TECHNOLOGY UPDATE:

Preventing pressure ulcers occurring on the heel

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Pressure ulcers are defined as localised injury to the skin and/or underlying tissue, usually over a bony prominence, as a result of pressure, or pressure in conjunction with shear. An important change to this definition is the elimination of friction as a cause of pressure ulcers. Patients can develop friction injury to the heel from the constant movement of the heel on their bed linen. The change to this definition stems from an understanding that frictional forces are superficial and lead to heat in the tissues, producing serum-filled blisters; friction does not involve pressure. Shear forces — the combination of pressure and movement — can and do lead to pressure ulcers.

INTRODUCTION

In a large, cross-sectional survey focusing on pressure ulcer prevalence (104,266 patients), heel pressure ulcers were found to occur in 18.2% of cases[1]. This number may seem lower than past estimates of heel ulcer prevalence — however, in this study pressure ulcers in 25 anatomical sites were recorded and ulcers that in the past were attributed to the heel were in fact shown to be located on other sites on the lower limb.

Earlier data from a similar cross-sectional survey on heel ulcers, this time with fewer patients (85,838), recorded prevalence ranging from 23–28.9% and incidence ranging from 23.6–26.1%[2]. The heel is the most common site for deep tissue injury (DTI)[3] and this area of the foot accounts for 41% of all DTIs[2].

COST AND SIGNIFICANCE

The cost of pressure ulcers is thought to be high, although no specific data on the cost of heel pressure ulcers could be found. General pressure ulcer prevention was estimated to cost $54.66 per day in acute care settings[4] in the US. The model used by Padula did not include specific prevention methods or devices for heel pressure ulcers. The cost of pressure ulcer treatment in the UK was estimated at £1.4bn to £2.1bn[5]. In 2012, US medical insurance claims comprised 394,699 cases of pressure ulcers that were treated at a cost of $8,730 per case, totalling $3.5bn. It is important to note that these costs related only to treatment submitted for payment.

Mortality data on patients with pressure ulcers on the heels are also not reported separately. Brown[5] reported on 74 patients at end of life with full thickness pressure ulcers (16.2% were on the heel). The 180-day mortality rate for these patients was 68.9%, with an average of 47 days from the ulcer onset to death.

Healing times for heel ulcers are long, in many cases over a year[6]. Some of the delays in healing can be attributed to underlying comorbid problems including poor arterial flow to the leg, diabetic neuropathy, continued use of tobacco and difficulty maintaining pressure relief on the heel for the length of time needed to heal the ulcer. Morbidity, that is to say amputation, for heel ulcers with osteomyelitis or critical limb ischaemia is also common. In one study, 11% of patients with ischaemic heel ulcers and gangrene required amputation, compared with a group of patients with ulcers on other aspects of the foot[7].

Similarly, Han and Ezquerro[8] reported that 42% of 43 patients (18 patients) with heel ulcers required leg amputation due to persistent infection or non-healing wounds.

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PATHOPHYSIOLOGY

The heel is at increased risk of ulceration due to its posterior prominence and lack of padding over the calcaneus. Gefen[9] found that the pressure on the fat pad of the heel when positioned at 90 degrees to the leg during bedrest is higher than when the foot is turned onto the side. Pressure can be applied to the heel during bedrest, and pressure can be higher if the heel is resting in a 'hammock' at the foot of the bed. Hammocks develop when the material of the mattress does not support the heel on the bed leaving the heel hanging in the mattress cover. This intense pressure can lead to ulceration and pain. Shear forces on the heel occur when the patient slides down in bed.

The hyperaemic response to pressure loading on the heel does not differ from other tissue. However, the heel is a unique bony prominence and with aging the number of capillaries are reduced, the amount of soft tissue padding over the calcaneus decreases and blood flow at rest to the heel is relatively low[10].

Owing to the unique anatomy of the heel and impaired ability to reperfuse (restoration of the blood flow to a previously ischaemic tissue or organ), the heel is a common site for deep tissue injury pressure ulcers[11,1]. Salcido et al[3] correlated the relative risk of deep tissue injury of the heel to the relatively small radius of the calcaneus and thin, overlying tissue.

Co-morbid diseases also can impair arterial inflow and when patients are hospitalised vasoconstriction from medications, hypovolemia or pain can further reduce arterial inflow[12]. Arterial blood flow to the heel is supplied by the lateral and medial plantar artery and the medial calcaneal branch of the posterior tibial artery *[Fig 1]*. Differences in blood flow to the heel were seen in patients with ankle-brachial indices lower than 0.8[13]. Blood flow, via transcutaneous oxygen levels to the heels, was tested in patients who underwent hip-replacement surgery and had elastic support stocking and sequential compression devices on the legs. Transcutaneous oxygen levels were lower in both heels, and more so in the operative limb during periods of pressure loading and when pressure was removed (unloading)[12].

IDENTIFYING HIGH RISK PATIENTS

The Braden Scale for detecting pressure ulcer risk has not been shown to consistently identify patients at risk of pressure ulcers on the heels. The National Database of Nursing Quality Indicators (NDNQI) and a study by Walsh and Plonczynski[14] focusing on hospital-acquired pressure ulcers found that they predominantly occur in patients who are at low to mild risk on the Braden assessment tool.

Unique intrinsic risk factors for pressure ulcers on the heels include diseases that impair sensation in the heel (such as diabetic neuropathy, stroke, nerve block after surgery, analgesia), conditions that reduce blood flow to the leg (ie peripheral vascular disease, vasopressive medications) and lower limb weakness (such as hip fracture, total knee replacement) are the most common.

Low serum albumin levels were also seen in the patients with pressure ulcers on the heels[14]. The calcaneus of the heel is prominent, extending into the mattress of the bed. Some patients have sharp posterior calcanei, thin soft tissue padding and heavy feet making them at higher risk[9], similarly, a 0.8 ankle brachial pressure index (ABI) provides high sensitivity and adequate specificity to predict pressure ulcer development on the heel.

It is recommended that nursing staff use a general pressure ulcer risk assessment tool and add risk factors unique to heel ulcers, including poor blood flow to the legs, neuropathy and lower limb weakness. Poor blood flow to the leg can be identified by a history of cardiovascular or peripheral vascular diseases with claudication and/or physical examination findings of thin, hairless legs, thick toenails, delayed capillary refill times, and/or absent pulses in the foot. Neuropathy can be assessed formally via Semmes-Weinstein monofilament testing or tested generally by asking the patient about pain in the legs or the ability to feel hot bath water, tight shoes or injury to the foot.

Neuropathy develops along with the other end-organ damage seen with diabetes, so if the patient is receiving dialysis or treatment of retinal damage, they probably have neuropathic changes in the feet. Inability to move the leg is tested by asking the patient to move his/her leg in bed — if the patient cannot or will not do so due to pain, the leg should be considered immobile.

PREVENTION METHODS

Due to the risk of ulceration to the heel, the high number of cases of heel pressure ulcers and the poor chance of recovery, precautions need to be taken for all patients at bedrest.

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Universal heel precautions

All bedridden patients need to be considered at risk of pressure ulcers on the heels. A set of 'universal heel precautions', created by the author, is designed to identify early stages of heel ulceration [*Table 1*]. Patients who are bedridden for 12 hours or less are a group at moderate risk of heel ulceration. The universal heel precautions should be followed along with heel elevation. Several groups of patients, namely, those with impaired mobility, arterial inflow or sensation, are at high risk and additional assessments and interventions are required for prevention, classified as strict heel precautions[15].

Quality improvement processes

Several quality improvement processes have been reported that can reduce pressure ulcer rates in general. Discussing the patient's skin status during hospital rounds has been shown to increase awareness of skin problems and decrease pressure ulcer development from 27% to 0%[16]. One-on-one clinical instruction, reminders and the presentation of raw data on pressure ulcer prevalence as a reminder of the importance of preventive measures was associated with a reduction in the number of pressure ulcers cases (from 50% to 8.3%) in one intensive care unit (ICU)[17].

Also, the use of computerised decision-support systems to assist the staff in selecting optimal, evidence-based care strategies improved understanding in one multi-disciplinary team[18].

Use of off-loading devices

Off-loading devices should completely lift the heel from the bed[19,20]. The use of pillows placed lengthwise under the calf, as well as boots to elevate the heel are common. Pillows can be used in patients who are not moving their legs, but boots are needed for those patients who move about in bed or who are at high risk for ulceration and/or delayed healing after ulceration. Boots can be made from plastic filled with air, foam, fibre or synthetic sheepskin.

Several authors have reported reduced heel ulcer incidence when off-loading boots are used, compared with when no heel elevation device[21] is used[17,22] along with intravenous (IV) bags[23]. Many authors have compared heel offloading devices[14,24,25] and none of these appears to be superior.

Clinical experience

Clinical experience suggests that boot-type devices are more likely to stay on the leg and support the foot in a neutral alignment to prevent prolonged plantar flexion[26]. Air-filled cells are lightweight, but may not hold the limb in place, allowing it to rotate. Foam boots tend to be warm and can cling to the bed linen. Furthermore, compressed foam does not have the ability to support the weight of the leg. Boots made from synthetic products wick away moisture and are not overly warm. Sheepskin vascular boots can be very warm but, until recently, did not suspend the heel from the bed.

The WOCN guidelines recommend against the use of synthetic sheepskin, bunny boots, rigid splints, IV bags, and rolled towels or sheets[20]. Adejumo and Ingwu[27] reported on the practice of nurses of using water-filled gloves for heel ulcer prevention in Nigeria, where resources are limited. While this practice is frowned upon in developed nations, the principles of pressure redistribution are fulfilled by the use of these water-filled gloves.

A common clinical issue encountered is whether a brace, often called an ankle-foot orthotic (AFO), can be an adequate substitute for a heel elevation boot. Clinical experience has shown that AFOs can lead to pressure ulcers on both legs/feet. These devices are rigid and while they maintain foot and ankle alignment, they do not seem to prevent pressure ulcers[26]. Boots that reduce pressure on the heels and maintain normal ankle-foot flexion were studied by Meyers[28] in patients who were sedated on ventilators. The application of heel protectors led to a 50% reduction in the prevalence of abnormal foot positioning and no patients developed plantar flexion contractures or new ulcers in this study.

Aspects to be considered when choosing an off-loading device include the ability of the device to suspend the heel from the bed surface, the ease at donning and doffing the device, the likelihood of the device coming off through movement in the bed, and the need for ambulation as none of the heel elevation devices can be worn during ambulation.

Support surfaces

Nicosia and colleagues[29] reported on a meta-analysis of 14 studies examining the effect of support surfaces on heel ulcer development.

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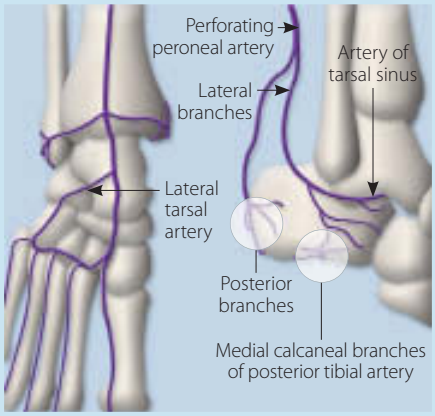

Figure 1: Arterial blood flow to the heel.

Their combined analysis indicated that specialty air or foam mattresses or overlays reduced the relative risk of developing a heel ulcer by 50% compared with standard hospital mattresses (P = 0.03). When interventions were analysed individually, only the foam mattresses had sufficient evidence of efficacy in preventing heel pressure ulcer development. Variability in the air mattress study results, in addition to the fact that most overlays were compared with other overlays instead of a standard hospital mattress, obscured these results.

Vanderwee et al's study[30] was not in the meta-analysis. However, they studied 447 patients and found that significantly more subjects developed pressure ulcers on the heels using a viscoelastic foam mattress compared with those on alternating air surfaces.

CONCLUSION

Pressure ulcers on the heels occur frequently and lead to significant morbidity and mortality. All bed-bound patients are at risk, and most pressure ulcer prediction scales do not accurately identify the risk factors related to changes in arterial blood flow, neuropathy and lower limb weakness.

Heel elevation boots should be used for high risk patients. Data on which boot is most effective is not available, however, anecdotally, support surfaces do not adequately reduce the risk in the heel.

AUTHOR DETAILS

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Table 1: Universal heel precautions for all patients at bedrest

1. Inspect feet and heels every shift and document skin integrity of the heel

2. Remove stockings or boots to inspect the posterior heel

3. Do not reapply stockings if they are too tight

4. Palpate quality of pulses in the foot and ankle, and for bogginess/edema in the heel

5. Apply cream/lotion to heels every day

6. Avoid massaging heel prominence

Preventive heel precautions for patients immobilised for over 12 hours

Universal precautions, plus:

7. Float heel from the bed on pillows

8. Prevent friction injury in agitated patients with stockings or by applying film/foam dressings to the heel

9. Turn bedridden patients every two hours to remove pressure from the posterior heel

10. Get patient out of bed as soon as possible

11. Teach alert patients an active range of motion enabling them to move the ankle every hour while awake

Strict heel precautions for patients immobilised for over 12 hours

Universal and preventive precautions, plus:

12. Float heel from the bed with boots

13. Assess the fit of the boot on each shift, reposition as needed

14. Avoid hyperextension of the knee

15. Perform range of motion exercises including dorsal flexion of the foot

16. Consider use of heel protectors to maintain the foot at 90 degrees ankle flexion

17. Get patient out of bed three times per day if possible