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Iatrogenic Injury to the Posterolateral Knee during Anterior Cruciate Ligament Reconstruction with Anteromedial Portal Technique

Sholahuddin Rhatomy[1,2]*, Fajar Mahda[3], Riky Setyawan[3], Thomas Edison Prasetyo[3], Nicolaas C. Budhiparama[4]

[1]Department of Orthopaedics and Traumatology, Dr. Soeradji Tirtonegoro General Hospital, Klaten, Indonesia; [2]Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia; [3]Soeradji Tirtonegoro Sport Center and Research Unit, Dr. Soeradji Tirtonegoro General Hospital, Klaten, Indonesia; [4]Nicolaas Institute of Constructive Orthopaedics Research and Education Foundation for Arthroplasty and Sports Medicine, Medistra Hospital, Jakarta, Indonesia

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***Correspondence:** Sholahuddin Rhatomy, Department of Orthopaedics and Traumatology, Dr. Soeradji Tirtonegoro General Hospital, Klaten, Indonesia; Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia. Tel: +62272-321102, Fax: +62272-321104, E-mail: doktergustomrhatomy@yahoo.co
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Abstract

BACKGROUND: Femoral tunnel reaming through anteromedial portal, also known as transportal technique, allows for anatomic femoral tunnel placement in restoring anterior cruciate ligament (ACL) kinematics. This procedure may cause iatrogenic injury to the posterolateral structures of the knee.

PURPOSE: This study aims to assess the risk of posterolateral structure injury in ACL reconstruction using transportal technique.

METHODS: ACL reconstruction using transportal technique was performed in 20 patients. Clinical and radiological examination was performed preoperatively and 1 month postoperatively. Clinical examination included any pain or paresthesia on posterolateral area of the knee, varus alignment of the knee, abnormal gait, and specific tests for posterolateral stability. Radiological evaluation was plain radiography and stress radiography for posterolateral stability, and magnetic resonance imaging (MRI) for assessing structural damage.

RESULTS: Post-operative evaluation showed pain in posterolateral area in five patients, numbness on posterolateral knee in one patient, both pain and numbness in two patients and lateral gastrocnemius muscle injury on MRI in six patients. We did not find varus knee alignment and abnormal gait. Specific tests were negative in post-operative evaluation. Post-operative radiographic imaging did not show the sign of lateral widening.

CONCLUSION: Femoral tunnel drilling using transportal technique in ACL reconstruction is safe even it might risk to damage lateral gastrocnemius muscle, according to clinical and MRI findings.

Introduction

The main function of the anterior cruciate ligament (ACL) is resisting anterior tibial translation and maintaining rotational stability [1], [2]. The importance of ACL in rotational stability of the knee is to resist tibial rotation in internal direction and valgus torsion. Technique for ACL reconstruction has changed according to these new findings [3]. Recent anatomical and biomechanical studies have suggested that improvement of graft placement (e.g., lowering the femoral tunnel from 11 to 10 o'clock position) provided better control in rotational instability [4], [5].

Two common techniques for creating femoral tunnel are transtibial technique and anteromedial portal (transportal) technique. In transtibial technique, femoral tunnel is approached through the tibial tunnel, whereas in transportal technique, femoral tunnel is made using an additional arthroscopy portal in anteromedial area [5]. Anatomic femoral tunnel placement with transtibial technique is difficult to perform. The risks might be avoided with an additional small incision on anteromedial area as an entry point for drills. This transportal technique allows more anatomic placement of femoral tunnel [4], [5].

Injury to posterolateral structures may increase knee instability and disturb knee kinematics. There were few studies regarding an iatrogenic injury affect to the patients and to the knee stability, especially with the developed transportal technique. This study aims to investigate soft-tissue injuries clinically and radiologically in posterolateral knee during ACL reconstruction using transportal technique.

Methods

Study design

This study was a cohort prospective study that was investigating soft-tissue injuries in posterolateral

area of knee when performing ACL reconstruction surgery with transportal technique. All included patients examined clinically and radiologically at 1 month after surgery. The study was conducted in Soeradji Tirtonegoro General Hospital Klaten, Indonesia. This study was approved by Medical Ethics Committee with IRB number KE/FK/0248/EC/2019. Between November 2018 and January 2019, patients with chronic total ACL rupture were recruited consecutively in the outpatient clinic in Soeradji Tirtonegoro General Hospital Klaten, Indonesia by one orthopedic surgeon (S.R.). After assessing subjects eligibility, they were then included in this study. Eligibility criteria are shown in Table 1.

Assessing ACL injury

One orthopedic surgeon (S.R.) performed history taking and clinical evaluation to all patients with chief complaint of chronic knee instability. History of trauma to the knee, onset of the complaints, knee pain, and feeling of joint locking were taken from the patients. Pre-operative pain, paresthesia, or numbness in posterolateral area of the knee were also noted. Special test of the knee included anterior drawer test, posterior drawer test, McMurray test, dial test, external rotation recurvatum test, posterolateral drawer test, posterolateral external rotation test, revers pivot shift test, and varus stress test. These specific tests were used to assess injury to multiligamentous structures of the knee [6].

Table 1: Eligibility criteria

Inclusion criteria	Exclusion criteria
Patients with ACL rupture	
1. Chronic total ACL rupture (>1 month)	1. Presence of soft-tissue injury other than ACL
2. In unilateral knee	2. Presence of any fractures including avulsion fracture
3. Age 18–50 years	3. Bilateral ACL injury
4. Confirmed by clinical examination, MRI, and knee arthroscopy	4. Previous invasive procedures to knee joint

ACL: Anterior cruciate ligament, MRI: Magnetic resonance imaging.

If ACL injury was suspected, standing knee X-ray, knee stressed radiography, and knee magnetic resonance imaging (MRI) were obtained. X-ray examination was done in standing position with anteroposterior and lateral view of the knee. X-ray was used to evaluate for fracture or bony avulsion, malalignment of the knee joint mechanical axis. Stressed test radiography was done to check the medial or lateral knee stability. MRI was used to locate damage of ligament, tendon, meniscus, and cartilage. Knee arthroscopy was used as the gold standard of diagnosing injury of knee intra-articular structures. ACL reconstruction was performed following a confirmed ACL rupture.

ACL Reconstruction

Patients that were fulfilled the inclusion criteria will be treated with ACL reconstruction. After confirming the ACL rupture, then the graft was harvested from the ipsilateral peroneus longus tendon. First, the skin was incised approximately 2.5 cm above and 1 cm behind lateral malleolus. The tendon of peroneus longus and peroneus brevis was identified. An end-to-side suture was made from the distal area of peroneus longus tendon to the peroneus brevis tendon. Tendon stripper was used to harvest the peroneus longus tendon around 4 cm below the head of fibula.

Further debridement was carried out inside the knee joint to improve visualization. A 2 mm guide wire was inserted to the femoral footprint using transportal technique. K-wire was inserted through posterolateral side of the knee with the knee in full flexion position. Initial reaming was performed using a 5-mm drill through outer side of the femoral cortex (Figure 1). Second reaming was performed according to the graft diameter. For tibial tunnel placement, guiding wire was inserted at the center of ACL tibial footprint. By low-speed drilling technique, the tibial tunnel was created with suitable size in accordance to the graft diameter.

Figure 1: Initial reaming through outer side of femoral cortex

The prepared graft was passed through the canal from the tibia to the femur, and fixated to the femur using an adjustable loop suspensory device (GraftMax®, Conmed©, USA). Fixation to the tibia was done using a bioabsorbable screw (Bioscrew®, Conmed©, USA) with the knee which was flexed 30°. Stability of the joint after fixation was assessed by anterior drawer test and was compared to before fixation.

Patients were hospitalized for 1 day. Before discharge, they were referred to rehabilitation department to begin the post-operative rehabilitation program. All patients were prescribed 3 weeks partial weight bearing, followed by full weight bearing. Gradual

range of motion training for knee flexion and extension was also initiated immediately.

Follow-up

After 1 month post-reconstruction, patient was scheduled for monitoring and evaluation. Assessment was performed by the same orthopedic surgeon (S.R.). Patients were evaluated about their pain or numbness around the posterolateral of the knee.

We performed some knee physical examination. Patients were asked to walk to assess their gait. Any difference of the gait phases than normal, we recorded it as a positive case. Then, we evaluated varus and valgus test, dial test, external rotation recurvatum test, posterolateral drawer test, posterolateral external rotation test, and revers pivot shift test.

The objective evaluation included lateral widening in knee X-rays (with and without stressed) and presence of structural damage seen in knee MRI. On MRI, we evaluated lateral structures such as gastrocnemius, biceps femoris, popliteus, plantaris, and lateral collateral ligament.

Results

Between November 2018 and January 2019, there were 47 patients who seek medical care for the first time at outpatient clinic that clinically diagnosed with ACL injury based on their history and physical examination. Twenty-seven patients were excluded from the study, as shown in Figure 2.

The baseline characteristics of the patients included in this study are shown in Table 2. There were 12 female and 8 male subjects. Their age ranged from

Table 2: Baseline Characteristics

Characteristics	Mean (SD)	n (%)
Age	25.2±4.7	
Sex		
Female		12 (60)
Male		8 (40)
BMI	22.8±3.6	
Cause of ACL rupture		
Sports related		18 (90)
Accident		2 (10)

BMI: Body mass index, ACL: Anterior cruciate ligament.

18 to 50 years with a mean age of 25.2 ±4.7 years. Cause of the injury was 18 (90%) in sports related or 2 (10%) in accidental trauma. Mean body mass index was 22.8 ± 3.6.

The follow-up details are shown in Table 3. Two patients complained of both pain and numbness in the posterolateral knee, five patients reported pain only and one patient complained numbness only. There was no varus abnormality of the knee while standing and no

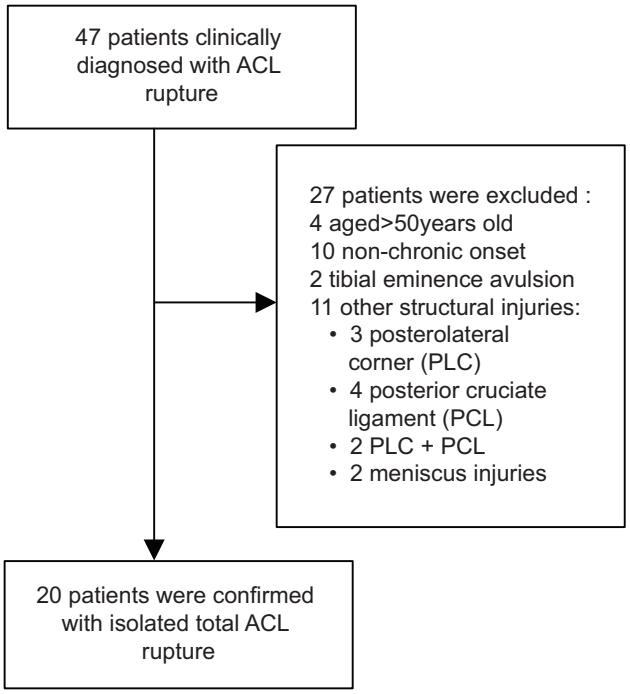

Figure 2: Study flow chart. ACL: Anterior cruciate ligament; MRI: Magnetic resonance imaging

abnormal gait seen at walking. Dial test, external rotation recurvatum test, posterolateral draw test, posterolateral external rotation test, reverse shift pivot test, and varus stress test of all patients were all negative.

Table 3: Follow-up 1 month after ACL reconstruction

Evaluation	Number of positive cases, n (%)
Patient's subjective	
Pain on posterolateral side	5 (25)
Numbness on posterolateral side	1 (5)
Both pain and numbness on posterolateral side	2 (10)
Physical examination	
Varus knee on standing	0
Gait abnormality	0
Dial test	0
External rotation recurvatum test	0
Posterolateral drawer test	0
Revers pivot shift test	0
Varus stress test	0
Plain X-ray	
Abnormal result	0
Stressed X-ray	
Abnormal result	0
MRI	
Injury to lateral gastrocnemius	6 (30)
Injury to biceps femoris	0
Injury to popliteus	0
Injury to plantaris	0
Injury to other structures (LCL, etc)	0

ACL: Anterior cruciate ligament, MRI: Magnetic resonance imaging, LCL: Lateral collateral ligament.

The MRI revealed that lateral gastrocnemius tendon was torn (2-5 mm) at the origin of the muscle in six patients. All these patients had pain or numbness. Plain and stressed X-ray radiography did not show lateral widening.

Discussion

Our primary finding was that some patients experienced pain or numbness (25% and 5%, respectively) or both pain and numbness in 10%

on the posterolateral area of the knee. Only lateral gastrocnemius lesion was present in MRI. No abnormalities were found in physical examination, suggesting of good stability of posterolateral knee.

In ACL reconstruction, femoral tunneling using transportal technique requires K-wire to penetrate structures at posterolateral side of the knee. The pitfalls were that operator could not determine the exact direction of the exit point of K-wire. This technique increases the risk of posterolateral structures injury of the knee, posterior wall, and femoral condyles damage [7], [8], [9]. Some literatures did not discuss about iatrogenic injury to the posterolateral structures in details [10], [11], [12], [13]. Hall *et al*. performed a descriptive study on cadavers that they drilled the femoral tunnel from low-medial accessory portal to femoral cortex, with the knee flexed at 120°, 90°, and 70°. That procedure may increase the risk of injury at 70° knee flexion and less with more flexion. Biceps femoris tendon was at risk if guide pins were inserted at 70°, but no injury was found at 120° [14]. A study by Nakamura *et al.* [12] found that lower flexion angle might have higher risk of damage to the common peroneal nerve and posterior articular cartilage. This risk was also reduced by increasing the flexion angle. Plantaris muscle was injured in ten knees (50%), lateral gastrocnemius muscle in 9 (45%), and biceps femoris muscle in 4 (20%). Evaluation of the knee MRI in our study found that only lateral gastrocnemius was injured in six knees (30%).

We did not found any abnormality in physical examination for posterolateral structures. This finding suggested a relatively stable posterolateral corner even with a sustained iatrogenic injury [6], [15]. A primary posterolateral corner disruption may increase the risk of graft failure after ACL reconstruction because of the disturbance to knee biomechanics. It might be suggested that femoral tunnel drilling using transportal technique will result in good posterolateral stability [6], [16].

Wang *et al*. [17] performed a dynamic post-ACL reconstruction knee kinematics study while walking, comparing the transportal with transtibial technique. Anterior-posterior translation during swing phase and femoral external rotation at midstance was better restored in transportal than in transtibial technique. Another kinematics study by Schairer *et al.* [18] yielded similar outcomes in favor of transportal technique. Translation and rotation of the tibia and the tibiofemoral contact area was measured. They found that transportal technique resulted in comparable measurement to the healthy contralateral knee. This kinematics improvement might be explained with better joint stability in transportal technique. In our study, we found that there was no gait abnormality at 1 month after ACL reconstruction using transportal technique.

Our study has several limitations. First, this study has no comparison group. Second, time to follow-up was relatively short. Therefore, further research is needed to consider the best angle of the knee flexion to minimalize damage to soft tissues in posterolateral area.

Conclusion

Femoral tunnel drilling using transportal technique in ACL reconstruction is safe even it might risk to damage lateral gastrocnemius muscle according to clinical and MRI findings. The injury of the gastrocnemius can be reduced using the smallest pin during femoral tunnel drilling.

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