Clinical Case Report

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Effects of seating education and cushion management for adaptive sitting posture in spinal cord injury

Two case reports

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Abstract

Rationale: Pressure ulcers can frequently occur in spinal cord injured patients living in wheelchairs. Therefore, to manage the cushion in sitting posture is important for preventing ulcers.

Patient concerns: The patients visited seating clinic in rehabilitation hospital for uncomfortable sitting posture. The patients were asked for posture control and cushion air management training in a sitting posture to prevent sores.

Diagnosis: The diagnosis was spinal cord injury.

Interventions: Two patients with spinal cord injury were subjected to posture training while the quantity of air in the cushion was being modulated to minimize gluteal pressure by measuring the pressure in the sitting position in the driver's seat using an X-sensor.

Outcomes: In Case 1, as a result of air control, contact area showed 1108.06 cm^2, average pressure 45.20 mmHg, contact area increased, and mean pressure decreased. In Case 2, the contact area 974.19 cm^2 and the average area 41.00 mmHg were measured by applying the change to the ROHO low-Quardro type, showing a decrease in the average body pressure from the initial stage.

Lessons: From the results of this study, it was found that measurement of body pressure and posture training using a sensor that provides visual feedback is effective in preventing pressure ulcer. Therefore, it is necessary to perform routine control of the sitting pressure in the clinic and management training of the air cell cushion.

Abbreviations: ASIA = American Spinal Injury Association, COPM = Canadian Occupational Performance Measure.

Keywords: adaptive sitting, cushion management, postural education, spinal cord injury

1. Introduction

Spinal injuries are fractures of the bone structures constituting soft tissues, such as the vertebral body, vertebral pedicle, spinal lamina, pleurapophysis, and subspinous region, and injuries of soft tissues that support the vertebra.[1] Spinal cord injuries commonly occur from traffic accidents, falls, and diving. After a spinal cord injury, crural palsy can occur, which makes patients rely on wheelchairs for their daily activities. The use of wheelchairs is an important aspect that the spinal cord injured patients should be trained for so that patients can move in and out of the home.[2]

In spinal cord injured patients, body posture control is mostly related to posture control in the seated position. Moving using wheelchairs requires the physical effort to sit in the same posture for a long period of time. It is important to ensure that there are no skin breaks so that spinal cord injured patients can perform activities while sitting in the same posture for a long time.[3]

Decubitus ulcers caused by spinal cord injuries account for 4% of total direct deaths; thus, the ulcer should be properly managed in spinal cord injured patients.[4] The causes of decubitus ulcer are diverse, such as pressure, shearing force, friction, age, posture, humidity, temperature, and nutrition.[5] The biggest cause of decubitus ulcer is pressure, which results from maintaining one posture for a long time. Decubitus ulcer more commonly occurs from sitting than from lying, and it causes suffering and serious pain in the patients. After spinal cord injury, soft tissue loss results in a decrease in the gluteal contact area, thereby reducing pressure dispersion to the subcutaneous tissues.[6] When the contact area is reduced, the pressure per unit area is increased. Previous studies have reported that compared with normal individuals, the gluteal contact area is reduced by 50% or more due to muscle atrophy in patients with spinal cord lesions.[7] When the gluteal contact area is relatively reduced, the weight pressure is exerted only on one side, and the incidence of

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decubitus ulcer is increased. Therefore, it is important to prevent the occurrence of decubitus ulcer by reducing the pressure on the gluteal region using a decompression technique in wheelchair-bound patients with prolonged sitting posture.[8]

Unlike other complications, patients with decubitus ulcer can receive a lot of help through assist devices and education for the prevention of decubitus ulcer. Many people with decubitus ulcer have received education about preventing decubitus ulcer by applying air cushions.[9] Air cushions help visually estimate the distribution of the gluteal pressure according to the height change of the air cell; however, the accuracy is low. Therefore, pressure measurement sensors and softwares can be used to obtain visual feedback to measure the degree of pressure distribution when sitting on air cushions.[10] The purpose of this study is to investigate the effect of pressure relief training and air-cushion control in a seating posture using a body pressure measurement sensor capable of visually monitoring pressure changes in spinal cord injured patients.

2. Ethical review

This study was not required the approval by an ethics committee due to retrospective study using chart review. All patients provided written informed consent and they agreed to measure on their status.

3. Case description

Two patients were commissioned to the seating clinic in local rehabilitation center for training of posture control and cushion air management. The patients received posture control training and cushion air management service to prevent pressure ulcer by an occupational therapist. Generally, the processes of the measuring and training were composited by 3 steps; initial assessment on the pressure in the current status, measuring changes of pressure after a lapse about 5 minutes, and final assessment on the changes after posture adjustment training and cushion air management. All patients were fully informed about measurement and training and agreed to participate in the study.

3.1. Case 1

The subject was a 43-year-old woman (height, 155 cm; body weight, 45 kg) who developed an incomplete injury in the 7th cervical vertebrae and American Spinal Injury Association-B (ASIA-B) in 2015. Since 2012 after having undergone decubitus ulcer surgery, she has been using a rigid-type wheelchair and ROHO Low Cushion with a width of 36 cm manufactured by Quickie. Although her skin became scraped while moving, there was no sign of chronic decubitus ulcer after the surgery. Her decubitus ulcer care was performed by self-dressing using Medifoam. She used to work in a marketing agency, but since the injury, she has been involved in marketing using socal network service in her home. Therefore, she keeps sitting for 2 and half hours a day while using a computer, reading books, and writing, and she lies down to relax when she feel exhausted. She drives, but recently, she has had complaints of anxiety about developing a decubitus ulcer. Therefore, she wants intervention to avoid the risk of developing a decubitus ulcer. The COPM test results showed that the activity she needed the most was moving and driving, and she complained of the inconvenience with maintaining the sitting posture during long-distance driving. The ROHO cushion used by the subject has an anatomically similar shape to the human body, and it is an air-inflated cushion that can be adjusted to specific needs by adjusting the pressure of each air cell differently (STAR cushion, 2014). It can assume different shapes depending on the range of pressure. The research team measured pressure changes in the gluteal region when the subject sat on the driver's seat to test for her concern about the occurrence of decubitus ulcer. The pressure changes in the gluteal region were measured using X-SENSOR 4.2 system (X-SENSOR Technology Corporation, Calgary, Canada). The X-sensor comprises a pressure sensitive mat and an interconnecting device linked to a computer. When the patient sits on the mat, the computer displays images and figures according to pressure, thus making real-time measurements possible.[11] It also provides visual data to enable easy observation of pressure distribution.

The patient was scheduled for a test, and evaluation and sitting posture training were conducted. In the first step, pressure distribution was measured using an X-sensor when the subject sat on the ROHO cushion. In the second step, the pressure of the gluteal region was measured after 5 minutes had passed. In the third step, the patient was given posture control training while controlling the gluteal air pressure to measure the gluteal pressure. Posture training was given to achieve uniform weight distribution in both ischial tuberosities, and pressure relief education was also conducted.

In the first evaluation, the pressure of the gluteal contact area was 953.22 cm^2, the peak pressure was 220 mmHg, and the average pressure was 47.37 mmHg. After 5 minutes, the pressure of the gluteal contact area was 1050.00 cm^2, the peak pressure was 220 mmHg, and the average pressure was 57.27 mmHg. As a result of adjusting air in the cushion in the third evaluation, the pressure of the gluteal contact area was 1108.06 cm^2, the peak pressure was 220 mmHg, and the average pressure was 45.20 mmHg. Thus, the gluteal contact area increased, and the average pressure decreased (Fig. 1).

3.2. Case 2

The subject was a 30-year-old male patient (height, 174 cm; weight, 64 kg) who was diagnosed with T12, ASIA-A in 2016. Since rehabilitation, he has been working and complained of posture pressure resulting from grade 1 decubitus ulcer in Lt. ischial tuberosity. As only color change appeared in his decubitus ulcer, he received posture prevention education from an occupational therapist. He uses avant-garde Ti 8.9 (Ottobock, Korea) for outdoor use and a manual standing wheelchair for indoor use. He uses a honeycomb cushion for outdoor use and a ROHO low back cushion for indoor use. The posture and pressure were measured in the sitting position for both outdoor and indoor use. Both pelvis alignments tended to be asymmetric while seating, and the ROHO low back cushion contained inadequate amounts of air. The intervention included pressure relief training and education on the measurement of cushion air amount and proper cushion application. First, we emphasized the importance of pressure relief activities in the sitting posture. In addition, ROHO low back cushion used by the subject is for the prevention of decubitus ulcer in the lumbar region; thus, we recommended that he replaces it with ROHO Low Quardtro cushion, which helps prevent decubitus ulcer in the gluteal region. The pressure measurement results of the air cushion are as follows.

In the first evaluation of the patient with the use of a honeycomb cushion, the pressure of the gluteal contact area was 1125.80 cm^2, the peak pressure was 220 mmHg, and the average pressure was 32.29 mmHg. After 5 minutes, the pressure of the

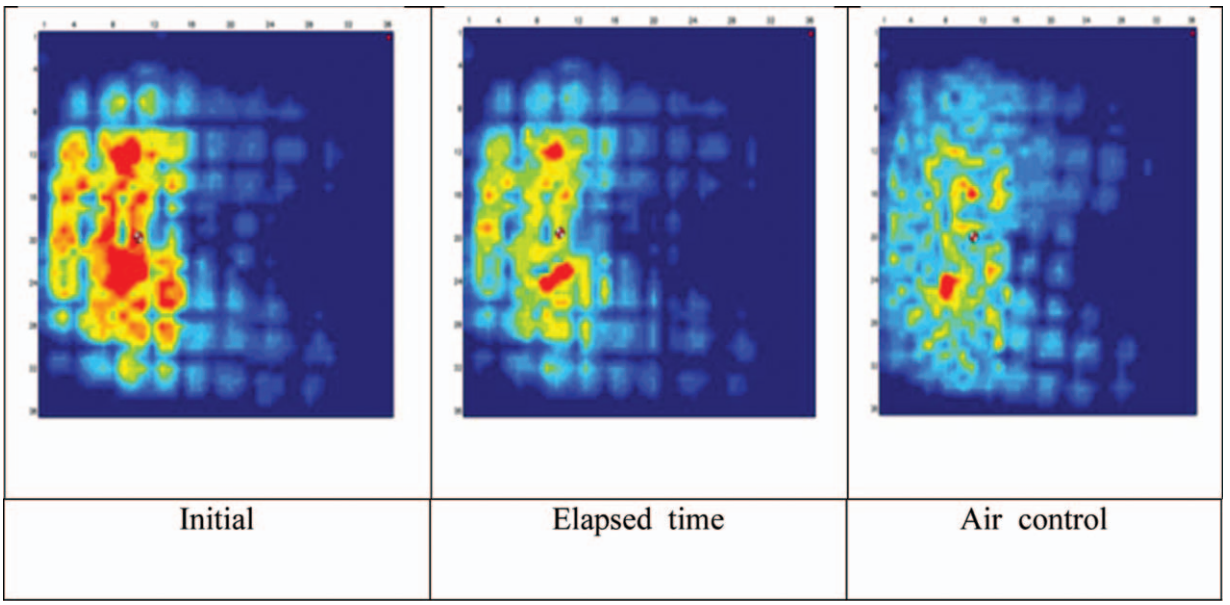

Figure 1. Pressure mapping in Case 1.

gluteal contact area was 1200.00 cm^2, the peak pressure was 220 mmHg, and the average pressure was 39.79 mmHg. The pressure was measured when the ROHO back cushion was applied to the gluteal region. Consequently, the initial pressure of the contact area was 748.33 cm^2, the peak pressure was 146 mmHg, and the average pressure was 36.64 mmHg. After time elapsed, the pressure of the contact area was 803.22 cm^2, the peak pressure was 220 mmHg, and the average pressure was 40.93 mmHg. The pressure was measured after the cushion was replaced so that the patient could apply the appropriate cushion for the correction position. With ROHO Low Quadtro cushion, the pressure of the contact area was 958.36 cm^2, the peak pressure was 103 mmHg, and the average pressure was 34.94 mmHg. After time elapsed, the pressure of the contact area was 974.19 cm^2, the peak pressure was 132 mmHg, and the average pressure was 41.00 mmHg (Fig. 2).

4. Discussion

In this study, demonstrate the methods of controlling contributing factors of decubitus ulcer by measuring the pressure changes while controlling the air of the cushion and correcting the seating posture to prevent the occurrence of decubitus ulcer in spinal cord injured patients. Spinal cord injured patients perform most of their daily life activities using wheelchairs; thus, many of them sit for a long time, which increases the risk of decubitus ulcer. The intervention for pressure relief in patients with spinal cord injury is closely related to daily life. Therefore, the air in the cushion should be controlled to prevent decubitus ulcer.

In these cases, it proved the effect of posture education and air conditioning of cushion to prevent sores using pressure sensor. In Case 1, as the average pressure in the air cells of the cushion used to control interface pressure was high, the cushion was partially deflated until the proper air pressure for prevention of decubitus ulcer was achieved. When the pressure of the air cell cushion is too high, the contact surface of the buttocks tends not to be widened, and the average pressure tends to be high. Also long-lasting high pressure of the tissue is risk factor for evoking pressure ulcers. Interface pressure was affected various factors such as tissue condition, weight, and time. Several studies were found difference of interface pressure among time duration.[12,13] In the study of Yuen and Garrett,[14] the interface pressure was taken at 2, 5, 10, 15 minutes interval and they notified when the interface pressure was stabilized. The result showed the phenomenon that the pressure stabilized after 5 minutes had elapsed. Similarly, in this study, the stable range of interface pressure was measured based on the change in the average pressure of the patient after 5 minutes from the initial measurement posture, when the pressure of a specific part was showed continuously high, the air pressure control of seat cushion was carried out.

In Case 2, when an air cell cushion was applied to the gluteal region rather than the honeycomb cushion previously used by the patient, the gluteal interface pressure was significantly reduced in the sitting posture. In previous studies, the interface pressure was measured in the sitting posture using low-profile air, high-profile air, dual-compartment air, and gel-firm foam cushions. As a result, dual-compartment air cushions were the most effective for pressure distribution.[15] This shows that the dual-profile air cushion applied in the second case was more effective than the honeycomb cushion in preventing decubitus ulcer and relieving the gluteal pressure.

As shown in this study, the effects of air pressure control and cushion type on the adaptive seating posture were different in patients with spinal cord injuries. For spinal cord injuries, cushion management and seating education are very important for adaptive seating postures. In seated condition, mal-alignment is affected not only by the physical disability of the patient but also by the condition of the cushion being used. The research by Vos-Draper and Morrow[16] have recommended the control of the patient's posture through cushion control. Especially, the cushion control of the sensor measurement method which can provide visual feedback is useful because it promptly gives feedback and arousal to the patient. In the study of Lee et al,[17] they investigated whether there was a significant difference in postural symmetry of patients when sitting in a wheelchair, spongy cushion, air cushion, and gel cushion. As a result, it was found that there was a difference in the posture alignment of the

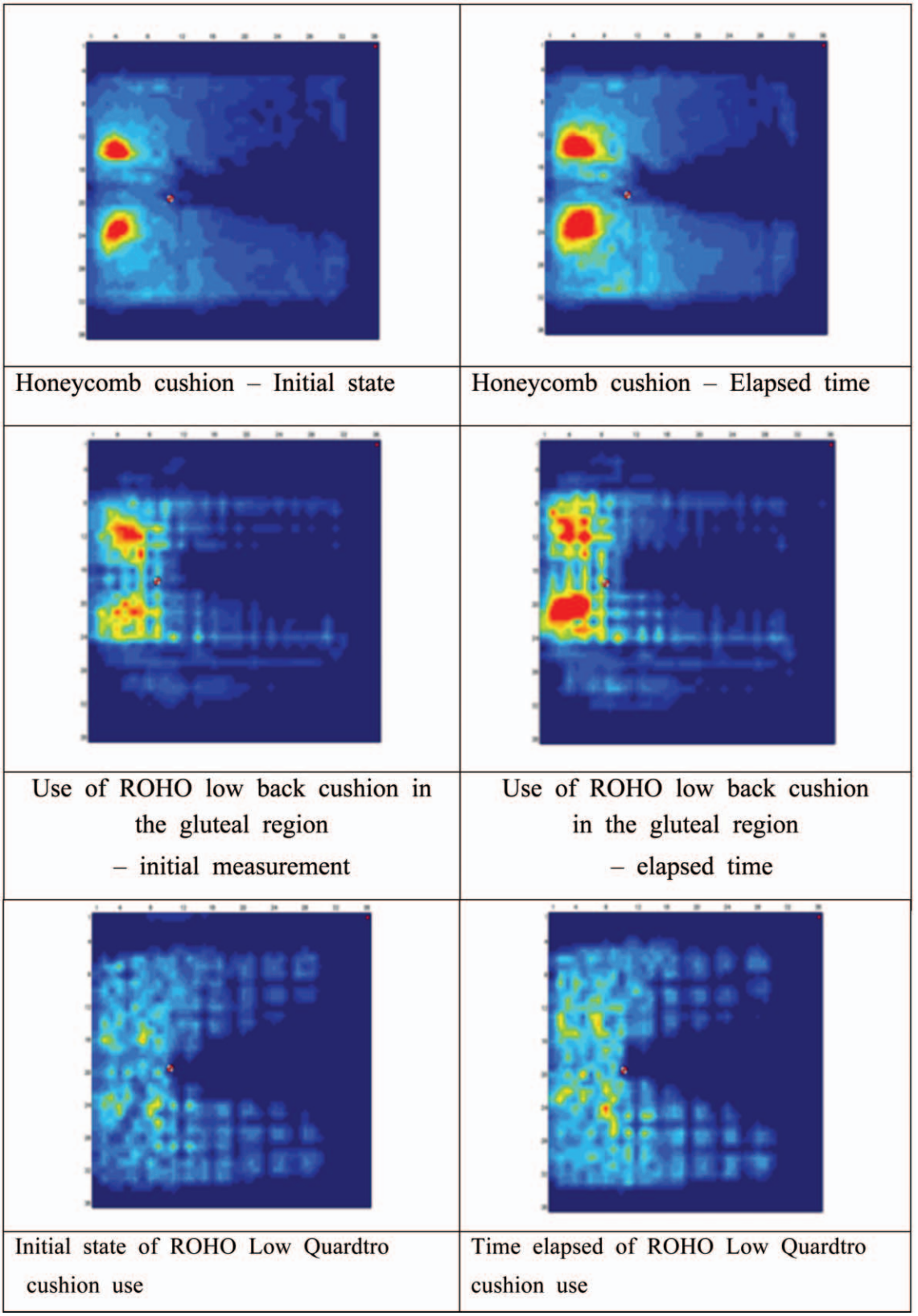

Figure 2. Pressure mapping on Case 2.

patient according to the shape of the cushion. These previous studies support the results presented in this case study.

This study has some limitations. The research type was a case report type, so it could not be performed on many research groups that showed homogeneity. However, it is meaningful that the case report can provide concrete examples of the patient's situation. In this study, only the change of the pelvic area was measured by measuring the pressure of the cushion in the sitting position of the

wheelchair. Although this is not a clinically incorrect method of measurement, it is necessary to measure pressure changes in the backrest region as well as the buttocks in the sitting position of the patient. This is because the postural control of the buttocks also affects the trunk and back support surface. Although there are some limitations, this study is meaningful in that it informs the importance of training the pressure measurement of the cushion and the posture adjustment regularly for the adaptive seating posture of the spinal cord injured patients.

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