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The Effect of Sponge on Proprioception at Tilt Table Standing: A Pilot Study

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국문요약

경사침대에서 스폰지가 고유수용성 감각에 미치는 효과

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본 연구는 건강인에 있어서 발의 세 가지 조건하에서 경사침대를 세울 때 완전히 섰다고 인지하는 각도를 측정하여 스폰지가 고유수용성 감각 변화에 미치는 효과를 알아보는 것이다. 34명의 지원자(남자 15명, 여자 19명)를 대상으로 하였다. 대상자의 연령 범위는 20세에서 31세(평균 21.4±2.3세)이었다. 실험 대상자는 3일에 걸쳐 무작위 방법에 의한 세 가지 조건 중 하루에 한 가지씩 실험하였다. 실험 과정은 6단계로 나뉘었다. 실험 기구는 전동 경사침대를 이용하였으며 맨발로, 낮은 스폰지 혹은 높은 스폰지위에 맨발로 경사침대를 세울 때 '정지'하는 각도를 측정하였다. 연구자 외에 2명의 보조 연구자가(기록자 2, 경사침대 조정자 1) 참여하였다. 맨발, 낮은 스폰지, 높은 스폰지 순으로 경사침대의 평균 각도가 높았으며 통계학적으로 유의한 차이를 보였다. 맨발과 낮은 스폰지, 맨발과 높은 스폰지, 그리고 낮은 스폰지와 높은 스폰지 사이에서 통계학적으로 유의한 차이를 보였다. 성별에 따른 차이는 없었다. 체중이나 키에 따른 차이도 없었다. 본 연구의 결과로 미루어볼 때, 스폰지가 완전히 섰다고 인지하는 고유수용성 감각을 둔화시켰음을 보였다. 앞으로의 환자 치료에 있어서 고유수용성 감각 촉진을 위한 치료 프로그램이 필요하며, 환자를 대상으로 한 임상연구가 필요하다고 사료된다.

핵심단어: 경사침대; 고유수용성감각; 스폰지.

Introduction

Clinically proprioception is one of main problem of evaluation and treatment for traumatic brain injury or cerebrovascular accident. The term proprioception is used to describe an awareness of the position or movement of the body. The sensory involved in proprioception provide information to the central nervous system about the relative position of the body parts and their movement. Central to a knowledge of body position is information regarding the degree of angulation of all joints in all planes and their rates of movement (Rothwell, 1987).

Loss of protective, proprioceptive, and touch sensations following stroke is common, occurring in up to 65% of patients. The type and degree of sensory loss varies and is usually incomplete. More commonly, marked deficits occur in discrimination and interpretation of sensory experiences. Furthermore they have detrimental effects on safety, leisure activities, ability to sustain an appropriate level of force during activities, and influence the reacquisition of skilled movements. It has been suggested that a learned nonuse phenomenon, occuring with sensoy loss, leads to futher deterioration of motor abilities. Hemisensory loss, as well as of more complex perceptual functions, was found to be a factor contributing to inferior results in level of function and longer rehabilitation in several studies.

Winstein and Schmidt (1989) described six sources of movement-related sensory information that form the basis of kinesthesis. These are muscle spindles, Golgi tendon organs, articular receptors, cutaneous receptors, vision, and audition. The use of sensory afference from these receptors defines limb movement and position through a complex interaction between the peripheral and central nervous systems.

Most of traditional neurophysiologic approaches are used to emphasize the importance of applying proper sensory input in the treatment of patients with movement disorders. In the 1950's, Ayres realized that functional limitations of many brain damaged adults were due to sensory or percepual factors rather than to motor problems (Patricia and Barbara, 1991). Rood used sensory stimuli by applying pressure and stretch for postural muscle activation (Stockmeyer, 1967). General treatment in PNF includes the use of appropriate sensory cues and techniques for facilitating movement and postural responses (Voss, 1967). Johnstone outlined principles is designed to apply even deep pressure to use the soft tissues to address sensory dysfunction (Patricia and Barbara, 1991).

There are indications of potential for recovery. Although scientific data on recovery of human somatosensation is lacking, potential for improvement has been noted in discriptive accounts. Furthermore, controlled studies with experimentally lesioned primates show that extensive training of proprioception, vibration, light touch, and two-point discrimination abilities result in recovery of most fine discriminatory abilities, and reorganization of the somatosensory cortex can occur, which may compensate for impaired sensory function. Plasticity of the somatosensory system has also been highlighted in studies on intact animals.

The purpose of this study was to identified the effects of the full standing perception of the proprioception on tilt table standing (TTS) in healthy persons.

1. To measure TTS degree under three conditions(barefoot, low sponge, and high sponge).
2. Difference of degree would be found between the barefoot and low sponge (LoSP), barefoot and high sponge (HiSP), the LoSP and the HiSP.
3. Difference degree would be found between males and females.

Methods

Subjects

Male and female volunteers were recruited from the Department of Physical Therapy, Yeojoo Institute of Technology. A sample of 15 men and 19 women, with a mean of 21.4 years of age (range, 20 to 31 years), 166.1 ㎝ in height, 61.8 ㎏ in weight, participated in this study (Table 1). A screening interview was conducted by the researcher to assess each subject's ability participating in the study. Subjects were excluded if they had any orthopedic or neurological problems, or if they had taken any medications just before aprticipating in this study.

Table 1. Characteristics of the subjects

Gender	Age (yr)		Height (㎝)		Weight (kg)	
	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range
Male (n_1=15)	21.9±1.95	20~26	168.7±5.40	162~182	68.2±6.88	56.4~83
Female (n_2=19)	21.1±2.57	20~31	162.9±5.91	158~175	56.8±4.29	48.7~65
Total (N=34)	21.4±2.32	20~31	166.1±5.78	158~182	61.8±7.93	48.7~83

Equipment

The SAKAI electrical tilt table instrument (適整医療株拭會社, 日本) was used in this study. This instrument has tiling angle of -10 to 90° , adjustable two foot board (15 ㎝×27 ㎝) of inversion, eversion, plantar flexion and dorsiflexion, three belts, foot pressure switch and emergency stop switch, and free-moving needle with markings in 1 degree increments. The sponge size were low sponge (30 ㎝×30 ㎝×8.3 ㎝), and high sponge (30 ㎝×30 ㎝×16.6 ㎝) with soft cussion.

Procedure

All subjects were tested under three conditions, that is, barefoot, barefoot with low sponge, and bare foot with high sponge. Each test was subdivided into six steps: 1) adjusted TTS with zero degree and a right degree foot board, 2) tied belt of the knee and pelvis after a subject was supine on the tilt table with the feet positioned 10 ㎝ in width, 3) absent vision by black leather, 4) started TTS after a subject was instructed to call 'stop' as soon as he and she felt full standing sensation, 5) stopped and recorded standing degree as soon as the subject calls, 6) set the tilt table down. Time was not limited and each test was completed up to 7 minutes, and next test was performed at different days. Three testers were paticipated in this study. One tester operated equipment, and another two persons recorded the degrees.

Intertester reliability was examined for 34% randomly selected data of TTS degrees. Intertester reliability calculated using a percentage of agreement for the occurrence of the recorded TTS degree, was .98.

Staistical Analysis

The data were analyzed using the SPSS/WIN computer package. Mean and standard deviation were calculated for all variables. Independent t-tests were used to compare TTS degree in gender. Paired t-test were used to compare TTS degree in each difference under two conditions with males and females or without. Differances among three conditions were determined using an one-way analysis of variance (ANOVA) for repeated measures. The results were accepted as being statistically significant at $p<.05$.

Results

All 34 subjects completed the tests. Table 2 shows the mean values of tilt table standing degree in three conditions. The TTS degree were greater in high sponge condition than barefoot and low sponge.

Table 3 shows the comparison of mean values of TTS degree in paired conditions (barefoot versus low sponge, barefoot versus high sponge, low sponge versus high sponge). There were statistically significant differences between barefoot and low sponge ($p<.05$), between barefoot and high sponge ($p<.05$), and between low sponge and high sponge ($p<.05$). Table 4 shows the results of the mean statistically significant differences in TTS measurements between all paired conditions in males ($p<.05$). There was also significant differences of paired conditions in women (Table 5). However, there was no significant differences among three conditions for females and males (Table 6).

The result of the mean differences in TTS measurements among the three conditions of subjects (all, men, and women) indicated a statistically significant differences ($p<.05$) for among condition effects (Table 7).

Table 2. Mean values of TTS degree in three conditions (unit: °)

Conditions	Minimum	Maximum	Mean±SD
Barefoot	68.0	85.0	78.6±3.65
LoSP†	70.0	87.0	80.6±4.22
HiSP‡	77.0	88.0	82.3±2.69

† Low sponge
‡ High sponge

Table 3. Comparison of TTS in paired conditions (unit: °)

Condition	Tilt table degree Mean ± SD		t-Value	p
Barefoot vs LoSP†	78.6±3.65	80.6±4.22	-4.73	.000*
Barefoot vs HiSP‡	78.6±3.65	82.3±2.69	-7.72	.000*
LoSP vs HiSP	80.6±4.22	82.3±2.69	-2.97	.006*

* Statistically significant differences at the $p<.05$ level.
† Low sponge
‡ High sponge

Table 4. Comparision of TTS degree in males (unit: °)

Conditions	Tilt table degree Mean ± SD		t-Value	p
Barefoot vs LoSP†	78.66±2.28	80.80±3.42	-2.951	.011*
Barefoot vs HiSP‡	78.66±2.28	82.20±2.27	-5.233	.000*
LoSP vs HiSP	80.80±3.42	82.20±2.27	-1.974	.068

* Statistically significant differences at the p<.05 level.
† Low sponge
‡ High sponge

Table 5. Comparison of TTS degree in females (unit: °)

Conditions	Tilt table degree Mean±SD		t-Value	p
Barefoot vs LoSP†	78.5±4.51	80.5±4.84	-3.64	.002*
Barefoot vs HiSP‡	78.5±4.51	82.4±3.04	-6.58	.000*
LoSP vs HiSP	80.5±4.84	82.4±3.04	-3.03	.007*

* Statistically significant difference at the p<.05 level.
† Low sponge
‡ High sponge

Table 6. Comparison of TTS between females and males (unit: °)

Condition	Female (n=19)	Male (n=15)	t-Value	p
	Mean±SD	Mean±SD		
Barefoot	78.47±4.51	78.66±2.28	-.151	.881
LoSP†	80.52±4.84	80.80±3.42	-.185	.854
HiSP‡	82.42±3.04	82.20±2.27	.234	.816

† Low sponge
‡ High sponge

Table 7. The result of repeated measured one-way ANOVA

Subjects	SS	DF	MS	F	p
All	241.90	2	120.95	35.20	.000*
Men	94.98	2	47.49	12.82	.001*
Women	148.1	2	74.05	21.87	.000*

* Statistically significant difference at the p<.05 level.

Discussion

Ambulation is a primary functional goal for many patients. Physical therapists need to be able to identify problems that limit or prevent ambulation, to determine their causes, and to plan appropriate therapeutic intervention. This intervention typically includes preambulation training program will be to facilitate proprioceptive feedback and to develop postural stability in standing (Schmitz, 1994).

Bohannon (1993) reported, patient was strapped to the table and elevated to 80° from the horizontal for 30 minutes for reducing spasticity with spinal cord injury. The effects seem to be pronounced immediately after standing. Perhaps prolonged sensory input via spinal cord during standing from cutaneous and joint receptors has a modulating influence on decreases the excitability of the spinal motor neurons. Odeen and Knutsson (1981) suggest that the benefits of long-term stretch by weight loading. This study used to standing table for gradually increamental weight bearing of the feet. Although physical therapists commonly use tilt table standing in treating patients with several conditions, specific information on the benefits of the standing table is minimal. Some research studies have measured the effects of tilt table standing on spasticity.

Monitoring the internal and external environment is the primary function of sensory receptors. Sensory input denotes the location of the body in space, location of the body parts to one another, and aspects of the environment including temperature, location of objects, and conditions of the support surface. The organism relies on a constellation of sensory cues from cutaneous and kinesthetic receptors located in the skin, joints, and muscles, as well as vestibular, visual, auditory, and olfactory information. Winstein and Schmidt (1989) described six sources of movement-related sensory information that form the basis of kinesthesis. There are muscle spindles, Golgi tendon organs, articular receptors, cutaneous receptors, vision, and audition. Vision provides the motor system with information about the horizon and about the location of objects and the body in space. Visual cures are important in balance, gait, and many skilled motor activities (Cordo and Flanders, 1989). According to this study was absent vision by black leather for block of visual inputs.

Perception is the integration of sensory input in conjunction with memory of similar situations. Sensation cannot be changed with repeated experience, whereas, perception is changed with repeated experience (Sage, 1977).

This study showed that TTS on sponge was effective in decreasing proprioception. Proprioception in sensory input is closely related to both postural control and motor learning. Brunnstrom advocated that preparation for walking be emphasized early in the treatment for promoting voluntary control of the synergies by the patient through the use of sensory input (Perry, 1967). All the joints of the trunk and lower extremities are weight bearing on the sole of the foot may stimulate the positive support reflex or crossed extension response. However, if the more distal proprioceptive receptors do not transmit the sensory change, standing perception may delay due to decreasing sensory input. This study demonstrated that the mean value of degree was barefoot 78.6 °, low sponge 80.6 °, and high sponge 82.3 °. The mean significantly differed between barefoot and LoSP, barefoot and HiSP, LoSP and HiSP. The result of this findings indicate that the sponge influences on proprioception in healthy persons with tilt table standing.

Many patients are unable to maintain a standing position. The maintenance of an upright posture requires the ability to make postural adjustments as changes occur to the center of mass, the base of support, or the support surface. Asymmetric weight distribution in the lower extremities and deviation of the center of gravity from body midline have been identified as common problems for persons with hemiplegia during static stance (Badke and Duncan, 1983). Lack of symmetry in postural control was found to correlate significantly with measures of walking performance in persons with hemiplegia (Wall and Turnbull, 1986). Numerous studies have been published on the improvement of postural control during static standing. Use of loading exercises emphasizing weight transfer and weight bearing on the affected limb have been show to be effective in reducing the asymmetrical standing posture (Bohannon and Larkin, 1985; Lee, 1997). Weight shifting will improve dynamic stability through increased joint approximation (Stockmeyer, 1967). Bobath (1969) emphasized that active repeatation of normal sensory-motor experiences and facilitating normal patterns of postural control. In those patients with abnormal alignment of body segments, appropriate alignment is practiced in conjunction with forceplate and visual biofeedback to reinforce new positions (Shumway-Cook et al, 1988). Guided weight shifting onto lower extremities with tilt table standing on the sponge will decrease proprioception, because the sponge was shock absorption. Proprioceptive input from skin, pressure, and joint receptors of the foot plays a significant role in correction of slow postural changes. One-way repeated ANOVA, The result of the mean differences in TTS measurements among the three conditions of subjects (all, men, and women) indicated a statistically significant differences($p<.05$) for among condition effects. However, there was no statistical difference according to weight and height.

Limitations of this study and implications for further research are noted in relation to the number of subjects involved and three conditions that were used. A larger number of subjects would provide better information on the effects of standing perception of the proprioception on TTS, as well as more variety of conditions.

Conclusion

Identical functional problems are treated by physical therapists in a variety of ways depending on their understanding of the problem and the treatment model their approach is based upon. This study showed full standing sensation on the effects of the tilt table standing with sponge. The results of this study suggest that the use of a specific intervention program involving a facilitation of the sensory stimulation and a increasing of the weight bearing and weight shifting. Because a variety of sensory inputs should be incorporated to increase awareness of the body parts and position in space as well as to challenge balance.

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