Effects of Lumbar Position Sense on Swing Chair in Healthy Adults

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Purpose: To recognize the change in the proprioception under conditions that activate the local muscles, this study found the difference in the proprioception on a fixed and swing chair.

Methods: Healthy adults (7 males, 13 females) in their twenties were evaluated lumbar position sense on fixed and swing chair. And the difference of the position sense between the fixed and swing chair were analyzed.

Results: The joint position senses were compared between the fixed and swing chair. As a result, there was a significant difference from all motions.

Conclusion: This study found that the improvement of proprioception using swing chair means that the local muscle is activated. Therefore, to use a swing chair, which was designed in this study, is able to replace the general chair either at work or during studies. Thus, this method is easily accessible for busy modern people who are exposed to low back pain or spinal disorders due to a pattern of inactivity.

Keywords: Swing chair, Proprioception, Low back pain

I. Introduction

Among the people living in the 21st century, inactive life patterns, which are static activity types, account for the majority of people’s work patterns rather than active life patterns.¹ Such patterns decrease the amount of physical activity. As a result, a weakness of the skeletal muscles is engendered, resulting in the development of musculoskeletal diseases. In addition, many people today work on computer desks and thus, sit in a chair for the entire day. Such position induces spinal disorders caused by the incorrect postural alignment of the chair. As a result, low back pains occur, engendering a typical musculoskeletal disease in today’s people.²

The most scientific therapeutic exercise to treat and prevent a low back pain is the lumbar stabilization exercise of the local muscles such as the multifidus and transverse abdominis.³⁴ These local muscles are the most critical in stabilizing the lumbar and maintaining proprioception.⁵ The inappropriate and insufficient activation of the local muscles produce spinal instability, which appears as a low back pain.⁶⁷ Therefore, treatment of a low back pain should be focused on the improvement of proprioception as well as the lumbar stabilization exercise.

In some of the current studies on lumbar stabilization exercises, they discuss therapeutic exercises which help to strengthen the local muscles.⁸⁻¹¹ For example, there are researches on therapeutic methods with an unstable surface such as the Swiss-ball or sling.¹²⁻¹⁵ Lumbar exercise is an effective method for prevention as well as treatment.³⁴ Thus, an exercise to strengthen local muscles during a daily routine, either working or not, may be essential in the busy lives of modern people. Moreover, it is significant to develop an understanding as well as to study chairs with movable seats.
for research purposes.

To recognize the change in the proprioception under conditions that activate the local muscles, this study found the difference in the proprioception on a fixed and swing chair. Furthermore, we suggest that a swing chair prevents low back pain due to an inactive life pattern. Also, using a chair in one’s daily life activates the local muscles and improves the lumbar proprioception.

II. Materials and Methods

1. Subjects
Healthy adults (7 males, 13 females) in their twenties were enrolled in this study (mean age=23.0 yr, height=165.8 cm, weight=59.7 kg). They had no neurologic and orthopedic problems. The subjects voluntarily agreed to participate in the experiment after listening to the purpose and method of the study.

2. Experimental methods
1) Experimental equipments
(1) Chairs (Figure 1)
The chairs used in this experiment were a fixed chair, which are commonly used, and a swing chair, which was specially designed. The fixed chair was a common usable chair, and it was fixed between the seat and the column. The seat on the swing chair was designed only to translate freely to 5 cm maximally and to sway any direction on a horizontal plane. Both chairs had the same design and both seats were 40 cm in diameter. Adjusting the height of the chair was also possible.

(2) Zebris
Zebris is a device measuring the range of motion (ROM) of the spine, and it is has proven the equipment with reliability and validity.\(^\text{16,17}\) Two sensors are used to measure the ROM of the lumbar spine, which is the angle of acceptance recognized from sensors using an ultrasonic. In this experiment, Zebris was used to measure the joint position sense, known as proprioception.

First, the subjects maintained a neutral position. Then, the examiner manually guided the subject to an arbitrary angle, and the subjects were kept at the angle for about 5 seconds to fully recognize the angle. After the subjects changed back into the neutral position, they actively moved to find the arbitrary angle. At this time, the difference between the actual and arbitrary angle was measured.

2) Experimental procedure
Subjects were equipped with Zebris with lumbar spine and they were measured in a position three times in each of the fixed and swing chair. Three times the average was used as a measurement value. First, chair height was achieved at a 90 degree angle of hip and knee, respectively. Their arms crossed over their chest while moving so that the arms did not obstruct the sensor. They were measured after sufficient explanation and practice of sitting in chairs in a sitting position. Position senses were measured in all motions including flexion/extension, right/left rotation, and right/left lateral flexion.

3. Data analysis
A paired-t test was used to compare the position sense between a fixed and swing chair. The IBM SPSS ver. 19.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. p-values less than 0.05 were used to identify significant differences.

III. Results

1. The position sense according to type of chairs
The joint position senses were compared between the fixed
and swing chair. As a result, there was a significant difference from all motions (Figure 2).

During flexion, reposition error was 1.83±0.96 degree on a fixed chair, and 0.75±0.67 degree on a swing chair (p<0.00). During extension, reposition error was 2.17±1.05 degree on a fixed chair, and 1.20±0.94 degree on a swing chair (p<0.00). During right lateral flexion, reposition error was 1.11±0.77 degree on a fixed chair, and 0.60±0.42 degree on a swing chair (p<0.00). During left lateral flexion, reposition error was 1.10±0.54 degree on a fixed chair, and 0.58±0.44 degree on a swing chair (p<0.00). During right rotation, reposition error was 1.37±0.63 degree on a fixed chair, and 0.65±0.39 degree on a swing chair (p<0.00). During left rotation, reposition error was 1.28±0.48 degree on a fixed chair, and 0.55±0.25 degree on a swing chair (p<0.00).

IV. Discussion

The purpose of this study was to determine whether there are any differences of the proprioception between a fixed chair and a swing chair. Moreover, while the local muscles are activated, the study demonstrated whether or not the proprioception improved. In this study, the chair with a movable seat on a fixed column was designed in order to activate the local muscles. The swing chair was produced to move in any direction over a horizontal plane. We believed that maintaining the stability in a sitting position on a swing chair will activate the local muscles.

The result of the study reveals that proprioception was more enhanced on a swing chair compared to that of a fixed chair. Local muscles stabilize and maintain the posture of the lumbar spine. These postural muscles contain a large percentage of type I fiber, which is distributed in many of the muscle spindles. Muscle spindles are typical proprioceptive receptors, thus, the improvement of proprioception means that the local muscle is activated.

Proprioception in the spine is essential in maintaining the correct postural alignment. It is also a significant sense in order to prevent low back pain or musculoskeletal disorders. Therefore, researches on methods to improve proprioception as well as lumbar stabilization exercises have been actively studied in order to prevent and treat low back pain. One of the ways for prevention is to use equipment such as Biodex. Biodex is training equipment as well as a measurement of proprioception, yet, it is expensive, difficult to use, and needs the help of a skilled therapist. Therefore, Biodex has many temporal and spatial constraints in its use. Methods of training on a movable surface are used greatly such as a sling or Swiss ball training. Sling is expensive and needs the help of a skilled therapist. Although the Swiss ball is used for home treatment, there is a risk of falling and further, its users often fear of falling from the ball. Proprioceptive training methods have several temporal and spatial limitations, such as having to set aside time to devote to exercise and experience limitations on the use of the equipment.

A swing chair, which was designed in this study, is able to replace the general chair either at work or during studies. Thus, this method is easily accessible for busy modern people who are exposed to low back pain or spinal disorders due to a pattern of inactivity. In addition, unlike the Swiss ball, it does not include a risk of falling. Therefore, it may be an efficient way both temporally and spatially.

According to a study in Australia, the use of Swiss ball is to improve the attention of children. Although it raises doubts that to work on a swing chair may adversely affect the
ability to work, working on a swing chair is also expected to increase one’s attention, similar to the Swiss ball. Thus, future research will need to prove whether using a swing chair can improve attention. It has been demonstrated that the use of a swing chair improved proprioception. Thus, in order to investigate whether an improvement of proprioception is due to local muscles, EMG studies about local muscles on a swing chair is required.

Author Contributions

Research design: Park JW, Ko YM
Acquisition of data: Kim YJ, Yun SB
Analysis and interpretation of data: Park S, Ko YM
Drafting of the manuscript: Park S
Administrative, technical, and material support: Ko YM
Research supervision: Park JW

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