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Research on the application effect of arthroscopic access modification in meniscal injury repair

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Abstract

Objective To investigate the application value of arthroscopic channel modification in meniscal injury repair.

Methods We retrospectively analyzed the data of 100 patients with meniscus injuries treated with knee arthroscopy from December 2022 to December 2023 and divided them into a control group and a modified group according to the application of "arthroscopic access modification technology". We compared the operation time, postoperative hospitalization time, VAS score, Lysholm knee function score, postoperative complications, and postoperative images of the patients in these two groups. We compared the operation time, postoperative hospitalization time, pre- and postoperative VAS scores, Lysholm knee function scores, postoperative complications and postoperative imaging indices of the patients in the two groups.

Results All patients successfully underwent surgery and were followed up without intraoperative vascular or nerve injury or postoperative complications such as infection, wound necrosis or thrombosis. The average follow-up time was 16.03 ± 3.69 months; the average operation time and postoperative hospitalization time of the modified group were significantly better than those of the control group were ($P < 0.05$); the pain and knee function of the two groups significantly improved over time ($P < 0.05$); and, compared with those of the control group, the modified group could obtain a more satisfactory score at an early stage of the postoperative period ($P < 0.05$), and the comparison of the intermediate and long-term scores of the two groups was not statistically significant ($P > 0.05$). There was no statistically significant difference ($P > 0.05$).

Conclusion The improved arthroscopic access technique can make the entry and exit of instruments into and out of the joint cavity smoother, improve the surgical field of view, significantly shorten the operation time, reduce the occurrence of intraoperative complications, improve the function of patients' knee joints earlier, and increase their satisfaction with the operation.

Keywords Meniscus injury, Arthroscopic access modification, Rapid rehabilitation

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Introduction

The meniscus is a tissue within the knee joint that has important biological functions and plays an important role in knee joint activity. In recent years, people's demand for sports has increased, and there has been an increase in sports injuries, among which meniscus injuries are more common [1]. The main symptoms of meniscus injury are localized swelling, pain, etc. With prolonged disease, muscle atrophy can occur around the knee joint, which leads to dysfunction, affecting a patient's ability to play sports and quality of life; thus, timely and effective treatment is particularly important for patients with meniscus injury [2, 3]. Meniscal injury can be treated with medication, rehabilitation, physiotherapy and surgery. Early surgical treatment is mainly meniscectomy, and early functional recovery after meniscectomy is better; however, postoperative surgery is prone to serious knee inversion, knee valgus and arthritis and other complications. With the development of minimally invasive technology, arthroscopic meniscus shaping or suture surgery has gradually been used in orthopedic clinics, which has the advantages of minimal trauma, fast healing, a short operation time and fast recovery of joint function after surgery. With the development of minimally invasive technology, arthroscopic meniscoplasty or suture surgery has been gradually used in orthopedic clinics, which has the advantages of less trauma, faster healing, a shorter operation time and faster recovery of joint function after surgery and can maximally preserve healthy meniscus tissue [4, 5]. However, owing to its high surgical requirements and large learning curve, it easily causes intraoperative articular cartilage damage or soft tissue bleeding, which affects the surgical outcome. The initial design intention is to improve arthroscopic access, which makes the intraoperative instrumentation in and out of the joint cavity smoother, reduces the occurrence of intraoperative complications, and improves surgical satisfaction. Therefore, the present study was designed to investigate the value of arthroscopic access modification in meniscal injury repair by comparing the surgical time, postoperative hospitalization time, pre- and postoperative VAS scores, Lysholm knee function score, postoperative complications, and postoperative imaging indices of patients who underwent conventional arthroscopic surgery.

Table 1 Preoperative general information and comparison of the two groups of patients

Norm	Improved group ($n=50$)	Control group ($n=50$)	P value
Age (years. $\bar{x}$ ±s)	48.50 ± 9.56	45.86 ± 10.50	0.192
Sex (e.g. male/female)	17/33	18/32	0.831
BMI (kg/m^2 . $\bar{x}$ ±s)	24.50 ± 2.96	24.40 ± 3.67	0.886
Side (e.g. left/right)	21/29	23/27	0.687
Part (e.g. internal/external)	33/17	27/23	0.221

Materials and methods

Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) 18 years of age ≤ 60 years of age; (2) preoperative symptoms such as knee pain, joint popping, etc., diagnosed as meniscus grade III injury by MRI; (3) unilateral knee arthroscopic meniscoplasty; (4) cartilage lesions lower than Outerbridge grade 3; and (5) patient inpatient case data, complete postoperative follow-up data, mental status, cognitive function, and compliance.

The exclusion criteria were as follows: (1) bilateral knee lesions or surgery; (2) a combination of other knee injuries (e.g., cartilage avulsion of the knee, anterior and posterior cruciate ligament injuries, or medial and lateral collateral ligament injuries); (3) a combination of more serious underlying medical diseases affecting patient recovery after surgery; (4) a history of previous knee surgeries; and (5) incomplete follow-up and incomplete data collection.

General information

We retrospectively analyzed patients who underwent knee arthroscopic meniscoplasty in our department from December 2022 to December 2023, and a total of 100 patients met the above criteria and were included in this study. Among them, 50 patients were treated with the "arthroscopic channel modification technique", which was used as the modified group, and 50 patients were treated with conventional arthroscopic surgery, which was used as the control group. The general information of the two groups is shown in Table 1, and the differences in age, sex, BMI, side and site of injury were not statistically significant ($P > 0.05$). This study was approved by the Ethics Committee of the hospital, and all patients provided informed consent.

Surgical methods

After the patient was satisfied with general anesthesia, the patient was placed in the lying position, a fixed baffle was placed on the lateral side of the root of the thigh on the operative side, and a fixed baffle was placed on the distal side of the foot. The skin of the affected limb was routinely sterilized and toweled, and the anterolateral approach to the affected knee was taken first. The medial and lateral intertrochanteric grooves, suprapatellar bursa, femoral trochanter, medial and lateral condyles of the femur, and tibial plateau were probed in detail to define the site, scope, and type of meniscus injury and to determine whether there was any combination of synovial fold proliferation, cartilage exfoliation, and so on. In the control group, after arthroscopic exploration was completed,

Fig. 1 Schematic diagram of modified knee arthroscopy channel establishment

the anteromedial approach to the knee joint was routinely established, and arthroscopic meniscoplasty surgery was performed.

In the modified group, after completion of arthroscopic exploration, an anteromedial approach to the knee was established, and after subcutaneous blunt separation via straight forceps, the straight forceps were not removed for the time being, the arthroscopic sheath+body was pulled out, another straight forceps was used to hold a small rubber drain tube into the joint cavity, and then the arthroscopic sheath+body was placed from the posteromedial approach. The first straight forceps were used to grasp the anterior end of the drain tube inside the joint cavity and drain it out of the medial port under the microscope, the drain tube was closed and knotted and tightened outside the body, and the drain was closed and knotted and tightened externally (Fig. 1). Once the channel was established, arthroscopic meniscoplasty was performed for surgical treatment.

At the end of the operation, the joint cavity was repeatedly rinsed, and the fluid in the joint cavity was suctioned out. In the modified group, the catheter was removed, its integrity was checked, the surgical incision was sutured layer by layer, and gauze and cotton pads were used to band the knee joint with pressure. The same rehabilitation team instructed the patients in postoperative rehabilitation and functional exercises.

Collection of clinical data

The perioperative-related indices of both groups, including operation time and postoperative hospitalization time, were recorded. The visual analog scale (VAS), Lysholm score, and knee extension and flexion mobility were used to assess knee pain and function. MRI was reviewed at 3 months postsurgery to assess cartilage degeneration via the Outerbridge grading system [6].

Table 2 Perioperative data of the two groups of patients ($\bar{x} \pm s$) and comparison

Norm	Improved group ($n=50$)	Control group ($n=50$)	*P* value
Surgical time (min)	52.50 ± 13.52	69.60 ± 15.61	**< 0.01**
Length of postoperative hospitalization (d)	2.62 ± 0.75	2.96 ± 0.81	**< 0.01**

Statistical analyses

SPSS 24.0 software was used for statistical analysis. The measured data are expressed as $\bar{x} \pm$ s. When the data were normally distributed, an independent samples t test was used for comparisons between two groups, and one-way ANOVA was used for comparisons between time points within groups; when the data were not normally distributed, the rank sum test was used. The χ^2 test was used for comparisons of count data, and $P < 0.05$ was considered statistically significant.

Results

Comparison of perioperative data

Surgery was successfully completed in both groups, and no serious intraoperative complications occurred. The perioperative data of the two groups are shown in Table 2. The operation time and postoperative hospitalization time of the modified group were significantly better than those of the control group, and the difference was statistically significant ($P<0.05$). The incisions in the two groups healed in one stage, and no infection or skin necrosis occurred.

Changes in patients' knee joint scores during follow-up

All patients successfully completed the surgery and were followed up for an average of 16.03 ± 3.69 months, and the follow-up data of the two groups are shown in Table 3. All patients had no intraoperative vascular or nerve injuries or postoperative complications, such as infections, wound necrosis, or thrombosis; compared with those in

Table 3 Follow-up results of the two groups of patients ($\bar{x} \pm s$) and comparison

Norm	Improved group ($n=50$)	Control group ($n=50$)	*P* value
VAS score (points)			
preoperative	6.74 ± 1.12	6.84 ± 1.08	0.650
1 month after surgery	4.02 ± 0.87	4.76 ± 1.45	**0.003**
3 months after surgery	3.40 ± 0.86	3.20 ± 0.83	0.240
At last follow-up	1.48 ± 0.89	1.62 ± 0.83	0.417
P value	**< 0.01**	**< 0.01**	
Lysholm Rating			
preoperative	46.06 ± 4.59	46.48 ± 4.14	0.632
1 month after surgery	68.14 ± 5.33	61.26 ± 5.30	**0.000**
3 months after surgery	75.14 ± 5.51	73.72 ± 5.71	0.209
At last follow-up	82.90 ± 4.07	81.50 ± 5.59	0.154
P value	**< 0.01**	**< 0.01**	

Table 4 Postoperative imaging data [case (%)] and comparison between the two groups of patients

Norm	Improved group ($n=50$)	Control group ($n=50$)	*P* value
Outbridge Cartilage Degeneration Classification			
I	32 (64)	28(56)	0.414
II	18(36)	22(44)	
III	0 (0.00)	0 (0.00)	
IV	0 (0.00)	0 (0.00)	

the preoperative period, the visual analog scale (VAS) scores of the two groups decreased significantly with time ($P<0.05$), and the Lysholm scores of knee function improved significantly ($P<0.05$). Compared with those in the preoperative period, the VAS scores of both groups decreased significantly over time ($P<0.05$), and the Lysholm scores of knee joint function improved significantly ($P<0.05$).

Comparison of postoperative imaging data

A review of the knee MRI at the 3-month postoperative follow-up revealed good recovery of the meniscus, and no retears occurred in any of the patients; the degree of cartilage degeneration in the patients in the two groups is shown in Table 4, and the difference in the degree of cartilage degeneration between the femoral condyles of the medial compartment and the tibial plateau was not statistically significant ($P>0.05$).

Discussion

Minimally invasive arthroscopic treatment techniques play an important role in the diagnosis and treatment of joint diseases as a common treatment for soft tissue injuries within the knee [7]. However, unlike thoracoscopic and laparoscopic surgeries, the intra-articular space is smaller, the surgical requirements are greater, and the learning curve is larger. As we all know, the established arthroscopic operation channel can easily be misplaced at various levels of tissues due to changes in the joint position, and arthroscopic surgeries need to replace surgical instruments repeatedly, which can easily result in intra-articular instrument breakage, intra-articular normal tissue damage, tissue damage around the arthroscopic entrance, or intra-articular hematoma, etc., if one does not enter and exit the arthroscopic channel in the same way as in the original path. If they do not follow the original path to and from the arthroscopic channel, damage to intra-articular instruments, normal intra-articular tissues, damage to tissues around the arthroscopic portal, intra-articular hematoma, etc., can easily occur. In particular, for beginners who are just in contact with arthroscopic surgery, it is common for them to be lost in the channel, which affects the overall effect of the surgery [8]. In this context, the knee arthroscopy channel modification technique was developed.

Compared with traditional arthroscopic surgery, improved channel technology has obvious advantages in the following aspects. First, the improved channel design can always provide "navigation" for the operation channel, which allows the instruments to enter and exit the joint cavity more smoothly, reduces damage to the surrounding tissues and articular cartilage, and reduces the incidence of postoperative complications; even beginners can start quickly, which greatly reduces the learning curve. The incidence of postoperative complications is reduced; even beginners can start surgery quickly, greatly reducing the learning curve. Second, in terms of operation time and postoperative functional recovery, the improved group also presented certain advantages. The average operation time and postoperative hospitalization time of the improved group were significantly shorter than those of the improved group, which is highly important for both patients and the healthcare system. At the same time, the improved group obtained a more satisfactory score in the early postoperative period, which may be attributed to the finer surgical operation, smaller degree of trauma, and better tissue protection, which is in line with the concept of rapid rehabilitation and provides more benefits to patients [9]. rehabilitation, resulting in better and more efficient medical care for patients.

In addition, minimizing damage to infrapatellar fat pad (IFP) tissue is also a consideration in this arthroscopic access modification. The IFP can be considered a special form of fibroadipose tissue located near the synovial membrane and articular cartilage, which is richly vascularized and innervated [10]. The IFP is rich in adipocytes, adipose stem cells, and fibroblasts and can secrete large amounts of anti-inflammatory factors, which are important for protection of the knee joint. IFP is rich in adipocytes, adipose stem cells and fibroblasts, which can secrete large amounts of anti-inflammatory factors,

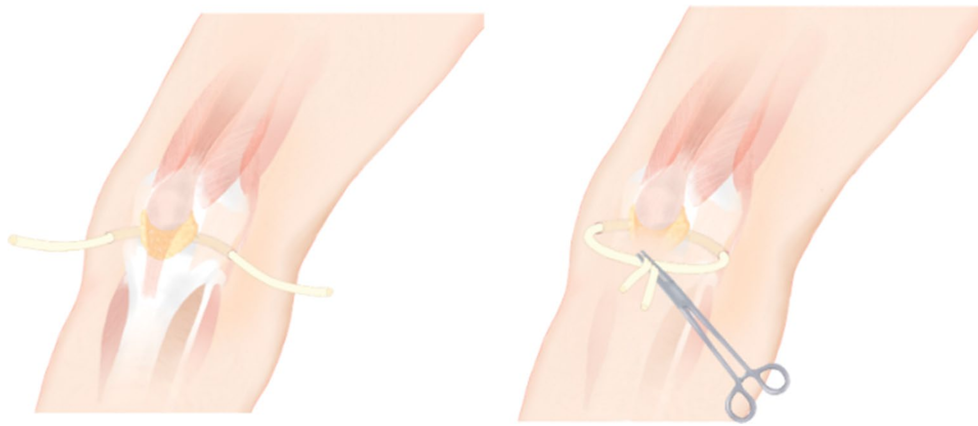

Fig. 2 Schematic of the infrapatellar fat pad "belt"

which play important protective roles in the knee joint. Once the IFP tissue is damaged, the secretion of anti-inflammatory factors decreases, and a patellar tendon contracture or scar is formed, which easily leads to the aggravation of anterior knee pain [11, 12]. In addition, some scholars have reported that the IFP also has biomechanical function, which is closely related to the occurrence of anterior knee pain syndrome, and that resection of the IFP has different degrees of influence on the biomechanics of the patella and the mechanics of knee joint movement [13, 14]. When performing knee arthroscopy, not only does surgical access pass through the IFP tissue area, but the IFP tissue is also often resected to varying degrees intraoperatively to expand the surgical field, which may cause postoperative prepatellar pain and joint dysfunction. Compared with the traditional technique, the rubber tube used in this improved access can act as a "belt" (Fig. 2), thus "tightening" the IFP tissue, reducing intraoperative occlusion, effectively expanding the surgical field, and facilitating visualization of the medial interventricular compartment and the anterior horn of the lateral meniscus, thereby avoiding the need to expose the anterior horn of the medial interventricular compartment and the lateral meniscus. This reduces intraoperative occlusion, effectively expands the surgical field, facilitates the exposure of the medial compartment and the anterior horn of the lateral meniscus, and avoids the need for massive planning of the IFP tissue during the operation.

However, the improved technology also faces some challenges. First, the channel design needs to be further optimized according to the individual differences and special conditions of different patients, such as the choice of rubber tube thickness and the adjustment of the tightness of the restraints, to achieve personalized treatment. Second, the accumulation of long-term follow-up data is crucial for a comprehensive assessment of the long-term effects of this technology. Finally, the training and accumulated experience of doctors are important for the promotion and application of this technology.

Conclusion

In summary, the present knee arthroscopy channel modification technique has significant advantages in shortening the operation time, improving the surgical effect, reducing complications, accelerating patient recovery, etc. Despite these challenges, the technique is expected to play a greater role in the treatment of joint diseases and improve patient prognosis through continuous improvement and optimization.

Abbreviations

IFP Infrapatellar fat pad
VAS Visual analog scale

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Author contributions

S.L. and H.S. were responsible for the investigation, visualization, and writing of the original draft. J.Z. was responsible for the investigation. H.G. and L.Y. were responsible for methodology and data curation. F.T. was responsible for conceptualization, funding acquisition, resources and software, supervision, and writing-review, and editing. All the authors reviewed the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Fujian Provincial Hospital. We performed this study in accordance with the principles outlined in the Declaration of Helsinki. The patients/participants provided written informed consent to participate in the study.

Competing interests

The authors declare no competing interests.

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References

1. Enzo SM, Suhas PD, Luc MF et al. Review of Meniscus anatomy and Biomechanics[J]. Curr Rev Musculoskelet Med. 2022;15(5).
2. Ergali N, Arnat B, Khadisha K et al. Meniscal Repair compared to Meniscectomy for Meniscal Injury: 3-year outcomes from a retrospective cohort Study[J]. Med J Islam Repub Iran. 2023;37(0).
3. Atul KT, Frederico CM, Laercio AR et al. Meniscal ramp lesions: an illustrated review[J]. Insights Imaging. 2021;12(1).
4. Camma D, Søren TS, Per H et al. Early surgery Versus Exercise Therapy and Patient Education for traumatic and nontraumatic meniscal tears in young Adults-An exploratory analysis from the DREAM Trial[J]. J Orthop Sports Phys Ther. 2024;54(5).
5. Dhong WL, Sung JK, Rak JK et al. Clinical and radiological outcomes of Medial Meniscal Allograft Transplantation Combined with Realignment Surgery[J]. Am J Sports Med. 2024;52(9).
6. Jiong L, Yinan C, Minwei H et al. Clinical efficacy of arthroscopy in the treatment of discoid meniscus injury and related risk factors for postoperative pain[J]. Ann Palliat Med. 2020;9(6).
7. Wang W, Yi Z, Ruiying L et al. Efficacy of meniscus suture absorbability on meniscus healing success rate via second-look arthroscopy after meniscal repair: a systematic review and meta-analysis[J]. BMC Musculoskelet Disord. 2023;24(1).
8. Héléna GB, Quentin B, Jad EK et al. Arthroscopic approach in initial training: study of a novice cohort using inverse direct and indirect approaches and its implication in the development of training programs[J]. Orthop Traumatol Surg Res. 2023;109(8).
9. Neculau DC, Avram GM, Simion C et al. Dynamic anterior stabilization with Hill-Sachs Remplissage can be employed in skeletally immature patients-operative. Technique[J] Orthop Surg. 2024;16 (3).
10. Mutsuaki E, Tomofumi O, Hirotake Y et al. Morphological characteristics of the infrapatellar fat pad[J]. Sci Rep. 2022;12(1).
11. Markus N, Alexander O, Olga K et al. Infra-patellar fat pad-derived mesenchymal stem cells maintain their chondrogenic differentiation potential after arthroscopic harvest with blood-product supplementation[J]. Int Orthop. 2023;48(1).
12. Maryam FA, Madeline MS, Lindsey HB et al. Removal of the infrapatellar fat pad and associated synovium benefits female guinea pigs in the Dunkin Hartley model of idiopathic osteoarthritis[J]. Ann Transl Med. 2024;12(3).
13. Taeho K, Jin KK, Hong SL et al. Patella-patellar tendon angle in relation to the medial patellar plica syndrome, chondromalacia patella, and infrapatellar fat pad syndrome[J]. PLoS ONE. 2022;17(3).
14. Chaofan Z, Zeyu Z, Yunzhi L et al. A Novel Infrapatellar Fat Pad Preservation Technique in total knee arthroplasty reduced Postoperative Pain and Wound Complications[J]. Orthop Surg. 2024;16(8).

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