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Randomized Controlled Study Comparing Hamstring Graft and Peroneus Longus Tendon Graft in Arthroscopic ACL Reconstruction

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Learning Point of the Article:

The study suggests that a peroneus longus tendon graft might be better than a hamstring tendon graft in ACL reconstruction due to larger graft diameter, shorter harvesting time, faster return to sports, and potentially better patient-reported outcomes, although more research is needed.

Abstract

Introduction: Graft choice for anterior cruciate ligament reconstruction (ACLR) has been evolving. The peroneus longus tendon (PLT) has been seen as a suitable choice for ACLR, providing comparable results to those of hamstring tendon (HT) autograft, but its clinical relevance in terms of return to sports, to our knowledge, has not been studied.

Materials and Methods: One hundred and twenty patients who sustained an isolated ACL injury were enrolled and underwent ACLR using tripled or quadrupled PLT autograft (if graft thickness exceeded 10 mm then tripled) or quadrupled HT autograft. Patients were followed for 24 months. Functional scores (International Knee Documentation Committee [IKDC] and Tegner–Lysholm scores) were assessed preoperatively and at 3, 6, 12, and 24-month post-operatively. Graft diameter and graft harvesting time were measured intraoperatively. Donor-site morbidity was evaluated using subjective evaluation. Time to return to sports in both groups was compared.

Results: The mean diameter of the PLT autograft was significantly larger than that of the HT autograft, and the mean graft harvesting time was less ($P < 0.001$). Patients in the PLT group returned to sports a mean of 36 days earlier than those in the HT group ($P < 0.001$) and had a lower rate of donor-site morbidity, and better patient-reported outcomes at the knee ($P < 0.001$). There was a significant difference between the groups in IKDC and Tegner-Lysholm scores at the 24-month follow-up.

Conclusion: Despite some donor site complications, such as numbness and infection, both PLT and HT grafts offer acceptable knee stability. However, PLT grafts seem to provide superior subjective functional outcomes based on patient-reported scores. More research is needed to further establish these findings and optimize graft choices for individual patients.

Keywords: Anterior cruciate ligament reconstruction, graft choice, peroneus longus tendon, hamstring tendon, functional outcomes, donor site morbidity.

Introduction

The anterior cruciate ligament (ACL) is the most often injured ligament in the knee joint, with a population incidence of 1 in 3500 [1]. The majority of ACL injuries occur during participating in agility sports and almost half of them are accompanied by injury to other knee structures. The ACL reconstruction is the current gold standard treatment for ACL injury.

The "ideal graft" for ACL reconstruction is still a topic of debate. An ideal donor graft must have an acceptable strength, and adequate size, and should be easily and safely harvested. A variety of autograft options are available in ACL reconstruction each

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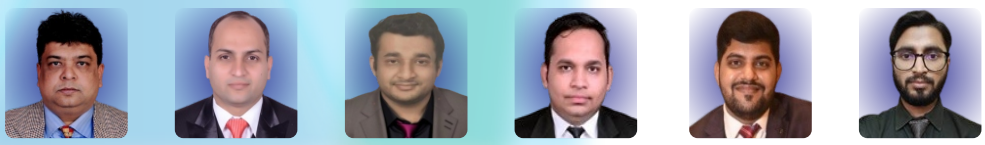

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having its own set of injury and patient-specific factors that must be addressed before surgery. It should be noted that any autograft used for ACL reconstruction loses 50% of its strength after recollagenation and revascularization [2]. Therefore, an autograft substituting ACL must be stronger than the native ACL.

The most commonly used graft in ACL reconstruction in athletes is the bone-patellar tendon-bone (BPTB) graft and the overall most common is the hamstring tendon (HT) graft [3]. However, due to their various shortcomings, the search for an ideal donor graft is still on-going, which should have strength and properties close to the native ACL and should be easily and safely harvested without any donor site side effects.

Recent studies have shown that the peroneus longus tendon (PLT) has shown potential as a better substitute because of its tensile strength and the potential for regeneration post-replacement. PLT is easily harvested at ankle level without significant donor site morbidity because PLT and peroneus Brevis tendons have synergistic actions and peroneus brevis is a more effective ankle evertor than PLT. Both PLT graft and HT graft have demonstrated good clinical outcomes in arthroscopic ACL reconstruction. However, clinical trials directly comparing the outcome of both these grafts are few and the consensus is thus yet to be achieved regarding the graft of choice in ACL reconstruction.

Need for the study

As there is currently no consensus present regarding the autograft of choice in arthroscopic ACL reconstruction and at the same time, there is a need for a more effective and efficient graft that provides better outcomes in ACL-deficient knees.

Limited research compares hamstring and PLT grafts for ACL reconstruction. Our randomized controlled trial will try to determine which graft is superior.

Statistics

Su et al. [4] observed that the mean post-operative Lysholm scores were 90.94 ± 3.81 and 89.32 ± 4.13 in the PLT group and HT group, respectively. Considering these values as a reference, the pooled standard deviation was calculated using the formula-

$$\sigma^{pooled} = \frac{\sqrt{\sigma^{PT^{\wedge 2}} + \sigma^{HT^{\wedge 2}}}}{2}$$

Where

σpooled = pooled standard deviation based on the previous research of the same type.

σPT. = mean standard deviation of a variable on previous research on PLT graft.

σHT = mean standard deviation of a variable on previous research on HT graft.

$$\sigma^{pooled} = \frac{\sqrt{(3.81)^2 + (4.13)^2}}{2}$$

Taking the values from the above-mentioned study, pooled was calculated as follows.

σpooled=3.97

Data were analyzed using IBM Statistical Packages for the Social Sciences Statistics for Windows, Version 20.0 Armonk, NY: IBM Corp.

Materials and Methods

This randomized controlled study was conducted at a tertiary care center in Western Uttar Pradesh. The study population was all young and middle-aged patients presenting with suspected/diagnosed ACL injury around the knee to our hospital outpatient department/arthroscopy and sports clinic

Figure 1: Infra-malleolar peroneus longus graft harvest.

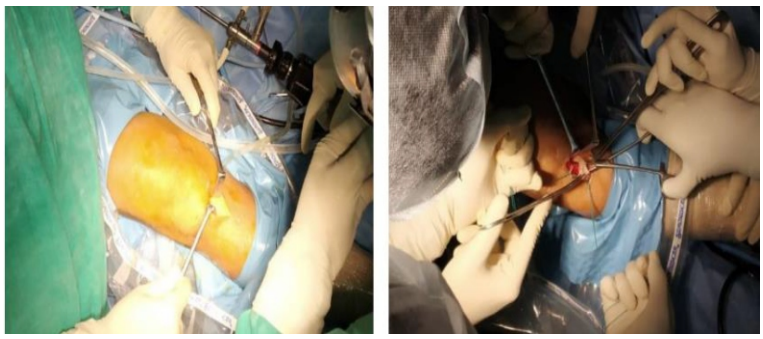

Figure 2: Hamstring tendon graft incision and tendon exposure.

from November 2018 to December 2022.

The randomization of the patients was done using computer-generated random numbers on Microsoft Excel software.

All skeletally mature patients with symptoms and a clinical and radiologically confirmed diagnosis of injury to the ACL requiring reconstruction were included in the study. Severe osteoarthritis and any associated fracture around the knee were excluded.

Initially, a clinical examination (Anterior Drawer and Lachman test) was done to evaluate ACL injury. The integrity of other structures was also assessed by the valgus/varus stress test, McMurray's test and posterior drawer test.

The radiological examination included plain radiographs of the affected knee in a standing position in an anteroposterior view and a lateral view. Magnetic resonance imaging of the affected knee was done in all suspected cases for confirmation of the ACL injury.

Pre-operative scoring

Calculation of knee score is done based on -

1. International Knee Documentation Committee (IKDC) subjective knee evaluation

2. Lysholm's knee score

Graft selection was done by randomization using the computer-generated numbers on Microsoft Excel 2019 software. Patients were assigned the allocated graft strictly according to the chart generated (Figs. 1 and 2).

The standard surgical procedure was followed for arthroscopic anatomic ACL reconstruction in all cases.

We used anteromedial and anterolateral portals in all the patients in our study.

In our case study, the tunnel was placed through the medial instrument portal. The positioning of the anteromedial portal was placed at a lower (supra-meniscal) level to avoid difficulty reaching the over-the-top position.

In our study, adjustable loop and fixed loop both were used as femoral graft fixation devices and interference screws, tibial post and suture disc as tibial fixation devices.

Standard rehabilitation protocol was followed in all patients for post-operative mobilization and physiotherapy [5].

Results

This randomized controlled study was done at our institute between November 2018 and December 2022. A total of 120 patients were included in this study who underwent anatomic single-bundle ACL reconstruction using PLT graft and HT graft. Out of which 60 patients were included in the peroneus group and 60 were in the hamstring group based on randomization.

The mean age of the patients in the peroneus group was 24.4 ± 9.54 years and the mean age of the patients in the hamstring group was 24.73 ± 8.18 years. There were 8 female patients in our study and the rest of the patients were males. The most common mode of injury in our study was found to be road traffic accidents followed by sports injuries. 84 patients had a

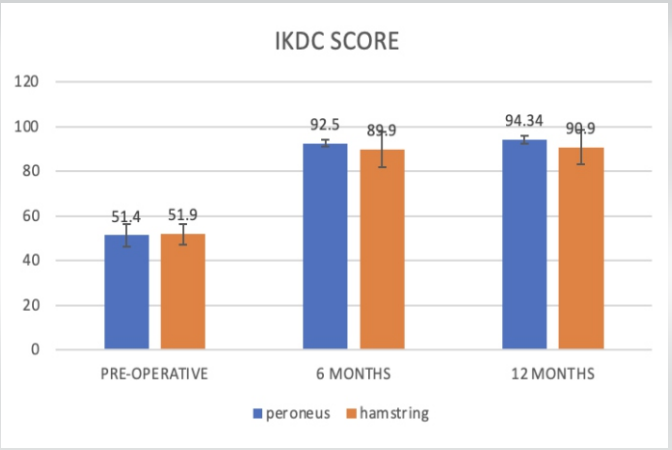

Figure 3: Mean distribution of international knee documentation committee score.

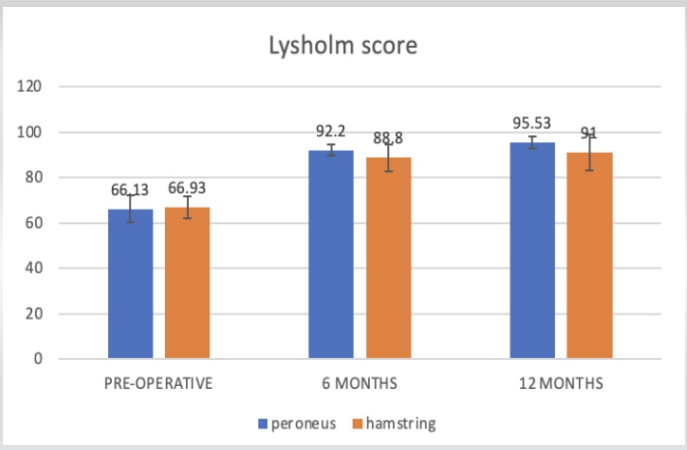

Figure 4: Mean distribution of Lysholm score.

right-sided injury.

In our study, the mean duration of injury before surgery in the peroneus group was 12.66 ± 7.68 months and the mean duration before surgery in the hamstring group was 12.86 ± 11.14 months. However, the difference between the groups is not significant (P > 0.05).

26.6% of patients were operated on within 6 months of the injury period while the remaining 73.3% were operated on after 6 months.

40% of the patients had isolated ACL injury followed by 33.3% had associated medial meniscus injury and 13.3% had lateral meniscus injury. The mean graft-harvesting time for PLT was 7.46 min, which was 2.8 min less than for HT (P < 0.001). There was no statistically significant difference in the

Body mass index (BMI) of both groups. The mean graft diameter of the PLT is 9.13 ± 0.7 mm whereas the mean graft diameter of the HT is 8.26 ± 0.7 mm. The P < 0.01 signifying the difference in graft diameters of both the grafts is statistically significant. The mean graft length of the PLT graft is 336.33 mm whereas the mean graft length of the HT graft is 290.26 ± 15.6 mm. The P-value between the two groups is <0.01 signifying a statistically significant difference.

Our data showed a strong positive correlation of hamstring graft diameter with the height of the patients and the correlation is statistically significant (r = 0.824) (P = 0.000). There is a positive correlation between hamstring graft diameter with weight and BMI of the patients, but the correlation is not statistically significant. Furthermore, data shows a strong positive correlation of peroneus graft diameter with the weight and BMI of the patients and the correlation is statistically significant. There is a positive correlation of peroneus graft diameter with the height of the patients, but the correlation is not statistically significant.

The knee range of motion in all the patients pre-operatively and at the final follow-up of 12 months were 0–140°. This shows no patient had any loss of range of motion in both groups.

At the final follow-up, 20% of patients had grade 1 anterior drawer laxity in the PLT group, whereas 26.6% had anterior drawer laxity in the HT group. At the final follow-up, 13.2% of patients had Lachman test laxity present in the PLT group, whereas 20% of patients had Lachman test laxity in the HT group.

The mean IKDC score (Fig. 3) at final follow-up in the PLT group is 94.34 ± 1.75 whereas the mean IKDC score is 90.9 ± 7.56 in the HT group. The difference between the two groups is statistically significant.

The mean Lysholm score (Fig. 4) in the PLT group is 95.53 ± 2.66 whereas the mean Lysholm score in the HT group is 91.0 ± 7.86. The difference between the groups is statistically significant (P < 0.05).

The mean post-operative thigh wasting in the PLT is 1.33 ± 1.11 cm whereas the mean thigh wasting in the HT group is 2.03 ± 0.9 cm. The difference between the two groups is statistically significant (P < 0.05). We observed that thigh wasting was apparent till 3 months and it recovered in majority of patients in 6 months time.

At the final follow-up, all the patients in the peroneus longus group had complete power of eversion and first-ray plantar flexion.

The mean ankle society hindfoot-ankle score (AOFAS) score and foot and ankle disability index score in the Peroneus tendon group were comparable pre and post-operatively.

Complications

The most common complication in the PLT group is numbness over the incision site (20%) followed by a tingling sensation (13.3%). 46.6% of patients had no graft site complications. Numbness, tingling sensation and wound infection all were equally seen in the HT group (13.3%).

Discussion

Our study highlighted various comparisons between the 2 autograft choices for primary ACLR in patients with ACL injury.

Graft characteristics

In our comparison, PLT performed favorably in terms of graft harvesting time and graft diameter. The mean graft-harvesting time for PLT was 7.46 min, which was 2.8 min less than for HT (P < 0.001), supporting the results of Joshi et al. [6] The shorter harvesting time for PLT is likely due to its superficial location and the relatively less muscle tissue attached to it as compared with HT [7]. This finding is important for surgeons to consider, as PLT may provide potentially reduced operative time and surgeon fatigue.

The current literature offers various discussions on the optimal graft diameter. Our comparison revealed that the mean diameter of the quadrupled HT graft was 8.26 ± 0.7 mm, which was significantly less than that of the doubled PLT graft, which was noted to be 9.13 ± 0.7 mm (P < 0.001). Spragg et al. [8] concluded that, within the range of 7.0–9.0 mm, there was a 0.82 times lower chance of a graft rupture with every 0.5 mm incremental increase in graft diameter. In their 2018 review of the literature, Figueroa et al. [9] concluded that most studies indicate that a smaller diameter could result in higher rate of

graft ruptures and revisions.

Return to sports and knee outcomes

Return to sports is a crucial factor when selecting an optimal graft. It is especially important in resource-limited countries, where professional athletes may further suffer from the financial strain of not being able to return to sports quickly enough. To our knowledge, previous studies have not highlighted the time to return to sports among athletes who have undergone ACLR with PLT autograft. We found that the mean time to return to sports was 195.3 days (range, 164–241 days) for patients with PLT autograft compared with 231.2 days (range, 189–289 days) for those who received HT autograft ($P < 0.001$). Moreover, professional athletes returned to sports sooner than recreational athletes (201 versus 223 days, respectively), which could be explained by their athletic endurance and motivation to return to sports [10].

In our analysis, both groups had significant and clinically notable improvements in their knee function following ACLR. At 24 months, both groups performed similarly ($P > 0.05$).

Our results are similar to those of several previous studies comparing PLT with HT and confirmed that PLT is a suitable autograft for ACLR at a follow-up of 24 months. In keeping, we saw an earlier return to sports in the PLT group. Further studies measuring this outcome could provide an answer regarding the choice of graft depending on the patient's motivation and requirement for return to sports. Donor-site morbidity is one of the central outcomes when it comes to choosing a graft. Despite its ability to stabilize the knee better, BPTB autograft has demonstrated a significantly higher rate of anterior knee pain [11, 12]. HT was associated with a statistically higher rate of thigh weakness and potential hypotrophy of thigh muscles [13]. Moreover, the hamstring muscles work synergistically with the ACL tendon in preventing anterior laxity of the leg [14]. In our study, there was a significantly higher rate of donor-site morbidity in the HT group ($P < 0.001$), with patients reporting persistent thigh weakness or their knee being "never like before." This complaint was considerably less in patients with PLT autograft in our study (as no further damage was done to the knee in terms of autograft harvesting) and is a reason why PLT should be considered as an excellent candidate for ACLR. Donor-site morbidity for the PLT group was one of the primary foci of our study. At 24 months, AOFAS ankle and hallux function scores were excellent subjectively and clinically. We found a small but significant difference (0.51%; $P = 0.004$) between the preoperative and 24-month post-operative AOFAS ankle and hindfoot scores. The preoperative and 24-month post-operative AOFAS hallux metatarsophalangeal-interphalangeal scores did not differ significantly ($P > 0.05$). The ankle function scores of our subjects were similar to the ankle functions scores of healthy populations as described by Schneider and Jurenitsch [15]. Keyhani et al. found that the post-operative AOFAS score was 93.42, which was not significantly different from that of the contralateral side [16]. Rhatomy et al. also described similar clinical ankle function and an AOFAS score of 98.93 at the last follow-up [17].

Limitations of the study

The study's main weakness is the use of the anterior drawer test and Lachman test for clinical laxity assessment, which are subjective tests based on the examiner's observations and prone to inter-examiner variations. Lack of isokinetic muscle testing for assessing hamstring weakness and power of eversion and 1st ray plantar flexion. The sample size was small due to the COVID-19 lockdown which also affected the rehabilitation of the patients and proper follow-up.

Conclusion

The harvested PLT graft can be recommended as superior to the HT graft as it is found to have a significantly larger graft length thus leading to a thicker graft diameter which provides better post-operative knee stability, higher post-operative subjective knee function, and lesser post-operative index thigh muscle atrophy. The infra-malleolar harvested PLT causes no significant ankle instability or loss of power with minimal donor site morbidity. Due to increased thickness, it can be recommended superior in athletes where early return to sports is needed.

Clinical Message

The study suggests the PLT grafts may offer advantages over hamstring grafts in ACL reconstruction, including faster harvesting, quicker return to sports, and improved patient-reported outcomes. While some donor-site complications may occur with PLT, both grafts provide acceptable knee stability. Further research is needed, but surgeons should consider PLT grafts as a potential alternative for suitable patients, especially those prioritizing a faster return to sports.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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