



Original Article

Reliability of the special support system for sitting pressure redistribution

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Abstract. [Purpose] This study investigated the reliability of the Special Support System. [Subjects and Methods] Eighteen female and 14 male volunteers participated in this study. Participants were asked to sit on the Special Support System with their chins tucked in, spines straight, pelvis neutrally positioned, and their hands placed on their thighs. They were also asked to flex their hips, knees, and ankles to approximately 90 degrees and to put their feet flat on the floor. The total contact area, mean total pressure, as well as mean and peak pressures of each quadrant were each measured 15 times. Test-retest reliability was analyzed for inflated air pressure, and pressure redistribution values by using intraclass correlation coefficients. [Results] The intraclass correlation coefficient was greater than 0.89 for inflated air pressure and greater than 0.92 for total contact area, mean total pressure, and each quadrant's mean and peak pressure. [Conclusion] The findings suggest that the Special Support System is reliable and can be used as an alternative method for redistributing sitting pressure.

Key words: Pressure mapping, Sitting pressure, Special support system

(This article was submitted Jun. 20, 2016, and was accepted Aug. 20, 2016)

INTRODUCTION

Pressure ulcers, also known as decubitus ulcers or bedsores, are defined as localized tissue breakdown in the skin and adjacent tissue caused by prolonged high pressure and mechanical forces over the bony prominences¹⁻⁴⁾. The most common sites of pressure ulcers are over the sacrum, coccyx, heels, and hips. Other sites such as the elbows, knees, ankles, or the back of the cranium can also be affected. External pressure or mechanical forces may reduce or interrupt blood flow to the skin and affect the transport of nutrients into the cells, resulting in decreased tissue oxygenation and ischemia that may eventually lead to tissue necrosis⁵⁻⁷⁾. Pressure ulcers are hazardous, particularly for individuals with additional risk factors related to poor health⁸⁾. Even small injuries may have significant implications on the quality of life of disabled people. Therefore, preventing pressure ulcers is important.

Various types of cushions have been developed to prevent or treat pressure ulcers. These cushions are made of viscoelastic materials such as foam, gels, air, or a combination of these and in South Korea, foam, gel, and air cushions are widely used. The seating areas of these inflatable cushions are not divided, and the inflated air pressure in the compartments does not adjust automatically. The Participation Science Laboratory, through collaboration with small- and medium-sized enterprises (SMEs), developed a prototype Special Support System (SSS). SSS is a novel inflatable cushion with four separate support surfaces made to left buttock, right buttock, left thigh, and right thigh, and the inflated air pressure in each support surface can be adjusted automatically. Before the SSS can be utilized in a clinical setting, its reliability must be demonstrated, and this was the purpose of this study.

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Table 1. General characteristics of the participants

	Age (years)	Height (cm)	Weight (kg)
Male (N=18)	21.1 ± 1.6	171.7 ± 5.0	64.9 ± 5.6
Female (N=14)	20.1 ± 0.3	162.7 ± 3.8	57.6 ± 9.6

Table 2. Test-retest reliability of the inflated air pressure

Item	Mean	95% CI	ICC
Lt. Buttock	11.2 ± 0.6	0.82–0.94	0.89
Rt. Buttock	11.2 ± 0.5	0.84–0.95	0.90
Lt. thigh	9.6 ± 1.2	0.92–0.97	0.95
Rt. Thigh	9.6 ± 1.3	0.94–0.98	0.96

SUBJECTS AND METHODS

Ethical approval for this study was obtained from the Institutional Review Board on Human Subjects Research and Ethics Committees, Soonchunhyang University, Cheonan, Korea. This was a pilot study testing the reliability of the Special Support System (SSS) and it may influence the future direction of research in the field of normal adult pressure mapping. The participants were 32 healthy young adults. Exclusion criteria included any type of sitting problem, hearing, vision, or cognitive impairments that would have interfered with accurate assessments. Eighteen female and 14 male volunteers participated in this study. Ages of the male and female subjects were 21.1 ± 1.6 years and 20.1 ± 0.3 years respectively. The procedure was fully explained to all of the participants, and written consent was obtained prior to commencing measurements. The participant characteristics are shown in Table 1.

All the study procedures were performed at the Participation Science Laboratory of Soonchunhyang University.

The SSS has 30 air columns that are divided into four parts: right thigh, left thigh, right buttock, left buttock. One column in each of the four parts contains a thin tube to introduce and remove air from that particular section. Each of the four part's inflated air pressure can be controlled automatically or manually. In the automatic mode, air is introduced and removed via the thin tube every 5 minutes over a 20 minute period, based on the measured interface pressure distribution. The air pressure in the automatic mode can also be increased up to 15 kPa. The standard air pressure for each part was set to the 50% of maximum air pressure of each column. In the manual mode, the inflatable air pressure can be adjusted from level 1 to level 10, with each level representing a 10% change in pressure. After inflation, the inflated air pressure of each part was digitally displayed on a LCD each display. In this study, the SSS was set to automatic mode, and the inflated air pressure of each part was recorded consecutively 15 times for each subject. The reliability of the air pressure after inflation was evaluated based on the reading given by the LCD display.

The ConFORMAT system was used for pressure mapping, and V7.2 × research software was used for data acquisition (both ConFORMAT and V7.2 × are manufactured by Tecksan Inc., MA, USA). The ConFORMAT was placed on the SSS during data acquisition. One occupational therapist and three university students collected the pressure data. While being seated on the SSS, participants were asked to keep their chins tucked in, spines straight, pelvis neutrally positioned, and to place their hands on their thighs. They were also asked to flex their hips, knees, and ankles to approximately 90 degrees and to put their feet flat on the floor. The seating position and each joint angle were checked prior to each measurement. After all measurements were obtained, the pressure map was divided into four quadrants (left hip, left thigh, right hip, and right thigh) on the screen. Mergl's method was adapted for quadrant division and analysis of the pressure on the cushion. In this study, the total contact area, mean total pressure as well as each quadrant's mean and peak pressures were measured consecutively 15 times and then analyzed. Test-retest reliability was analyzed using intraclass correlation coefficients (ICCs).

RESULTS

The ICC was more than 0.89 for the inflated air pressure of the four areas, with the right thigh area having the highest ICC (Table 2). The ICCs for total contact area, total pressure mean, each quadrant's mean, and the peak pressure of each quadrant were statistically significant (Table 3). The lowest ICC was 0.92, while the highest was 0.98.

DISCUSSION

Pressure ulcers are common in the elderly and the immobile, and result in increased healthcare costs and reduced quality of life. Pressure-relieving support surfaces (e.g. beds, mattresses, seat cushions etc.) are used to help prevent ulcers⁹. The

Table 3. Test-retest reliability of the pressure redistribution values of each quadrant of the special support system

Item	Mean	95% CI	ICC
Total contact area	804.2 ± 96.1	0.88–0.96	0.96
Total pressure mean	45.3 ± 5.8	0.95–0.99	0.97
Lt. Buttock pressure mean	50.8 ± 26.8	0.96–0.99	0.98
Rt. Buttock pressure mean	54.1 ± 10.9	0.91–0.98	0.95
Lt. thigh pressure mean	43.1 ± 17.7	0.96–0.99	0.98
Rt. Thigh pressure mean	41.6 ± 9.7	0.85–0.96	0.92
Lt. Butt pressure peak	91.6 ± 32.6	0.92–0.98	0.95
Rt. Butt pressure peak	92.9 ± 8.1	0.86–0.96	0.92
Lt. thigh pressure peak	80.0 ± 14.6	0.89–0.97	0.94
Rt. Thigh pressure peak	79.7 ± 10.2	0.89–0.97	0.94

use of suitable support surfaces has been found to be beneficial in the prevention and management of pressure ulcers. Carrying out a holistic assessment of the patient and recording the patient's at-risk score helps clinicians determine the most suitable pressure-relieving surface for a patient¹⁰.

The purpose of this study was to test the reliability of the prototype SSS that measures and redistributes the interface sitting pressure. The Special Support System was developed to provide four, interactive, dynamic, support surfaces that measure interface pressure while a subject is seated on it. As with other measures of reliability, there are no standard values defining acceptable reliability when using the ICC. ICC values range between 0.00 and 1.00, with values closer to 1.00 representing greater reliability¹¹. As a general guideline, an ICC of 0.75 and above is indicative of good reliability, while an ICC below 0.75 indicates poor to moderate reliability. In the present study, the lowest ICC obtained was 0.89 for inflated air pressure, while ICCs for sitting pressure were even higher.

This study demonstrated that the special support system is a reliable tool for measuring sitting interface pressure redistribution and continuously maintaining an appropriate level of inflated air pressure. Future studies need to be conducted to compare the clinical interface pressure redistribution effects of SSS against those of gel, hybrid, air, and foam cushions.

ACKNOWLEDGEMENT

This work was supported by the Soonchunhyang University Research Fund.

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