Comparison of the effect of weight-bearing and non-weight-bearing positions on knee position sense in patients with chronic stroke

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Abstract. [Purpose] The purpose of this study was to investigate the knee joint proprioception in weight-bearing (WB) and non-weight-bearing (NWB) positions and to study the difference between the methods in chronic stroke patients. [Subjects and Methods] The subjects were 15 stroke patients who were randomly scheduled to perform both positions by a physical therapist not involved in the study. The subjects performed the positions (WB and NWB) based on a randomized controlled cross-sectional design. WB subjects were positioned in one-leg standing to assess the knee joint position sense. NWB subjects were instructed to sit comfortably in a chair and maintain the knees at 90° of flexion with the leg out of the plinth. [Results] The results revealed that the WB position showed a significant difference in knee position sense. The proprioception sense in the WB position was higher than that in the NWB position. [Conclusion] The knee proprioception of chronic stroke patients differs between the weight-bearing and non-weight-bearing positions.

Key words: Knee proprioception, Stroke, Weight bearing

INTRODUCTION

Stroke is accompanied by a decline in muscular strength, sensory perception, neuromuscular control, and balance, consequently increasing the risk to fall¹, ². These factors cause poor neuromuscular control and problems relating to proprioceptive sense³. Proprioceptive sense is considered an essential element for activities of daily living⁴, ⁵. There are several methods of assessing joint proprioceptive sense⁶, ⁷. Most joint proprioception assessments are used to evaluate the function of conscious joint position⁸. From an anatomic perspective, histologic studies can be conducted to identify mechanoreceptors within specific joint structures. Neurophysiological testing can measure the sensory threshold and nerve conduction velocities. Clinically, proprioceptive sense can be assessed by measuring the two components that make up the proprioceptive mechanism, namely, kinesthesia and joint position sense. Most studies have conducted testing knee proprioception with participants in a non-weight-bearing (NWB) position. In recent years, increasing numbers of authors have recommended a weight-bearing (WB) test for joint position sense, as weight-bearing tests are more functional and involve all of the cutaneous, articular, and muscular proprioceptors during activities of daily living⁹, ¹⁰. There have been few studies describing assessment of joint position sense by using functional WB protocols. In a study performed by Lokhande et al.¹¹, the authors investigated the differences in reproducibility of knee joint angles in healthy subjects during a WB task performed while standing and an NWB task performed while sitting. More accurate reproduction of knee joint angles was noted during the WB protocol. In a study performed by Magalhaes et al.⁹, a WB task offered more proprioception and sensorimotor feedback than an NWB task. On the other hand, Keifer et al.¹² reported greater position error during a WB task compared with an NWB task. In stroke patients, both the more affected side and less affected side showed deficits in joint position sense¹³. However, the differences between the sides have been little studied in previous studies, and few studies have compared WB and NWB positions in chronic stroke patients. Thus, our study aimed to assess knee joint proprioception in WB and NWB positions and to study the difference between the positions in chronic stroke patients.

SUBJECTS AND METHODS

The subjects were fifteen people who had had a stroke and had been admitted to a rehabilitation clinic. They were randomly scheduled by a physical therapist not involved in the study. Random scheduling was performed by selection of
For the NWB position method, subjects were instructed to sit comfortably in a chair and maintain the knees at 90° of flexion with legs out of the plinth and the thighs fully supported and were blindfolded to avoid any visual cues. To minimize cutaneous input, the subjects were asked to wear short and to perform the tests while barefoot. They were asked to extend the knee joint from 90° to 120° or 150°. When the target angle of 120° or 150° of knee extension was attained, the subjects were instructed to stop and hold the position for 5 seconds. They were then instructed to flex the knee. After 7 seconds, the subjects indicated when they felt they had attained the target angle. The tester instructed the subjects to return to the starting position. The knee joint position sense was measured and recorded for both knees. The hold times used were the same as those used in previous studies1,10.

For the NWB position method, subjects were instructed to sit comfortably in a chair and maintain the knees at 90° of flexion with legs out of the plinth and the thighs fully supported and were blindfolded to avoid any visual cues. To minimize cutaneous input, the subjects were asked to wear short and to perform the tests while barefoot. They were asked to extend the knee joint from 90° to 120° or 150°. When the target angle of 120° or 150° of knee extension was attained, the subjects were instructed to stop and hold the position for 5 seconds. They were then instructed to flex the knee. After 7 seconds, the subjects indicated when they felt they had attained the target angle. The tester instructed the subjects to return to the starting position. The knee joint position sense was measured and recorded for both knees. This sequence was repeated for a total of 5 trials. The angles of knee and extension were chosen randomly from 120° or 150° to prevent a learning effect.

Measurements were recorded as an absolute error for both the target angle and the reproduced angle. The absolute error was the arithmetic difference between tested and reproduced angles. The mean of each set of 5 absolute errors was then calculated. Paired t-tests were used to compare differences between the WB and NWB positions. One-way repeated measures ANOVA was performed for comparison of the knee joint position sense for both the more affected and less affected sides. Post hoc testing was performed with Bonferroni correction. All statistical analyses were performed by using the PASW Statistics version 18.0 software. Data are presented as the mean and SD. The level of statistics significance was set at p<0.05.

RESULTS

Fifteen people met the inclusion criteria and voluntarily agreed to participate in this study. The subjects were randomly scheduled for testing in the WB and NWB positions. All subjects characteristic are shown in Table 1.

The mean absolute error and SDs according to the WB and NWB positions for both the more affected and less
affected limbs are presented in Table 2. The WB position showed a significant difference between the more affected and less affected limbs for the knee joint angle of 120° (p<0.05, F=103.14). The NWB position showed a significant difference between the more affected and less affected limb for the knee joint angle of 120° (p<0.05, F=87.35). The WB position showed a significant difference between the more affected and less affected limb for the knee joint angle of 150° (p<0.05, F=55.92). The NWB position showed a significant difference between the more affected and less affected limb for the knee joint angle of 150° (p<0.05, F=15.29). The more affected limb showed a significant difference between the positions (WB versus NWB) for the knee joint angle of 150° (p=0.03, 95% CI= 4.86–7.68). The less affected limb showed a significant difference between the positions (WB versus NWB) for the knee joint angle of 150° (p=0.04, 95% CI= 3.39–4.97). The more affected limb showed a significant difference between the positions (WB versus NWB) for the knee joint angle of 120° (p=0.04, 95% CI= 1.46–8.91). The less affected limb showed a significant difference between the positions (WB versus NWB) for the knee joint angle of 150° (p=0.03, 95% CI= 0.57–6.7).

### DISCUSSION

This study was conducted to compare knee joint position sense between WB and NWB positions in chronic stroke patients. The results of the present study point out (1) that comparison of the mean of absolute errors in the WB and NWB positions showed a significant difference in knee position sense and (2) that there were significant differences in knee position sense between the more affected and less affected limbs.

Our study was conducted to compare the effect of the WB and NWB positions on knee joint position sense in chronic stroke patients, which has not been reported previously. However, previous studies have measured knee joint position sense with aging and in subjects with muscular skeletal diseases, injured knees, or knee ligament injuries\(^1\)\(^\text{,}15\)\(^\text{,}16\). The absolute errors found in our study for knee joint position sense were higher than those under other conditions. Thus, interventions for improving the proprioception of stroke patients should focus on both sides.

The central component of proprioception, that is, the integration of sensory input, is also affected by neurologic disorder. The conductive function of the central somatosensory pathway is impaired by loss of function of the dendrite system in the motor cortex\(^1\)\(^\text{,}21\), a decrease in the number of neurons and receptors, and neurochemical modifications in the brain\(^1\)\(^\text{,}22\)\(^\text{,}23\). Additionally, a decrease in muscle spindle sensitivity can also result from mediated changes in the gamma drive to the spindle themselves\(^24\).

The knee proprioception of chronic stroke patients differs between the weight-bearing and non-weight-bearing positions. This study also noted significant differences when comparing the more affected and less affected lower limbs. However, the study has some limitations, including the relatively small groups and lack of investigation of training effects. Therefore, the results must be interpreted with caution.

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| Error scores (degree) | 120° (n=15) | 150° (n=15) |
|----------------------|------------|------------|
|                      | WB         | NWB        | WB         | NWB        |
| More affected limb   | 6.5 (1.4)* | 12.7 (2.7)* | 7.0 (1.0)* | 12.2 (7.0)* |
| Less affected limb   | 3.0 (0.8)* | 7.18 (1.5)  | 3.5 (2.1)* | 7.1 (5.0)  |

*Means (SD). *Significant difference within position for the same angle. **Significant difference between positions for the same angle. The significance level were set at p < 0.05 for differences between the groups.
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