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Technical Notes

A cadaveric study on the anatomy of anterior cruciate ligament in Vietnamese adults

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ABSTRACT

Objectives: To report the anatomical characteristics of the ACL in Vietnamese individuals.

Subjects and methods: Ten fresh knees were dissected to investigate the anatomical characteristics of ACL. The insertion position, length and diameter of ACL were measured.

Results: The average lengths of AM and PL bundle of the ACL were 30.6 mm and 25.6 mm, respectively. The average sizes of the femoral and tibial ACL attachment sites were 13.8 × 10.6 mm and 13.4 × 10.2 mm, respectively.

Conclusion: The anatomical characteristics of the ACL in Vietnamese individuals were reported.

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Introduction

Anterior cruciate ligament (ACL) is composed of two bundles,^{1,2,3} which acts as the primary restraint to anterior tibial translation and guides the screw-home mechanism associated with knee extension. ACL injury is common, especially in sports. In the US, there are 100,000 to 200,000 ACL tears per year, with an annual incidence of about 1 in 3500.⁴

In recent decades, ACL reconstruction surgery has a lot of development, start from open surgery, until now surgical arthroscopy absolute dominant. In recent years, surgeons are more interested in anatomic ACL reconstruction. They desire to restore the normal ACL anatomy as closely as possible. Therefore, to achieve a good outcome of ACL reconstruction, the knowledge of the anatomy of the ACL is very important.³ There are very few studies have precisely described the anatomical characteristics of ACL. The anatomy of the ACL varies by race.⁵ There is no literature on the ACL anatomy in Vietnamese individuals. In order to understand the anatomical characteristics of the ACL in Vietnamese and help to improve the ACL reconstruction surgery, we performed this study to report the ACL anatomy in the Vietnamese adults.

Materials and methods

Ten knees (five left and five right) that taken from the limb amputation of patients who had severe leg injury with an intact knee joint at Saint Paul Hospital and from fresh cadavers at the Medicine University of Ho Chi Minh city were dissected during the period from April to August 2016.

All of the knees were obtained from people aged 22–57 years without chronic knee condition, expression of knee degeneration (loss of cartilage), knee bone fracture (include the condyles of the femur and proximal tibia) and without ACL and PCL injuries (found by direct observation).

The distal femurs were cut at the level of the bursae of the quadriceps, and the proximal tibias were cut approximately 3 cm below the knee joint line. All soft tissues around the knee joint were removed to clearly expose the ACL and the meniscus (Fig. 1).

The knees were temporarily fixed at 90° with the Kirschner pins. The ACL femur attachment sites were observed and evaluated. The medial femur condyle was cut with a bone saw, PCL was flipped to observe the anatomy of the ACL.

We observed the two bundles of the ACL. We measured the length of the AM bundles with the knee at 90° flexion (as arthroscopic evaluation of the ACL typically occurs with the knee flexed to 90°) and measured the length of the PL bundles with the knee extended. The sizes of the ligaments were measured at the middle third of the ligaments, including the smallest and the largest diameter of the ligaments. All sizes were measured by a 150 mm

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Fig. 1.

Electronic Caliper (Model 500-181-20, Mitutoyo Corp., Kawasaki, Japan) with the resolution of 0.01 mm and the instrumental error of ± 0.02 mm.

The anatomical characteristics of the femoral attachment site included: The location of the attachment site of the AM and PL bundle; the distance from the centre of the AM and PL attachment site to the posterior cartilage edge of the lateral femoral condyle; the distance from the centre of the AM and PL bundle attachment site to the articular cartilage edge of the lateral femoral condyle (Fig. 2).

The anatomical characteristics of the femoral attachment site included the following: location of the attachment site of the AM and PL bundle; distance from the centre of the AM and PL attachment site to the posterior cartilage edge of the lateral femoral condyle; and distance from the centre of the AM and PL bundle attachment site to the articular cartilage edge of the lateral femoral condyle.

The anatomical characteristics of the tibial attachment site of the ACL included the following: 1.) Distance from the centre of the AM and PL bundle attachment site to the retro-eminence ridge (RER) and 2.) Distance of the centre of these attachment sites to the anterior edge of the tibial plateau.

Results

There were ten knees from five people (three men and two women) with an average age of 45 years (range 22–57 years) in this study.

Anatomy of the femoral attachment site

The femoral attachment site of the ACL was an oval-shape zone, with an average size of 13.8×10.6 mm.

When observing the ACL from the front, with knees at 90° , we found the following: In the five right knees, the femoral attachment site stretched from 11 o'clock position counter-clockwise to 9 o'clock position. And in the five left knees, the attachment site stretched from 1 o'clock position clockwise to 3:30 position.

The attachment site of the AM bundle stretches from 11 o'clock to 9:30 position in four right knees and from 11 o'clock to 9:45 position in one right knee; In left knees, this site stretches from 1 o'clock to 2:45 position in two knees and from 1 o'clock to 3 o'clock

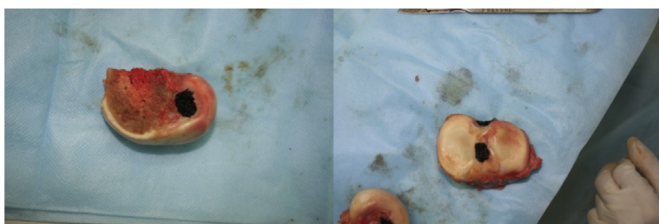


Fig. 2.

position in three knees. The other anatomical characteristics of AM and PL bundle were shown in Table 1.

The attachment site of the PL bundle stretched from 9:30 to 9 o'clock position in four right knees and from 9:45 to 9 o'clock position in one right knee. This site stretched from 2:45 to 3:30 position in two left knees and from 3 o'clock to 3:30 position in three left knees. The anatomical distances of the femoral attachment site of the ACL were shown in Table 2.

The anatomy of the tibial attachment site of the ACL

The anatomical distances of the tibial attachment site of the ACL were shown in Table 3.

Discussion

Most studies have reported that the ACL is composed of two bundles: AM and PL.^{1,2,3,6} In many studies, the average length of the ACL is approximately 37 mm–41 mm.^{7,8,9} The length of the ACL varies depending on the knee position. In this study, the average length of the AM bundle of ACL with knees at 90° was 30.6 mm, and the average length of the PL bundle with the fully extended knee was 25.6 mm. These measurements are consistent with the results of many previous studies.^{10,11} Binh et al.¹⁰ reported that the average length of the AM and PL bundle of the ACL in 20 formalin soaked Vietnamese knees is 28.3 mm and 23.4 mm, relatively. But the the knee position when measuring was not reported.

Understanding the length of the ACL and each bundle will assist surgeons in arthroscopic ACL reconstruction surgery, especially in all-inside ACL reconstruction surgical technique. The ACL has been reported to have an average diameter of approximately 7–12 mm.^{2,6,12–14} However, the cross-sectional area of the medial third of the ACL is an ellipse, not a circle. We observed that the smallest and the largest diameter of the ACL averaged 3.8 mm and 7.7 mm, respectively. This result differs from that reported by Binh et al. from formalin-fixed cadavers.¹⁰ Knowing the size of the ACL will help the surgeons choose grafts for ACL reconstruction surgery.

The size of the femoral attachment site was described by previous studies. Binh et al. reported that the average size of this site is $17.3 \text{ mm} \times 9.1 \text{ mm}$.¹⁰ Musahl et al. reported that the average size is $18 \text{ mm} \times 11 \text{ mm}$.¹⁵ In our study, the average size of the femoral attachment site was $13.8 \text{ mm} \times 10.6 \text{ mm}$.

The position of the centre of the femoral attachment site of the ACL and its two bundles have also been described in many studies.^{1,2,15,16} In our investigation, the distances from the centre of

Table 1
The anatomical characteristics of ACL.

Anatomical characteristics	Average \pm SD (mm)	Range (mm)
AM bundle length	30.6 ± 2.1	27.1–31.7
PL bundle length	25.6 ± 2.0	20.0–29.4
Smallest diameter	3.8 ± 0.5	3.2–5.1
Largest diameter	7.7 ± 1.1	6.3–8.8

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