ORIGINAL ARTICLE

Functional Results of Anterior Cruciate Ligament Reconstruction in Manual Workers Using Peroneus Longus Tendon Graft

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Background	Anterior cruciate ligament (ACL) tears in manual workers often need reconstruction and the knee joint has to return to the utmost functional results as it will be subjected to huge stresses upon returning to work. There were earlier reports of lesser outcomes in manual workers sustaining spine or upper limb injuries in comparison with other patient groups. The peroneus longus tendon autograft (PLTA) is easy to harvest, however, the concerns about its use include the donor site morbidity and the possible damage to the common peroneal nerve (CPN). In this study, the functional results of arthroscopic ACL reconstruction (ACLR) in manual workers both in terms of knee stability and ability to return to the same level of work will be discussed as well as the ankle joint function after harvesting PLTA.
Patients and Methods	Between April 2019 and February 2023, 27 manual workers (comprising of 23 men and 4 women) aged between 19 and 39 (average age of 29.7, standard deviation of 5.9) received arthroscopic ACLR with PLTA. The average length of time between the injury and reconstruction surgery was 17 weeks, with a range of 6 weeks to 29 weeks and a SD of 6.2. The follow-up period varied between 9 and 25 months (average 18.1 months; SD 4.5).
Results	After surgery, the average degree of movement ranged from 2.4° of hyperextension (10–0°) to 133.5° of flexion (110–150°), with a SD of 3.2 and 12.3, respectively. The Lachman test, the anterior drawer test, and the pivot shift test showed significant improvement following the reconstruction procedure ($P<0.001$). After surgery, there were important statistical improvements in the functional knee score, which comprised the Tegner activity score, Tegner-Lysholm Knee score, and modified Cincinnati knee rating system ($P<0.001$). Additionally, after the operation, the American orthopedic foot and ankle society score and foot and ankle disability index demonstrated exceptional results. No postoperative neurological damage was experienced by any of the cases. Every patient was able to resume work within an average of 20.8 weeks, with a range of 14–28 weeks and a SD of 4.
Conclusions	Reconstruction of the ACL tears with the PLTA seems safe. It didn't result in an excessive delay in return to work, so it can be used safely in the manual workers' population.
Keywords	Anterior cruciate ligament, Anterior cruciate ligament reconstruction in manual workers, Manual workers, Peroneus longus tendon autograft.
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INTRODUCTION

Injuries of soft tissue stabilizers of the knee joint have long been a source of pain and disability to manual workers. Anterior cruciate ligament (ACL) injury presents a significant proportion of these injuries [1]. The ACL reconstruction (ACLR) research is mainly derived by seeking perfection in outcomes in terms of minimizing

rates of re-tear and speed of return to pre-injury activities, whether work-related or sport-related. Thus, reconstruction of the ACL has been thoroughly researched. This reflects the importance of this ligament on the well-being of the knee joint and the patient in general which frequently needs reconstruction once injured [2,3].

Most reports in the literature focus on a younger patient group and their ability to return to sport [4,5]. However, there are relatively fewer reports regarding the outcome in middle age patients who sustain the injury as a result of work-related trauma [6,7].

Autografts can originate from many sources of tendon. The Bone-Patellar Tendon-Bone (BPTB) graft and the hamstring tendon graft are the two most popular types. One advantage of BPTB graft is bone-to-bone healing, which facilitates the easy integration of the tunnel and graft and expedites the return to work and sports. Nevertheless, there is a chance that BPTB will cause morbidity at the donor site, such as patellar fracture, anterior knee discomfort, and loss of mobility. Conversely, a hamstring autograft resembles native ACL and can be readily extracted at the donor site with minimal morbidity. However, the size of the graft is unknown, and the hamstring capacity may be reduced, which is crucial for some competitive sports performances that need hamstring strength [8].

Peroneus Brevis and peroneus longus work together; therefore, longus can be used as an autograft. This ligament is being more frequently utilized as a self-transplant in orthopedic reconstruction, such as in foot deltoid ligament reconstruction and patellar maltracking medial patellofemoral ligament reconstruction [9].

In an attempt to avoid complications inherent to the use of either BPTB or hamstring tendon graft, a peroneus longus tendon autograft (PLTA) was proposed [2,3,10–15]. Some authors reported its use in supplementing hamstring tendon grafts in case of insufficient girth [3,16,17]. However, concerns about its efficacy and donor site morbidity i.e.; ankle function have been raised [14,18].

Manual workers as a special subgroup of patients who have several characteristics including a heavy workload, the need for speedy and sound recovery as well as possibility of malingering [6]. Reports in the literature regarding work-related spine and upper limb injuries point to the much-prolonged recovery with less predictable results and likely to have secondary issues related to their work adding shadows of confusion over the results of management [6,19–21]. Hence, this study focusing on the speed of return to work-related activities and patient-reported outcome measures is the first to our knowledge

to investigate the efficacy and safety of PLTA in manual workers.

PATIENTS AND METHODS

This study was conducted between April 2019 and February 2023 and included 27 manual workers who sustained isolated unilateral ACL tear with the exclusion of those who have associated other ligament injuries, revision cases, those associated with fractures, those with positive anterior drawer test for the anterior talofibular ligament, and those chronic pain after previous twisting injury of the ipsilateral ankle.

Physical tests were used to determine the extent of the ACL injury, and MRI was used to confirm it. Before the procedure, plain radiographs of each patient's knee joint were taken. All patients consented to the study. The study was done after approval from the Ethical Committee of the authors' institution (IRB number: 00012098; FWA number: 00018699; and serial number 0306830).

All the operations were done by the first author. Arthroscopic ACL reconstruction was done after a brief period of preoperative rehabilitation which consisted of medication to help alleviate the effusion that invariably occurs after such injuries as well as targeted physiotherapy to help maintain range of motion and quadriceps strength [6].

After the patient was anesthetized, with the patient supine a tourniquet was applied, then an examination under anesthesia as well as diagnostic arthroscopy to confirm the diagnosis. Then, tendon graft harvesting was accomplished through a direct lateral incision over the peroneal tendons after palpating them (Figure 1a). Then, isolation of each tendon with the peroneal brevis being the anterior one with some muscle fibres still attached to it (Figure 1b). Then tenodesis of the distal 2 inches of peroneus longus to the peroneus brevis (Figure 1c). They were then cutting the peroneus longus tendon just above the tenodesis site after securing it with suture loop (Figure 1d). The head of the fibula is then palpated, and four fingers are applied just distal to the head of the fibula to feel the stripper at a safe distance before reaching the head of the fibula to protect the common peroneal nerve (CPN). The Tendon stripper is then applied to the tendon stump (Figure 1e). Harvesting the tendon with the protection of the CPN was then completed.

Tendon graft preparation was then done (Figure 1f) to achieve suspensory fixation in the femoral tunnel with a gliding loop and interference screw in the tibia, with the knee in 20° flexion, after doubling its girth to achieve graft thickness not less than 8mm.

Figure 1: (A): Site of incision; (B): Identification of peroneus longus and brevis tendon; (C): Tenodesis of peroneus longus remaining stump to the peroneus brevis tendon; (D): Cutting the peroneus longus tendon graft after securing it with suture loop; (E): Harvesting the tendon with a stripper; (F): Preparation of the graft.

Arthroscopy was done through standard medial and lateral portals. If there was an associated meniscal tear (Figure 2a), then labral repair (Figures 2b, c) or debridement was performed first. The femoral tunnel was placed on the inner side of the outer femoral condyle, with significant bending of the knee, ensuring a gap of 1–2mm from the condyle's rear wall (Figure 2d).

Next, the tibial tunnel was placed 8–10mm ahead of the posterior cruciate ligament so that its center is located just behind and toward the inner side of the anterior horn of the lateral meniscus, and a curette was introduced over the tip of the tibial guide-wire to protect against the over-penetration of the drill bit (Figure 2e). then the scope was shifted to the medial portal to assess the femoral tunnel and ensure that there was no hindrance to the passage of the graft (Figure 2f). The passage of the graft was done under arthroscopic visualization (Figure 2g). Cycling was done to counter the viscoelastic properties of the graft. After fixation in the tibial tunnel then re-tension of the graft through the gliding loop was done to get rid of any slackness in the tension of the graft. A test of impingement of the graft was done to ensure that there was no abutting of the graft against the top of the notch (Figure 2h). A 12mm radivac drain was inserted through one of the portals to allow drainage of hemarthrosis, which is expected to follow such a procedure. The tourniquet was then removed to allow for hemostasis at the site of peronus longus tendon harvesting. Closure is then done in layers.

Postoperative medications included 48h of antibiotics and 2 weeks of prophylactic anticoagulation.

The early exercise was done in the form of gait training, isometric quadriceps strengthening, closed chain knee flexion, and repeated ankle dorsiflexion to activate the calf muscle pump.
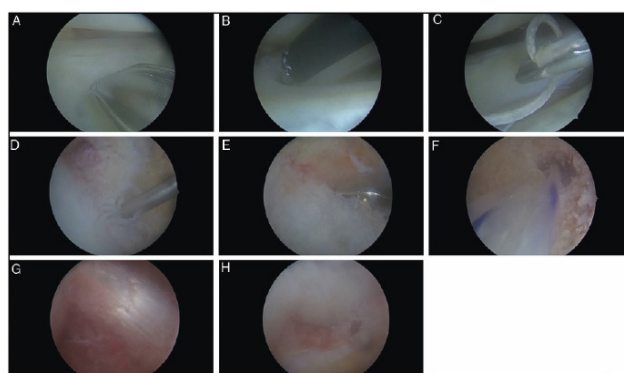

Figure 2: 31 years old male who works in heavy lifting in a factory sustained an ACL tear together with; (A): Lateral meniscal tear; (B, C): Which was repaired; (D): Femoral tunnel position; (E): Curette was used to protect against the over-drilling of the tibial drill bit; (F): Inspecting the femoral tunnel looking from the medial portal; (G): Passage of the graft under visualization; (H): Impingement test showing that the graft does not impinge on the roof of the notch.

Sutures were then removed at 2 weeks postoperative. Then referral to physiotherapy was routinely done to restore range of motion and muscle strength as well as proprioceptive training. The rehabilitation continued under the supervision of physiotherapy. Return to competitive sports such as football was only allowed after 6 months after the operation.

Subsequent checks were conducted every month for the following 6 months. The patient completed all questionnaires to remove any bias from the interviewer or surgeon. These were finished during the last check-in.

Patient satisfaction was assessed subjectively by having them use a visual analog scale on a 10cm ruled scale to graphically represent their level of satisfaction. Also, patients were asked to complete the following questionnaires: Tegner Activity Score, Tegner-Lysholm score, foot and ankle disability index (FADI), and American orthopaedic foot and ankle society (AOFAS) score. The time needed to return to work, Cincinnati Job Title Occupational Rating System, Modified Cincinnati Rating system, final range of motion, hop tests, and the results of the anterior drawer test, the Lachman test, and the pivot shift test were recorded.

The examination of the knees involved testing the range of motion while lying down using a goniometer, as well as performing the Lachman (LT), anterior drawer (ADT), and pivot shift (PVT) tests. Ligamentous laxity was assessed and classified as 1^+, 2^+, or 3^+ based on the degree of laxity (0–5mm, 6–10mm, 10mm). The PVT was assessed as 1^+ (slip), 2^+ (jump), and 3^+ (transient lock) in the thigh

abduction and external rotation position that enhances the pivot shift phenomenon.

The hop tests were carried out and the outcomes were documented as a percentage of how well the other leg performed. During the single-hop test, the distance a patient could jump on one leg without falling and landing securely was recorded as a percentage of their other leg. The triple hop test measures the distance a person can jump on one leg three times in a row without losing balance, landing securely, as a percentage of the other leg. The cross-over hop test measured the furthest distance a patient could jump on one leg across a midline three times without losing balance, landing firmly, as a percentage of the opposite leg. During The timed hop test, the duration taken to hop on one leg for 6m while maintaining balance and landing securely was observed and documented as a proportion of the opposite leg.

IBM Inc. in Chicago, Illinois, USA employed SPSS version 26 for conducting statistical analysis. The mean and SD were used to represent the statistical variables, and the paired Student's t-test was used to analyze the preoperative and postoperative scores. Frequency and percentage (%) were utilized for qualitative variables, with the χ^2 or Fisher's exact test used for analysis as appropriate. A statistically significant result was determined for a P value with two tails lower than 0.05.

RESULTS

Total 27 patients (23 males and four women) with ages ranging from 19 to 39 years old (mean 29.7 years, SD, 5.9) were included in this study. Of the patients, 11 had problems with their left knee and 16 with their right knee. The average amount of time between the injury and reconstruction was 17 weeks (SD=6.2; range, 6 weeks to 29 weeks).

The distribution of the mode of trauma showed that 12(44.4%) patients were results of injury during recreational sports participation, 10(37%) patients were results of work-related trauma, four (14.8%) patients were results of domestic falls, and one patient was a result of road traffic accident (bike).

The follow-up period varied from 9 to 25 months (average 18.1 months; SD 4.5). Four patients were lost to follow-up.

In the research, eight (29.6%) individuals had medial meniscal tears linked, while five (18.5%) individuals had lateral meniscal tears. Seven tears were fixed, making up 25.9% of the participants, while six tears underwent partial meniscectomy, accounting for 22.2% of the participants.

Before surgery, the LT showed grade 1 in one (3.7%) patient, grade 2 in 11(40.7%) patients, and grade 3 in 15(55.6%) patients. The ADT revealed grade 1 in one (3.7%) patient, grade 2 in 16(59.6%) patients, and grade 3 in 10(3.7%) patients. The PVT indicated grade 1 in two (7.4%) patients, grade 2 in 20(74.1%) patients, and grade 3 in five (18.5%) patients.

After surgery, the LT showed grade 1 in 21(77.8%) patients, grade 2 in five (18.5%) patients, and grade 3 in one (3.7%) patient, while the ADT had grade 1 in 21(77.8%) patients, grade 2 in five (18.5%) patients, and grade 3 in one (3.7%) patient, and the PVT was graded 1 in 23(85.2%) patients, grade 2 in three (11.1%) patients, and grade 3 in one (3.7%) patient.

The improvement in knee joint stability as evidenced by these tests was statistically significant ($P<0.001$).

The average range of motion after surgery was 2.4° hyperextension (range, 10° hyperextension–0°; SD, 3.2) to 133.5° flexion (range, 110°–150°; SD, 12.3).

Overall satisfaction was evaluated using a visual analog scale. The mean score on this scale was 8.3, with a range of 4–10 and a SD of 1.4.

The postsurgery AOFAS score for the donor's ankle ranged from 91 to 100, with an average of 96.1 and a SD of 3.1. FADI scores after surgery varied from 91 to 100, with an average of 95.9 and a SD of 3.2. The average score for the single hop test was 90.2, with a SD of 7.7. The average result for the triple hop test was 90.9, with a SD of 7.4. The average result for the cross-over hop test was 92.3, with a SD of 5.6. The average result for the timed hop test was 90.1 with a SD of 7.7.

All patients were able to resume work within an average of 20.8 weeks (with a range of 14–28 weeks and a SD of 4). Nonetheless, 17(63%) patients went back to their previous activity level, nine (33.3%) patients returned to a lower activity level, and just one (3.7%) patient achieved a higher activity level upon return. The Cincinnati Job Title Occupational Rating System evaluated this as well, with an average of 7.26 preoperatively and 7.04 postoperatively, showing no significant difference (P=0.8).

Preoperative Tegner activity score ranged from 4 to 8 points (the mean was 5.6; SD, 1.3). Postoperatively it improved to range from 5 to 10 points (the mean was 7.4; SD 1.5). The improvement was statistically significant ($P<0.001$).

Preoperative Tegner-Lysholm Knee score ranged from 52 to 92 points (the mean was 74.5; SD, 10.6).

Postoperatively it improved to range from 70 to 100 points (the mean was 90.9; SD 7.6). The improvement was statistically significant (*P*<0.001).

Preoperative modified Cincinnati knee rating system score ranged from 45 to 81 points (the mean was 64.4; SD, 8.5). Postoperatively it improved to range from 56 to 100 points (the mean was 87.1; SD 7.6). The improvement was statistically significant (*P*<0.001).

There was one (3.7%) case of superficial site infection at the site of graft harvesting was managed by repeated wound dressing and oral antibiotics. None of the patients suffered postoperative neurological deficits.

DISCUSSION

Even though historically the patellar tendon and the hamstrings were the most commonly used autografts for arthroscopic ACLR. The patellar tendon graft will likely cause discomfort, especially for those who kneel frequently for work-related or religious reasons. Also, it can be complicated by patellar tendon rupture or patellar fracture.

The hamstrings' role as accessory medial stabilizers of the knee joint would be lost if they are used as autograft. That would further jeopardize the joint if the medial collateral ligament was injured in association with the ACL tear. Also, the hamstrings offer an advantage for certain athletes, especially footballers.

The concerns about using PLTA are the donor site morbidity, as well as, possible injury to CPN.

Hossain and colleagues conducted a prospective study with 439 patients, following them for 24 months. They observed that all patients had a negative ADT result at the final follow-up, and the LT showed significant improvement in all but 7.7% of cases with slight laxity. The PVT showed a negative result in 97.43% of patients 24 months after the surgery, with the rest showing only a Grade-I positive result [2]. Wexler and colleagues conducted a review of 22 workers with compensation claims who were monitored for at least 2 years after receiving arthroscopic ACLR using BPTB autografts. In their study, 91% of patients had a negative ADT, 68% had a negative LT, and 96% had a negative PVT when returning to work [6]. In the current study, following surgery, all patients were able to go back to work with 21(77.8%) patients graded as level 1 on the LT, five (18.5%) patients as level 2, and one (3.7%) patient as level 3, while 21(77.8%) patients scored level 1 on the ADT, five (18.5%) patients as level 2, and one (3.7%) patient as level 3. The PVT revealed 23(85.2%) patients at level 1, three (11.1%) patients at level 2, and one (3.7%) patient at level 3.

This research found that before surgery, the average rating on the Cincinnati Job Title Occupational Rating System was 7.26 (with a range of 5–10 and a SD of 1.5), and after surgery, it was 7.04 (with a range of 4–10). The difference was not statistically significant (*P*=0.8). In their study, Wexler *et al.,* found that the Noyes Job Title rating system score did not change, remaining at 5 following the surgical procedure [6].

In this study, preoperatively Tegner activity score ranged from 4 to 8 points (the mean was 5.6; SD, 1.3). Postoperatively it improved to range from 5 to 10 points (the mean was 7.4; SD 1.5). The improvement was statistically significant (*P*<0.001). Preoperative Tegner-Lysholm Knee score ranged from 52 to 92 points (the mean was 74.5; SD, 10.6). Postoperatively it improved to range from 70 to 100 points (the mean was 90.9; SD 7.6). The improvement was statistically significant (*P*<0.001). Preoperative modified Cincinnati knee rating system scored 45–81 points (the mean was 64.4; SD, 8.5). Postoperatively it improved to range from 56 to 100 points (the mean was 87.1; SD 7.6). The improvement was statistically significant (*P*<0.001). Similar improvements were reported by other researchers [2,8,10,18,22].

Agarwal and colleagues compared outcomes of ACL reconstruction using peroneus longus graft versus hamstring tendon graft, and results showed no notable variances in preoperative, six-month postoperative, and one-year postoperative scores for IKDC (*P*=0.356) and Lysholm knee score (*P*=0.289) between the two groups. The average AOFAS score was 99.05±3.56 for the PLT group and 99.80±0.70 for the HT group, indicating no significant statistical discrepancy [10]. Mustamsir and his colleagues conducted a biomechanical analysis and compared the hamstring tendon and peroneus longus grafts, finding no variation in tensile strength [23].

Many authors linked early ACLR with arthrofibrosis [24–26]. In this research, all individuals underwent preoperative rehabilitation overseen by a skilled physiotherapist to assist in achieving a sufficient range of motion and quadriceps strength before the reconstruction. Other authors also reported the benefits of this approach [27,28].

The average score for the single hop test in the research was 92.5±6.5. The average score in the triple hop test was 92.36 with a SD of 4.7. The average result for the cross-over hop test was 95.2±3.7. The average result for the timed hop test was 93.28 with a standard deviation of 4.3. All these scores were calculated based on the contralateral side as a percentage. Functional testing through the hop test offers both the benefit of dependability and the ability to anticipate the tear's reoccurrence [29–32].

In the current study, the postoperatively AOFAS score of the donor's ankle ranged from 91 to 100 (mean 96.1; SD 3.1). Postoperative FADI ranged from 91 to 100 (mean 95.9; SD 3.2). The low donor site morbidity is because the peroneus longus tendon is attached to the peroneus brevis tendon, allowing the latter to perform the same functions.

In this study, none of the patients suffered postoperatively from any neurological damage. This can be attributed to identifying the head of the fibula as a bony landmark and terminating the tendon harvesting four finger widths distal to it to avoid hitting the CPN as it swirls around the neck of the fibula. Other studies also corroborated this result [2].

This study's limitations involve a relatively small patient sample size, lack of a control group, absence of arthrometric assessment, and a fairly short follow-up period.

CONCLUSION

This research indicates that conducting arthroscopic ACLR with PLTA in manual laborers yields similar outcomes as arthroscopic ACLR with PLTA in the overall population, as well as other autograft types used for the manual workers population.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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