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The Effects of a Warm Whirlpool Bath on Pain and Stiffness of Patients with Chronic Stroke Induced Knee Osteoarthritis

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Abstract. [Purpose] This study set out to investigate the effects of leg immersion in warm water on pain, and stiffness of patients with stroke-induced chronic osteoarthritis. [Subjects] Forty-four patients with chronic stroke were randomly assigned to either the whirlpool group (n=24) or the control group (n=20). [Methods] Subjects in the whirlpool group immersed their legs in a whirlpool bath at 40 °C for 40 minutes 5 times a week for 8 weeks. The control group of patients was instructed to perform activities as usual without using a whirlpool bath. Pre-immersion and post-immersion measurements of the Western Ontario and McMaster University arthritis index (WOMAC)-pain and stiffness indexes were compared to determine the effects of the intervention. The paired t-test was performed to test the significance of differences before and after the experiment. The independent t-test was conducted in order to test the significance of differences between the whirlpool and control groups. Statistical significance was accepted for values of $p<0.05$. [Results] The WOMAC-pain score, and stiffness index were significantly lower after the intervention. [Conclusion] Immersion of the lower extremities in a whirlpool bath was beneficial for patients with chronic stroke-induced knee osteoarthritis.
Key words: Stroke, Osteoarthritis, Whirlpool

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INTRODUCTION

Stroke is caused by the blockage of brain blood vessels or hemorrhage. The main symptoms of stroke are sensory, motor, cognitive, and emotional problems, and they impose constraints on carrying out basic daily activities[1)]. These stroke problems are treated focusing on the nervous system[2)].

Pain caused by stroke is mainly neuropathic arising from damage to the central nervous system, and it occurs in parts related to the neurological system that are related to cerebrovascular lesions. These pains are continuous or intermittent and are associated with sensory abnormalities at the site of pain[3)]. In contrast, musculoskeletal pain in patients with stroke is a consequence of stroke. It results from excessive use, and causes secondary functional disorders[4)]. Excessive use of the unaffected side of patients with stroke, damages the soft tissue, and intra-articular cartilage changes occur[5)]. Radiographs of the knee joint of the hemiparetic and unaffected side of post-stroke hemiplegia patients show asymmetry[6)]. Generally, in the lower limbs of elderly subjects or patients with hemiplegia, causes the part with arthritis is most commonly the knee. Osteoarthritis is a disease that causes pain and physical dysfunction as articular cartilage wears out and local degenerative change appears[7)]. In patients with stroke, knee arthritis induces arthralgia, ROM limitation, muscle strength reduction, and motor dysfunction[8)]. Generally, preceding studies using non-surgical intervention methods for patients with osteoarthritis have reported electrical treatments such as superficial heat application and short wave diathermy for deep heat application[9)], transcutaneous electrical nerve stimulation, electroacupuncture, low level laser therapy[10)], and therapeutic exercises such as aerobic exercise show beneficial effects[11)].

Water is commonly used in the therapeutic field as it generally has an effect that promotes healing[12)]. Whirlpool treatment was first started by the French army in the period of the First World War. It is currently used as a treatment method in many countries for medical and surgical conditions[13)]. The whirlpool treatment relaxes muscle tension, and provides a feeling of comfort. Especially, in post-surgical patients, it decreases pain, reduces complications, and helps to bring forward the discharge date[14)]. Whirlpools are recommended as a treatment for reducing pain in patients with osteoarthritis and rheumatoid arthritis[15)]. However, we couldn't find any reports in the literature of research targeting osteoarthritis of patients with stroke.

Therefore, the purpose of this study was to evaluate the effects on pain, stiffness, and function of whirlpool treatment for patients with knee osteoarthritis caused by chronic stroke.

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Table 1. General characteristics of participants

Group	N	Gender (male/female)	Stroke type (CI/ICH)	Hemiplegic side (Rt./Lt.)	Age (years)	Height (cm)	Weight (kg)
Whirlpool Group	24	14/10	19/5	11/13	58.1 (4.6)	160.6 (6.6)	65.2 (8.3)
Control Group	20	14/6	13/7	12/8	57.3 (4.4)	164.5 (7.1)	65.0 (7.5)

Values are frequency or mean (SD), CI; Cerebral Infarction, ICH; Intra-Cranial Hemorrhage

SUBJECTS AND METHODS

The subjects of this study were patients with stroke who were hospitalized at a university hospital located in D city. The selection criterion was patients who had had stroke with hemiplegia for more than 6 months and less than 5 years. The exclusion criteria were: patients who were incapable of cycling or functional training due to lumbodynia, inflammation of the joints, or degenerative disease, who were undergoing other medical treatments for other specific details, or who were incapable of implementing exercise programs due to inability to understand verbal commands due to severe impairment of perceptual abilities, or cognitive and communication disorders. Through the selection criteria, 50 patients were enrolled in this research. Prior to distributing consent forms, all the subjects received an explanation of the procedures and the purpose of this research, and the research was then implemented with subjects who signed consent forms.

The 50 subjects who were selected by the selection criteria were randomly divided into 2 groups, 25 subjects each were allocated to the whirlpool group and the control group. The randomization method was selection of a sealed envelope. During the 8 weeks of the research, 1 patient in the whirlpool group, and 5 patients in the control group dropped out, leaving 24 subjects in the whirlpool group, and 20 subjects in the control group. The data of these subjects were used in the statistics of the final analysis. The reasons for dropping out were: three patients in the control group moved to another hospital, and the remainder gave up voluntarily.

In the whirlpool group, the subjects' legs were immersed in whirlpool baths at 40 °C for 30 minutes after conservative physical therapy for 30 minutes. The subjects of the control group received conservative physical therapy only for 30 minutes without the whirlpool bath. The interventions were conducted 5 times a week for 8 weeks.

In this study, pain and stiffness were used to evaluate the knee osteoarthritis of the subjects, patients with stroke. For assessment tools, the Western Ontario and McMaster University Arthritis Index (WOMAC) was used. WOMAC has 3 categories of pain, stiffness, and function. In this study, WOMAC-pain scores and WOMAC-stiffness scores were used. Subjects are interpreted to have better functional status when their WOMAC scores are lower[16]. Many translated versions of the WOMAC indices in several languages are available. The Korean version of WOMAC used in this study has a good reliability (ICC 0.79–0.89) and its psychometric properties are comparable with those of the original[17].

SPSS 18.0 for Windows was used for the statistical analysis of this research. The data were normally distributed. To compare the before and after exercise effects within the whirlpool group and the control group, the paired sample t-test was implemented. To compare the difference between the two groups, the independent sample t-test was implemented. The level of statistical significance (α) was chosen as 0.05 for all analyses.

Table 2. Comparisons of pain and stiffness between the interventions

Measures		Whirlpool Group (n=24)	Control Group (n=20)
Pain	Pretest	15.00 (3.74)	13.37 (2.12)
	Posttest	11.10 (4.64)	9.75 (1.35)
	t	3.932*	8.996*
Stiffness	Pretest	5.85 (0.93)	5.20 (0.83)
	Posttest	3.65 (0.93)§	3.75 (0.98)
	t	10.341*	7.000*

Values are frequency or mean (SD), *$p<0.05$ significant difference from pretest, §$p<0.05$ significant difference from control

RESULTS

The characteristics of subjects participating in this study were as follows. The final number of participants in this research was 44, 24 in the whirlpool group, and 20 in the control group. There were no significant differences in gender, stroke type, hemiplegic side, age, height or weight between the whirlpool and control group (Table 1).

Subjects' pain after the intervention was significantly lower ($p<0.05$) in both the whirlpool and control groups. Stiffness also significantly decreased ($p<0.05$) in both groups. Comparing between the two groups, the stiffness of the whirlpool group was significantly lower ($p<0.05$) than that of the control group after the intervention. This shows that the whirlpool treatment was more effective at reducing stiffness (Table 2).

DISCUSSION

Knee osteoarthritis commonly occurs in stroke patients due to the left and right imbalance arising from hemiplegia and compensatory behavior by the unaffected side[6]. Arthritis accompanying stroke causes pain, and worsens patients' functional status, becoming an undermining cause of independent living[18]. Chronic pain is observed in 75% of patients with stroke, and the level of pain is moderate to severe[19]. In this study, the whirlpool treatment had a meaningful effect on pain and stiffness.

Water soaking treatments utilize hydrostatic pressure, buoyancy, viscosity and thermodynamics, physical characteristics of water. Especially, hydrostatic immersion combined with warm temperature particularly is bath effective at reducing and improving blood circulation[12]. Generally, the optimum temperature of a whirlpool bath is 36–40°C[13]. Since Koreans prefer hot temperature, 40 °C was used in this research. The pain score after the whirlpool therapy reduced 26%, from 15.0 to 11.1 ($p<0.05$). The stiffness reduced 37.3%, from 5.9 scores to 3.7 ($p<0.05$). Heat treatment for patients with osteoarthritis and rheumatoid arthritis involve conduction such as hot pack and paraffin bath, convection such as whirlpool bathing, and methods that uses conversion such as ultrasound[15]. The warm whirlpool bath used in this research had a heat transfer effect on the immersed area. Blood flow, capillary permeability, nerve conduction, and collagen extensibility increases through vasodilation as a result of heat treatment[15]. Therefore in this research, we think that pain and stiffness were reduced by the effect of heat. During whirlpool immersion, the pain adjustment mechanism which is generated by the warm water temperature and water turbulence increases the threshold of pain[14]. Also, whirlpool therapy increased joint ROM by stimulating the muscle spindles and Golgi tendon organs[20]. However, it is not correct to conclude that all aspects of arthritis improve with pain reduction. In previous research, not all pain reductions due to interventions for knee osteoarthritis were reflected in patients' activity levels[9]. Muscle weakness of muscles such as the quadriceps is the major cause of knee osteoarthritis. Proprioceptive deficits of joints as well as muscle weakness impose limitations on physical balance and daily living activities of patients with arthritis[21]. With the purpose of restoring the strength of weakened muscles, muscle strengthening exercises have been effective for arthritis[11]. Accordingly, research into the effects of muscle strengthening exercise combined with whirlpool treatment for post-stroke arthritis patients is necessary in the future. A limitation of this study is that the physical function assessment of WOMAC was not performed, because it is difficult to distinguish whether the cause of functional limitation is osteoarthritis or stroke. Therefore, further study of the functional evaluation of stroke patients with osteoarthritis is needed consider specific outcome measures.

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