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ORIGINAL ARTICLE

Half-peroneus-longus-tendon graft augmentation for unqualified hamstring tendon graft of anterior cruciate ligament reconstruction

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Abstract
Background In some situations, harvested hamstring tendon grafts are not qualified for anterior cruciate ligament (ACL) reconstruction. This study aimed to present a reinforcing method with additional half peroneus longus tendon (half-PLT) graft augmentation.
Methods Eight cases underwent ACL reconstruction with unqualified hamstring tendon grafts (diameter <7 mm) and were salvaged by additional half-PLT graft augmentation. The pivot shift test and KT-1000 tests were performed 3 years after surgery. Functional evaluation of subjective International Knee Documentation Committee (IKDC) and Lysholm scores was also done. In addition, Foot and Ankle Disability Index (FADI) scores were used to evaluate the function of the ankle donor site.
Results The diameter of unqualified four-strand hamstring tendon grafts was 6.2 mm on average (range, 6.0–6.5 mm). The average diameter of hamstring grafts with half-PLT augmentation was 9.6 mm (range, 9.5–10.0 mm). The pivot shift test was negative in all patients. No significant differences between normal and abnormal knees were found by KT-1000. The average IKDC score was 86.0 (range, 83 to 89), and the average Lysholm score was 84.4 (range, 80–90). The average FADI score for the donor sites of half-PLT was 135.8 (range, 134–136).
Conclusions Additional half-PLT can successfully and safely reinforce unqualified hamstring tendon grafts for ACL reconstruction.

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Introduction

Reconstruction of the knee anterior cruciate ligament (ACL) is performed to restore its function after injury. Currently, this procedure is performed under arthroscopy, and it can be done with different types of graft including the bone patellar tendon bone, hamstring tendon, quadriceps tendon, allograft and artificial grafts, all of which have pros and cons. The advantages of a hamstring tendon graft are the high strength, high stiffness, easier rehabilitation, less anterior knee pain and less joint stiffness [1]. The strength and stiffness of the graft are important considerations for choosing the kind of graft and reconstruction technique. It is widely accepted that a four-strand hamstring tendon autograft represents a reliable option for ACL reconstruction [2–6]. However, a disadvantage is the unpredictable size of both the diameter and length. The size of the hamstring tendon graft is correlated with the patient's condition [7].

Insall et al. [8] reported that the average length of a normal ACL is 38 mm (range, 25–41 mm) with an average width of 10 mm (range, 7–12 mm). Female patients have statistically significantly shorter length and smaller diameter hamstring grafts compared to male patients. The hamstring graft size has been also shown to be correlated to the anthropometric parameters of the patient. One prospective evaluation revealed patients weighing less than 50 kg, less than

140 cm in height, with less than 37 cm thigh circumference and body mass index less than 18 should be considered at high risk for having a quadrupled hamstring graft diameter less than 7 mm [9]. However, the diameter of tendon grafts for knee cruciate ligament reconstruction must be at least 7 mm [10–12]. A reinforcing additional graft source must be sought in order to obtain a usable ACL graft.

Biomechanical evaluations of the properties of complete peroneus-longus-tendon (PLT) grafts have been done recently and revealed that both the strength and stiffness of complete PLT grafts are suitable for knee ACL reconstruction [13, 14]. In addition, this graft is easy to harvest with minimal complications of the donor site in short- and mid-term reports [15, 16]. However, the PLT is an important stabilizing structure of the foot and ankle. If all of the PLT is removed as a graft, complications may occur in the long term. Therefore, we only took half of the PLT for the reinforcing tendon graft, and the other half was left in place to maintain its function in the current study. This half-PLT graft was used as a salvaging additional graft to reinforce unqualified hamstring tendon grafts for ACL reconstruction. The aim of this study was to present the effectiveness and safety of this reinforcing method.

Materials and methods

This study was approved by the Ethics Committee of our institute. All patients who participated in this study provided informed consent. We routinely took semitendinous and gracilis tendons of hamstrings for ACL reconstruction. If the diameter of the hamstring graft was less than 7 mm, it was considered an unqualified hamstring tendon graft [10–12]. We used half-PLT grafts to salvage unqualified hamstring tendon grafts for ACL reconstruction. The diameter of the cross-sectional area of the graft was measured using a graft sizing block (Arthrex AR-1886) with 5-mm intervals.

From 2011 to 2012, a total of 182 cases underwent primary ACL reconstruction in our hospital. There were eight cases with unqualified hamstring tendon grafts, and these were salvaged by additional half-PLT grafts. All of these eight cases were female. The average age was 31.4 years (range, 18–49 years), and the average body height was 158.6 cm (range, 155–160 cm). All of the diagnoses of ACL rupture were made by magnetic resonance imaging (MRI), and the menisci were relatively intact in all cases. ACL reconstruction was done by arthroscopy. Hamstring tendon grafts including semitendinous and gracilis tendons were harvested using the inside-out technique. An oblique, 3-cm skin incision was made over the insertion of the pes anserine. The distal end of the semitendinous tendon and gracilis tendon were lifted up with scissors and grasped with a Kocher. The conjoined tendon between the distal ends of these two tendons was divided with scissors, and each tendon was released by traction. The tendons were taken from the muscle proximally by advancing the tendon stripper.

During the reconstruction procedure, bone tunnel positioning of both the femur and tibia was carefully determined. We fixed the ACL graft using the single bundle technique with interference screws on both the femur and tibia. The femoral tunnel was placed at a 2-mm rim of bone between the tunnel and posterior cortex of the femur on the sagittal plane and on the lateral wall of the intercondylar notch (10 or 2 o'clock position) on the coronal plane to create a more horizontal graft. The tibial tunnel was placed at 10 mm in front of the anterior border of the PCL insertion on the sagittal plane and halfway between the tibial tubercle and posterior medial edge of the tibia on the coronal plane.

The procedure for half-PLT graft harvesting was performed by making a 2-cm skin incision over the posterior border of the lateral malleolus. A zig-zag incision of the retinaculum of the peroneal tendons was made to expose the PLT. The graft was pulled using a peon clamp, and it was split longitudinally through the middle using a knife (Fig. 1). A distal cut was then made with scissors, freeing the posterior part of the PLT (Fig. 2). The free end of the tendon was grasped with an Allis clamp, and whipstitch sutures were placed using number 2 Ti-Cron. The tendon

Fig. 1 Harvesting and preparation of the half-PLT grafts (see details in the Methods section). A 2-cm incision was made over the posterior border of the lateral malleolus to expose the PLT, and it was split longitudinally through the middle

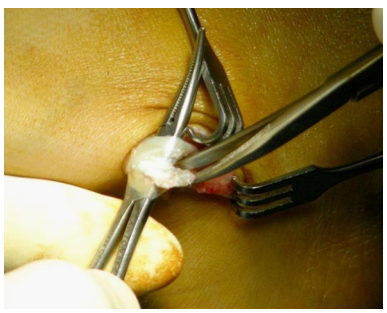

Fig. 2 A distal cut was made freeing the posterior part of the PLT

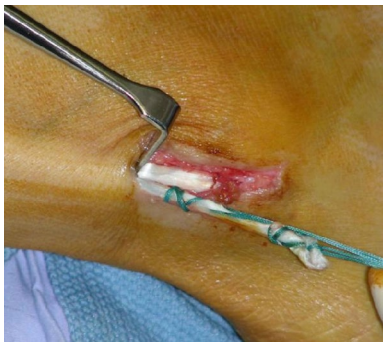

Fig. 3 The tendon was then further split longitudinally proximally

was then further split longitudinally proximally (Fig. 3). A tendon stripper was used to harvest the half tendon from the muscular part of the peroneus longus (Fig. 4). Half of the PLT was removed as a salvaging tendon graft, and the other half was left in place to maintain its original function. The retinaculum of peroneal tendons must be repaired properly because it is very important to reduce the risk of dislocation of the tendon postoperatively. A zig-zag incision of the retinaculum is suggested because it can make repair much easier. The harvested half-PLT was added to the unqualified hamstring tendon graft for reinforcement (Fig. 5).

A standard four-strand hamstring tendon graft consists of folded semitendinous and folded gracilis tendons. If the diameter of the standard four-strand hamstring tendon graft was less than 7 mm, it was considered an unqualified graft for ACL reconstruction [10–12]. In the current study, this half-PLT was folded in half and added to the four-strand hamstring tendon graft to create a six-strand graft. This graft included a folded semitendinous tendon, folded gracilis tendon and folded half-PLT.

The augmented ACL grafts were tensioned at 20 N for at least 20 min before implantation. We followed the standard postoperative protocol for ACL reconstruction. Patients are restored to normal gait 3–6 weeks postoperatively and restored to a full active range of motion 6–12 weeks postoperatively. They have improved strength from training by 3 months postoperatively and can return to sports after 6 months postoperatively.

A pivot shift test was performed 3 years after the reconstruction. Both knees were also tested in each patient using the KT-1000 arthrometer [17–20] with 89 N anterior force. Each knee was tested twice with the arthrometer with a 1-min gap between the tests. The side-to-side difference in the anterior displacement between the patient's normal and abnormal knee was measured, and a mean of the two readings was taken. A difference of 2 mm was taken as significant. The machine was in good working order, and reproducible measurements were obtainable with it. Functional evaluation of the subjective International Knee

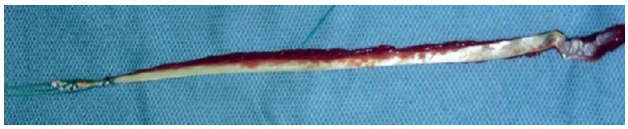

Fig. 4 A tendon stripper was used to harvest the tendon graft. Half of the PLT was removed as a salvaging tendon graft, and the other half was left in place to maintain its original function

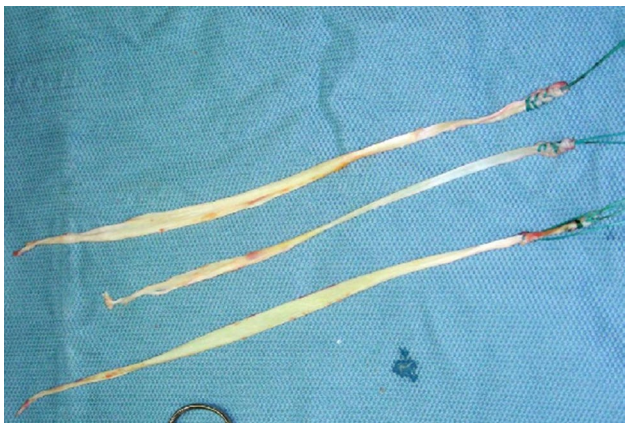

Fig. 5 The upper one is the semitendinous tendon; the middle one is the gracilis tendon; the lower one is the half-PLT. The length and thickness of the half-PLT after preparation were quite similar to the semitendinous tendon of the same patient. This half-PLT was folded in half and added to the four-strand hamstring tendon graft to create a six-strand graft for ACL reconstruction

Documentation Committee (IKDC) [21] and Lysholm scores [22] by the questionnaire were also done. The IKDC Subjective Knee Form is a patient-oriented questionnaire that assesses the symptoms and functions in daily activities, and the Lysholm score is commonly used to document outcomes after arthroscopic knee surgery. These outcome measurements are subjective in nature and evaluate performance and activity restrictions. In addition, the Foot and Ankle Disability Index (FADI) [23] scores were used to evaluate the ankle donor site of the half-PLT. The FADI is designed to assess functional limitations related to foot and ankle conditions, and a maximum FADI score of 136 means normal ankle function without any disability.

Results

A standard four-strand hamstring tendon graft consists of folded semitendinous and folded gracilis tendons. In eight cases of the current study, the diameter of four-strand hamstring tendon grafts was less than 7.0 mm. The average diameter was 6.2 mm (range, 6.0 to 6.5 mm), and the average length was 9.3 cm (range, 9.0 to 10.0 cm). These patients therefore had unqualified hamstring tendon grafts,

and we took additional half-PLT grafts for augmentation. The average diameter of these six-strand grafts was 9.6 mm (range, 9.5 to 10.0 mm).

Three years after the reconstruction, the pivot shift test was performed, and the results were all negative. No significant side-to-side differences (>2 mm) between normal and abnormal knees were found by KT-1000 with 89 N anterior force in all cases. The average anterior translation recorded by KT-1000 was 1.28 mm.

The average IKDC score was 86.0 (range, 83–89), and the average Lysholm score was 84.4 (range, 80–90). The functional outcomes of these half-PLT salvaged patients were moderate according to the IKDC and Lysholm scores.

The average preoperative FADI score of the donor site of the half-PLT grafts was 136, and the average postoperative FADI score was 135.8 (range, 134–136) at the last follow-up. No pain, range of motion limitation or any other discomfort over the donor site of the ankle was noted. The muscle power of plantar flexion and eversion of the foot did not decrease compared to the intact contralateral side. No significant complications over the ankle donor sites were noted after half-PLT harvesting (Table 1).

Table 1 Patient list

Case	Gender	Age	Body height (cm)	Diameter of hamstring graft (mm)	Length of hamstring graft (cm)	Diameter of hamstring add half-PLT graft (mm)	Postoperative pivot shift test	Postoperative KT-1000 side-to-side difference (mm)	IKDC score	Lysholm score	FADI score
1	Female	18	155	6	9	9.5	Negative	1.0	89	90	136
2	Female	49	160	6.5	10	10	Negative	1.6	83	80	134
3	Female	32	160	6.5	10	10	Negative	1.2	86	84	136
4	Female	36	159	6.5	9	9.5	Negative	1.4	85	82	136
5	Female	30	158	6	9	9.5	Negative	1.0	87	86	136
6	Female	24	159	6	9	9.5	Negative	1.2	86	84	136
7	Female	22	160	6.5	9	9.5	Negative	1.0	89	90	136
8	Female	40	158	5.5	9	9.5	Negative	1.8	83	80	136
Average	Female	31.4	158.6	6.2	9.3	9.6	Negative	1.28	86	84.4	135.8

Discussion

Female patients have statistically significantly shorter length and smaller diameter hamstring grafts compared with male patients [7]. In the current study, eight Asian female cases had unqualified hamstring grafts because the diameters of these standard four-strand tendons were too thin. Therefore, for patients with shorter body height, other graft choices for knee ACL reconstruction should be considered rather than hamstring tendon grafts [24]. These choices include the bone-patellar-tendon-bone, quadriceps tendon, allograft and artificial grafts. If a hamstring tendon graft is still selected for these patients, salvaging methods should be prepared, and half-PLT is a good option for augmentation. Some surgeons take the opposite hamstring tendon for salvage in this situation. However, the increased risk of infection should be considered when exposing both legs during surgery, and the postoperative rehabilitation becomes more difficult with this method.

According to the previous research on the Chinese population, there were strong correlations between hamstring graft size and the patient's anthropometric parameters. Simple regression analysis demonstrated that height and weight can be used to predict hamstring autograft length and diameter [25]. Some other research on Caucasian populations also provided similar preoperative information about the size of hamstring grafts. The graft size is significantly associated with the weight, height, leg length, thigh length, thigh diameter and gender [26–28]. One

prospective evaluation also revealed that patients weighing less than 50 kg, less than 140 cm in height, with less than 37 cm thigh circumference and body mass index less than 18 should be considered at high risk for having an unqualified hamstring graft [9]. However, there were significant variations between the results in different studies, and those equations were not completely reliable. In the current study, all of our eight cases had body height more than 155 cm, but they still had unqualified quadrupled hamstring grafts. Some studies revealed only moderate correlation of the hamstring graft size and those anthropometric parameters. They found no statistically important predictor for graft diameter in female patients [7]. Patients' anthropometric parameters are useful for patient counseling and alternative graft source planning, but exceptions still exist, like our cases.

Besides, preoperative MRI can also predict the graft size. According to the research, there is a strong correlation between the cross-sectional areas of hamstring tendons on MRI and graft size [29–33]. Preoperative cross-sectional area threshold values of 10 and 17 mm^2 for the gracilis and semitendinosus tendons, respectively, can predict the sufficiency of hamstring grafts for ACL reconstruction [34]. This is a more reliable option to assist the surgeon with preoperative determination of graft size.

The average IKDC score was 86 and the average Lysholm score 84 in the current study. The functional outcomes of these half-PLT salvaged patients were moderate, and there are some possible reasons for the deduction of scores. All patients in the current study were females with short stature. According to the previous literature, female patients exhibited significantly worse outcome scores [35, 36] and experienced greater magnitude reductions in quadriceps function after ACL reconstruction than male patients [37]. Female gender is also an independent negative predictor for returning to sports after ACL reconstruction [38]. The scores of these half-PLT salvaged patients were similar with female patients undergoing traditional ACL reconstruction by four-strand hamstring graft. Half-PLT is an effective method to reinforce the unqualified hamstring graft. Although the scores were just moderate in these patients, the self-reported satisfaction rate was very high.

In the current study, the average diameter of six-strand grafts was 9.6 mm (range, 9.5 to 10.0 mm), and it was thought to be thicker than the normal ACL. One study determined whether using a thicker than normal tendon as an ACL graft source affected the postoperative outcome. It revealed there was no statistically significant difference in the postoperative KT-1000 arthrometer, quadriceps muscle strength scores, modified Noyes questionnaire subjective scores, or postoperative stability and pain scores. These results indicated that an abnormally thick tendon graft wound did not influence the outcome of ACL reconstruction [39].

Reviewing the literature, the biomechanical properties of PLT grafts were evaluated, and the average failure load for a doubled PLT was 2483 N with a maximum stiffness of 244 N/mm [13]. Previous authors have documented the biomechanical strength of grafts for ACL reconstruction to be between 1700 and 2900 N. Complete PLT grafts showed excellent biomechanical properties of tensile strength and stiffness for ACL reconstruction. Another study also reported similar results [14]. These results showed that both the strength and stiffness of complete PLT grafts are suitable for knee ACL reconstruction. In addition, this graft is easy to harvest with minimal complications of the donor sites in short- and mid-term reports [15, 16]. Kerimoğlu et al. [15] evaluated the results of ACL reconstruction with complete PLT grafts. The results were assessed after at least 5 years of follow-up and showed a mean Lysholm score of 83.7, with excellent or good results in 79.3 % of the patients. In addition, no patients experienced ankle joint donor site dysfunction or difficulty in sports activities because of the complete PLT graft transfer. Another short-term study of ACL reconstruction with a complete PLT graft also showed encouraging results and no donor site complications [16].

The aforementioned studies show that the PLT alone can be an appropriate autograft source for ACL reconstruction. However, the PLT is an important supporting structure of the foot. Cadaver research has revealed that the PLT creates an eversion locking effect on the first ray of the foot, which stabilizes the medial column [40]. Sonography studies of asymptomatic cases have revealed that the peroneal tendons also control frontal plane motion of the rear foot [41]. In addition, peroneal tendons are known as active stabilizers in acute ankle sprains, and intact lateral ligaments are required for passive stability of the ankle joint [24]. Many case reports have discussed the association between rupture of peroneal tendons and instability of the ankle joint [42, 43]. Chronic lateral ankle pain has also been reported with PLT rupture in long-term follow-up studies [44, 45]. In summary, the PLT is an important stabilizing structure, and if the whole PLT is harvested as a graft source for ACL reconstruction, complications can occur. To date, no long-term studies have addressed the function of the foot after complete PLT harvesting. In the current study, only half of the PLT was harvested as a salvage graft to reinforce unqualified hamstring tendon grafts, and the remaining half was left in place to maintain its original function. This therefore resulted in fewer long-term complications of the donor site.

The peroneal tendons share a common tendon sheath above the level of the tip of the fibula and are held in place by the superior peroneal retinaculum. The superior

peroneal retinaculum functions as the primary restraint to peroneal tendon subluxation and is also a secondary restraint to anterolateral ankle instability [46–48]. We had to open this retinaculum in the current study to harvest the half-PLT tendon. A zig-zag incision was made for easier repair after harvesting. It is important to repair the retinaculum because its insufficiency will result in peroneal tendon subluxation or dislocation [49].

There are some limitations to this study. We only used half-PLT grafts to salvage unqualified hamstring tendon grafts for ACL reconstruction. It was not routinely used so the case number is not very large. In addition, quantified data for the muscle power and range of motion of the ankle donor site should be evaluated. A large number of patients is needed to verify the efficacy of this novel procedure.

Conclusion

Additional half-PLT can successfully and safely reinforce unqualified hamstring tendon grafts for ACL reconstructions. No significant complications of the ankle donor site of half-PLT grafts were noted.

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Biau DJ, Katsahian S, Kartus J, Harilainen A, Feller JA, Sajovic M, Ejerhed L, Zaffagnini S, Ropke M, Nizard R. Patellar tendon versus hamstring tendon autografts for reconstructing the anterior cruciate ligament: a meta-analysis based on individual patient data. Am J Sports Med. 2009;37(12):2470–8.
2. Freedman KB, D'Amato MJ, Nedeff DD, Kaz A, Bach BR Jr. Arthroscopic anterior cruciate ligament reconstruction: a metaanalysis comparing patellar tendon and hamstring tendon autografts. Am J Sports Med. 2003;31(1):2–11.
3. Feller JA, Webster KE. A randomized comparison of patellar tendon and hamstring tendon anterior cruciate ligament reconstruction. Am J Sports Med. 2003;31(4):564–73.
4. Hamner DL, Brown CH Jr, Steiner ME, Hecker AT, Hayes WC. Hamstring tendon grafts for reconstruction of the anterior cruciate ligament: biomechanical evaluation of the use of multiple strands and tensioning techniques. J Bone Joint Surg Am. 1999;81(4):549–57.
5. Woo SL, Kanamori A, Zeminski J, Yagi M, Papageorgiou C, Fu FH. The effectiveness of reconstruction of the anterior cruciate ligament with hamstrings and patellar tendon: a cadaveric study comparing anterior tibial and rotational loads. J Bone Joint Surg Am. 2002;84(A(6)):907–14.
6. Williams RJ, Hyman J, Petrigliano F, Rozental T, Wickiewicz TL. Anterior cruciate ligament reconstruction with a four-strand hamstring tendon autograft. J Bone Joint Surg Am. 2004;86(A(2)):225–32.
7. Papastergiou SG, Konstantinidis GA, Natsis K, Papathanasiou E, Koukoulias N, Papadopoulos AG. Adequacy of semitendinosus tendon alone for anterior cruciate ligament reconstruction graft and prediction of hamstring graft size by evaluating simple anthropometric parameters. Anat Res Int. 2012;2012:424158.
8. Torzilli PA, Greenberg RL, Hood RW, Pavlov H, Insall JN. Measurement of anterior-posterior motion of the knee in injured patients using a biomechanical stress technique. J Bone Joint Surg Am. 1984;66(9):1438–42.
9. Treme G, Diduch DR, Billante MJ, Miller MD, Hart JM. Hamstring graft size prediction: a prospective clinical evaluation. Am J Sports Med. 2008;36(11):2204–9.
10. Siebold R, Webster KE, Feller JA, Sutherland AG, Elliott J. Anterior cruciate ligament reconstruction in females: a comparison of hamstring tendon and patellar tendon autografts. Knee Surg Sports Traumatol Arthrosc. 2006;14(11):1070–6.
11. Grood ES, Walz-Hasselfeld KA, Holden JP, Noyes FR, Levy MS, Butler DL, Jackson DW, Drez DJ. The correlation between anterior-posterior translation and cross-sectional area of anterior cruciate ligament reconstructions. J Orthop Res. 1992;10(6):878–85.
12. Hamada M, Shino K, Horibe S, Mitsuoka T, Toritsuka Y, Nakamura N. Changes in cross-sectional area of hamstring anterior cruciate ligament grafts as a function of time following transplantation. Arthroscopy. 2005;21(8):917–22.
13. Pearsall AW, Hollis JM, Russell GV Jr, Scheer Z. A biomechanical comparison of three lower extremity tendons for ligamentous reconstruction about the knee. Arthroscopy. 2003;19(10):1091–6.
14. Chan DB, Temple HT, Latta LL, Mahure S, Dennis J, Kaplan LD. A biomechanical comparison of fan-folded, single-looped fascia lata with other graft tissues as a suitable substitute for anterior cruciate ligament reconstruction. Arthroscopy. 2010;26(12):1641–7.
15. Kerimoglu S, Aynaci O, Saracoglu M, Aydin H, Turhan AU. Anterior cruciate ligament reconstruction with the peroneus longus tendon. Acta Orthop Traumatol Turc. 2008;42(1):38–43.
16. Cao HB, Liang J, Xin JY. Treatment of anterior cruciate ligament injury with peroneus longus tendon. Zhonghua yi xue za zhi. 2012;92(35):2460–2.
17. Graham GP, Johnson S, Dent CM, Fairclough JA. Comparison of clinical tests and the KT1000 in the diagnosis of anterior cruciate ligament rupture. Br J Sports Med. 1991;25(2):96–7.
18. Forster IW, Warren-Smith CD, Tew M. Is the KT1000 knee ligament arthrometer reliable? J Bone Joint Surg Br. 1989;71(5):843–7.
19. Malcom LL, Daniel DM, Stone ML, Sachs R. The measurement of anterior knee laxity after ACL reconstructive surgery. Clin Orthop Relat Res. 1985;196:35–41.
20. Daniel DM, Malcom LL, Losse G, Stone ML, Sachs R, Burks R. Instrumented measurement of anterior laxity of the knee. J Bone Joint Surg Am. 1985;67(5):720–6.
21. Higgins LD, Taylor MK, Park D, Ghodadra N, Marchant M, Pietrobon R, Cook C. Reliability and validity of the International Knee Documentation Committee (IKDC) Subjective Knee Form. Joint Bone Spine. 2007;74(6):594–9.
22. Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. Clin Orthop Relat Res. 1985;198:43–9.
23. Martin RL, Irrgang JJ, Lalonde KA, Conti S. Current concepts review: foot and ankle outcome instruments. Foot Ankle Int. 2006;27(5):383–90.
24. Ziai P, Benca E, von Skrbensky G, Graf A, Wenzel F, Basad E, Windhager R, Buchhorn T. The role of the peroneal tendons in passive stabilisation of the ankle joint: an in vitro study. Knee Surg Sports Traumatol Arthrosc. 2013;21(6):1404–8.
25. Xie G, Huangfu X, Zhao J. Prediction of the graft size of 4-stranded semitendinosus tendon and 4-stranded gracilis tendon for anterior cruciate ligament reconstruction: a Chinese Han patient study. Am J Sports Med. 2012;40(5):1161–6.

26. Pinheiro LF Jr, de Andrade MA, Teixeira LE, Bicalho LA, Lemos WG, Azeredo SA, Silva LA, Gonzaga LG. Intra-operative four-stranded hamstring tendon graft diameter evaluation. Knee Surg Sports Traumatol Arthrosc. 2011;19(5):811–5.
27. Schwartzberg R, Burkhart B, Lariviere C. Prediction of hamstring tendon autograft diameter and length for anterior cruciate ligament reconstruction. Am J Orthop (Belle Mead NJ). 2008;37(3):157–9.
28. Tuman JM, Diduch DR, Rubino LJ, Baumfeld JA, Nguyen HS, Hart JM. Predictors for hamstring graft diameter in anterior cruciate ligament reconstruction. Am J Sports Med. 2007;35(11):1945–9.
29. Bickel BA, Fowler TT, Mowbray JG, Adler B, Klingele K, Phillips G. Preoperative magnetic resonance imaging cross-sectional area for the measurement of hamstring autograft diameter for reconstruction of the adolescent anterior cruciate ligament. Arthroscopy. 2008;24(12):1336–41.
30. Hamada M, Shino K, Mitsuoka T, Abe N, Horibe S. Cross-sectional area measurement of the semitendinosus tendon for anterior cruciate ligament reconstruction. Arthroscopy. 1998;14(7):696–701.
31. Erquicia JI, Gelber PE, Doreste JL, Pelfort X, Abat F, Monllau JC. How to improve the prediction of quadrupled semitendinosus and gracilis autograft sizes with magnetic resonance imaging and ultrasonography. Am J Sports Med. 2013;41(8):1857–63.
32. Conte EJ, Hyatt AE, Gatt CJ Jr, Dhawan A. Hamstring autograft size can be predicted and is a potential risk factor for anterior cruciate ligament reconstruction failure. Arthroscopy. 2014;30(7):882–90.
33. Abe T, Loenneke JP, Thiebaud RS. Ultrasound assessment of hamstring muscle size using posterior thigh muscle thickness. Clin Physiol Funct Imaging. 2014 Nov 3.
34. Wernecke G, Harris IA, Houang MT, Seeto BG, Chen DB, MacDessi SJ. Using magnetic resonance imaging to predict adequate graft diameters for autologous hamstring double-bundle anterior cruciate ligament reconstruction. Arthroscopy. 2011;27(8):1055–9.
35. Aldrian S, Valentin P, Wondrasch B, Krusche-Mandl I, Ostermann RC, Platzer P, Hofbauer M. Gender differences following computer-navigated single- and double-bundle anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc. 2014;22(9):2145–52.
36. Sutton KM, Bullock JM. Anterior cruciate ligament rupture: differences between males and females. J Am Acad Orthop Surg. 2013;21(1):41–50.
37. Kuenze CM, Hertel J, Hart JM. Quadriceps muscle function after exercise in men and women with a history of anterior cruciate ligament reconstruction. J Athl Train. 2014;49(6):740–6.
38. Sandon A, Werner S, Forssblad M. Factors associated with returning to football after anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc. 2014 May 27.
39. Shelbourne KD, Liotta FJ. ACL reconstruction using an abnormally thick autogenous patellar tendon graft. Am J Knee Surg. 1999 Spring;12(2):79-81.
40. Johnson CH, Christensen JC. Biomechanics of the first ray. Part I. The effects of peroneus longus function: a three-dimensional kinematic study on a cadaver model. J Foot Ankle Surg. 1999;38(5):313–21.
41. Murley GS, Tan JM, Edwards RM, De Luca J, Munteanu SE, Cook JL. Foot posture is associated with morphometry of the peroneus longus muscle, tibialis anterior tendon, and Achilles tendon. Scand J Med Sci Sports. 2014;24(3):535–41.
42. Leiter JR, Gourlay R, McRae S, de Korompay N, MacDonald PB. Long-term follow-up of ACL reconstruction with hamstring autograft. Knee Surg Sports Traumatol Arthrosc. 2014;22(5):1061–9.
43. Alanen J, Orava S, Heinonen OJ, Ikonen J, Kvist M. Peroneal tendon injuries. Report of thirty-eight operated cases. Ann Chir Gynaecol. 2001;90(1):43–6.
44. Patterson MJ, Cox WK. Peroneus longus tendon rupture as a cause of chronic lateral ankle pain. Clin Orthop Relat Res. 1999;365:163–6.
45. Dombek MF, Lamm BM, Saltrick K, Mendicino RW, Catanzariti AR. Peroneal tendon tears: a retrospective review. J Foot Ankle Surg. 2003;42(5):250–8.
46. Eckert WR, Davis EA Jr. Acute rupture of the peroneal retinaculum. J Bone Joint Surg Am. 1976;58(5):670–2.
47. Wang XT, Rosenberg ZS, Mechlin MB, Schweitzer ME. Normal variants and diseases of the peroneal tendons and superior peroneal retinaculum: MR imaging features. Radiographics. 2005;25(3):587–602.
48. Rosenberg ZS, Bencardino J, Astion D, Schweitzer ME, Rokito A, Sheskier S. MRI features of chronic injuries of the superior peroneal retinaculum. Am J Roentgenol. 2003;181(6):1551–7.
49. Maffulli N, Ferran NA, Oliva F, Testa V. Recurrent subluxation of the peroneal tendons. Am J Sports Med. 2006;34(6):986–92.