

COMPARISON AND FUNCTIONAL ANALYSIS OF SINGLE-BUNDLE ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION ALONE WITH LATERAL EXTRA-ARTICULAR TENODESIS AS AN ADJUNCT TO ANTERIOR CRUCIATE LIGAMENTRE CONSTRUCTION IN ANTEROLATERAL INSTABILITY

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ABSTRACT

Objectives: The aim of this study is to compare the functional outcome of ACL reconstruction (ACLR) alone, with patients who underwent ACLR with lateral extra-articular tenodesis (LET).

Methods: This prospective study was conducted in 30 patients with ACL deficient knee with high-grade pivot (Grade-II and Grade-III) Skeletally mature to 56 years of age, 2 or more of: Competitive pivoting sport, Chronic ACL insufficiency, Revision ACLR and Generalized ligament laxity-Beighton score of 4 greater.

Results: A total of 30 patients were evaluated in this study. Fifteen cases were operated for ACLR and 15 cases for ACLR + LET. Most of the patients were in the age group of 21–30 with all male gender indicating ACL injuries are common in young males with a history of road traffic accident (63.33%) at the time of injury. The mean operating time in our study (also the total tourniquet time) was 110 min (range 100–130 min). Instability was controlled well in ACLR + LET group. Two patients in ACLR+LET group have complained of instability episodes. Preoperatively, Grade 2 pivot shift was observed in 80% in control and 33.33% in other group. Grade 3 pivot shift on examination was found in 20% in control group and 66.66% in experimental group. Post-surgery patients who received ACLR alone had Grade 1 pivot in 60%, Grade 2 in 33.33%, and Grade 3 in 6.67%. Combined group (ACLR+LET) had Grade 1 in 33.33, Grade 2 in 60%, and Grade 3 pivot in 66.66%. Regarding pre-operative International knee documentation committee (IKDC) scores, patients treated with ACLR alone had 26.66% below 45, 40% between 45-55, 6.66% in 60–70, 70–80, and in patients treated with both ACLR+LET had 6.66% in 40–50, 20% in 50–60, 46.66% in 60–70, and 26.66% in 70–80 before surgery. Post-surgery, patients in both groups had excellent scores (90–100 IKDC score).

Conclusion: The combination of LET and intra-articular ACLR is effective in eliminating the high-grade pivot-shift phenomenon. Adding a lateral extra-articular tenodesis can improve patient outcome without the need for future revision ACL surgery and its obligatory intense post-operative rehabilitation, in moderately active patients.

Keywords: Anterior cruciate ligament reconstruction, Lateral extra-articular tenodesis, International knee documentation committee.

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INTRODUCTION

The anterior cruciate ligament (ACL) is the most frequently operated ligament in the knee. Although the real incidence is unknown in India, but approximately 200,000 ACL injuries per year occur in the United States, and 100,000 ACL reconstructions (ACLRs) are performed. To know the incidence of ligament injuries in India, Indian Arthroscopic Society has launched Indian Ligament Registry (ILR). ILR is an initiative of the Indian Arthroscopy Society which is the official national organization for arthroscopy surgeons. The ILR can collect all critical patient data before, during, and after surgery using a standardized “click and go” form on a secure Internet gateway. The ILR can collect all critical patient data before, during, and after surgery using a standardized “click and go” form on a secure Internet gateway. ILR was created by renowned professionals in the area and has been validated by eminent surgeons around the country. NEC Software Solutions (NEC), a UK-based corporation that maintains some of the world’s largest healthcare registries, has technically commissioned and supported ILR [1].

On December 1, 2021, the ILR was formally introduced. First-line treatment for ACL injuries is arthroscopically assisted ACLR in active patients. The main aim of surgery is to bring sagittal and rotational instability of the knee under control. Even if anterior laxity can be brought under control using modern surgical techniques, sufficient

control of internal rotational instability may not always be provided. A positive pivot-shift sign continuing after surgery indicates continuing rotational instability and may be associated with poor functional results, patient dissatisfaction, and the development of osteoarthritis. It has been shown in cadaveric studies that while isolated ACL injuries do not increase rotational laxity, injury to the anterolateral structures together with the ACL causes significant rotational laxity. ACL injuries rarely occur in isolation, and associated meniscal, chondral, and ligamentous lesions all influence the outcome of treatment [2,3].

To prevent this coronal or rotational instability, different surgical techniques were employed such as double-bundle ligamentous reconstruction, lateralization of femoral tunnels, and combined intra- and extra-articular reconstruction, have been developed. These hybrid techniques almost always provide the possibility of reconstruction of anterolateral structures that have been damaged in knees with rotational instability. One of the surgical solutions that can be applied to prevent anterolateral laxity is extra-articular lateral tenodesis. Compared with intra-articular reconstructions, the advantage is that internal rotation can be better controlled via the long force arm formed because it is farther from the center of rotation of the knee. In studies, successful results have been reported using extra-articular reinforcement applied in addition to single-bundle ACLR. Despite evolving techniques in ACLR and improved instrumentation, shift from non-anatomic to anatomic in

the last few decades, the problem of pivot is yet to be resolved. Hence, the hypothesis that, rotation may not be resolved with only ACLR and that augmentation with lateral extra-articular tenodesis (LET), may have successful results [4].

It can be considered necessary to determine the conditions, leading to rotational instability and to decide on the surgical treatments required for these pathological conditions on an individual patient basis. The finding of pivot shift in physical examination is effective in showing rotational instability in patients and is the physical examination test showing the best correlation with functional results after ACLR. We apply an algorithm that targets 2 basic pathologies ACL, anterolateral ligament, which leads to the finding of pivot shift. The aim of this study is to compare the functional outcome of ACLR alone, with patients who underwent ACLR with LET. To assess the effectiveness in reducing pivot shift when LET is added as an adjunct to single bundle ACLR and to clearly determine the indication for LET and to prospectively evaluate the surgical results of our method aimed at eliminating the pivot-shift, finding without creating any unnecessary surgical comorbidity.

METHODS

This prospective study was conducted in Nizams institute of medical sciences (NIMS) Hospital, Hyderabad from June 2021 to September 2022.

There were 30 patients included in our study of which 30 patients (100%) were male and 0 (0%) were female. Seven patients (46%) had right-side injury while 8 (53%) had injury to the left knee where ACLR+LET was performed. Seven patients (46%) had right-side injury while 8 (53%) had injury to the left knee where ACLR was performed. The patients with ACLR +LET were followed up for an average duration of 8.6 months with a minimum follow-up of 4 months and maximum follow-up of 15 months.

All young and middle-age patients presenting with unilateral knee complaints and a history of trauma to the knee in the orthopedic emergency and outpatient departments in NIMS Hospital, Hyderabad, were evaluated by a thorough general and local examination of the knee. In a relaxed patient and in supine position, the uninjured knee was examined first to establish ligament excursions after which the affected knee was examined.

The specific tests were performed for diagnosing ACL deficiency as Lachmantest, Anteriodrawertest, and pivot shift test.

Injuries to the associated structures were assessed by performing the following clinical tests as Valgus/varus stress test (for collateral ligaments), McMurray's test/Apley grinding test (for menisci), and Posterior drawer test (for posterior cruciate ligament).

Routine radiographs of both knees in standing position in anteroposterior view and lateral view of the affected knee were taken. MRI of the knee was done in all ACL-torn cases for confirmation.

Inclusion criteria

All patients 18 years to 56 years with ACL deficient knee with high-grade pivot (Grade-II and Grade-III) Skeletally mature to 56 years of age, 2 or more of: Competitive pivoting sport, Chronic ACL insufficiency, Revision ACLR, and Generalized ligament laxity - Beighton score of 4 greater were included in the study.

Exclusion criteria

Multi-ligament injury (two or more ligaments requiring surgical attention), symptomatic articular cartilage defect requiring treatment other than debridement, >3° of asymmetric varus as unable to complete outcome questionnaires, immature skeleton, and PLC injury were excluded from the study.

Patients with torn ACL that are proven clinically and radiologically are admitted in Department of Orthopedics, NIMS, Hyderabad. Routine investigations such as hemoglobin, total and differential counts, platelet count, chest X ray, and ECG were taken and anesthetic assessment for regional and general anesthesia was done.

Pre-operative rehabilitation

Pre-operative strength and range of movement of knee joint were measured and documented. Static and dynamic quadriceps exercise were taught to patients while awaiting for surgery. All patients were enlightened on post-operative rehabilitation.

All patient in this study were explained about the injury, diagnosis, various management options, complication of non-operative treatment and operative management, per-operative and post-operative complications, donor site morbidity, injury to surrounding structures, infection, compartment syndrome, anaesthesia risks, post-operative knee pain, restriction of range of motion.

Consent for surgery was obtained for all the patients who were included in this study. All consent was obtained before surgery. Patients and their attenders were well explained about the advantages and disadvantages of procedure. Risk benefit ratio was explained.

The various fixation options available for soft tissue grafts can be classified into direct methods and indirect methods.

RESULTS

Based on the data of patients, all the patients gender belongs to male category. Out of 30, two patients are of age below 20, 20 belong to the age group 20–30 age, and 8 patients belong to the age group 30–40. According to the data collected from the patients out of 30, majority of affected due to road traffic accidents (19), followed by Kabbadi sport (5), Falling (2), Dancing (1), Hurt against door (1), and Playing (1). Out of 30 patients, 14 were injured on the right knee and 16 were injured on the left knee side Table 3.

Pre- and post-operation studies of right knee operated patients: Based on the Pivot scale analysis of left knee operated patients using ACL and ACL in couple with LET, out of seven who have undergone ACL alone, five has reported 3 and two have reported 2 whereas in case of post-operation, three reported 0 and two reported 1. In case of 7 patients who have undergone, before operation, four patients have reported 3 scale and two patients have reported 3. Post-operation 5 has reported 2, 1 reported 1, and 1 has reported 1.

According to the International knee documentation committee (IKDC) analysis, ACL alone operated patients before treatment belongs to the % range of below 45 (3), 45–55 (1), 55–60 (2), and 70–80 (1) (Table 9a) and post-operation, all patients were reported to be in the range of 90–100. In case of patients operated with ACL coupled with LET 45–55 (1), 55–60 (2), 60–70 (3), 70–80 (1), and post operation, all patients were reported to be in the range of 90–100 (Table 9b).

According to Lysholm analysis in ACL alone operated patients before treatment belong to the % range of below 50–60 (4), 60–70 (3) (Table 10a) and post-operation, all patients were reported to be in the range of 90–100. In case of patients operated with ACL coupled with LET 50–60 (3), 60–70 (4) and post-operation, all patients were reported to be in the range of 90–100.

On the basis of VAS analysis in ACL alone, operated patients before treatment belong to the scale 4 and after operation 6 reported 0, 1 reported 1, and 3 reported 2 (Table 11a). In case of patients operated with ACL coupled with LET before operation, all patients reported 4 and post-operation all seven have reported.

Table 3 Effectiveness of ACL Reconstruction along with Lateral Tenodesis for Functional stability of Knee.

Table 1: Patients based on the demographic details

Age group	No of patients	%
Below 20	2	6
21-30	20	67
31-40	8	27
Mode of injury		
RTA	19	63.33
KABADDI	5	16.66
FALL	2	6.66
SLIP	1	3.33
Dancing	1	3.33
door playing	1	3.33
Area of injury		
Right knee	14	47
Left Knee	16	53

Table 2: Pivot grade of pre and post of left knee-operated patients

Ligament injury	Pre-operation		Post-operation	
	No of Patients	% of patients	No of Patients	% of patients
ACL	3 (7)	87.5	0 (6)	75.5
	2 (1)	12.5	2 (1)	12.5
ACL+LET	3 (6)	75	2 (4)	50
	2 (2)	25	1 (4)	50

Table 3: IKDCC of pre and post of left knee operated patients ACL alone and ACL+LET in %

IKDCC of Pre and Post of Left Knee operated Patients ACL alone	IKDC PREOP	IKDC POST OP
below 45	12.5	0
45-55	62.5	0
55-60	25	0
60-70	0	0
70-80	0	0
80-90	0	0
90-100	0	100
IKDCC of Pre and Post of Left Knee operated Patients ACL+LET		
below 45	0	0
45-55	0	0
55-60	25	0
60-70	50	0
70-80	25	0
80-90	0	0
90-100	0	100

DISCUSSION

A total of 30 patients were evaluated in this study. Fifteen cases were operated for ACLR and 15 cases for ACLR + LET. Most of the patients were in the age group of 21-30 with all male gender indicating ACL injuries are common in young males. In our study, most of the patients had a history of road traffic accident (63.33%) at the time of injury. The combination of LET and intra-articular ACLR is effective in eliminating the high-grade pivot-shift phenomenon. Adding a lateral extra-articular tenodesis can improve patient outcome without the need for future revision ACL surgery and its obligatory intense post-operative rehabilitation, in moderately active patients. Based on the study combined ACLR and LET procedure reduces pivot in high-grade cases and probably protects the ACL graft.

Arthroscopic ACLR is nowadays standard operative procedure for ACL injury in high-demand individuals but residual tibiofemoral

Table 4: Lysholm of pre and post of left knee operated patients ACL alone and ACL+LET in %

Lysholm	Pre Operation	Post Operation
Lysholm of Pre and Post of Left Knee operated Patients ACL alone		
40-50	12.5	0
50-60	37.5	0
60-70	50	0
70-80	0	0
80-90	0	0
90-100	0	100
Lysholm of pre and post of left knee operated patients ACL alone+LET		
40-50	0	0
50-60	25	0
60-70	75	0
70-80	0	0
80-90	0	0
90-100	0	100

Table 5: VAS of pre and post of left knee operated patients ACL alone and ACL+LET in %

VAS of pre and post of left knee operated Patients ACL alone	VAS Preop	VAS Post OP
0	0	12.5
1	0	50
2	0	37.5
3	0	0
4	100	0
VAS of pre and post of left knee operated patients ACL+LET		
0	0	100
1	0	0
2	0	0
3	0	0
4	100	0

Table 6: Pivot grade of pre and post of right knee-operated patients

Ligament injury	Pre-operation		Post-operation	
	No of patients	% of patients	No of patients	% of patients
ACL	3 (5)	71.4	0 (3)	42.85
	2 (2)	28.57	2 (1)	14.28
			1 (3)	42.85
ACL+LE	3 (4)	57.14	2 (5)	71.42
	2 (3)	42.85	1 (1)	14.28
			3 (1)	14.28

rotatory instability in some knees post-ACL reconstruction results in poor outcome (Hamada et al, 2021) [5]. For people with chronic ACL deficiency, the rotational stability offered by ACLR alone may be insufficient to diminish the pivot shift. Previous clinical studies which compared isolated ACL reconstruction versus combined ACL plus lateral extra-articular procedures suggested that LET performed with ACLR reduced lateral compartment translation which was demonstrated by stress radiography. Although the LET procedure has re-emerged as an adjunct surgical option for the treatment of ACL-deficient knees, clear indications for its use are still lacking. Hence, this study focused on the importance of ACLR performed with LET. The main aim of this study was to analyze and compare the outcomes of patients who had undergone ACLR alone (control group) with patients who had ACLR plus a LET (experimental group). Majority of the patients belonged to the age group 21-30 years (67%). All patients were male. Road traffic

Table 7: IKDC of pre and post of left knee operated patients ACL alone and ACL+LET in %

IKDC of pre and post of left knee operated patients ACL alone	IKDC PREOP	IKDC POST OP
below 45	42.85	0
45-55	14.28	0
55-60	28.57	0
60-70	0	0
70-80	14.28	0
80-90	0	0
90-100	0	100
IKDC of Pre and Post of Left Knee operated Patients ACL+LET		
below 45	0	0
45-55	14.28	0
55-60	28.57	0
60-70	42.85	0
70-80	14.28	0
80-90	0	0
90-100	0	100

Table 8: Lysholm of pre and post of left knee operated patients ACL alone ACL+LET in %

Lysholm	Pre-operation	Post-operation
Lysholm of pre and post of left knee operated patients ACL alone		
40-50	0	0
50-60	57.17	0
60-70	42.85	0
70-80	0	0
80-90	0	0
90-100	0	100
LYSHOLM of pre and post of left knee operated patients ACL alone+LET		
40-50	0	0
50-60	42.85	0
60-70	57.14	0
70-80	0	0
80-90	0	0
90-100	0	100

Table 9: VAS of pre and post of left knee operated patients ACL alone ACL+LET in %

Score	VAS PREOP	VAS POSTOP
VAS of Pre and Post of Left Knee operated Patients ACL alone		
0	0	85.71
1	0	14.28
2	0	0
3	0	0
4	100	0
VAS of Pre and Post of Left Knee operated Patients ACL+LET		
0	0	100
1	0	0
2	0	0
3	0	0
4	100	0

accident was the most common cause of injury (63.33%). Young, male individuals who are breadwinners of the family were mainly involved in RTA and hence the majority in our study.

In our study, clinically all patients presented with positive anterior drawer test with varying grades, positive Lachman test and high-grade pivot shift test (Grade 2 and 3). However, under anesthesia, all patients showed Grade 3 anterior drawer and pivot shift test. All cases in our

study were operated by a single surgeon. The mean operating time in our study (also the total tourniquet time) was 110 min (range 100–130 min) and once the time exceeded more than 120 min in some cases, the tourniquet was released and applied again after 20 min under aseptic conditions.

In our study, we have used ipsilateral hamstring autograft for ACL for 29 cases and peroneus longus graft for one case which was in the control group. The average graft length for ACL was 90 mm and average intraarticular thickness of ACL was 8 mm. LET was performed in all with 8 mm thickness of Iliotibial band and was fixed with 7 × 25 interference screw in femoral tunnel by modified Lemaire procedure. Some studies have concluded that a graft diameter of 8.5 mm had a 1.7% revision rate. Furthermore, the risk of a patient needing a revision ACL was 0.82 times lower with every 0.5 mm increase in graft diameter between graft thicknesses of 7 mm and 9 mm. The effect of the autograft diameter on the re-rupture and revision rate of the reconstructed ACL injuries of the knee has been extensively studied. Some authors have shown that a reduction in autograft (hamstrings) diameter is related to a higher revision rate, especially in younger patients. Another study found a significant positive correlation between a 1 mm increase in graft diameter, with a higher KOOS score and IKDC score, and a higher revision rate with graft sizes of >8 mm [6]. In our study, average graft diameter was 8.5 mm intarticular thickness.

There were some donor site morbidities in our study (2/15 cases) in the experimental group (ACLR + LET) group and 2/15 in control group (Isolated ACLR) like thigh hypotrophy and subjective symptoms such as hypoesthesia or anesthesia caused by injury to the infrapatellar branch of the saphenous nerve. Our study findings were similar to studies of Simonian *et al.*, 1997; Nishino *et al.*, 2006; Choi *et al.*, who noticed an average of 10–20 mm of decrease of thigh musculature wasting in STG group compared to unoperated leg [7].

Instability was controlled well in ACLR + LET group. Two patients in ACLR+LET group have complained of instability episodes. Both individuals had this episode of instability during jogging 7 months postoperatively. We attribute the reason for this instability to the associated lateral meniscus tear which was treated by partial meniscectomy during the ACLR. In the control group (ACLR), five cases with high-grade pivot shift complained about instability during jogging at 8 months of post-operative period and all these cases had normal meniscus. Musahl *et al.* also reported a significant correlation between lateral compartment acceleration and translation in male patients with combined ACL and lateral meniscal tears.

During the rehabilitation in early post-operative period and during initiation of weight bearing two patients in experimental group complained of knee swelling and pain which aggravated on walking. These symptoms are reduced over time with symptomatic treatment. At 9-month follow-up, no patient had knee pain or swelling on walking and all graft site incisions healed well.

In our study, no post-operative infections were noted. We have soaked all our grafts with vancomycin before fixing them as it prevents graft from post-operative infection. Baron *et al.* [8], in their study of 1640 patients, concluded that vancomycin soaked grafts had less infection. There was no graft rupture at the end of 9–16 month follow-up in both the groups. There was no evidence of loss of knee flexion-extension in either group. Post-operative evaluation was performed by various parameters such as Visual analog scale (VAS), Pivot grade, IKDC, and LYSHOLM scores.

In immediate post-operative period and at suture removal, there was no significant difference in VAS scores in both groups. Preoperatively, Grade 2 pivot shift was observed in 80% in control and 33.33% in other group. Grade 3 pivot shift on examination was found in 20% in control group and 66.66% in experimental group. Post-surgery patients who received ACLR alone had Grade 1 pivot in 60%, Grade 2

in 33.33%, and Grade 3 in 6.67%. Combined group (ACLR+LET) had Grade 1 in 33.33, Grade 2 in 60%, and Grade 3 pivot in 66.66%. The most important finding of our study is that the group of knees treated with a combined ACL plus lateral tenodesis had a reduced prevalence of rotational instability (pivot glide) than did the group which had only had an isolated ACL reconstruction and that this restraint of laxity was not associated with any loss of motion.

Regarding preoperative IKDC scores, patients treated with ACLR alone had 26.66% below 45, 40% between 45 and 55, 6.66% in 60–70, 70–80 and in patients treated with both ACLR+LET had 6.66% in 40–50, 20% in 50–60, 46.66% in 60–70, and 26.66% in 70–80 before surgery. Post-surgery, patients in both groups had excellent scores (90–100 IKDC score).

Based on the data collected and analyzed by Lysholm Scale, patient in control group had scores of 40–50 in 6.66%, 50–60 in 73.33%, and 60–70 in 20%, whereas in patients received ACLR+LET has scores of 40–50 in 6.66%, 50–60 in 30%, 60–70 in 13.33%, and 70–80 in 20% preoperatively. Post-surgery, in patients treated with ACLR alone 6.66% had 40–50, 40% had 50–60, 6.66% had 60–70 scores and in patients treated with ACLR+LET had 50–60 in 46.66%, 60–70 in 6.66%, and 90–100 in 46.66%.

Our findings are similar to Song *et al.* [9], Hewison *et al.* [10] and Rezende *et al.* [11], Zaffagnini *et al.* [12] and we also report a decrease in the pivot-shift grade but no difference in IKDC scores in which patients underwent combined ACL reconstruction and LET than those who had ACLR alone. Our hypothesis of ACL+LET procedure providing superior clinical outcome and objective decrease in pivot shift is proved, particularly in regard to rotational stability testing, as determined by the various parameters. Similar results were reported by LaPrade *et al.* [13] who evaluated the role of a LET procedure in the setting of ACL reconstruction. ACL graft forces were decreased when a subsequent LET procedure was performed, suggesting a possible role for the protection of an ACLR graft.

Limitations

Small sample size Short duration of follow-up Long-term follow-up of patients is needed. Large sample size and long duration would probably have strengthened our study.

CONCLUSION

A total of 30 patients were evaluated in this study. Fifteen cases were operated for ACLR and 15 cases for ACLR + LET. Most of the patients were in the age group of 21–30 with all male gender indicating ACL injuries are common in young males. In our study, most of the patients had a history of road traffic accident (63.33%) at the time of injury. The combination of LET and intra-articular ACLR is effective in eliminating the high-grade pivot-shift phenomenon. Adding a lateral extra-articular tenodesis can improve patient outcome without the need for future revision ACL surgery and its obligatory intense post-operative rehabilitation, in moderately active patients. Based on the study combined ACLR and LET procedure reduces pivot in high-grade cases and probably protects the ACL graft.

REFERENCES

1. Miller RH 3rd, Azar FM. Anterior cruciate ligament injuries. In: Canale ST, Beaty JH, editors. Campbell's Operative Orthopaedics. 12th ed., Vol. 2133. Netherlands: Elsevier; 2013.
2. Paschos NK, Howell SM. Anterior cruciate ligament reconstruction: Principles of treatment. EFORT Open Rev 2016;1:398–408. doi: 10.1302/2058-5241.1.160032, PMID 28461919
3. Ayeni OR, Chahal M, Tran MN, Sprague S. Pivot shift as an outcome measure for ACL reconstruction: A systematic review. Knee Surg Sports Traumatol Arthrosc 2012;20:767–77. doi: 10.1007/s00167-011-1860-y, PMID 22218828
4. Inderhaug E, Stephen JM, Williams A, Amis AA. Anterolateral tenodesis or anterolateral ligament complex reconstruction: Effect of flexion angle at graft fixation when combined with ACL reconstruction. Am J Sports Med 2017;45:3089–97. doi: 10.1177/0363546517724422, PMID 28898106
5. Tsujii A, Yonetani Y, Kinugasa K, Matsuo T, Yoneda K, Ohori T, *et al.* Outcomes more than 2 years after meniscal repair for longitudinal tears of the lateral meniscus combined with anterior cruciate ligament reconstruction. Am J Sports Med 2021;49:684–92. doi: 10.1177/0363546520981976, PMID 33449798
6. Jagadeesh N, Dhawan T, Sheik F, Shivalingappa V. Does hamstring graft size affect functional outcome and incidence of revision surgery after primary anterior cruciate ligament (ACL) reconstruction? Cureus 2022;14:e21158. doi: 10.7759/cureus.21158, PMID 35165608
7. Nomura Y, Kuramochi R, Fukubayashi T. Evaluation of hamstring muscle strength and morphology after anterior cruciate ligament reconstruction. Scand J Med Sci Sports 2015;25:301–7. doi: 10.1111/sms.12205, PMID 24646218
8. Baron JE, Shamrock AG, Cates WT, Cates RA, An Q, Wolf BR, *et al.* Graft preparation with intraoperative vancomycin decreases infection after ACL reconstruction: A review of 1,640 cases. J Bone Joint Surg Am 2019;101:2187–93.
9. Song GY, Hong L, Zhang H, Zhang J, Li Y, Feng H. Clinical outcomes of combined lateral extra-articular tenodesis and intra-articular anterior cruciate ligament reconstruction in addressing high-grade pivot-shift phenomenon. Arthroscopy 2016;32:898–905. doi: 10.1016/j.arthro.2015.08.038, PMID 26524939
10. Hewison CE, Tran MN, Kaniki N, Remtulla A, Bryant D, Getgood AM. Lateral extra-articular tenodesis reduces rotational laxity when combined with anterior cruciate ligament reconstruction: A systematic review of the literature. Arthroscopy 2015;31:2022–34. doi: 10.1016/j.arthro.2015.04.089, PMID 26116497
11. Rezende FC, de Moraes VY, Martimbianco AL, Luzo MV, da Silveira Franciozi CE, Belloti JC. Does combined intra- and extraarticular ACL reconstruction improve function and stability? A meta-analysis. Clin Orthop Relat Res 2015;473:2609–18. doi: 10.1007/s11999-015-4285-y, PMID 25845949
12. Zaffagnini S, Bruni D, Russo A, Takazawa Y, Lo Presti M, Giordano G, *et al.* ST/G ACL reconstruction: Double strand plus extra-articular sling vs double bundle, randomized study at 3-year follow-up. Scand J Med Sci Sports 2008;18:573–81. doi: 10.1111/j.1600-0838.2007.00697.x, PMID 18208432
13. LaPrade RF, Johansen S, Wentorf FA, Engebretsen L, Esterberg JL, Tso A. An analysis of an anatomical posterolateral knee reconstruction: An *in vitro* biomechanical study and development of a surgical technique. Am J Sports Med 2004;32:1405–14. doi: 10.1177/0363546503262687, PMID 15310564