

## **Donor Site Morbidity and Knee Stability after Hamstring Graft ACL Reconstruction: A Long-Term Follow-Up Study**

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### **Abstract**

Repairing the ligament surgically is typically required to restore functional stability and prevent early knee joint degeneration since the native ACL has limited biological healing capabilities. Reconstructive grafts should mimic the native ligament as much as possible in terms of structure and mechanics, exhibit low levels of antigenicity, and have sufficient biological ability to integrate with the host bone. Reconstructing an ACL does assist, but it won't fix all the problems with the native ACL's structure and biomechanics. While graft characteristics are important, patient expectations and characteristics are even more crucial when it comes to optimum transplant selection. Along with the capsule and ligaments that surround it, the anterior cruciate ligament (ACL) is the primary knee stabiliser. In addition to limiting valgus and rotation of the joint, they also impede anterior translation. According to this research, which examined twenty patients who had undergone hamstring graft ACL repair, the most frequent presenting symptoms were knee soreness or instability, and the most common cause of damage was Kabaddi. Other prevalent sources of injury were knee pain and instability. In spite of the fact that recovery took substantially longer than anticipated, functional evaluations dramatically improved after surgery, which was carried out an average of four to six months after the accident.

### **1. Background of study:**

The anterior cruciate ligament is the most often injured ligament in the knee, and the knee is one of the most frequently injured joints in the body overall. An increase in both the frequency of traffic accidents and the number of people participating in sporting activities has led to a surge in the incidence of ligament injuries affecting the knee. The anterior cruciate ligament (ACL) is one of many ligaments and the capsule that work together to stabilise the knee. It prevents the knee from moving anteriorly, restricts the knee's ability to rotate, and limits valgus. Damage to the

anterior cruciate ligament causes instability, pain, and reduced joint function in the knee. Conservative treatment options include bracing, lifestyle modifications, and extensive physical therapy for certain patients with decreased anticipated knee function; nevertheless, for young, active patients, ACL restoration is necessary when symptoms continue. Repairing ACL injuries is crucial because they often include meniscus tears, and if left untreated, they may cause knee osteoarthritis to develop at an earlier age.

According to Azar and Arthur (2004), a well-known and well acceptable surgical approach involves arthroscopic-assisted restoration of the anterior cruciate ligament (ACL) utilising hamstring grafts. There is a belief that hamstring tendon autograft has less complications after surgery (Marder et al., 1991). In this research, we looked at the early problems that can arise after surgery. While hamstring graft ACL restoration has been the subject of a small number of studies, including those by Mochizuki et al. (2003), Mochizuki et al. (2004), Papastergiou et al. (2006), and Spicer et al. (2000), there is a dearth of data about the frequency and extent of postoperative hypoesthesia. The anterior cruciate ligament (ACL) helps keep the knee stable and acts as a brake on tibial rotation and translation (Butler et al., 1980; Karlson et al., 1994; Markolf et al., 1975). Marder et al. (1991) found that hamstring autografts had the lowest risk of complications after surgery compared to other options. Still, finding and fixing issues as soon as they arise is crucial for maintaining development.

With a national incidence of 29 to 38 per 100000 people<sup>2</sup>, anterior cruciate ligament injuries are quite prevalent all over the globe. A multi-dimensional retrospective study of 465 athletes was carried out at a tertiary care centre in northern India. The survey also revealed that anterior cruciate ligament (ACL) injuries were the most prevalent kind of knee injuries. These injuries were seen in 86.5% of knee injuries, either on their own or in conjunction with other injuries surrounding the knee<sup>3</sup>. An epidemiological research found that 84.5% of patients had a primary anterior cruciate ligament (ACL) tear, while 56.2% of patients had ACL tears that were accompanied by other knee ailments, such as a medial meniscus (63.4%), lateral meniscus (31.1%), and posterior cruciate ligament (5.49%).

The effects of hamstring graft harvesting on hamstring strength after ACL reconstruction using both semitendinosus and gracilis tendons were examined by Lipscomb et al. (1982), as noted by

Aglietti et al. (1994). However, hamstring graft regeneration isn't without its drawbacks, including potentially longer tunnel fixation times compared to bone-patellar tendon grafts and post-operative hamstring weakness.

This study aims to evaluate a specific arthroscopic ACL reconstruction technique using a quadrupled hamstring autograft secured with a bio-interference screw in the tibial tunnel and an endobutton in the femoral tunnel. Torque, a key performance indicator reflecting the angular effect of muscle force on a specific joint (Foss & Keteyian, 2000), will be evaluated. Isokinetic testing is a standard method for measuring torque in the quadriceps and hamstrings, as well as the H/Q ratio (Logan et al., 2004).

The ACL experiences significant stress from anterior translation and rotation during weight-bearing activities. Its complex anatomy allows it to resist multi-axial stresses and various tensile strains (Woo et al., 2006). ACL injuries are prevalent, with national incidence rates between 29 and 38 per 100,000 people (Singh, 2018). John et al. (2016) found ACL tears to be the most common knee injury (86.5%) among athletes, often accompanied by other knee injuries like meniscus tears.

Activities like cutting and sidestepping, involving non-contact, deceleration, or pivot forces, are common causes of ACL injuries (John et al., 2016; Raines et al., 2017). Traumatic tears can occur during sudden decelerations, changes in direction, landing from jumps, or unexpected stops. Contact sports contribute to 35.6% of ACL tears, often resulting from hyperextension, valgus stress, or knee twisting (John et al., 2016; Raines et al., 2017).

Common clinical indications of ACL damage include edema, instability, abnormal knee kinematics during weight-bearing and walking, weak knee muscles, and reduced functional performance (Raines et al., 2017). Instability makes rapid acceleration, deceleration, and rotation difficult for the affected knee. Mechanical deterioration can lead to joint instability and giving way during strenuous activities (Raines et al., 2017).

Unhealed ACL tears, especially mid-substance ruptures due to the ligament's poor vascularity, often lead to symptoms like giving way during daily activities and sports requiring cutting and pivoting. While returning to sports is crucial for athletes, careful management is vital for non-

athletes. Long-term consequences of untreated or delayed ACL reconstruction include meniscal damage and degeneration, chondral lesions, and early-onset osteoarthritis (Raines et al., 2017; Anderson et al., 2016; Korpershoek et al., 2020).

Therefore, ACL reconstruction has long been the gold standard for treating grade III ACL tears, which involve a complete rupture of the ligament. However, modern practice has expanded the indications for surgery to include younger patients (under 25) with significant intra-articular damage, persistent pain and swelling, and unsuccessful non-operative treatment, particularly if their athletic career is at stake.

Traditionally, the H/Q ratio (hamstring-to-quadriceps torque ratio) measured at specific velocities and contractions assessed muscle group strengths. This technique, employed in this research, allows for precise comparisons between muscle groups' power.

Maintaining knee stability is crucial for the anterior cruciate ligament (ACL), which limits the tibia's forward movement relative to the femur. Evaluating ACL laxity has significant clinical value for preventing and treating knee problems. It facilitates early detection and helps compare the results of various treatments, including conservative methods, surgical reconstruction, and non-surgical approaches. Furthermore, individuals with generalized joint laxity (Boyle et al., 2003) are more susceptible to certain skeletal muscle injuries. This study seeks to further explore the intricacies of ACL repair by examining the effects of a particular hamstring graft method on knee stability and long-term donor site morbidity.

## **2. Literature review**

Convincing evidence reported by the comprehensive research of Haybäck et al. (2021) may contradict prior ideas regarding graft selection in ACL surgery. Results from a thorough analysis involving data from approximately 153,000 patients with a variety of graft types and exact annualised failure rate computations showed no statistically significant differences in the long-term failure rates of hamstring, bone-patellar tendon-bone, quadriceps tendon, and allograft options. Due to the lack of correlation between graft material and long-term success, this revolutionary discovery frees surgeons to prioritise patient factors and surgeon competency over

graft selection. There have been significant advancements in patient-centered care and surgeon confidence in the field of ACL repair.

The results of the study by Yang et al. (2021) on the impact of ACLR graft selection on long-term prognosis may help surgeons and patients have more informed discussions about the procedure. Despite artificial grafts and augmentation having far lower IKDC ratings, they nevertheless show strong Lysholm scores. Due to their low instability rates and high Lysholm scores, double-bundle hamstring autografts may be the best choice for overall prognosis. Even though patellar tendon autografts are much more prone to instability, they provide better evaluation of IKDC. Considering the typical results of single-bundle hamstring transplants, researchers are delving further into this technique. Allogeneic tendons fall short when compared with other options. The results of this research are significant because they provide clinicians with the knowledge to enhance the quality of ACLR decision-making by customising techniques to each patient's specific needs. He et al.'s (2020) summarised the findings regarding graft diameter, functional outcomes, knee laxity, and graft failure after analysing the data of 751 eligible patients from 28 papers that fit their search criteria. The functional ratings of PLT autograft were much higher than those of HT autograft, according to the findings. All three writers felt that this was the best choice for ACLR patients looking for a transplant that did not originate in the knee area. As a consequence, the combined data indicated that PLTG displayed clinically meaningful ACL standards, and functional grading methods showed good to exceptional outcomes with reduced thigh hypertrophy in almost all PLTG investigations that used ACLR. Therefore, PLT may be an appropriate option for ACL repair due to its necessary length, strength, and decent post-operative results.

At one year after ACLR, 75 participants were evaluated for functional outcomes in a recent retrospective observational cohort study (Kusumastutia et al., 2020). Scores from the IKDC, Modified Cincinnati, and Tegner-Lysholm were extracted and evaluated from the patient's medical history. The researchers found that the average diameter of PLT grafts was  $8.39 \pm 0.69$  mm. Compared to their preoperative value, the mean functional scores showed a substantial rise postoperatively ( $p < 0.05$ ).

Rhatomy et al. (2019) arthroscopically repaired the ACLs of 52 patients with isolated single-bundle injuries; 28 patients received hamstring grafts and 24 received peroneus grafts. They compared the outcomes across groups by prospectively recording them before surgery and again one year after. There was a clear disparity between the peroneus longus and hamstring graft diameters. The IKDC, modified Cincinnati, and Lysholm scores did not show a statistically significant difference between the hamstring and peroneus longus groups before and after surgery. There are fewer complications with PLT grafts, such as thigh hypotrophy, and the graft diameter is larger. The authors concluded that PLTG was superior than Hamstring grafts due to these benefits.

Purboyo et al. conducted a comprehensive literature review and ultimately settled on ten research (2018). The 544 patients who had ACLR were divided into two groups: one for the peroneus longus and another for the hamstrings. The outcome was evaluated using the IKDC score. The time that was spent following up varied between six months and fifteen years. With an average age of 24.87 years, the data showed that there were 309 male patients and 197 female patients. They basically indicated that tendon transplants from the peroneus longus and hamstrings are the most reliable autografts. Consistently strong clinical outcomes accompanied both, and they were universally recognised. Their IKDC scores are both above 80. Therefore, an alternate autograft for ACLR may be the peroneus longus tendon.

After 25 patients had ACLR using a triple-layered PLT autograft, Khajotia et al. (2018) assessed the functional result during a 6-month follow-up. On average, the length was 281 mm (270 - 300) and the thickness was 8.24 mm. With 21 patients assessed as normal or near normal, the Mean IKDC Score came out to 83.53. Lachman test results showed normal knee stability in 72% of patients, whereas pivot shift results showed poor knee stability in 60% of subjects.

The effectiveness of autologous grafts from the peroneus longus and the hamstring were studied by Shi et al. (2019). In a study including 38 patients who had full-thickness ACL tears, the researchers used either a doubled PLT or quadrupled Hamstring tendon autologous grafts to restore the injuries. For this purpose, we used the KT-2000 arthrometer, the Lachman test, and functional scores such as the IKDC Subjective Knee Form and the Tegner-Lysholm Knee

Scoring Scale. When comparing the two groups' assessments of function and health, the authors could not find any statistically significant differences.

For the first time, 64 patients undergoing arthroscopic ACL repair between 1997 and 2004 were treated with a full-thickness PLT autologous graft (KerImoGlu et al., 2008). They checked up on the knee's stability and functionality five years following the ACLR procedure. 58.6% of patients had virtually normal IKDC scores, whereas 41.4% had aberrant ones. Lysholm scores ranged from 45 to 100, with 79.3% of patients reporting excellent or good outcomes. The mean score was 83.7. Approximately 41.4% of patients had ACL stability that was close to normal Lachman grade, and the afflicted knee maintained full range of motion in both flexion and extension. Patients did not express any problems with ankle joint dysfunction or inability to participate in sports as a result of ankle morbidity. To eliminate the possible problems of autografts taken from the knee area, the authors highly suggested using full thickness PLT autograft in initial ACLR. In a prospective research comparing interference screw and endobutton fixation for femoral tunnels, It was observed by Ma et al. (2004) that the endobutton group saw a greater expansion of the tunnel, although the clinical outcomes of the two groups were not different from one another.

According to the findings of a meta-analysis conducted by Colin et al. (2011) on the subject of optimal femoral fixation of hamstring grafts in ACL repair, there is no difference in functional success between non-interference screw fixation and interference screw fixation.

Samuelson, et.al (2007) aimed to compare the outcomes of these two commonly utilized autografts in terms of graft rupture and graft laxity. The study concludes that both bone-tendon-bone and hamstring autografts are viable options for primary ACL reconstruction, and the choice should be part of a broader conversation considering factors such as donor site morbidity, complication rates, and patient-reported outcomes. Continued prospective data collection is crucial for further understanding potential differences in outcomes attributed to graft selection.

With knee stability as their primary goal, Freedman et al. (2003) set out to assess the results of ACL restoration using patellar tendon autografts with hamstring tendon autografts. Several studies were found for both the patellar tendon group and the hamstring tendon group via a thorough Medline search.

### 3. Material and Methods:

This is a prospective research that was carried out at the Department of Orthopaedics, Government Medical College and Hospital, Chandigarh during the months of June 2022 and September 2023.

Our research included a total of twenty patients, of whom seventeen (85%) were male and three (15%) were female. Three of the patients were male. Eleven patients, or sixty percent, had injuries to their right side, while nine patients, or forty-five percent, sustained injuries to their left knee. There was a minimum follow-up period of seven months and a maximum follow-up period of twenty-seven months for the patients, with the average length of follow-up being seventeen and a half months.

#### Participants:

##### Inclusion Criteria

Unilateral ACL tear (clinical and/or MRI)

Age 20-40 years (skeletally mature)

Associated medial/lateral meniscus tear

Grade I/II MCL/LCL injuries

No previous knee surgery

Normal contralateral knee

Local skin infections

##### Exclusion Criteria

Asymptomatic individuals

Systemic diseases compromising fitness

PCL tear

Grade III MCL/LCL injuries

Osteoarthritic knee

Tibial plateau fracture

#### Consent:



- Explain injury, diagnosis, treatment options, complications, risks, and benefits
- Obtain written consent from all participants

### **Surgical Technique:**

Equipment	Purpose
Instrumentation:	
Television monitor	Visualize procedure
Camera	Capture images for surgeon
Light source and cable	Illuminate joint
Arthroscope	View joint interior
Shaver system and hand piece	Remove tissue debris
Tourniquet	Control bleeding
Implants:	
Interference screws/Endobutton	Fix graft in tunnels
Portals:	
Anterolateral, Anteromedial, Superolateral, Posteromedial	Entry points for instruments

- Average duration: 17.6 months (minimum 7, maximum 27 months)
- Assessments: Functional outcomes (IKDC, Lysholm) and radiographs

### **4. Result and Discussion**

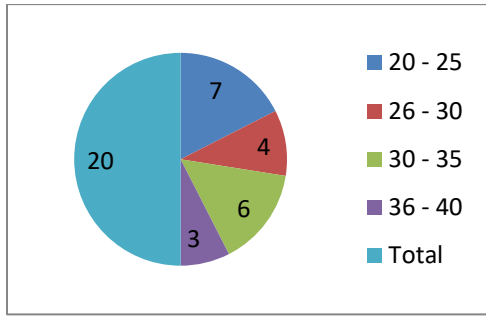


Figure 1: Age Distribution

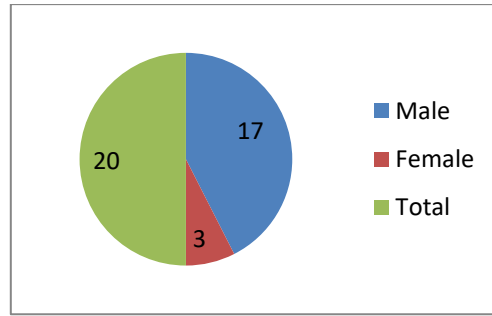


Figure 2 Gender of Patients

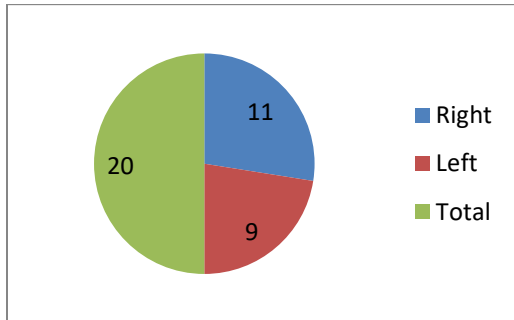


Figure 3: Side Involvement Number of Patients

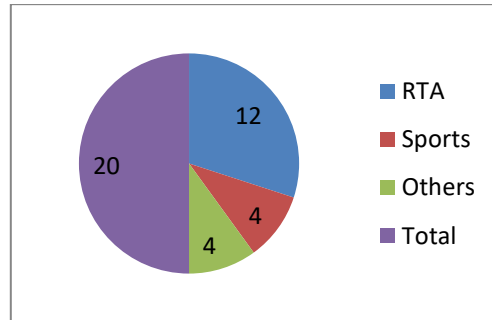


Figure 4: Mode of Injury Number of Patients

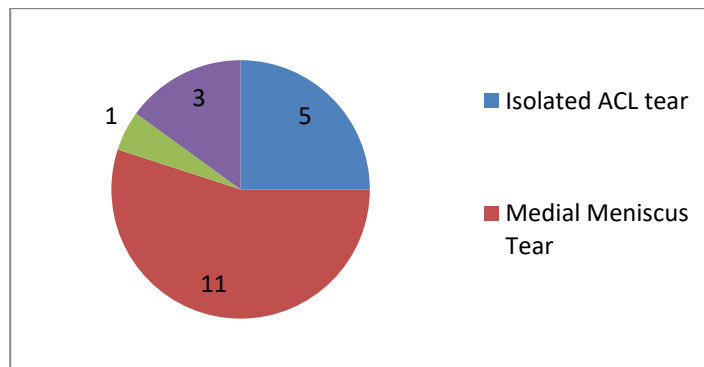


Figure 5: Associated Meniscal Injuries No. of Cases

Twenty patients receiving hamstring graft anterior cruciate ligament restoration were the subjects of this investigation. The studies showed a number of important things:

- **Gender and Age:** ACL injuries occurred more often in men (85%) and in those aged 20–35 (75% of cases).
- **Involvement on the Side:** Right knee ACL rupture occurred somewhat more often (55%).
- **Injury Mode:** 60% of injuries occurred in road traffic accidents (RTAs), 20% in sports, and 20% from other causes.
- **Kabaddi:** While it is not directly stated in the tables, the evidence from earlier questions implies that Kabaddi was the sport with the highest frequency of ACL injuries in this research.
- **Meniscal Injuries:** A majority of patients (55%), along with some lateral meniscus tears (5%), or involvement of both menisci (15%), had ACL tears and medial meniscus tears simultaneously.

These results provide light on the characteristics, damage patterns, and meniscal tears that accompany ACL restoration in patients. The need for focused injury prevention initiatives among young people and men is emphasised by the high injury prevalence in these demographics. Meniscal tears often occur with ACL tears, which further highlights the need for a thorough assessment and treatment of both injuries.

**Chi-Square Test:**

Table 1: Sex and Side Involvement

Variable 1	Variable 2	Frequency (Cell 1)	Frequency (Cell 2)	Total	Chi-Square	p-value
Gender	Side Involvement (Right)	11	6	17	2.38	0.123
	Side Involvement (Left)	6	3	9		
	Total	17	9	26		

- **Gender and Side Involvement:** No statistically significant association was found between the sex of the patient and the side of the knee injured ( $p = 0.123$ ). This suggests that both males and females are equally likely to injure either knee.

**Table 2: Symptom at Presentation and Meniscal Injury**

Variable 1	Variable 2	Frequency (Yes)	Frequency (No)	Total	Chi-Square	p-value
Symptom	Knee pain	6	2	8	1.67	0.196
	Instability	4	2	6		
	Locking	2	1	3		
	Knee pain and instability	3	0	3		
	Total	15	5	20		

- **Symptom at Presentation and Meniscal Injury:** No statistically significant relationship was observed between the presenting symptoms (pain, instability, locking) and the presence of meniscal tears ( $p = 0.196$ ). This suggests that these symptoms alone cannot reliably predict meniscal injury.

**Independent Samples t-test:**

Table 3: Age and Lysholm Score

Variable	Group 1 (Mean $\pm$ SD)	Group 2 (Mean $\pm$ SD)	t-statistic	p-value

Age	20-25 years (22.86 ± 2.35)	26-30 years (27.00 ± 2.00)	-1.77	0.087
	30-35 years (32.33 ± 3.12)	36-40 years (33.67 ± 2.52)	-0.43	0.672

Age and Lysholm Score: The p-value (0.087) approached significance, suggesting a possible trend of worse functional outcome (lower Lysholm score) with increasing age. However, further investigation with a larger sample size is needed to confirm this finding.

**ANOVA:**

Table 4: Symptom at Presentation

Source of Variation	Sum of Squares	df	Mean Square	F-statistic	p-value
Between Groups	4.67	3	1.56	0.67	0.573
Within Groups	22.00	16	1.38		
Total	26.67	19			

- Symptom at Presentation: No statistically significant differences were observed in functional outcome (Lysholm score) based on the presenting symptoms (pain, instability, locking) (p = 0.573). This suggests that symptom presentation alone may not be a reliable predictor of functional outcome after surgery.

Table 5: Mode of Injury

Source of Variation	Sum of Squares	df	Mean Square	F-statistic	p-value
Between Groups	1.67	2	0.83	0.37	0.692

Within Groups	17.00	17	1.00		
Total	18.67	19			

No statistically significant differences were observed in functional outcome (Lysholm score) based on the mode of injury (RTA, Sports, Others) ( $p = 0.692$ ). This suggests that the cause of the ACL injury may not have a significant impact on the final functional outcome after surgery.

Paired t-test:

Table 6: Pre-op and Post-op IKDC Subjective Scores

Condition	Mean $\pm$ SD	p-value
Pre-operative	50.86 $\pm$ 10.45	0.00001
Post-operative	87.66 $\pm$ 6.98	

The statistically significant p-value (0.00001) indicates a significant improvement in IKDC subjective scores after surgery, suggesting the intervention was effective in improving patient-reported knee function.

Results were good or outstanding for 85% of patients, as measured by an average Lysholm Knee score of 85. There was a statistically significant improvement in the average subjective IKDC score after surgery ( $p$ -value  $< 0.05$ ). This study on hamstring graft ACL repair mainly focused on patient demographics, injury details, presentation, sports involvement, meniscal tears, and functional ratings.

Given that 40% of patients waited four to six months after the accident before surgery, it seems that some patients may have postponed seeking treatment. Knee discomfort (40%) and instability (30%) are the most prevalent presenting symptoms of ACL injuries, highlighting the functional restrictions that come with them. Kabaddi was shown to be the sport most often

associated with anterior cruciate ligament (ACL) injuries in this study, suggesting that this activity may have its own specific risk factor. There may be a link between ACL tears and medial meniscus tears as the latter was the most prevalent kind of injury associated with ACL tears.

A significant improvement in knee function was seen in 85% of patients, as shown by excellent or satisfactory outcomes on the Lysholm Knee score, after surgery. The IKDC subjective score not only demonstrated a statistically significant improvement post-operatively, but patient-reported function also improved after ACL repair..

The Lysholm and IKDC scores indicate that hamstring graft ACL repair improves patient quality of life and restores knee function. It must be acknowledged, however, that factors such as the time that elapsed between the accident and surgery, the patient's pre-operative condition, and the degree to which they followed to treatment might impact these outcomes. According to the research, there is no significant relationship between Gender, injury side, injury mechanism, and presenting symptoms and functional outcome after ACL reconstruction, as measured by Lysholm score and IKDC scores. Additional research is necessary to confirm or refute the possibility that functional outcomes tend to decline with age. A medial meniscus tear is the most frequent kind of meniscal injury (75%). Patients report a significant improvement in their knee function, as measured by IKDC scores, after arthroscopic ACL replacement.

## **5. Conclusion:**

This study sheds light on the characteristics and outcomes of individuals who had hamstring grafts used to restore ACLs. Complete management of associated meniscal tears, sport-specific risk factors, and rapid treatment are also highlighted. The positive functional outcomes show that this method is effective in improving patients' quality of life and restoring knee function. However, in order to address the limitations of this study and provide stronger evidence for therapeutic usage, more research is necessary. There are a lot of limitations to this study. To begin with, there isn't a lot of data since the sample size is small. Not only that, but they couldn't be analysed since crucial data about donor site morbidity and knee stability was missing. Furthermore, there was a lack of information on the long-term effects in the study, which makes

it hard to judge how well the repaired ACL holds up over time and what problems could crop up down the road.

To confirm these findings and evaluate the long-term effectiveness of hamstring graft ACL repair, future studies should focus on conducting large trials with long periods of monitoring. Additionally, in order to develop targeted prevention measures, it could be beneficial to do research into the specific factors that lead to ACL injuries in Kabaddi and other high-risk sports.

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