

KAATSU training as a new effective exercise therapy in a case of femoral medial condyle osteonecrosis

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Idiopathic osteonecrosis of the medial condyle of the femur, a relatively common disease among Japanese women 60 years or older, is often progressive and requires surgical treatment. In this paper, we report on a case where KAATSU training was effective for a 71-year-old woman with bone necrosis in the left femoral medial condyle revealed by magnetic resonance imaging (MRI). At the first visit, the patient was suffering severe pain, and unable to walk without a cane. After 1 to 2 months of KAATSU training, her pain was mitigated and in about 3 months she was able to walk without a cane. In 6 months she could go upstairs and downstairs using the handrails and about 2 to 3 months later, she no longer needed to use the handrails. MRI revealed marked shrinkage (to 10 mm x 15 mm) of the necrotized region as a result of bone tissue remodeling. From these results, KAATSU training seems to be useful as a new method of rehabilitation for patients with idiopathic osteonecrosis of the medial condyle of the femur.

Introduction

Osteonecrosis (ON) of the medial condyle of the femur may develop as a secondary condition associated with the prolonged use of steroids. However, idiopathic ON of the medial condyle of the femur is relatively common among women 60 years or older. In the early stages, the disease is difficult to distinguish from knee osteoarthritis by radiography and sometimes it is accompanied by severe pain. The patients may be followed up after conservative treatment. In many cases, however, surgical treatments such as arthroplasty are unavoidable because progression cannot be suppressed by conservative treatment alone^{1,2)}.

KAATSU training^{3,4)} is expected to be effective for increasing muscle volume and muscle power, even with low loads by training under blood flow restriction. KAATSU training represents a method of rehabilitation suitable for patients with various diseases and this aged society⁵⁻⁹⁾. The exercises include load-free exercises, elastic bands¹⁰⁾, and free weights, as well as walking¹¹⁾ and ergometers¹²⁾. As such, KAATSU training is attracting much attention as a method of rehabilitation which avoids high physical loads. We recently reported a case in which KAATSU training was effective in a patient with steroid-induced osteonecrosis of the femoral head¹³⁾. In this paper, we report a patient with idiopathic ON of the medial condyle of the femur who achieved remarkable improvement of the disease by KAATSU training.

1. Case review

Patient: A 71-year-old woman (157 cm in height, weighing 70 kg)

Diagnosis: Idiopathic osteonecrosis of the medial condyle of the femur

Chief complaint: Left medial knee pain on walking

Family history of illness: Non-contributory.

History of present illness:

In 2014, the patient presented with left medial knee pain at a nearby orthopedic clinic. She was diagnosed with knee osteoarthritis, and underwent ambulatory treatment for several months. Since her symptoms did not remit, and the pain worsened, she visited another medical institution in November 2014. The diagnosis of osteonecrosis of the medial portion of the medial condyle of the left femur was established. In January 2015, MRI findings suggested further exacerbation. KAATSU training was started in March 2015. One year 3 months later, in June 2016, the outcome was good with marked shrinkage of the necrotized region and improved activities of daily living.

2. KAATSU training protocol

KAATSU training was performed using the KAATSU MASTER equipment (KAATSU Japan Co., Ltd.). Taking into account the fact that the patient was an elderly woman, the wearing pressure was set at low levels (20-30 SKU). In March to April 2015, at the start of training, KAATSU training was performed for the leg on the dis-

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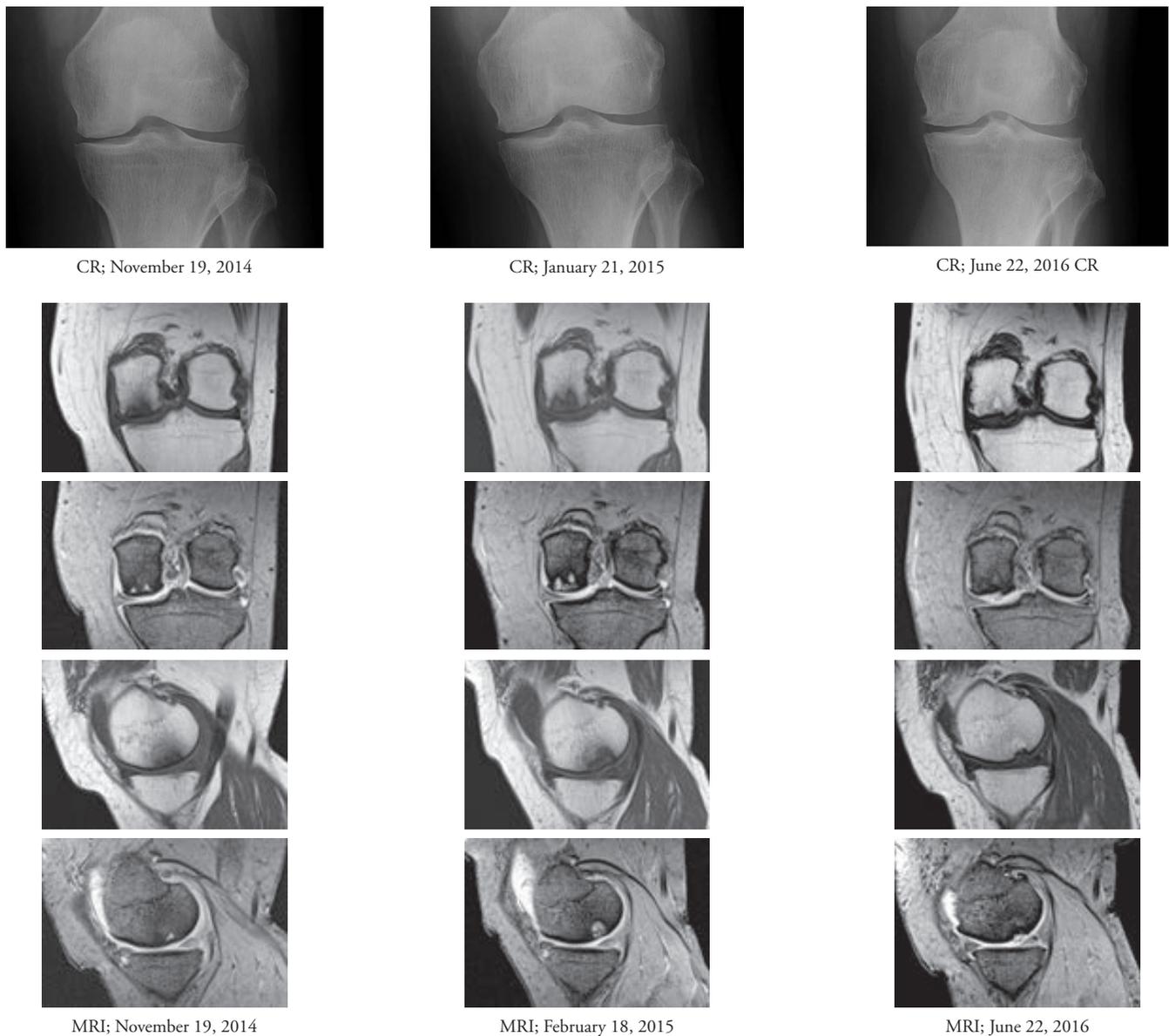


Figure 1. Bone x-ray and MRI images taken before and after KAATSU training.

eased side (left) only. Drills which were performed exclusively on the diseased side of the lower half of the body included the following: 1) compression and decompression, 2) three point set: Toe curls, ankle dorsiflexion, and ankle plantar flexion. 3) leg extensions, and 4) leg curls. In April to May 2015, the patient became accustomed to unilateral leg pressurization and switched to bilateral pressurization. In addition to the unilateral program, quarter squats were added. Bilateral sessions for the lower half of the body included the following: 1) compression and decompression, 2) quarter squats, 3) diseased-side leg extensions, 4) diseased-side leg curls, and 5) bilateral pressurized walking (KAATSU walking). In June 2015, a set of sessions for the upper half of the body was newly included in the training program. Bilateral sessions for the upper half of the body consisted of the following: 1) compression and decompression, 2) three point set: Toe curls, ankle dorsiflexion,

and ankle plantar flexion, 3) stiff shoulder course, and 4) dumbbell curls (1 kg). Bilateral sessions for the lower half of the body included: 1) compression and decompression, 2) quarter squats, 3) high-knee drills, 4) diseased-side leg extensions, 5) diseased-side leg curls, and 6) bilateral pressurized walking (KAATSU walking). Equipment pressure was increased step by step with gradual adaptation, and it was finally set at 320 SKU for unilateral application, and 280 SKU for bilateral application.

3. Course of symptoms

At the first visit, the patient was suffering severe pain, and was unable to walk without a cane. After 1 to 2 months of KAATSU training, her pain was remarkably mitigated and in about 3 months she was able to walk without a cane. In 6 months she was able to go upstairs and downstairs using handrails and about 2 to 3 months

later, she no longer needed the use of handrails.

4. Bone X-ray and MRI findings (see Figure 1)

November 19, 2014

CR showed a mild regression of bone cortex, suspected of being bone necrosis in the load-exerted portion of the left femoral medial condyle; MRI revealed a 10 mm x 40 mm necrotized bone region at the same site.

February 18, 2015

The necrotized region was found to have expanded.

June 22, 2016

MRI revealed marked shrinkage of the necrotized region (to 10 mm x 15 mm) as a result of bone tissue remodeling, with mild regression persisting on the load-exerted surface of the medial condyle at the necrotized bone.

Discussion

Idiopathic femoral osteonecrosis develops mainly in the medial condyle of the femur, the anatomical site on which much of human body weight is exerted. Therefore, patients may undergo conservative treatments, including symptom relief by the reduction of stress on the affected portion with the use of, for example, a cane, and enhancement of lower limb function by training of the quadriceps femoris muscle. In many cases, however, surgical treatments such as arthroplasty are unavoidable because the progression cannot be suppressed by conservative treatment alone. Surgical treatments for idiopathic osteonecrosis of the medial condyle of femur include unilateral knee arthroplasty (UKA), total knee arthroplasty (TKA), and opening wedge high tibial osteotomy (OWHTO)¹⁴. In particular, OWHTO sometimes leads to bone regeneration via drilling following curettage of the necrotized portion.

In the present case of osteonecrosis of the medial condyle of femur, KAATSU training was found to be effective; it produced bone regeneration, without surgical maneuvers. The patient achieved marked mitigation of pain in 1 to 2 months after the start of KAATSU training. Although the mechanisms for this pain mitigation by KAATSU training remains unknown, muscle strengthening and building by KAATSU training^{3,4} might lessen the physical load on the patient's knees. KAATSU training may be described as a method of rehabilitation suitable for patients with various diseases and for this aged society⁵⁻⁹. The available means of applying training burdens include load-free exercises, elastic bands¹⁰, dumbbells, walking¹¹, and ergometers¹²; KAATSU training is considered quite a useful method of rehabilitation for patients who do not wish to undergo heavy physical loads. In the present case, the patient undertook pressurized walking, squatting, self-weighted leg extensions, leg curls, and other exercises in a way such that the femoral head would not bear a high load.

On the other hand, it remains unclear as to the mecha-

nism of bone regeneration through KAATSU training without surgical treatment. In addition to its effects on muscle strengthening and building, and the endocrine system, including growth hormones¹⁵, KAATSU training may increase the production of vascular endothelial growth factor (VEGF), nitric oxide (NO), and other substances by decreasing muscular oxygen tension and hypoxia in the muscles during exercises, and by inducing vascular reactive hyperemia following belt release^{16,17}, and hence it improves endothelium function and blood circulation, which in turn may lead to the amelioration of the necrosis.

In conclusion, KAATSU training is potentially highly useful as a new method of rehabilitation for patients with idiopathic osteonecrosis of the medial condyle of the femur. Further investigation is expected to elucidate the mechanism of the onset of the effects of this non-invasive method with slight physical burden.

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