Effect of posteromedial corner injury on stability and second-look arthroscopic findings after posterior cruciate ligament reconstruction using allograft

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ABSTRACT

Purpose: The purpose of our study was to assess effect of posteromedial corner (PMC) injury on clinical outcomes and second-look arthroscopic findings after posterior cruciate ligament (PCL) reconstruction using Achilles tendon allograft.

Methods: A total of 51 patients who underwent arthroscopic PCL reconstruction for PCL rupture and second-look arthroscopy were retrospectively enrolled in our study from 2009 to 2019. The subjects were divided into two groups: PMC intact group included 31 patients; and PMC injured group included 18 patients. At least 1 years follow-up, clinical outcomes and arthroscopic findings including synovial coverage, tension were evaluated.

Results: Arthroscopic findings including the synovial coverages, tension showed significantly better at PMC intact group. ($p < 0.005$) but, no statistic difference was seen in clinical outcomes including KT-2000 value, last Lysholm score, posterior drawer test.

Conclusion: For PCL ruptures with PMC injuries, treatment for PMC should be considered due to graft status.

Level of study: IV.

1. Introduction

Recently, Injury to Posteromedial corner (PMC) of the knee has been reported in several studies. PMC injuries rarely occur alone. They are more related to clinically dominant injuries and can mask PMC injuries. Common injuries include anterior cruciate ligament (ACL) injuries, including O'Donoghue triad of ACLs, medial collateral ligament (MCL) and medial meniscal damage; Posterior cruciate ligament (PCL) injury; Combined ACL and PCL damage; And MCL injury. Concurrent PCL and PMC injury patients who performed PCL reconstruction without treating the posteromedial knee injury may experience failed PCL reconstruction Unrecognized and unaddressed injury of the PMC is one of the causes of PCL graft failures.¹

Arthroscopic PCL reconstruction is preferred procedure with reduced meniscal injuries and long-term outcomes of improved function as compared with the unreconstructed knee.² However, in case of PCL reconstructed knee, there is no reports correlation between PMC injury and the result of 2nd look arthroscopic findings. The purpose of present study was to assess the influence of PMC injuries on clinical outcomes and second-look arthroscopic findings after PCL reconstruction. The hypothesis of this study was that PMC injuries are related with graft

tension after PCL reconstruction while less correlation for clinical outcome at least 1-year follow-up.

2. Materials and methods

This study received approval from our institutional research ethics committee, and informed consent was obtained (DKUH). From January 1, 2009 to December 31, 2019, a total of 91 consecutive patients underwent arthroscopic PCL reconstruction using an allograft, by a single surgeon (H.G.P.). The indications for PCL reconstruction are symptomatic isolated acute grade-3 PCL ruptures, or acute grade-3 PCL ruptures with repairable meniscal root tears or body. In case of chronic PCL tears, indications include comparative PCL stress radiographic laxity of 8 mm in a symptomatic patient and functional limitations due to the PCL tear. The inclusion criteria were patients who underwent a second-look arthroscopic surgery after primary single-bundle PCL reconstruction with an achilles tendon allograft. imaging (MRI) performed at our institution. Patients who had a history of multi-ligament injuries (ACL, MCL, Lateral collateral ligament), previous surgery on the injured knee, or lateral meniscus injuries were excluded.

Among the patients who underwent PCL reconstruction, 17 patient

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Fig. 1. Patient flow throughout the study.

who were lost to follow-up and 11 patients who underwent an MRI examination at other hospitals were excluded. 3 patients accompanied with ACL injuries were added to exclusion. Of the 63 patients, 49 patients underwent a second-look arthroscopic operation. The patient's flow is illustrated in Fig. 1. The final study population consisted of patients with intact PMC and damaged PMC.

For PCL reconstructions, The surgical technique consisted of routine examinations under anesthesia and arthroscopy using standard anteromedial, anterolateral portals to confirm diagnosis and other accompanying injuries. We added a posteromedial portal for using the original posteromedial portal guide system to remove torn PCL and define the tibial PCL footprint. The tibial tunnel is made through the aiming guide pin located on the tibial PCL footprint during posterior tibial view using a 30° arthroscopic through the posterior tibia using a PCL drilling guide, and the drill sleeve is located on the anteromedial side of the proximal tibia. Then the tibial bone tunnel was created from the PCL footprint. Only one bone tunnel was created in the tibia. The tibial bone tunnel was drilled at least 0.5 mm above the graft diameter of the tibial region. The edge of the tunnel was chamfered with rasps and a shaver. For the single-bundle technique, The femur tunnel was created in the intercondylar space 5 mm posterior to the articular margin, 5 mm distal away from the Blumensaat line, which is closed in the anterolateral bundle insertion area. We used allo achilles tendons as grafts to reconstruct the PCL in all cases. An aseptically harvested, fresh-frozen, irradiated free tendon Achilles allografts (Tissue Banks International, San Rafael, CA, USA) were prepared.

The postoperative rehabilitation protocol was the same in both groups. Joint flexion and expansion began one day after surgery. The patient was able to perform partial weight bearing for 2 weeks while

wearing the PCL brace. After 2 weeks, full weight bearings were allowed. Jogging was allowed 3 months after surgery. The state of exercise was allowed between 6 and 9 months after surgery, depending on the state of recovery.

Our MRI protocol includes coronary T1 weighted sequences; Sagittal, axial and coronal T2 weighted sequences with fat saturation; And sagittal proton density-weighted sequence. Knee position recommended when fully extended. However, if the patient was unable to fully extend his knee due to swelling or pain, a slightly bent posture was allowed. Examination results were assessed by two orthopedic surgeons (H.G.P. and H.J.H.). If they disagree, they follow the opinions of the more experienced orthopedic surgeon H.G.P. The evaluation by the orthopedic fellow was used to assess the interobserver correlation. PMC injuries were considered when irregular contour associated with periligamentous edema or discontinuity was observed. We classified the PMC as normal or as having a lesion. Additionally, the PMC injuries were divided according to five components (the superficial MCL, the deep MCL, POL, posterior horn of medial meniscus, oblique popliteal ligament.) Each portion was marked as intact, or injured.

All the patients had a second-look arthroscopic examination and hardware removal at least one years after PCL reconstruction. Initially, the PCL graft status was evaluated by a single surgeon (H.G.P.). We bring the ACL graft classification system based on synovial coverage, tension of the grafts, described by Yoo et al. to evaluate PCL graft status during second-look arthroscopy.³ Synovial coverage over the grafts was classified into the following 3 categories: good, synovial coverage more than 80% around graft; fair, more than 50%; poor, less than 50% (Fig. 2). The tension were evaluated by probing maximal displacement of tendon from 20 to 90 of knee flexion. Then, the tension of the grafts

Fig. 2. Arthroscopic classification of graft synovial coverage. (a) Good synovialization of the grafted tendon (> 80%); (b) fair synovialization of the grafted tendon (> 50%); (c) poor synovialization of the grafted tendon (no coverage; < 50%).

Fig. 3. Arthroscopic classification of graft tension. (a) taut tension of the grafted tendon (probing, < 2 mm); (b) mildly lax tension of the grafted tendon (probing, < 5 mm); (c) lax tension of the grafted tendon (probing, > 5 mm).

was classified as taut(< 2 mm), mildly lax(< 5 mm), and lax(> 5 mm). (Fig. 3).

The hardware was removed after the PCL graft evaluation. After the surgery, compression bandages were applied without splints and allowed to withstand weight. Two weeks after the operation, running and returning to the sport were allowed.

Each knee was clinically evaluated just before the initial and second-look arthroscopic surgery(except anteromedial drawer test, performed at second-look arthroscopy only). A KT-2000 arthrometer test at 30 lb. was performed to measure the side-to-side difference in Posterior translation with the knee positioned in 20° of flexion. In anteromedial drawer test and posterior drawer test performed by a single surgeon (H.G.P.), the knee was graded as normal, close to normal, and abnormal. An anteromedial drawer test is performed with the knee flexed 80–90° and the foot externally rotated 10–15°. The examiner then applies anterior and external rotational forces to the foot and tibia and evaluates the amount of medial tibial rotation. The examiner visually evaluates the location of the tibial rotation to differentiate between posterolateral and anteromedial tibial rotation, along with an increase in tibial external rotation through increased movement of the tibial tubercle. The Lysholm knee score was used for general evaluation of the knee.

Kolmogorov-Smirnov tests were performed to determine the normal distribution of continuous data. Continuous variables were analyzed using an independent *t*-test, and non-continuous variables were analyzed using a Pearson chi-square test. All statistical analyses were performed using Statistical Package for Social Sciences version 25.0 (SPSS, Inc., IBM Co., IL, USA). Statistical significance was considered at *p*-value < 0.05 for all analyzes.

3. Results

With respect to the MRI evaluation of PMC injuries, interobserver reliability (H.G.P. and H.J.H.) was high, with “almost perfect agreement” (*k* = 0.81). 18 of 49 patients were accompanied by PMC damage. Comparison of demographic characteristics, follow-up period to second-look arthroscopy between two groups is shown in Table 1. Both groups had similar statistical results. Of 18 PMC injured patients, injured anatomical location was shown in Table 2. 6 patients had semimembranosus tendon injury, 2 had oblique popliteal ligament injury, and 3, 4, 5 for posterior oblique ligament, posteromedial capsule, posterior horn of medial meniscus injury respectively.

As summarized in Table 3, 22 patients of PMC intact group showed good synovial coverage, 9 and 0 patients respectively had fair and poor synovial coverage. 5 PMC injured patient attained good synovial coverage, 12 with fair and 1 with poor synovial coverage was shown. 25 patients in the PMC intact group had taut tensions, and 5 and 1 patient had mild and laxative tensions, respectively. 3 PMC injured patients were taut, 11 had mildly lax, and 4 had lax tension. there is significant difference intergroup was found with respect to synovial coverage

Table 1

Demographic data.

	PMC intact group (n = 31)	PMC injured group (n = 18)	p-value
Age	33.3 ± 11.5	35.3 ± 12.6	0.568
Sex (Male:Female)	27 : 4	14 : 4	0.443
Weight (kg)	70.9 ± 11.3	67.6 ± 13.6	0.369
Height (cm)	170.2 ± 9.1	169.0 ± 9.2	0.678
Body mass index	24.5 ± 3.8	23.4 ± 2.6	0.288
Mean follow up to 2nd look arthroscopy (months)	25.5 ± 6.5	22.8 ± 6.3	0.268

* PMC = Posteromedial corner.

Table 2

Anatomical location of posteromedial injury group.

	PMC injury group (n = 18)
Semimembranosus tendon	6
Oblique popliteal ligament	2
Posterior oblique ligament	3
Posteromedial capsule	4
Posterior horn of medial meniscus	5

Table 3

Second-look arthroscopic evaluation.

	PMC intact group (n = 31)	PMC injured group (n = 18)	p-value
Tension			
Taut	25	3	< 0.001
Mildly lax	5	11	
Lax	1	4	
Synovial coverage			
Good	22	5	0.005
fair	9	12	
Poor	0	1	

Second-look arthroscopic findings comparison as posteromedial corner(PMC) injury.

(*p* = 0.005) and graft tension (*p* < 0.001).

The mean KT-2000 value was similar at both pre-operation(5.2 in PMC intact vs 5.1 in PMC injured), Last follow-up(1.9 in PMC intact vs 2.0 in PMC injured). The mean last Lysholm score was respectively 94.1 and 93.6 for PMC intact, PMC injured group. Furthermore, Posterior drawer test showed better results(18 normal in PMC injured group) than pre-operation(0 normal). And Anteromedial drawer test just before second-look arthroscopic exam showed 24 normal in PMC intact group, 9 normal in PMC injured group and 7 closed to normal in PMC intact group, 9 closed to normal in PMC injured group (*p* = 0.063). There was no statistically significant difference in mean KT-2000 value

Table 4
Clinical outcomes comparison as posteromedial corner(PMC) injury.

	PMC intact Group (n = 31)	PMC injured group (n = 18)	p-value
Mean last Lysholm score	94.1 ± 7.3	93.6 ± 7.9	0.818
Mean KT 2000			
Pre-operation	5.2 ± 0.98	5.1 ± 1.1	0.567
Last follow up	1.9 ± 0.73	2.0 ± 0.87	0.837
Posterior drawer test			
Pre-operation			0.546
Normal	0	0	
Close to normal	1	2	
Abnormal	30	16	
Last follow up			0.372
Normal	18	13	
Close to normal	13	5	
Abnormal	0	0	
Anteromedial drawer test			
Last follow up			0.063
Normal	24	9	
Close to normal	7	9	
Abnormal	0	0	

(p = 0.837), mean last Lysholm score(p = 0.818), Posterior drawer test (p = 0.372) described in Table 4.

4. Discussion

Some clinical studies have reported undesirable clinical outcomes after reconstruction of an isolated PCL at midterm follow-up in many patients.⁴ One explanation for the high incidence of poor clinical outcomes in treating patients injured with PCL may be the high incidence of unrecognized or inappropriate treated accompanying injuries. Studies have shown that a high percentage of PCL injuries damage other structures in the knee.^{5,6} Hammoud et al. showed that untreated PMC injuries may be considered a cause of PCL reconstruction failure.⁷

PMC is composed of five major components: the superficial medial collateral ligament (MCL), the deep MCL, the posterior oblique ligament (POL), posterior horn of medial meniscus, oblique popliteal ligament. Posterior oblique ligaments is a secondary stabilizer, especially for tibial posterior tibial translation. This stabilizing effect increases with internal tibial rotation. POL support for posterior tibial translation is particularly important in PCL deficient knees^{8–12} Peterson et al. concluded that the posterior oblique ligament and posteromedial capsule take an important role in the prevention of additional posterior tibial translation at the knee due to posterior cruciate ligament injury.¹³ Therefore, failure to resolve a PMC injury can lead to increased stress on PCL reconstructed knee ligaments, which eventually lead to their failure.¹⁴

With similar idea, Tibor et al. mentioned surgical treatment of PMC would be considered when there are PCL injuries.⁸ Weimann et al. also concluded that posteromedial instability should be treated in the patient with combined injuries of the PCL and the posteromedial structures.¹⁵ Treatment of posteromedial instability is still controversial. Surgical procedures usually consisted of repair or reattachment of the capsule structure containing the posterior central component.¹⁶ However, Stannard et al. mentioned higher failure rate with repair (20%) vs reconstruction (4%).¹⁷ so their preference is to use 2 semitendinosus allografts for reconstruction¹⁸ Bauer et al. reported technique of reconstruction reestablishes the biomechanically important triangle of the MCL, POL, and semitendinosus sling to recreate the stability provided by the PMC.¹⁹ In this study, there is no patient whom had been performed PMC treatment. Additional study results can be performed on the results of arthroscopy in patients treated with PMC.

We assumed that PMC injuries are related with poor graft status after PCL reconstruction while less correlation for clinical outcome and

we assured that in PMC intact group, synovial coverage, graft tension was better than PMC injured group. But the anteromedial drawer test showed susceptible results with p-value 0.063, it means that there is possibility that PCL reconstructed knee with PMC injury would show poorer anteromedial drawer test results if similar studies with more cases performed. In brief, arthroscopic graft tension was significantly poor in the PMC injured group at the second arthroscopic examination, although clinical stability did not show any significant difference. These results showed that clinical stability did not fully reflect the graft status. This is because clinical stability is the result of a combination of various conditions.

This study has several limitations. First, this study is retrospective study to compare the clinical outcome, second-look arthroscopic findings after PCL reconstruction using Achilles allograft. Second, Only 18 patients were included in the PMC injured group. A small number of cases may have resulted in a type 2 error caused by low statistical power, although a retrospective power analysis determined that 16 patients were needed in each group to obtain a 10% difference between the groups, with a level of 0.05 and a value of 0.80. Third, we did not consider false negatives of PMC injuries findings in MRI. If PMC injury was not seen on MRI, patients were assigned to the Intact group. Forth, the index of second-look arthroscopic findings might be subjective although several studies have used for the evaluation of graft in ACL reconstruction. Fifth, we didn't examine about microscopic properties including synovial thickness with histological methods. Sixths, there was no concerning and examination for proprioception. Evaluation of the proprioception correlated with synovialization would be necessary in addition. Finally, the correlation between arthroscopic PCL graft status and clinical outcome was not analyzed, also it's hard to find proceeding studies.

Nevertheless, as far as we know, it is difficult to find a similar study to evaluate the impact of PMC injury on second look arthroscopic findings after PCL reconstruction. This study has a meaning that evaluate graft status with second look arthroscopic exam.

5. Conclusion

We concluded that PMC injury was significantly correlated with graft tension after at least one year of follow-up after PLC reconstruction, although clinical outcomes were statistically similar regardless of whether PMC was damaged. Considering graft status, Surgical treatment for PMC injuries would be considered when PCL reconstruction performed.

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CRediT authorship contribution statement

Hee-Gon Park: Supervision. **Hee-Jeong Ham:** Data curation, Formal analysis.

Declaration of competing interest

The authors declare that they have no conflict of interest.

This study was granted exemption by our Institutional Review Board.

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