European Review for Medical and Pharmacological Sciences 2016; 20: 214-219

The curative efficacy of arthroscopic therapy in treating anterior cruciate ligament rupture with secondary osteoarthritis

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Abstract. – OBJECTIVE: To compare and analyze the clinical effects of arthroscopic therapy and drug therapy in treating anterior cruciate ligament (ACL) rupture with secondary osteoarthritis (OA).

PATIENTS AND METHODS: A total of 68 patients that were diagnosed as ACL rupture with secondary OA in our hospital from February 2014 to February 2015 were enrolled in our study. All of the patients were randomly divided into control group (n = 30) and observation group (n = 38) according to the order of admission. The patients in the control group were given analgesic, anti-inflammatory drugs + functional rehabilitation training whereas the patients in the observation group were given ACL reconstruction + OA debridement and functional rehabilitation training under arthroscopy.

RESULTS: The success rate of the observation group was 92.1%. After 3-month follow-up, the clinical total effective rate of the observation group was significantly higher than that of the control group, the prevalence of complications in the observation group was significantly lower than in the control group, and differences were statistically significant ($p < 0.05$). Lysholm scale scoring of observation group was significantly higher than of the control group, modified McGill pain scale score was significantly lower than that of the control group, and differences were statistically significant ($p < 0.05$). Quadriceps muscle peak torque, average power, and the optimal single work at 60°/s, 120°/s, and 180°/s were significantly higher than those of the control group, and differences were statistically significant ($p < 0.05$).

CONCLUSIONS: Arthroscopic operative therapy was safe and effective for the treatment of ACL with secondary OA. Compared with drug therapy, it can significantly improve the movement function of the knee joint, so it was worthy of clinical application.

Key Words:
ACL, Secondary OA, Arthroscope, Lysholm scale score, Isokinetic muscle test.

Introduction

Knee joint osteoarthritis (OA) was a chronic inflammation with degenerative changes of articular cartilage being the core. It would involve the structures, including sclerotin, synovium, joint capsule, meniscus and so on and then result in the changes of dynamic stability structures around the knee joint[1]. Logan et al[2] have shown that anterior cruciate ligament (ACL) rupture changed the movement mechanism of tibial and femoral joint, such that the lateral tibial plateau might have the possibility to develop forward dislocation, thus increasing the prevalence of secondary OA. According to Nebelung and Wuschech[3], 60% of ACL patients would have secondary OA in 10 years, 60-100% in 20 years, and 86-100% in 30 years. Based on the pathogenesis of OA, both drug therapy and arthroscopic surgery therapy could be adopted. But the results of different researches[4,5] were not quite the same, even contrary. In our study, we have further analyzed the difference between the clinical effect and the improvement of motor function of the two therapies, thus, providing a new basis for clinical treatment.

Patients and Methods

Patients

A total of 68 patients that were diagnosed as ACL with secondary OA in our hospital from

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February 2014 to February 2015 were enrolled. After CT or MRI examination, all of the patients have been confirmed with ACL rupture and conformed to the OA diagnostic standards released by the American Institute of Rheumatism. Inclusion criteria included: (1) Patients that were aged at or more than 18 years old or less than 80 years old; (2) Patients that conformed to the diagnostic standard of ACL rupture and OA; (3) Patients that conformed to the arthroscopic operation indications. Exclusion criteria included: (1) Patients with a history of knee injuries or knee operations, and a history of ACL and OA treatment. (2) Patients with joint deformities, autoimmune diseases, other knee joint lesions besides ACL, such as posterior cruciate ligament injury, accessory ligament injury, joint space narrowing, meniscus injury, and so on; (3) Patients combined with severe dysfunctions in heart, liver, kidney, and other organs, with pregnancy, infection, or patients with poor compliance or refused the study and so on.

After obtaining the approval of Ethics Committee of our hospital and the informed consent of patients as well as their family members, all of the patients were divided into two groups according to the admission order: control group (n = 30) and observation group (n = 38). In the control group were 18 cases of male and 12 cases of female, being aged from 48 to 73 years old, on average (59.7 ± 12.4) years old, with a disease course from 3 months to 6 years, on average (3.4 ± 1.2) years; 6 cases were confirmed with early OA, 17 cases with middle-term OA, and 7 cases with advanced OA. In the observation group were 23 cases of male and 15 cases of female, being aged from 44 to 76 years old, on average (56.6 ± 15.2) years old, with a disease course from 4.5 months to 8.7 years, on average (3.2 ± 1.3) years; 9 cases were confirmed with early OA, 21 cases with middle-term OA, and 18 cases with advanced OA. Differences on the baseline data between the two groups had no statistical significance ($p > 0.05$).

Experimental Method

Patients in the control group were treated with drug therapies, including non-steroidal anti-inflammatory drug, corticosteroids anti-inflammatory drug, calcitonin or closed treatment in acupuncture point of sodium hyaluronate, being assisted by early functional rehabilitation training, such as patellar activity, ankle pump motor, strength training, cold compressing, knee pressing, lift leg movement, skateboarding, straight leg raising movement, weight-bearing, progressive elastic band resistance training, power car, micro squat training, swimming training and proprioceptive training, jogging, squats, the slow movement, and so on.

Patients in the observation group were treated with ACL reconstruction + OA debridement and functional rehabilitation training under arthroscopy. Details were as follows: (1) ACL reconstruction: Maintain the patients in prone position under general anesthesia, find out and take out the patients' semitendinosus and gracilis tendon with tendon drawing device, and polish the exposed bone by shaver under arthroscope, then take the polished bone as the dead center of ACL. Place the knee at 100°, input guide din by tibia sight in an angle of 45°-50° from horizontal level and 15° from sagittal plane, then use core drill to drill tibial and femoral tunnels and make precise measurement on the length of each tunnel, fix the prepared semitendinosus and gracilis tendon inside the patient's tibial and femoral tunnels, conduct repeated tract on the guide line. After confirming that the steel plate has turned over completely on condylus lateralis femoris, close the tendons, use a bolt to press the screw nail, then use finger pin to detect the reconstructed ligament to confirm its tightness and to check whether there was any attack or not. (2) OA debridement: Plan synovium and synovial plica with hyperplasia and degeneration were gouged, especially the fossa intercondyloidea and medial and lateral joint space, according to the condition of meniscus injury, wearing and tearing, implement partial removal, large partial removal and complete removal; erase the cartilage of coarse and cartilage surface, or the cartilage, most of which have been exfoliated, restore the impaired cartilage surface, use Kirschner wire or small knife to drill a hole in small area bone exposure; then, remove when intercondylar fossa osteophyte was protruted and joint flexion and extension could reach to condyle fossa, internal and external femoral condyle, anterior and posterior cruciate ligament and patellar bursa; take out the episode inside joint and the peeling cartilage. (3) Functional rehabilitation training: Details were as above. Patients could wear a brace.

Observation Index and Evaluation Criteria

After 3-month follow-up, we have compared and analyzed the differences between the two groups on the clinical total effective rate and

complication rate. Judgment on curative effect was subject to *Guiding Principles for Clinical Treatment of Osteoarthritis* and was divided into four levels: clinical control, excellent, efficient, and inefficient. The case that pains disappeared and joint activity became normal was defined as clinical control; the case that pains almost disappeared and patients could participate in normal activities and work was defined as excellent; the case that pains almost disappeared, joint activity was slightly limited, and the patients' ability to take normal activities and work was improved was defined as efficient; the case that did not reach up to the standard of effectiveness was defined as inefficient.

We have also compared and analyzed the differences between the two groups on Lysholm scale and modified McGill pain scale. Lysholm scale included 8 items, including limp, support, locking, instability, pain, swelling, stairs climbing, and squat. The higher the score was, the better the result was. Modified McGill pain scale included pain rating index (PRI), a total of 9 items, and pain intensity (PPI), a total of 6 items. The higher was the score, the more severe was the pain.

Besides, we have compared and analyzed the differences between the two groups on quadriceps muscle peak torque, average power, and the optimal single work at 60°/s, 120°/s, and 180°/s. Details were as follows: apply Type Contrex System-Top1000 multi joint isokinetic strength testing and training system that was introduced from Sports Skills Research Center, Shanghai University of Sport. Fix electrode on the skin surface corresponding to vastus lateralis, rectus femoris, vastus medialis oblique, semitendinosus muscle, and biceps femoris muscle. Set the sampling frequency at 1000 Hz, band-pass filtering at 10-400 Hz. Use bipolar Ag/AgCl disk electrode specialized for surface electromyography and set the electrode spacing at 2.0 cm, noise level < 5 uV. Each operation was conducted by the same person to minimize the error. Measurement was carried out according to the sequence of low speed (60°/s), medium speed (120°/s), and high speed (180°/s). Under the velocity of 60°/s, 120°/s, and 180°/s, knee joints made 5 centered motions and the rest time between each group was 30 s.

Statistical Analysis

Statistical software package SPSS 19.0 (SPSS Inc., IBM, NY, USA) was applied to record and analyze the data; measurement data was presented by means±standard deviation; *t*-test was applied in comparisons between groups; enumeration data was presented by case or percentage; χ^2 test was applied in comparisons between groups; $p < 0.05$ was considered with statistical significance.

Results

Comparison on Total Effective Rate and the Occurrence of Complications Between the Two Groups of Patients

The success rate of the observation group was 92.1%. After 3-month follow-up, the clinical total effective rate of the observation group was significantly higher than that of the control group, the occurrence of complications in the observation group was significantly lower than in the control group, and differences were statistically significant ($p < 0.05$) (Table I).

Comparison on Lysholm Scale Score and Modified McGill Pain Scale Score Between the Two Groups of Patients

Before treatment, the differences on Lysholm scale score and modified McGill pain scale score between the two groups of patients were not statistically significant ($p > 0.05$); after 3-month follow-up, Lysholm scale scores in both groups were increased while modified McGill Pain table scores in both groups were decreased, and the observation group improved more obviously, and differences were statistically significant ($p < 0.05$) (Table II).

Comparison on the Results of Isokinetic Muscle Strength Evaluation Between the Two Groups of Patients

Quadriceps muscle peak torque, average power, and the optimal single work at 60°/s, 120°/s, and 180°/s were significantly higher than those of the control group, and differences were statistically significant ($p < 0.05$) (Table III).

Discussion

At present, the etiology and pathogenesis of OA are not very clear. Clinically, it is still lacking of fundamental treatment therapy and the curative effect is not so satisfactory. The research on the repair of articular cartilage is also very limited. Therefore, establishing an animal model

Table I. Comparisons on total effective rate and the prevalence of complication between the two groups of patients [case (%)].

Group	Case	Clinical control	Excellent	Effective	Ineffective	Total effective	Infection	Digestive tract discomfort	Synarthrophysis	Complication prevalence
Control group	30	6	9	8	7	23 (76.7)	1	3	5	9 (30.0)
Observation group	38	12	15	7	4	34 (89.5)	1	1	2	4 (10.5)
χ^2						4.112				4.112
p						0.043				0.043

of OA can benefit our in-depth study. Stoop et al[6] have dissected the knee joint ACLs of Wistar rats, executed them on the 2nd, 7th, 14th, 28th, and 70th day, collected degenerative type II collagen under the detection of routine histology and immunohistochemistry as well as the chondrocytes and cartilage matrix in the surface zone that was firstly changed after ACL rupture; on the 14th day after operation, the surface layer of cartilage cells was swollen and the surface layer had fibrosis. Four weeks and 10 weeks later, changes were clearer. Therefore, cartilage degeneration that was induced by early mechanical overload on the surface layer of cartilage and the degeneration of articular cartilage were closely related with type II collagen degradation products. Collagenase had played a key role in articular cartilage degeneration.

ACL would result in joint instability and changes of joint stress, thus resulting in degenerative changes of the joints and formation of OA. Wu et al[7], through simulating the contact zone and stress distribution of normal and abnormal cartilage loads of cats, speculated that OA secondary to ACL rupture was resulted from an overload of a special zone of the joint, which was incurred from the changes of contact mechanism and the instability of joints. von Porat et al[8] have made a 14-year follow-up on football players with ACL injuries and found that whatever treatments were adopted, the injury induced OA would often lead to knee joint symptoms, which seriously affected the quality of the patients' joints after middle age. Liu et al[9], after comparing the pathological changes of primary OA and OA secondary to ACL, found that the changes of proteoglycan in both kinds of cartilage were quite different. They held that the changes of proteoglycan might indicate a more active restoration process and that both kinds of OA might have different development mechanisms.

At present, the anatomic reconstruction of the joint after ACL injury has become a consensus, which, with the aid of minimally invasive surgery, could recover the players' athletic ability and competitive level with the minimal surgical trauma[10]. Hogervorst et al[11] have made bone scanning on 80 ACL reconstructed patients before and 2 years after operation, respectively, and found that ACL reconstruction could protect meniscus and articular cartilage and that reconstruction had better been performed within 6 months after injury. While emphasizing on ACL reconstruction, early diagnosis and treatment on

Table II. Comparisons on Lysholm scale score and modified McGill pain scale score between the two groups of patients.

Group	Pretreatment Lysholm scale score	Follow-up score	Pretreatment modified McGill pain scale score (PPI)	PRI	Follow-up PPI score	PRI
Control group	42.7 ± 10.3	62.8 ± 12.7	4.5 ± 1.1	15.3 ± 5.2	2.6 ± 0.6	7.7 ± 1.3
Observation group	40.6 ± 11.2	84.3 ± 13.5	4.8 ± 1.2	16.2 ± 6.3	0.9 ± 0.4	5.4 ± 1.2
t	0.527	4.527	0.326	0.108	3.947	3.648
p	0.318	0.036	0.489	0.732	0.041	0.042

Table III. Comparison on the results of isokinetic muscle strength evaluation between the two groups of patients.

Group	Peak torque (Nm)			Average power (W)			Optimal single work (J)		
	60°/s	120°/s	180°/s	60°/s	120°/s	180°/s	60°/s	120°/s	180°/s
Control group	32.5 ± 10.3	26.4 ± 11.4	23.7 ± 8.4	38.7 ± 13.6	39.4 ± 15.2	41.2 ± 16.3	103.5 ± 35.4	92.8 ± 31.2	86.7 ± 28.9
Observation group	38.7 ± 12.5	30.2 ± 9.7	27.9 ± 7.6	42.3 ± 14.2	45.6 ± 15.7	47.9 ± 17.8	127.4 ± 36.9	113.6 ± 33.8	98.5 ± 30.7
t	3.746	3.689	3.947	4.103	4.038	4.257	5.617	5.329	5.128
p	0.042	0.043	0.037	0.038	0.039	0.036	0.024	0.026	0.029

OA secondary to ACL should also arouse great attention. Clinically, medical therapies mainly included non-steroidal anti-inflammatory analgesic drugs, corticosteroids anti-inflammatory drugs, matrix metalloproteinase inhibitor that could reduce cartilage matrix components, nitric oxide synthase inhibitor, antioxidant, glucosamine sulfate, hyaluronic acid, chondroitin sulfate, cytokine and growth factor regulation drugs and gene therapy, so on and so forth, which have greatly improved the clinical effect and long-term prognosis of OA[12-14]. In our study, we have compared the arthroscopic therapy and drug therapy. After 3-month follow-up, we found that the success rate of the observation group was 92.1%; the clinical total effective rate of the observation group was significantly higher than that of the control group, the incidence of complication in the observation group was significantly lower than in the control group, and differences were statistically significant. Lysholm scale score of observation group was significantly higher than of the control group, modified McGill pain scale score was significantly lower than that of the control group, and differences were statistically significant. Quadriceps muscle peak torque, average power, and the optimal single work at 60°/s, 120°/s and 180°/s were significantly higher than those of the control group, and differences were statistically significant. Strict control of the surgical indications, reasonable choice of surgical approach, and postoperative functional rehabilitation training were important factors that might affect the clinical outcomes[15,16]. Besides, we have also analyzed the work efficiency of the stock four muscles from the perspective of kinematics function, which could better support our conclusion.

Conclusions

The cause and mechanism of ACL with secondary OA and pure OA were quite different. Arthroscopic operative therapy was safe and effective for the treatment of ACL with secondary OA. Compared with drug therapy, it can significantly improve the movement function of the knee joint, so it was worthy of clinical application.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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