Assessing Mattress Performance Characteristics:

Comparison of Contact Pressures and Blood Flow Measured at the Heels of Healthy Volunteers Resting Upon Four Mattress Configurations

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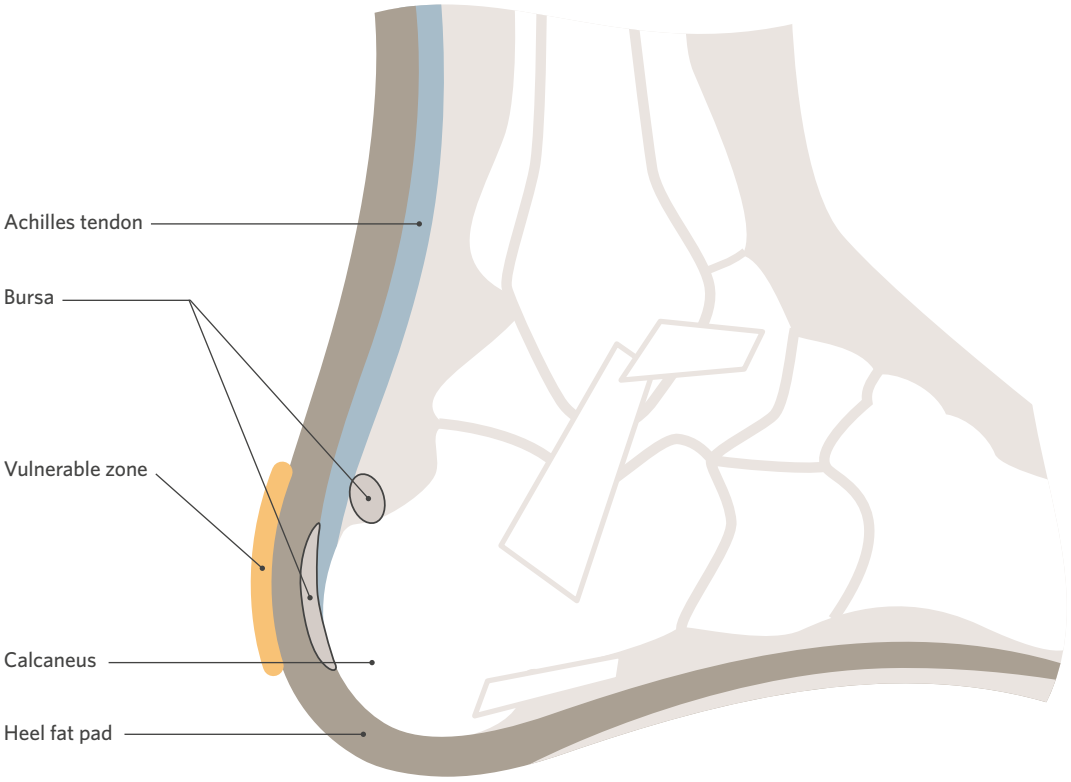
Introduction & Clinical Context

Measurement of interface (contact) pressure is a long-established technique used to characterise one aspect of the performance of a pressure redistributing support surface. For reactive surfaces, concepts of immersion and envelopment are commonly used to give context to interface pressure measurements. However for active surfaces the performance of the surface depends not upon immersion and envelopment but refers more to the amplitude between maximum and minimum interface pressures, the rate of interface pressure increase as air cells inflate and the time between maximum inflation and maximum deflation[1]. Skin blood flow provides a physiological 'check' on the impact of applied contact pressures upon skin viability[2].

The heel presents unique challenges for pressure injury prevention given its small area, pronounced curvature, limited soft tissue cover and reduced perfusion on loading[3]. Given these challenges it is unsurprising that pressure injuries occur commonly at the heel, second only to those that develop at the sacrum. Within acute care in NHS Wales 8.9 % of all hospital in-patients were found to have pressure injuries[4] with 161/589 (27.3 %) pressure injuries with a verified classification presenting at the heels; of these wounds 47 (29.2 %) were full-thickness injuries extending beyond the dermis into deeper tissues.

* The Welsh Wound Innovation Centre (WWIC) has recently launched its own support surface testing facility in South Wales. With the recent release of the 20342-1 standards for mattress testing, WWIC over time will seek accreditation for its test facility making this one of the first accredited mattress test laboratories in Europe

Anatomy of the Heel



Test Objectives:

Over December 2019 and January 2020 contact pressures and blood flow were measured at the heels of eleven healthy volunteers who rested upon four mattress configurations. The four configurations were:

- Auto logic alternating pressure mattress replacement
- Auralis alternating mattress replacement
- Auto logic with a Skin IQ microclimate management system
- Auralis with a Skin IQ micromanagement system

The overall objective of the laboratory tests was to determine heel contact pressures and skin perfusion whilst healthy volunteers rested supine on four pressure redistributing mattress configurations. A similar effect was observed in previous work using a wooden mannequin.[5]

Methodology

All devices investigated in the healthy volunteer study were CE marked and used within their intended purpose. The order of the presentation of the support surfaces to the subjects was made using a pre-determined randomisation schedule. All work was performed according to the general requirements of ISO 20342-1[6]. At the time of testing specific details of ISO 20342 part 2 mattress performance tests were not available and WWIC therefore worked to the best available technologies for characterising alternating support surface perfromance.

Inclusion Criteria:

- Aged over 18 years
- Able to position themselves upon the mattresses and leave the bed safely

Exclusion Criteria:

- Under 18 years
- Unable to access or leave the mattresses independently

Auralis Powered Down Heel Zone Section

Test Participants

Eleven adult volunteers (aged over 18 years with no upper age limit) were invited to rest upon the support surfaces. All participants were provided with information upon the evaluation and if they consented to participate an informed consent form was signed by each participant.

Performance Measurements

Subjects were asked to wear loose fitting clothing during the measurement period and to lay upon each mattress configuration in a supine position – flat on their backs, with feet no more than shoulder width apart and their arms rested by their side. No attempt was made to standardise the time of day when measurements were performed given no evidence of diurnal changes in measured skin blood flow[5]

- Each mattress was set up according to manufacturer's instructions and covered with a standard cotton sheet
- Subjects rested upon each mattress configuration for an hour; between each test the subject was instructed to ambulate for at least 10 minutes to counter the effects of muscle relaxation
- Continuous measurements of contact pressure were conducted with a X-Sensor 3.0 pressure measurement mat with a surface dimension of 44 cm x 44 cm and a measurement range of 0–200 mmHg. The mat was positioned under the right heel and lower leg. The mat was used to gather data upon the maximum and minimum pressures applied to the heel
- Laser Doppler perfusion measurements were performed using the Perimed Series 4000 laser scanning Doppler with a flat skin Doppler probe for use between the skin and the support surface. The probe was attached to the left heel using easily removable sensor attachment tape
- Both the X-Sensor Mat and the Laser Doppler scanner were calibrated as per the manufacturers recommendations before use
- Contact pressures were measured under the right heel while ensuring that both heels were located along the centre of the same cell
- There was one 5 hour long measurement session for each volunteer within a single day. During measurement periods, the subjects were invited to remain in a static position and were free to use their own headphones and devices to listen to audio content
- All interface pressure data was initially viewed in XSensor 3 Medical Software (Version 6.0, XSensor Technology Corporation, Calgary, Canada)
- The maximum and minimum contact pressure recorded during the third cycle of each mattress was recorded for analysis purposes
- Skin blood flow was recorded at 30 second intervals during the third cycle and maximum and minimum blood flow recorded

Key Results

- The eleven subjects ranged in age from 27 to 45 years; mean 35.3 (Standard Deviation (SD) 6.4). Only 2 of the 11 were male with Body Mass Index ranging from 19.8 to 42.4; mean 27.3 (SD 6.7)
- The maximum and minimum contact pressures at the heel were similar upon both the Auto logic and Auralis support surfaces (Table 1). Typically heel contact pressures are high given the very small contact area the heel makes with the mattress
- No apparent differences were observed between the two surfaces, in terms of maximum perfusion at the heel. This would suggest that the relatively high minimum contact pressures observed did not compromise tissue perfusion. The results should be interpreted with caution because small subject repositioning can create large artefacts in maximum perfusion measured at the heel
- The introduction of the Skin IQ to the two mattresses did increase minimum contact pressures upon both mattresses,. A similar effect was observed in previous work using a wooden mannequin[5]. This effect would be anticipated given the observation that introducing additional layers between the patient and the support surface can dampen the action of an alternating surface[6]
- Anecdotally the volunteers appeared to prefer lying on the two mattresses with the Skin IQ in-situ

Conclusions & Relevance to Clinical Practice

The laboratory studies summarised in this document highlighted relatively similar performances of the Auto logic and Auralis mattress systems with both applying similar contact pressures and having similar impact on heel blood perfusion. The introduction of a microclimate management system upon both mattresses increased the minimum contact pressures applied to the heels as would be anticipated where a new surface is introduced between the active mattress and the human body. A similar effect was observed in previous work using a wooden mannequin.[5] It should be noted that this study was not designed to assess the performance of the Skin IQ and any additional benefits it may present in terms of microclimate and comfort.

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