ORIGINAL ARTICLE

Arthroscopic Management of Combined Posterior Cruciate Ligament Injuries: A Systematic Review

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Abstract

Background: ***One of the four main ligaments of the knee, the Posterior Cruciate Ligament (PCL) keeps the tibia in place on the femur. The ligaments begin on the inside of the medial femoral condyle, near the intercondylar notch, and end on the inside of the tibial plateau. Its purpose is to stop the tibia from sliding backwards on the femur.***

Aim and objectives: ***To conduct a meta-analysis and systematic review of the literature on arthroscopic treatment techniques, results, and problems associated with combined PCL injuries.***

Subjects and methods: ***Searches in several databases, including PubMed, the Cochrane Bone and Muscle Trauma Group Specialized Register, MED-LINE, and The Cochrane Library, uncovered articles about arthroscopic treatment of combined posterior cruciate ligament (PCL) injuries that were published between 2010 and 2024.***

Results: ***The current state of knowledge suggests that when it comes to numerous ligament injuries in the knee, surgical treatment is superior to nonsurgical options. Single or double bundle PCL and ACL reconstruction utilizing allografts or autografts was carried out, with graft selection, bundle structure, femoral tunnel drilling, and graft fixation being the main concerns.***

Conclusion: ***Postoperative problems occurred in a small percentage of patients (12.2%), and extra therapy was necessary for 46 patients (6.4%). There is a higher chance of getting satisfactory functional results with combined surgical reconstruction of combined lesions, which is why we recommend it. Preliminary reports indicated a low complication rate, strong knee stability, and a high percentage of satisfying outcomes.***

Keywords: Systematic Review; Arthroscopic Management; PCL

1. Introduction

When the knee is bent, the proximal tibia takes a direct hit from the front, tearing the posterior cruciate ligament (PCL) in the process. Injuries sustained when the knee is pressed against the dashboard as a result of a car accident are a common occurrence. Another cause of PCL injury is a forward fall onto a flexed knee. Sports like football, skiing, soccer, and baseball have a disproportionately high rate of PCL injuries. A rotational hyperextension injury is a less prevalent cause of knee pain.[1]

There is a scale from I to III for PCL injuries, with grade I indicating a partial tear. Fully isolated, 1–5 mm posterior translation grade III (full posterior cruciate ligament rupture with concomitant capsular and ligamentous injury): 6-10 mm.[2]

Combined lesions are very challenging, whether to operatively repair or reconstruct all the ligaments, or only the most significant instability present. Also, whether to operate on an acute basis or to wait, and to do one-stage or two-stage surgeries. The best way to assess the results and the rehabilitation program to follow. All these debates give an idea about the controversies in the management of such injuries.[3]

If a patient experiences symptoms from a grade-III (full) PCL tear and does not show sufficient functional improvement after non-operative treatment, surgical intervention may be necessary. Operative treatment should also be considered for patients with PCL injuries who have high-grade knee laxity or who also have intra-articular or capsuloligamentous injuries.[4]

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If a stress-radiographic measurement of the posterior tibial translation (PTT) is more than 8 mm from side to side, it suggests a full PCL tear and suggests that individuals experiencing symptoms should undergo surgical repair. Furthermore, PCL reconstruction is recommended for athletes since the patient's needs are crucial in treatment decision-making.[5]

This study set out to conduct a meta-analysis and systematic review of the literature on arthroscopic treatment options for combined PCL injuries, as well as their outcomes and potential consequences.

2. Patients and methods

Search Strategy:

A comprehensive search was conducted using relevant databases such as MEDLINE, PubMed, the Cochrane Bone and Muscle Trauma Group Specialized Register, Central, Scopus, Web of Science, and the Cochrane Register of Controlled Trials. The primary objective was to identify published studies pertaining to arthroscopic management of combined PCL injuries that occurred between 2010 and 2024. A variety of medical subject headings were used to identify the relevant articles, including(Posterior Cruciate Ligament or PCL Injuries or Combined Injuries) and(Arthroscopy or Arthroscopic Management or Surgical Treatment).

PICO (Population, intervention, comparison, and outcome):

The following is the definition of PICO; P: combined PCL injuries in adult population, I: Arthroscopic reconstruction, C: Arthroscopic reconstruction through trans-tibial methods versus tibial inlay, O: Surgical success, complications rate, time of functional recovery and mobility, severity of pain and discomfort levels, quality of life, the need for reoperation, patient satisfaction, and cost-effectiveness.

Study selection:

In order to find articles that discuss arthroscopic management of combined posterior cruciate ligament injuries, two reviewers searched the literature. We followed the PRISMA criteria when we performed our searches. Conversations with the third researcher helped settle the disagreements.

Inclusion criteria:

Human subjects' studies, adult patients with combined PCL injuries (PCL injury with ACL injury), PCL injury with posterolateral corner injury, or PCL injury with medial collateral injury, and English articles.

Exclusion criteria:

Non-English studies, Meta-analysis studies, Case reports, Case series of less than 5 cases, and cases with vascular and nerve injuries.

Statistical analysis:

To characterize the research and the patients' demographics and outcome measures, descriptive statistics(mean, standard deviation, median, range, percentage, and, when applicable, the 95% confidence intervals. The review management software, namely Rev Man version 5.4.1 for Windows, was used to conduct the statistical analysis. The event rates were used to calculate the effect sizes for dichotomous data using random-effect models. A t-test was used to compare the means of the continuous data. We provided a 95% confidence interval for every effect size. A measure of heterogeneity was I2 (ranging from 0% [total consistency] to 100% [total inconsistency]).

3. Results

A total of 14-studies were selected for the current analysis, including a total of 712-patients with combined PCL injuries undergoing arthroscopic reconstruction. Basic features of the research that were considered,Table 1.

The publication year ranged between 2012-2023. Three studies were published between 2012-2014, three studies were published between 2015-2017, five studies were published between 2018-2020, and three studies were published between 2021-2023.

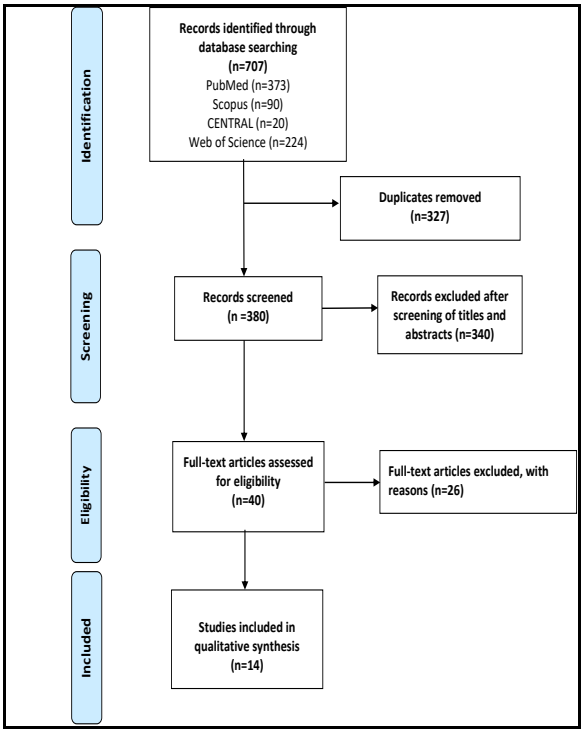

Figure 1. PRISMA flow diagram of the study selection process.

Table 1. Study characteristics.

FIRST AUTHOR	YEAR	COUNTRY	DESIGN	SAMPLE SIZE	FOLLOW-UP(YEARS)
FANELLI ET AL.[6]	2012	USA	Retrospective	28	4-18
KIM ET AL.[7]	2013	Korea	Retrospective	24	3(2-4)
PIONTEK ET AL.[8]	2013	Poland	Prospective	11	2.3±0.3
PANIGRAHI ET AL.[9]	2016	India	Prospective	20	2.2(1.2-3)
PETRILLO ET AL[10]	2017	Italy	Retrospective	NA	(1-9)
MYGIND-KLAVSEN ET AL.[11]	2017	Denmark	Retrospective	119	5.9(3.1-9.7)
LAPRADE ET AL.[12]	2019	USA	Retrospective	50	3.5(2-8)
LI ET AL.[13]	2019	China	Retrospective	49	2.6(2-6.8)
RAMOS ET AL.[14]	2019	Brazil	Prospective	15	2
TUCKER ET AL.[15]	2019	USA	Retrospective	75	1.6±1.6
GUPTA ET AL.[16]	2020	India	Retrospective	21	6.6±0.9
DRENCK ET AL.[17]	2022	Germany	Retrospective	23	3.8±1.1
WINKLER ET AL.[18]	2023	Sweden	Prospective	203	2
YOON ET AL.[19]	2023	Korea	Retrospective	16	3(2.3-5)

NA:NOT AVAILABLE

The country of origin varied across the studies. As shown in Figure 2, three-studies were carried out in the USA, two studies were carried out in Korea, two-studies were carried out in India, and one study was carried out in each of the following countries, Brazil, China, Denmark, Germany, Poland, Italy and Sweden. Regarding the study design, 10-studies were retrospective, and four were prospective in nature. The mean follow-up duration ranged between 6-52.3 months.

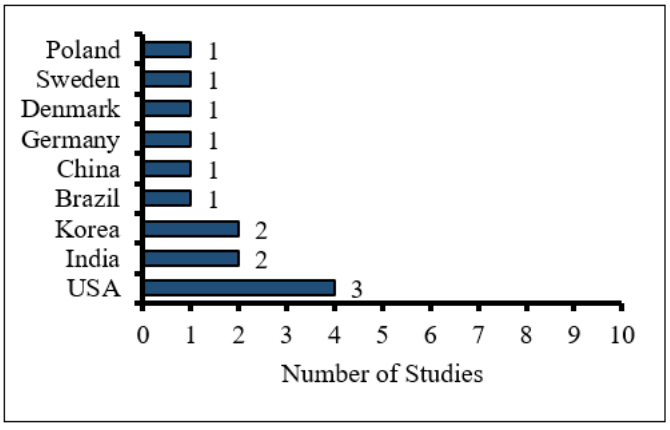

Figure 2. Country of origin.

Baseline characteristics of reported injuries, including mechanism of injury, grade of PCL injury, and associated injuries, Table 2.

Table 2. Injury characteristics.

FIRST AUTHOR	PCL INJURY GRADE	MECHANISM(%)					
		ACL	PLC	PMC	Sport	RTA	Other
FANELLI ET AL.[6]	III	100	100	100	NA	NA	NA
KIM ET AL.[7]	I-II	0	100	0	17	10	41.7
PIONTEK ET AL.[8]	NA	100	0	36	45	4	18
PETRILLO ET AL.[10]	NA	0	100	100	72	14	3
PANIGRAHI ET AL.[9]	NA	100	20	0	30	12	10
MYGIND-KLAVSEN ET AL.[11]	III	100	43	43	NA	NA	NA
LAPRADE ET AL.[12]	NA	54	42	70	100	0	0
LI ET AL.[13]	III	0	100	0	NA	NA	NA
RAMOS ET AL.[14]	NA	0	100	0	NA	NA	NA
TUCKER ET AL.[15]	II-III	100	100	100	NA	NA	NA
GUPTA ET AL.[16]	III	100	0	0	NA	NA	NA
DRENCK ET AL.[17]	II	0	100	0	30	12	17
WINKLER ET AL.[18]	NA	100	0	0	54	54	20
YOON ET AL.[19]	III	0	100	0	75	3	6

Eight studies specified the grade of PCL injury. As demonstrated in Figure 3, 504(71%) patients had associated ACL injury, 364(51%) patients had associated PLC injury and 251(35%) patients had associated PMC injury.

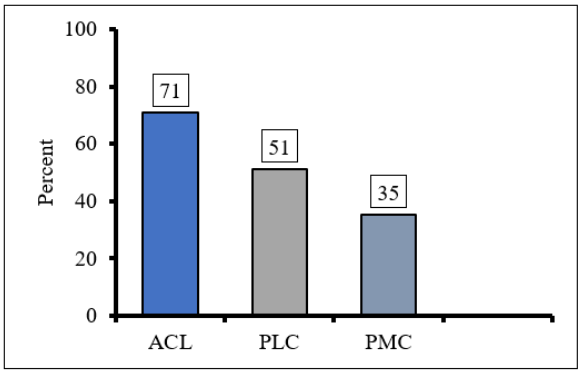

Figure 3. Associated injuries.

The mechanism of injury was reported in eight studies (405-patients). As shown in Figure 4, sports injuries were reported in 109(27%) patients, RTA was reported in 235(58%) patients, and other causes of injuries were reported in 61(15%) patients.

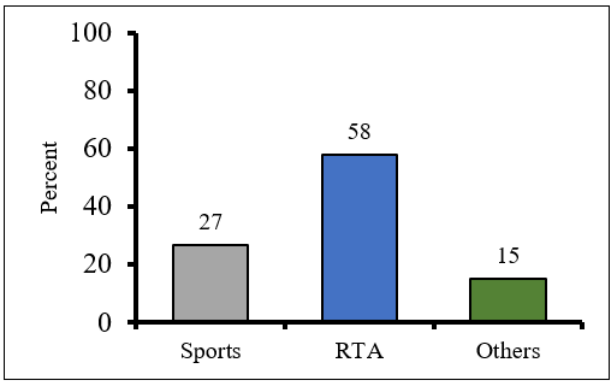

Figure 4. Mechanism of injury.

Table 3 summarizes the details of PCL reconstruction techniques as described by included studies as regards graft choice, bundle structure, femoral tunnel drilling, and graft fixation.

Table 3. PCL reconstruction techniques.

FIRST AUTHOR	GRAFT CHOICE	BUNDLE STRUCTURE	FEMORAL TUNNEL	FEMORAL FIXATION	TIBIAL FIXATION
FANELLI ET AL.[6]	26-Achilles tendon allograft 7-BPTB autograft 2-Hamstring autograft	Single or Double	ALP	EB+IS	EB+IS
KIM ET AL.[7]	Achilles tendon bone allograft	Single	ALP	IS	IS
PIONTEK ET AL.[8]	Hamstring autograft	Single	OI	EB+IS	IS
PETRILLO ET AL.[10]	Achilles allograft with or without bone plug and tibialis anterior allograft	Single or Double	ALP	EB+IS	EB+IS
PANIGRAHI[9]	Hamstring autograft	Single	ALP	EB or IS	EB or IS
MYGIND-KLAVSEN ET AL.[11]	Hamstring autograft	Double	TT	NA	NA
LAPRADE ET AL.[12]	Achilles tendon and tibialis anterior allografts	Double	NA	NA	NA
LI ET AL.[13]	Achilles tendon allograft	Single	OI	NA	NA
RAMOS ET AL.[14]	Quadriceps tendon autograft	NA	NA	IS	IS
TUCKER ET AL.[15]	NA	NA	NA	NA	NA
GUPTA ET AL.[16]	Hamstring autograft	Single	ALP	IS	IS
DRENCK ET AL.[17]	Hamstring autograft	Single	OI	EB	IS
WINKLER ET AL.[18]	NA	NA	NA	NA	NA
YOON ET AL.[19]	Achilles tendon bone allograft	Single	ALP	IS	IS

NA:NOT AVAILABLE; BPTB:BONE PATELLAR TENDON BONE; ALP:ANTEROLATERAL PORTAL; OI:OUTSIDE IN; TT:TRANSTIBIAL; EB:END BUTTON; IS:INTERFERENCE SCREW

Single or double bundle PCL reconstruction was performed using either allografts(Achilles tendon or tibialis anterior), or autografts(Hamstring, BPTB, or quadriceps tendon). Drilling of PCL femoral tunnels was carried out using the far anterolateral arthroscopic portal, the outside-in, or transtibial technique. PCL graft was fixed using EB and/or IS.

Table 4 summarizes the details of ACL reconstruction techniques as described by included studies as regards graft choice, bundle structure, femoral tunnel drilling, and graft fixation. Single or double bundle ACL reconstruction was performed using either allografts(Achilles tendon or BPTB), or autografts(Hamstring, BPTB). Drilling of ACL femoral tunnels was carried out using the far anteromedial portal or transtibial technique. ACL graft was fixed using EB and/or IS.

Table 4. ACL Reconstruction techniques.

FIRST AUTHOR	GRAFT CHOICE	BUNDLE STRUCTURE	FEMORAL TUNNEL	FEMORAL FIXATION	TIBIAL FIXATION
FANELLI ET AL.[6]	16-BPTB autograft 12-BPTB allograft 6-Achilles tendon allograft 1-Hamstring autograft	Single or Double	TT	EB+IS	EB+IS
PIONTEK ET AL.[8]	Hamstring autograft	Single	AMP	EB	IS
PANIGRAHI ET AL.[9]	Hamstring autograft	Single	AMP	EB or IS	EB or IS
MYGIND-KLAVSEN ET AL.[11]	NA	NA	TT	NA	NA
LAPRADE ET AL.[12]	BPTB autograft or allograft	NA	NA	NA	NA
TUCKER ET AL.[15]	NA	NA	NA	NA	NA
GUPTA ET AL.[16]	BPTB autograft	Single	AMP	IS	IS
WINKLER ET AL.[18]	NA	NA	NA	NA	NA

NA:NOT AVAILABLE; BPTB:BONE PATELLAR TENDON BONE; AMP:ANTEROMEDIAL PORTAL; TT:TRANSTIBIAL; EB:END BUTTON; IS:INTERFERENCE SCREW

Complications:

A total of 87(12.2%) patients developed postoperative complications, and 46(6.4%) patients required additional management. Table 5 summarizes the details of postoperative complications in included studies.

Table 5. Complications.

FIRST AUTHOR	COMPLICATION	MANAGEMENT
FANELLI ET AL.[6]	8-Radiographic OA 11-Decreased activities	None
KIM ET AL.[7]	1-Fibular head fracture	Immobilization for 6-weeks
PIONTEK ET AL.[8]	1-Arthrofibrosis 3-Hyperesthesia or paranesthesia	Medical treatment
PETRILLO ET AL.[10]	None	-
PANIGRAHI ET AL.[9]	1-Popliteal artery thrombosis 1-Pain at donor site 2-Limited knee flexion	Vascular intervention
MYGIND-KLAVSEN ET AL.[11]	12-Instability	Revision PCL
LAPRADE ET AL.[12]	18-Arthrofibrosis	Manipulation under anesthesia

LI ET AL.[13]	3-DVT	None
	3-hardware migration	Metal removal
	2-painful hardware	Metal removal
	1-infection	Irrigation and debridement
	1-pneumonia	None
	1-Arthrofibrosis	Manipulation under anesthesia
RAMOS ET AL.[14]	None	-
TUCKER ET AL.[15]	14-Overall complications	6-Re-operation
GUPTA ET AL.[16]	1-Infection 3-Limited knee flexion	None
DRENCK ET AL.[17]	None	-
WINKLER ET AL.[18]	None	-
YOON ET AL.[19]	None	-

4. Discussion

It is particularly difficult to manage young, high-demand athletes who have suffered PCL and PLC injuries at the same time.[20]

In this systematic review and meta-analysis, rehabilitation protocols for recovery after ACL and PCL surgery, and it typically involves staged protocols to restore strength, range of motion, and knee stability. The rehabilitation process is similar for both ACL and PCL reconstruction, but includes specific considerations for each ligament.

In this review, we focused on a total of 14-studies, including a total of 712-patients with combined PCL injuries undergoing arthroscopic reconstruction that met our inclusion criteria.

At this time, there is no solid proof that, in cases of multiple ligament injuries to the knee, double-bundle PCL repair yields better results than single-bundle PCL reconstruction.[6]

Reconstruction may be necessary for Grade III injuries to the PCL or MCL. Concomitant injuries often result in tunnel convergence among the structures' drilled tunnels; to avoid these, PCL tunnels, it is helpful to drill the MCL tunnel at a coronal angle of 40°. The best way to restore the knee's kinematics and get better results is to use surgical treatments that involve anatomical procedures for the attachment sites. While subjective outcomes can be restored with single-bundle (SB) reconstructions, patient outcomes often show the progression of osteoarthritis (OA). Longitudinal studies are necessary to fully characterize the results of double-bundle (DB) procedures, and research describing the treatment of concurrent medial collateral ligament (MCL) and posterior cruciate ligament (PCL) injuries is also required.[21]

Three studies were published between 2012-2014, three studies were published between 2015-2017, five studies were published between 2018-2020, and three studies were published between 2021-2023.

Four studies were carried out in the USA, two studies were carried out in Korea, two studies were carried out in India, and one study was carried out in each of the following countries: Brazil, China, Denmark, Germany, Poland, and Sweden. Regarding the study design, 10 studies were retrospective, and four were prospective in nature. The mean follow-up duration ranged between 6-52.3-months.

The overall male percentage was 70%, ranging between 61%-94%, while the female percentage was 30%, ranging between 6%-39%.

The right side was involved in 47%, ranging between 29%-82%, while the left side was involved in 53%, ranging between 18%-71%, (71%) patients had associated ACL injury, 364(51%) patients had associated PLC injury, 251(35%) patients had associated PMC injury, and 110(15%) patients had associated meniscal injuries.

Injuries resulting from various sources were reported by 109(27%) patients, 235(58%) patients, and 61(15%) patients. Of these, 53(27%) patients were deemed grade-A, 89(4%) patients grade-B, 53(27%) patients grade-C, and zero(0%) patients grade-D.

Similarly, Kim et al.,7 As far as postoperative rehabilitation is concerned, they documented that every single patient in both the isolated PLC reconstruction group and the combined PLC and PCL reconstruction group adhered to the exact same procedure. For the first four to six weeks, the affected knee was immobilized in extension using a hinged knee brace. Immediate postoperative care included strengthening and mobilizing the quadriceps muscles with patellar exercises. Weight-bearing up to the toes was permitted. For the first two weeks, you could do light range-of-motion exercises three times daily if you felt comfortable. Crutch weight-bearing as tolerated and limited knee flexion, with a progressive increase up to 90°, were encouraged after the first four to six weeks. Closed kinetic chain activities were started 8-10 weeks following surgery, once the brace was removed. Squatting, full flexion, riding a stationary bike, and stair climbing were all cleared 12–14 weeks following surgery. Bicycling and swimming were allowed for four to five months. At 6-9 months post-op, patients were cleared to resume leaping and pivoting sports.

Moreover, this was agreed with, Panigrahi et al.,[9] They proved that, on average, it took eight weeks for the recovery process to wrap up after ACL and PCL reconstruction done at the same time. Returning to full-time employment and sports took an average of 2.6–6.2 months. With the exception of two patients, who showed a decrease of less than five degrees of flexion, nearly all of the patients exhibited a full range of motion from five degrees of hyperextension to one hundred thirty degrees of flexion at the last follow-up appointments. A single patient had some discomfort at the donor site of the healthy knee on the opposite side, but no one else

reported any donor-site morbidity or malfunction in their healthy leg.

In addition, Yoon et al.,[19] evaluated the clinical and radiologic results of two groups of patients with posterolateral knee laxity less than grade-III: those who underwent combined posterior cruciate ligament (PCL) and patellofemoral ligament (PLC) replacement (group B) and those who underwent isolated posterior cruciate ligament (PCLR) restoration (group A). The results showed that both groups' pre- and postoperative Lysholm and Tegner activity scale scores were statistically indistinguishable. Group B demonstrated a greater IKDC subjective score than group A at the last follow-up (72.7±10.1 vs. 72.8±8.9 for group A; $p<0.05$). At the final follow-up, group B exhibited a substantially smaller side-to-side variation in posterior tibial translation (3.8±2.1 mm vs. 4.8±2.3 mm in group A; $p<0.05$) in relation to the radiologic results.

In the nine studies that included data on complications, 87 patients (12.2% of the total) experienced postoperative problems, and 46 patients (6.4% of the total) needed further treatment.

The study of, Gupta et al.,[16] No patient in any of the groups experienced graft rupture, although there were a total of three complications in group 1 (2 infections and one patient not being able to bend their knees beyond 120 degrees), and four complications in group 2 (1 infection and three patients not being able to bend their knees beyond 120 degrees).

Also, Kim et al.,[7] revealed that in group B, there was a single instance of fibular head cortical fracturing during fibular tunneling. Immobilization was sustained for 6 weeks since bioabsorbable interference screws could not establish a solid fixation.

Furthermore, the study's most crucial conclusion was that of, LaPrade et al.,[12] was that in cases of multiple-ligament knee injuries sustained in athletic activities, postoperative rehabilitation following a single-stage reconstruction of all injured ligaments led to far better results with far fewer complications.

Twelve patients (or 5.2% of the total) required PCL revision surgery throughout the follow-up period. As a whole, instability was the red flag that prompted the review. This group did not experience any iatrogenic nerve damage or postoperative infections. Several issues were identified during the postoperative testing as well: Arthrofibrosis occurred in one patient (9% of the total) and had to be surgically removed one year following repair, and postoperative infections.[11]

Further study, Piontek et al.,[8] demonstrated that during the postsurgical tests, a few complications had also been noted: one patient(9%) had developed arthrofibrosis, requiring surgical removal one year after the reconstruction.

4. Conclusion

There were few patients(12.2%) who developed postoperative complications, and 46(6.4%) patients required additional management. Therefore, we suggest that combined surgical reconstruction of combined lesions provides the greatest likelihood of achieving acceptable functional outcomes. A high percentage of satisfactory outcomes, good knee stability and a low complication rate were reported in the literature.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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