

Original Research Article

# ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION WITH QUADRUPLED HAMSTRING TENDON GRAFT – A PROSPECTIVE FUNCTIONAL OUTCOME STUDY

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## ABSTRACT

### BACKGROUND

In contrast to the previous gold standard of a bone patellar tendon-bone graft, the use of hamstring tendons in anterior cruciate ligament restoration has gained appeal recently. Unlike the bone patellar tendon-bone graft, where the mechanical characteristics decrease with age, the mechanical properties of hamstring tendons appear to be retained with increasing age. The purpose of this research was to prospectively assess the functional and clinical results of ACL reconstructions performed utilising the quadrupled hamstring graft technique for knees lacking in ACL.

### METHODS

This study involved individuals between the ages of 21 and 45 who were having the anterior cruciate ligament surgically rebuilt using the quadrupled hamstring tendon. Individuals were followed up 4, 8, 12, and 20 weeks after the procedure.

### RESULTS

The patients' ages ranged from 21 to 45 years old, with a mean age of  $27.08 \pm 6.43$ . The follow-up duration had a mean of  $14.18 \pm 3.9$  months, with a range of 10-21 months. Nineteen patients (73.07%) had a pre-operative pivot shift, which decreased to three patients (11.53%) after surgery. At the final follow-up, the mean Lysholm and IKDC scores showed a considerable improvement ( $p < 0.0001$  for each) in comparison to their preoperative values. At the final follow-up, 92.30% ( $n = 24$ ) of the patients had an IKDC score of either normal, nearly normal (A or B), or abnormal (C). In contrast, 7.7% ( $n = 2$ ) of the patients had an abnormal score. None of them received a D, which is a highly abnormal score. Based on the

Tegner-Lysholm score, 3 patients (11.53%) had excellent results, 18 patients (69.23%) had good results, 5 patients (19.24%) had acceptable results, and no patient had poor results. In three patients (11.54%), there were six problems. Infection happened to two patients. Knee arthrotomy and debridement with graft retention were used in the treatment of both patients. At the time of the final follow-up, both patients' knee stiffness was noted, and their ability to bend their knees past 110° did not improve.

## **CONCLUSION**

Using the AAM arthroscopic portal, anatomic ACL restoration with a quadrupled hamstring tendon graft is a repeatable procedure that yields satisfactory results in the short- to medium-term follow-up. By positioning the graft more horizontally than during traditional transtibial restoration, it offers the advantage of reducing rotational instability and hence lowering the risk of graft re-rupture.

## **KEYWORDS**

ACL Reconstruction, Quadrupled Hamstring Tendon.

## **INTRODUCTION**

Compared to the previous gold standard of a bone patellar tendon-bone graft, the use of hamstring tendons in anterior cruciate ligament reconstruction has gained favour recently. Nevertheless, the early outcomes were not as good in terms of stability and clinical outcomes. Recent studies, on the other hand, shows that the graft of semitendinosus and gracilis tendon, which is quadrupled and evenly tensioned, works better than the bone-patellar tendon-bone graft because it is made of better materials.<sup>[1]</sup> In contrast to the bone patellar tendon-bone graft, where the mechanical characteristics decline with age, the mechanical properties of hamstring tendons appear to be conserved with increasing age.

The inadequate graft attachment may possibly account for the hamstring graft's initially subpar clinical outcomes. Steiner et al. were the first to show that the secret to a successful surgical procedure was a direct and firm anchoring of the hamstring graft to the bone.<sup>[2]</sup> In order to improve hamstring graft fixation, newer fixation devices have been devised. As a result, patient satisfaction, joint stability, and the ability to resume athletic activity have all improved dramatically, according to clinical findings. Compared to bone-patellar tendon grafts, hamstring graft harvesting carries a reduced risk of morbidity. Patellar fractures and chronic anterior knee discomfort are less common. Due to the early onset of patello-femoral arthritis and prolonged knee discomfort, bone-patellar bone grafting has also proven discouraging.

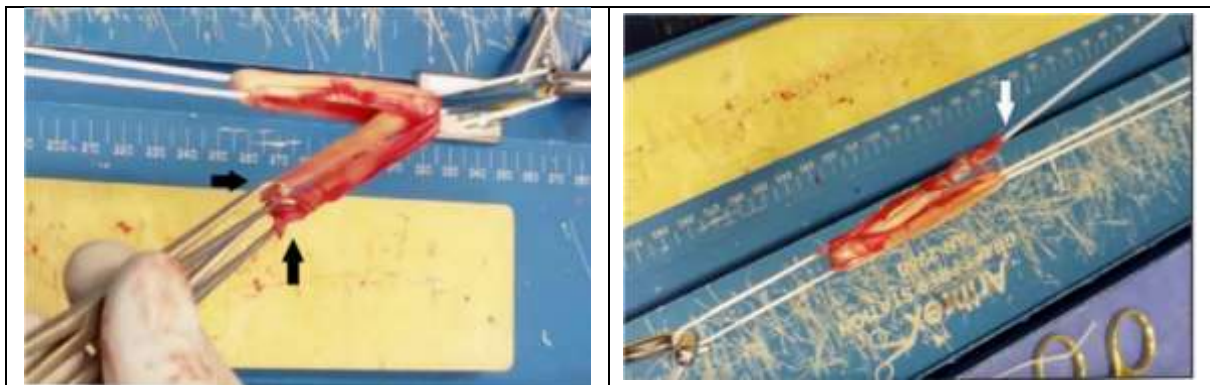
The aim of this research was to prospectively assess the functional and clinical results of ACL reconstructions performed utilising the quadrupled hamstring graft technique for knees lacking in ACL.

## METHODS

This prospective study was conducted among the patients who attended the emergency and outpatient departments of Sree Balaji Medical College and Hospital in Chromepet, Chennai, whose MRIs showed that their ACL (Anterior Cruciate Ligament) was completely torn. Patients between the ages of 21 and 45 were included in the research. Only recent instances of ACL injuries (0–12 months) were covered. December 2022 to January 2024 was the study period. The hiring took place between December 2022 and January 2024 and lasted for a full year. The average duration of the follow-up was 14 months (10 to 20 months). Over a year ago, injuries were not included. Other ligamentous injuries and ACL injuries connected to intra-articular fractures were not included. ACL repairs that were re-ruptured were not included in the research. As seen in images 1-3, every patient underwent an arthroscopic restoration of the anterior cruciate ligament using the quadrupled hamstring tendon. Everybody followed the same post-operative physical therapy regimen, and they were evaluated 4, 8, 12, and 20 weeks after surgery. The subjective IKDC score, the objective IDKC score, the Lysholm score, and the Tegner activity score were used to evaluate each patient both before and after surgery. After analysis, the data were displayed as percentages.



*Figure 1: Double Loop-Four Stranded Graft of Hamstring Tendon (Semitendinosus and Gracilis)*



*Figure 2: Tendon Graft Preparation and Tensioning*



## RESULTS

87% of the patients in our study were men. The patients' ages ranged from 21 to 45 years old, with a mean age of  $27.08 \pm 6.43$ . (Table 1)

Sl. No	Age Group	Male	Female	Total	Age (%)
1	21-25	5	1	6	23.07
2	26-30	7	0	7	26.92
3	31-35	2	1	3	11.53
4	36-40	3	2	5	19.24
5	41-45	4	1	5	19.24
6	<b>Total</b>	21	5	26	100

*Table 1: Age Sex Distribution*

The majority of the knees in our investigation were right-sided. Preoperatively, the most common symptoms were effusion (80.76%) and a feeling that the knee was giving way (96.15%).

RTA was the cause of injury in 61.54% of cases, whereas sports-related injuries happened in 4 patients (15.38%). Other than these two, the mode of damage was determined for six individuals (23.1%). In 9 patients (34.62%), concurrent meniscal damage was discovered; partial meniscectomy was the chosen course of treatment. 88.45% of the cases had surgery done within six months of the accident.

### Post-Operative Follow-Up

The follow-up duration had a mean of  $14.18 \pm 3.9$  months, with a range of 10-21 months. Nineteen patients (73.07%) had a pre-operative pivot shift, which decreased to three patients (11.53%) after surgery. (Table 2)

Clinical Test (ADT)	Pre-Operative	Post-Operative
Equal	0	5
1	0	16
2	18	4
3	8	1
Pivot Shift Test	19	3

**Table 2: Pre and Post-Operative Anterior Drawer and Pivot Shift Tests**

When comparing the mean Lysholm and IKDC scores at the last follow-up to their preoperative values, each showed a significant improvement ( $p < 0.0001$ ). Table 3

	Lachman Test		
<3 mm (-)	3.5 mm (1+)	6-10 mm (2+)	>10 mm (3+)
18 (69.23%)	6 (23.07%)	2 (7.7%)	0 (0%)

**Table 3: Lachman Test at Last Follow-Up**

At the final follow-up, 92.30% ( $n = 24$ ) of the patients had an IKDC score of either normal, nearly normal (A or B), or abnormal (C). In contrast, 7.7% ( $n = 2$ ) of the patients had an abnormal score. None of them received a D, which is a highly abnormal score. Table 4.

Fixation Method	IKDC			
	Normal (A)	Nearly Normal (B)	Abnormal (C)	Severely Abnormal (D)
Quadrupled Hamstring Tendon Graft	7 (26.92%)	17 (65.38%)	2 (7.7%)	0 (0%)

**Table 4: International Knee Documentation Committee Score at Last Follow-Up**

Based on the Tegner-Lysholm score, 3 patients (11.53%) had excellent results, 18 patients (69.23%) had good results, 5 patients (19.24%) had acceptable results, and no patient had poor results. Table 5

Grading the Tegner-Lysholm Knee Score Scale			
>90 Excellent	84.90 Good	65.83 Fair	>65 Poor
3 (11.53%)	18 (69.23%)	5 (19.24%)	0 (0%)

**Table 5: Mean Tegner-Lysholm Knee Scoring Scale at Last Follow-Up**

The Tegner activity level scale average preoperative score was 2.3; the postoperative follow-up score increased to 6.1.

Table 6 displays the frequency of problems following surgery. In three patients (11.54%), there were six problems. Infection happened to two patients. Knee arthrotomy and debridement with graft retention were used in the treatment of both patients. At the time of the final follow-up, both patients' knee stiffness was noted, and their ability to bend their knees past 110° did not improve. Table 6

Complication	No of patients	Age (%)
Knee Stiffness	3	11.53
Infection	2	7.69
Femoral Tunnel Blowout	1	3.84
Graft Re-Rupture	0	0

*Table 6: Complications*

## DISCUSSION

Restoring knee kinematics and delaying the onset of osteoarthritis are the two main objectives of ACL restoration. Restoring anteroposterior knee stability in flexion has always been a desirable outcome of ACL restoration. Numerous publications have suggested that drilling the femoral tube in the natural ACL's footprint is a hallmark procedure to enhance the knee's rotational stability.<sup>[3,4]</sup>

With a high success rate, the bone-patellar tendon-bone autograft is recognised as the gold standard for ACL restoration.<sup>[5,6]</sup> However, the use of hamstring tendon grafts, which have the benefits of low donor site morbidity, avoiding extensor mechanism problems, and improved cosmesis, has grown in popularity recently due to the extensor mechanism problems and donor site morbidities associated with BPTB graft use.

When comparing the four-strand hamstring tendon autograft and patellar tendon autograft, Corry et al.<sup>[7]</sup> discovered that there were no differences between the two transplants' overall symptoms, range of motion, or clinical stability. Additionally, the graft harvest site morbidity was reduced in the hamstring tendon group. According to a study by Akgun et al.<sup>[8]</sup> the hamstring group did not experience any sensory disturbances. They also came to the conclusion that the hamstring group most likely had superior cosmesis. Nikhil Joseph Martin et al.<sup>[9]</sup> comparative study, published in 2009, found that following ACL surgeries, knee stability and function are effectively improved by both hamstring and BPTB grafts. After two years, both groups' subjective results at the follow-up evaluation were comparable. Even long-term investigations by Pinczewski et al.<sup>[10]</sup> and Liden et al.<sup>[11]</sup> found no statistically significant difference in sports activity or Lysholm score between patients following HT ACL reconstruction or BPTB. Numerous additional prospective investigations have validated these findings. According to the findings of the study conducted by Benjamin Wipfler et al.<sup>[12]</sup> there was no discernible variation in the strength of the quadriceps and hamstrings. They claimed that neither the functional hop test nor the return to the pre-injury sports level were impacted by the permanent loss of almost 5% of hamstring strength. They also found that at the 1-year follow-up and the 9-year follow-up, the HT patients' results on the hop tests were still significantly superior. Furthermore, in their long-term prospective analysis, Pinczewski et al.<sup>[10]</sup> found that the BPTB group had a considerably higher incidence of radiographic arthritic alterations than the HT group.

At the conclusion of a 5-year follow-up, Sajovic M et al. found no statistically significant difference in the Lysholm score, clinical and KT2000 arthrometry laxity testing, anterior knee pain, single-legged hop test, IKDC values, or graft failure rates in a prospective

randomised comparison of semi-tendinosus and gracilis tendon vs. patellar tendon grafts for anterior cruciate ligament reconstruction. At five years following surgery, individuals who had patellar tendon grafts, however, were more likely to have osteoarthritis.<sup>[13]</sup> Beynon BD et al. found that in terms of knee laxity, pivot-shift grade, and knee flexor muscle strength, the objective outcomes of anterior cruciate ligament replacement with a bone-patellar tendon-bone autograft were better than those of replacement with a two-strand semitendinosus-gracilis graft. In contrast, the two groups' outcomes in terms of activity level, knee function, and patient satisfaction were similar.<sup>[14]</sup>

Aglietti et al. found no differences in the knee injury and osteoarthritis outcome score, the functional knee score for anterior knee pain, the KT-1000 side-to-side laxity measurements, the visual analogue score, the functional knee documentation committee subjective and objective evaluation scores, or the return to sports activities in a prospective randomised clinical trial comparing the results of the grafts, BPTB, and double semitendinosus and gracilis tendon grafts. He discovered that there was a larger area of decreased skin sensitivity ( $p < 0.001$ ) and a higher prevalence of postoperative kneeling discomfort ( $p < 0.01$ ) in the bone-patellar tendon-bone group.<sup>[15]</sup> Jansson KA et al. found that despite the significant bone-tunnel enlargement seen on the follow-up radiography, the STG-endo-button knees were stable, and the patients were satisfied. This was in their clinical, radiological, and MRI study on bony tunnel enlargement following hamstring tendon graft for ACL reconstruction compared with age-matched controls with B-PT-B grafts.<sup>[16]</sup> Tashiro et al. found that tendon harvest significantly reduces hamstring muscle strength at high knee flexion angles, but that this weakness can be reduced if the gracilis tendon is preserved in their investigation of the impact of the medial hamstring tendon on knee flexor strength following ACL reconstruction.<sup>[17]</sup>

The majority of patients in our study were male (80.76%), which is in line with the findings of Kumar et al.'s study<sup>[18]</sup> which also found a male preponderance of 87.1%. Our patients' mean age was 27.08 years, which is in good agreement with Kumar et al.'s reported mean age of 28.07.<sup>[18]</sup> The study conducted by Kumar et al. (18) found that the two primary causes of injury were RTA (Road Traffic Accidents) (61.52%) and sports injuries (15.38%). These findings are in good agreement with the incidence of injuries caused by RTA (62.9%) and those linked to sports injuries (30.6%). Comparing our series to Kumar et al. study, which found 30.6% of cases, simultaneous meniscal damage necessitating partial meniscectomy was 34.62%. In the Kumar et al. trial, 85.5% of patients experienced a favourable pivot shift; in our series, that number was 73.07%. Our research, along with that of Kumar et al.<sup>[18]</sup> demonstrated a significant improvement ( $p < 0.0001$  for both) in Lysholm and IKDC scores at the last follow-up in comparison to their preoperative values. In our study, 92.30% of patients were either normal or nearly normal (A or B) at the last follow-up, based on the IKDC score. 1890.3% of patients in the Kumar et al. trial had normal or nearly normal scores (A or B) at the time of the last follow-up.

In our series, 80.76% of patients had excellent to good results based on the Tegner-Lysholm score. This compares favourably with the study conducted by Kumar et al., which found that 89.1% of cases had excellent to good results. Inácio et al.<sup>[19]</sup> investigation on femoral fixation employing rigid fix and AM portal reconstruction of the ACL revealed a mean post-operative Lysholm score of 87.81 and a median subjective IKDC score of 83.72.

The functional outcome of these results is likewise similar to ours. Nonetheless, we secured the graft using an open button on the tibial side and a flip-button on the femoral side. Four patients in the study by Kumar et al. experienced six problems in their series. In our series, 3 patients (11.54%) experienced 6 problems. We had to perform an arthrotomy and debridement with graft retention on the two infected patients. There were no graft re-rupture incidents.

The literature contains a wealth of clinical and analytical data that supports the superiority of anatomic tunnel placement. Numerous cadaveric and clinical investigations have cast doubt on the traditional trans-tibial drilling method's capacity to reconstruct the ACL footprint. Therefore, it has been suggested that an AAM (Accessory Antero-Medial) portal be used to drill the femoral tunnel centre at the anatomical site using ACL restoration.

We concur with Abdelkfy et al.<sup>[20]</sup> that the establishment of an AAM portal is the sole way to enable anatomical transplant insertion. In order to obtain perpendicular access to the medial wall of the lateral femoral condyle and prevent iatrogenic injury to the medial femoral condyle's cartilage, the position of this portal is crucial.

In recent studies on ACL restoration, the femoral tunnel's anatomical location and obliquity have drawn a lot of attention. Nonanatomical tunnel placement has been linked to pain and instability, and more vertical tunnel orientation has been linked to rotatory instability. These findings may eventually lead to poor outcomes and graft ruptures.<sup>[21]</sup> The femoral tunnel location is determined by the portal position and reconstruction surgical method, which in turn influence the results of ACL reconstruction. Kaseta et al.<sup>[22]</sup> highlighted the significance of these factors.

The anatomical femoral tunnel placement is not possible with the traditional trans-tibial procedure, which creates the tibial tunnel first. Because of the femoral tunnel's unusually high position, placing a graft nearly perpendicularly is necessary, which is counterproductive to restoring rotatory stability. The limitations of the conventional trans-tibial approach were intended to be addressed by modified trans-tibial techniques, which provide adjustments to the tibial tunnel position and the reamer insertion site for less oblique femoral tunnel placement. The methods are not without flaws, though: the tibial tunnel should be positioned at an excessively posterior site or through the medial collateral ligament and medial condyle; the tunnel orientation is still more oblique than in other surgical techniques; and the acceptable margin of error is small. A modified trans-tibial approach was shown to be less successful in restoring anterior translation at 0° flexion of the knee than the antero-medial portal technique or outside-in technique in a cadaver investigation by Sim et al.<sup>[23]</sup> A drilling pin is inserted using an outside-in approach from a lateral site in the direction of a target point identified by the antero-medial portal. Low-obliquity femoral tunnels can be created more easily with this approach; however, depending on the drilling angle and site of wire insertion, there is a considerable chance of misplacement. The use of fluoroscopy to solve this issue results in a higher radiation dose. Furthermore, notch-plasty is frequently required to guarantee guide wire insertion and visualisation. Compared to the trans-tibial approach, the typical antero-medial portal permits a less angled femoral tunnel orientation. However, the femoral tunnel is relatively short compared to that in modified trans-tibial techniques due to the insufficient working space and angle, extensive cortical bone destruction is inevitable, and the field of view is limited by the availability of the antero-



lateral portal alone for arthroscopic visualisation.<sup>[24]</sup> Additionally, the removal of the tunnelling equipment and transfer of the arthroscope are necessary for intraoperative visualisation, which raises the possibility of modifying the tunnel obliquity and expanding the tunnel diameter.

Our study has a few limitations, one of which is the absence of a control group and a randomised design. Another drawback is the lack of long-term follow-up data, which prevents us from making comments about the onset of degenerative changes in the knee joints of patients who have had surgery.

## CONCLUSION

Using the AAM arthroscopic portal, anatomic ACL restoration with a hamstring tendon graft is a repeatable procedure that yields satisfactory results in the short- to medium-term follow-up. By positioning the graft more horizontally than during traditional transtibial restoration, it offers the advantage of reducing rotational instability and hence, lowering the risk of graft re-rupture.

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