Benha Journal of Applied Sciences (BJAS) **print: ISSN 2356–9751**
Vol. (7) Issue (2) (2022), (69- 77) **online: ISSN 2356–976x**
http://bjas.journals.ekb.eg

Effect of internal brace technique on postoperative laxity in PCL reconstruction Short term study

H.E.Elbegawy, A.M.Halawa, E.M.Bayomy and A.T.Abdel-Razek
Orthopedics, Dept., Faculty of Medicine, Benha Univ., Benha, Egypt
E-mail: ahmed.taha5018@yahoo.com

Abstract

The posterior cruciate ligament (PCL) is critical to the stability of the knee and is sometimes referred to as the "pivot." Multiligamentous knee injuries are the most prevalent sort of pcl injuries, however they may also be PCL injuries on their own. Pcl injuries may result from a variety of causes, including a sports injury, a car accident, or a hyperextension injury. Pcl injury in non-athletes is treated with conservative treatment for a few weeks to allow for healing of the PCL, but in cases of multi-ligamentous knee injury or complete isolated pcl injury grade 3, surgical repair or reconstruction is required to restore knee mechanics and allow healing of the pcl in a proper length and position. Injuries to the anterior cruciate ligament (PCL) can be treated surgically in a variety of ways, including a single or double bundle reconstruction, anatomical transtibial or all-inside technique, tibial inlay reconstruction, or just repair of the PCL and augmentation with an internal brace, depending on the healing power of the pcl. Post-operative laxity after posterior cruciate ligament restoration with or without internal brace augmentation was compared in this research. Thirty patients who had PCL injuries and underwent PCL repair at Benha University Hospital or the Health Insurance Hospitals were included in a prospective research to evaluate postoperative laxity. Fifteen patients had PCL repair with an internal brace and fifteen underwent PCL reconstruction without an internal brace. Results: In the first group with an internal brace, outstanding in 7 instances, good in 7 cases, and average in one case. Without internal bracing, outstanding in two instances 13.3%, good in five cases (33.3%), and fair in eight cases (53.3%) are all that can be said. Structural integrity was improved by adding an independent ST to the PCL repair, regardless of the method utilised, resulting in decreased dynamic and total elongation and increased ultimate strength. During high loads, the ST seems to be a "safety belt" that becomes more prominent, demonstrating increased plastic deformation.

Key words: internal brace technique, postoperative laxity, PCL reconstruction.

1. Introduction

The PCL is the strongest of the two cruciate ligaments in the knee joint and acts as a barrier against knee dislocation at 90-degree flexion. The PCL develops from an inclining, depressed ledge on the posterior part of the tibial plateau. There is a prevalent perception that PCL injuries are caused by automobile accidents rather than sports-related incidents. Hyperflexion injuries of the knee in sports have been observed to be more prevalent in younger people. PCL tears do not have as obvious symptoms as ACL tears. Knee instability, soreness in the posterior knee area, or unidentified pain are all possible symptoms. Often, there is no pop sound or feel to it. A little amount of joint edema is also possible. As a third physical examination test, the posterior drawer test is the most accurate, with a sensitivity of 90% and 99.999% specificity. MRI is used if a PCL injury is suspected and confirmed. Chronic PCL insufficiencies have been linked to medial and patellofemoral compartments, degenerative arthritis, and a higher risk of meniscal tears as a consequence of tibial posterior dislocation, according to several studies. In the past, nonoperative therapy for PCL-injuries without fractures has been the norm. A great deal has been learned about PCL anatomy, epidemiology, biomechanics, clinical diagnosis, and therapy management in the last several years. [6]. Advances in PCL reconstruction have resulted in outstanding clinical and functional results that might lead to improved decisions in the treatment of PCL tears. If a patient has a grade III injury, persistent symptomatic solitary PCL lesions, or multi-ligament injuries, surgery should be considered. There have been several approaches to PCL reconstruction, but the ideal method is still a mystery. Allografts and autografts of the hamstring and Achilles tendon may be used for single-bundle or double-bundle reconstructions, as well as for transtibial or tibial inlay. In addition, stent operations may be used to enhance surviving residual fibres in order to restore the PCL. An rise in the usage of suture tape augmentation for ligament repairs and reconstructions in the knee, elbow, and ankle has been seen. When comparing suture tape augmentation to repair or reconstruction alone, biomechanical tests have demonstrated that it provides higher strength. One of the ideas behind the internal brace is to use ultrahigh molecular-weight polyethylene/polyester suture tape fastened to femoral and tibial buttons to assist prevent re-injury. ACL, PCL, MCL, LCL, ACL, ALL, and patellofemoral ligaments have all been effectively augmented using the internal brace for knee ligament augmentation (PFL). Improved surgical outcomes and reduced postoperative laxity may be achieved via the use of internal bracing techniques. Remaining laxity is the most prevalent problem after a PCL repair. The patient's gender, age, weight, inappropriate graft placement, strength, size, or tensioning, reinjury, or concomitant ligament injuries are all potential causes of residual laxity. Tibial slope (TS) is also a factor in post-PCL reconstruction posterior laxity. [14]

2. Patients and Methods

Type of the study : Prospective study

Patient : A prospective study will be done on thirty patients, attending at Benha university hospital or Health insurance hospitals, complaining of PCL injuries treated by PCL reconstruction to assess postoperative laxity. Fifteen patients will be treated with PCL reconstruction with internal brace technique and fifteen patients will be treated with PCL reconstruction without internal brace technique.

Follow up periods between 6 month and 2 years.

IKDC (International Knee Documentation committee version 2000) will be used as scoring system signed pre and post-operative.

Inclusion criteria: All patients has high grade PCL injuries with significant knee instability

Exclusion criteria :

- Age of patients more than 50 years.
- Previous cruciate ligament injury or surgery sustained in the affected knee.
- Osteoarthritis in the joint or abnormal bone structure or bone tumor seen on standard knee radiograph.
- Active site infection.
- Vascular injury or peripheral vascular disease.

Methods:

In this study the following sheet for every patient will be used:

- Preoperative assessment sheet.
- Operative sheet.
- Postoperative assessment sheet.

Preoperative sheet include

- Personal history: Name, Address ,Sex, Occupation, Age, Affected side, Dominant side and Sport of interest: (Type of the sport &Level of activity).
- Complaint : Giving way, pain, swelling, locking
- Trauma: mechanism, duration, immediate ambulation and immediate management
- **Clinical examination:**
  - **1-**Inspection: skin, swelling, scar, color, muscle wasting, position of the knee and deformity.
  - **2-**Feel for tenderness, warmth, crepitus, effusion, synovial thickening and patellar examination.
  - **3-**Move (flexion and extension) (Passive ROM).
  - **4-**Tests: Posterior drawer test, Reverse Lachman test, Reverse Pivot shift test, McMurray test, Valgus stress test at 0° and 30°, Varus stress test at 0° and 30°, Tests for effusion, Measure thigh girth (examination of the back of the knee and examination of the patellofemoral joint).
- Clinical evaluation using International Knee Documentation Committee (IKDC) system for preoperative assessment
- Radiographic examination.
  - **1-**Plain X-ray both Antero-posterior and lateral positions.
  - **2-**Magnetic resonance imaging.

Operative sheet include

- Date of surgery.
- Operation duration.
- Operative technique.
- Used instrumentations and screws.
- Type of the graft.
- Fixation method: (Femoral button and Tibial button and biodegradable screw).
- Operative details:

For PCL reconstruction with internal brace (skin incision and harvesting graft, preparation of graft, arthroscopic examination, notch preparation, tibial tunnel, femoral tunnel, passage of graft and fiberwire tape within femoral and tibial buttons ,distal fixation of graft with biodegradable screw and ending of operation) For PCL reconstruction without internal brace (skin incision and harvesting graft, preparation of graft, arthroscopic examination, notch preparation, tibial tunnel, femoral tunnel, passage of graft ,distal fixation of graft with biodegradable screw and ending of operation)

- Complication.

Postoperative sheet

- Clinical evaluation using IKDC score and posterior drawer test to assess postoperative laxity
- Radiological evaluation by stress radiograph to assess postoperative laxity
- Postoperative rehabilitation:

For PCL reconstrucion

- A hinged knee brace locked in full extension are placed on the operative limb.
- Weight bearing as tolerated with an assisted device begins at 2–4 weeks given the extent of injury and typically graduates to weight bearing as tolerated without an assisted device after 6 weeks.
- Full range of motion closed chain exercises are added in the 4th postoperative month and athletes are returned to straight-line running at 6 months. Most athletes return to full sports activities between 9 and 12 months.

A- Patients

This prospective nonrandomized clinical study was carried out on patients diagnosed with PCL injury presented to the sports orthopedic department at Benha university hospital and Health Insurance Hospitals. The diagnosis of PCL tear was confirmed based on clinical examination and radiological investigation. Full counseling of participants in this research and informed consent was obtained with full privacy of participants and confidentiality of the data.

Number of patients in this study:

The total number of participants in this study was 30 patients 2 groups (group 1 with internal brace contains 15 patients and group 2 without internal brace contains 15 patients)

Duration of the study:

The duration of this study was 2.5 years from April 2019 to November 2021.

1- Patients age:

Patients age ranged from 24 to 50 years at the time of the operation with a mean age of (36) years in group 1 and mean age of (37) years in group 2.

B- Method:

Preoperative assessment: a- History taking and clinical examination:

Detailed history taking and thorough physical examination was done for every patient to evaluate pattern of instability.

b- Laboratory investigations:

All patients had complete blood count, coagulation profile, renal function tests, liver function tests and blood sugar examination.

c- Radiological examination:

All patients received a knee plain X-ray, anteroposterior and lateral views as well as MRI study for detailed analysis of the injury. Stress X-rays were done under anesthesia in the operating room before the surgery to confirm the diagnosis.

Anesthesia: General anesthesia was used in all patients after cardiac and chest consultation.

Tourniquet: All procedures were done with the use of a pneumatic upper thigh tourniquet that could be inflated and deflated during surgery. **4- Surgical technique:**

The patient was positioned in a supine position with a pneumatic tourniquet on the upper thigh. A metal post was attached to the operating table next to the upper thigh, to work as a bulkhead, facilitating arthroscopic inspection of the medial compartment. Fig. (1) The patient was prepared and draped in a standard fashion.

The procedure began with clinical examination under anaesthesia to check the instability grade and the presence of associated lesions. Figs. (2, 3) A fluoroscopic knee stability examination was performed with the patient under anesthesia Fig. (4), Laxity in the coronal and sagittal plane was evaluated for the affected knee and compared with the contralateral side.

Fig. (1) Patient Positioning

Fig. (2) Examination under anesthesia reveals pathological recarvatum in a case with PLC injury.

Fig. (3) Examination under anesthesia with positive stress valgus test indicating medial side injury.

Fig. (4) Intraoperative stress X-ray showing excessive posterior translation and lateral joint opening in a case with combined PCL and PLC injury.

5- Postoperative protocol:

Immediate postoperative, a knee brace with dorsal calf elevation support fig. (5) Was applied for 24 hours a day in the first 6 postoperative weeks. Starting from the 7th to the 12th postoperative week a functional dynamic PCL brace was applied at daytime and alternated with the knee brace with dorsal calf support at nights.

Isometric quadriceps exercises were allowed starting from day one after surgery, together with patellar mobility exercises and cryotherapy to decrease postoperative oedema and control pain.

Subcutaneous low molecular weight heparin is administrated until full weight bearing; ibuprofen is usually given for the first week for pain control.

Patients were instructed not to bear weight on the operated leg for the first 6 postoperative weeks followed by partial weight bearing of 20 kg for 2 weeks followed by gradual loading 20 kg per week starting from the 8th week until full weight bearing.

Active hamstring contraction was avoided for 5 months postoperative, passive range of motion (ROM) in prone position limited to 90 degrees of flexion in the first 6 weeks postoperative was recommended followed by progressive increase of active and passive ROM starting from 7th postoperative week.

Fig. (5) Knee support with dorsal calf elevation is typically applied after surgery.

3. Results

Injury characteristics

No significant difference was noted between both groups regarding the affected side (P-value = 0.269), mechanism of injury (P-value = 0.439), degree of PCL injury (P-value = 0.598), and Schenk classification **(Table 1).**

Table (1) Injury characteristics on both groups.

			Group I (n = 15)	Group II (n = 15)	P-value
Affected side	Right	n (%)	7 (46.7)	10 (66.7)	0.269
	Left	n (%)	8 (53.3)	5 (33.3)	
Mechanism of injury	Sport injury	n (%)	6 (40.0)	4 (26.7)	0.439
	Motor vehicle injury	n (%)	9 (60.0)	11 (73.3)	
Degree of PCL injury	Grade I	n (%)	0 (0.0)	0 (0.0)	0.598
	Grade II	n (%)	1 (6.7)	3 (20.0)	
	Grade III	n (%)	14 (93.3)	12 (80.0)	
Schenk classification	Grade I	n (%)	9 (60.0)	12 (80.0)	NA
	Grade II	n (%)	1 (6.7)	2 (13.3)	
	Grade III	n (%)	4 (26.7)	0 (0.0)	
	Grade IV	n (%)	1 (6.7)	1 (6.7)	

Chi-square test was used **NA: Not applicable**

Associated injuries

No significant differences were observed between both groups regarding all associated findings, including ACL (P-value = 0.427), MCL (P-value = 1.0), PLC (P-value = 0.136), and Meniscal injuries (P-value = 1.0) **(Table 2).**

Table (2) Associated injuries in both groups.

		Group I (n = 15)	Group II (n = 15)	P-value
ACL	n (%)	6 (40.0)	3 (20.0)	0.427
MCL	n (%)	4 (26.7)	4 (26.7)	1.0
PLC	n (%)	8 (53.3)	4 (26.7)	0.136
Meniscal injuries	n (%)	4 (26.7)	5 (33.3)	1.0

Chi-square or Fisher's exact test was used **ACL: Anterior cruciate LIGAMENT**
MCL: Medial collateral ligament **PLC: Posterolateral corner**

Pre-operative X-ray stress and posterior drawer test

All patients in both groups showed positive stress finding X-ray and positive posterior drawer test **(Table 3).**

Table (3) Pre-operative X-ray stress and posterior drawer test in both groups

		Group I (n = 15)	Group II (n = 15)	P-value
Positive X ray stress finding	n (%)	15 (100.0)	15 (100.0)	-
Positive posterior drawer test	n (%)	15 (100.0)	15 (100.0)	-

Early postoperative complications

Laxity was significantly higher in group II (86.7%) than group I (40.0%) (P-value = 0.008). Also, loss of flexion was significantly higher in group II (53.3%) than group I (13.3%) (P-value = 0.02).

No significant differences were observed between both groups regarding early post-operative complications, including laxity (P-value = 0.427), loss of extension (P-value = 1.0), infection (P-value = 1.0), anterior knee pain (P-value = 0.065), popliteal vessel injury (P-value =1.0), tibial nerve injury (P-value = 1.0), and tourniquet palsy (P-value = 1.0) **(Table 4).**

Table (4) Early postoperative complications in both groups.

		Group I (n = 15)	Group II (n = 15)	P-value
Laxity	n (%)	6 (40.0)	13 (86.7)	0.008
Loss of flexion	n (%)	2 (13.3)	8 (53.3)	0.020
Loss of extension	n (%)	0 (0.0)	1 (6.7)	1.0
Infection	n (%)	0 (0.0)	1 (6.7)	1.0
Ant knee pain	n (%)	6 (40.0)	11 (73.3)	0.065
Popliteal vessel injury	n (%)	0 (0.0)	1 (6.7)	1.0
Tibial nerve injury	n (%)	0 (0.0)	1 (6.7)	1.0
Toniquet palsy	n (%)	1 (6.7)	1 (6.7)	1.0

Chi-square or Fisher's exact test was used

Chi-square test was used

Late postoperative complications

Laxity was significantly higher in group II (86.7%) than group I (40.0%) (P-value = 0.008). Arthritis was significantly higher in group II (66.7%) than group I (13.3%) (P-value = 0.003). No significant differences were observed regarding laxity (P-value = 0.439) and loss of flexion (P-value = 0.003) **(Table 5).**

Table (5) Late postoperative complications in both groups.

		Group I (n = 15)	Group II (n = 15)	P-value
Laxity	n (%)	6 (40.0)	13 (86.7)	0.008
Loss of flexion	n (%)	0 (0.0)	1 (6.7)	1.0
Arthritis	n (%)	2 (13.3)	10 (66.7)	0.003

Chi-square or Fisher's exact test was used

Postoperative posterior drawer test

Positive posterior drawer test was significantly higher in group II (86.7%) than group I (40.0%) (P-value = 0.008). Also, grading showed a significant difference between both groups (P-value = 0.041); Grade I was higher in group I (83.3%) than group II (23.1%), while grade II was significantly higher in group II **(Table 6).**

Table (6) Postoperative posterior drawer test in both groups.

			Group I (n = 15)	Group II (n = 15)	P-value
Positive posterior drawer test	n (%)		6 (40.0)	13 (86.7)	0.008
posterior drawer test grading	Grade I	n (%)	5 (83.3)	3 (23.1)	0.041
	Grade II	n (%)	1 (16.7)	10 (76.9)	

Fisher's exact test was used

Postoperative PCL instability score

There was a significant difference on PCL instability score between both groups (P-value = 0.023). Excellent score was higher in group I (46.7%) than group II (13.3%), and fair score was higher in group II (53.3%) than group I (6.7%) **(Table 7).**

Table (7) Post-operative PCL instability score in both groups.

			Group I (n = 15)	Group II (n = 15)	P-value
PCL instability score	Excellent	n (%)	7 (46.7)	2 (13.3)	0.023
	Good	n (%)	7 (46.7)	5 (33.3)	
	Fair	n (%)	1 (6.7)	8 (53.3)	

Fiser's exact test was used

Postoperative stress X-ray

There was a significant difference in stress X-ray between both groups (P-value = 0.023). Stable finding was higher in group I (46.7%) than group II (13.3%), and residual postrolateral instability was higher in group II (53.3%) than group I (6.7%) **(Table 8).**

Table (8) Post-operative stress X-ray in both groups.

			Group I (n = 15)	Group II (n = 15)	P-value
Stress x ray	Stable	n (%)	7 (46.7)	2 (13.3)	0.023
	Residual post laxity	n (%)	7 (46.7)	5 (33.3)	
	Residual postrolateral instability	n (%)	1 (6.7)	8 (53.3)	

Fisher's exact test was used

Postoperative IKDC

IKDC showed a significant difference between both groups (P-value = 0.033). Excellent score was higher in group I (33.3%) than group II (6.7%). In contrast, fair score was higher in group II (46.7%) than group I (6.7%) **(Table 9).**

Table (9) Post-operative IKDC in both groups.

			Group I (n = 15)	Group II (n = 15)	P-value
IKDC	Excellent	n (%)	5 (33.3)	1 (6.7)	0.033
	Good	n (%)	9 (60.0)	7 (46.7)	
	Fair	n (%)	1 (6.7)	7 (46.7)	

Fisher's exact test was used IKDC: International Knee Documentation Committee

Postoperative Tegner score

Tegner score showed a significant difference between both groups (P-value = 0.011). Excellent score was higher in group I (33.3%) than group II (6.7%). In contrast, fair score was higher in group II (40.0%) than group I (0.0%). **(Table 10).**

Table (10) Post-operative Tegner score in both groups.

			Group I (n = 15)	Group II (n = 15)	P-value
Tegner score	Excellent	n (%)	5 (33.3)	1 (6.7)	0.011
	Good	n (%)	10 (66.7)	8 (53.3)	
	Fair	n (%)	0 (0.0)	6 (40.0)	
	Poor	n (%)	0 (0.0)	0 (0.0)	

Fisher's exact test was used

4. Discussion

It was shown that PCL internal bracing resulted in acceptable subjective ratings, with an average IKDC score of 82 and an activity score of 6. According to the research, these ratings are equivalent to those obtained using more conventional reconstruction methods. [3]

The average IKDC score was 67.9 in a study by King et al.[15] that included 56 patients who had PCL-based knee dislocations and were followed for an average of 6.5 years following surgery. The lower IKDC values were mostly associated with MCL repairs and female gender.

At least two years following arthroscopic double bundle PCL repair, Laprade et al.[16] evaluated 53 patients with PCL-based multiligament knee injuries. After a final follow-up, patients with bicruciate injuries had the lowest IKDC and Tegner activity scale scores (an average of 4) and IKDC scores (an average of 67).

Using the single bundle transtibial reconstruction approach, Engebretsen et al. [17] examined the long-term outcomes, on average 5.3 years, of 85 patients who had PCL-based multiligament knee injuries. Final Lysholm scores ranged from 15–100, Tegner activity scores ranged from 0–9, and the IKDC score ranged from 64–20. Those with KD-IV had a considerably lower IKDC score than patients with KD-II and III. The research also found a 50% chance of getting posttraumatic osteoarthritis within a year of a knee dislocation.

At two years after combined PCL injuries, Eduard et al.[18] reported an average IKDC score of 62.7 in 39 patients. The study concluded that bicruciate injuries, chondral and meniscal injuries, and PLC reconstruction were factors predictive of poorer functional results, and while surgical treatment provides good overall function, ROM, and stability, it rarely results in a "normal" knee and the chances of complications and reoperation are high....

It was reported by Laprade et al. [19] that after PCL-based multiligament reconstructions, the average Lysholm knee score had increased to 84, with an activity score of 5 as the ultimate outcome. Postoperative posterior tibial translation on stress radiographs showed a mean SSD for combined PCL tears of 1.7 mm. Based on this, he concluded that anatomically based double bundle PCL reconstructions resulted in significantly improved functional and objective outcomes with low complication rates over a mean follow-up of three years, regardless of concurrent ligamentous pathology or timing of surgery. Compared to arthrometer and clinical posterior drawer testing, PCL stress radiography using the kneeling or Telos approach has been shown to provide better objective findings to both.

The laxity of the PCL was assessed using posterior stress radiographs and the SSD. The stress radiograph showed a mean SSD of posterior translation of 4.7 inches. Internal PCL bracing produced satisfactory short-term clinical outcomes. Most patients had an incomplete SSD of posterior translation, but they felt that this did not have a significant impact on everyday life. – These findings are in line with those found in other studies.

The average posterior translation SSDs using a hamstring autograft were 4 mm, according to Wang et al. [20], while a retrospective study by Chahla et al.[21] found that the use of the double-bundle technique for autograft and allograft resulted in posterior tibial translation SSDs of 2.4 and 4.9 mm on average. Both studies used seven-year follow-up data. Study by Xu and colleagues [22] found that the average SSD for hamstring autograft and LARS artificial ligament was 3.3 and 4.2 respectively.

The IKDC subjective knee scores and residual posterior laxity are linked in this research. Stress radiography examined anteroposterior laxity, although the Tegner activity scale found that individuals with persistent posterior laxity may return to everyday activities but are typically forced into reducing their sports activities because of it.

Both Shelbourne et al.[23] and Torg et al.[24] found that posterior knee laxity, as assessed by a KT-1000 arthrometer, had no link to the patient's functional status.[23] Previous research found no association between PCL laxity grade and subjective ratings.

An investigation of 57 individuals with isolated PCL injuries treated nonoperatively by Patel et al. [25] yielded no conclusive evidence. Both the period of follow-up (mean, 6.9 years) and the degree of PCL laxity had no association to subjective ratings, and neither did they.

25 of 37 PCLs treated conservatively (68 percent) restored or maintained continuity, but showed changed morphology, such as elongation, thickening, and angulation, on MRI images after treatment. A link between PCL continuity and stability or function was also not found in their investigation.

According to the opposite study conducted by researchers at Akisue et al.[26], there was an association with a solid endpoint with a posterior drawer test and PCL continuity following conservative therapy on MRI images. However, this study also discovered evidence of posterior instability. PCL-like tissue may serve as an effective posterior tibial restraint in the majority of acutely damaged PCL, according to the study's authors.

Despite the fact that both the PLC and the PCL work synergistically to prevent posterior tibial translation, biomechanical studies have shown increased forces on the ACL and PCL when the PLC is insufficient, which could contribute to PCL graft failures by allowing significantly higher forces on the PCL graft.

Outcomes of grade III knee dislocations on the medial (KD III-M) side were compared to the results of dislocations on the lateral (KD III-L) side. From 1999 to 2014, they documented 69 instances of KD III-M and 84 cases of KD III-L. KD III-M patients had 66.7 percent excellent or good outcomes, whereas KD III-L patients had 57.1 percent excellent or good results. However, this difference was not statistically significant

Following an examination of the clinical outcomes of PCL-based multiligament injured knees by Tardy et al.[29], which contrasted PLC reconstruction with medial collateral ligament and posteromedial corner (PMC) repair or reconstruction, the researchers came to the conclusion that PLC reconstructions had worse clinical outcomes than medial-sided surgeries, with an average Lysholm score of 79, 89 and an average subjective IKDC score of 70, 81 resp.

In contrast, King et al. [15] reported that certain patients with KDIII-M dislocations had worse outcomes than patients with KDIII-L dislocations after operational therapy. There were substantial differences in outcomes between medial reconstructions, lateral reconstructions, and lateral repairs after multivariate analysis.

After single-stage surgery for sports-related multiple-ligament knee injuries, Laprade et al [19] found no difference in results between medial and lateral based injuries. In a few research, it was claimed that KD-IV injuries were more detrimental than KD-III injuries. Laprade et al. [19] found that simultaneous ACL and PCL damage was related with worse functional scores. The clinical ratings based on Schenck's knee dislocation categorization were not significantly different in this investigation, although

statistical comparison may have limited significance because to the small number of patients with KD-IV (n=3).

5. Conclusion

Improved metrics were found when an independent ST was added to a PCL reconstruction, lowering dynamic as well as total elongation as well as enhancing final strength, regardless of the method employed. During high loads, the ST seems to be a "safety belt" that becomes more prominent, demonstrating increased plastic deformation.

References

[1] G.C.Fanelli, J. D.Beck, C. J. Edson. Current concepts review: the posterior cruciate ligament. The journal of knee surgery.vol.23(02),pp.061-072,2010.

[2] C. G.Stevens, K.Jarbo, K.Economopoulos, A. Chhabra. Anatomy and Biomechanics of the Posterior Cruciate Ligament and Their Surgical Implications. In Posterior Cruciate Ligament Injuries Springer, Cham.vol.12,pp.19-31,2015.

[3] M.Osti, P.Tschann, K. H.Künzel, K. P. Benedetto. Anatomic characteristics and radiographic references of the anterolateral and posteromedial bundles of the posterior cruciate ligament. The American journal of sports medicine.vol.40(7),pp.1558-1563,2012.

[4] S. J.Mortazavi, A. R.Asl, H. Jafari, H.Asgari, M. H.Kaseb, M. J.Dehghanifiroozabadi. Tibial Tunnel Preparation in Posterior Cruciate Ligament (PCL) Reconstruction. A Technical Tip to Lessen the Stress. Archives of Bone and Joint Surgery.vol.7(5),pp.463-490,2019.

[5] B.Forsythe, C.Harner, C. A .Martins, W.Shen, O. V.Lopes Jr, F. H. Fu. Topography of the femoral attachment of the posterior cruciate ligament: surgical technique. JBJS, 91(Supplement_2_Part_1), 89-100. , (2009)

[6] Anderson, C. J., Ziegler, C. G., Wijdicks, C. A., Engebretsen, L., & LaPrade, R. F. Arthroscopically pertinent anatomy of the anterolateral and posteromedial bundles of the posterior cruciate ligament. JBJS.vol.94(21),pp.1936-1945,2012.

[7] A. A.Amis,C. M.Gupte, A. M. J.Bull, A.Edwards .Anatomy of the posterior cruciate ligament and the meniscofemoral ligaments. Knee Surgery, Sports Traumatology, Arthroscopy, .vol.14(3),pp.257-263,2006.

[8] M.Takahashi, T.Matsubara, M.Doi, D.Suzuki, A.Nagano. Anatomical study of the femoral and tibial insertions of the anterolateral and posteromedial bundles of human posterior cruciate ligament. Knee Surgery, Sports Traumatology, Arthroscopy.vol. 14(11),pp.1055-1059,2006.

[9] A.Bedi, R. F.LaPrade, M. T.Burrus. Radiographic and anatomic landmarks of the major knee ligaments. JBJS, .vol.100(14),pp.1241-1250,2018.

[10] C.Kweon, E. S.Lederman, A.Chhabra. Anatomy and biomechanics of the cruciate ligaments and their surgical implications. In The multiple ligament injured knee Springer, New York, NY.vol.20,pp.17-27,2013.

[11] S.Apsingi, A. M.Bull, D. J.Deehan, A. A. Amis. femoral tunnel placement for PCL reconstruction in relation to the PCL fibre bundle attachments. Knee Surgery, Sports Traumatology, Arthroscopy.vol.17(6),pp.652-659,2009.

[12] A.Panagopoulos, K.Solou, P. M.Kitrou, A.Kouzelis, , Z. T.Kokkalis. I. K .Triantafyllopoulos. Injury to the Medial Superior Genicular Artery After Isolated Posterior Cruciate Ligament Reconstruction: A Case Report. JBJS Case Connector.vol.11(1),pp.200-250,2021.

[13] K. B.Van Dorp, S. J.Breugem, M. J. Driessen. Popliteal pseudoaneurysm after arthroscopic posterior cruciate ligament reconstruction. Knee surgery & related research, .vol.26(3),pp.787–92,2014.

[14] R. T.de Carvalho, L. A.Ramos, J. V.Novaretti, L. M.Ribeiro, P. R. D. Q.Szeles , S. J. M.Ingham, R. J. Abdalla. Relationship between the middle genicular artery and the posterior structures of the knee: A cadaveric study. Orthopaedic journal of sports medicine,.vol. 4(12),pp.155-190 , 2016.

[15] AH.King, AJ.Krych, MR .Prince, A. Pareek, MJ. Stuart, BA.Levy Surgical Outcomes of Medial Versus Lateral Multiligament-Injured, Dislocated Knees. Arthroscopy.vol.32(9),pp.1814-9., 2016.

[16] R. F.LaPrade , C.Heikes , A. J.Bakker, R. B. Jakobsen .The reproducibility and repeatability of varus stress radiographs in the assessment of isolated fibular collateral ligament and grade-III posterolateral knee injuries: an in vitro biomechanical study. JBJS.vol. 90(10),pp. 2069-2076. ,2008.

[17] L .Engebretsen, MA. Risberg, B .Robertson, TC. Ludvigsen, S. Johansen Outcome after knee dislocation: a 2 to 9 year followup of 85 consecutive patients. Knee Surg Sports Traumatol Arthrosc.vol.17,pp.1013–1026,2009.

[18] Alentorn-Geli, Eduard , Lazarides, Alexander & Utturkar, Gangadhar & Myers, Heather & Samuelsson, Kristian & J.Choi, & Stuart, Joseph & Moorman, Claude. Factors predictive of poorer outcomes in the surgical repair of multiligament knee injuries. Knee Surgery, Sports Traumatology, Arthroscopy. .vol.27. ,pp.1-15,2018.

[19] R. F.LaPrade , A. S Bernhardson, C. J.Griffith, J. A.Macalena, C. A.Wijdicks,. Correlation of valgus stress radiographs with medial knee ligament injuries: an in vitro biomechanical study. The American journal of sports medicine.vol.38(2),pp.330-338,2010.

[20] Wang, Rui & Xu, Bin & Wu, Lei & Xu, Honggang. Long-term outcomes after arthroscopic single-bundle reconstruction of the posterior cruciate ligament: A 7-year follow-up study. Journal of International Medical Research.vol. 46,pp.123-155,2017.

[21] J.Chahla, G.Moatshe, C. S.Dean, R. F.LaPrade. Posterolateral corner of the knee: current concepts. Archives of Bone and Joint Surgery.vol.4(2),pp.97,-150,2016.

[22] H.Xu, R.Guo, B. Xu.An irreducible posterolateral knee dislocation: diagnosis, arthroscopic view, and treatment. The American journal of emergency medicine.vol. 34(11),pp. 22-56 ,2016.

[23] K. D.Shelbourne, S. E. Urch, T.Gray, H. Freeman.Loss of normal knee motion after anterior cruciate ligament reconstruction is associated with radiographic arthritic changes after surgery. The American journal of sports medicine.vol. 40(1),pp.108-113,2012.

[24] JS.Torg, TM.Barton, H.Pavlov, R.Stine. Natural history of posterior cruciate ligament-deficient knee. Clin Orthop Relat Res.vol.246,pp.208-216, 1989.

[25] DV.Patel, AA.Allen, RF.Warren, TL.Wickiewicz, PT.Simonian,. The nonoperative treatment of acute, isolated (partial or complete) posterior cruciate ligament-deficient knees: an intermediate-term follow-up study. HSS J.vol.3,pp.137-146,2007.

[26] T.Akisue, M.Kurosaka, S.Yoshiya, R.Kuroda, K.Mizuno. Evaluation of healing of the injured posterior cruciate ligament: Analysis of instability and magnetic resonance imaging. Arthroscopy. Mar.vol.17(3),pp.264-269,2001.

[27] SL.Logterman, FB.Wydra, RM.Frank. Posterior Cruciate Ligament: Anatomy and Biomechanics. Curr Rev Musculoskelet Med.vol.11(3),pp.510-514,2018.

[28] Wu. Jiang, Yao, Jianhua & Yuan.He, Sun, Wei & Huang, Yan & Kong, Dejia. (The timing of surgical treatment of knee dislocations: a systematic review. Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA.vol. 23.10.1007/s00167,pp.014-3435-1, 2014.

[29] N.Tardy, P.Boisrenoult, P.Teissier, C.Steltzlen, P.Beaufils, N.Pujol. Clinical outcomes after multiligament injured knees: medial versus lateral reconstructions. Knee Surgery, Sports Traumatology, Arthroscopy. vol. 25(2),pp. 524-531,2017.