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Effect of Whole Body Cryotherapy with Spinal Decompression on Cervical Disc Herniation by Digital Infrared Thermal Imaging

WONTAE GONG, PhD, PT[1)], SANGYEOL MA, PhD, PT[2)], HYOLYUN RO, PhD, PT[3)]

[1)]*Department of Physical Therapy, Gumi College*
[2)]*Department of Physical Therapy, Sewoori Hospital: Dunsan-dong, Daejeon City, 302-829 Republic of Korea. TEL: +82 42-478-8000, FAX: +82 42-478-8008, E-mail: sptmsy@paran.com*
[3)]*Department of Occupational Therapy, Kangwon National University*

Abstract. [Purpose] This study investigated the effects and safety of whole body cryotherapy (WBC) and spinal decompression on the pain, cervical function, and body surface temperature of cervical herniated nucleus pulposus (C-HNP) patients. [Subjects] The subjects were 20 patients (6 males and 14 females) with cervical disc herniation (C_{5-6}) who visited Hospital S in Daejeon, Korea. [Methods] Treatment Group 1 (3 males and 7 females) received interference current therapy, ultrasonic therapy, spinal decompression therapy, and WBC. Treatment Group 2 (2 males and 8 females) received interference current therapy, ultrasonic therapy, and spinal decompression therapy. [Results] Visual Analog Scale (VAS), Neck Disability Index (NDI), and differences in body surface temperatures between left and right upper extremity muscles decreased after treatment compared to prior to treatment. The group receiving spinal decompression and WBC application had a greater degree of change in VAS and NDI. However, change of body surface temperatures of the upper extremities after treatment between the two treatment groups was not statisticaly significant. [Conclusion] A combination of spinal decompression therapy and WBC offers a safe and appropriate treatment for cervical disc herniation.
Key words: Whole body Cryotherapy, Spinal decompression, C-HNP

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INTRODUCTION

Physical therapies such as interference current therapy and ultrasonic therapy and new techniques such as cryotherapy and spinal decompression therapy have seen applications in recent years. Whole-body cryotherapy (WBC), a mode of cold therapy, exposes patients wearing minimal clothing to very cold air (–110C)[1)]. Studies have reported that the application of cold air increases the stimulation threshold of sensory nerve terminals[2)] and slows the conduction velocity of peripheral nerves[3)]. As a result, the application of cold air decreases the harmful receptive information transmitted from the afferent nerve fibers to the spinal cord, which in turn decreases the behavioral reaction to pain and the activity of the spinal olfactory nerve cells. Studies have applied WBC to different conditions and diseases: inflammatory states of spinal vertebrae joints, degeneration and inflammatory states of joints (monoarthritis and oligoarthritis) and periarthritis[4)], rheumatism and low back pain diseases[5)] and sclerosis multiplex[6)]. In spite of these studies of cold therapy, few have applied cold air to cervical disc herniations. Furthermore, some research notes concerns about frostbite due to the extreme temperature of the cold air[1)].

Spinal decompression represents an improved form of traction therapy in which a computer program adjusts the direction and angle of traction force in line with the position of the target disc. A bidirectional motor connected to a sensor applies curved traction in both directions. The traction force is slowly increased, and, if muscular contraction occurs near the spine in this process, a gradual increase of traction force is induced as a temporal relief. In this way, pressure inside the disc can be greatly decreased to a negative pressure[7,8)].

Digital Infrared Thermal Imaging (DITI) measures temperature differences between homogeneous regions. Normal human bodies show a symmetrical body temperature profile, and a seriously asymmetrical body temperature profile is regarded as pathologic[9)]. Thermal mapping diversifies local blood flow and the degenerative and inflammatory state of tissues. Studies have reported[5,10)] that an enhancement of the skin temperature profile increases the diagnostic sensitivity of infrared imaging in patients.

The present study investigated the effects of WBC and spinal decompression on the pain, cervical function, and

body surface temperature of cervical herniated nucleus pulposus (C-HNP) patients to determine the effect and safety of WBC.

SUBJECTS AND METHODS

The subjects of this study were 20 patients (6 males and 14 females) with C_{5-6} cervical disc herniation verified through physical examination and magnetic resonance imaging (MRI) by a radiologist and neurosurgeon at Hospital S, Daejeon, Korea. Treatment Group 1 (3 males and 7 females) received interference current therapy, ultrasonic therapy, spinal decompression therapy, and WBC. Treatment Group 2 (2 males and 8 females) received interference current therapy, ultrasonic therapy, and spinal decompression therapy. Treatment Group 1 had a mean age, height, weight, and prevalence period of 34.8 ± 4.2, 168.4 ± 6.1 cm, 64.1 ± 6.2 kg, and 6.70 ± 2.8 weeks, respectively; and the respective values for Treatment Group 2 were 35.1 ± 5.8, 164.8 ± 8.0 cm, 58.80 ± 6.8 kg, and 6.60 ± 2.2 weeks. We excluded from the study patients with spinal canal stenosis, discogenic pain, infection in the vertebral region, history of surgical treatment of the cervicospinal area, malignant tumors, rheumatism, neck pain accompanied by pressure fracture, heart disease, unstable hypertension, and immunological disease associated with cold air antibody. Subjects received an explanation of the intent of the study and the general details of the experiments and gave their voluntary consent to participation.

We arranged interference current (CL-11, Multiple Stimulator Ltd., Canada), inhalation-type 4-pole electrodes as a cross and set the intensity to 25 mA, aspiration strength to 2–3, and stimulation time to 15 min. For ultrasonic waves (Sonic 15, Fysiomed, Belgium), we used a continuous waveform at a frequency of 1 MHz and an intensity of 1–3 W/cm^2. We performed interference current and ultrasonic therapy 20 times in total: 12 times for the first 2 weeks, and 8 times for the second 2 weeks. For spinal decompression therapy, the study used a spinal decompression treatment machine (Spine MED S200B/C, ERT Health sciences, USA). Subjects assumed a supine position on the traction table with a knee support placed under their knees to flatten the cervical lordosis. Furthermore, the intervertebral foramina was widened by allowing the opening of the posterior joints, and the cervical vertebrae nos. 5 and 6 were bent at 28° to extend the posterior soft tissues. The traction force began at 10 lbs and was increased at a fixed rate of 1 lb each day, up to the maximum traction force of 20 lbs. If subjects felt any pain from the increased traction force, the traction force was lowered or maintained. The traction treatment time lasted 30 minutes with 20 cycles of hold time and rest time at a ratio of 2:1 or 60:30 seconds. The traction force during the rest time was set to half of the force during the hold time. We performed spinal decompression therapy 20 times: 12 times during the first 2 weeks, and 8 times during the second 2 weeks.

The WBC system (Deluxe-2000, Cryomeditec, Korea) consists of two rooms: a main treatment room with a temperature ranging from –100 to –120°C and a subsidiary treatment room with a temperature ranging from –40 to –60°C. Before every WBC session, the subjects underwent a blood pressure test and echocardiography to exclude the possibility of disease. They removed metal accessories and undressed, except for protective clothing such as gloves, socks, sneakers, and caps to protect hands, feet, and head, which have low blood circulation in cold air. Subjects remained in the subsidiary treatment room for 60 seconds and then moved to the main treatment room, kept at a temperature of –110°C, in which they moved their body lightly for 2 minutes and 30 seconds. They then returned to the subsidiary treatment room where they stayed for 30 seconds. Inside the WBC treatment rooms, subjects were asked to breathe out shortly and deeply. After exiting, they walked for about 10 minutes. Patients received WBC twice a day, 6 days a week, for the first 2 weeks and 4 days a week for the second 2 weeks.

Individuals were assessed before and after treatment, using the Visual Analog Scale (VAS) for measurement of subjective pain and the Neck Disability Index (NDI) developed by Vernon and Mior[11] for measurement of cervical function. The NDI consists of 10 items. A higher NDI value indicates a higher degree of cervical dysfunction and scores ranges from 0 to 50. A score of 0–4 indicates no dysfunction; 5–14, minor dysfunction; 15–24, moderate dysfunction; 25–34, severe dysfunction; and 35 or higher, complete dysfunction. We used a DITI (IRIS-XP, medicore, Korea) to measure the temperature difference between the left and right sides of the upper body. Before the test, to minimize the factors that may affect body heat in accordance with the standards of the International Academy of Clinical Thermology (IACT), we asked subjects to avoid drug treatment, physiotherapy, bathing, sunbathing, smoking, and other factors that may change the temperature of the body surface for 24 hours before being photographed. All the testing processes, including infrared photography of body heat were carried out in an infrared body-heat test room, which was cut off from external light and heat and maintained at a constant temperature (23–24°C) and humidity (60%). After arriving at the test site, subjects relaxed for 15 minutes and then changed into a hospital gown before entering the test room. We recorded the temperature differences between the left and right body surfaces of the upper trapezius regions (UTR), triceps brachii regions (TBR), and biceps brachii regions (BBR)[12].

We used the SPSS 12.0 KO (SPSS, Chicago, IL, USA) statistics program to analyze the measurement data. The paired t-test and Wilcoxon's signed rank test were used to test the significance of changes following the intervention within of each group, and the independent t-test and Mann Whitney U test was used to test the significance of differences between the two groups. Values of $p<0.05$ were considered statistically significant.

RESULTS

VAS, NDI, and the difference in temperature on body surfaces of the left and right upper extremity muscles

Table 1. The comparison of pre- and post- treatment values in each group

Category	Group		Pre-test			Post-test		
VAS	Exp 1*[c]	†[d]			6.10 ± 0.73			3.00 ± 0.81
	Exp 2*	†			6.20 ± 0.63			4.20 ± 0.63
NDI	Exp 1*	†			13.90 ± 1.37			10.10 ± 1.28
	Exp 2*	†			13.80 ± 1.03			11.70 ± 1.05
UTR	Exp 1*	†	36.85[a]	36.27[b]	0.58 ± 0.18	36.91[a]	36.56[b]	0.35 ± 0.13
	Exp 2*	†	36.64	36.01	0.63 ± 0.24	36.71	36.25	0.46 ± 0.18
TBR	Exp 1*	†	35.42	34.60	0.82 ± 0.60	35.11	34.68	0.43 ± 0.22
	Exp 2*	†	35.37	34.74	0.63 ± 0.50	35.07	34.62	0.45 ± 0.26
BBR	Exp 1*	†	35.52	35.01	0.51 ± 0.27	35.38	35.03	0.35 ± 0.13
	Exp 2*	†	35.83	35.29	0.54 ± 0.19	35.64	35.21	0.43 ± 0.14

*,† $p<0.05$, [a]: Sound side, [b]: Affected side, [c]: T-test, [d]: Non-parametric test.

significantly decreased after treatment in both Treatment Group 1 and Treatment Group 2 ($p<0.05$) (Table 1). Therefore, both the treatments seem effective for cervical disc herniations.

The changes in VAS, NDI and TBR showed a statistically significant difference between the two treatment groups ($p<0.05$). Treatment Group 1, in which we applied spinal decompression and WBC, showed a greater degree of change in VAS, NDI and TBR. However, the temperature differences on the body surfaces of UTR and BBR did not show statistically significant differences between the two groups ($p>0.05$) (Table 2).

Table 2. The comparison of the rates of change between Treatment Group 1 and Treatment Group 2

Category		TG1	TG2
VAS*[c]	†[d]	–3.10 ± 0.56	–2.00 ± 0.47
NDI*	†	–3.80 ± 0.63	–2.10 ± 0.31
UTR		–0.23 ± 0.06	–0.17 ± 0.15
TBR	†	–0.39 ± 0.40	–0.17 ± 0.26
BBR		–0.16 ± 0.14	–0.10 ± 0.07

*,† $p<0.05$, for differences between TG1 and TG2 and post-test changes in VAS, NDI, UTR, TBR, BBR in both groups. [c]: t-test, [d]: Non-parametric test.

DISCUSSION

This study found both the application of spinal decompression therapy alone and in combination with WBC and spinal decompression therapy effectively reduced VAS and NDI scores. One previous study reported that spinal decompression therapy decreased pain and improved quality of life of L-HNP patients[13]. Furthermore, in the same study, an analysis of responses from 46 patients revealed that patients who reported reduced pain levels and improved health tolerated WBC well. After a 10-day cycle of cryotherapy, 39.3% of the patients reported a slight decrease of pain level, and 53.6% of patients noted a marked decrease, while 7.1% of patients did not feel any improvement at all[14]. These reports are consistent with the findings of this study; from the patients' point of view, WBC was beneficial.

The performance of both spinal decompression therapy and WBC gave greater reduction in pain and greater improvement cervical function than spinal decompression therapy alone. Both treatment groups showed a change in body temperature after treatment, but the degree of change in body temperature did not show a significant difference between the two treatment groups. This suggests spinal decompression therapy and WBC are appropriate treatments for cervical disc herniation, and it appears that WBC did not cause a change in body temperature. When the body temperature drops rapidly, adaptation mechanisms must develop for stress avoidance. Physiological mechanisms such as surface vessel contraction, muscle trembling and shivering protect an organism against excessive cooling[15]. Therefore, after WBC, all skin temperatures recover rapidly[16]. Tarja et al. found, by measuring rectal and skin temperatures, that WBC did not put patients at risk of frostbite[1]. Among people with cervical disc herniation, the recurrent activation of the meningeal nerve, associated with reflex sympathetic vasoconstriction, causes a change in the body surface temperature[14]. That is, low temperature arises from vasoconstriction in the skin area where sympathetic nerves are included in the compressed nerves[17].

In this study, the difference in body heat between the left and right upper extremities decreased similarly in the two experimental groups. Since the group that received both spinal decompression therapy and WBC had a greater decrease in cervical dysfunction and pain, we consider WBC combined with spinal decompression therapy is safe and appropriate for the treatment of cervical disc herniation.

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