Influence of Interferential Current Therapy and Laser Therapy on Functional Recovery after Total Knee Replacement

Seung-Keun Oh[1], Yong-Nam Kim[2]

[1]Department of Physical Therapy, Graduate School of Public Health, Nambu University, [2]Department of Physical Therapy, Nambu University

Purpose: The purpose of this study is to investigate the effects of interference current therapy and laser therapy on functional recovery after total knee arthroplasty by measuring the Berg balance scale and range of motion.

Methods: Subjects were 30 patients who were admitted to G Hospital after total knee arthroplasty. They were randomly assigned to experimental group I in which interference current therapy was applied (n=10), experimental group II in which laser therapy was applied (n=10), or the control group (n=10). The Berg balance scale and range of motion of the subjects were measured before, after 2 weeks, and after 4 weeks of therapy.

Results: There was a statistically significant change ($p<0.05$) in the Berg balance scale and range of motion before and after therapy intervention among the laser therapy group and the interference current therapy group. There was also a significant change between the groups in the Berg balance scale and range of motion. Tukey's post hoc comparison showed a statistically significant difference between the control group and experimental group I and between the control group and experimental group II ($p<0.05$).

Conclusion: The application of interference current therapy and laser therapy resulted in a significant change in both the Berg balance scale and range of motion among patients with total knee arthroplasty. The findings of this study can be used as preliminary clinical data in evaluating functional recovery in patients with total knee arthroplasty in a post-clinic setting.

Key Words: Functional Recovery, Berg balance scale, Range of motion

I. Introduction

Osteoarthritis is a chronic disease that damages subchondral bone through the gradual degeneration of articular cartilage; it secondarily limits physical function by causing inflammation in other tissues.[1] Osteoarthritis is a disease that has a high rate of prevalence and is easily generated in keen articulation that supports weight. In addition, the constant pain associated with this disease causes nerve damage with a loss of reflexes and eventually causes problems in nerve roots. The shortening of soft tissue dominated by nerves presents several functional problems for daily activities, including limitations of motor skills and gait disturbance.[2] Knee joint bone arthritis is a disease that shows characteristics of destruction and recovery due to biochemical and biomechanical activity and therefore is metabolically active.[3] Although a variety of therapeutic methods, such as drug therapy and physical therapy, have been attempted to treat degenerative osteoarthritis, total knee arthroplasty is recommended when daily activities are severely limited due to pain or significant degenerative change leading to the destruction of articulation. And it continues to increase statistically.[4]

Accurate bone resection plays an important role for knee articulation in total joint arthroplasty; however, an appropriate

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Corresponding author Yong-Nam Kim, kyn5441@hanmai.net

balance of soft tissue is equally important for successful total joint arthroplasty.[5] Thus, electric therapy devices are being utilized as a general interventional method in physical therapy to mitigate pain and improve the function of joint motion. These devices have almost no risk or side effects and instead tend to minimize tissue damage during electrotherapy.[6]

Interference current therapy mainly utilizes medium frequencies between 3000 Hz and 6000 Hz and causes an interference current in the range of 1 to 250 Hz at a desired treatment area by mixing two similar currents, such as 4000 Hz and 4100 Hz.[7] Interference current therapy is a widely used electric therapy that is reported to be effective for backache, musculoskeletal pain, joint pain, and pain due to fractures.[8] However, recent reports on the pain relief of interference wave therapy indicate that it differs from that of existing interference current therapy. Ward and Robertson[9] reported that pain relief is greater when using a frequency of 10 KHz, whereas Dermmink[10] found that the bipolar method using two electrodes caused a more accurate interference wave than using four electrodes. Hurley[8] et al. reported that an electrode attachment site is more effective for an attachment in accordance with spinal nerves than a pain site. These reports indicate that changes are needed to interference current therapy to improve its therapeutic effect. These differences compared to existing interference current therapy can be attributed to the fact that information on existing interference current therapy is mostly derived from clinical experience rather than from randomized double-blind studies, and some information comes directly from transcutaneous electrical nerve stimulation therapy.

Unlike general light, laser has a high-intensity beam. Also, laser maintains collaterality without scattering or fading even at long distances. Its spectrum bandwidth is very narrow and it has a high degree of coherence. Lasers are being utilized in various fields, including for medical issues. A medical laser can be broadly classified into a surgical laser, which is used in various surgeries, and a therapeutic laser. Generally, a high-power laser, such as a CO_2 laser, has been known to selectively interfere with collagen synthesis, whereas photo stimulation that promotes the biological process of tissues is a known therapeutic effect of a low-power laser, such as a He-Ne laser and GaAs laser.[11] As a therapeutic method, a laser can be applied to damaged tendons and ligaments, arthritis, edema, soft tissue damage, ulcers and burns, for scar inhibition, and acute phase treatment.[12]

In total knee arthroplasty, several interventional methods for pain control accompanied by functional recovery therapy are essential for the treatment of patients after surgery. Thus, this study was undertaken to determine a method that would be more effective and systematic for improving articulation and function while reducing sustained pain as measured by the Berg balance scale (BBS) and range of motion (ROM) after total knee arthroplasty surgery.

II. Methods

1. Subjects

The participants of this study consisted of 30 patients, 15 men and 15 women, who were admitted to G hospital after receiving total knee arthroplasty on the right knee and within one month of surgery to limit interference from external conditions. The period of study was from January to March of 2014. For participation in the study, subjects had to meet the following conditions: received total knee arthroplasty after being diagnosed with degenerative knee arthritis; had no risk of falling after surgery; could ambulate after surgery and had no paralysis of central or peripheral nerves; had no inflammation or side effects; and had a clear understanding about the purpose of the study and could follow instructions. All participants voluntarily agreed to participate and provided consent following an explanation of the purpose of the study.

2. Experimental groups

Patients were randomly classified into the following three groups: control group (n=10); interference current therapy group (Group I, n=10); and laser therapy group (Group II, n=10). Homogeneity analysis between subjects confirmed no difference among the groups. Homogeneity of raw data in this study was tested and all data satisfied normality and homoscedasticity. The general characteristics of the study subjects are shown in Table 1.

Table 1. General characteristics of subjects (n=30)

	Control group (n=10)	Experimental group I (n=10)	Experimental group II (n=10)	F	P
Age(yrs)	64.80 ± 8.38	64.90 ± 7.51	64.90 ± 8.00	0.00	0.80
Height(㎝)	164.60 ± 8.17	164.60 ± 8.48	164.60 ± 8.44	0.00	0.86
Weight(㎏)	63.30 ± 5.31	63.20 ± 6.36	63.20 ± 6.32	0.01	0.73
BMI(㎏ /m2)	23.38 ± 1.46	23.32 ± 1.40	23.32 ± 1.48	0.06	0.87

All values are shown in means±standard deviation
*p<0.05

3. Experimental Method

1) Interference current therapy and laser therapy

After basic application of infrared treatment equipment for 15 minutes and a continuous passive motion device for 20 minutes to all the three groups, the interference current therapy group received interference current treatment and the laser therapy group went through laser treatment for 15 minutes as additional treatment. It was applied to the knee alternatingly by using the 4 pole method and was applied with adequate intensity so as not to feel pain. Additional laser therapy for 15 minutes was then applied. The center of the knee surgical site was intensively treated when applying the laser. The subjects were measured and evaluated for each variable before the experiment and 6 weeks after the experiment.

4. Measurement tools and methods

1) Berg balance scale

The Berg balance scale mainly measures sitting, standing, and posture change and is completed in approximately 15 minutes. The total score from 14 items is 56, which is achieved by applying a minimum score of 0 points and a maximum score of 4 points. A higher score indicates a better degree of balance.[13] This measurement tool has a high level of reliability and internal validity (reliability within a measurer r=0.99, reliability between measurers r=0.98).[14] It was measured once before the experiment and 6 weeks after the experiment.

2) Range of motion

We measured the angle between the center of the femur and the center of the heel bone when fully bent. The maximum bending angle based on an imaginary line that makes the lateral condyle of the femur of the knee become a right starting point at the state of being fully unfolded was measured. A protractor is the basic element of clinical assessment and an effective method for measuring the range of motion.[15] Thus, it was used to assess the status before and after exercise and to measure changes. For the range of knee motion, the joint range was measured with a protractor (digital angle rule) before treatment and 6 weeks after the experiment.

5. Statistical analysis

The results were statistically processed by using IBM SPSS Statistics 20.0 software to analyze the impact on function recovery after the 6-week intervention. General physical characteristics between the groups were tested by one-way ANOVA. Functional recovery before and after the experiment for the experimental groups and the control group was compared by means of a t-test. The difference between groups before and after the experiment was tested by one-way analysis of variance (ANOVA). The Tukey test was conducted with post hoc analysis to explain the difference between the groups. The significance level α was set to 0.05.

III. Results

1. Change of BBS

The matching sample t-test showed a statistically significant difference before and after the intervention among the interference therapy group and the laser therapy group ($p<0.05$) (Table2).

The ANOVA showed the changes in group balance ability

Table 2. A comparison of BBS and ROM between pre and post value for the three groups

Variables	Group	Pre-value	Post-value	Value difference	t	p
BBS	Control group	32.70 ± 4.24	34.70 ± 3.43	-2.00 ± 3.56	-1.78	0.11
	Experimental group I	31.30 ± 7.41	43.10 ± 4.51	-11.80 ± 4.34	-8.60	0.00*
	Experimental group II	32.50 ± 8.62	43.40 ± 4.99	-10.90 ± 5.32	-6.48	0.00*
ROM	Control group	98.80 ± 7.45	102.40 ± 9.83	-3.60 ± 5.70	-2.00	0.08
	Experimental group I	97.00 ± 20.03	117.20 ± 11.67	-20.20 ± 10.13	-6.31	0.00*
	Experimental group II	97.50 ± 19.18	117.50 ± 9.79	-20.00 ± 11.79	-5.37	0.00*

All values are shown in means±standard deviation
*p<0.05

Table 3. A comparison of BBS and ROM on pre-value and value difference in each group

Variables		SS	df	MS	F	p
BBS	Pre-value					
	Between groups	11.47	2	5.73	0.12	0.89
	Within groups	1324.70	27	2.214		
	Value difference					
	Between groups	586.87	2	293.43	14.71	0.00*
	Within groups	538.50	27	19.94		
ROM	Pre-value					
	Between groups	17.27	2	8.63	0.30	0.99
	Within groups	7422.10	27	274.89		
	Value difference					
	Between groups	1815.20	2	907.60	9.94	0.00*
	Within groups	2466.00	27	91.33		

*p<0.05

before and after treatment for each group to be statistically significant ($p<0.05$) (Table 3). Tukey's post hoc test showed a statistically significant difference between the control group and the interference therapy group and also between the control group and the laser therapy group ($p<0.05$). However, there was no statistically significant difference between the interference therapy group and the laser therapy group ($p>0.05$) (Table 4).

2. Change in ROM

A statistically significant difference was found before and after the intervention among the interference therapy group and the laser therapy group (t-test, $p<0.05$) (Table 2), and the difference before and after the treatment for each group was statistically significant (ANOVA, $p<0.05$) (Table 3). Tukey's post hoc test to examine the difference between the three groups in accordance with the type of intervention showed a statistically significant difference between the control group and the interference therapy group and between the control group and the laser therapy group ($p<0.05$). However, there was no statistically significant difference between the interference therapy group and the laser therapy group ($p>0.05$) (Table 4).

IV. Discussion

With total knee arthroplasty, it is very important to maintain the range of joint motion for performing normal functions of

Table 4. Post hoc tests of BBS and ROM on each group

Variables	Intervention	Intervention	MD	SE	p
BBS	Control group	Experimental group I	-9.80	2.00	0.00*
		Experimental group II	-8.90	2.00	0.00*
	Experimental group I	Experimental group II	0.90	2.00	0.90
		Control group	9.80	2.00	0.00*
	Experimental group II	Experimental group I	-0.90	2.00	0.90
		Control group	8.90	2.00	0.00*
ROM	Control group	Experimental group I	0.20	4.27	0.99
		Experimental group II	16.60	4.27	0.00*
	Experimental group I	Experimental group II	-0.20	4.27	0.99
		Control group	16.40	4.27	0.00*
	Experimental group II	Experimental group I	-16.60	4.27	0.00*
		Control group	-16.40	4.27	0.00*

*p<0.05

knee articulation and stability as well as for muscle recovery and pain relief after surgery. However, the surgical approach as a therapeutic method is less effective compared to the normal recovery state in terms of ROM, articulation function assessment, and pain control. Furthermore, surgery does not have a significant impact on the systematic development of joint functions.[15] The difference in recovery speed and reduced range of joint motion cause a decrease in balance and an increase in posture disparity; these additional problems result in an imbalance between muscular strength and the function of the knee joint.[16] Therefore, specific and adequate treatment during the long recovery period after total knee arthroplasty is essential. Moreover, the analysis of function and pain is essential for assessing the progress of disease and the therapeutic effect of patients who have muscular skeletal system diseases.[17]

For the surgical treatment of degenerative knee arthritis, we examined the impact of interference current therapy and laser therapy on functional recovery after conducting the existing total knee replacement system with total knee arthroplasty. Our results after 6 weeks of therapy showed a significant effect for functional recovery in experimental groups I and II after treatment as measured by the BBS and ROM. Range of motion was measured in order to evaluate the subjects' functional activity and the berg balance scale was used to examine their balance state.[2] The therapeutic effect of the interference wave may vary depending on various factors; however, there is a lack of relevant studies on this topic with most studies addressing actual treatment after undergoing clinical experiences and trial and errors. Therefore, there is a large difference between users, and no effective interference current therapy is being performed.[8] Nonetheless, interference current therapy is the most commonly used electric therapy in the United Kingdom , and the situation is more or less the same in South Korea, although there has been no specific report on this topic. Interference wave is widely used in clinics; however, we aimed to examine its effect through experimental design and to assess its effect from experimental results.[18] Interference current therapy was first used for treatment by Nelson et al. in 1950 and has since been widely used in pain treatment. It has also proved effective for backache, knee joint bone arthritis, and joint pain.[19] The experiment of total knee arthroplasty was conducted on the elderly; thus, interference wave current that would have less stimulation to skin was effectively utilized. Moreover, interference current therapy was effective at 6 weeks based on BBS and ROM. Laser has been reported to be very effective for cell reproduction and inflammation inhibition.[20] It is a therapeutic method using

light amplification by stimulated emission of radiant rays; thus, it represents a photochemical effect to control normal enzymatic activity by stimulating a thermal effect, a pressure effect in terms of cells, and a light effect using wavelength and glass for physiologically controlling materials in a short time.

Tennis elbow reduces the healing period of scar tissue or damaged tissue due to an increase in protein synthesis and generation of collagen fibers through increased stimulation of excitement and nucleic acid of mitochondrial membranes.[21] Using the various effects of laser as noted in previous studies allowed us to reduce the feeling of stimulation during treatment and to increase the therapeutic effect. At 3 weeks, there was no significant difference between the control group, experimental group I, and experimental group II. However, at 6 weeks interference current therapy and laser therapy were found to be more effective compared to the control group.

We used the BBS as a tool to identify the falling by several researchers.[22] The BBS[13] is easy to measure at no cost and allows for functional analysis. A disadvantage is that it is difficult to accurately and specifically measure motion compared to gait analysis. Gait analysis, which is used to study the gait attributes of elderly people who easily fall, has the potential to identify the extent of balance damage that would not be easily found clinically; however, it requires expensive equipment and minimal space along with professional staff. Thus, it is used more often for experimental research rather than clinical research.[23] In this study, the BBS showed a significant difference in terms of the interaction between the time and group, whereas there was no significant change between the groups. ROM significantly differed in accordance with the length of therapy but showed no significant difference between the groups or with the interaction between the time and groups. We suggest that our results reflect a short study period (3 weeks and 6 weeks) and a small number of subjects. Our results indicate, however, that interference current therapy and laser therapy are worthy of clinical use for patients with total knee arthroplasty. However, a comparative study to address the limitations of this study should be carried out.

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