Article

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Postural management system for bedbound patients

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Abstract

Objectives

To explore the potential effectiveness of postural management system considering peak contact pressure and user perceptions.

Methods

Fifteen healthy participants were screened using a modified Red Flags Screening tool. Conformat® system was used to analyze contact pressure under the shoulder and buttocks and was recorded for 10 minutes in supine and side-lying positions with and without a postural management system. Participants were asked about their comfort and restrictiveness using a numerical rating scale.

Results

In side-lying position, the peak contact pressure at greater trochanter was significantly lower when a postural management system was applied. In supine position, the peak contact pressure at shoulders was respectively lower. In turn, the peak contact pressure at ischial tuberosity was significantly higher lower when a postural management system was applied. The postural management system did not affect the level of perceived comfort. Participants reported that they felt more restricted with the intervention.

Conclusions

A postural management system reduced pressure at the shoulders in supine-lying position and at the greater trochanter in side-lying position lowering the risk of pressure injury formation. A postural management system may reduce the economic burden of health problems associated with poor positioning, enhance patient care, and reduce the risks associated with manual handling techniques when repositioning.

Keywords:

postural management; contracture; spasticity; sleep system

INTRODUCTION

Individuals with disability due to neurologic conditions, such as stroke, cerebral palsy (CP), motor neuron disease (MND), spinal cord injuries (SCI), or catastrophic brain injuries (CBI) often present with limited mobility and impaired sensory perception. Those with the most severe sequelae may be unable to mobilize and could need help in all activities of daily living (1–3) with even simple postural adjustments to redistribute pressure and relieve discomfort being impossible to perform without assistance (2). When in bed, subcutaneous ischemia occurs within regions that are in contact with the sleep surface (4). Around bony prominences, the skin becomes compressed between the sleep surface and the bone due to reduced amounts of soft tissue (5). In a healthy individual, the presence of tissue ischemia provides a sensory stimulus which triggers the individual to alter their position to relieve pressure within ischemic tissues. An inability to make postural adjustments independently can lead to many negative health implications if not remedied with assistance or intervention (6). These include pressure injuries and body shape deformity.

With the adoption of a prolonged position, the skin and underlying tissues are under continued stress, which over time reduces blood flow, restricts oxygen and nutrient delivery to the tissue, ultimately leading to cell and tissue degradation (7,8). This produces a pressure injury, which are the most commonly discussed medical complication for bed-bound individuals. Pressure injuries are areas of localized tissue damage caused by pressure, friction or shear, often developing in areas of bony prominence (8,9). The formation of a pressure injury is now commonly viewed as patient neglect if they are considered to have been preventable with an appropriate level of care (10). As such there is accountability within the NHS for the development of a preventable pressure injury, so staff are required to regularly reposition patients as part of the Pressure Ulcer Prevention Strategy (11). However, clinicians must consider the consequences of postural asymmetry, instability and dysfunction when planning a pressure injury prevention strategy (12).

Much like pressure injuries, body shape distortion is a secondary complication that can develop amongst individuals who are unable to independently change position (7). It has previously been reported that regardless of an individual's diagnosis, if they have movement difficulties and are unable to maintain a therapeutic posture, there is a significant risk of developing body shape distortion and associated negative implications (7). These

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Conflicts of interest: The intervention (Hugga) used within the study was provided, free of charge, by the company (PostureCare Ltd)
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Table 1: Peak Contact pressure recorded at the shoulder and hip with and without Postural Management System (PMS).

Position	Condition	Shoulder (kPa)	Hip (kPa)
Side Lying	Control	1.56 (0.6)	1.71 (0.5)
	PMS	1.61 (0.5)	1.55 [a] (0.4)
Supine Lying	Control	1.23 (0.4)	1.24 (0.4)
	PMS	1.18[a] (0.4)	1.32[a] (0.5)

[a] Significant difference ($p \leq 0.05$)

include the worsening of muscle imbalances associated with postural asymmetries, contractures and body deformities, all of which can result in reduced respiratory and digestive function, compression of internal organs and reduced personal hygiene (7,13). A 24-hour postural management plan should be implemented by healthcare professionals to enable patients to adopt a therapeutic position (14), protect from body shape deformity, formation of contractures and provide adequate pressure relief (14–16). In addition to preventing pressure injuries, a 24-hour postural care plan should ensure that appropriate levels of support are provided to modulate muscle tone, maximize muscle function and assist with the maintenance of soft tissue length (7,17–20).

Symmetrical supine lying has been shown to achieve best clinical outcomes through symmetrical and level positioning of the shoulders and pelvic girdle, and gravity assisted knee straightening (7,21). Although there is agreement upon how frequently repositioning should occur (every 2-4 hours), there is no formal guidance relating to the processes of positioning, turning or re-positioning (2,22). Consequently, there are inconsistences amongst health-care professionals as to what is considered best practice (2,3,11,18,20,23). Previous research highlights the need for the development of formal clinical guidance to inform best practice and standardized patient positioning methods, as current nursing and care programs do not provide this (6,16).

Positioning aids, primarily whole-body systems, as a bed-time positioning intervention may provide a solution and effectively reduce the risk or severity of body shape distortion amongst immobile patients (7). The majority of evidence to support the use of bed-positioning equipment has been amongst a pediatric population (15) and as a result, postural support at night is now recommended by the National Institute for Health and Care Excellence for children and young people with non-progressive brain disorders (24). More recently the importance of 24-hour postural support in sitting, standing and lying for both children and adults with complex postural needs has been recognized (3). Furthermore, it has been recommended that Clinical Commissioning Groups should consider implementing postural management interventions where necessary to improve patients' quality of life (13). A recent scoping review reinforced the urgent need for further research into bed-time postural equipment (25). The most common type of whole-body positioning systems used in the postural management of a patient incorporate multi-component parts held in position by a base layer sheet, although sadly patient access to this equipment varies (3,26). At present, there is a lack of robust evidence to support the use of postural management systems (3). The aim of this research study is to explore the potential effectiveness of a postural management system (PMS) through analysis of peak contact pressure and user perceptions amongst a healthy population.

METHODS

Participant Recruitment

All volunteers were screened using a modified Red Flags screening tool (27) to assess eligibility. Eligible volunteers were aged between 18 to 50 years and had no history of musculoskeletal disorders, including back pain, within the six months before participation. Volunteers were excluded if they had any musculoskeletal or neurological disorders of the spine, pelvis, or shoulder. Anyone with a history of postural corrective or spinal surgery was also excluded. All data collection conformed to the Declaration of Helsinki (28) and general data protection regulations. Volunteers gave written informed consent before participation. Full ethical approval was granted by the University of Central Lancashire's Ethics Committee (STEMH).

Procedure

The study was set in a movement analysis laboratory. This was a repeated-measures crossover study. Throughout the study there were two conditions; the PMS intervention (Hugga®, PostureCare®, UK), and the control condition (without PMS). For each condition there were two test positions; side lying and supine (Figure 1).

Participants were asked to wear comfortable unrestrictive clothing throughout testing. A standard hospital bed frame and foam mattress was used for testing. Two pressure sensor mats (Conformat®, Tekscan®, USA) were positioned on top of the mattress to collect body-mattress interface contact pressure data from the top of the shoulder to the inferior angle of scapula, and from the posterior superior iliac spines (PSIS) to the gluteal fold. The PMS's associated bed sheet was placed over the top of the mattress and pressure sensor mats.

Body-mattress interface contact pressures were recorded for thirty seconds after 10 minutes of each test condition (Figure 2). The order of the test conditions was randomized using an online generator (www.randomization.com). For the PMS conditions, the components were installed around each participant in accordance with manufacture's guidelines and training. Following each of the test conditions participants completed Numerical Rating Scales (NRS) relating to perceived comfort and restrictiveness.

Statistical Analysis

Peak contact pressure at the shoulder, greater trochanter (in side lying) and ischial tuberosity (in supine lying) were exported from Conformat® Clinical 7.60 (Tekscan®, USA) into Microsoft Excel® 2016 (Microsoft Corp. USA). NRS scores for perceived comfort and restrictiveness were input into Microsoft Excel® 2016 (Microsoft corp. USA). Statistical analysis was performed in SPSS 24 (SPSS®, Inc., Chicago, USA). Repeated measures ANOVA tests with post-hoc pairwise comparisons were used for statistical analysis of mean and peak contact pressures. For non-parametric data, a Friedman test was performed. Significance was set at $p \leq 0.05$.

Table 2: Perceived comfort and restrictiveness (NRS 1-10)

Position	Condition	Comfort	Restrictiveness
Side Lying	Control	7.67 (1.72)	0.60 (1.3)
	PMS	7.93 (1.49)	3.13 [a] (2.26)
Supine Lying	Control	8.33 (1.11)	0.53 (1.36)
	PMS	8.07 (1.53)	3.47 [a] (2.10)

[a] Significant difference ($p \leq 0.05$)

RESULTS

Of the fifteen healthy participants, 10 were women and 5 were men. Their mean age was 29.1 (8.7) years, height 1.71 (0.6) m, and weight 78.2 (17.9) kg.

Side lying

In side lying, peak contact pressure at the greater trochanter was significantly lower with the PMS compared to the control condition (p=0.001, 9.3%) (Figure 3, Table 1). There was no significant difference in peak pressure at the shoulder with the PMS compared to the control condition in side lying.

Supine lying

In supine lying, the PMS reported significantly lower peak contact pressures at the shoulder (p=0.007, 4%), but at the ischial tuberosity peak contact pressure was significantly higher with the PMS compared to the control condition (p=0.034, 6%) (Figure 3).

Participant Reported Outcome Measures

Perceived comfort was not significantly different between the test conditions (p=0.558, range 7.67–8.33) (Table 2). There was a significant difference between conditions in perceived level of restrictiveness NRS (p=0.001). Participants reported that they felt significantly more restricted with the PMS in both supine (p=0.002, mean 3.47) and side lying (p=0.007, mean 3.13) compared to the control conditions (mean 0.53 and 0.60 respectively).

DISCUSSION

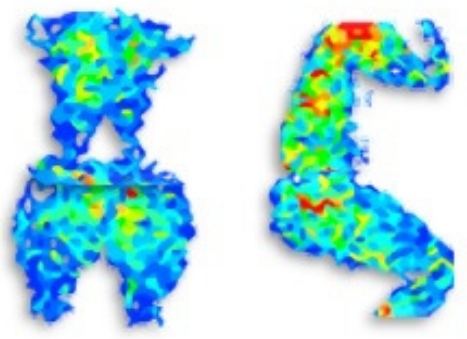
Although many healthcare professionals position patients as part of a 24-hour postural management plan, it has been recognized that there is a lack of evidence-based guidance to inform standardized and effective therapeutic positioning (2,3,11,18,20,23). The findings from this study present interesting information relating to perceived comfort and restrictiveness of a whole-body PMS; the presence of the PMS did not alter perceptions of comfort compared to the control condition, although it was perceived to be significantly more restrictive. When using these systems with people who have severe neurological impairments, it may not be possible to gather this information as they are likely to have severe sensory, cognitive and motor impairments making communication difficult (3).

The results provide a proof of concept that postural management systems have the ability to reduce peak pressure in healthy participants. The findings suggest that use of this system can reduce the risk of pressure injury formation at the greater trochanter when adopting a side-lying position and at the shoulder when adopting a supine lying position. Given that the greater trochanter is the region of most concentrated pressure and most susceptible to pressure injuries when in a side lying position (5), the ability to reduce this risk through use of the PMS provides potential clinical benefit for the end user, the caregiver and the NHS in terms of reducing the cost of treating secondary complications.

The shoulder region, most specifically the scapulae is another region that is at risk of developing pressure injuries when placed under prolonged stress (5). In this study, through use of the PMS peak pressure at the shoulder was reduced compared to the control test condition in supine lying, providing further potential clinical benefit in PMS use as a whole-body system to manage body-mattress interface pressure. In the supine test condition, pressure at the ischial tuberosities were greater in the PMS condition compared to the control condition. When positioned in the PMS, the knees and hips are slightly flexed which may in turn transfer pressure towards the buttocks. However, a peak pressure value of 1.32 KPa, as recorded at the ischial tuberosities with the PMS in supine is not considered large enough to cause ischemia within the compressed tissues, with an acceptable threshold for pressure when sleeping

Figure 1. Top left: supine lying control without Postural Management System (PMS). Top right: supine lying control with PMS (Top right). Bottom left: side lying position without PMS. Bottom right: side lying position with PMS. The PMS system bed sheet is placed over the pressure sensors to enable the proper attachment of PMS

Figure 2. Example of a pressure maps in supine and side lying positions



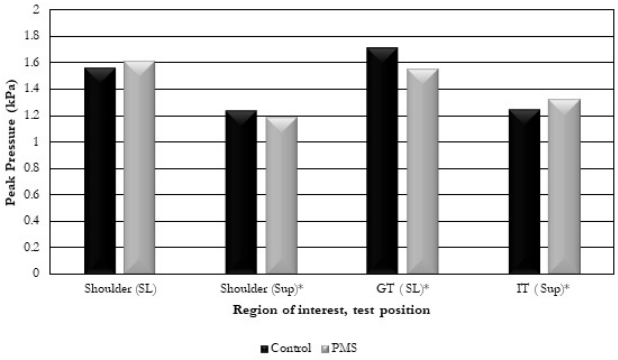
previously estimated to be between 3.9 and 5.3 KPa (4). A pressure of 9.3 kPa applied for 2 hours could cause dermal damage and pressure exceeding 10.7 kPa could cause necrosis (29). Through implementation of a PMS alongside adhering the guideline of 2 hour turning by alternating between supine and side-lying, there is the potential to offload two key bony prominence areas of high risk for pressure injury development, and by doing so, reduce the risk of pressure injury development.

PMS were developed with therapeutic aims of making end users as comfortable as possible, preserving body shape, and improving sleep quality (3). Whilst posture or body position was not an outcome measure tested within this study, it is suggested that the significant level of perceived restrictiveness may be associated with a restriction of unwanted peripheral or trunk movement which often occurs when an individual with neurological impairment is left unsupported in an unstable position.

This study was an exploratory trial to further understand the potential use of a PMS. The study is not without its limitations; it was a small study (n=15) and participants included were of a healthy status; it would be unethical to conduct an initial study investigating the use of a PMS intervention on a patient population without first understanding what effects it has amongst a healthy sample. A second limitation of the study is that each test condition was only maintained for 10 minutes when, in practice, much longer periods would be spent in one position.

However, the findings from this study suggest that the PMS does not negatively influence perceived comfort, yet does provide significant restriction, which may assist in the prevention of body shape deformity or spasticity amongst a patient group requiring postural support. The peak pressure reductions identified at the greater trochanter in side lying and at the shoulder in supine lying also further support its potential evaluation amongst a physically impaired patient group when used over longer durations. Further research is now required to investigate the efficacy and effectiveness of the PMS amongst people with significant mobility restrictions. Gathering the views and opinions from the caregivers may also provide an insight into whether the PMS would likely be accepted and integrated into clinical practice.

Figure 3. Peak pressure (kPa).
SL – Side Lying, SUP – Supine Lying, GT – Greater Trochanter, IT – Ischial Tuberosity.



CONCLUSIONS

A postural management system reduced pressure at the shoulders in supine-lying position and at the greater trochanter in side-lying position lowering the risk of pressure injury formation. A postural management system may reduce the economic burden of health problems associated with poor positioning, enhance patient care, and reduce the risks associated with manual handling techniques when repositioning.

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