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Original Article

The effect of changing condition of walking speed on the knee angle of rats with osteoarthritis

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Abstract. [Purpose] The purpose of this study was to investigate the positive effect of exercise on knee osteoarthritis in rats with osteoarthritis induced by applying effective walking speed when changing speed conditions during walking. [Subjects and Methods] The rats used in this study were male Sprague-Dawley rats weighing 300 g and 7 weeks old, and 20 rats were used. The Osteoarthritis (OA) rats model was induced by MIA (monoiodoacetate). The rats was randomly divided into experimental group (MIA injection group) and control group (normal cell line injection group). Treadmill exercise was provided two groups for 2 weeks, 4 days per week. The knee joint angle of the stance was divided into pre-test and post-test, and each group was subjected to paired sample test. Independent sample t-test was conducted to examine the difference between experimental group and control group. [Results] There were statistically significant changes in the control and experimental groups. The knee angle was changed from 99.70 ± 2.40 to 85.60 ± 2.67 in the control group. The knee angle was changed from 100.96 ± 1.36 to 87.71 ± 1.57 in the experimental group. [Conclusion] In conclusion, the angle of the knee gradually decreases. It is considered a characteristic of progressive osteoarthritis. The change of knee angle was less in the experimental group than in the control group. This means that the stiffness of the joints during the walking exercise was less progressed in the experimental group than in the control group.

Key words: Osteoarthritis, Knee angle, Motion pictures

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INTRODUCTION

The definition of osteoarthritis is pain and deformity in the knee joint. Definition of osteoarthritis is due to repetitive use and damage of the structure that protects between the knee joints, causing irregular changes in the joint surface, making the behavior of daily life unnatural, Which causes changes in the shape of the joint surface and damage to the bones, ligaments, tendons and surrounding tissues, causing inflammation or causing pain around the joints[1)]. It's called osteoarthritis, and it mainly affects the weight bearing joints that support the weight much like the spine and the leg in the human body. It's characterized by soft tissue degenerative changes around the joints. It is a disease characterized by bony spindle formation on the joint surface[2)]. Aging is the leading cause of osteoarthritis. This is related to the age, which occurs most often at the age of 50 to 60 years and is characterized by a large number of women[3)].

The rate of progression of osteoarthritis progresses very slowly over many years or decades. Depending on the form, it can be divided into primary idiopathic osteoarthritis and secondary osteoarthritis. Primary idiopathic osteoarthritis is characterized by no specific cause and mechanism of injury, It is known that joints are caused by internal changes[4)]. Also, age, gender, obesity, bad posture, genetic factors, family history, and excessive use of joints are related. It may be exacerbated by malnutrition of articular cartilage, various internal factors such as decrease of lubrication and defects of joint are caused. Secondary osteoarthritis is a relatively precise cause and can be caused by trauma, dislocation, infection, deformity, pathocrine problems, and metabolic disease[5)]. Knee osteoarthritis is a chronic disease that is progressing in the long term, and pain

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Table 1. Comparison of knee angle in the control group (n=10)

	Pre-test	Post-test	t	p
Knee angle	99.70 ± 2.40	85.60 ± 2.67	10.57	0.000*

*p<0.05, unit: degree

Table 2. Comparison of knee angle in the experimental group (n=10)

	Pre-test	Post-test	t	p
Knee angle	100.96 ± 1.36	87.71 ± 1.57	24.21	0.000*

*p<0.05 unit: degree

Table 3. Comparison of experimental and control groups (n=20)

	Control	Experimental	t	p
Knee angle	85.60 ± 2.67	87.71 ± 1.57	2.15	0.045*

*p<0.05 unit: degree

and dysfunction are typical symptoms of knee osteoarthritis. Treatment of knee osteoarthritis emphasizes the importance of exercise and emphasizes pain reduction, improvement of physical function[6].

Osteoarthritis is most common in the knee joints. Patients with knee osteoarthritis were reported to have difficulty in daily activities such as walking and stair climbing due to limited knee motion. Since osteoarthritis is associated with an increased risk of limited life due to the limitation of exercise-related disorders or daily life movements, management through continuous exercise methods is necessary[7]. Exercises have been shown to be effective in improving knee osteoarthritis, with fewer side effects for body care and maintenance of the knee osteoarthritis subjects. When exercising, you will need to reduce stress, improve joint function and exercise with protection[8]. Walking was performed underwater in osteoarthritis patients, which showed improvement in balance and overall function of the body[9]. Therefore, this study selected effective and less stressful walking exercise. The purpose of this study was to investigate the positive effect of exercise on knee osteoarthritis in rats with osteoarthritis induced by applying effective walking speed when changing speed conditions during walking.

SUBJECTS AND METHODS

The rats used in this study were male Sprague-Dawley rats weighing 300 g and 7 weeks old, and 20 rats were used. Two rats were housed in one cage. A light cycle of 12 hours from 8:00 am to 8:00 pm during the day and a dark cycle of 12 hours from 8:00 pm to 8:00 am were applied. Surgical and experimental methods of experimental animals were carried out in accordance with the guidelines of the Animal Care and Use Committee in accordance with Daegu University's guidelines. Rats were randomized by Excel random lottery. The experimental group performed the speed change walking exercise and the control group performed the same speed walking exercise.

MIA (monoiodoacetate) (3 mg / 50 µl, diluted in saline, Sigma, St Louis, MO, USA) was intraarticularly injected into the right knee joint using a 26 gauge syringe. Before the syringe is inserted into the knee joint cavity, the knee joint is flexed 90 degrees to secure a completely wide joint space. The knee ligaments were touched under the knee bones of the rats, and the knee ligaments were inserted through the knee joints into the synovial membranes. The injection needle was inserted into the knee joints while avoiding contact with the cruciate ligaments around the joints[10]. MIA was injected into the right knee joints in the experimental group and the control group to induce osteoarthritis. The temperature of the knee surface injected with MIA was measured using a surface contact thermometer. Animals with warmth, swelling, and tenderness as compared to the opposite knee joints in rats were judged to be caused by osteoarthritis. Osteoarthritis was induced and intervention was applied[11].

The intervention was carried out using a small treadmill for 2 weeks, 4 days per week, and 30 minutes of intervention. The experimental group was given a speed change of 7 m/min + 15 m/min + 25 m/min and a same speed of 15 m/min was applied to the control group. The evaluation of the knee joint angle at the initial stance was evaluated because the initial stance was important when the walking was classified. Experimental measurements were performed using a Dartfish program (Pro Suite, Dfkorea, Korea). It is a software that can trace the trajectory of an object and is widely used for rehabilitation, sports, diagnosis and motion analysis[12]. The results of the experimental data obtained in this study were described as mean ± SD. The knee joint angle of the stance was divided into pre-test and post-test, and each group was subjected to paired sample test. Independent sample t-test was conducted to examine the difference between experimental group and control group. The significance level was 0.05.

RESULTS

There were statistically significant changes in the control and experimental groups. The knee angle was changed from 99.70 ± 2.40 to 85.60 ± 2.67 in the control group (Table 1). The knee angle was changed from 100.96 ± 1.36 to 87.71 ± 1.57 in the experimental group (Table 2). In the independent sample test, the comparison of the two groups was 85.60 ± 2.67 for the control group and 87.71 ± 1.57 for the experimental group (Table 3).

DISCUSSION

The purpose of this study was to investigate the positive effect of exercise on rats with osteoarthritis induced by applying effective walking speed when changing speed conditions during walking. The angle of the knee was measured during walking. People with knee osteoarthritis generally show decreased ability in functional gait of the lower extremities. Osteoarthritis induces a decrease in the range of motion of the ankle and knee joints and muscular atrophy of the muscles around the arthritis[13].

Another problem for osteoarthritis patients is that they have limitations in daily activities such as walking, stair climbing, and housework. In general, patients are associated with obesity-related disorders such as heart disease, hypertension, diabetes, and depression or sleep disorders, which ultimately lower the quality and satisfaction of patients with osteoarthritis[14].

These problems can be improved through appropriate walking exercises. Patients with osteoarthritis can improve their walking ability and have a positive impact on their daily life or occupational environment by choosing a walking exercise[15]. Among the joints of the body, the knee joints of the lower limbs that support weight are developed by mechanical stress[16]. If mechanical irritation is not given to the knee joint or if activity is reduced due to disease or injury, atrophy will occur[17]. If proper stimulation is given to the joint during walking, it will help to maintain the physical function of the knee joint. Patients develop pain in the knee joints due to weight transferred to the joints during work, daily life, leisure activities and exercise. This results in a decrease in physical functioning activity. At this time, improving muscle endurance through walking exercise will also have a positive effect on pain and inflammatory response. As a result, it will have a good effect on walking ability.

In conclusion, the angle of the knee gradually decreases. It is considered a characteristic of progressive osteoarthritis. The change of knee angle was less in the experimental group than in the control group. This means that the stiffness of the joints during the walking exercise was less progressed in the experimental group than in the control group. As the angle of the knee joint progressed a little and the range of motion of the joint was maintained, the shape of the gait was well maintained and helped when walking. As a limitation, it may be possible to show differences from humans by conducting experiments on rats. However, since it is not possible to induce arthritis directly in humans, it was possible to carry out experiments by changing the conditions of walking speed of rats. Also, if you perform muscle strengthening exercise gradually, you will get good results in maintaining your muscles. However, it was limited to the knee angle. In other studies, it would be better to present a more accurate gait by performing other parts of the gait.

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