

Study on the Application of Anatomical Structure of Knee Joint to Clinical Arthroscopic Treatment

Wei Huang

Kunming Medical University Haiyuan College, Kunming, Yunnan, 650000, China

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Abstract: objective: to summarize the anatomical characteristics of posterior mediastinum of knee joint and its application in arthroscopic surgery, especially in the establishment of trans-posterior mediastinum access. Methods fifty-two patients with simple posterior mediastinum were selected. All patients underwent arthroscopic reconstruction and were divided into two groups according to different graft materials: autogenous bone-patellar ligament-bone group (group a, 26 cases); autologous semitendinosus tendon group (group b) 26 cases. The posterior mediastinum was observed by arthroscopy, and the microscopic findings and gross anatomical results were compared and analyzed. Results: the blood vessels and nerves in the upper part of the posterior mediastinum were abundant and were close to popliteal artery at the tibial plateau level. The posterior chamber of knee joint is divided into smaller outer chamber and larger inner chamber. Knee arthroscopy should bend your knees 90 degrees when establishing a trans-posterior mediastinum channel. It is safer to pass through from the outside to the inside and from the middle to the lower part of the posterior mediastinum. Conclusion: the anatomical structure of anterior cruciate ligament is complex, and there is no obvious relationship between the curative effect after arthroscopic anterior cruciate ligament reconstruction and the types of graft materials.

1. Introduction

With the development of arthroscopy technology, foreign countries have begun to try to apply small arthroscopy to the observation and adjuvant treatment of posterior mediastinal lesions [1]. However, due to relatively little research in this field, further clinical application is also limited to a large extent. The posterior mediastinum of knee joint plays an important role in ligament injury of knee joint. It cannot heal itself after injury. If it is not repaired in time, it will cause obvious joint instability, secondary meniscus and articular cartilage damage degeneration, leading to knee osteoarthritis, thus seriously affecting knee joint function [2]. Knee arthroscopy can be used to examine synovial lesions, bone and femur bare cartilage lesions, meniscus injuries, and knee cruciate ligament injuries. It is also possible to remove the free body of the knee joint, perform biopsy, meniscectomy and cartilaginous resection under the direct vision of the knee arthroscope [3]. In this study, the general anatomy of the posterior mediastinum of fresh corpses and the comparative study under arthroscopy are used to clarify the morphological characteristics and distribution areas of various structures in the joint observed by posterior mediastinoscopy under normal conditions, so as to lay a foundation for arthroscopic operation and arthroscopic auxiliary diagnosis and treatment.

2. Data and Methods

2.1 General Information

In this study, 52 patients were selected. All patients had different degrees of knee joint trauma history. The average course of disease was (17 ± 13) days. All patients were diagnosed by mri and treated by arthroscopy. According to different transplantation materials, they were divided into two groups: autogenous bone patellar ligament bone group (group a) 26 cases; autogenous double semitendinosus tendon gracilis tendon group (group b) 26 cases.

2.2 Operative Method

All the surgeries were performed with the guiding equipment produced by germany's arthrex company, and the tibial and femoral bone canals were fixed with kurosaka and paramax interface screws of the united states's unvatec company. Arthroscopic examination is routinely performed during the operation to further clarify the disease condition, graft materials are cut, intercondylar fossa is formed, and femoral and tibial tunnels are established after positioning. Inject 1.5~2~3mm normal saline into the posterior mediastinum from here with a 5ml syringe, and then cut the skin transversely with a sharp knife, with a length of about 2 ~ 3 mm. The dorsal digital vein and cutaneous nerve were bluntly separated in the incision by mosquito vascular forceps until reaching the joint capsule. By comparing the stained sections of the upper and lower parts of the posterior mediastinum, it was found that the upper blood vessel was richer than the lower part, and the diameter of the upper blood vessel was thicker. In addition, the upper posterior mediastinal neuro-mechanical receptors are abundant. Connect the irrigation device to the puncture needle of knee joint. After puncture, 100ml of normal saline is injected to fully expand the joint cavity.

2.3 Main Observation Indicators

The skin around the posterior mediastinum was incised and the dorsal nerve, blood vessel and dorsal digital tendinous membrane structure of the posterior mediastinum were observed. The internal structure of the posterior mediastinum was observed under direct vision from the inside of the joint after incision of one joint capsule, and was compared with what was seen under arthroscope.

2.4 Statistical Method

SPSS 16.0 software was used for statistical analysis. Count data were expressed as mean \pm standard deviation ($\bar{x} \pm s$), t test was used, χ^2 test was used for comparison of measurement data, and analysis of variance was performed before and after self-control.

3. Result

The proximal end of the posterior mediastinum is a hemispherical metacarpal bone with wide palmar side and narrow dorsal side, flat distal side and palmar process, the distal end of the joint is a shallow mortar-shaped proximal phalanx base, and the periphery of the joint is covered by a looser joint capsule. From top to bottom, from back to the anterior posterior cruciate ligament tibial plateau stop point, through the tibial plateau plane back to the rear; Behind the plane of the tibial plateau of the posterior cruciate ligament, the popliteal artery is closest to the posterior articular capsule due to the traction of the soleus fibrous arch. The posterior 1/3 of the lateral meniscus is not connected with the joint capsule, and its attachment is blocked by the posterior mediastinal hiatus of PT. A clearly defined "lateral meniscus-posterior mediastinal notch" can be seen on the lateral side of the lateral meniscus. On the volar side of the lateral collateral ligament, there is also a bundle of weaker ligaments that run forward and stop at the palmar plate, called the collateral collateral ligament.

Table 1 Joint Mobility, Muscle Strength Recovery and Joint Test Comparison [$\bar{x} \pm s$, n(%)]

Group	Joint extension restriction is less than 3 degrees	Joint flexion limitation is less than 5 degrees	The difference between the circumference of the thigh and that of the healthy side(cm)	Povit Shift test negative	Lachman test negative
Group A (26)	23(88.46%)	25(96.15%)	1.023 \pm 0.075	23(88.46%)	25(96.15%)
Group B (26)	20(76.92%)	24(92.30%)	1.047 \pm 0.063	22(84.61%)	21(80.77%)

Joint mobility: there was no significant difference between the two groups in the proportion of patients with knee extension limitation of less than 3 degrees and the proportion of patients with flexion limitation of less than 5 degrees compared with the healthy side ($P > 0.05$), which indicated

that there was no difference between the two groups in the joint flexion and extension mobility; therefore, it was better to confirm the anatomic position again when cutting the skin, and stretch and stabilize the surrounding skin. In the subcutaneous tissue, the radial and ulnar nerves can be found in the dorsal branch and dorsal venous network. All patients' quadriceps muscle strength returned to normal. There was no significant difference in the difference in the circumference of the thigh between the two groups between the surgical side and the healthy side ($P > 0.05$); In addition, through the measurement of the distance between the posterior condyle and the posterior capsule of the femur by the arthrography of the knee joint cavity, it is found that the medial distance is about 1 / 3 wider than the lateral distance, so when the posterior mediastinal passage is established, it is safer for the surgical instruments to pass through the posterior mediastinum from the outside to the inside [8]. There was no significant difference between the two groups ($P > 0.05$). See Table 1.

4. Discussion

Through our research on the applied anatomy of the posterior mediastinum, we found that if the current small arthroscopic equipment is reasonably applied, the posterior mediastinum can be observed by arthroscopy. When ACL is normal, it starts from the posterior side of lateral femoral condyle, runs inward, downward and forward, and stops at the anterior lateral side of tibial intercondylar eminence. The average ligament is 39mm long, 11mm wide and 3.8mm thick, including anteromedial bundle and posterolateral bundle. The former is relatively slender, while the latter is relatively short and thick, covering any part of the knee joint. Of the 22 knee joints, 8 knee joint posterior mediastinum ends at the posterior joint capsule around the outer edge of the posterior cruciate ligament, 14 knee joint posterior mediastinum branches at the front of the posterior cruciate ligament and wraps around the posterior cruciate ligament to end at the posterior joint capsule. MRI examination of normal ACL shows that each fiber bundle has a clear direction, showing a straight and continuous thin band shadow obliquely running backward and upward [4]. However, there are no reports of finger necrosis or nerve injury caused by finger cuff traction. However, if the finger cuff is too tight and the ischemia time is too long, it will inevitably lead to swelling due to ischemia-reperfusion injury of the affected finger, which is not conducive to postoperative recovery and functional exercise. The posterior mediastinal reconstruction school thinks that the posterior mediastinum plays a more important role in controlling the external rotation, so it emphasizes the reconstruction of the static structure of the popliteal complex, i.e. the posterior mediastinum, to achieve the purpose of controlling the external rotation [5]. The popliteal ligament reconstruction school believes that the popliteal ligament has good isotropy and can play a role in most angles of knee flexion and extension activities [6]. If the affected finger swells due to trauma before surgery, the traction force should be limited to less than 5lb during surgery.

Patients with ACL injury are diagnosed by MRI images, and their direct signs play an important role, including abnormal ACL course, loss of continuity, ligament thickening, signal enhancement, loss, etc. Indirect signs mainly include posterior cruciate ligament index, posterior cruciate ligament angle, meniscus posterior shift sign, tibia anterior shift, contusion to kiss bone, etc. In addition, the center of the tibial insertion point of the anterior external bundle of posterior cruciate ligament is about 0.9 mm from the medial side of the posterior mediastinum, about 3.25 mm from the upper edge surface of the posterior cartilage of the lateral tibial plateau, about 4.35 mm from the lateral side of the posterior mediastinum, and about 6.91 mm from the upper surface of the cartilage edge of the lateral tibial plateau. Shang Fuqing reported that a lateral meniscus of a patient with anterior cruciate ligament reconstruction was sutured and fixed with Fast-Fix system, and the suture knot was accidentally sutured to PT [7]. Although the author did not mention whether the patient's postoperative function is limited, theoretically the integrity of PLC will be damaged after PT is sutured and fixed. Its function of limiting tibial rotation and genu varum will be weakened, and adhesion and even fracture may occur. Therefore, the reconstruction of popliteal ligament is advocated. Anatomical reconstruction school believes that the three structures of reconstruction PLC work together as a whole and cannot ignore any one of them. It advocates the simultaneous reconstruction of three ligament structures [8]. Therefore, the operator should be as skilled as

possible in the operation of arthroscope and design the puncture points of different instruments in advance according to the specific conditions of patients before operation, so as to ensure accurate puncture during operation and reduce repeated operations.

Because anterior cruciate ligament rupture cannot be repaired by itself, anterior cruciate ligament reconstruction is required clinically. At present, the reconstruction materials of autologous anterior cruciate ligament used clinically include the medial 1/3 patellar ligament, semitendinosus and gracilis tendons, each with its own advantages and disadvantages. Zhang Wei et al measured the distance between the tibial insertion point of the posterior cruciate ligament and the popliteal artery on MRI after bending the knee joint of the corpse at different angles. It was found that the distance between the tibial insertion point of the posterior cruciate ligament and the popliteal artery was 7.6 mm when bending extremely, and 9.9 mm [9] when bending 100 [9]. It has been reported in the literature to be used for arthritis evaluation, synovial resection, flushing of bacterial arthritis, removal of foreign bodies, reconstruction of the insertion point of lateral collateral ligament, reduction and fixation of intra-articular fractures, etc [10]. Although PT's individual injuries are rare, the knee joint PLC injuries, especially the cruciate ligament injuries (bending knees to rotate the upper tibia, PT tension), are often accompanied by PT's injuries. The anatomic location of the posterior mediastinum is deep and adjacent to the popliteal vessels. It is very difficult to expose the tendon-muscle-abdominal junction during incision and reconstruction. Sometimes, the operator's finger is only used to touch the upper tibiofibular joint to locate and protect the vessels. Arthroscopic observation of this junction point is very clear and can be directly located. Its advantages are high initial tension, firm fixation, early rehabilitation training and fast recovery. However, there are many complications in donor site, such as patellofemoral joint pain, weakening of quadriceps femoris muscle strength, patellar fracture, patellar tendinitis, etc. Through this test, it can be found that the above structure can be clearly revealed only by removing a small amount of local synovial membrane reflexes and posterior joint capsules on the femoral side.

The results of this study are similar to those reported in most literatures. The results of this article show that there is no obvious correlation between the clinical curative effect and the types of autograft materials. Zhang Baojun found that the average distance from the center of the tibial insertion point of the posterior cruciate ligament to the posterior joint capsule was 10.3mm, and the distance from the posterior edge of the insertion point to the posterior joint capsule was about 1.7mm [11]. Chen Jianghu et al. found in the cadaver study that PMF still had the third bundle, the posterior inferior bundle. 90.5% (19 sides) of PMF in 26 specimens studied in this group were divided into anterior inferior, posterior superior and posterior inferior bundles [12]. 9.5% (2 sides) were divided into front lower beam and rear lower beam. Therefore, protection is needed when drilling tibial tunnel to prevent Kirschner wire and drill bit from excessively drilling into damaged blood vessels. In addition, potential surgical complications include increased pressure in the calf fascial compartment caused by extravasation of arthroscopic perfusion fluid and subcutaneous edema at the femoral tunnel side. The knee joint must be completely straightened before operation. Pay attention to proper shaping of intercondylar fossa during operation. Tibial bone canal is close to the stop of posterior cruciate ligament. There is no collision between the graft and the intercondylar fossa and the pretension should be moderate. After the operation, the knee joint was completely straightened, immediately loaded, and the brace was fixed in the fully straightened position for 10-12 weeks.

In this study, knee joint function scoring system was used for evaluation and comparison. The results showed that there was no significant difference between the two groups. Modern research shows that after anterior cruciate ligament rupture and reconstruction, patient satisfaction and knee joint function score are closely related to the proprioception of the ligament. The improvement of the operation conditions includes filling the joint capsule with perfusion pump system, enlarging the distance between the instrument and popliteal blood vessel, and minimizing the scope of posterior mediastinum removal under the condition of realizing the operation purpose. The author thinks that the main reason of knee joint relaxation may be the incorrect position of bone tunnel, the reconstructed ligament is not anatomical position, and the femoral drilling position is too forward.

However, due to the limited literature in this area, the practical application of posterior mediastinoscopy needs careful design and research.

5. Conclusion

Arthroscopic surgery designed by this research aims at reconstructing the static stability function of the posterior mediastinum and achieving the purpose of controlling the instability of knee joint external rotation. Therefore, simple external rotation instability or PLC injury accompanied by slight external direct instability should be selected in future clinical surgery. In this study, it was found that the reconstructed graft maintained a stable relative tension during multiple flexion activities within 120 degrees, and a relaxation phenomenon occurred when it was greater than 120 degrees. This strongly suggests that during the rehabilitation period after clinical reconstruction of PLC, the author should not perform high-angle knee flexion exercise prematurely before the graft is fully healed and mature. The puncture site is preferably located slightly lower than the middle of the posterior mediastinum close to the posterior border of the posterior cruciate ligament, which can not only reduce the damage to the branches of the medial genicular artery and proprioceptive nerve in the upper posterior mediastinum, but also avoid the popliteal artery immediately behind the tibial insertion point of the posterior cruciate ligament. It is worth noting that although the establishment of trans-posterior mediastinal channel has greatly increased the application of arthroscopic knee surgery, it still has its limitations and needs flexible combination with other surgical approaches [5] in order to achieve the surgical purpose.

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