The Egyptian Journal of Hospital Medicine (July 2025) Vol. 100, Page 3738-3746

Comparative Study Between 6 versus 4 Bands Hamstring Autografts for Anterior Cruciate Ligament Reconstruction

Ali Elshrkawy*, Taher Eid, Amr Darwish, Soliman Zalalo
Departments of Orthopedic Surgery, Faculty of Medicine, Menoufia University, Egypt
***Corresponding author:** Ali Elshrkawy, **Mobile:** (+20) 01030443915, **E-mail:** alshrqawyl390@gmail.com

ABSTRACT

Background: Active people frequently sustain anterior cruciate ligament (ACL) injuries, which frequently need surgical repair for functional recovery. Hamstring tendon autografts are widely used, with variations in graft preparation techniques influencing outcomes.

Objective: To compare the functional outcome after reconstruction of ACL by six band hamstrings versus four band hamstring autografts.

Patients and methods: This study is a controlled randomized prospective study, that was conducted at Menoufia University Hospitals from March 2021 to December 2023. Twenty patients underwent ACL reconstruction using 6-band hamstring tendon autograft and twenty patients underwent ACL reconstruction using 4-band hamstring autograft with a minimum 12 months follow up period.

Results: The 6-band and the 4-band hamstring tendon (HT) graft groups both showed significant improvement in functional outcome following ACL reconstruction. Within the 6-band HT group, the Lysholm score increased from preoperative mean of 63.1 to 95.9 at postoperative, while within the 4-band group it increased from 64.3 to 96.6. Similarly, the IKDC score increased from 62.9 to 96.70 in the 6-band group and from 64.50 to 96.25 in the 4-band group, indicating comparable improvements in patient-reported outcomes and knee function with both grafting techniques.

Conclusion: Both graft groups are valid options for ACL reconstruction with comparable results with no significant difference between both groups regarding clinical and functional results especially when we need to increase graft size.

Keywords: ACL reconstruction, Functional outcome, Hamstring tendon, IKDC, Lysholm knee score, Tendon autograft.

INTRODUCTION

ACL rupture has been projected to be a common surgical operation performed by orthopedic surgeons and considered the sixth most common orthopedic surgery, affecting roughly 125,000 people in the USA each year [1,2].

To restore normal knee stability, stop more intraarticular disease, and stop recurring injuries in the knee with an ACL deficiency, reconstruction of the ACL is advised. In order to continue playing cutting or pivoting sports in the future, the majority of these patients ultimately have their ACLs rebuilt [3].

A semitendinosus or combination semitendinosus and gracilis tendon graft is frequently utilized for restoration of the torn ACL because to the observed decreased donor-site morbidity. In terms of ACL graft fixation and graft preparation methods, hamstring tendon autografts encouraged surgeons' inventiveness and originality [4].

There are various graft alternatives for ACL reconstruction. Autografts consist of hamstring tendons such semitendinosus and gracilis, bone-patellar tendon-bone composites, quadriceps tendon, and peroneus longus tendon. Allografts, harvested from donors, may include the Achilles tendon and the tibialis anterior or posterior tendons. In addition, synthetic grafts such as carbon-fiber grafts are also utilized in some cases [5].

Harvesting hamstring tendon autografts is simple and repeatable; no extra surgical procedures or specialized tools are required; hence the procedure takes less time. After surgery, no extra care is required. Compared to BPTB grafts, there is less donor-site morbidity (kneeling discomfort, scarring, etc.). The HT graft has a robust biomechanic. The method is economical [6, 7].

Hamner *et al.* demonstrated that initial tensile strength of the graft increases linearly with cross section area of the graft, so graft size decreases the potential risk of ACL reconstruction failure. The tripled 6-strand graft preparation yields a robust graft with a diameter more than 8 mm and a substantial cross-sectional area [4].

Unlike the single-strand patellar tendon transplant, the non-isometric nature of the natural ACL is preserved. There is no issue about graft-tunnel length mismatch. The semitendinosus and gracilis tendons were tripled to create a 6-strand hamstring tendon transplant. A non-absorbing suture is used to whip-stitch the proximal end of the gracilis tendon [5].

This work's objective was to compare the functional outcome after reconstruction of ACL by six band hamstrings versus four band hamstring autografts.

PATIENTS AND METHODS

From March 2021 to December 2023, a prospective controlled, randomized trial was conducted to compare two patient groups at Menoufia University Faculty of Medicine. Group A comprised patients who were treated with ACL reconstruction using a six-band hamstring tendon (HT) autograft, and Group B comprised patients who underwent ACL reconstruction using a four-band HT autograft.

Received: 20/04/2025
Accepted: 17/06/2025

The inclusion criteria for the current study were patients with isolated ACL insufficiency, who met the following criteria: active patients who are heavy laborers and need knee stability, and patients who experience knee instability with activities of daily living. Patients meeting the inclusion criteria were those with a unilateral ACL rupture, expressed as giving way episodes, a positive pivot shift test, and MRI confirmation. Only mature patients of both sexes were included.

Exclusion factors were young patients, patients above 45 years of age, patients with concomitant ligamentous injuries in the same knee (lateral, posterolateral, medial insufficiency, or posterior cruciate ligament insufficiency), and osteoarthritic patients.

40 patients with primary ACL insufficiency who fulfilled the inclusion criteria underwent arthroscopically assisted ACL reconstruction using the two graft types described above. Twenty patients received ACL reconstruction with the six-band HT graft, and 20 patients received the procedure with the four-band HT graft. All patients were prospectively followed for at least 12 months.

The age distribution was also comparable in the two groups and no discrepancies were recorded. Regarding the knee involved, the majority of patients in both groups had an injury to the left knee, at 60% in Group A and 55% in Group B. The most common cause of injury was sporting in nature, at 60% in Group A and 65% in Group B, and the remainder were due to other causes. Moreover, the time interval from trauma to operation was the same in both groups with no statistical difference.

Clinical outcomes were measured at admission, before operation, and after surgery, with clinical findings established by Lysholm and International Knee Documentation Committee (IKDC) scores. Postoperative, a functional assessment was carried out 12 months after the operation in an independent blinded observer with the Lysholm score and the subjective IKDC score. The maximum score that can be achieved is 100, graded as follows: Excellent (95–100), Good (85–94), Fair (65–84), and Poor (≤64).

Subjective IKDC questionnaire is a self-administered questionnaire that evaluates knee symptoms, function, and sports activity. The total score is 87, which is normalized to a 0 to 100 scale. A high score indicates good knee function and fewer symptoms.

Clinically and radiologically diagnosed ACL tear patients were admitted to the Orthopedic Department, Menoufia University Hospitals, for preoperative assessment. Complete blood count, prothrombin time (PT), partial thromboplastin time (PTT), INR, kidney function tests, liver function tests, and serological testing for HCV, HBV, and HIV were the routine investigations.

The procedure was performed under spinal anesthesia in a supine position. The patient received a prophylactic dose of 1 gram of 3rd-generation cephalosporin at least 30 minutes before tourniquet application. The limb was scrubbed and routine tests (anterior drawer, Lachman, pivot shift) were performed under anesthesia.

Arthroscopy was used to assess the joint before graft harvesting. Anterolateral portal was established on inferior pole of patella, lateral to patellar tendon. Diagnostic arthroscopy was done followed by supra-patellar pouch, patellofemoral joint, menisci, intercondylar notch, and the posterolateral compartment examination.

Graft harvesting was performed by hamstring tendon incision and tendon preparation for the graft. The ACL reconstruction was performed by employing the respective graft (six-band or four-band HT autograft), and graft fixation was performed with bio-absorbable interference screws on the tibial side and lube adjustable on the femoral side.

In each case, semitendinosus and gracilis tendons were harvested with a 3–4 cm oblique incision above the pes anserinus with a closed tendon stripper, and loose ends were whipstitched. Graft preparation was performed on a sterile surface (Figure 1). In Group A (four-band group), the tendons were doubled and whipstitched both ends. In the six-band group (Group B), both tendons were tripled to form a six-strand construct, also whipstitched on both ends. The graft diameter was measured on the graft-end using a graft sizing block and constructs were stretched under 20 lbs of tension approximately 9 kg) for 10 minutes.

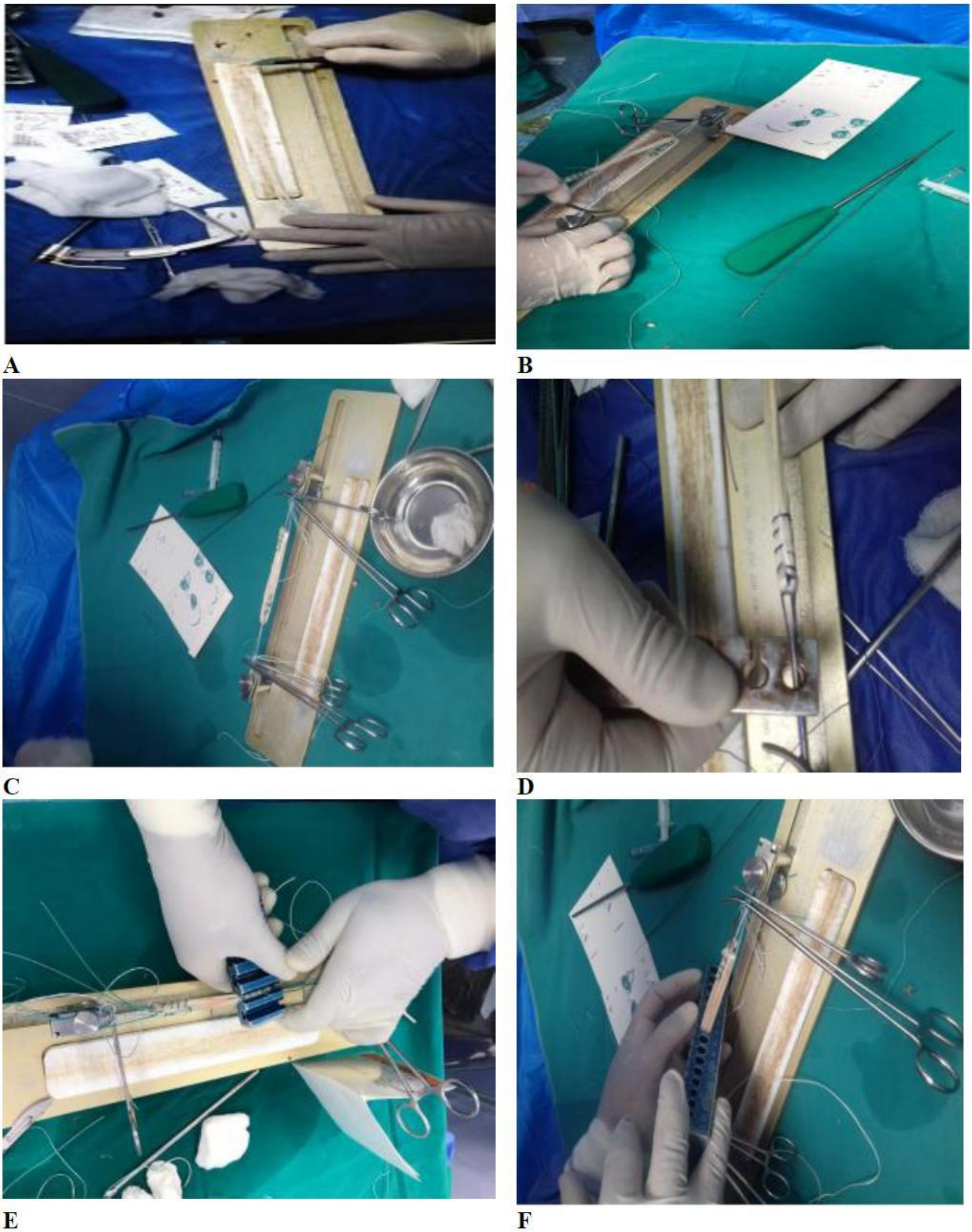

Figure (1): Demonstrates the step-by-step graft preparation from A through F, emphasizing length sizing and contouring. Panel A presents the raw harvested tendon graft soon after it was removed, with loose and unprocessed ends. Panel B shows the initial stages of graft preparation, where the tendon was partially cleaned and whip-stitched at the ends, and the beginnings of length and shape determination were made. In panel C, the graft was trimmed to length to the dimensions required for tunnel placement, and both ends then appeared symmetrical and standardized. Panel D demonstrates the diameter sizing, with the graft being sized against sizing cylinders to confirm a good fit within the femoral and tibial tunnels. In panel E, the graft was well-prepared with a smooth, symmetrical shape, representing final confirmation of shape and diameter. Lastly, panel F illustrates the completed graft with both ends sutured and available for insertion into anatomical tunnels, finishing off the preparation process.

Femoral tunnels were created through the anteromedial portal technique with knee flexion of 120°. Tunnel lengths ranged from 30 to 40 mm, and tunnel diameters were coordinated with the size of the graft. A 50° angle tibial guide was set.

The tibial tunnel was threaded and the graft advanced into the femoral tunnel. Femoral tunnel fixation was with an EndoButton CL. A bioabsorbable interference screw with the same diameter as the tunnel was used to immobilize the tibial fixation, holding the knee in a 20° flexion position and applying the maximum posterior drawer. All patients followed a standardized rehabilitation plan and were assessed clinically and functionally following surgery using the IKDC and Lysholm ratings.

Ethical approval:

The Ethics Committee of the Menoufia Faculty of Medicine authorized this study. All patients were informed about the nature of the injury, diagnosis, treatment, and the risks. Written consent for surgery was signed by all patients prior to undergoing surgery, and all patient data were coded and anonymized. The Helsinki Declaration was followed throughout the course of the investigation.

Statistical Analysis

To analyze the data, SPSS version 26.0 was utilized. Range, mean ± SD, median, and IQR were used to show quantitative variables, and the independent samples t-test was used to compare the two groups. Comparing pre-operative and post-operative scores within groups was done using paired t-tests. Using Fisher's exact test, categorical variables were compared after being shown as frequencies and percentages. One was deemed statistically significant if the p-value was less than 0.05.

RESULTS

Table (1) shows a comparison of IKDC scores between the 4-band and 6-band hamstring autograft groups, both pre-operatively and post-operatively. Pre-operatively, there was no statistically significant difference between the groups, indicating comparable baseline knee function. Post-operatively, both groups showed significant improvements in IKDC scores. Although the 6-band group had slightly higher post-operative mean and median IKDC scores, the difference between groups did not reach statistical significance, indicating that the two graft techniques were equally successful in enhancing knee function following ACL reconstruction.

Table (1): Comparison between the two studied groups according to IKDC

IKDC (%)	4 band (n = 20)	6 band (n = 20)	t	p
Pre-operative				
Min. – Max.	54.0 – 74.0	54.0 – 73.0	0.850	0.401
Mean ± SD.	64.50 ± 6.39	62.90 ± 5.48		
Median (IQR)	64.50 (59.50 – 70.0)	63.0 (57.50 – 66.50)		
Post-operative				
Min. – Max.	95.0 – 98.0	95.0 – 98.0	1.424	0.163
Mean ± SD.	96.25 ± 0.91	96.70 ± 1.08		
Median (IQR)	96.0 (96.0 – 97.0)	97.0 (96.0 – 98.0)		
t_0 (p_0)	**22.880* (<0.001*)**	**26.917* (<0.001*)**		

t_0: Paired t-test; *: significant. p: p value for comparing between the two studied groups; p_0: p value for comparing between **pre-operative** and **post-operative**

Table (2) shows the LYSH scores for both groups before and after ACL reconstruction. Pre-operatively, there was no significant difference between the 4-band and 6-band groups, indicating similar baseline knee function. Post-operatively, both groups demonstrated significant improvement ($p < 0.001$ for each), reflecting successful surgical outcomes. Although the 4-band group had a slightly higher mean post-operative LYSH score, the difference between the two groups was not statistically significant.

Table (2): Comparison between the two studied groups according to LYSH

LYSH (%)	4 band (n = 20)	6 band (n = 20)	t	p
Pre-operative				
Min. – Max.	56.0 – 73.0	54.0 – 71.0	0.724	0.474
Mean ± SD.	64.30 ± 5.11	63.10 ± 5.37		
Median (IQR)	64.50 (60.50 – 69.0)	64.50 (58.0 – 67.0)		
Post-operative				
Min. – Max.	95.0 – 98.0	95.0 – 99.0	1.916	0.063
Mean ± SD.	96.60 ± 1.05	95.95 ± 1.10		
Median (IQR)	97.0 (96.0 – 97.0)	96.0 (95.0 – 96.0)		
t_0 (p_0)	**27.660* (<0.001*)**	**27.095* (<0.001*)**		

IQR: **Inter quartile range**; SD: **Standard deviation; t: Student t-test; t_0: Paired t-test,** p: p value for comparing between the two studied groups; p_0: p value for comparing between **pre-operative** and **post-operative,** *: significant.

Table (3) shows that the 4-band and 6-band groups differed significantly in terms of graft size and graft length. There was a significant difference in length between the 4-band grafts (mean = 105.8 mm) and the 6-band grafts (mean = 94.0 mm), with p < 0.001. On the other hand, the 6-band grafts were significantly larger than the 4-band grafts (mean = 9.90 mm vs. 9.05 mm), with a p-value of less than 0.001.

Table (3): Comparison between the two studied groups according to graft length and graft size

		4 band (n = 20)	6 band (n = 20)	T	p
Graft length	Min. – Max.	95.0 – 115.0	90.0 – 100.0	6.629*	<0.001*
	Mean ± SD.	105.8 ± 6.93	94.0 ± 3.84		
	Median (IQR)	105.0(100.0 – 110.0)	95.0 (90.0 – 95.0)		
Graft size	Min. – Max.	9.0 – 10.0	9.0 – 10.0	9.992*	<0.001*
	Mean ± SD.	9.05 ± 0.22	9.90 ± 0.31		
	Median (IQR)	9.0 (9.0 – 9.0)	10.0 (10.0 – 10.0)		

*: **significant.**

Post-operative complications in this study in both types of grafts were the same and had no difference in post-operative results **(Table 4)**.

Table (4): Comparison between the two studied groups according to complication

		4 band (n = 20)		6 band (n = 20)		FET	P
		No.	%	No.	%		
Complication	No	18	90.0	18	90.0	0.485	1.000
	Paresthesia	1	5.0	1	5.0		
	Skin infection	1	5.0	1	5.0		

FET: Fisher Exact test; p: p value for comparing between the two studied groups.

Comparing pre-operative and post-operative Lysholm score of patients in this study reveals significant improvement in all 8 items of the Lysholm score. Pre-operative mean score was 64.50 ± 6.39, while post-operative mean score was 96.25 ± 0.91 **(Table 5)**.

Table (5): Comparison between pre-operative and post-operative for (4 band) graft according to symptoms of Lysholm score

Symptoms of Lysholm score	Pre-operative 4 band (n = 20)	Post-operative 4 band (n = 20)	p
Limb			<0.001*
Min. – Max.	0.0 – 5.0	5.0 – 5.0	
Mean ± SD.	2.93 ± 0.94	5.0 ± 0.0	
Support			0.034*
Min. – Max.	2.0 – 5.0	5.0 – 5.0	
Mean ± SD.	4.40 ± 1.22	5.0 ± 0.0	
Locking			
Min. – Max.	2.0 – 10.0	10.0 – 15.0	<0.001*
Mean ± SD.	7.90 ± 2.81	14.67 ± 1.27	
Instability			<0.001*
Min. – Max.	10.0 – 20.0	20.0 – 25.0	
Mean ± SD.	13.67 ± 3.2	24.83 ± 0.91	
Pain			<0.001*
Min. – Max.	5.0 – 20.0	15.0 – 25.0	
Mean ± SD.	14.33 ± 3.14	21.33 ± 2.60	
Swelling			
Min. – Max.	0.0 – 10.0	2.0 – 10.0	<0.001*
Mean ± SD.	5.07 ± 1.95	9.33 ± 1.84	
Stair climbing			<0.001*
Min. – Max.	2.0 – 6.0	10.0 – 10.0	
Mean ± SD.	4.53 ± 1.96	10.0 ± 0.0	
Squatting			<0.001*
Min. – Max.	2.0 – 4.0	4.0 – 5.0	
Mean ± SD.	2.93 ± 1.02	4.53 ± 0.51	
Score			<0.001*
Min. – Max.	54.0 – 74.0	95.0 – 98.0	
Mean ± SD.	**64.50 ± 6.39**	**96.25 ± 0.91**	

*: **significant.**

Comparing pre-operative and post-operative Lysholm score of patients in this study reveals significant improvement in all 8 items of the Lysholm score. Pre-operative mean score was 62.90 ± 5.48, while post-operative mean score was 96.70 ± 1.08 **(Table 6)**.

Table (6): Comparison between pre-operative and post-operative for (6 band) graft according to symptoms of Lysholm score

Symptoms of Lysholm score	Pre-operative 6 band (n = 20)	Post-operative 6 band (n = 20)	p
Limb			<0.001*
Min. – Max.	0.0 – 5.0	5.0 – 5.0	
Mean ± SD.	2.93 ± 0.94	5.0 ± 0.0	
Support			0.014*
Min. – Max.	2.0 – 5.0	5.0 – 5.0	
Mean ± SD.	4.40 ± 1.22	5.0 ± 0.0	
Locking			
Min. – Max.	2.0 – 10.0	10.0 – 15.0	<0.001*
Mean ± SD.	7.90 ± 2.81	14.67 ± 1.27	
Instability			<0.001*
Min. – Max.	10.0 – 20.0	20.0 – 25.0	
Mean ± SD.	13.67 ± 3.2	24.83 ± 0.91	
Pain			<0.001*
Min. – Max.	5.0 – 20.0	15.0 – 25.0	
Mean ± SD.	14.33 ± 3.14	21.33 ± 2.60	
Swelling			
Min. – Max.	0.0 – 10.0	2.0 – 10.0	<0.001*
Mean ± SD.	5.07 ± 1.95	9.33 ± 1.84	
Stair climbing			<0.001*
Min. – Max.	2.0 – 6.0	10.0 – 10.0	
Mean ± SD.	4.53 ± 1.96	10.0 ± 0.0	
Squatting			<0.001*
Min. – Max.	2.0 – 4.0	4.0 – 5.0	
Mean ± SD.	2.93 ± 1.02	4.53 ± 0.51	
Score			<0.001*
Min. – Max.	54.0 – 73.0	95.0 – 98.0	
Mean ± SD.	**62.90 ± 5.48**	**96.70 ± 1.08**	

*: **significant.**

DISCUSSION

ACL injuries are one of the most common and functionally disabling knee injuries, particularly in sports persons and physically active athletes. ACL injuries are frequently those which need surgery to restore the knee stability, prevent further joint deterioration, and enable patients to resume prior activity levels. ACL reconstruction with autologous hamstring tendon graft is a widely accepted procedure due to its optimal outcomes, minimal donor site morbidity, and adequate tensile strength. Variations in graft preparation, i.e., the number of strands used, however, can significantly influence postoperative biomechanical function, graft incorporation, and late stability **(7)**.

Newer technologies for ACLR have incorporated the creation of multi-strand hamstring autografts, including the use of six-strand constructs, as an emerging method to enhance graft strength and stability. Several studies have indicated that the use of additional strands may result in a larger graft diameter, more similar to that of the native ACL and perhaps reducing graft failure risk. Despite these theoretic advantages, no consensus within the literature exists regarding clinical benefit of six-strand grafts over traditional four-strand technique. This study aims to provide a comparative assessment of six-band vs. four-band hamstring tendon autografts for ACL reconstruction through examination of graft diameter, functional outcome, and complication rate, hence contributing to the ongoing endeavor to maximize surgical technique for ACLR **(8,9)**.

This study was a prospective study, that was conducted at Menoufia University hospital. Twenty patients underwent ACL reconstruction using six-band hamstring autograft and twenty patients underwent

ACL reconstruction using four-band hamstring autograft.

40 patients with primary ACL insufficiency who fulfilled the inclusion criteria underwent arthroscopically assisted ACL reconstruction using the two graft types described above. Twenty patients received ACL reconstruction with the six-band HT graft, and 20 patients received the procedure with the four-band HT graft. All patients were prospectively followed for at least 12 months.

The age distribution between the two groups was comparable, with no significant differences observed. In terms of the affected knee, the majority of patients in both groups sustained injuries to the left knee 60% in Group A and 55% in Group B. Sports-related activities were the most common cause of injury, accounting for 60% of cases in Group A and 65% in Group B, while the remaining cases were attributed to other causes. Additionally, the time interval between the traumatic event and surgical intervention was similar in both groups, with no statistically significant difference.

In our recent study, there was no significant difference in pre-operative or post-operative IKDC scores between both band groups, indicating similar baseline and post-surgical knee function. Both groups demonstrated a highly significant improvement in IKDC scores following surgery ($p < 0.001$), confirming the effectiveness of ACL reconstruction using either graft type. Overall, the results suggest that both four-band and six-band hamstring autografts provide comparable functional outcomes in terms of subjective knee assessment.

ACL reconstruction with a six-strand hamstring autograft. According to **Shah *et al.*** [(10)] after surgery, the average subjective IKDC score increased considerably at 3 month (63.42±5.38) and 6 months (82.82±7.49) compared to pre-operative levels (50.55±1.84). The Tegner-Lysholm score in their study likewise revealed a similar result. After 6 months in our study, all patients had normal to nearly normal functional results with no significant problems.

While, **Kyung *et al.*** [(11)] observed no discernible differences between patients who got a combined semitendinosus and gracilis tendon graft and those who underwent ACL restoration utilizing a four-strand semitendinosus tendon graft in terms of clinical or functional results, including IKDC ratings. Both techniques led to significant postoperative improvements, indicating that either graft option can be effectively used to restore knee stability and function.

Compared to the traditional 4-strand (4HS) hamstring autograft, the failure rates of 5-strand (5HS) and 6-strand (6HS) hamstring autografts were examined in research. 5 instances for 5HS, 3 cases for 6HS, and 3 cases for 4HS made up the study's total ACLR failure rate of 11 cases (8%). The groups did not vary statistically significantly ($P = 0.06$) [(12)].

Similar to this study, **Braithwaite *et al.*** [(13)] found that subjects who had surgery for ACLR using a 6-strand hamstring autograft had a mean post-operative IKDC subjective score of 96.8 (range 82–100) at least a year following the procedure.

Furthermore, a six-month follow-up IKDC subjective score of 79.02±1.30 was recorded following ACLR employing a four-stranded hamstring graft [(14)].

In our recent study ACL reconstruction using 6-band HT was 9.9±0.31 with range between 9-10 in mm, while graft diameter in the patients with ACL reconstruction using 4-band HT was 9.05±0.22 with range between 9-10 in mm. No re-rupture was reported. In both the 6-strand and 4-strand groups, the ultimate graft's mean diameter was 9.9±0.31 cm and 9.05±0.22 cm, respectively ($P<0.001$).

The variability in hamstring autograft diameter remains a significant concern in ACL reconstruction, as smaller graft sizes have been consistently associated with inferior outcomes. **Boniello *et al.*** [(15)] revealed in biomechanical research that graft tensile strength increased with diameter, highlighting the mechanical benefits of using larger grafts.

This conclusion is supported by **Magnussen *et al.*** [(16)] **and Mariscalco *et al.*** [(17)] revealed that smaller grafts are associated with lower functional outcomes—including lower Knee injury and Osteoarthritis Outcome Scores (KOOS) and increased rates of graft failure.

Similarly, **Snaebjornsson *et al.*** [(18)] **and Spragg *et al.*** [(19)] found that smaller graft diameters significantly raise the risk of revision surgery, with **Spragg *et al.*** [(19)] noting that the chance of revision fell by 0.82 times for each 0.5mm increase in graft diameter between 7.0 and 9.0 mm. **Grawe *et al.*** [(20)] also observed elevated failure rates when grafts were smaller than 8.0 mm. Based on these findings, many authors and experts recommend a minimum graft diameter of 8.0 to 8.5 mm in adult patients. Nevertheless, an analysis of four-strand hamstring (4HS) autografts performed at our institution revealed a significantly smaller mean diameter of 7 mm, with considerable variability and grafts as small as 5.5 mm.

Keith *et al.* [(21)] found that graft diameters of 7 mm resulted in a 1.7% revision rate. Furthermore, the likelihood of a patient requiring a revision ACL repair decreased by 0.82 times with each 0.5mm increase in graft diameter between 7 mm and 9 mm.

In this study, regarding the post-operative complications of both groups, ACL with 6 band HT autograft group had one patient with knee hypoesthesia, one patient with post-operative superficial wound infection at recipient site managed by medical treatment and 18 patients with no post-operative complications.

In the study by **Shah *et al.*** [(10)]**,** at the 6 months follow-up, they assessed the functional outcomes of patients who had ACLR using a six-strand HT autograft. Twelve cases of paresthesia (21.80%), 6 cases of hardware prominence (10.90%), four cases of superficial infection (7.27%), three cases of hemarthrosis (5.45%), and two cases of knee effusion (3.63%) were listed as complications.

One patient experienced hypoesthesia due to damage to the saphenous nerve's infrapatellar branch, one patient with superficial wound infection at the recipient site managed by medical treatment and 18 patients with no post-operative complications in group B. In our study, sensory impairments such as hypoesthesia or numbness surrounding the site of surgery are common after hamstring tendon harvest for ACL reconstruction. In **Kjaergaard *et al.*** [22] study, 88% of patients developed hypoesthesia after surgery, although the affected area decreased by approximately 46% within a year. In another study, all 12 hypoesthesia instances were in the group that received hamstring tendon autografts, perhaps because the saphenous nerve was injured during graft harvest.

While postoperative wound infection after ACL reconstruction in general is low, hamstring autografts have been found to pose a minimal increased risk among all of the graft choices. In one such report, for instance, one patient developed a superficial infection and one developed a deep infection after ACL reconstruction with hamstring tendon autografts[23]. Another study by **Maletis *et al.*** [24] revealed that the overall superficial surgical site infection (SSI) rate after ACL reconstruction to be 0.16%, with hamstring tendon autografts carrying an 8.2-fold increased risk in comparison to bone-patellar tendon-bone autografts.

Kyung *et al.* [11] reported one case of superficial infection and one case of knee effusion after ACLR using a four-strands HT autograft.

In the current study, pre-operative and post-operative Lysholm score of patients operated by 6 bands revealed significant improvement in all 8 items of the Lysholm score. Pre-operative mean score was 62.90±5.48 (54.0–73.0) while postoperative mean score was 96.70±1.08 (95.0–98.0). Pre-operative and post-operative Lysholm score of patients operated by 4 bands revealed significant improvement in all 8 items of the Lysholm score also. Pre-operative mean score was 64.50±6.39 (54.0–74.0) while postoperative mean score was 96.25±0.91 (95.0–98.0).

Mengaji *et al.* [25] who examined functional outcomes of arthroscopic assisted ACL restoration utilizing quadrupled hamstring autograft, reported a considerable increase in knee function, as reflected by the significant increase in mean Lysholm scores from 59.19 preoperatively to 94.95 postoperatively. This finding aligns with multiple reports supporting the efficacy of quadrupled hamstring autografts in restoring joint stability and function.

Similarly, **Runer *et al.*** [26] measured in a study mean Lysholm scores improving from 69.3 preoperatively to 96.03 at 12 months follow-up in patients undergoing ACL reconstruction with hamstring tendon grafts.

In contrast, comparison study between different methods of ACL reconstruction revealed no statistically significant difference in Lysholm scores across groups, suggesting that results may be determined by factors other than the surgical technique[27].

This study highlights that both six-band and four-band hamstring tendon autografts in ACL reconstruction lead to significant improvements in functional outcomes, as demonstrated by IKDC and Lysholm scores, with no major complications or graft failures observed in either group. While the six-band grafts tended to have slightly larger diameters and may offer enhanced biomechanical stability, both techniques proved effective and comparable in terms of clinical success. These findings support the continued use of both graft configurations, with graft size and strand number considered as part of individualized surgical planning to optimize patient outcomes.

CONCLUSION

Both graft groups are valid options for ACL reconstruction with comparable results with no significant difference between both groups regarding clinical and functional results especially when we need to increase graft size.

No funding.
No conflict of interest.

REFERENCES

1. **Irarrázaval S, Kurosaka M, Cohen M *et al.* (2016):** Anterior cruciate ligament reconstruction. J ISAKOS., 1(1):38–52.
2. **Kim S, Bosque J, Meehan J *et al.* (2011):** Increase in outpatient knee arthroscopy in the United States: a comparison of National Surveys of Ambulatory Surgery, 1996 and 2006. JBJS., 93(11):994–1000.
3. **Struewer J, Frangen T, Ishaque B *et al.* (2012):** Knee function and prevalence of osteoarthritis after isolated anterior cruciate ligament reconstruction using bone-patellar tendon-bone graft: long-term follow-up. Int Orthop., 36(1):171–77.
4. **Hamner D, Brown C, Steiner M *et al.* (1999):** Hamstring tendon grafts for reconstruction of the anterior cruciate ligament: biomechanical evaluation of the use of multiple strands and tensioning techniques. JBJS., 81(4):549–57.
5. **Dhammi I, Rehan-Ul H, Kumar S (2015):** Graft choices for anterior cruciate ligament reconstruction. Indian J Orthop., 49(2):127-28
6. **Vinagre G, Kennedy N, Chahla J *et al.* (2017):** Hamstring graft preparation techniques for anterior cruciate ligament reconstruction. Arthrosc Tech., 6(6): 2079–84.
7. **Conte E, Hyatt A, Gatt Jr C *et al.* (2014):** Hamstring autograft size can be predicted and is a potential risk factor for anterior cruciate ligament reconstruction failure. Arthroscopy, 30(7):882–90.

8. **Paudel Y, Sommerfeldt M, Voaklander D (2023):** Increasing incidence of anterior cruciate ligament reconstruction: a 17-year population-based study. Knee Surg Sports Traumatol Arthrosc., 31(1):248-255.
9. **Vyacheslavovich O, Vladimirovna N, Bekzhan D *et al.* (2024):** Evaluating the efficacy of reconstruction: Systematic review of six-strand hamstring autografts for anterior cruciate ligament reconstruction: Biomechanical and clinical outcomes. Surgeries, 5: 449-464
10. **Shah N, Dodiya H, Damor R *et al.* (2024):** Clinical outcomes of primary anterior cruciate ligament reconstruction using six-strand hamstring autograft. Journal of Arthroscopic Surgery and Sports Medicine, 5(1):24-31.
11. **Kyung H, Lee H, Oh C *et al.* (2015):** Comparison of results after anterior cruciate ligament reconstruction using a four-strand single semitendinosus or a semitendinosus and gracilis tendon. Knee Surg Sports Traumatol Arthrosc., 23(11):3238-43.
12. **Attia A, Nasef H, ElSweify K *et al.* (2020):** Failure rates of 5-strand and 6-strand vs quadrupled hamstring autograft ACL reconstruction: A comparative study of 413 patients with a minimum 2-year follow-up. Orthop J Sports Med., 8(8):2325967120946326. doi: 10.1177/2325967120946326.
13. **Braithwaite C, Hafen T, Dean R *et al.* (2024):** Outcomes of primary anterior cruciate ligament (ACL) repair for proximal tears: A systematic review and meta-analysis. Cureus, 16(4):e59124. doi: 10.7759/cureus.59124.
14. **Krishna L, Chan C, Lokaiah L *et al.* (2021):** Five-strand versus four-strand hamstring autografts in anterior cruciate ligament reconstruction-A prospective randomized controlled study. Arthroscopy, 37(2):579-585.
15. **Boniello M, Schwingler P, Bonner J *et al.* (2015):** Impact of hamstring graft diameter on tendon strength: a biomechanical study. Arthroscopy, 31(6):1084–1090.
16. **Magnussen R, Lawrence J, West R *et al.* (2012):** Graft size and patient age are predictors of early revision after anterior cruciate ligament reconstruction with hamstring autograft. Arthroscopy, 28(4):526–531.
17. **Mariscalco M, Flanigan D, Mitchell J *et al.* (2013):** The influence of hamstring autograft size on patient-reported outcomes and risk of revision after anterior cruciate ligament reconstruction: a Multicenter Orthopaedic Outcomes Network (MOON) cohort study. Arthroscopy, 29(12):1948–1953.
18. **Snaebjornsson T, Hamrin Senorski E, Ayeni O *et al.* (2017):** Graft diameter as a predictor for revision anterior cruciate ligament reconstruction and KOOS and EQ-5D values: a cohort study from the Swedish National Knee Ligament Register based on 2240 patients. Am J Sports Med., 45(9):2092–2097.
19. **Spragg L, Chen J, Mirzayan R *et al.* (2016):** The effect of autologous hamstring graft diameter on the likelihood for revision of anterior cruciate ligament reconstruction. Am J Sports Med., 44(6):1475–1481.
20. **Grawe B, Williams P, Burge A *et al.* (2016):** Anterior cruciate ligament reconstruction with autologous hamstring: can preoperative magnetic resonance imaging accurately predict graft diameter? Orthop J Sports Med., 4(5):2325967116646360. doi: 10.1177/2325967116646360.
21. **Keith H, Christine Y, Bekzhan D *et al.* (2024):** Evaluating the efficacy of reconstruction: systematic review of six-strand hamstring autografts for anterior cruciate ligament reconstruction: Functional and clinical outcomes. Surgeries, 5(2):449–64.
22. **Kjaergaard J, Faunø L, Faunø P (2008):** Sensibility loss after ACL reconstruction with hamstring graft. Int J Sports Med., 29(6):507-11.
23. **Komnos G, Chalatsis G, Mitrousias V *et al.* (2022):** Postoperative infection after anterior cruciate ligament reconstruction: Prevention and management. Microorganisms, 10(12):2349. doi: 10.3390/microorganisms10122349.
24. **Maletis G, Inacio M, Reynolds S *et al.* (2013):** Incidence of postoperative anterior cruciate ligament reconstruction infections: graft choice makes a difference. Am J Sports Med., 41(8):1780-85.
25. **Mengaji S, Nayak A, Naik S (2022):** Assessment of functional outcome of arthroscopic assisted anterior cruciate ligament reconstruction using quadrupled hamstring auto-graft: Case series. International Journal of Orthopaedics Sciences, 8(1): 624-628.
26. **Runer A, Wierer G, Herbst E *et al.* (2018):** There is no difference between quadriceps- and hamstring tendon autografts in primary anterior cruciate ligament reconstruction: a 2-year patient-reported outcome study. Knee Surg Sports Traumatol Arthrosc., 26(2):605-614.
27. **Lai S, Zhang Z, Li J *et al.* (2023):** Comparison of anterior cruciate ligament reconstruction with versus without anterolateral augmentation: A systematic review and meta-analysis of randomized controlled trials. Orthop J Sports Med., 11(3):23259671221149403. doi: 10.1177/23259671221149403.