

Comparison of Clinical Efficacy Between Arthroscopically Assisted Gracilis Autograft With Suture Reinforcement Technique and Transtibial Pull-out Technique in Treating Medial Meniscus Posterior Root Tears

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Research article

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Abstract

Background: To compare the short-term efficacy of the transtibial pull-out technique and gracilis autograft with suture reinforcement technique in the treatment of medial meniscus posterior root tears.

Methods: A total of 64 patients with medial meniscus posterior root tears received reconstruction of the posterior root of the meniscus attachment point through the tibial tunnel between June 2018 and April 2019 were included in this study, patients were divided into 2 groups (transtibial pull-out technique group: 35 cases; gracilis autograft with suture reinforcement technique group: 29 cases) according to the different posterior meniscus root tear repair methods. Clinical outcomes were evaluated by the visual analogue scale (VAS) and Lysholm score and IKDC score, and the demographics and functional recovery of the knee were compared between the two groups.

Results: Intraoperative and postsurgical complications such as infection were not found in the two groups, and there was a statistically significant improvement in the Lysholm score, IKDC score and VAS score ($P < 0.001$; respectively). All the patients were very satisfied with the function of their knee at the last follow-up. However, compared with the transtibial pull-out repair group, the reinforced medial meniscal root reconstruction technique with gracilis autograft group were significant improvement in the meniscus healing rates and Lysholm score, IKDC score and VAS score at the end of follow-up ($P < 0.05$; respectively).

Conclusions: Compared with the transtibial pull-out technique, the reinforced medial meniscal root reconstruction technique with gracilis autograft is advantageous for treating these patients because it is a minimally invasive procedure with superior clinical outcome and meniscus healing rates.

Levels of Evidence: \square , Case-control study Retrospective comparative study

Introduction

The meniscus is critical components of the knee and plays an essential role for maintaining various aspects knee functions [1]. Medial meniscus posterior root tears were significantly lower occurrence rate and more difficult to diagnose comparing with meniscal body or horns tears, moreover, complete posterior meniscal root tears dramatically inhibit normal meniscal function similar to total meniscectomy [2], studies have been shown that the medial meniscal root tears result in the loss of circumferential hoop stresses can change native physiologic properties of the knee, and strongly correlate with knee degenerative [3].

Therefore, most of the studies indicated that surgery should be recommended for patients with high demands and no to low-grade osteoarthritis [4]. Currently, there are several methods used for surgically managing meniscus root tears, like meniscectomy, meniscal repair, and reconstruction of the posterior meniscus root. Moreover, compared with meniscectomy or meniscal repair, more evidence indicates that the meniscal root reconstruction can performed to re-establish the normal biomechanics of the knee is advantageous for patients [5].

Transtibial pull-out repair technique has been reported promising clinical improvements by securing the meniscus to its original anatomic^[6]. The initial fixation strength of suture must be strong enough to maintain the entire biological healing, therefore, Holmes et al [7] present an arthroscopic reconstructive technique using gracilis autograft with suture reinforcement for medial meniscus posterior root tears is expected to yield improved healing rates compared with direct repair techniques. However, many repairs have not reversed or prevented progressive symptomatic knee arthritis, and no consensus regarding the ideal repair or reconstruction technique for meniscal root repair [6–8]. Furthermore, the current literature lacks studies comparing different repair techniques of clinical outcome assessments [8].

This study aims to compare the short-term efficacy of the transtibial pull-out technique and gracilis autograft with suture reinforcement technique in the treatment of medial meniscus posterior root tears. Also, we hypothesized the gracilis autograft with suture reinforcement technique led to comparable or even better results than the transtibial pull-out technique.

Materials And Methods

1. Patient selection

This study was approved by the medical research ethics committee of our institutional. A total of 64 patients with medial meniscus posterior root tears received treatment of posterior meniscus root attachment point through the tibial tunnel between June 2018 and April 2019 were included in this study, and patients were divided into 2 groups (transtibial pull-out technique group: 35 cases; gracilis autograft with suture reinforcement technique group: 29 cases) according to the different repair methods for the meniscus posterior root tear.

Diagnosis of patients with medial meniscus posterior root tears primarily relies on clinical evidence and knee magnetic resonance imaging (MRI), all patients underwent arthroscopic reconstruction of the posterior root of the meniscus attachment point with a minimum 2-year follow-up. Indications for surgery included medial meniscus posterior root tears and no changes or 1–2 stages osteoarthritis of the knee joint. Patients undergoing surgery for other indications (cartilage resurfacing, osteotomy or ligament reconstruction), previous surgery of the same knee (previous tibia or femur fracture), complex root tears, concomitant ACL injury or other associated knee joint lesions were excluded from the study. As medial meniscus posterior root tears occurred frequently associated with other meniscus concomitant injury, so meniscus concomitant injury was not excluded from the study.

2. Data collection

The following parameters were recorded: age, gender, comorbidities, stages OA of the knee joint evaluated according to Kellgren and Lawrence, treatment for medial meniscus posterior root tears, hospitalization time, side of injury, preoperation and postoperative visual analogue scale (VAS), Lysholm score and International Knee Documentation Committee (IKDC) score of the affected knee, complications, and healing status of the repaired meniscus at the final follow-up.

3. Surgical techniques

3.1 pullout repair techniques

Arthroscopic evaluation and treatment of the medial meniscus posterior root tear and other intraarticular lesions with patients under spinal anesthesia. A limited refreshed was applied to the torn edge of the meniscus with a motorized shaver, and a guide pin drilled from a small incision over the anterior proximal tibia and advanced to the posterior horn root of knee under the special guide system (Smith & Nephew) assisted. Then, the suture shuttle was used to place a No. 0 fiber wire suture (Smith & Nephew) through the posterior meniscus and shuttled into the tibial tunnel and the meniscus root down into the posterior horn root attachment under arthroscopic visualization control. The fiber wire sutures were tightened to button to ensure appropriate position and tension of the construct.

3.2 Gracilis autograft with suture reinforcement technique

Arthroscopic evaluation and treatment of the medial meniscus posterior root tear and other intraarticular lesions with patients under spinal anesthesia. A limited refreshed was applied to the torn edge of the meniscus with a motorized shaver, and a guide pin drilled from a small incision over the anterior proximal tibia and advanced to the posterior horn root knee joint under the special guide system (Smith & Nephew) assisted. The suture shuttle was used to place a No. 0 fiber wire suture (Smith & Nephew) through the posterior meniscus, then, the soft tissue tunnel is dilated with multiple passes of No. 0 fiber wire followed by the gracilis tendon passes through the medial meniscus posterior root and shuttled into the tibial tunnel. The tails of the gracilis tendon were fixed with an anchor to the tibial, and arthroscopic visualization is used to maintain the appropriate position and tension of the graft.

4. Postoperative management

Passive knee flexion and quadricep-strengthening exercises were started on the second day. Moreover, patients were allowed to walk non-weight-bearing with two crutches for six weeks, and weight bearing was progressed as tolerated starting at 6 weeks postoperatively, no heavy strenuous activities were allowed for the first 12 weeks.

5. Outcome assessment

The outcome was evaluated by 2 orthopedics surgeons, and imaging and clinical examinations were performed at directly postoperative, 1 month, 3 months, 6 months, 12 months, and 24 months, and knee functional assessment was performed according to the Lysholm score, IKDC score and VAS score.

At the final follow-up, radiologic outcomes of the repaired meniscus healing status were assessed by orthopedic surgeons and radiologist using knee MRI according to the criteria of previous studies [9-11].

6. Statistical analysis

Quantitative variables were presented as mean value \pm standard deviation (SD), and the two groups were compared using the Student's t-test. Count variables were expressed as numbers and percentages and were assessed by the Chi-square test. Statistical significance was set as P value less than 0.05. All analysis was performed by IBM SPSS Version 22 (SPSS Inc. Chicago IL).

Results

1. Patient demographics

The reinforced medial meniscal root reconstruction technique with gracilis autograft group included 29 subjects (mean 33.0 ± 11.2 age years), and the transtibial pull-out technique group involved 35 subjects (mean 36.1 ± 10.9 age years). As presented in Table 1, the mean follow-up period was 26.9 ± 2.3 months (range, 24–32 months). In detail, there were no significant differences in age, gender, injured side, K-L grade, comorbidities, and length of postoperative hospital stay among the two groups ($P > 0.05$). Moreover, there were no significant differences in intraoperative and postoperative complications among the two groups ($P > 0.05$). However, compared with the transtibial pull-out technique, the reinforced medial meniscal root reconstruction technique with gracilis autograft were significant improvement in the meniscus healing rates at the end of follow-up ($P = 0.043$).

Table 1
Patient demographics in different groups.

Characteristic	Pullout repair (35)	RT (29)	P
Age (y)	36.1 ± 10.9	33.0 ± 11.2	0.265
Gender: male n (%)	20 (78.6%)	17 (78.6%)	0.951
Comorbidities			
Diabetes mellitus	3	3	1
High blood pressure	4	5	0.725
Smoking status	4	3	1
Alcohol status	5	5	1
Injured side: right n (%)	18(51.4%)	17(58.6%)	0.620
K-L			0.471
0	14	16	
I	19	12	
II	2	1	
III	0	0	
IV	0	0	
Follow-up time (months)	26.6 ± 2.2	27.4 ± 2.3	0.158
Length of postoperative hospital stay (d)	2.3 ± 0.6	2.4 ± 0.6	0.433
Postoperative complications	0	0	1
meniscus healing rates			0.043
complete healing	30	18	
Failed healing	5	11	
RT: reconstruction technique; MRI: magnetic resonance imaging			

2. Comparison of functional results of the study groups

Table 2 shows the functional recovery of the knee joint in the different groups. the postoperatively pain in the knee was relieved in all cases, and the Lysholm score, IKDC score and VAS score was significantly improved at the end of follow-up ($P < 0.001$; respectively). Furthermore, compared with the transtibial pull-out repair group, the reinforced medial meniscal root reconstruction technique with gracilis autograft

group were significant improvement in the Lysholm score, IKDC score and VAS score at the end of follow-up.

Table 2
Functional Results of the Study Groups

Characteristic	Pullout repair (35)	RT (29)	P
Preoperative VAS score	5.4 ± 1.1	5.1 ± 1.4	0.309
Preoperative Lysholm score	60.2 ± 6.2	62.0 ± 8.2	0.353
Preoperative IKDC score	61.1 ± 5.9	62.5 ± 8.0	0.437
Postoperative VAS score	1.2 ± 0.9 ^a	1.2 ± 0.8 ^a	0.996
Postoperative Lysholm score	88.0 ± 6.2 ^a	91.3 ± 3.4 ^a	0.009
Postoperative IKDC score	88.3 ± 4.7 ^a	90.7 ± 3.2 ^a	0.020

Data are reported as mean ± SD. RT: reconstruction technique; ^a significant improvement in the Lysholm score, IKDC score and VAS score (P < 0.001 for both)

Discussion

The major findings of this study are that there was a significant improvement of Lysholm score, IKDC score and VAS score postoperatively in patients who underwent arthroscopic reconstruction of the posterior meniscus root. Moreover, compared with the transtibial pull-out repair technique, the arthroscopically assisted reinforced medial meniscal root reconstruction technique with gracilis autograft is advantageous for treating these patients because it's superior clinical outcome and meniscus healing rates.

Studies have been shown that meniscal root tears lead to the loss of circumferential hoop stresses, and strongly correlate with progressive symptomatic joint arthritis [9]. Therefore, most of the studies indicated that surgery should be recommended for patients with high demands and no to low-grade osteoarthritis [12, 13]. Transtibial pull-out technique has been reported promising function improvements of the knee by securing the meniscus to its original anatomic [14], however, the anatomic healing of the repair had been examined in a few studies and MRI or second-look arthroscopy studies have shown less than 2/3 of the patients healed completely [7]. Feucht et al [15] systematically review the outcome of the arthroscopically assisted transtibial pullout technique for medial meniscus posterior root tear, and 62% cases with complete healing and 37% cases with lax healing was observed at MRI or second-look arthroscopy. In accordance with previous studies, the postoperative knee MRI at the end of follow-up in our study revealed that 62% patients achieved complete healing and 38% patients with failed healing in the transtibial pull-out technique group, moreover, the healing status was rated as complete in 86% and failed in 14% in the reinforced medial meniscal root reconstruction technique with gracilis autograft group.

During the past decade, growing interest has focused on the reconstruction techniques for medial meniscus posterior root tear, compared with the clinical and radiologic outcomes of meniscectomy or meniscal repair, more evidence indicates that the meniscal root reconstruction can be performed to re-establish the native physiologic properties of the knee is advantageous for function recovery [16, 17]. Ulku et al [13] analyzed the clinical and radiological results of arthroscopically transtibial pullout repair for the medial meniscus, it was found that transtibial pull-out medial meniscus posterior root repair is an effective method for improvement of Lysholm scores (Postoperative Lysholm scores were 88.8 ± 3.7) postoperatively at middle follow-up period. Wang et al [8] examined the clinical outcomes and radiological progression following meniscus posterior root tears repair treatment, confirmed meniscus posterior root tears repair can not only improve functional scores (the Lysholm score increased 28.87, IKDC score increased 31.73) but also avoid or at least delay progressive symptomatic knee arthritis. Referring to our study, All patients had outcome scores available at 2 years or longer, and there was a statistically significant improvement in the Lysholm score, IKDC score and VAS score at the end of follow-up.

Li et al [18] demonstrated successful use of semitendinosus tendon autograft in rabbit model resulted in biomechanical properties were similar that of normal meniscus, demonstrating that tendon autograft is a promising alternative substitution in meniscus reconstruction. Holmes et al [7] present an arthroscopic reconstructive technique using gracilis autograft with suture reinforcement for medial meniscus posterior root tears is expected to yield improved healing rates and clinical results compared with direct repair techniques. Like ACL model, reinforced reconstruction technique that the initial fixation is strong enough to resist initial displacement and provide a long-term stability structure to allow the tendon graft heal to meniscus and bony tunnels [17]. In consistence with previous studies, compared with the transtibial pull-out technique group, the reinforced medial meniscal root reconstruction technique with gracilis autograft group were significant improvement in the Lysholm score, IKDC score, VAS score and meniscus healing rates on postoperative MRI at the end of follow-up.

Several limitations were also detected in this study. First, our current study is a single-center study, and a relatively small number of patients may introduce bias into the results, further prospective study with increased sample size is required to answer the question whether the arthroscopically assisted reinforced medial meniscal root reconstruction technique with gracilis autograft is superior to the transtibial pull-out technique or not. Second, we just observed the knee functional scores within 2 years after medial meniscal root reconstruction, the follow-up period was relatively short and no second-look arthroscopy was performed, therefore, a prospective study with long-term follow-up is needed for a more reliable and accurate conclusion. Third, the main limitation of this procedure is its complexity and working in the narrow medial compartment of the knee, but it is no more complicated than commonly performed reconstructive surgery like ACL reconstruction.

Conclusions

The present study showed successful short-term clinical outcomes for patients with the medial meniscal root reconstruction repair. Compared with the transtibial pull-out technique, the reinforced medial

meniscal root reconstruction technique with gracilis autograft is advantageous for treating these patients because it is a minimally invasive procedure with superior clinical outcome and meniscus healing rates.

Abbreviations

ACL: Anterior cruciate ligament injury; VAS: visual analogue scale; MRI: magnetic resonance imaging; K-L: Kellgren-Lawrence; IKDC: International Knee Documentation Committee.

Declarations

Conflicts of Interest

No benefits in any form have been or will be received from any commercial party related directly and indirectly to the subject of this manuscript.

Authors' contribution

The authors made the following contributions: Lan min made the conception for this research. Data collection and analysis were performed by Jianyin He, Guanxiang Liao and Xuelei Ke. Lan min, Nie Si and Li Hongbo analyzed the data and drafted the article. Lan min and Si Nie reviewed/ edited the manuscript. All the authors critically revised the article for important intellectual content. The author(s) read and approved the final manuscript.

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Ethics approval and consent to participate

This study was approved by the ethics committee of the Jiangxi Provincial People's Hospital Affiliated to Nanchang University, the volunteer involved in the study consent to participate in the study, and the written consent has been obtained from the volunteer.

Consent for publication

All individual person's data consent to publish.

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