



ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: PERONEUS LONGUS GRAFT ALTERNATIVE OPTION TO HAMSTRING GRAFT

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Abstract

Background: Anterior cruciate ligament (ACL) reconstruction is known to improve knee stability and functioning.

Aim of the work: The aim of this study is functionally effective anterior cruciate ligament reconstruction either by peroneus longus autograft or hamstring tendon autograft.

Methods: The study was conducted in Orthopedics department, Zagazig University Hospitals, Zagazig, Egypt. 18 Patients were included in our study divided into two groups; **Group A** (9): had ACL reconstruction by peroneus longus graft. **Group B** (9): had ACL reconstruction by hamstring graft.

Results: There is significant improvement in Modified Cincinnati knee rating system, Lysholm and IKDC score Six months Postoperative in both groups. There are no significant changes in Foot and ankle disability index and Ankle hindfoot score in both groups.

Conclusion: Peroneus longus tendon autograft is suitable alternative graft choice from outside the knee for patients undergoing ACL reconstruction, as it given the same postoperative result as ACL reconstruction using hamstring tendon graft.

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Introduction

Anterior cruciate ligament (ACL) tear is the commonest ligamentous injury of knee. ACL is mandatory in maintaining knee joint stability, so if an injury occurs, it can be followed by degenerative changes and future meniscal injuries. One of the two cruciate ligaments that helps to stabilize the knee joint is the ACL¹. The anterior cruciate ligament (ACL) is one of the most frequently injured knee joint structures, with an estimated incidence of 1.5% to 1.7% primary ACL cases per year in the general population².

ACL reconstruction is the current gold standard for restoring knee stability, to reduce the risk of secondary meniscal tears and symptomatic osteoarthritis³. Anterior cruciate ligament (ACL) reconstruction is known to improve knee stability and functioning with different types of grafts like autografts or allografts⁴. The choice of graft is the most crucial operative plan consideration. The appropriate graft helps to prevent re-injury or rerupture incidents and provides optimal knee stability⁵. Anterior cruciate ligament reconstruction (ACLR) is the most common surgery to restore the injured ACL using the placement of graft material.

This procedure is minimally invasive as it is assisted by the use of arthroscopy⁶.

Autografts can be derived from several compatible muscles to maintain the strength and resistance of the original ACL structure. However, there is no consensus regarding the most appropriate graft choice to replace the injured ACL⁶.

A hamstring autograft is easy to harvest with minimal donor site morbidity and strength that is comparable to that of the native ACL. Additionally, HT graft may cause a significant decrease in strength at the original HT muscle site⁷. Hamstring grafts are autogenous grafts harvested from the semitendinosus and gracilis tendons of the patient. They are commonly used for ACL reconstruction surgery. There are different methods of femoral fixation for hamstring grafts, such as cortical button, cross-pin, and interference screws. These methods have different advantages and disadvantages in terms of biomechanical performance⁸.

Peroneus longus tendon (PLT) graft has been a preferred choice because of the various knee joint complications of the previously mentioned muscle graft. Furthermore, the advantage of PLT graft is that it does not cause secondary injury to the knee and its adjacent structures⁶. The peroneus longus tendon (PLT) shows promise as an autograft material for

ACL reconstruction. It can be easily and quickly harvested, possesses sufficient thickness, and does not affect the dynamic knee joint stabilizers, thereby preventing complications associated with autograft harvesting⁹.

Some previous case series reported using the peroneus longus tendon as the first choice for an autograft in ACL reconstruction, with good clinical outcome and minimal donor site morbidity^{10 11}, while other studies did not agree, due to donor site morbidity¹².

Patients and Methods

The study was conducted in Orthopedics department, Zagazig University Hospitals, Zagazig, Egypt.

Inclusion Criteria:

- 18 years < age > 45 years.
- Both genders.
- Traumatic ACL rupture.
- No other ligament repair

Exclusion Criteria:

- Associated ligament injury.
- Chondral damage.
- Fracture around the knee.
- The presence of a pathological condition in the lower extremity.

Operative Techniques:

18 Patients were included in our study divided into two groups;

- Group A (9): had ACL reconstruction by peroneus longus graft.
- Group B (9): had ACL reconstruction by hamstring graft.

1) Preoperative assessment:

- A routine preoperative clinical evaluation was done noting soft tissue and distal neurovascular status. Lachman test and anterior drawer test done.
- Preoperative scoring for 2 groups using modified Cincinnati knee rating system, Tegner Lysholm knee scoring scale, International knee documentation committee (IKDC) score and Foot and Ankle Disability Index score (FADI) index.
- Magnetic resonance imaging.

- Routine laboratory investigations including complete blood count, liver and renal function tests, and bleeding profile, blood glucose.

2) Operative details

A- Diagnostic arthroscopic evaluation is performed with specific attention to articular chondral defects and the presence of meniscal lesions and to ensure ACL tear..

B- Peroneus longus tendon graft

- Peroneus longus tendon graft was harvested with a longitudinal skin incision at 2 to 3 cm (2 finger-breadths) above and 1 cm (1 finger-breadth) behind the lateral malleolus, followed by superficial fascia incision in line with skin incision, tenodesis for peroneus longus and peroneus brevis tendons were done, The peroneus longus tendon was stripped proximally with a tendon stripper to at least 5 cm from the fibular head to prevent peroneal nerve injury. Graft preparation will be performed with a standard procedure to obtain the suitable graft size.

C- Hamstring tendon graft

The semitendinosus and gracilis tendons are harvested through a 3-cm incision that is one finger-breadth medial and two fingerbreadths distal to the tibial tubercle; this should be directly over the pes anserinus tendons.

3) Postoperative evaluation and follow up

The postoperative evaluation was performed 6 Months after the surgery to give the patient enough time to complete the rehabilitation protocol and return to sports activity, as well as being likely to obtain peak function after an ACL injury.

We fill the modified Cincinnati knee rating system, Tegner Lysholm knee scoring scale, IKDC score, Ankle hindfoot score Foot and Ankle Disability Index score for 2 groups.

Ethical approval:

The Institutional Review Board [IRB] and the local ethics committee of the Faculty of Medicine, Zagazig University.

Statistical analysis

The information was analyzed using SPSS software (USA). The mean, standard deviation, or percentage are used to represent the parametric data.

Results

Table (1) Demographic data

| | Group A N=9 Peroneus longus graft | Group B N=9 Hamstring graft. | P value |
|--------------------------------|--|---|----------------|
| Age | | | |
| Mean ± SD | 29.80 ±7.5 | 27.60 ± 8.1 | 0.646 |
| Gender | | | |
| Male | 8(88.8%) | 7(77.7%) | 0.830 |
| Female | 1(11.2%) | 2(22.3%) | |
| BMI (kg/cm²) | | | |
| Mean ± SD | 26.6 ± 3.2 | 27.9 ± 1.9 | 0.795 |

We conducted an intervention at Orthopedics department, Zagazig University Hospitals, Zagazig, Egypt on 18 cases : Group A (9): undergoing ACL reconstruction by peroneus longus graft and Group B (9): undergoing ACL reconstruction by

hamstring graft. We found that the mean age in group A was 29.80 ,group B was 27.60 . BMI mean in group A was found 26.6 but for group B it was 27.9 .There is no significant difference between the two groups regarding demographic data.

Table (2) injury characteristics

| Variables | Group A N=9 Peroneus longus graft | Group B N=9 Hamstring graft. | P value |
|---|--|---|----------------|
| Duration from injury to intervention (in months) | | | |
| Mean ± SD | 15.10 ± 6.23 | 14.70 ± 6.68 | 0.891 |
| Mechanism of injury | | | |
| Sports injury | 7(77.8%) | 6(66.7%) | 0.794 |
| Traffic accident | 2(22.2%) | 3(33.3%) | |
| Side | | | |
| Left | 4(44%) | 3(33.3%) | 0.681 |
| Right | 5(55.6%) | 6(66.7%) | |

Table above shows that , there is no significant difference between the two groups regarding injury characteristics.

Table (3) The functional outcome of patients comparison between group A and group B.

| Variables | Group A N=9 Peroneus longus graft | Group B N=9 Hamstring graft. | P value |
|---|--|---|----------------|
| Foot and ankle disability index | | | |
| Six months Postoperative | | | |
| Mean ± SD | 99±0.34 | 99.70±0.44 | 0.852 |
| Modified Cincinnati knee rating system | | | |
| Six months Postoperative | | | |
| Mean ± SD | 89±7.1 | 85±6.9 | 0.910 |
| Lysholm score | | | |
| Six months Postoperative | | | |
| Mean ± SD | 95±6.2 | 94±10.5 | 0.670 |
| IKDC score | | | |
| Six months Postoperative | | | |
| Mean ± SD | 92.5±9.8 | 93.4±6.2 | 0.794 |
| Ankle hindfoot score | | | |
| Six months Postoperative | | | |
| Mean ± SD | 99.75 ± 0.44 | 99.72 ± 0.34 | 0.871 |

According to the table, there is no significant difference between the two groups regarding Foot and ankle disability index, Modified Cincinnati knee rating system, IKDC score, Ankle hindfoot score and Lysholm score six months Postoperative

Table (4) Comparison of Anterior drawer test between the two groups

| Variables | Group A N=9 Peroneus longus graft | | Group B N=9 Hamstring graft. | | P value |
|-------------------|---|-------|------------------------------------|-------|---------|
| | Pre-op | | | | |
| Grade 0 | 0 | 0.00 | 0 | 0.00 | 0.437 |
| Grade 1 | 0 | 0.00 | 0 | 0.00 | |
| Grade 2 | 1 | 11.1% | 2 | 22.2% | |
| Grade 3 | 8 | 88.9% | 7 | 89.8% | |
| Six months | | | | | |
| Grade 0 | 7 | 89.8% | 6 | 66.7% | 0.631 |
| Grade 1 | 2 | 22.2% | 3 | 33.3% | |
| Grade 2 | 0 | 0.00 | 0 | 0.00 | |
| Grade 3 | 0 | 0.00 | 0 | 0.00 | |

There is no significant difference between the two groups regarding Anterior drawer test pre and post operative.

DISCUSSION

Anterior cruciate ligament (ACL) injury is one of the most common knee injuries, with an estimated 200,000 injuries in the United States annually. ACL reconstruction is the current gold standard for restoring knee stability, to reduce the risk of secondary meniscal tears and symptomatic osteoarthritis and requires either an autograft, allograft, or artificial graft (He et al., 2021)¹³.

Hamstring tendon (HT) autograft is the most popular graft choice for ACL reconstruction worldwide. Other autografts include bone–patellar tendon–bone and quadriceps tendon, yet no globally accepted gold standard of graft choice exists for use in ACL reconstruction (Rhatomy et al., 2019)¹⁴.

Recently, the peroneus longus tendon (PLT) autograft, harvested just proximal and posterior to the lateral ankle, has been explored as an alternative autograft for ACL reconstruction (Kumar et al., 2020)¹⁵.

All current popular autografts are harvested from the knee which carries several potential disadvantages, such as knee laxity or quadriceps-hamstring imbalance after harvest and for multiple ligament injury, the HT autograft may not be sufficient to create suitable graft (de Oliveira et al., 2021)¹⁶.

In many countries, allograft and artificial graft choices are not possible. In these settings, the PLT autograft could offer an additional viable option. PLT autograft use in ACL reconstruction was first described by the Turkish group (Joshi et al., 2021)¹⁷.

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 (Trung et al., 2019)¹⁸.

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 (Vijay et al., 2022)¹⁹.

The aim of this study was to evaluate functionally effective anterior cruciate ligament reconstruction either by peroneus longus autograft or hamstring tendon autograft.

In the current study we found that 18 cases: Group A (9): undergoing ACL reconstruction by peroneus longus graft and Group B (9): undergoing ACL reconstruction by hamstring graft. We found that the mean age in group A was 29.80, group B was 27.60. BMI mean in group A was found 26.6 but for group B it was 27.9. We revealed that the mean duration from injury to intervention in patients of group A was 15 and 14.70 for group B. There was no significant difference between the two groups regarding demographic data.

In agreement with our results, Murley et al. (2014)²⁰ showed that There were 28 males and 11 females in the peroneus group. From the patients' mean characteristics, age was 25.10 ± 9.16 , body weight 71.23 ± 14.17 , height 169.13 ± 8.81 , and BMI 20.96 ± 3.44 . The intraoperative peroneus longus diameter measurement was 8.56 ± 0.82 . Spearman correlation showed significant correlation between intraoperative peroneus longus diameter with patient's height, body weight, and BMI with $p < 0.05$.

These results were compatible with Xu et al. (2016)²¹ 130 patients who underwent ACLR in two groups of hamstring tendon (n=65) and peroneus longus tendon (n=65) were followed up for at least 2 years (range 24–31 months). There were no significant differences in demographic data and injuries between the two groups ($P > 0.05$).

On the other hand, Parkinson et al. (2017)²² stated that A total of 156 patients were included in this study. There were 118 men and 38 women. The mean age was 29.5 years (14–51 years), the mean height was 174.1 cm (152.0–192.0 cm), the mean weight was 76kg (54–110kg), and the average BMI was 25.0 (16.7–34.6). When the samples were split by gender, the mean PLT graft diameters were 8.5 and 7.8mm and the mean graft lengths were 8.6 and 8.2 cm for men and women, respectively, the age,

height, BMI, and weight were all statistically significant between the 2 groups.

In the present study we found that there is no significant difference between the two groups regarding injury characteristics, (Duration from injury to intervention (in months), Mechanism of injury, Side, Associated injuries).

This was in accordance with, **Xie et al. (2012)**²³ who showed that 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.

Crawford et al. (2013)²⁴ reported that the duration of injury was associated with the graft diameter, which has never been reported before. Patients with a history of ACL rupture for more than 3 months were more likely to have a thinner PLT graft ($P=0.012$). The explanation for this finding might be the disuse atrophy of skeletal muscle after ACL injury.

Nazem et al. (2014)²⁵ illustrated that Among 48 patients, 19 (39.58%) of them had injuries due to road traffic accidents, 17 (35.41%) due to sports, 7 (14.5%) assault, and 5 (10.41%) domestic accidents.

Caplan et al. (2014)²⁶ stated that the injury mechanism was sports in 19 patients, traffic accident in 7 patients, and other causes in 5 patients. The diameter of the peroneus longus tendon graft was measured and recorded intraoperatively; the mean diameter was 8.74 ± 0.56 mm (range, 8.00-10.00 mm). No translation was seen on the Lachman test for any patient 6 months after surgery.

Angthong et al. (2015)¹² reported that the average age of the research group is 35.4 years old, of which the smallest is 18 years old, the oldest is 51 years old. There are 19 male patients accounting for 63.3%, higher than female with 11 patients occupy 36.7%. The most common cause is sport injury in 12 cases accounting for 40%, 12 cases of daily activities accident accounting for 40%, traffic accident occupy 20%

In the current study we found that there is no significant difference between the two groups regarding Graft diameter and Thigh muscle circumference either Preoperative or postoperative.

On the other hand, **Cristiani et al. (2018)**²⁷ showed that directly compared the diameter of 4-strand PLT and 4-strand HT, showing a PLT, (Peroneus longus tendon) mean diameter of 8.8 ± 0.7 mm versus 8.2 ± 0.8 mm for HT. **Shi et al. (2019)**²⁸ noted that the mean diameter of the 2-strand peroneus longus tendon was 8.71 ± 0.4 (range 8-9 mm), and the mean diameter of the four-strand hamstring tendon autograft was 7.65 ± 0.6 (range 6.5-8.5 mm) that showed significant difference ($P < 0.001$). In the second group, a five-strand hamstring autograft was used for some patients with an autograft diameter of 7 mm.

Biau et al. (2009)²⁹ reported that 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).

In the current study we found that there is no significant difference between the two groups regarding Lysholm score, Modified Cincinnati knee rating system, IKDC score, Foot and ankle disability index and Ankle hindfoot score six months Postoperative evaluation.

These results were compatible with **Magnussen et al. (2012)**³⁰ who stated that most patients had acceptable functional outcomes after ACLR operation in each group ($P < 0.001$); however, no significant differences between the two groups were observed in functional scores.

Cao et al. (2012)³¹ reported that Functional outcomes using PLT, (Peroneus longus tendon) autograft were satisfactory with 83.96% of cases showing good to excellent results by Lysholm score and 75.82% of cases showing normal or nearly normal IKDC subjective score.

Rahr-Wagner et al. (2014)³² stated that the average Lysholm score after surgery of the study group is 95.13 ± 3.98 (highest is 99 and the smallest is 80) compared to Lysholm before surgery is 59 (highest is 69 score, smallest is 56 with statistically significance difference.

In the current study we found that There is significant improvement in Modified Cincinnati knee rating system, Lysholm and IKDC score Six months Postoperative in both groups. There are no significant changes in Foot and ankle disability index and Ankle hindfoot score in both groups.

In agreement with our results, **Angthong et al. (2015)**¹² reported that a significantly higher mean Lysholm score ($p=0.02$) and IKDC subjective score ($p=0.03$) were found in the PLT group. In 7 studies of 361 patients, weighted mean PLT autograft diameter was 8.42 mm, which is considered consistently larger than 4-strand HT.

Bi et al. (2018)³³ stated that PLT harvest does not appear to affect foot and ankle function to any clinically significant degree. No difference of FADI (Foot and Ankle Disability Index) and slightly decreased of AOFAS, (American Orthopedic Foot and Ankle Society) (0.31, 95% CI 0.07–0.54) were found upon follow-up of PLT harvest compared with pre-operation values.

In the present study we found that There is no significant difference between the two groups regarding Anterior drawer test pre and postoperative. There is a significant difference between pre and postoperative Anterior drawer test in both groups.

Cao et al. (2012)³⁴ showed that the stability of knee was evaluated through the results of anterior drawer test post operation: the rate of negative is 96.7%; level 1 is 3.3% and no longer level 2,3. Compared to the Lachman before surgery, it was 96.7 positive.

CONCLUSION

In Conclusion, peroneus longus autograft and hamstring autograft have the same result of postoperative improvement regarding Modified Cincinnati knee rating system, Lysholm and IKDC subjective scores. Also, no significant changes in FADI score postoperative. Given these findings, PLT autograft is suitable alternative graft choice from outside the knee for patients undergoing ACL reconstruction. ACL reconstruction using a peroneus longus graft autograft revealed no muscle strength deterioration during eversion and first ray plantarflexion of the ankle joint.

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