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Risk Factors and Prevention of Pressure Injuries After Orthopedic Procedures: A Literature Review

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ABSTRACT

Aim: The objective of this narrative review was to summarize existing literature on the epidemiology, mechanisms, risk factors and prevention of pressure injuries following orthopedic surgery.

Materials and methods: A focused literature search was performed using recently published scientific literature related to pressure injuries, pressure ulcers, orthopedic surgery, fractures, hip fractures, perioperative care, device-associated injuries, nutrition, and early mobility.

Results: Patients with orthopedic conditions have a greater chance of developing pressure ulcers due to their pain from fractures, limited mobility, being on transport surfaces or in the hospital for long periods, the way they are positioned during surgery, delayed post-op mobilization, and use of casts, braces, and/or splints or other orthopedic devices. The main risk factors are age, frailty, lack of nutrition, hypoalbuminemia, problems with circulation, prolonged surgical time, skin being too moist, and uses of devices over time.

Conclusions: Pressure ulcers that occur after orthopedic surgery should be seen not just as complications of nursing care but also indicate a higher potential for issues related to perioperative care or quality of care. Prevention efforts to prevent pressure ulcers should start with patient admission to the hospital and continue through the time spent in surgery, rehabilitation, and discharge planning. A multi-disciplinary approach utilizing risk assessment, skin assessment, pressure relief, anticipating how to position the patient, nutrition, monitoring of the device used on the patient, and getting the patient out of bed as soon as possible post-operatively should help to decrease the potential for pressure ulcer development in orthopedic patients.

Keywords: pressure injury, pressure ulcer, fracture, hip fracture, prevention

1. Introduction

1.1. Definition of Pressure Injuries

Pressure injuries are referred to as localized destruction of the skin and/or underlying soft tissue usually occurring directly over bony prominences or within an area in which a medical device has been applied to the skin due to sustained pressure or sustained pressure and shear combined. This definition has great importance when assessing potential for development of injury to tissues prior to having an obvious break in the skin in patients in an orthopedic practice as tissue injury can occur prior to the development of skin breakdown. Therefore, the injury that is diagnosed postoperatively can be construed as the final expression of injury that

has been initiated at some stage during the period of immobilization, excessive time spent in one position or excessive pressure from a medical device over the time preceding surgery [1].

1.2. Vulnerability of Orthopedic Patients

Orthopedic patients present a special vulnerability for the development of pressure injuries. Many patients fracture their limbs and then have to lay on a stretcher, be carried on a stretcher, or lay in a hospital prior, postoperatively, or during transporting them from the hospital after sustaining a fracture. While laying on the stretcher, or mattress, they experience very severe pain; their mobility is greatly reduced and they are, therefore, unable to move about and reduce the amount of sustained pressure. Many orthopedic patients are required to have molds, splints, braces, dressings, and/or immobilization after surgery. In addition, the risk of pressure injury development is particularly great in older patients who have fragile skin, compromised vascular systems, or poor nutritional status [2,3].

1.3. Clinical Importance in Orthopedic Care

New research shows that pressure injuries are not an uncommon finding in orthopedic treatment. Studies show that there is a high overall incidence of pressure injuries in fracture populations, particularly with spinal fractures and hip fractures. Likewise, other groups of orthopedic injuries related to the use of devices are also considered an emerging clinically relevant subgroup of pressure injuries [4]. The evidence presented reinforces the idea that pressure injuries in orthopedics represent a perioperative quality of care issue, rather than just a postoperative wound issue.

This review summarizes recent literature published through PubMed on pressure injuries after orthopedic procedures, in regard to the epidemiology, pathophysiology, risk factors, and prevention strategies associated with orthopedic and fracture care.

2. Aim

This literature review aims to discuss the evidence available on the occurrence of pressure ulcers after orthopedic surgery. This paper will focus on the epidemiology, mechanisms of development, risk factors (patient and perioperative), causes related to devices, and prevention strategies, especially for patients with fractures and/or hip fractures. Specific consideration will be given to the effects of immobilization, prolonged surgical positioning,

nutritional status, orthopedic devices, and early mobilization on the development and prevention of pressure ulcers.

3. Methodology

Using PubMed as the primary database, a targeted narrative literature review was completed. The key search terms were in various combinations of "pressure injury," "pressure ulcer," "pressure sore," "orthopedic surgery," "orthopaedic surgery," "fracture patients," "hip fracture," "perioperative pressure injury," "medical device related pressure injury," "pressure injury prevention," "nutrition," and "mobilization." Only scientific papers published within five years of the search date were eligible for inclusion in the core evidence base.

Systematic reviews, meta analyses, prospective observational studies, retrospective cohort studies, and clinical perioperative reviews had the highest priority when selecting literature for the core evidence base. Studies that addressed an area of interest and met the inclusion

criteria were included in the review. Studies were classified as eligible if they provided epidemiology data, described mechanisms of development, identified risk factors, or discussed prevention or treatment of pressure injury in the setting of adult orthopedic, fracture patients, or perioperative patients. Broader studies conducted in hospitals or perioperative settings were included only if the findings could be directly related to care of patients with orthopedic conditions.

The authors did not conduct formal risk-of-bias assessments or meta analysis of the studies included in this article because it is a narrative review. The literature that was selected was synthesized thematically for purposes of this review and included epidemiology, mechanisms, risk factors (patient-related, perioperative device-related), prevention, nutritional support, and early mobilization.

4. Results

4.1. Epidemiological burden of pressure injury in orthopedic care

Research has shown that orthopedic and fracture patients carry an ongoing risk of developing pressure injuries. Jiao et al. have reported that there is a pooled incidence of 20.4% of pressure injuries developing in fracture patients, with rates even higher for those with spinal fractures and hip fractures. The most common anatomical locations affected by these injuries are the sacrococcygeal area of the body and the heels; both locations are affected by long periods of lying in the supine position, limitations to repositioning due to pain, and limited mobility after the injury.

This type of injury does not only occur in the ward. Studies that have been conducted on perioperative outcomes also indicate that pressure injuries are still a consideration as surgical complications, especially in patients who have had longer surgical procedures, and more complex medical conditions [5]. The issue of pressure injuries is of direct relevance to orthopedics because patients undergoing orthopedic surgeries often receive prolonged anesthesia, are fixed into a position for the duration of the surgery, and have restrictions on mobility after the surgery.

Orthopedic device-related injuries have also become more recognized recently based on the research published in the literature. Guan et al. found that there was a pooled incidence of 12.0% of having pressure injuries caused by orthopedic devices, thereby establishing that

pressure caused by devices was not just a secondary issue, but that it is a recurring cause of injuries and complications throughout the orthopedic pathway. This is particularly true for patients who have received casts, braces, splints, immobilizers, and traction systems.

Epidemiological evidence supports the conclusion that pressure injuries can lead to problems with patient's comfort, speed of rehabilitation and overall nursing workload and also help measure quality of care in orthopedic patients. Consequently, pressure injuries should be treated as clinically significant outcomes, not simply background disease. [6,7].

4.2. Orthopedic-specific mechanisms of tissue injury

The pathophysiology behind a pressure injury includes sustained tissue loading, microvascular deficiency, stagnant lymphatic drainage, impaired blood flow due to lack of oxygen to the tissues, the reperfusion of tissues that were previously starved for oxygen and ultimately shear and microclimate effects. In orthopedic pathways, these physiologic

functions become all the more relevant because they can occur over the course of multiple phases of care that involve repetitive events that load the same area due to insufficient capacity to absorb the total weight of the body.

Li et al. contributed to the evidence base for the orthopedic-specific model of intraoperatively-acquired pressure injury (IP63) in orthopedics by demonstrating through statistically significant studies that low pre-operative mobility, the presence of moisture on tissues resulting in an increase of compressive forces, and an prolonged duration of surgery were independent factors that contributed to the development of pressure injuries (IP63).

These findings are of importance because they identify multiple clinically relevant risk factors for developing an IP63 pressure injury; however, some of these risk factors are modifiable.

Risk of developing an IP63 pressure injury is further compounded by how the patient is positioned on the operating room table. A recent systematic review [8] demonstrated definitive evidence of operationally related harm resulting from the position taken while the patient is on an operating room table, including pressure ulcers occurring during the perioperative phase, nerve injuries, vascular impairment, as well as musculoskeletal complications, with a greater risk of these operating room/surgery-related challenges occurring during longer periods of surgery and/or during more technically demanding surgeries or surgical procedures.

Evidence from the literature indicates that there is a lack of recognition amongst clinicians of the development of an IP63 pressure injury while on the operating room table due to the fact that changes in skin integrity will not develop until after surgery. Savci et al. underscore the fact that most IP63 pressure injuries will be identified within 48 hours to 72 hours postoperatively, which can obscure their intraoperative origin unless perioperative assessment is systematic [9].

4.3. Patient-related risk factors

Advanced age continues to be one of the most significant links between injury to skin and injuries to those past their prime. Older orthopedic patients often experience thinner skin as well as diminished fat padding, reduced blood flow to the skin, and decreased tolerance for tissue distortion. These age-related biological changes occur frequently in concert with the presence of several comorbidities and frailty.

Evidence for this is especially strong in patients suffering from hip fractures. There were established associations between perioperative injuries and various factors including: malnutrition, low albumin levels, poor muscle tone, peripheral vascular disease, dementia, urinary tract infections, atrial fibrillation, and blood transfusions. The same authors demonstrated that developing a pressure ulcer may indicate a high risk of death within the following year; thus, it may be viewed as an indicator of an older patient's vulnerability to other types of medical problems rather than simply as an isolated issue.

Additionally, evidence from multiple literature reviews indicates that immobility and poor nutrition are common risk factors for along-out-the-shelving syndrome injuries. In particular, the pain from fractures, weakness, cognitive impairment, or after surgery limitations may prevent orthopedic patients from shifting body positions and contribute to protracted loading of the same areas of skin. Malnutrition will also adversely affect collagen formation, reduce

the potential for wounds to heal, and lower the amount of pressure that can be tolerated for extended periods of time.

Clinically, these factors interact. An older adult with a fracture, low albumin levels, edema, and limited ability to change position is at risk not just from one factor but from the interaction of multiple overlapping mechanisms that, when combined, decrease tissue resilience. In light of this, it is not surprising that the orthopedic pressure injury problem is frequently found in frail older adults.

4.4. Perioperative and device-related risk factors

When it comes to orthopedic patients, their risk in relation to and as a result of perioperative complications should not only be considered based on the factors of general frailty and impaired movement but also with regard to the age, edematous status/mobilization timing, the use of parenteral nutrition, blood transfusions, and glucose levels as these variables play a role in the development of pressure injuries [10]. Each of these factors plays a role in that they contribute to either tolerance or the duration of pressure that is applied and therefore is not provided enough time for relief.

In addition to the above, injuries resulting from the use of devices need to be considered independently. Guan et al. identified duration of device application as well as length of stay as major risk factors for pressure injury related to orthopedic devices [11]. This is particularly important to orthopedic practices that utilize external devices both for the treatment of patients and also for an extended period of time during recovery.

Further meta-analytic data supports this conclusion. For example, Zhang et al. found that medical-device related pressure injuries occur at a high frequency and are clinically relevant in the adult inpatient population, while Lee and Choi also documented that the development of device-specific protocols for the prevention of these injuries resulted in improved evidence of practice when these protocols are systematically implemented [12,13]. Much of this literature has included critically ill patients, however, the basic mechanism for persistent focal pressure due to the application of devices is fully applicable to orthopedic practice.

Additional synthesis from Gou et al. and Lyu et al. demonstrated that edema, immobility, extreme disease severity, prolonged device application and inconsistent use of preventive strategies contribute to increased risk of injury from the use of devices. In orthopedic practice,

it is critical that casts, braces, splints and immobilizers are considered to be active forms of assistance and therefore require continual evaluation of pressure interface effects, especially when there has been swelling, escalating pain, reduced feeling, or long term use.

4.5. Prevention bundles and structured prevention

The most current literature regarding prevention shows favoring multicomponent methods rather than isolated methods; Chaboyer et al., demonstrated that using pressure injury prevention bundles (PIPBs) reduced hospital-acquired pressure injuries, although the overall level of certainty of the studies were relatively low due to the heterogeneity in the sources. The general outcome in terms of direction of effect has been favourable.

There are further findings to support this position in the general nursing and implementation literature. According to Lovegrove et al., Prophylactic Dressings; Positioning Strategies, Support Surfaces and Combination Interventions represent some of the best evidence for

preventing pressure injury in high-risk adults. Similarly, Alshahrani et al., found that the most effective nursing interventions in critically ill adults could be classified into prevention bundles, repositioning and support surface strategies, medical-device related prevention strategies, and access to expert resources.

In addition, an orthopedic specific systematic review provided further support for this schema. This review by Zhou et al., collated 34 pieces of the best available evidence for pressure injury prevention in orthopaedic patients, and established that effective prevention requires, at a minimum, comprehensive risk assessment; support surfaces; repositioning; nutrition assessment; moisture and skin care; device related prevention; and education. This represents one of the few specialty specific prevention models available at this time.

Risk assessment is also an important aspect of risk assessment. Fulbrook and co-workers showed that structured assessments from structured assessors were not identical to those given by clinicians using their clinical judgment. Therefore; a structured assessment was associated with greater consistency in prescribing preventative measures and reducing the likelihood of an assessor underestimating an individual's vulnerability [14]. This holds particularly true within orthopaedic pathways as risk can fluctuate rapidly due to swelling, postponed operation and/or prosthetic use.

4.6. Nutrition and early mobilization

The concept of nutritional support being merely an adjunct to medical care is becoming increasingly difficult to support. A new Cochrane review by Langer et al. details how nutritional interventions continue to play a large role in both the prevention and treatment of pressure ulcers, with varying levels of evidence based on the specific type of nutritional intervention that are utilized [15]. The results from many of these interventions have been confirmed by an increasing amount of orthopedic studies. For instance, Moran et al. demonstrated that patients who received nutritional support after receiving treatment for hip fractures (one of the most at-risk populations for developing pressure ulcers) had a decreased incidence and severity of pressure ulcers compared to patients who did not have the benefit of receiving nutritional support [16].

Many orthopedic patients may not have their malnutrition diagnosed due to the focus of their acute care being on their fracture repair, pain management, and discharge planning, and may therefore have difficulty healing or resisting the effects of pressure, shear, and immobilization

from pressure ulcers as a result of receiving inadequate nutritional support. Therefore, while a nutritional screen is considered a supportive aspect to the prevention of pressure injuries, it is important to recognize that developing a nutritional screen should be incorporated into the pressure injury prevention process as a standard part of orthopaedic patient care.

Mobilizing patients as soon as possible after hip fracture surgery is the best way to avoid developing a new pressure injury. Agarwal et al. conducted a systematic review and meta-analysis showing how early mobilization improves patient outcomes after hip fracture surgery [17]. Gray et al. emphasize that there are many factors affecting early mobility after surgery, including patient-specific variables, surgical variables, and organizational factors. They noted that mobility is not just a goal of rehabilitation—it is also a factor that influences the risk of complications [18].

The significance of mobilizing patients is easily understood when considering the prevention of pressure injuries. By mobilizing a patient, natural pressure redistribution occurs and

prolonged tissue loading is broken up. When an individual is unable to mobilize soon after surgical intervention due to instability, pain, and/or fixation restrictions, other prevention techniques, such as repositioning the patient, the use of pressure-relieving support surfaces, and increased monitoring/surveillance, may be relied upon more heavily for skin protection. Therefore, planning for mobilization and skin protection are inseparable parts of the overall orthopedic skin protection plan.

5. Discussion

The information provided suggests that understanding postoperative pressure ulcers after orthopedic surgery should be done with a more comprehensive view, than to consider such incidents as a postoperative complication. The current literature identifies that the cause of pressure ulcers in orthopedic patients is a series of daily stresses placed on the patient (by virtue of their overall vulnerability as well as the weight of surgical devices) during both the preoperative and postoperative periods (from the time they receive a fracture; until they are discharged).

One of the advantages of utilizing more recent literature related to pressure ulcers in orthopedic patients is that there is an increasing amount of orthopedic specific data available to facilitate these comparisons. There are multiple groups of patients (fractures, hip fractures, intraoperative studies of orthopedics and meta-analyses of devices used in orthopedics), that provide much more relevant data to determine the best means to reduce the incidence of pressure ulcers than those extrapolations from studies of critically ill patients; the information consistently identified in these studies is: age (also known as advancing age), frailty, malnutrition, prolonged operative time, tissue moisture, delayed mobilization following surgery, and the frequency of mechanical failure of the devices themselves.

The finding that there is a link between pressure injury and overall physiological risk is one of the most clinically significant discoveries. In studies of patients with hip fractures, pressure injury has been correlated not just to the presence of a local wound, but also to the presence of poorer prognostic factors (including increased one-year mortality) [19]. As such, pressure injury may serve as a visible manifestation of deeper systemic risk. Therefore, the appearance of a pressure injury should lead clinicians to reassess mobility, nutrition, hemodynamic stability, and level of care more broadly than just focusing on the wound itself.

The current literature now makes it increasingly difficult to support the use of single

interventions as a way of preventing pressure injuries. While repositioning is still an important part of preventing pressure injuries, existing evidence supports a coordinated approach to pressure injury prevention that incorporates risk assessment, support surfaces, positioning, moisture management, device surveillance, and nutritional assessment [20,21]. The relevance of these points to orthopedics is magnified because no single intervention can compensate for the cumulative effects of immobility, edema, prolonged surgical procedure, and device pressure.

The issue of orthopedic devices is another aspect of importance; examples of such devices include casts, braces, splints and immobilizers. Although these devices serve as means of therapeutic application, they are also potential interfaces through which injury may occur. The current orthopedic literature supports the notion that device-related pressure injury occurs frequently enough to warrant routine surveillance protocols instead of ad hoc monitoring [22]. This has implications for inpatient care, as well as for discharge planning and patient education.

A second theme is that of implementation. According to Wan et al., barriers and facilitators to the prevention of pressure injuries in acute settings stem from individual and organizational levels and include knowledge, skill, environment, resources, role expectation, and social influence [23]. The presence of these conditions can explain why preventable injuries continue to occur even when clinicians practice in environments where they are generally familiarised with prevention principles.

Another area receiving renewed focus is risk assessment guidance. Serafin et al. identified significant variability exists among clinical practice recommendations regarding assessment of pressure injury risk, highlighting the need for consistent and well-implemented guidance [24]. Moreover, in perioperative settings such as surgery, Stanton and Spruce both emphasise that the effective prevention of pressure injury is reliant on anticipatory planning and appropriate positioning strategies, selection of support surfaces, and postoperative assessment, as opposed to reactive wound care after-the-fact [25].

Prevention should be a part of routine workflow as opposed to being optional at the bedside. Evidence from current integrative reviews demonstrates that care bundles work best when integrated with daily documentation, staff education, and consistent care processes. The processes through which patients move from acute to elective surgical treatment, are often as important components of intervention efficacy as the specific elements within the bundles of care.

This review does have some limitations; the data available for review are not comparable with one another in terms of definitions, timing of the assessments, and exactly what constitutes a bundle. Orthopedically specific literature is strongest with respect to fractures and hip fractures while other orthopedically specific etc subspecialties have not been studied as extensively. Despite these limitations of the literature the consistency of the findings of the most recent literature supports the types of recommendations that can and should be made with regards to the clinical management of patients through the use of evidence based medicine

6. Conclusions

Pressure sores are a common and preventable source of morbidity following orthopedic procedures. Patients with orthopedic injuries and fractures are often associated with a distinct profile of risk factors, including advanced age, frailty, malnutrition, immobility, long

operative times, increased moisture in compressed skin areas, delayed mobility after surgery, and long-term dependence on orthopedic devices.

The most effective scientifically-based strategies for preventing pressure sores involve the use of a coordinated, multidisciplinary approach that includes risk assessment, skin assessments and monitoring, positioning (i.e., shifting patient's weight off pressure points), pressure redistribution techniques (e.g., specialized mattresses), nutritional support, monitoring use of orthopedic devices, and mobilization strategies.

In order to reduce the number of injuries from pressure sores and promote optimal recovery of patients with orthopedic injuries and fractures, the prevention phase should begin when patients are admitted and continue through the pre-operative, post-operative, rehabilitation, and discharge stages of care. Thus, a pathway-based approach is most likely to reduce the incidence of pressure sore-related injuries and optimize the recovery process.

Disclosure

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