study found that malnourished animals developed a greater degree of ischemic skin destruction than well-nourished animals, when exposed to similar amounts of pressure [30]. Hypoalbuminemia as a marker of malnourishment is a risk factor for the development of pressure injuries. In addition, it can result in interstitial edema, decrease the delivery of nutrients to damaged tissues, and impact the healing of pressure injuries [31, 32]. In one study, sacral skin thickness decreased by 60% under high compression, and it was found that patients with low body mass index are more prone to developing a sacral decubitus ulcer [33]. Therefore, it is important to promptly correct nutritional deficiencies in malnourished patients as nutritional optimization contributes to the maintenance of sacral skin integrity.

Steroids Several studies in literature suggest that the use of steroids is independently associated with the development of pressure injuries [34, 35]. Despite the beneficial effects of steroids, they can delay healing of sacral decubitus ulcers, especially when used for an extended period of time.

Diabetes According to the American Diabetes Association, the prevalence of diabetes in the American population is 9.4%, making it the seventh leading cause of death in the USA [5]. Diabetes is a risk factor for pressure injuries since it decreases pain and sensation, which prevents the patient from perceiving and subsequently relieving prolonged pressure. Furthermore, it affects the stiffness properties of connective tissue and decreases the ability of the skin to mitigate exerted pressure, in this case, the sacral skin [36•]. It is important for a diabetic patient to control his or her blood sugars as this can also cause cellular dysfunction that will further delay the healing of pressure injuries [37].

Reduced Perfusion Reduced blood perfusion results in the obstruction of blood flow in the sacral skin. This leads to tissue ischemia and oxygen deprivation that makes the skin more prone to developing a sacral decubitus ulcer [9, 29]. This risk factor is especially increased in critical patients in the intensive care unit due to shock, organ dysfunction, and use of vasopressors.

Spinal Cord Injury Patients with a spinal cord injury are at the highest risk for developing a sacral decubitus ulcer due to the loss of motor function and immobility, the decreased sensation of pain and pressure, and the compromised local blood flow. Several studies have shown that patients with a spinal cord

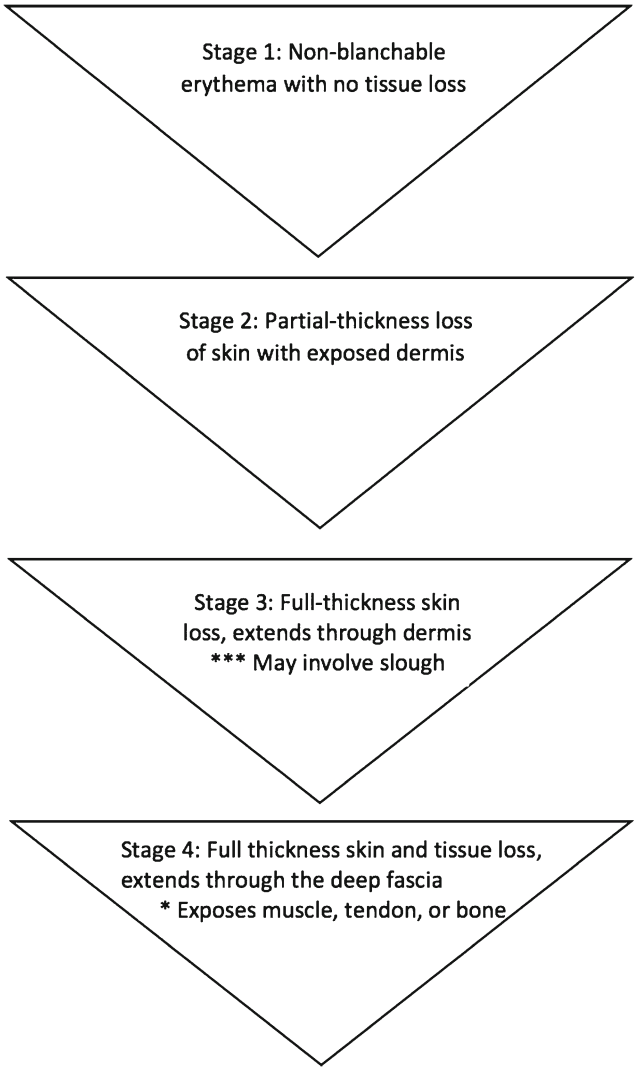

Fig. 2 Clinical staging of pressure ulcers based on the 2016 National Pressure Ulcer Advisory Panel

injury have decreased sacral skin blood flow in response to short periods of external pressure loading compared with healthy participants [8, 38–40].

Risk Prediction

The most commonly used tools used to predict patients' risks of developing sacral pressure injuries are the Norton and Braden scales [5, 21].

Norton Scale The Norton scale is the first pressure injury risk assessment scale developed in 1962 [41]. It evaluates five items: physical condition, activity, mobility, incontinence, and mental status [2, 41, 42]. Each item is scored with a value of 1 (worst condition) to 4 (best condition) [42]. The total Norton score is the sum of all five items, and a score < 14 is indicative of high risk for pressure injury development [42, 43]. Since the 1980s, several new risk assessment scales have been developed that are based on the Norton scale, but the Norton scale remains the most popular and the most widely used risk assessment tool [41].

Braden Scale The Braden scale is most frequently used in research and is also recommended to predict the risk of pressure injury formation [41, 44]. This scale uses six risk factors as its categories: sensory perception, moisture, activity, mobility, nutrition, and friction/shear [2, 5, 45]. All categories are rated on a scale from 1 to 4, except the friction category, which is on a scale to 3 [5]. The closer the score is to the maximum of 23, the lower the risk of developing a pressure injury, and scores ≤ 18 are considered high risk [5].

Comparison of the Braden and Norton Scale A few studies have suggested that the Braden scale is a better and more validated decubitus ulcer risk predictor than the Norton scale [2, 44]. However, other data often point out that the effectiveness of formal risk assessment instruments is not greater than clinical judgement in predicting and preventing pressure injuries [2, 46–48]. Resources associated with the use of these tools might be better spent on daily skin inspection and improving management targeted at specific risks [48]. A proper history and physical examination should identify potential risk factors, and specific interventions can be implemented accordingly [49].

Prevention, Management, and Care

The prevention, management, and care of sacral decubitus ulcers require a multifaceted approach, including skin care, pressure redistribution, pressure reduction, and nutrition optimization.

Skin Care Proper skin care is important in the prevention of sacral decubitus ulcers. For this reason, the condition of the skin overlying the sacrum should be inspected and documented daily [50]. The sacral skin must be kept moisturized without oversaturation [51]. Lotions containing fatty acids protect the skin against friction, pressure, and reduce hyperproliferative skin growth [52].

Perspiration, excessive wound drainage, and urinary or fecal incontinence result in an excessively moist environment that enhances the tissue damaging effects of pressure, friction, and shear [53]. Friction and moisture exert their greatest effects in areas of high pressure, such as the sacrum of a bedridden patient in the supine position or using a wheelchair [53]. For this reason, excess moisture or skin oversaturation should be minimized to prevent the development of sacral decubitus ulcers.

Pressure Redistribution Both static (i.e., mattresses or foam) and dynamic (i.e., alternating-pressure beds) pressure redistribution options exist, but no definitive data has proven one method to be best [51]. Despite their high cost, many hospitals use some sort of specialized mattresses for patients with pressure injuries [54]. Their purpose of repositioning an individual is to reduce the quantity and duration between a patient and his or her resting surface [54]. A recent Cochrane review identified 52 randomized control trials and concluded that patients at high risk for developing pressure injuries should have specialized mattresses instead of regular hospital mattresses [55•].

The frequency of repositioning or ideal position for patients with pressure injuries has been examined in various studies, but the evidence is insufficient to suggest an optimal protocol [56]. A study found that frequent changes of a patient's position, such as lateral tilt or repeated head elevation, cause deformation of the sacral skin that could result in pressure injury formation [57]. Despite the inconclusiveness of pressure redistribution, repositioning is considered to be beneficial, since excessive pressure for prolonged periods of time can decrease capillary blood flow resulting in pressure injuries [58].

Pressure Reducing Dressings Dressings have traditionally been used as a treatment for existing ulcers. Recent studies have examined the role of multilayer foam dressing in preventing sacral decubitus ulcers. One of those studies specifically showed that in critically ill patients, a multi-layered soft silicone foam dressing is effective in preventing sacral decubitus ulcers when applied in the emergency department before transfer to the intensive care unit [59•]. In two studies, it was found that a prophylactic sacral dressing can prevent hospital-acquired sacral decubitus ulcers [60•, 61•]. Another study used polyurethane foam dressing and found it to not only be effective in reducing the rate of sacral decubitus ulcer formation in elderly patients with hip fractures but also to decrease the overall cost of patient care [62•]. Applying multilayer foam dressings to the sacrum mitigates the loading force applied to the skin and helps prevent the development of sacral decubitus ulcers.

Nutrition Interventions aimed at improving patients' nutrition help prevent pressure injuries and fasten their healing when they have already occurred [49, 63, 64].

Surgical Procedures

Debridement The initial surgical intervention and management of sacral decubitus ulcers with necrotic tissue is debridement. In addition to removing necrotic tissue, debridement provides tissue for culture and biopsy when infection is suspected, and prepares the ulcer for future reconstruction [5]. The ultimate goal of debridement is to create a bed of well-granulated tissue throughout the ulcer cavity that will heal with re-epithelialization [15]. A few debridement options include non-surgical mechanical, biological, enzymatic, autolytic, chemical, and surgical methods [5, 54].

- *Non-surgical mechanical debridement* includes wet to dry dressings, wound cleansing, and the use of acoustic energy in the form of ultrasound [5, 54]. Low-frequency ultrasound can be used to decrease bioburden of the ulcer and speed its healing [65].
- *Biological debridement* includes sterile larvae or maggot therapy [5, 54]. When a patient cannot tolerate surgical debridement, he or she can undergo medical maggot debridement, in which maggots remove dead tissue that allows the pressure injury to heal [66].
- *Enzymatic debridement* uses preparations such as collagenase [54].
- *Autolytic debridement* uses naturally occurring enzymes that dissolve dead tissue under an occlusive dressing, such as hydrocolloid [54].
- *Chemical debridement* uses chemical compounds such as sodium hypochlorite (Dakin's solution) [54].
- *Surgical methods* include wide excision (centripetal) or centrifugal using a tangential hydrosurgery debridement device [5, 15]. The tissue should be resected until healthy bleeding tissue is encountered [15]. Among all the above debridement methods, surgery remains the most efficacious and the most effective.
- *Fecal diversion* with a colostomy or ileostomy might be needed in patients with advanced sacral decubitus ulcers if the ability to maintain the wound clean from fecal contents is seriously compromised.

Reconstruction Reconstruction for sacral decubitus ulcers has always been challenging. Recurrence rates can be extremely high. Patient selection, patient compliance, and overall nutritional status are the most critical aspects to a successful reconstruction. Wound coverage requires thick tissue to provide padding of bony prominences and to obliterate dead space [3, 67]. Reconstruction can be performed directly after debridement [5]. Delayed primary closure, however, is typically not an option due to the tissue deficit and the tension needed for wound closure. Split thickness skin grafting has an extremely high rate of recurrence as these grafts do not replace the missing muscle, adipose, or full thickness normal skin that is deficient. Flaps composed of muscle and/or fascia are more efficacious surgical method of reconstruction as they more appropriately replace the multiple tissue types that are required for durable coverage of these bony prominences. Flaps maintain their own named blood supply, and therefore have a strong anti-infection capability.

Fig. 3 Bilateral V to Y fasciocutaneous flap. Pre-surgical procedure (*above*), post operation (*center*), and 2.5 months post operation (*below*)

Furthermore, they can be used to fill dead space and preserve the structure integrity [3].

Table 1 Summary of different surgical options used when the gluteus maximus muscle has already been used

Type of flap	Description of flap
Distant fasciocutaneous flap	• Posterior thigh flap or extended tensor fasciae latae flap is used.
Vastus lateralis muscle transfer	• Tunneled under the skin to the defect • Muscle surface is covered with skin graft.
Disarticulation and total thigh flap	• Used when both gluteus maximus muscles are diminished, and sacral bone and pelvic floor are exposed. • Only used when no other option is available.

Some considerations when choosing the appropriate flap includes size, whether the ulcer is primary or recurrent, and the ambulatory status of the patient [4, 5]. Most commonly, the gluteus maximus muscle is used for coverage via rotation and/or advancement. The flap can include fascia and the overlying skin as well [68–70]. Bilateral or unilateral V to Y fasciocutaneous flaps, without the use of the gluteus muscle, are also frequently used for sacral decubitus ulcer closure (Fig. 3). Other surgical options are used when there is a complete loss of the gluteus maximus muscle. These are described in Table 1 [18].

The musculocutaneous flap is used to cover large defects in non-ambulatory patients and can be designed as a rotation flap, advancement island flap, or split flap depending on the size of the ulcer and whether it is primary or recurrent [18]. The advantages and disadvantages of each of these flaps are organized in Table 2 [18]. Furthermore, the musculocutaneous flap has the benefit of ample padding at the pressure point; however over time, the padded portion can experience muscular degeneration [71•]. Normally, the central portion of the gluteus muscle is thinner than the lateral side, so padding of the sacrum with a standard musculocutaneous flap is difficult [71•]. A fasciocutaneous flap, however, is thinner than a musculocutaneous flap, but can be advantageous during the process of flap rotation [71•]. Furthermore, a fasciocutaneous flap has lower rate of sacral decubitus ulcer recurrence than a musculocutaneous flap and is often preferred since it preserves the function of the gluteal muscles [18, 72–74]. A recent retrospective study indicated that there are no significant differences between the use of musculocutaneous flaps and fasciocutaneous flaps as a surgical technique in regard to early complications, postoperative morbidity, or ulcer recurrence [75].

There are many controversies as to whether the musculocutaneous or fasciocutaneous flap is the best surgical method for reconstruction of a sacral decubitus

Table 2 Summary of the advantages and disadvantages of different flap selections for sacral decubitus ulcer reconstruction surgery

Type of flap	Advantages	Disadvantages
Gluteus maximus as a myocutaneous rotation flap	• Covers large defects in non-ambulatory patients.	• Extensive dissection • Blood loss • Covers fasciocutaneous
Gluteus maximus sliding Island flap	• Used for small and medium defects • Less extensive dissection • Less blood loss • Ideal for ambulatory and sensory patients • Exposed bone is covered with muscle bulk.	• Requires a bilateral flap in larger defects
Gluteus maximus splitting flap	• Used for coccygeal ulcer • Less dissection • Less blood loss • Covers coccygeal bone with muscular bulk	• Not used for larger defects
Superior gluteal artery perforator flap	• Used for small defects • Ambulatory patients	• Requires careful dissection • Cannot be revised in cases of wound complications or recurrent ulceration

ulcer. A research study combined the advantages of both surgical techniques called the combined V-Y fasciocutaneous advancement and gluteus maximus muscle rotation flaps. This new method proved to provide sufficient padding, and has little muscle donor-site morbidity [71•]. Another flap known as the couple-kissing flap was introduced and proved to be successful for the reconstruction of sacral decubitus ulcer in elderly patients [27•]. The dual-dermal-barrier fashion flap was also reported to be effective in reconstructing sacral decubitus ulcers [76•]. Lastly, a surgical method known as "double-A" bilateral flaps based on perforators also proved to treat sacral decubitus ulcers [77].

Conclusion

Pressure injuries are more common in individuals bedridden in the supine position or using a wheelchair [27•]. One of the most common sites involved in developing a pressure injury is the sacrum. Management and care of sacral decubitus ulcers are multifaceted and involve optimizing nutrition, controlling infection, improving the overall medical and mental condition, and eliminating sources of external skin pressure [5]. It is essential for the patient to receive immediate care for a sacral decubitus ulcer, most importantly optimizing nutrition, topical wound care, and early aggressive surgical and reconstructive care. The advantages of such early and aggressive interventions include reducing the risk or progression of infection, improving the patient's quality of life, facilitating rehabilitation, and even decreasing patient mortality [5].

Compliance with Ethical Standards

Conflict of Interest The authors declare no conflicts of interest relevant to this manuscript.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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