

Original Article

# Variations in functional outcome based on hamstring autograft thickness estimated using transportal technique in arthroscopic anterior cruciate ligament reconstruction

K. R. Radhik<sup>1</sup>, A. K. Arumugam<sup>1</sup>, V. Manooj Kumar<sup>1</sup>, S. Venkatesh Kumar<sup>1</sup>, Harsha Kumar Koramutla<sup>2</sup>

<sup>1</sup>Department of Orthopaedics, Dhanalakshmi Srinivasan Medical College and Hospital, Perambalur, Tamil Nadu, <sup>2</sup>Department of Orthopaedics, Narayana Medical College and Hospital, Nellore, Andhra Pradesh, India.

## ABSTRACT

**Objectives:** We aimed to study the functional outcome difference in arthroscopic anterior cruciate ligament reconstruction (ACLR) using hamstring autograft thickness between more than 85% and  $\leq 85\%$ .

**Materials and Methods:** In our study, 50 patients with anterior cruciate ligament (ACL) tears were operated with arthroscopic ACLR using an autologous hamstring graft. The anteroposterior diameter (APD) of the tibial footprint of ACL is measured using an arthroscopic ruler using a transportal and the graft thickness of more than 70% of the tibial footprint APD was used. The international knee documentation committee and knee society score (KSS) were compared between the groups in the 1<sup>st</sup> month, 6<sup>th</sup> month, and 12<sup>th</sup> month between autograft thickness of  $>85\%$  and  $\leq 85\%$ .

**Results:** The mean International Knee Documentation Committee score (IKDC) scores of patients with graft thickness  $>85\%$  were higher compared to graft thickness  $\leq 85\%$  in the 6<sup>th</sup> and 12<sup>th</sup> post-operative months, with a statistically significant difference at the 12<sup>th</sup> post-operative month. The mean KSS scores of patients with graft thickness  $>85\%$  were higher compared to graft thickness  $\leq 85\%$  at the 3<sup>rd</sup>, 6<sup>th</sup>, and 12<sup>th</sup> post-operative months, with a statistically significant difference at the 12<sup>th</sup> post-operative month.

**Conclusion:** The functional scores were better for autograft thickness of more than 85% compared to autograft thickness of  $\leq 85\%$  at short-term follow-up of the 3<sup>rd</sup> and 6<sup>th</sup> post-operative month with a statistical difference at long-term follow-up of the 12<sup>th</sup> month.

**Keywords:** Anterior cruciate ligament reconstruction, Hamstring autograft thickness, International Knee Documentation Committee score, Knee Society score, Transportal approach

## INTRODUCTION

The arthroscopic anterior cruciate ligament reconstruction (ACLR) is one of the most common surgeries in orthopedic surgery done for complete anterior cruciate ligament (ACL) tears.<sup>[1]</sup> Several studies have also shown that autograft and allograft (patellar tendon, hamstring tendon, tibialis anterior, and Achilles tendons) may successfully reconstruct the ACL.<sup>[2,3]</sup> However, no convincing data currently exist regarding recent trends for the appropriate thickness of the graft to be used, especially in the Indian subcontinent. Adequate thickness of the graft for a primary ACLR determines the functional and morbidity status following the surgery, thereby providing better outcomes in the ACL deficient knees. The study's major goal is to assess the average anterior-posterior diameter (APD) of the tibial footprint during arthroscopic

ACLR and its functional outcome to determine optimum graft thickness using a transportal technique.

## MATERIALS AND METHODS

### Sample size

This prospective study was carried out in a tertiary care center from August 2019 to March 2021 in South India. The Institutional Ethical Committee has sanctioned our study in 50 patients with ACL tears calculated by the "Complete Enumeration Method" by which, taking all the cases that comes between the study periods.

### Participants

Out of 100 patients who were screened, 50 were selected according to the criteria [Table 1].

\*Corresponding author: S. Venkatesh Kumar, Department of Orthopaedics, Dhanalakshmi Srinivasan Medical College and Hospital, Perambalur, Tamil Nadu, India. mailvenkatesh91@gmail.com

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**Table 1:** Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
MRI confirmed 20–50-year-old patients with full thickness ACL tear	<ol style="list-style-type: none"> <li>1. Age below 20 years and above 50 years</li> <li>2. More than 6 months old ACL injury</li> <li>3. Associated PCL injury/major meniscal tear/collateral ligament injury/major articular cartilage injury</li> <li>4. Patient with established knee osteoarthritis/rheumatoid arthritis</li> <li>5. History of knee trauma/previous surgery/deformity</li> <li>6. Local skin disease/neurovascular deficits involving the knee</li> <li>7. Obese patients to prevent abnormal mechanical loads.</li> </ol>
MRI: Magnetic resonance imaging, ACL: Anterior cruciate ligament, PCL: Posterior cruciate ligament	

### Allocation and implementation

After taking informed consent, the target population was selected with similar baseline characteristics.

### Interventions

The anteromedial and anterolateral portals were made and diagnostic examination of the knee was done to diagnose any associated injury to the knee. The ACL footprint was identified and remnants were removed from the tibial notch. The APD of the tibial footprint of ACL is measured using an arthroscopic ruler through transportal [Figures 1 and 2]. The gracilis and semitendinosus tendons were harvested and prepared. The ideal graft thickness of more than 70% of the tibial footprint APD was adhered to in all the cases.

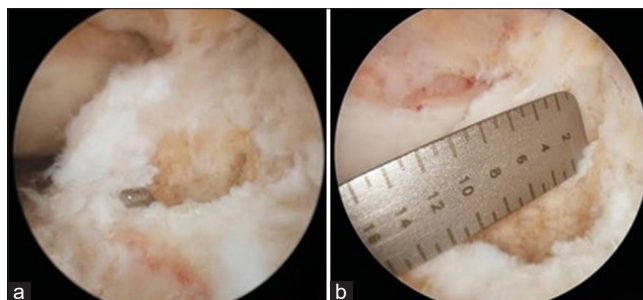
The femoral footprint has marked at the center with an awl. The anatomical femoral and tibial tunnels were prepared meticulously to prevent non-anatomical tunnel placements in both coronal and sagittal planes. We used a fixed loop device and the graft was fixed to the femur. Following that, repeated flexing-extending cycles of the knee were done to pre-install the graft. The tibial fixation was done with an ideal amount of tension using absorbable interference screws. After performing ACL reconstruction, other minor Grade-1 and 2 meniscal tears were identified and conservative management was carried out accordingly.

### Objectives

1. To determine the average thickness of the autograft compared to the normal tibial footprint of the ACL of the individual using an arthroscopic ruler
2. To determine the postoperative clinical outcome at the 3<sup>rd</sup> month, 6<sup>th</sup> month, and 1<sup>st</sup> year postoperatively to assess the outcomes.



**Figure 1:** Arthroscopic ruler.



**Figure 2:** (a) The anteroposterior diameter of the tibial footprint of the anterior cruciate ligament is measured using (b) an arthroscopic ruler.

### Outcomes

The assessment was done using:

1. The average thickness of the autograft for ACL was measured using an arthroscopic ruler
2. The functional outcome postoperatively was done using
  1. International Knee Documentation Committee (IKDC)
  2. Knee society score (KSS).

### Statistical analysis

To find the significant difference between the bivariate samples in independent groups, the independent sample *t*-test was used.

### Post-operative protocol

Proper wound care, along with phase 1–4 ACL rehabilitation protocol was followed. The sutures were removed on an average of 12<sup>th</sup> post-operative day. The patients were followed up post operatively at 3<sup>rd</sup> month, 6<sup>th</sup> month, and 12<sup>th</sup> months. The Lachman test, anterior drawer test, pivot shift test, and knee's range of motion were examined clinically. The X-rays were taken to study the screw location and tunnel

positioning. The functional scoring was done using IKDC and KSS scores.

**RESULTS**

**Observations and results**

In our study, the average age was 26 years. The youngest patient was 23 years old, while the oldest was 45. Magnetic resonance imaging confirmed associated medial meniscal tear in 10% and lateral meniscal injury in 4% of our patients with no occurrences of concomitant medial and lateral meniscal tears. We measured tibial footprint APD in our patients, with six patients having 9 mm (12%), 20 patients having 10 mm and 11 mm each (80% in total), and four patients having 12 mm anterior-posterior (AP) diameter (8%). The maximum number of patients had a mean APD of 10–11 mm [Table 2].

**IDKC score**

The mean IKDC scores of patients with graft thickness ≤85% were slightly better compared to graft thickness >85% at 3<sup>rd</sup> post-operative month with a statistically insignificant difference. However, the mean IKDC scores of patients with graft thickness >85% were higher compared to graft thickness ≤85% in the 6<sup>th</sup> and 12<sup>th</sup> post-operative months. However, the difference was statistically insignificant at the 6<sup>th</sup> post-

operative months with a statistically significant difference at the 12<sup>th</sup> post-operative month [Table 3].

**KSS score**

The mean KSS scores of patients with graft thickness >85% were higher compared to graft thickness ≤85% at 3<sup>rd</sup>, 6<sup>th</sup>, and 12<sup>th</sup> post-operative months. However, the difference was statistically insignificant at 3<sup>rd</sup> and 6<sup>th</sup> post-operative months with a statistically significant difference at the 12<sup>th</sup> post-operative month [Table 4].

**DISCUSSION**

ACLR with the hamstring tendon has become a common and most preferred tendon graft for surgeons and it has shown itself to be efficient inadequately selected individuals.<sup>[4]</sup> A good functional outcome depends on graft size, tunnel position, fixation methods, treatment of associated lesions, and proper rehabilitation after surgery. Biomechanically, both hamstring and bone patellar tendon bone graft show similar properties.<sup>[5]</sup> We used absorbable interference screws for graft fixation in all our cases. Several recent meta-analyses and network meta-analyses have

**Table 2: Demographic data.**

	Frequency	Percentage
<b>Gender</b>		
Female	10	20
Male	40	80
<b>Mechanism of injury</b>		
Road traffic accident	26	52
Sport	24	48
<b>Side</b>		
Left	20	40
Right	30	60
<b>Associated injury</b>		
Grade-III lateral meniscal injury	1	2
Grade-III medial meniscal injury	3	6
Nil	46	92
<b>Graft %</b>		
≤85%	24	48
>85%	26	52
<b>Tibial footprint anteroposterior diameter</b>		
9 mm	6 patients	12
10 mm	20 patients	40
11 mm	20 patients	40
12 mm	4 patients	8

**Table 3: IKDC score difference.**

IKDC	Graft %	n	Mean	SD	t-value	P-value
Pre	≤85	24	51.54	7.03	1.199	0.237 <sup>#</sup>
	>85	26	49.23	6.60		
3 months	≤85	24	63.17	6.08	0.808	0.423 <sup>#</sup>
	>85	26	61.88	5.13		
6 months	≤85	24	77.25	8.11	1.401	0.169 <sup>#</sup>
	>85	26	80.00	5.37		
12 months	≤85	24	85.83	9.02	2.454	0.019 <sup>*</sup>
	>85	26	91.15	5.84		

<sup>#</sup>Significant at P<0.05 and <sup>\*</sup>No statistical significance at P>0.05, SD: Standard deviation, IKDC: International Knee Documentation Committee

**Table 4: KSS score difference.**

KSS	Graft (%)	N	Mean	SD	t-value	P-value
Pre	≤85	24	76.17	13.57	0.375	0.709 <sup>#</sup>
	>85	26	74.92	9.68		
3 months	≤85	24	23.33	6.36	0.462	0.646 <sup>#</sup>
	>85	26	24.19	6.75		
6 months	≤85	24	67.96	17.82	1.514	0.137 <sup>#</sup>
	>85	26	74.77	13.88		
12 months	≤85	24	75.75	13.94	1.995	0.05 <sup>*</sup>
	>85	26	82.54	10.49		

<sup>#</sup>No statistical significance at P>0.05 level, SD: Standard deviation, KSS: Knee society score. <sup>\*</sup>Statistically significant difference

demonstrated a similar functional outcomes in the fixation methods.<sup>[6,7]</sup>

We studied the variance in the functional outcome of autograft thickness at the tibial footprint measured using an arthroscopic ruler through an arthroscopic trans-portal approach during ACLR. The femoral footprint occupies 70% of the area compared to tibial insertion and the substance of ACL constitutes only about 50% of tibial insertion. This shows that the tibial insertion footprint is the single most important measurement required for pre-operative planning of individualized ACLR.<sup>[8,9]</sup>

The APD of the tibial footprint aids in determining the graft's adequacy and the ideal thickness of the graft to be placed should be >70% of the tibial footprint APD<sup>[10]</sup> and it is one of the important components to regain a functionally stable knee joint. Furthermore, an inadequate graft size may result in graft failure. However, the literature on the autograft thickness on the functional outcome is rare. Hence, we studied the difference in functional outcome in ACLR autograft thickness between graft thickness >85% and graft thickness ≤85%.

Studies have shown that revision surgery is more common among grafts with a diameter of 7 mm or less.<sup>[11,12]</sup> According to Spragg *et al.*,<sup>[11]</sup> the patients that required revision surgery more often with the graft thickness falling between 7.0 and 7.5 mm on the lesser side. Mariscalco *et al.*<sup>[12]</sup> state that an inadequate graft size is directly proportional to poor functional score and increased revision rate. Treme *et al.*<sup>[13]</sup> proposed that the graft diameter of <7 mm will have a higher risk of failure.

Conte *et al.*<sup>[14]</sup> state that the ACLR using hamstring autograft with a diameter 8 mm or more increases the success rates compared to graft diameter <8 mm. Howe *et al.*<sup>[15]</sup> reported that 96% patients were content with their functional results, while only 4% patients had unsatisfied results in their long-term follow-up.

Similarly, Chen *et al.*<sup>[16]</sup> reported to have normal or nearly normal IKDC scores in 91% patients undergoing ACL surgery. Khajotia *et al.*<sup>[17]</sup> recorded a mean graft diameter of 8.24 mm from their study and the IKDC score was normal in 84% of patients and only 26% of patients had an abnormal score. Chodavarapu *et al.*<sup>[18]</sup> state that with a mean graft diameter of 7.9 mm that 84% of patients regained pre-injury level activity. The post-operative IKDC scores were 0–60 in 72% patients and 24% patients had a score at 60–70.

The mean IKDC scores of patients with graft thickness ≤85% were insignificantly higher than graft thickness >85% at 3<sup>rd</sup> post-operative month, but the scores of patients with graft thickness >85% were insignificantly higher than graft thickness ≤85% in the 6<sup>th</sup> postoperative month. However, the IDKC score difference was statistically higher for graft thickness >85% than graft thickness >85% at the 12<sup>th</sup> post-operative month. The mean KSS scores of patients with graft thickness >85% were insignificantly higher compared to

graft thickness ≤85% at 3<sup>rd</sup> and 6<sup>th</sup> post-operative months. However, the KSS score difference was statistically higher for graft thickness >85% than graft thickness >85% at the 12<sup>th</sup> post-operative month.

Hence, both the IKDC and KSS scores were better for graft thickness >85% compared to graft thickness ≤85% at the early post-operative months with a statically significant better scores for graft thickness >85% at 12<sup>th</sup> post-operative month. From our study, we can say that the functional outcomes were better for patients with graft thickness more than or equal to 85%.

Confounding factors of this study are anatomical femoral tunnel placements, femoral tunnel diameter, graft bending angle, and graft fixation methods.<sup>[19]</sup> The post-operative stiffness, instability, infection, arthrofibrosis, complex regional pain syndrome, and synovitis were the common complications<sup>[20]</sup> and were not recorded in our study. Clinically, studies comparing different hamstring and quadriceps tendon graft preparations, thickness, and fixation are needed. Larger comparative studies are also needed to validate the results for the specific study populations. Finally, the current literature lacks long-term follow-up studies and higher level of evidence studies is also needed.

## CONCLUSION

Our study evaluated the relationship between ACL graft APD thickness and patient-reported functional outcome scores, which was done rarely in the literature. We conclude from our study that the patients with graft thickness more than 85% of tibial AP footprint had better short-term functional outcome and a significant long-term outcome at 12<sup>th</sup> post-operative month compared to patients with ≤85% graft thickness in arthroscopic ACL reconstruction using transportal approach.

**Author contributions:** KRR and HKK: Conceptualization and supervision; SVK, KRR, AKA, VMK: Writing- original draft preparation. KRR: Data acquisition, analysis and interpretation. SVK and KRR: Critical review and final approval.

**Ethical approval:** The research/study was approved by the Institutional Review Board at Narayana Medical College, Nellore, number NMC/Adm/Ethics/approval/Ortho/005/11/2019, dated November 19, 2019.

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

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