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Original Research

Providing Graft Tension in ACL Reconstruction with Preservation of the Hamstring Tibial Attachment Site: A Report on the Technique and Clinical Results

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ABSTRACT

Objective: Hamstring autograft is the most commonly used graft in the surgical technique for anterior cruciate ligament reconstruction. Different femoral fixation materials can be used in this surgery. This study aimed to share the surgical technique for anatomic single-band anterior cruciate ligament reconstruction, preserving hamstring tibial attachment site and the clinical results.

Methods: Total 42 consecutive patients who were operated for anterior cruciate ligament rupture were included in the study. Anatomic single-band anterior cruciate ligament reconstruction was performed for patients without disjointing the hamstring distal attachment site. Patients were evaluated in terms of age, sex, four-arm tendon length, total tunnel length from the hamstring attachment site, femoral tunnel length, length of the graft in the femoral tunnel, and the average tendon length calculated as per the tunnel length. The mean follow-up duration was 17 months. The patients were evaluated clinically using the Tegner activity score, Lysholm score, and International Knee Documentation Scale (IKDC). The anterior translation of the tibia was evaluated with a KT 1000 device.

Results: The preoperative and postoperative mean Tegner, IKDC, and Lysholm scores were improved significantly.

Conclusion: The surgical method for anatomic single-band anterior cruciate ligament reconstruction with preservation of the hamstring attachment site is a useful technique. Moreover, this technique is cost-effective and did not increase patient morbidity.

Keywords: ACL reconstruction, graft tension, hamstring tendon preserving

INTRODUCTION

Hamstring autograft is the most commonly used graft in the surgical technique for anterior cruciate ligament reconstruction. Different femoral fixation materials can be used in this surgery (1, 2). In the anterior cruciate ligament reconstruction technique with Hamstring autograft, the graft is first removed from the attachment site. Thereafter, the graft is inserted through the tibial and femoral tunnel drilled with appropriate diamater and fixed on the femoral tunnel. Then, upon stretching from the tibial side, it is fixed in the tibial tunnel. Stretching is performed on the tibial side, and the fixation is ensured here. In this technique, graft rupture and pull out are possible early complications (3). It is known that the hamstring graft undergoes necrosis in 4 weeks during its ligamentization, after which it is revascularized and ligamentized (3, 4). During this period, the graft is weak, and there is a possibility of rupture (3). On the tibial side, there is a risk of pulling out of the graft before the graft tunnel is completely healed (3). In our study, we harvested the hamstring autograft, preserving the tibial attachment site, and have shared our results of the anterior cruciate ligament reconstruction surgery. We used the ToggleLoc Fixation Device with ZipLoopTechnology by Biomet Orthopedics 56 East Bell Drive P.O. Box 587 Warsaw, Indiana 46581 USA for femoral fixation. Owing to the use of this device and the measurements we performed during the surgery, we ensured graft tension and completed the surgery. The clinical results of this surgery are shared in this report.

METHODS

This was a retrospective study. All the procedures performed in studies involving human participants were as per the ethical

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standards of the institutional and national research committees and the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from the subjects enrolled in the study.

Total 42 adult patients who underwent single-band anatomic anterior cruciate ligament reconstruction with a 4-arm hamstring autograft at the Orthopedics and Traumatology Clinic between January 2016 and December 2017 were included in this study retrospectively. For the dependent groups, t-test was used. Mean and standard deviation values were calculated as descriptive statistics, and a $p<0.05$ was considered to indicate statistical significance.

Surgical treatment was indicated for patients with positive (+) Lachman test result in the physical examination, a complaint of instability, and anterior cruciate ligament rupture in the MRI. All the patients were operated by the same surgeon. The patients who had undergone anterior cruciate ligament reconstruction surgery previously were excluded. The patients were evaluated in terms of age, sex, four-arm tendon length, total tunnel length from the hamstring attachment site, femoral tunnel length, length of the graft in the femoral tunnel, and the average tendon length calculated as per the tunnel length. The mean follow-up period was 17.86±5.266 months. The patients were clinically evaluated before the operation and at the last visit after the operation with the IKDC subjective evaluation score, Lysholm score, and Tegner activity score. The anterior translation of the tibia was measured with a KT 1000 device.

Surgical Technique

Diagnostic arthroscopy was performed from the inferolateral and inferomedial portals opened after sterile preparation of the patient's knee. Anterior cruciate ligament rupture was detected, and grafting was initiated. The hamstring tendons were reached by an approximately 5 cm longitudinal incision opened from the distal to the tibial tuberosity over the hamstring tendons. The fascia was opened, and the tendons (gracilis and semitendinosus)

Main Points:

- The most important advantage of the technique we describe in our study is to leave a distance of 1 centimeter to ensure the tension of the hamstring autograft to be placed thanks to the calculation of the distance from the hamstring tendon sticking point to the button apparatus used for femoral fixation with completely mathematical calculations. Thus, the failure of ACL reconstruction technique with preserving tendon attachment site to maintain the graft tension is eliminated by our technique.
- The fact that no graft rupture occurs as a result of the anterior cruciate ligament reconstruction technique that we have described supports that the preservation of the tendon adhesion site does not disrupt the feeding of the graft and increases the graft incorporation.
- Another advantage of the described technique is that it is cost effective since fixation material is not required in the tibial tunnel.

Figure 1. a, b. Measuring the distance from origin of the hamstring adhesion site to beginning of the femoral tunnel.

were removed with an open-ended tendon scraper without disjointing the tibial attachment site. Tendons were removed from the muscle tissue and folded over themselves to obtain a four-arm tendon graft. Graft thickness and length were measured. Then, the second inferomedial portal was opened, and the camera was moved to this portal. The knee was flexed 90°. Using the freehand technique, the guide wire was advanced to the femoral tunnel from approximately 2 mm anterior of the stump of the anteromedial band. The wire was removed from the lateral of the thigh. The tunnel required for the fixation button of the ZipTight Fixation device (Biomet, Warsaw, IN) to pass was opened with a 5-mm drill. The length of the tunnel was measured, and the femoral tunnel was opened where the graft would be placed in a way that it was 5 mm shorter than the length of the tunnel. The guide wire was

Figure 2. View of prepared 4-arm Hamstring graft

Figure 3. Control of graft tension at the end of surgery

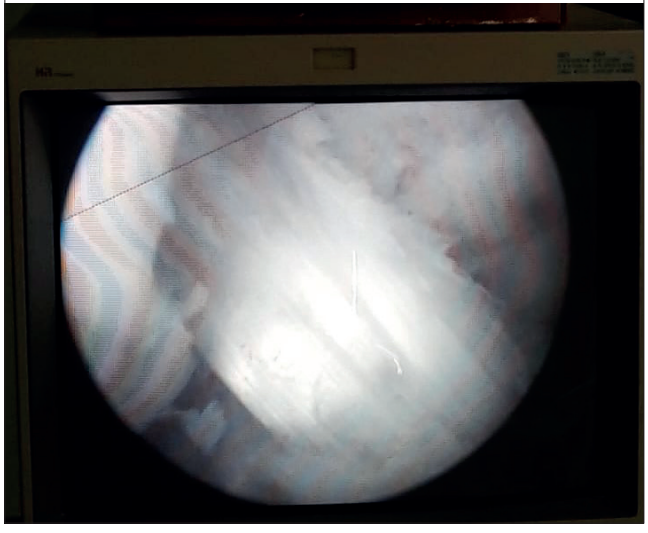
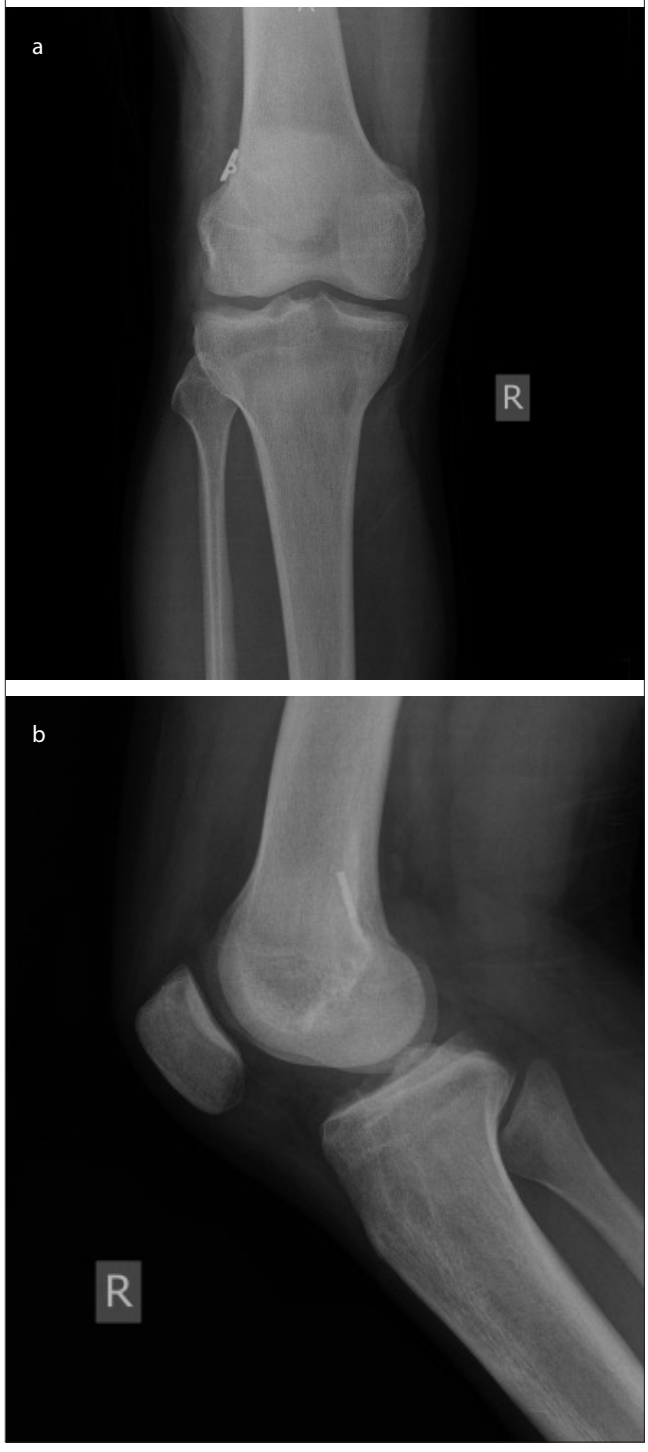


Figure 4. a, b. Postoperative anteroposterior and lateral knee radiographs



withdrawn from the lateral thigh so that the other end of the wire was at the intraarticular origin of the femoral tunnel. The knee was again flexed 90°. The tibial tunnel was opened using a 55-degree tibial tunnel guide based on footprint, and the distance from the hamstring attachment site to the femoral tunnel was measured (Figure 1a, b). The femoral tunnel length was added to this measurement, and the average length was determined. The length of the graft was prepared to be 1.5 cm shorter than this measured value (5 mm healthy bone tissue length left at the end of the femoral tunnel and 1 cm length required to stretch the tendon). The 4-fold hamstring tendon was first suspended in the rope system of the ZiptTight Fixation device (Biomet, Warsaw, IN) graft stretching was performed with a sterile ruler. The ruler was leaned against the hamstring attachment site and held parallel to the graft, and the graft was sutured using absorbable sutures from the distal in a way that its length was 1.5 cm shorter than the measured tunnel length (Figure 2). A marker suture was placed on the graft length point within the femoral tunnel, proximal to the graft. The ropes of the ZipTight Fixation device (Biomet, Warsaw, IN) that would allow the graft to pass through the tunnels and ensure fixation in the femoral tunnel, were sent through the tibial tunnel into the joint with the help of a grasper; the ropes were moved out using a discharge cannula placed in the anteromedial portal. The knee was flexed to 120°, and the guide wire in the femoral tunnel was pushed out of the discharge cannula. The ropes of the ZipTight Fixation device (Biomet, Warsaw, IN) were threaded through this end of the wire that had a hole, and the ropes were pulled from the end on the lateral of the thigh and taken to the lateral of the thigh. The knee was flexed 90°, and the button of the ZipTight Fixation device (Biomet, Warsaw, IN) was passed through the cortex in the femur lateral and rolled over. After the position of the button was monitored with a single-dose fluoroscope, the ropes of ZipTight Fixation device (Biomet, Warsaw, IN) to shift the graft into the femoral tunnel were taken from the anteromedial portal. The ropes suitable for the axis of the femoral tunnel were retracted, and the graft was placed in the tibial and femoral tunnel. With the optical camera, the marker suture on the graft was observed, and the graft was completely placed in the femoral tunnel. We checked the stretching of the graft. Then, the knee was flexed 30°, and the ropes in the medial port were retracted. We checked the tension of the graft again (Figure 3). At this stage, it was determined that the marker suture was lost in the tunnel in all patients. Intraarticular washing was performed, and hemovac drains were placed in the graft-harvesting site and the joint. The portals and the wound were closed (Figure 4, 5). No kneepad was used, they were given partial weight bearing with crutches the following day, and quadriceps exercises were described. Knee Range Of Motion was planned to be complete after 3 weeks and full weight bearing was planned after 3 weeks. The sutures were taken at 2 weeks. Routine control follow-up was performed at 4, 6, 8, and 12 weeks, and at 3 and 6 months. The subjects were allowed to climb up the stairs after 8 weeks, flat race after 3 months, and participate in pivot sports after 6 months. At the end of the study, the patients were called for a final follow-up.

Clinical evaluation was performed, using the Tegner activity score, Lysholm score, and IKDC subjective evaluation score. Anterior tibial translation objective measurement was performed using a KT 1000 device. Clinical evaluation tests and anterior tibial translation measurement with KT 1000 device were performed preoperatively and postoperatively at the last follow-up. T-test was used for the statistical analyses.

RESULTS

The mean age of the patients was 29.33±8.714 years. There were 39 male and 3 female patients. Meniscus injury was detected in 19 patients; 7 of these patients had bucket handle medial meniscal tear, and these tears were repaired using the inside-out suture technique. The remaining 12 patients underwent partial meniscectomy. The mean duration of the tourniquet application was determined as 57.52±5.190 minutes. The mean graft thickness was 7.774±0.8968 mm, the mean four-arm hamstring tendon length was 130.40±7.626 mm, the mean tunnel length was 137±5.548 mm, the mean femoral tunnel length was 40.76±2.335 mm, the length of the graft in the femoral tunnel was 25.76±2.335 mm, and the mean graft length calculated according to the tunnel length was 122.12±6.122 mm. The mean follow-up duration was 17.86±5.266 months. While the preoperative mean Tegner activity score was 3.79±0.725, that at the last follow-up was 5.81±0.64; the preoperative IKDC subjective evaluation score was 55.39±8.418 and that at the last follow-up was 84.57±6.421; the preoperative Lysholm score was 46.29±8.819 and that at the last follow-up was 95.92±2.421. The preoperative anterior translation of the tibia using the KT 1000 device was 11.05±1.607 mm and the value at the last follow-up was 4.01±1.041 mm. The change in all the scores was statistically significant. No avulsion in the hamstring tibial attachment site occurred; further, no fracture and relaxation or loosening in the cortical area of the preoperative femur were detected in any patient. Infection, surgical site infection, graft re-rupture, and pull out were not observed in the patients.

DISCUSSION

In the literature, there are studies of anterior cruciate ligament reconstruction with hamstring autograft applied with preservation of the hamstring tibial attachment site (1-3, 5-9). In these studies, interference screw, staple, and a combination of interference screw and staple were used for tibial fixation. In 2 studies, no fixation was used on the tibial side (3, 9). For the femoral fixation, endobutton (8) and interference screw (3, 9) were used. In one study, the inside-out femoral tunnel was opened (with flip cutter), and the second-generation cortical suspensory device (7) was used. In our study, no fixation was used on the tibial side, and the ZipTight Fixation device (Biomet, Warsaw, IN) was used for the femoral side. This system allows fixation on the femoral lateral cortex with a button and is a system where the ropes are pulled into the femoral tunnel and self-tied in the tunnel.

An important problem in the studies of anterior cruciate ligament reconstruction that preserve the hamstring tibial attachment site seems to be the inability to ensure graft stretching. In the study performed by Sinha et al. (3), graft stretching was achieved by manual stretching of the graft from the femoral side, and femoral fixation was performed with an interference screw so that it would be outside in. In this technique of preserving the hamstring tendon attachment site, the femoral tunnel was

opened outside in and the grafts were passed from both the tunnels without calculating the tunnel and graft lengths. Graft tension was obtained manually from the femoral side, and the graft was fixed outside in. In this technique, it is difficult to find a solution to problems, such as shortness of the graft because the length of the graft and tunnels is not calculated. If the graft length is short, fixation and graft tension will be difficult (4). In the study by Ali et al. (8), in cases where the stretching was insufficient, stretching was achieved with stitch tapes passed from the hamstring attachment site to the tendons, and fixation was achieved with a staple on the tibial side. An important attribute of our study is that the tunnel length was calculated, and the graft was prepared to be 1 cm shorter than the tunnel length; further, a distance of 1 cm was left in the tunnel for graft stretching. The stretching of the graft was checked manually using the manual probe at the hamstring tendon attachment site after the completion of the surgery. There might be a question regarding the reason for leaving a distance of 1 cm for graft stretching. The study by Kim et al. on intraoperative graft isometry was used as a reference for this length (10). In this study, when the graft was retracted with 30 Ibs power in 30° of flexion, the change in the length of the graft at the exit of the tibial tunnel was investigated, and a graft length change between 0.4 and 0.6 mm was observed. Therefore, in our study, a 1-cm stretching share was found appropriate for the graft in the femoral tunnel. Moreover, in our study, a tunnel with a diameter equal to that of the graft was opened, and the graft was fitted to the tunnel.

The hamstring graft is revascularized in 6–12 weeks (3, 11, 12). There is a possibility of early rupture or pullout of the graft due to problems in graft tunnel healing (13). Separation of the tibial attachment site facilitates the biological healing of the tendon in the tunnel (14). Preservation of the tibial attachment site in the hamstring increases the tendon feeding by not disturbing the feeding of the tendon from the inferior geniculate artery (15). The hamstring tendon has longitudinal blood vessels that are located at the junction of the osteotendinous and the proximal musculotendinous. The proximal musculotendinous part is detached while harvesting the graft with this technique; therefore, the avascular necrosis is expected to occur only in the proximal detachment part (3, 15). In the animal experiment by Papachristion, it was observed that the necrosis was bypassed with this technique and feeding was provided, thus increasing the graft viability (16). Ruffili et al. (7) investigated the contribution of anterior cruciate ligament reconstruction with preservation or detachment of the hamstring tibial attachment site to the graft ligamentization. With a magnetic resonance imaging examination performed at the postoperative 6th month, the graft ligamentization was compared and it was argued that the preservation of the hamstring tibial attachment site increased intraarticular ligamentization. The need for better-designed studies was also reported (8). Therefore, it can be concluded that the risk of early graft rupture was lower with this technique; this result was also observed in our study wherein there were no cases of graft rupture.

Moreover, studies suggest that anterior cruciate ligament reconstruction surgery with preservation of the tibial attachment site is applicable and provides clinically superior results (3, 7-9). The point we observed in these studies is the uncertainty in providing graft stretching. The graft length was achieved using mathematical measurements in our technique, and stretching was achieved by applying a manual force, such as anterior cruciate ligament reconstruction performed with classical hamstring autograft, enabled by the femoral fixation system. In this technique, the graft was fit to the tunnel because a tunnel diameter that was equal to the thickness of the graft was opened.

CONCLUSION

The clinical result of the anatomic single-band anterior cruciate ligament reconstruction with preservation of hamstring tibial attachment site is a successful surgical procedure. The disadvantage is the difficulty in performing the grafting technique and the long surgical duration because arthroscopic treatment cannot be continued during the tunnel distance measurements and graft preparation. The advantages include those reported in the literature, such as superior graft feeding and viability, ability to achieve graft stretching without any additional incisions, and cost-effectiveness (given that there is no additional fixation on the tibial side). Research shows that the disadvantage of the surgical technique is the difficulty in ensuring graft tension; the ZipTight Fixation device (Biomet, Warsaw, IN) used in this study successfully achieved tensioning the graft without increasing patient morbidity.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of SANKO University (Date 03.10.2019, Decision number: 02).

Informed Consent: Informed consent was obtained from the subjects enrolled in the study.

Peer-review: Externally peer-reviewed.

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REFERENCES

1. Buda R, Ruffili A, Vannini F, Parma A, Giannini S. Anatomic anterior cruciate ligament reconstruction using distally inserted doubled hamstring tendons. Orthopaedics 2013; 36: 449-53. [CrossRef]
2. Marcacci M, Zaffagnini S, Giordano G, Iacono F, Presti ML. Anterior cruciate ligament reconstruction associated with extraarticular tenodesis: a prospective clinical and radiographic evaluation with 10 to 13 year follow up. Am J Sports Med 2009; 37: 707-14. [CrossRef]
3. Sinha S, Naik AN, Maneshwari M, Sandansniv S, Meena D, Arya RK. Anterior cruciate ligament reconstruction with tibial attachment preserving hamstring graft without implant on tibial side. Indian J Orthop 2018; 53: 170-6.
4. Janssen RP, Scheffler SU. Intraarticular remodelling of hamstring tendon grafts after anterior cruciate ligament reconstruction. Knee Surg Sports Traumato Arthrosc 2014; 22: 2102-8. [CrossRef]

5. Löcherbach C, Zayni R, Champat P, Sonnery-Cotet B. Biologically enhanced ACL reconstruction. Orthop Traumatol Surg Res 2010; 96: 810-5. [CrossRef]
6. Wagih AM. Anatomic double bundle anterior cruciate ligament reconstruction using in situ hamstring graft with 4 tunnels. Arthrosc Tech 2014; 3: e49-56. [CrossRef]
7. Ruffili A, Pagliazzi G, Ferranti E, Busacca M, Capanelli D, Buda R. Hamstring graft tibial insertion preservation versus detachment in anterior cruciate ligament reconstruction: a prospective randomized comparative study. Eur J Orthop Surg Traumatol 2016; 26: 657-64. [CrossRef]
8. Ali MS, Kumar A, Adnaan Ali S, Hislop T. Anterior cruciate ligament reconstruction using hamstring tendon graft without detachment of the tibial insertion. Arch Orthop Trauma Surg 2006; 126: 644-8. [CrossRef]
9. Sacramento SN, Magalhaes E, Christel P, Ingham S, Fukuda TY. A new technique in double bundle anterior cruciate ligament reconstruction with implant free tibial fixation. Knee Surg Sports Traumatol Arthrosc 2016; 24: 2831-7. [CrossRef]
10. Kim YK, Yoo JD, Kim SW, Park SH, Cho JH, Lim HM. Intraoperative graft isometry in anatomic single-bundle anterior cruciate ligament reconstruction. Knee Surg Relat Res 2018; 30: 115-20. [CrossRef]
11. Lane JG, McFadden P, Bowden K, Amiel D. The ligamentization process: A 4 year case study following ACL reconstruction with a semitendinosis graft. Arthroscopy 1993; 9: 149-53. [CrossRef]
12. Goradia VK, Rochat MC, Kida M, Grana WA. Natural history of a hamstring tendon autograft used for anterior cruciate ligament reconstruction in a sheep model. Am J Sports Med 2000; 28: 40-6. [CrossRef]
13. Deehan DJ, Cawston TE. The biology of integration of the anterior cruciate ligament. J Bone Joint Surg Br 2005; 87: 889-95. [CrossRef]
14. Doschak MR, Zenicke RF. Structure, function and adaptation of bone-tendon and bone-ligament complexes. J Musculoskelet Neuronal Interact 2005; 5: 35-40.
15. Zaffagnini S, Golanio P, Farinas O, Depasquale V, Strocchi R, Cortecchia S, et al. Vascularity and neuroreceptors of the pes anserinus: anatomic study. Clin Anat 2003; 16: 19-24. [CrossRef]
16. Papachristou G, Nikolau V, Efstathopoulos N, Sourlas J, Lazarettos J, Frangia K, et al. ACL reconstruction with semitendinosus tendon autograft without detachment of its tibial insertion: a histologic study in a rabbit model. Knee Surg Sports Traumato Arthrosc 2007; 15: 1175-80. [CrossRef]