Anthropometry of the patellar tendon in Chinese

KMS Luk, NM Wong, JCK Cheng
Department of Orthopaedics and Traumatology, United Christian Hospital, Hong Kong

ABSTRACT

Purpose. To assess the length of the patellar tendon in Chinese and its correlation with patient age, gender, and operated side.

Methods. 109 men and 11 women aged 15 to 45 (mean, 25) years underwent arthroscopic bone-tendon-bone reconstruction for anterior cruciate ligament (ACL) insufficiency. 55 (46%) injured the left side, and 65 (54%) the right side. Each patient’s age, gender, and operated side were recorded. The length of the patellar tendon harvested was measured.

Results. The mean length of the patellar tendon graft was 42.6 (standard deviation, 4.6; range, 30–54) mm. There was no correlation between the length of the patellar tendon and patient’s age (p=0.147), gender (p=0.076), or operated side (p=0.466).

Conclusion. The length of the patellar tendon in the Chinese is comparable to that in Caucasians. Because of the shorter ACL but similar patellar tendon length, graft-tunnel mismatch may be more common in Chinese than Caucasian patients.

Key words: anterior cruciate ligament; bone-patellar tendon-bone graft; patellar ligament; reconstructive surgical procedures

INTRODUCTION

Anterior cruciate ligament (ACL) injury is common among athletes; 100 000 new cases are reported annually in the United States. It is the most common arthroscopic finding in 208 sports trauma patients. For symptomatic ACL-deficient patients, ACL reconstruction using a bone-tendon-bone graft is a popular option. Biomechanically, the graft provides ultimate tensile strength of up to 2977 N. It is strong and easy to harvest and enables rigid fixation and bone-to-bone healing. Nonetheless, to achieve a good outcome, precise surgical techniques are essential for anatomic reconstruction of the ACL, in particular secure fixation of the bone block in the tibial and femoral tunnels.

Address correspondence and reprint requests to: Dr Man-sze Luk, 7A, Block G, United Christian Hospital, 130 Hip Wo St., Kwun Tong, Hong Kong. E-mail: lmskaren@yahoo.com.hk
Graft-tunnel mismatch is a common intra-operative problem leading to graft protrusion and insecure tibial tunnel fixation with screw interference (Fig. 1).5,6

Based on an anthropometric study of Singaporean Chinese cadavers, anatomic differences are reported between Chinese and Caucasian ACLs,7 but study of the patellar tendon is lacking. We aimed to assess the anthropometry of the patellar tendon among Chinese and its correlation with patient age, gender, and operated side.

MATERIALS AND METHODS

Between March 1998 and May 2004, 109 men and 11 women aged 15 to 45 (mean, 25) years underwent arthroscopic reconstruction for ACL insufficiency using the bone-tendon-bone graft. 55 (46%) injured the left side and 65 (54%) the right side. Each patient’s age, gender, and operated side were recorded. Patients with a history of patella bone/tendon injury, knee surgery, and developmental knee abnormalities such as patellar hypoplasia and Osgood-Schlatter disease were excluded.

To harvest the full length of the patellar tendon, the whole width of the tendon was identified and the central third harvested, with about 30-mm bone blocks over the patella and tibia. The tendinous part of the graft was measured. Any excess or nibbus was removed. The midpoint of an oblique end of the tendon was used as a measurement point (Fig. 2). A single senior surgeon made all the measurements to avoid inter-observer error.

The results were analysed using the Student’s t test and the Pearson correlation (one-tailed) test. A p value of <0.05 was considered statistically significant.

RESULTS

The mean length of the patellar tendon graft was 42.6 (standard deviation [SD], 4.6; range, 30–54) mm. No correlation was noted between the length of the patellar tendon and patient’s age (p=0.147), gender (p=0.076), or operated side (p=0.466) using the Pearson correlation (one-tailed) test. The heights and weights of the patients were not recorded.

DISCUSSION

Graft-tunnel mismatch describes the variation between the length of the patellar tendon graft and the intra-articular distance between the ACL origin and insertion sites.5

The mean length of the patellar tendon in 34 Americans was 48.4 (SD, 6.0; range, 40–63) mm.5 In 50 Italian knees it was 45.5 (SD, 4.71; range, 35–53) mm, and did not correlate with body weight but slightly with height.6 Findings of both studies were comparable to ours in 120 Chinese patients.

In 10 adult Caucasian cadavers, the mean length of the ACL was 39 mm.8 In 33 young Caucasian cadavers, the mean mid-substance length of the ACL was 31 (SD, 3) mm.8 In a study measuring the length, width, and orientation of the ACL of 30 Singaporean Chinese cadavers,7 the mean mid-substance length of the ACL was 23.3 (SD, 2.9) mm, which was significantly shorter than that of Caucasians,8,9 and the angle between the ACL and longitudinal axis of femur was 64º (SD, 17º), compared to 28º (SD, 4º) in Caucasians.8,9 Therefore, the ACL in Chinese appeared significantly shorter, narrower, and more vertical than in their Caucasian counterparts.7

Unlike the ACL, the length of the patellar tendon was similar in the Chinese and Caucasians. Graft-tunnel mismatch occurs when the patient has a long patellar tendon. The shorter ACL in the Chinese suggests a greater mismatch (lengths of patellar...
tendon minus ACL, 42.6-23.3=19.3 mm). Although this suggestion is based on 2 different studies (one on the living, and one on cadavers), it provides a rough guide to the extent of mismatch.

The problem of mismatch is further complicated by the functional anatomy of ACL. The ACL is a complex structure comprising 2 bundles with a large oval-shaped footprint over the femoral and tibial sides. A simple point measurement does not give a realistic picture of the extent of ACL deficit. Furthermore, an ACL-deficient knee is not ideal for measuring the normal length, as recurrent joint laxity and giving-way may affect other knee structures such as the medial collateral ligament and the joint capsule.

Graft-tunnel mismatch may be estimated preoperatively using magnetic resonance imaging. However, its accuracy can be affected by the knee’s position. To accommodate the graft-tunnel mismatch and enable rigid fixation using interference screws, several methods have been proposed including: recession of the femoral bone plug, tibial tunnel bone grafting, flipping the tibial bone plug, and graft rotation. Obliquity of the tibial tunnel also affects the tunnel length and graft accommodation. Hence, the ‘N+7’ and ‘N+2’ formulas have been suggested to determine the tibial tunnel angle and length, respectively (N denotes the length of the patellar tendon).

The length of the tendinous part of the graft should be routinely measured before constructing the tibial tunnel. When a mismatch is confirmed, the femoral bone block inside the femoral tunnel is recessed by 10 mm and then fixed with one interference screw or 2 bio-absorbable Rigidfix pins, with a view to provide secure fixation (Fig. 3). Chamfering the anterior portion of the femoral tunnel is recommended to prevent graft abrasion on the leading edge of the tunnel. We considered such chamfering not necessary in most cases, and our patients did not encounter graft rupture or failure. In a review of 100 patients, the theoretical concerns of tendon abrasion against the anterior wall of the femoral tunnel have not been clinically apparent.

Further mismatch can be dealt with by increasing the tibial tilting angle to about 50º to 55º. We never increased the angle to >60º because it was difficult to place the femoral tunnel through a transtibial approach if it was too steep, and a large angle would create a vertical graft that decreases the flexion range and rotational stability leading to earlier graft failure from cyclic loading. As the ACL consists of 2 bundles, a single bundle reconstruction is only a compromised remedy. An abnormally large angle (>60º) is a non-anatomic reconstruction of the tibial tunnel.

We resolved the mismatch problem in all our patients using these 2 methods. No bone plug protrusion was encountered during the operations, and there was no failure after a mean follow-up of 5 years.

We have no experience with graft rotation and graft flipping techniques. Although no short-term effect on knee laxity has been noted after an external twist of the graft by 90º, the long-term results of graft rotations of greater degrees are lacking. We also found the ‘N+7’ formula not useful, as it may result in undesirable tibial angles.

Besides ACL reconstruction, knowing the length of the patellar tendon is also useful in trauma situations. In treating patients with patellar tendon rupture, it is important to ensure no patella baja (infera) is produced by the repair. In chronic/neglected rupture cases, the patella may retract proximally, in which case it is more important to determine the appropriate patellar tendon length. Our findings on the length of patellar tendon in Chinese will help surgeons adjust the patella to the correct position and tension.

**CONCLUSION**

Unlike the ACL, the length of the patellar tendon in Chinese is comparable to that in Caucasians. Because of the shorter ACL but similar patellar tendon length, graft-tunnel mismatch may therefore be more common in Chinese than Caucasian patients. Further study of the anatomy of the normal ACL in our population is needed to better delineate the severity of any mismatch.
REFERENCES