The graft rotation technique is a good option to avoid graft tunnel mismatch during ACL reconstruction with BPTB graft

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Abstract

Backgrounds: The graft tunnel mismatch is a well-known complication of bone-patellar tendon-bone (BPTB) graft in anterior cruciate ligament reconstruction (ACLR) surgery. In the present study, graft rotation technique is used to tackle this problem.

Aim: The present study was conducted to study the effect of this technique on functional outcomes and graft failure rate.

Methods: Ninety-nine patients who underwent ACL reconstruction using BPTB graft were enrolled in the study and depending upon the graft length these patients were divided into 2 groups. Group A-patients had no graft tunnel mismatch(n=67) and group B-patients had graft tunnel mismatch (n=32). In group B patients, the graft was rotated inside the tibial tunnel to manage the graft tunnel mismatch problem. Functional outcomes (Lysholm score and return to sports), knee laxity (KT-1000 difference), and graft rupture rate were compared between two groups.

Results: The mean KT-1000 difference in group A was 2.11 mm and in group B was 2.03 mm (n.s.). There was no significant difference in mean Lysholm score (97 vs 97.3; $p>0.05$). 78% (49/67) of patients in group B and 73% (25/32) of patients in group A returned to the same or above level of pre-injury activity (n.s). The graft failure rate was 6% (4/67) in group A and 3% (1/32) in group B.

Conclusions: Rotation of graft inside the tibial tunnel is an effective way to deal with graft tunnel mismatch.

Introduction

Anterior cruciate ligament (ACL) tear is a common injury among athletes[1]and ACLR using hamstring tendon graft or bone-patellar tendon graft is the treatment of choice for this injury. Hamstring tendon graft is recently getting more popular due to less donor site morbidity as compared to bone-patellar tendon-bone (BPTB) graft[2]. However, BPTB graft is still considered a gold standard graft for athletes, as it is associated with early and higher return to sports and fewer chances of graft rupture[3]. ACLR with BPTB graft is associated with some technical problems also like graft tunnel mismatch[4]. Patellar tendon height is variable and it depends upon number of factors like gender, patient height, ethnicity, etc. [5–7]. Therefore, during ACL reconstruction surgeon often experiences the problem of extruding bone outside the tibial tunnel which need to be cut and that can leads to poor bone-to-bone tunnel healing as there is a smaller bone plug inside the tunnel[8, 9]. Graft-tunnel mismatch is a well-described complication in the literature with incidence as high as 81%[10]. Previously various probable solutions like pre-operative anthropometric measurements, calculation of patellar tendon length on MRI, etc. were described [4, 10]. Grawe et al. in their technique to avoid bone tunnel mismatch suggest using bone plug inside the femoral tunnel only while soft tissue graft inside the tibial tunnel (avoid harvesting patellar plug)[11]. However, with this technique, timing of graft integration inside the femoral (bone-to-bone healing) and tibial tunnel (soft tissue to bone healing) will be different.

Till now there is no full-proof method to prevent graft tunnel mismatch, therefore, the surgeon needs to improvise during surgery. Rotation of graft inside the tibial tunnel to reduce the graft length is one such technique to counter the graft tunnel mismatch. The present study aimed to study the effect of graft rotation technique on the functional outcomes, knee stability, and graft rupture rate. We hypothesized that rotated graft provides better knee stability and functional outcomes as braiding increases the tensile strength.

Methods

The present study was a prospective study, conducted after the institutional ethical committee approval. Inclusion criteria were professional sportsperson, ACLR with BPTB graft, and age 16-40 years. Patients having multi-ligamentous injury, skeletally immature, previously operated on the same knee, or having dysplastic patella were excluded from the study. Written and informed consent was received from all the patients. 106 athletes were included in the study. Patients were divided into two groups depending upon the graft tunnel mismatch- group A- patients who did not have any graft tunnel mismatch and group B- patients who had graft tunnel mismatch. In group B patient graft tunnel mismatch was corrected by rotation of graft inside the tunnel. All patients underwent similar rehabilitation programs. The Lysholm score was used to assess the functional outcomes. Knee laxity was checked using KT-1000 arthrometer and the difference in anterior translation between the normal knee and operated knee was calculated as KT-1000 difference. All patients were followed up for a minimum of 36 months.7/106 patients were lost to follow-up.

Surgical technique

This technical note presents the technique to correct the graft tunnel mismatch. Graft is rotated inside the tibial tunnel after fixing the graft inside the femoral tunnel. With this technique not only does protruding bone go inside the tibial tunnel, but it also strengthens the intra-articular part of the patellar tendon, as fibers change the linear to breaded alignment.

Technique

Diagnostic arthroscopy was done using a standard anterolateral and anteromedial portal. After managing the meniscal tears and confirming the ACL tear, BPTB graft was harvested. A single midline incision was given starting 1 cm above the inferior pole of the patella till 2 cm medial to the tibial tuberosity. Bone block of 10×25 mm from tibial tuberosity and 10×20 mm from patella was harvested. The diameter of the graft was kept at 10 mm. A larger bone block harvested from tibial tuberosity was marked at the bony tendon junction with a sterile marking pen. The graft was prepared, two holes at 90 degrees were made in bone plugs on each side and ethibond no.5 was passed through these holes. A femoral tunnel was made using transportal technique and a tibial tunnel was made with ACL tibial jig. Ethibond loop was passed through femoral tunnel and tibial tunnel. Tibial tuberosity bone block was kept inside the femoral tunnel and patellar bone block was kept inside the tibial tunnel. After passing the graft through femoral tunnel till the marked point went inside the tunnel, graft was then fixed inside the femoral

tunnel with the help of screw. Then knee was kept at 30 degrees of knee flexion and maximum pull was given to threads attached to bone block at tibia end. At this moment protrusion of bone outside the tibial tunnel was checked (figure 1). If the bone was protruding outside the tibial tunnel, we rotated the graft inside the tunnel to shorten the graft length (figure 2,).

Statistical analysis

The quantitative data were presented as mean and standard deviation. Quantitative data (Mean age, BMI, Lysholm score, and KT-1000) were analyzed using student's T-test. Categorical variables were presented as counts and percentages. The categorical data were analyzed using the Chi-squared test. All statistical analyses were performed at a significance level of $\alpha=0.05$.

Results

The ACL reconstruction using BPTB graft was performed on 106 patients. 34/106 patients had graft tunnel mismatch. In all these patients rotation of graft was done to avoid graft tunnel mismatch. The mean age was 24.8 years. 90 were males and 9 were females. The mean KT-1000 difference in group A was 2.11 mm and in group B was 2.03 mm (n.s.). At the final follow-up, mean Lysholm scores were comparable between two groups. 78% of patients in group B and 73% of patients in group A returned to the same or above level of pre-injury activity. The graft failure rate was 6% in group A and 3% in group B. average graft rotation required was 480 degrees.

Discussion

We presented a simple technique to avoid graft tunnel mismatch. The rotation of graft inside the tibial tunnel is an effective way to deal with graft tunnel mismatch without having any negative effect on functional outcomes and graft rupture rate.

Graft tunnel mismatch is a common problem, in the present study, 32% of patients had longer graft. The reason for graft tunnel mismatch is the longer length of patellar tendon as compared to ACL[12, 13]. Another possible cause of graft tunnel mismatch is a creation of femoral tunnel using a far medial portal, which produces smaller femoral tunnel[14].

Graft healing inside the bone tunnel is a very important process as it can affect functional outcomes. BPTB graft heals early than soft tissue graft inside the bone tunnel as bone-to-bone union occurs early as compared to bone-to soft tissue union[15]. Bone patellar tendon graft heals by primary bone healing, therefore, it is important to have sufficient bone-to-bone contact inside the tunnels. This technique is useful in increasing bone-to-bone contact inside the tibial tunnels without compromising graft tension. Another advantage of the present study was turning straight intra-articular graft into breaded structure. Breaded structure has more strength than non-breaded structures. Use of small length bone block or cutting the excessive bone or compromising on the tensioning of graft are some methods to counter the graft tunnel mismatch. However, with this technique, larger bone blocks can be used and graft can be

tension adequately. Larger bone block will allow early and strong healing of graft inside the tibial tunnel. In the present study, functional outcomes, knee laxity, and graft rupture rate were comparable among two groups. Although these results reject the author's hypothesis, there is still scope for biomechanical study or cadaveric study to see the effect of braiding on knee stability.

Most of the previous studies about the minimum graft length inside the tibial tunnel were done using a soft tissue graft. Li Q et al. in their animal study reported that there is a delay in histological maturity and biomechanical strength if the graft inside the tibial tunnel is less than 15 mm[16]. Currently, there is no literature available about the minimum required bone plug length inside the tibial tunnel. Therefore, there is no consensus regarding the minimum bone plug length inside the tibial tunnel. The present technique can help in achieving maximum bone-to-bone contact inside the tibial tunnel without compromising graft tensioning.

This study had some limitations: - Firstly, the number of patients in graft tunnel mismatch cohort was small. Secondly, a comparative study is needed that compared the patients with graft tunnel mismatch who underwent ACL reconstruction with smaller length bone plug and patients who underwent rotation of graft to maintain large bone plug.

Conclusions

Rotation of graft inside the tibial tunnel is an effective way to deal with graft tunnel mismatch during ACL reconstruction with BPTB graft.

Declarations

Conflict of interest: Authors have no conflict of interest.

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Informed consent: Informed and written consent was received from all the patients

References

1. Moses B, Orchard J, Orchard J. Systematic review: annual incidence of ACL injury and surgery in various populations. Res Sports Med 2012;20(3-4):157-79.
2. Gupta R, Kapoor A, Soni A, Khatri S, Masih GD, Raghav M. No Difference in Outcome of Anterior Cruciate Ligament Reconstruction with “Bone-patellar Tendon-bone versus Semitendinosus-gracilis Graft with Preserved Insertion”: A Randomized Clinical Trial. Indian J Orthop 2020;54(5):665-71.
3. Gupta R, Kapoor A, Soni A, Khatri S, Masih GD. Anterior cruciate ligament reconstruction with bone–patellar tendon–bone graft is associated with higher and earlier return to sports as compared to

hamstring tendon graft. Knee Surg Sports Traumatol Arthrosc 2020;28:3659-65.

4. Boddu C, Arif S, Hussain M, Sankaranarayanan S, Hameed S, Sujir P. Prevention of graft-tunnel mismatch during anatomical anterior cruciate ligament reconstruction using a bone-patellar tendon-bone graft. Bone Jt J 2015;97(3):324-8.
5. Goldstein JL, Verma N, McNickle AG, Zelazny A, Ghodadra N, Bach Jr BR. Avoiding mismatch in allograft anterior cruciate ligament reconstruction: correlation between patient height and patellar tendon length. Arthroscopy 2010;26(5):643-50.
6. Brown JA, Brophy RH, Franco J, Marquand A, Solomon TC, Watanabe D, et al. Avoiding allograft length mismatch during anterior cruciate ligament reconstruction: patient height as an indicator of appropriate graft length. Am J Sports Med 2007;35(6):986-9.
7. Navali AM, Jafarabadi MA. Is there any correlation between patient height and patellar tendon length?Arch Bone Jt Surg 2015;3(2):99.
8. Shaffer B, Gow W, Tibone JE. Graft-tunnel mismatch in endoscopic anterior cruciate ligament reconstruction: a new technique of intraarticular measurement and modified graft harvesting. Arthroscopy 1993;9(6):633-46.
9. Spindler KP, Bergfeld JA, Andrish JT. Intraoperative complications of ACL surgery: avoidance and management. Orthopedics 1993;16(4):425-30.
10. Ko D, Kim H-J, Oh S-H, Kim B-J, Kim S-J. How to Avoid Graft-Tunnel Length Mismatch in Modified Transtibial Technique for Anterior Cruciate Ligament Reconstruction Using Bone-Patellar Tendon-Bone Graft. clinc orthop surg 2018;10(4):407.
11. Grawe B, Smerina A, Allen A. Avoiding Graft-Tunnel Length Mismatch in Anterior Cruciate Ligament Reconstruction: The Single–Bone Plug Technique. Arthroscopy Techniques 2014;3(3):e417-e20. https://doi.org/https://doi.org/10.1016/j.eats.2014.04.003.
12. Robin BN, Lubowitz JH. Disadvantages and advantages of transtibial technique for creating the anterior cruciate ligament femoral socket. J Knee Surg 2014;27(05):327-30.
13. , , , . The calculation of the tibial tunnel depth in the endoscopic ACL reconstruction. Knee Surg Relat Res 1995; 7(1):21-25
14. Tudisco C, Bisicchia S. Drilling the femoral tunnel during ACL reconstruction: transtibial versus anteromedial portal techniques. Orthopedics 2012;35(8):e1166-e72.
15. Rodeo SA, Arnoczky SP, Torzilli PA, Hidaka C, Warren RF. Tendon-healing in a bone tunnel. A biomechanical and histological study in the dog.JBJS 1993;75(12):1795-803.
16. Qi L, Chang C, Jian L, Xin T, Gang Z. Effect of varying the length of soft-tissue grafts in the tibial tunnel in a canine anterior cruciate ligament reconstruction model. Arthroscopy 2011;27(6):825-33. https://doi.org/10.1016/j.arthro.2011.01.016.

Tables

Table 1: Demographic and functional outcomes comparison between group A and B

	Group A (n=67)	Group B (n=32)	P-value
Mean Age (years)	24.76±5.01	25±5.13	n.s.
BMI (kg/m$^{2)}$	22.54±4.75	22.3±4.64	n.s.
KT-1000 difference (mm)	2.11±1.62	2.03±1.59	n.s.
Lysholm Score	97±4.62	97.3±4.62	n.s.
Return to sports	49/67 (73%)	25/32 (78%)	n.s
Graft failure	4 (6%)	1 (3%)	n.s.
Loss to follow-up	5	2	

Figures

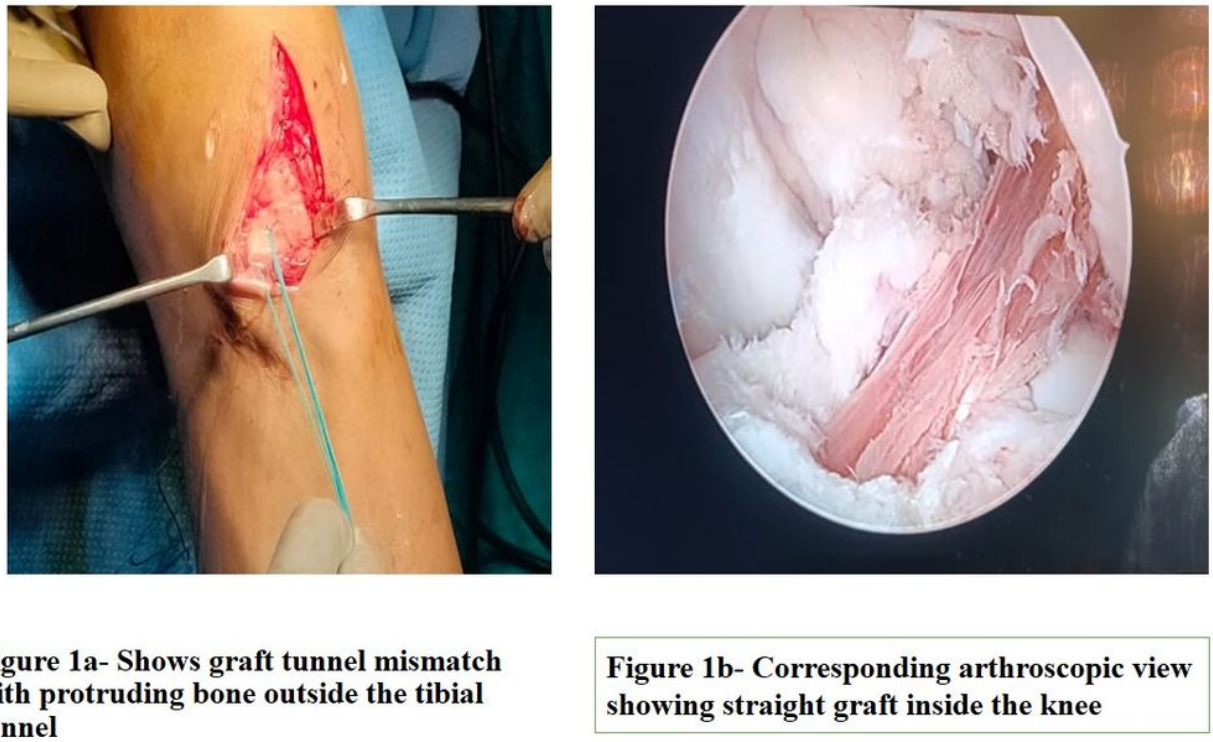

Figure 1

See image above for figure legend.

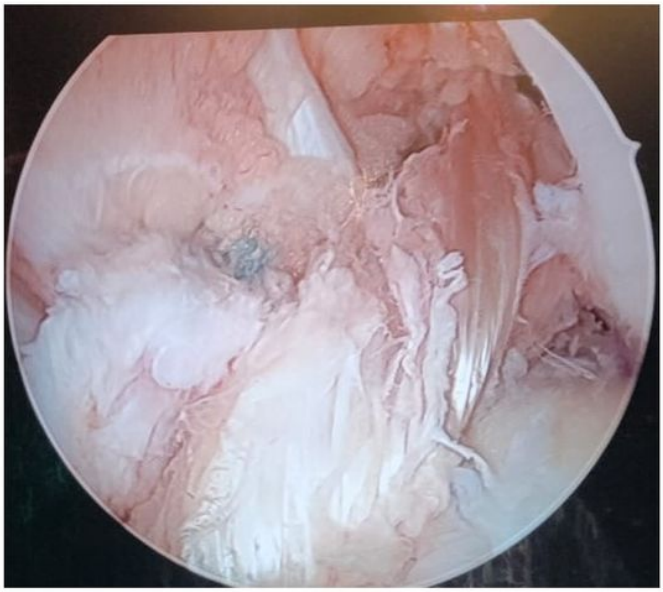

Figure 2- Arthroscopic view showing breaded graft formed after rotation of graft inside the tibial tunnel

Figure 2

See image above for figure legend.