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Research Article

Functional Outcomes after Posterior Cruciate Ligament Arthroscopic Reconstruction Surgery

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Abstract

Background: The posterior cruciate ligament (PCL) primarily stabilizes the knee joint's posterior part. PCL protects against tibial posterior translation and rotational instability by working together with the components of the posterolateral corner (PLC). PCL reconstruction has advancements; however, current approaches didn't yield consistent results. ***Objective***: To assess a functional outcome of patients after PCL reconstruction. ***Methods***: A case series study was conducted from Jan 2021 till Jan 2022. We enrolled 10 participants with PCL injuries, ages between 25 and 36 years, late presentation more than 1 month, and excluded those with degenerative changes, multi-ligament injury, and limb malalignment. PCL reconstruction was performed. Knee arthroscopy was conducted to discover the PCL disfigurement. The Lysholm score was evaluated preoperatively and 6 months postoperatively. It ranges from 0 to 100 points. A score of 95-100 means excellent, 84-94 means good, 65-83 means fair, and 65 means poor. ***Results***: The mean Lysholm score preoperatively was 60.7 and postoperatively was 89.4, with a significant difference. A significant correlation was found between age and Lysholm score after surgery, where younger age was associated with better functional outcomes. ***Conclusions***: Age plays a role in the improvement of the Lysholm score postoperatively. The timing of PCLR surgery doesn't affect the functional outcome when done for less than or more than six months.

Keywords: Knee, Posterior cruciate ligament, Posterolateral corner, Posteromedial bundle.

النتائج الوظيفية بعد جراحة إعادة بناء الرباط الصليبي الخلفي بالمنظار

الخلاصة

الخلفية: يعمل الرباط الصليبي الخلفي (PCL) بشكل أساسي على استقرار الجزء الخلفي لمفصل الركبة. يحمي الرباط الصليبي الخلفي من الترجمة الخلفية الظنبوبية وعدم الاستقرار الدوراني من خلال العمل مع مكونات الزاوية الخلفية الجانبية (PLC). إعادة بناء PCL لها تطورات. ومع ذلك ، لم تسفر الأساليب الحالية عن نتائج متسقة. **الهدف**: تقييم النتائج الوظيفية للمرضى بعد إعادة بناء الرباط الصليبي الأمامي. **الطرائق**: أجريت دراسة سلسلة حالات من يناير 2021 حتى يناير 2022. قمنا بتسجيل 10 مشاركين يعانون من إصابات PCL ، تتراوح أعمارهم بين 25 و 36 عاما ، وتأخر العرض أكثر من شهر واحد، واستبعدنا أولئك الذين يعانون من تغيرات تنكسية ، وإصابة متعددة الأربطة، وسوء محاذاة الأطراف. تم إجراء إعادة بناء PCL. تم إجراء تنظير الركبة لاكتشاف تشوه الرباط الصليبي الأمامي. تم تقييم درجة Lysholm قبل الجراحة وبعد 6 أشهر من الجراحة. يتراوح من 0 إلى 100 نقطة. النتيجة 95-100 تعني ممتاز، و 84-94 تعني الخير، و 65-83 تعني عادلة، و 65 تعني ضعيفة. **النتائج**: كان متوسط درجة Lysholm قبل الجراحة 60.7 وكان بعد الجراحة 89.4، مع اختلاف معتد به. تم العثور على علاقة ذات دلالة إحصائية بين العمر ودرجة Lysholm بعد الجراحة، حيث ارتبط العمر الأصغر بنتائج وظيفية أفضل. **الاستنتاجات**: يلعب العمر دورا في تحسين درجة Lysholm بعد الجراحة. لا يؤثر توقيت جراحة PCLR على النتيجة الوظيفية عند إجراؤها لمدة تقل عن ستة أشهر أو أكثر.

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INTRODUCTION

The posterior cruciate ligament (PCL) stabilizes the knee joint's posterior part [1]. PCL protects against tibial posterior translation and rotational instability through working together with the posterolateral corner (PLC) structures. PLC components involve the fibular collateral ligament, popliteofibular ligament, popliteus tendon, arcuate ligament, and extracapsular iliotibial band. PCL injuries are accompanied by PLC injury and happen less than the anterior cruciate ligament injuries [2]. The PCL structure encompasses the anterolateral bundle (ALB), which is larger, and the posteromedial bundle (PMB), which is smaller. PLC consists of the fibular collateral ligament, popliteofibular ligament, popliteus tendon, arcuate ligament, and extracapsular iliotibial band. PCL injuries are accompanied by PLC injury and happen less than the anterior cruciate ligament injuries [2]. Operative management has variable outcomes, with many people suffering knee pain and instability, especially those with high physical demand, including military personnel. Frequently, such injuries occur concomitantly and affect multiple ligaments; therefore, the clinical outcomes of PCL reconstructions are hard to identify alone. High-energy mechanisms lie behind multifilament injuries, with many variables shaping clinical outcomes [3].

Despite developed approaches for PCL reconstruction, no consistent results were obtained in restoring knee stability and patients' activity [4]. PCL injuries low incidence caused the literature describing operative management to focus on techniques rather than clinical and functional outcomes [5]. The ALB femoral attachment measures about two times that of the tibial attachment [6]. The femoral ALB footprint center lies at 7.4 mm, 11.0 mm, and 7.9 mm from the trochlear point, the medial arch point, and the distal articular cartilage successively. The ALB tibial attachment center lies at 6.1 mm to the back of the glossy white fibers of the posterior medial meniscus root, 4.9 mm from the bundle edge (which isolates the two bundles), and 10.7 mm from the champagne glass drop-off of the posterior tibia [7]. PMB femoral attachment area size is 60 - 90 mm^2, positioned between the anterior and posterior meniscofemoral ligaments. The distance between the center of the femoral PMB and the medial arch point is 11.1 mm, and between it and the posterior point of the articular cartilage margin is 10.8 mm. The distance from the center of the PMB tibial attachment and the anterior of the champagne glass drop-off of the tibia posteriorly is 4.4 mm, and between it and the lateral aspect of the medial groove of the articular surface of the medial tibial plateau is 3.1 mm. There are biomechanical and surgical significant effects of these distances, where reconstructing the anatomy of PCL bundles restores knee kinematics and improves clinical outcomes [8,9]. The PCL restricts tibial backward movement at all angles of flexion and restricts inward rotation farther than 90° and adds impedance to tibial outward rotation farther than 90° of flexion [10]. Both the ALB and PMB are involved in overcoming tibial backward translation at all flexion angles with a notable effect in stabilizing the knee even with the presence of only one of them [11]. The ALB is the principal barrier to tibial backward movement from 70° to 105°, while the PMB is the principal barrier from 0° to 15°. A surgical significance arises from this point about anatomic double-bundle (DB) PCL reconstructions (PCLR) when implementing graft fixation [1]. Kennedy *et al*. documented that sectioning both bundles produces 11.7 mm of tibial posterior translation at 90°; so, dual tear of bundles causes grade III PCL injury. PCL restricts inward rotation regardless of the angle of flexion, while PMB largely impacts rotation beyond 90° of flexion [9]. Trauma causes PCL tear, such as the "dashboard injury," by a force directed posteriorly and proximally to the front of the tibia at the knee flexion position. In sports, tears of the PCL alone result from a direct insult affecting the tibia anteriorly or coming down onto the knee with plantar flexion of the foot. Football, soccer, and skiing highly cause PCL tears [1]. Hyperflexion or hyperextension, which are non-contact mechanisms, are not so common. Variation of symptoms is brought by mechanism (high or low energy) and chronicity. The typical symptoms include pain of the knee posteriorly, stiffness, and swelling, while pain of the knee on the anterior aspect and lack of stability while descending stairs are going with chronic isolated tears [1]. Symptoms, injury mechanisms, and clinical examination tests in combination achieve accurate diagnosis. The posterior drawer test at 90° of flexion gains a 90% sensitivity with a 99% specificity [1]. The posterior sag test shows an abnormal sag at the anterior tibia proximally, viewed laterally if the PCL is torn. The quadriceps active test is positive while the individual contacts the quadriceps isometrically and reduces the tibia dynamically [1]. A dial test serves to explore concomitant injuries to the PLC via external rotation evaluation. If a positive result is gained at 30° and 90° of flexion, it means a PLC grade III tear accompanied by a PCL tear [12]. Moulton *et al*. revealed that evaluation of side-to-side variations in internal rotation occurred in anesthetized patients by measuring excursion of the anterior tubercle of the tibia [13]. The supine IR test conducted at 60° - 120° was shown to be 95.5% sensitive and 97.1% specific for obtaining a diagnosis of grade III PCL tear. 1 The quadriceps active test has excellent specificity for identifying PCL defects, whereas the best sensitivity was for the posterior sag sign [1]. Posterior stress radiographs quantify posterior knee laxity [14,15]. Kneeling stress radiography compares the tibial posterior displacement on the femur between both knees [16]. Magnetic resonance imaging (MRI) has about 100% sensitivity and specificity in acute PCL injury diagnosis [17] but decreases in chronic cases because the healing process can restore the signal and shape of the PCL in a misleading way. However, recently, Wilson *et al*. studied the asymptomatic population and quantified T2 and T2* PCL features [17], showing notable differences in T2 scores in the PCL proximal, middle, and distal sites, creating a reliable standard for comparing acute and chronic PCL tears. 17 Indeed, stress radiographs are highly appreciated in tears of chronic nature [18]. A high tibial osteotomy (HTO) is valuable for isolated PCL tears and a reduced posterior slope of the tibia, where it escalates their slope, which lowers forces onto the graft and the risk of failure. Stress radiographs at varus and valgus also serve to deal with the possibility of concurrent medial and/or lateral-sided injuries as proposed by examination [19,20]. Treating partial PCL tears conservatively was reported to have good outcomes, but some reports claimed to have poor results over longstanding monitoring with annoying symptoms and limited functionality [21]. Non-operative management for partial isolated PCL tears is agreed upon by many authors. The non-operative approach for completing PCL tears subjects the medial and patellofemoral components to a risk of future degenerative changes and limited function [22]. Thus, the surgical approach is superior for complete and combined PCL injuries accompanied by symptoms. The literature describes several surgical modalities, and no long-term study demonstrated that PCLR hampers the occurrence of knee OA [1]. Techniques are described by fixation of tibial graft (transtibial tunnel and tibial inlay techniques), the managed bundles (single versus double), and the grafting type [23], with controversy surrounding the sequelae of SB compared to DB PCLR. The SB PCL modality repairs only ALB, while the DB modality

repairs ALB and PMB together, thus anatomy and kinematics are restored [24]. A study showed that a DB PCLR reaches better recovery of knee kinematics compared to single bundle (SB) PCLR. Additionally, DB PCLR produces better stabilization of rotation compared to SB PCLR. Chahla *et al*. accomplished a comparison of the SB and DB PCLR technique and found that postoperative Lysholm and Tegner scores didn't show remarkable variability [25]. This study aimed to assess a functional outcome of patients after PCL reconstruction.

METHODS

Study design and setting

A case series study conducted in Baghdad city from Jan 2021 till Jan 2022.

Inclusion and exclusion criteria

The study population involved participants with a diagnosis of PCL injury, ages between 25 and 36 years, and late presentation more than 1 month. We excluded those who had degenerative changes (i.e., OA), multi-ligament injury, and limb malalignment.

Ethical consideration

Signing a written consent was done by those who agreed to take a role in the study after explaining to them the nature and aims of the study, and all ethical considerations were according to "The declaration of Helsinki".

Outcome measurements

Data was collected by direct interview with all participants. A questionnaire was used, comprised of two parts: Part one includes baseline demographic data, including age, gender (all were males), and duration of injury. Part two includes the surgical technique. Ten cases of isolated PCL tear underwent PCL reconstruction. Each participant was placed in a supine position under general anesthesia. Preoperatively, we assess the extent of posterior and rotational instability of the knee. A tourniquet was applied highly. Arthroscopy of the knee was implemented to discover PCL disfigurement. Reconstructing PCL was conducted by autograft (hamstring tendon) through SB reconstruction that is all-arthroscopic (the anterolateral bundle reconstruction). Semitendinosus hamstring harvest 320 mm long harvest using standard technique. An 80 mm four-strand graft link was prepared on 2 adjustable button system fixation devices using high-strength sutures (ALL inside technique). The knee joint accessed by classical anteromedial and anterolateral portals, diagnostic arthroscopy for all compartments revealed an isolated complete tear of the PCL. The femoral footprint from the trochlear point till the medial arch point was prepared using a shaver. A posteromedial portal was ensured via a 7 mm cannula to access the posterior sulcus of the tibia; the tibial footprint was debrided using a shaver; and care was taken to preserve the anatomy of the medial meniscus posterior root and deep posterior ligaments. The tibial tunnel was made ready via a blunt tip guide to protect the posterior neurovascular structures; fluoroscopy was used during drilling to confirm proper trajectory position and offset from the champagne glass drop-off; a 35 mm tibial socket was prepared using retrograde drilling. The femoral socket was prepared using the outside-in technique halfway between the medial arch point and the trochlear point, at 1 o'clock. A 25 mm femoral socket was prepared using retro-drilling; care was taken to keep the socket flush with the cartilage of the medial condyle to the intercondylar notch to mimic the native PCL. The graft was shuttled across the anteromedial portal in the tibia first, then into the femur, and tensioning was done in the femur first, and final tensioning was achieved by a self-locking adjustable button system device in the tibia in a flexion position and with manual translation of the tibia anteriorly. 20 mm was inserted in the femoral socket and 30 mm into the tibial socket, leaving 30 mm of intraarticular length of newly reconstructed PCL. Each patient had his lower extremity covered for 7 days with elastic bandage of full length. Outside immobilization (0° position) for 3 weeks was performed by knee orthosis (KO) (Nanjing Shule Prosthetics and Orthotics Co. LTD, Nanjing, China). Intermittent removal of the KO was done with the aid of exercises for knee flexion (angle: 0°-60°, 5 min each time, twice daily). One day postoperatively, the isometric contraction of the four quadriceps and dorsal flexion of foot-plantar flexion exercises were practiced. Three weeks postoperatively, the knee flexion exercises were practiced (angle: 0°-60°). Patients had a full weight-bearing lower extremity until gradual knee flexion angle to 90°. Six weeks postoperatively, KO was removed (the first 3 weeks all day long, the next 3 weeks at bedtime only), and then patients started walking as training to regain muscle strength and joint function. At 12-20 weeks, the patients' rehabilitation training was enhanced by the flexibility exercises and jogging.

Measures of functional outcomes

The position of embedded tendon fixation was explored by knee X-ray. Lysholm score was evaluated before surgery and the last time of follow-up (6 months) postoperatively to evaluate cruciate ligament injuries, with a range of 0 to 100 points based on 8 parameters: pain, limp, climbing stairs, locking, support, swelling, instability, and squatting. A score of 95-100 means excellent, 84-94 means good, 65-83 means fair, and 65 means poor [26] (Table 1).

Statistical analysis

The data was entered into the computer, and analysis was accomplished by the Statistical Package for the Social Sciences (SPSS) software, 23rd version. The mean (M), standard deviation (SD), minimum (Min),

and maximum (Max) values were used for continuous variables. Frequencies and percentages were used for categorical variables. The chi-square test was applied to identify differences in frequencies of categorical variables, while the independent samples T test was used for continuous variables. Pearson correlation was implemented to assess the correlation between continuous variables. $p<0.05$ was considered statistically significant.

Table 1: Lysholm Questionnaire (Scale)

Limping (5 points)	Pain (25 points)
Never= -5	No pain = 25
Mild or periodical = 3	Intermittent or mild during heavy-effort exercises = 20
Severe and persistent = 0	Marked during strong-effort exercises = 15
Support (5 points)	Remarkable during or after walking > 2 km = 10
Without support = 5	Marked during or after walking < 2 km = 5
Stick or crutches = 2	Continuous = 0
Impossible = 0	Swelling (10 points)
Restraining (15 points)	No swelling = 10
No restraining or restraining feeling = 15	Upon heavy-effort exercises = 6
Has the feeling without restraining = 10	Upon ordinary exercises = 2
Occasional restraining = 6	Continuous = 0
Frequent = 2	Climbing stairs (10 points)
Joint restrained at examination = 0	No obstacle = 10
Instability (25 points)	Slight damage = 6
No step missed = 25	One step at a time = 2
Seldom, during athletic events or other tough exercises = 20	Impossible = 0
Frequently through athletic activities or other strong-effort exercises (or unable to participate) = 15	Squatting (5 points)
Occasionally in daily activities = 10	No problem = 5
Frequently in daily activities = 5	Slight damage = 4
With each step = 0	Slight damage = 4
	Not more than 90 degrees = 2
	Impossible = 0
	Total: ----------

Score table: Excellent: 95–100; Good: 84–94; Fair: 65–83; Poor: < 54.

RESULTS

Ten cases in total; their mean age was 30.4±3.7 years (range 25-36 years). The mean duration of injury was 9.7±2.2 months. These results are clarified in Table 2.

Table 2: Descriptive statistics of age and duration of injury

Variable	Range	Mean±SD
Age (years) n=10	25-36	30.4±3.77
Duration of Injury (months) n=10	6-12	9.7±2.26

The mean Lysholm score preoperatively was 60.70±3.8, and postoperatively was 89.40±3.9, with a significant difference (p=0.0001) (Table 3).

Table 3: Report statistics of Lysholm score before and after reconstruction surgery

Lysholm score		*p-value*
Before	After	
60.7±3.83 55-68	89.4±3.92 84-95	0.0001

Table 4: Paired samples t-test for Lysholm score before and after surgery

Paired Differences				*p-value*
	mean±SD	95% CI		
		Lower	Upper	
Lysholm score pre and post-surgery	-28.7±5.056	-32.32	-25.08	0.0001

This result is shown in Tables 3 and 4. The correlation analysis between Lysholm scores before and after surgery and age/duration of injury showed a significant correlation between age and Lysholm scores after surgery, where younger ages were associated with better functional outcomes (p= 0.005, r= 0.8) (Table 5 and Figures 1-4).

Table 5: Correlations of Lysholm score before & after surgery with age/duration of injury

		Age	Injury duration	Lysholm score	
				Before	After
Age	r	1.0	0.120	-0.267	-0.807
	p-value		0.742	0.455	0.005
Injury duration	r	0.120	1.0	0.091	-0.048
	p-value	0.742		0.803	0.896

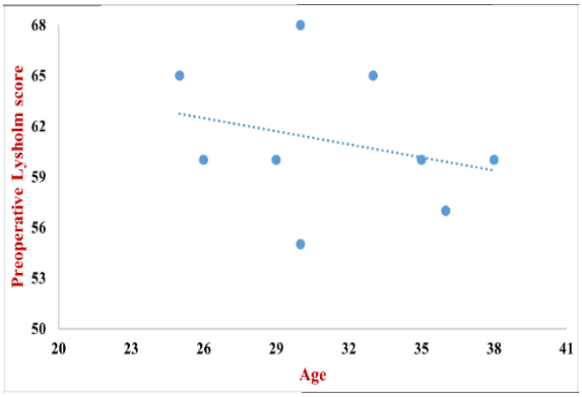

Figure 1: Simple scatter diagram of correlation of Lysholm score before surgery with age.

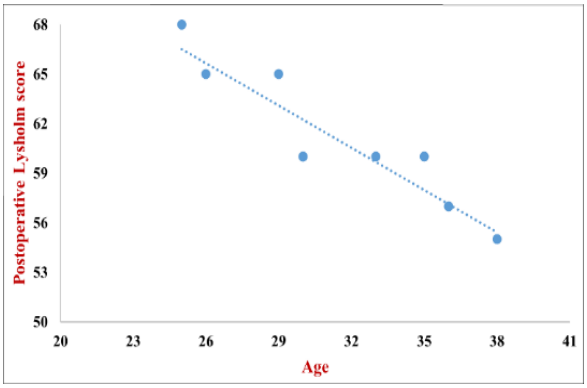

Figure 2: Simple scatter diagram of correlation of Lysholm score after surgery with age.

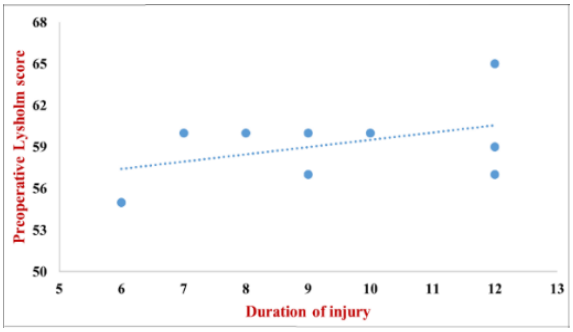

Figure 3: Simple scatter diagram of correlation of Lysholm score before surgery with duration of injury.

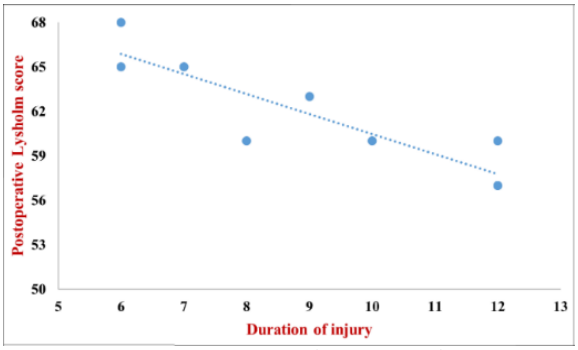

Figure 4: Simple scatter diagram of correlation of Lysholm score after surgery with duration of injury.

No other correlation has been observed. Before the surgery, the Lysholm Score category showed that most patients have poor scores. After surgery, the score increased, and most patients had good scores (Table 6).

Table 6: Lysholm Score before and after surgery

Lysholm Score	Category	Count(%)
Before surgery	Fair	1.0(10)
	Poor	9(90)
After surgery	Excellent	1.0(10)
	Good	9(90

DISCUSSION

Knee reconstructive surgery has many indications, with longstanding pain and instability as the prominent ones. The current study aimed to evaluate the postoperative functional outcomes among participants submitting to arthroscopic PCLR and determine whether age and time lapses from injury to surgery affect the end results. The mean age of patients included in this study was 30.4±3.7 years. This finding supports a recent study accomplished by Ng *et al.* that showed the mean age of the sample enrolled in their study was 31 years old [27]. This is because young people are more susceptible to sports and/or motorcycle accidents. As mentioned by Caldas *et al.* and Schulz *et al.*, motorcycle vehicle accidents made up the prominent portion of PCL injuries, whether isolated or combined, and were attributed to 78.8% and 45% of their samples successively [28,29]. Alternately, Bernhardson *et al.* proposed that more than three quarters of the victims of PCL injury were subjected to sports event trauma [30]. As mentioned earlier, a debate persists regarding the ideal interval from injury to having surgery in the field of the outcomes of cases. Early interventions may give a chance for earlier knee rehabilitation and mobility; thus, the total success chances following reconstruction are enhanced. However, early reconstruction procedures increase the possibility of arthrofibrosis, and this motivates surgeons to delay reconstruction [31]. Hohmann *et al.* have documented that early attempts at reconstructing knee ligaments, compared to late attempts, are obviously linked to better outcomes regarding Lysholm scores [32]. In contrast, Rusdi *et al.* declared that the ideal time of surgical intervention and patients' Lysholm scores are not associated with each other [32]. In this study, the mean time from injury to surgery was 9.7±2.2 months. Furthermore, no association has been found between time of injury and functional outcomes. The mean preoperative Lysholm score was 60.70±3.8, and the mean Lysholm score after surgery was 89.40±3.9, with a significant difference. A bunch of researchers agreed that PCL reconstruction positively impacts functional outcomes, causing their improvement [2,33,34]. Petrillo *et al.* accomplished a systematic review throughout the period 2000-2016 and came up with a result that PCL and PLC reconstruction enhanced the score of Lysholm from 54.7±9.1 to 83.2±4.9 among 66 cases [35]. Kim *et al.* explored dual PCL and PLC reconstruction outcomes among forty-two individuals and yielded improved Lysholm functional scores through a 2 to 6 year follow-up in comparison to preoperative figures [24]. A different study regarding dual reconstruction accomplished by Kim *et al.* documented a remarkable Lysholm score increase from 59.63±4.49 preoperatively to 83.04±5.68 post-operatively [36]. Also, Mygind-Klavsen *et al.* and Lind *et al.* documented that KOOS witnessed outstanding improvements from preoperative time until the end of follow-up [2,37]. Regarding our work, Lysholm scores gained significant improvements from preoperative to postoperative time; the study suggested that no variation in the functional outcomes was shown when performing the reconstructive surgery earlier than 6 months from injury. A lot of patients who had the surgery after 6 months from injury were facing obstacles in getting the required imaging and/or financial troubles impeding them from bearing the price of surgical intervention.

Study limitations

The small sample size reduces the chance of obtaining solid conclusions regarding the impact of surgery delay.

Conclusion

Age plays a role in the improvement of Lysholm score postoperatively. The timing of PCLR surgery doesn't affect the functional outcome when done for less than or more than six months.

Conflict of interests

No conflict of interest was declared by the authors.

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Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

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