EFFECTS OF VARIABLE VELOCITY AND RESISTANCE MUSCLE STRENGTH TRAINING EXERCISE WITH SODIUM HYALURONATE ON REHABILITATION EFFICACY OF PATIENTS WITH KNEE OSTEOARTHRITIS CAUSED BY TENNIS TRAINING

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ABSTRACT

Objective: This study was to investigate the effects of variable velocity and resistance muscle strength training exercise with sodium hyaluronate on rehabilitation efficacy of patients with knee osteoarthritis caused by tennis training.

Methods: The total of 1200 knee osteoarthritis patients caused by tennis training were divided equally into three groups: the observation group (variable velocity and resistance muscle strength training exercise with sodium hyaluronate therapy), the control group (merely sodium hyaluronate injection therapy), and the physiotherapy group (paraffinotherapy, drug-iontophoresis with pulse magnetic field and high frequency electro microwave therapy). The efficacies of three groups were then compared.

Results: The pain of the knee joint, the function of knee joint and low-limb muscle force were clearly improved in all three groups after the treatment for 5 weeks. There was a remarkable difference between among three groups as compared to the data before the treatment (P < 0.05). Efficacy in the observation group was significantly better than that of the control group and the physiotherapy group with statistical significance in the inter-group difference (P < 0.05).

Conclusions: The therapy with variable velocity and resistance muscle strength training exercise and the aid of sodium hyaluronate reveals a fairly good effect on knee osteoarthritis caused by tennis training, which is worthy for wide application and promotion in the future.

Keywords: Variable velocity and resistance muscle strength training exercise, Sodium hyaluronate, Knee osteoarthritis, Rehabilitation efficacy.

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Introduction

Knee osteoarthritis is known as a knee-joint injury in subchondral bone, synovium and periarticular soft tissues, which is a common chronic joint disease (Figure 1) (1). Its main symptoms in severe cases including knee pain, knee weakness, limited activity and deformity, which bring a great influence on patients’ work and life.

Due to the large exercise load and sports injury, knee osteoarthritis usually happened on the tennis athletes. In recent years, clinical researches have showed that the combination of training exercise and intra-articular injection of sodium hyaluronate on knee osteoarthritis exhibits fairly

good efficacy\(^2,3\). This has offered a new thought on clinical treatment. A total of 1200 tennis athlete with knee osteoarthritis were recruited in this study and were treated with different therapeutic treatment. The corresponding results proved that the training exercise with the aid of sodium hyaluronate injection possessed a significant efficacy on the treatment of knee osteoarthritis.

**Materials and methods**

**General information**

The clinical data from 1200 cases of the knee osteoarthritis caused by tennis training was collected. The 832 males and 368 females candidates who participated in the disease course between 3 and 14 months (at a mean duration 8.3±2.4 months) were enrolled for the research between March 2013 and March 2016. Their age were ranging from 21 to 34 years (at a mean age 26.5±3.2 years). Meanwhile, they were randomly divided into three groups on average. Basic data showed a good proportionality. This comparability of this study can be proven by the comparison of cross-group differences with P > 0.05 which showed no statistically significant.

**Inclusive and exclusive criteria**

There was either clinical performance or radiography of all patients was conformed to the diagnostic criteria of the osteoarthritis (OA) of American College of Rheumatology (ARA) (Figures 2 and Figure 3). All of them were professional tennis athletes who willing to participate in this investigation and signed the informed consent. Patients with secondary knee osteoarthritis, congenital knee anatomic anomalies as well as the patients who acquired knee deformities and traumatic or hemophilic arthritis were excluded from this study.

**Therapeutic methods**

**Observation group**

The patients in the observation group received the variable velocity and resistance (VVR) training exercise and the knee sodium hyaluronate injection. Type GT-150 of VVR lower-limb muscle force was applied in this study to measure the training system. When the patients were sitting on the VVR, they were fixed by fixing bands with 90-degree flexion on hip joint and natural falling of double lower limbs to avoid displacement. Lateral femoral condyle in the affected side was regarded as the skin-marker for the knee flexion and extension axis, which was aimed at the rotation axis for resisting arms in the training system\(^4\).

The resistance pad was posited above the ankle joint of the affected limbs. In this testing, patients should grip the handle with both hands and extend the knees fully up to 0-degree until relaxation, at which, the obtained torque by applied weight in the force arm was used for gravity correction\(^5\). Moreover, the range of motion for joint was 115 degree.

The training scheme including isometric muscle force exercise in 10 min was performed on quadriceps muscle and hamstring muscle, respectively, and the VVR training exercise in 20 min was also conducted. Then, patellofemoral joint paracentesis was carried out on the selected puncture points out of kneecap after the conventional disinfection. After confirming the needle into articular cavity, hydrops was attracted and 2 ml of sodium hyaluronate was injected into the patients. After withdrawing the needle, joint movement was executed slightly and slowly. This therapy was performed on the patients once a week with a total of 5 time.

**The control group**
Sodium hyaluronate injection was merely conducted on patients in the control group.

The physiotherapy group

The paraffinotherapy, high frequency electromagnetic wave therapy and drug-iontophoresis with pulse magnetic field were performed on patients in the physiotherapy group.

Paraffinotherapy: Pull the heated molten liquid wax into a plate and condensed it into a thick wax block with about 2 cm. Then, applied it around the affected knee joint when temperature was cooled down to 50-60° C with every 20 min.

Drug-iontophoresis with pulse magnetic field: With the utilization of magnetic pulse drug iontophoresis instrument produced in Henan province, China, drug patches, which contained extracted Chinese patent medicine. The extracted Chinese patent medicine was used to promote the circulation and remove stasis as well as relieve rheumatism and cold. It was placed on the distinct knee pain points, in contrapost way for 20 min.

Microwave therapy: Multi-functional microwave therapy apparatus WE2102-A (produced in Dalian, China), was conducted with 33 cm wavelength, frequency at 915 MHz, 30-150 W power and with temperature in the range of 39-41°C. The patients were lying in horizontal position and the extracorporeal irradiator was used to irradiate the most distinct knee pain position (above 1-3 cm on the skin) for every 30 min. This particular therapies were complied once a day. It is worth to note that the patient with any mental problem should not involve in this therapy, hence it is better for the female to avoid carry out the therapeutic during the monthly period.

Observation indexes

Efficacy evaluation: Visual analogue scale (VAS) on pain for patients among the three groups was performed before treatment and 5 weeks after treatment, respectively, with 0 score for painlessness and 10 score for the most painful moment. Lysholm knee score scale (LKSS) included 8 items with full score of 100, in which, lameness, request of support and crouch was of 5 scores respectively. On the other hand, the interlocking consists of 15 scores, 25 scores was appointed for the each un-stability and pain, and each swelling and capacity of going up and down consists of 10 scores.

Muscle test: VVR was adopted to evaluate the peak torque (PT) of quadriceps femoris and hamstring muscles, which was the largest torque in the knee flexion and extension movement.

Statistical methods

SPSS21.0 statistical software was implemented for data analysis and treatment. Chi-square test was used for enumeration data presented by (n, %) and t-test for measurement data presented by (x ± s), respectively. If P < 0.05, it is considered statistically significant.

Results

The knee VAS, VVR and PT score of quadriceps femoris and hamstring muscles were distinctly improved in the three groups after the 5 weeks treatment as compared to those before surgery. Meanwhile, the performance of patients in the observation group were significantly better than those in the control group and the physiotherapy group (P < 0.05). Meanwhile, there was no statistical significance between the physiotherapy group and the control group (P > 0.05). Data in details were shown in Table 1.

Discussions

VVR is a measuring and training system on knee joints with muscle force and muscular endurance. Its structure characteristic is that the rotated resistance of holder and training speed are able to be changed with the size of force acted on holder.

By providing the acted force on holder exists, the resistance will not be disappeared. The training
resistance and training speed can be adjusted by changing the opening and closing degree of variable regulator. If the force acted on holder is weaker, the given resistance in the apparatus will be weaker and the training speed will be slower, and vice versa. Variable velocity and resistance muscle strength training exercises the training with both variable velocity and variable load, therefore, VVR is able to overcome the shortage of isokinetic exercise which is unable to produce the accelerated movement.

Knee osteoarthritis of high disability rate and high price of end-stage treatment or operation, which reveals the more important rehabilitation treatment in the early phase. The conservative rehabilitation treatments for knee osteoarthritis includes exercise therapy, physical agents, drugs and intra-articular injection. In which the exercise therapy with longer efficacy by the evidence-based medicine is proved as more important treatment to the patients as compared to other treatments. This can be further explained by the exercise therapy is more beneficial to maintain and improve the range of motion, enhance the muscle force, resistance and coordination, as well as alleviate the pains.

Besides that, the VVR is a dynamic muscle contraction training and variable resistance training. In the movable area of the whole joints besides offering the training to enhance utmost muscle force and muscle resistance, VVR is also the best training load at all angles, which is hard for active isometric and isotonic contraction training. Moreover, the VVR muscle training able to impose any restriction on patients, and revealing a natural movement environment as well as improving the treatment compliance.

Sodium hyaluronate (SH) is a mucopolysaccharide which acts as chief component of synovial fluid and cartilage. SH in articular cavity is secreted by type-B cell in synovial lining cell and exist in three forms:

1) combination with the protein as SH-protein complexes, free in the synovial fluid;
2) combination with glycoprotein, adhered to the surface of cartilage or periosteum, in the form of indeterminate structure layer;
3) combination with glycoprotein subunit as protein polysaccharide biopolymer to compose cartilage matrix.

At the same time, SH is able to take part in various physiological functions in extracellular fluid, such as electrolyte, humidity control, joints lubrication, resistance to infection and wound healing. It is also playing an important role in joints protection, nutrition and function. Supplement of exogenous SH on knee disease can augment the concentration of hyaluronic acid in synovia of synovial membrane surface to form physical barriers again to prevent cartilage matrix from further destroying and disappearing. In addition, it can improve the biological function of synovial membrane in pathological state, as well as relieve and eliminate articular friction and pain. Through the effect of suppressing leukocyte movement and chemotaxis, SH is useful in decreasing the permeability of synovial membrane, augmenting the formation of polymer sodium hyaluronate and reducing intra-articular ankylosis. It can combine with medium pain by covering and protecting pain receptors so as to relieve pains.

SH not only can combine with glycoprotein to prevent the compound participating in inflammatory processes, but also able to combine with glycoprotein in cartilage matrix as polymer to repair injured cartilage.

It can be concluded that the therapy of the variable velocity and resistance muscle strength training exercise with sodium hyaluronate revealed a fairly good effect on the knee osteoarthritis caused by tennis training, which is worthy for widely application and promotion in the future.

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