

Outcomes After Posterior Cruciate Ligament (PCL) Reconstruction in Patients With Isolated and Combined PCL Tears

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Background: Posterior cruciate ligament (PCL) reconstructions are rarely performed compared with that for the anterior cruciate ligament (ACL).

Purpose: To evaluate the clinical and functional outcome after isolated or multiligament PCL reconstruction.

Study Design: Cohort study; Level of evidence, 3.

Methods: Patients who underwent PCL reconstruction between 2002 and 2010 were included. Standardized follow-up was performed between 2012 and 2013 and consisted of subjective scores (Tegner activity score, Knee injury and Osteoarthritis Outcome Score [KOOS], and subjective International Knee Documentation Committee [IKDC] score) and objective measures, including knee laxity (KT-1000), extension strength, and overall IKDC score.

Results: One hundred ninety-six patients were identified, of which 172 were available for postoperative follow-up: 39.3% with isolated PCL and 60.7% with multiligament injury. One hundred ten patients were available to complete both clinical follow-up and subjective questionnaires; 62 patients returned the subjective questionnaires. Mean follow-up was 5.9 years (range, 3.1-9.7 years). KOOS scores at follow-up in the isolated PCL group by subscale were 74 (symptoms), 76 (pain), 80 (activities of daily living), 55 (sport), and 55 (quality of life). Scores for patients in the multiligament group were 73 (symptoms), 79 (pain), 82 (activities of daily living), 53 (sport), and 56 (quality of life). Tegner scores were 4.5 and 4.4, respectively, and subjective IKDC scores were 63.8 and 65.0. The mean side-to-side difference in knee laxity was 2.7 mm in the isolated PCL group compared with 2.8 mm in the multiligament group. At 1-year follow-up there were significant differences in KOOS outcome scores between the isolated PCL subgroup and the multiligament subgroup, but no differences at final follow-up. Twelve patients (5%) had PCL revision surgery within the follow-up period.

Conclusion: Despite the type of injury, there were only minor differences in knee laxity and subjective outcome scores between the isolated PCL group and the multiligament group. The overall revision rate in this study was 5.2%.

Keywords: PCL; knee; outcome

Posterior cruciate ligament (PCL) reconstruction either isolated or in combination with other knee ligament reconstructions is rarely performed compared with anterior cruciate ligament (ACL) reconstruction. Although our anatomic and biomechanical understanding of PCL function has recently

increased,[‡] reconstruction of the PCL is still considered a complex surgical procedure. Despite this increase in anatomic and biomechanical knowledge, determining the best technique for PCL reconstruction has been limited by the low level of evidence provided by the small case series that have been published. Therefore, this study focuses on long-term follow-up of a large cohort of patients with injured PCLs treated with reconstruction at a single surgical center.

An update of the current literature regarding treatment of PCL injuries was summarized by LaPrade et al¹⁵ in 2015. The current literature on outcomes after PCL reconstruction focuses primarily on the different surgical techniques and therefore is based on case series. The reconstruction procedures include single-bundle or

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[‡]References 1, 5-7, 10-12, 16, 20, 21, 23, 24, 26, 27, 34.

double-bundle techniques with either transtibial tunnel or tibial inlay techniques. In the present study, only the transtibial PCL reconstruction technique was used. Clinical results after single-bundle PCL reconstruction were published in a systematic review by Kim et al¹⁴ in 2011. They concluded that normal knee stability was not fully restored but found a significantly improved posterior knee laxity, improved Lysholm knee score, and that 75% of patients had normal or nearly normal subjective function on International Knee Documentation Committee (IKDC) scores. When PCL reconstruction is performed in patients with multiligament injuries using the single-bundle transtibial technique, Fanelli and Edson^{3,4} reported similar results. Some studies also describe follow-up of patients with PCL reconstruction using the double-bundle transtibial technique. Spiridonov et al³⁰ found significant improvements in both subjective (Cincinnati, IKDC) and objective outcome scores in patients with either isolated or combined ligament injuries. Objective knee stability improved from 15 mm preoperatively to 0.9 mm postoperatively. Other studies¹⁵ also report significantly improved postoperative subjective outcome scores after isolated or combined transtibial double-bundle PCL reconstruction.^{13,35,36} Recently, a study by Owesen et al²² from the Norwegian ACL registry published 2-year follow-up data after isolated PCL reconstruction in 71 patients. They found similar incremental improvements in Knee injury and Osteoarthritis Outcome Score (KOOS) comparing PCL and ACL patients, but time from injury to surgery was longer for PCL patients. A recently published systematic review by Qi et al²⁵ comparing single- versus double-bundle reconstruction showed no significant difference in clinical outcome but superior results in favor of the double-bundle technique in biomechanical studies. Therefore, there is still a need to gain more knowledge of the clinical outcomes after PCL reconstruction.

The purpose of this study was to present the clinical and functional outcomes after PCL reconstruction either as an isolated or combined knee ligament reconstruction at a single referral center in a large study cohort. Our hypothesis was that patients with isolated PCL injuries have superior postoperative subjective outcome scores and less side-to-side difference in knee laxity after PCL reconstruction than patients with combined PCL injury in a multiligament-injured knee.

METHODS

Patients

A total of 230 patients who underwent PCL reconstruction between 2002 and 2010 were retrospectively identified. We excluded 34 patients for final follow-up. Six patients were excluded due to having revision PCL reconstruction when the primary procedure was performed at another center, 12 patients due to PCL revision in the follow-up period, and 16 pediatric patients (age <18 years) with PCL injuries. The remaining 196 patients with chronic grade III PCL injuries were included in this study. PCL reconstruction was performed either isolated or in combination with

TABLE 1
Demographic Data^a

Patients, n	196
Sex (M/F)	142/54
Mean age (range), y	34 (18-70)
Injury type (no. of patients)	
Isolated PCL	75
Combined PCL	121
Mean follow-up (range), y	5.9 (3.1-9.7)
Schenck classification, n	
KD I: ACL or PCL	57
KD II: ACL + PCL only	13
KD III: ACL + PCL + PMC or PLC	48
KD IV: ACL + PCL + PMC + PLC	3

^aACL, anterior cruciate ligament; KD, knee dislocation; PCL, posterior cruciate ligament; PLC, posterolateral corner; PMC, posteromedial corner.

reconstruction of other knee ligaments. The laxity grades used in this study were previously described by Lubowitz et al¹⁹: grade I, 0 to 5 mm; grade II, 6 to 10 mm; and grade III, >10 mm of posterior translation. Patients with grade I and II instability were excluded. The preoperative diagnoses were made using a combination of clinical examination, stability testing including knee laxity measurement (KT1000), and magnetic resonance imaging.

These 196 patients were invited for clinical follow-up (final follow-up) between 2012 and 2013. We collected data from our own database. Medical history and surgical data were collected through patient files. None of the patients were offered PCL reconstruction in the acute phase after trauma (within 6 weeks of injury). Patients with isolated PCL injuries were referred to our center due to instability symptoms and therefore most often diagnosed later. Patients with PCL injury in combination with collateral ligament injury were treated using a hinged brace for 6 weeks before surgery was performed.

Demographics

The total patient cohort (Table 1) included 196 patients; 172 patients (88%) were available for follow-up. One hundred ten patients (56%) were evaluated with clinical examination and subjective questionnaires, and 62 patients were evaluated only with subjective questionnaires. Mean follow-up was 5.9 years. The majority of patients were male (72%). The causes of injury in this cohort were, in most cases, related to trauma secondary to traffic accidents (33.7%) and sport activities (39.8%). Other causes of PCL injury were activities of daily living (13.8%) and work-related activities (7.1%). The initial cause of injury was unknown in 5.6% of cases. The majority of patients with multiligamentous injury had knee dislocation type KD I and KD III according to Schenck classification.³² The demographic data of this population are presented in Table 1.

Evaluation

The preoperative evaluation and 1-year follow-up were, in the majority of cases, performed by the surgeon. All

TABLE 2
PCL Graft Choice^a

Graft	Patients (n = 196)
Autograft	116
ST/GR	79
Quadriceps ^b	37
Allograft	80
Quadriceps ^b	35
Achilles tendon	35
Soft tissue tendon	10

^aGR, gracilis; PCL, posterior cruciate ligament; ST, semitendinosus.

^bTendon with bone plug.

patients were invited to our clinic for a prospective follow-up in 2012 or 2013. At follow-up, a standardized objective clinical examination by independent experienced physiotherapists was performed. Subjective scores were completed by the patients without investigator assistance. Patients not available for clinical examination completed subjective and complication data questionnaires.

Subjective Outcome Evaluation. Patients were evaluated using the validated KOOS score²⁸ preoperatively, at 1 year, and at final follow-up. At follow-up, IKDC objective and patient subjective assessment scores were obtained. The Tegner activity score³¹ was used in the assessment of knee functionality and activity level.

Follow-up KOOS profiles were compared between the isolated and combined PCL reconstruction cohorts. Furthermore, we performed subgroup analyses regarding sex, surgical technique (single- vs double-bundle), and type of graft used (allograft vs autograft).

Objective Outcome Evaluation. Knee laxity was measured as the side-to-side difference in anterior and posterior translation of the tibia using the KT-1000 arthrometer (MEDmetric). The side-to-side difference in knee extension strength test was also objectively assessed using the Leg Extension Power rig (LEP; Bio-Med International). This method for determining explosive power has been proven safe and suitable for all age groups and physical fitness levels. This test was performed with the patient seated and takes 0.25 to 0.40 seconds to push through 0.165 m against a flat pedal.²

Surgical Technique

Patients with either symptomatic grade III isolated PCL tears or PCL tear in combination with other knee ligament injury were offered surgery. All surgical procedures were performed by 5 experienced senior consultants. The standard PCL reconstruction procedure in this patient series was arthroscopic transtibial double-bundle reconstruction with a single-bundle fixation at the tibial side and a double-bundle femoral fixation, most often using semitendinosus and gracilis tendon autograft (41%) (Table 2). The standard ACL reconstruction technique used in this cohort was a transtibial technique with attempts to place the graft in the native ACL footprint. The medial collateral ligament (MCL) and posterior oblique ligament (POL) were

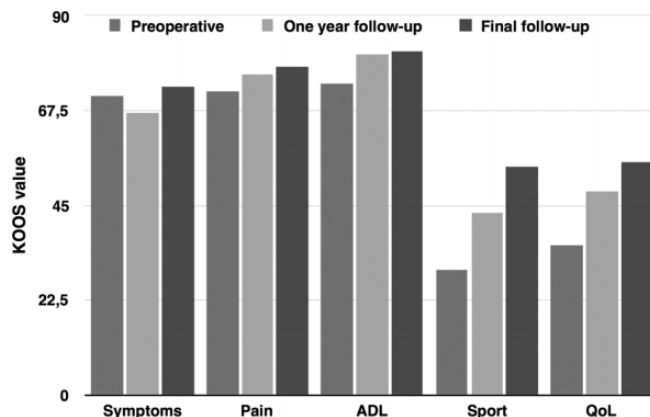


Figure 1. Knee injury and Osteoarthritis Outcome Score (KOOS) results at preoperative, 1-year follow-up, and final follow-up for the entire patient group undergoing posterior cruciate ligament reconstruction. ADL, activities of daily living; QoL, quality of life.

reconstructed as described by Lind et al.¹⁸ The lateral collateral ligament (LCL) and posterolateral corner (PLC) were reconstructed as described by Jakobsen et al.⁸

Rehabilitation

Postoperatively, all patients were immobilized in a hinged brace for 8 weeks. During the first 6 weeks, all patients were nonweightbearing and the brace was fixated in 0° to 20° of flexion. During the remaining 2 weeks, the patients initiated weightbearing activities and gradually increased motion as tolerated.

Statistics

Differences between preoperative and postoperative patient-reported outcome measure values and knee laxity were analyzed using the Student *t* test and the chi-square test. *P* values <.05 were considered to be a statistically significant improvement.

RESULTS

Subjective Outcomes

The total study population of PCL reconstructions demonstrated improvements (*P* = .00-.01) in all KOOS subscores except the symptoms subscore (*P* = .17) from preoperative to final follow-up (Figure 1). The subscores symptoms (*P* = .01), sport (*P* = .01), and quality of life (QoL) (*P* = .01) also showed significant improvement from 1 year to final follow-up.

In the isolated PCL group (n = 77) there were significant improvements from preoperative to 1 year follow-up in 2 KOOS subscores (sport, *P* = .02; QoL, *P* = .04) and no improvement from 1 year to final follow-up (*P* = .09-.49). In the isolated PCL group, the mean preoperative Tegner activity score was 3.4 ± 2.2, and at 1-year follow-up there was a significant increase (*P* = .02) to 4.1 ± 2.2. No

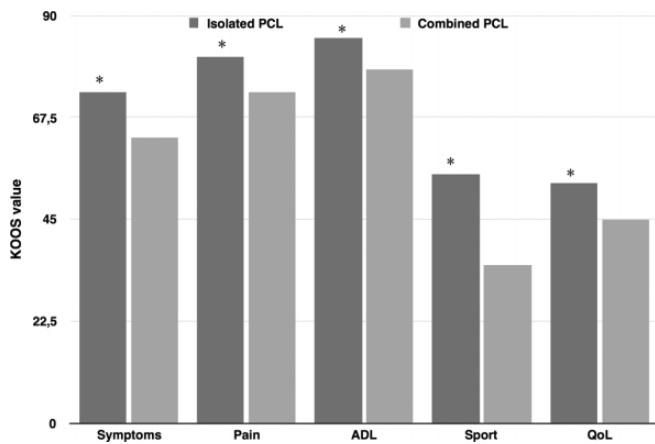


Figure 2. Comparison of Knee injury and Osteoarthritis Outcome Score (KOOS) subscores at 1-year follow-up between isolated and combined posterior cruciate ligament (PCL) reconstructions. *Statistically significant difference ($P < .05$). ADL, activities of daily living; QoL, quality of life.

improvement ($P = .27$) was observed between 1 year and final follow-up (Tegner score, 4.5 ± 2.2). The combined PCL group ($n = 119$) demonstrated improvement in 3 KOOS subscores (activities of daily living [ADL], $P = .004$; sport, $P = .007$; QoL, $P = .000$) at 1-year follow-up and further improvement from 1 year to final follow-up in 4 subscores (symptoms, $P = .003$; pain, $P = .047$; sport, $P = .000$; QoL, $P = .002$). The Tegner score in the combined PCL group showed improvement at 1-year follow-up ($P = .000$) and final follow-up ($P = .012$). The mean Tegner score was 2.1 ± 1.8 preoperatively, 4.1 ± 1.9 at 1-year follow-up, and 4.4 ± 1.9 at final follow-up. When comparing KOOS data at 1-year follow-up (Figure 2) between the 2 PCL groups, the isolated PCL reconstructions had significantly higher scores in all KOOS subscores ($P = .001-.024$).¹ The calculated point difference in KOOS subscores between the 2 groups varied from 7.9 to 20.7, and 2 of the KOOS subscores (symptoms [10.4] and sports [20.7]) had a difference of more than 10 points, which might be considered as a minimal clinically important difference. However, at final follow-up, only minor changes in KOOS subscores were observed compared with those at 1 year, but there were no significant differences ($P = .24-.50$) between the 2 groups (Table 3). Tegner scores between the 2 PCL groups showed no difference at 1 year ($P = .10$) or at final follow-up ($P = .32$). The IKDC subjective forms were not used at our facility until after 2010. Therefore, the postoperative IKDC subjective outcome scores were only recorded at final follow-up. The mean IKDC scores at final follow-up were 63.8 ± 24.1 in the isolated PCL group and 65.0 ± 22.0 in the combined PCL group, demonstrating no difference between the 2 groups ($P = .47$).

The different results from subgroup analysis are illustrated in Tables 4 through 6. Comparing single- ($n = 22$) and double-bundle ($n = 174$) technique patients, there was improvement in 1 KOOS subscore (sport, $P = .04$) at final follow-up in favor of the double-bundle technique, but no significant improvements were observed in the other subjective outcome scores ($P = .08-.15$). Comparing female ($n = 54$)

TABLE 3
Subjective and Objective Outcomes in Subgroup Analysis Between Isolated and Combined PCL Groups at Final Follow-up^a

	Isolated PCL (N = 77)	Combined PCL (N = 119)	P Value
KOOS			
Symptoms	74.6 (18.9)	72.5 (18.7)	.24
Pain	77.1 (21.5)	78.7 (19.1)	.31
ADL	81.0 (21.3)	82.4 (17.4)	.32
Sports	56.0 (21.3)	53.2 (30.9)	.28
QoL	55.7 (26.8)	55.7 (25.7)	.50
Tegner activity score	4.5 (2.2)	4.4 (1.9)	.32
IKDC subjective	64.8 (23.7)	65.0 (22.0)	.47
IKDC objective, n (%)			
A	5 (12)	9 (14)	
B	28 (65)	32 (49)	
KT-1000 side-to-side difference, mm	2.7 (2.0)	2.8 (3.0)	.38

^aData provided as mean (SD) unless otherwise indicated. ADL, activities of daily living; IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score; PCL, posterior cruciate ligament; QoL, quality of life.

TABLE 4
Subjective and Objective Outcomes in Subgroup Analysis Between Single- and Double-Bundle PCL Groups at Final Follow-up^a

	Single-Bundle (N = 22)	Double-Bundle (N = 174)	P Value
KOOS			
Symptoms	68.8 (14.6)	73.7 (19.2)	.15
Pain	71.3 (20.1)	78.5 (20.1)	.08
ADL	75.9 (21.3)	82.3 (18.9)	.09
Sports	41.4 (33.8)	55.5 (30.6)	.04 ^b
QoL	49.3 (25.8)	56.1 (26.1)	.15
Tegner activity score	4.6 (2.1)	4.4 (2.0)	.34
IKDC subjective	59.0 (24.8)	65.1 (22.6)	.15
IKDC objective, n (%)			
A	2 (17)	12 (12)	
B	9 (75)	52 (54)	
KT-1000 side-to-side difference, mm	1.9 (1.7)	2.9 (2.7)	.12

^aData provided as mean (SD) unless otherwise indicated. ADL, activities of daily living; IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score; PCL, posterior cruciate ligament; QoL, quality of life.

^bStatistically significant ($P < .05$).

with male ($n = 142$) patients, males had significantly better KOOS scores (all subscores), IKDC, and Tegner scores at final follow-up ($P = .00-.02$). There were no differences ($P = .15-.49$) between the use of allograft ($n = 80$) versus autograft ($n = 116$) in PCL reconstruction either in the subjective or the objective outcomes in this population.

The different Schenck classifications were also compared regarding subjective outcome measures within the PCL multiligament group. There were no significant differences

TABLE 5
Subjective and Objective Outcomes in Subgroup Analysis Between Female and Male PCL Groups at Final Follow-up^a

	Female (N = 54)	Male (N = 142)	P Value
KOOS			
Symptoms	67.7 (21.3)	75.3 (17.3)	.01 ^b
Pain	72.0 (23.5)	80.0 (18.3)	.02 ^b
ADL	76.0 (22.7)	83.8 (17.2)	.02 ^b
Sports	44.6 (36.1)	57.6 (28.4)	.01 ^b
QoL	48.7 (27.7)	58.0 (25.1)	.02 ^b
Tegner activity scale	3.8 (2.0)	4.7 (1.9)	.00 ^b
IKDC subjective	56.3 (25.8)	67.6 (21.3)	.00 ^b
IKDC objective, N (%)			
A	2 (8)	12 (14)	
B	18 (69)	43 (52)	
KT-1000 side-to-side difference, mm	2.3 (1.9)	2.9 (2.8)	.14

^aData provided as mean (SD) unless otherwise indicated. ADL, activities of daily living; IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score; PCL, posterior cruciate ligament; QoL, quality of life.

^bStatistically significant ($P < .05$).

TABLE 6
Subjective and Objective Outcomes in Subgroup Analysis Between Allograft and Autograft PCL Groups at Final Follow-up^a

	Allograft (N = 80)	Autograft (N = 116)	P Value
KOOS			
Symptoms	72.4 (19.3)	73.7 (18.4)	.34
Pain	77.7 (20.1)	77.8 (20.3)	.49
ADL	81.5 (18.5)	81.6 (19.8)	.49
Sports	51.2 (31.1)	55.9 (31.2)	.16
QoL	53.1 (26.6)	57.0 (25.7)	.17
Tegner activity scale	4.2 (2.0)	4.6 (2.0)	.14
IKDC subjective	62.4 (22.8)	66.0 (22.8)	.15
IKDC objective, N (%)			
A	4 (9)	10 (16)	
B	21 (47)	40 (63)	
KT-1000 side-to-side difference, mm	2.7 (3.0)	2.8 (2.3)	.48

^aData provided as mean (SD) unless otherwise indicated. ADL, activities of daily living; IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score; PCL, posterior cruciate ligament; QoL, quality of life.

when comparing KD I (n = 57) with KD II-IV (n = 64) ($P = .07-.48$) and comparing KD I-II (n = 70) with KD III-IV (n = 51) ($P = .11-.47$) in postoperative outcomes at 1 year or at final follow-up.

Objective Outcomes

The overall side-to-side posterior knee laxity measurement in the entire population demonstrated improvements from preoperative (6.6 ± 3.8 mm) to 1-year follow-up

(2.4 ± 2.3 mm) ($P = .00$). No differences were observed between 1 year and final follow-up (2.8 ± 2.6 mm) ($P = .17$). The mean side-to-side difference in the isolated PCL group was 5.4 ± 2.9 mm preoperatively and demonstrated improvement ($P = .00$) at 1-year follow-up (2.0 ± 1.9 mm) and no change ($P = .08$) at final follow-up (2.7 ± 2.0 mm). In the combined PCL group, the preoperative side-to-side posterior knee laxity was 7.7 ± 4.3 mm and improved ($P = .00$) to 2.8 ± 2.5 mm at 1-year follow-up; no change ($P = .48$) was observed at final follow-up (2.8 ± 3.0 mm). When comparing the side-to-side posterior knee laxity measurements between the 2 PCL groups, there was a difference preoperatively ($P = .00$) but no difference at follow-up ($P = .06$ and $.38$, respectively).

When separating the cohort into 2 groups using either allograft or autograft for the reconstruction of the PCL and comparing knee stability, there were no significant differences at 1 year ($P = .30$) or at final follow-up ($P = .48$) for knee laxity. No differences were found for laxity measures between single- and double-bundle reconstructions ($P = .46$ and $.12$, respectively). No difference in laxity was found between male and female patients ($P = .07$ and $.14$, respectively). No difference in leg extension power at final follow-up ($P = .09$) was observed between isolated PCL (2.6 ± 1.0) and combined PCL (2.3 ± 0.9) groups. The majority of patients in the 2 groups were characterized as normal (group A) or nearly normal (group B) at long-term follow-up. Tables 3 through 6 summarize objective outcome scores at final follow-up in all subgroup analyses.

Complications

During the follow-up period, 12 patients (5.2%) needed revision PCL surgery. The main indication for revision was instability. There were no postoperative infections or iatrogenic nerve injuries in this cohort.

DISCUSSION

The primary finding of the present study was that patients with both isolated and combined PCL reconstructions improved in terms of stability and subjective knee function after surgical management. Our study also found that after nearly 6 years the subjective and objective outcomes after either isolated or combined PCL reconstructions were almost identical. When performing subgroup analysis, the most prominent difference was found when comparing male with female patients. Subjective outcomes were better in male patients, although there were no differences in the objective measures (Table 5) between male and female patients.

Graft choice (allograft vs autograft; $P = .15-.49$), surgical technique (single-bundle vs double-bundle; $P = .08-.34$), and KOOS (except the sport subscale, $P = .04$) did not demonstrate any significant differences between groups. The degree of knee dislocation according to Schenck classification ($P = .07-.48$) did not demonstrate any significant differences between groups.

There are still controversies surrounding PCL reconstruction techniques, and the current literature is lacking

level 1 evidence comparing single- with double-bundle techniques as well as other surgical technique issues. The majority of patients in the present study had PCL reconstruction using the double-bundle technique (89%). A recent systematic review by Qi et al²⁵ evaluating both biomechanical and clinical evidence regarding single- versus double-bundle techniques and demonstrated no superiority in outcomes after double-bundle PCL reconstructions. Their evaluation was based on 8 clinical studies, which varied in level of evidence from 2 to 5. Their conclusion was that the current biomechanical studies did not show a definite advantage of double-bundle PCL reconstruction. The predominance of double-bundle technique procedures in our study cohort did not allow for comparison between the 2 methods of reconstruction.

In the present study, residual side-to-side laxity at final follow-up was 2.7 mm in the isolated PCL and 2.8 mm in the combined PCL group, as measured by KT-1000. Spiridonov et al,³⁰ in their study of 39 PCL patients, found a mean posterior translation of 0.9 mm, measured using posterior stress radiographs. When using the transtibial double-bundle technique, other studies have reported side-to-side posterior translations of 2.4 to 3.9 mm, which are similar to our results.^{13,35,36} Li et al,¹⁷ in their level 2 evidence prospective study of 46 PCL patients, demonstrated a significant improvement in side-to-side laxity in both single- and double-bundle groups. The posterior translation was 4.1 mm in patients treated with the single-bundle technique and 2.2 mm in patients treated with the double-bundle technique. This difference in laxity was significant, but there was no difference in overall patient satisfaction.

In the present study, patient-reported outcomes were compared between sexes. Males reported better outcomes at final follow-up than females even though there were no differences in posterior knee laxity. This is in contrast with the findings of Jung et al.⁹ In a level 3 study, they found superior reduction in posterior tibial laxity using stress radiographs in 90° of flexion in females compared with males. They did not find any significant differences in objective IKDC scores between the sexes postoperatively. However, they did not use a patient-reported outcome measure in their study. Spiridonov et al³⁰ did not find any significant differences in their study between sexes using Cincinnati scores. Only 1 clinical study³⁰ has demonstrated normalization of posterior knee stability after PCL reconstruction.

Despite the results of this study demonstrating clinically relevant improvements in patient-reported outcomes after surgical management of PCL injuries, the potential role of nonoperative management is still debatable. Shelbourne et al,²⁹ in a natural history study of acute, isolated, nonoperatively treated PCL injuries, reported that patients had good subjective and objective outcomes 14 years after their PCL injury. Therefore, there are continued challenges and controversies regarding management of PCL injuries. Nonoperative management may be a good option for isolated PCL injuries when treated acutely, but it remains uncertain whether nonoperative treatment has a role in the management of PCL lesions that are associated with other ligamentous injuries. Recent PCL support braces such as the Jack Brace (Albrecht) or the Rebound PCL brace

(Össur) used for both nonoperative management of acute PCL injuries and for postoperative rehabilitation are under evaluation for clinical efficacy.

Limitations

According to the suggested guidelines for future investigation and improvements in the quality of PCL reconstruction studies described by Watsend et al,³³ our study has some limitations. First, our study is primarily a cohort analysis and not a randomized clinical trial, but it was a prospective, consecutive follow-up of patients. Second, patients were not assessed using stress radiography or magnetic resonance imaging. Six of the other 8 study requirements consisting of a detailed rehabilitation protocol, both clinical and functional assessment and follow-up more than 24 months, outcome assessment by a truly independent investigator, patient inclusion and exclusion, validated outcome measures, and no commercial interest or funding were all met. Third, comparing isolated PCL with combined PCL reconstruction might be biased due to greater complexity of the surgical procedure in multiligament-injured knees and the severity of trauma with a potentially greater degree of combined soft tissue damage (muscle, nerve, and vascular). Fourth, the procedures were performed by several surgeons, and therefore, results might vary compared with a single-surgeon case series. Fifth, the conclusion of this study, especially the results of the objective measures, might be underpowered since only 56% of patients were available for the final clinical follow-up. Sixth, the comparisons between the Schenck classification groups might be influenced by the low patient numbers, especially in KD II and KD IV. Seventh, the preoperative examination and the 1-year follow-up were performed by the surgeon, whereas the final follow-up examinations were performed by 2 physiotherapists at the clinic. This may create interobserver variability.

CONCLUSION

Our hypothesis that patients with isolated PCL injuries have superior postoperative outcome scores and less side-to-side difference in knee laxity after PCL reconstruction than in patients with combined PCL injury in a multiligament-injured knee in this population was not confirmed. When comparing the 2 groups, inferior outcomes were found in the combined PCL group at 1-year follow-up but no differences were found between groups at final follow-up. Female patients had inferior subjective outcomes at 1-year follow-up, and no differences between the sexes were found at final follow-up. No differences were observed when investigating the influence of graft choice (allograft vs autograft), PCL reconstruction technique (single- vs double-bundle), and knee dislocation type. The overall revision rate in this study was 5.2%.

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