Combined posterior cruciate ligament and chronic posterolateral corner deficiency in varus knee, two-stage reconstruction

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Background
Conservative management of chronic posterolateral corner (PLC) knee injuries had a bad repetition and often followed by poor outcomes. In patients who had associated posterior cruciate ligament [PCL] and chronic PLC knee injuries with varus knee deformity, failure to correct the mechanical axis by correcting varus was usually followed by failure of the posterolateral knee repair or reconstruction.
Aim of the study
To assess prospectively the results of treatment of associated PCL and chronic PLC injury in the varus knee, with a two-stage procedure. Initial high tibial medial opening wedge osteotomy was followed by PCL reconstruction.
Methods
This study included 10 patients who had associated PCL and chronic PLC deficiency in varus knee who were treated by two-stage surgical technique, first stage was high tibial medial opening wedge osteotomy to align the mechanical axis and correct varus deformity, then PCL ligament reconstruction in the second stage.
Results
According to the International Knee Documentation Committee, the 10 patients included in the study [100%] were graded as grade C (abnormal) or D (sever abnormal) preoperatively, while 8 of the 10 patients [80%] were graded as grade A (normal) or B (nearly normal), and 2 patients [20%] were rated as abnormal grade C at final follow-up scoring. Statistically significant improvement was achieved. Radiologically, the average mechanical axis that preoperatively passed within the medial tibial plateau with varus deformity ranged between 10 and 15° in our cases, while the mechanical axis postoperatively passed through the mid of tibial plateau or slightly within the lateral tibial plateau with full correction of the deformity with valgus angle ranged from 5 to 10°. The preoperative posterior tibial sagittal slope angle was average 7.8°, which became 10.5° in the last follow-up visit.
Conclusion
Two-stage reconstruction of the knee in cases who had PLC injuries associated with varus knee, starting by proximal tibial medial opening wedge osteotomy followed by reconstruction of PCL, is a valuable technique and had good results.

Keywords:
posterior cruciate ligament [PCL], posterolateral corner [PLC], varus knee

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Introduction

Management of posterolateral corner (PLC) injuries is affected by several factors such as the time of diagnosis, the severity of injury, and associated injuries. PLC injuries were treated usually late by reconstruction due to delayed diagnosis. The PLC injuries are commonly associated with other injuries and rarely occur as isolated injury [1].

Posterior cruciate ligament (PCL) injury, the most common associated injury with the PLC injuries, occurred in 60% of cases. Varus deformity in patients with chronic PLC developed due to three factors: bony varus alignment of the limb, disruption of the lateral tibiofemoral compartment, and excessive external rotation and hyperextention of the tibia [2].

Associated ligamentous injuries increase the incidence of varus deformity development. It is important to evaluate the mechanical axis before treating patients with chronic PLC injuries, because reconstructions of the ligaments in the presence of varus malalignment had the risk of stretching or failing over time [3].

Petrigliano *et al.* [4], in their study on 10 cadaveric specimens, using computer-assisted navigation studied the role of high tibial osteotomy on knee stability.

After excising of the PCL and PLC structures, they examined the knee by posterior drawer and reverse pivot-shift tests. They found that increasing the posterior tibial slope leads to reduced translation of the medial compartment during the posterior drawer test but had little effect on the reverse pivot-shift test. They advised that increasing posterior tibial slope leads to more stability in the sagittal plain and must be considered during treatment of PLC-PCL-deficient knee [4].

Patients and methods

This prospective study included 10 cases with chronic PLC knee injuries, 8 patients male and 2 females, 7 patients with right knee while 3 patients with the left knee. Varus malalignment and PCL tear grade 3 injury were present in all patients. The clinical examination showed positive posterior drawer test and external rotation recurvatum, and the tibial dial test for external rotation was positive in both 30 and 90° of knee flexion. The varus stress test was positive. Varus deformity was diagnosed after undergoing long leg standing anteroposterior (AP) x-ray and drawing the mechanical axis that passed from medial to the tip of the medial tibial spine.

Preoperative AP, lateral radiographs and long standing AP radiographs were done. Magnetic resonance imaging examination was done for all patients to confirm PLC and PCL injuries.

Examination under anesthesia was done and revealed PCL and PLC tear. All patients were subjected to diagnostic arthroscopy at first, which showed tear of the PCL; the anterior cruciate ligament (ACL) was intact but lax.

Surgical technique

All patients signed a written consent and informed about the details of the operation and the expected complications.

A medial longitudinal incision was made on the tibia starting distal to the knee joint line and ending below the level of tibial tuberosity, centered over the planned osteotomy site, which usually started medially at the level of the tibial tuberosity and extending upward and laterally without interfering with the extensor mechanism, with the incision slightly medial to middle line. Guide wires were placed in the proximal tibia under fluoroscopic control to determine the direction and site of osteotomy. Osteotomy was started with an oscillating saw. The saw was maintained distal to guide wires to prevent proximal extension. Osteotomy is completed toward far cortex by osteotome but not through it. Far cortex was left intact and osteotomy site was opened using wedge plate that achieved the planned degree of varus correction; the wedge was placed antero-medially by elevating the proximal fragment by periosteal elevator and inserting the wedge plate. Correction was monitored with the use of a guide wire or the cable of the diathermy to measure the mechanical axis correction with the help of fluoroscopy.

Fixation of the osteotomy was done using a medial wedge plate and screws. In all patients, an effort was made to correct the varus deformity, and increasing the posterior tibial slope was also done by opening the wedge anteriorly and medially besides stabilizing by graft and plate and screws.

Postoperatively, knee immobilizer was used and patients were given instructions on straight leg raising exercise with the knee in full extension with the help of immobilizer. Patients were nonweight bearing for the first 2 months, while active and passive knee exercises were encouraged. Patients were then allowed to walk without crutches when good evidence of healing on follow-up x-rays was seen starting usually at 12 weeks postoperatively. Progressive strengthening program was then started by physiotherapist.

The second operation was done 5–6 months after the initial osteotomy, and PCL was reconstructed after plate removal. Arthroscopic PCL reconstruction was done by using quadruple hamstring tendon autograft. With the patient supine, both the semitendinosus tendon and gracilis tendon were harvested from the same surgical incision of plate removal. Endobutton fixation was used for the femoral side of the graft, while biodegradable interference screw was used for the tibial side. Flipping of the endobutton was confirmed by fluoroscopy and after 20 cycles of knee flexion; the tibial interference screw was inserted in 80° flexion.

Closure of the wound over drain, well-padded dressing was applied. Knee immobilizer and usual protocol of physiotherapy was advised.

Statistical analysis

The collected data were coded and analyzed using Statistical Package for the Social Sciences (SPSS)

(SPSS Inc., Released 2007. SPSS for Windows, Version 16.0. Chicago, SPSS Inc.) version 16 for quantitative data summarization mean, SD, and range; paired *t* test for analyses; number and percentage for qualitative data summarization; and McNemar test.

Results

Ten patients with chronic associated PLC and PCL injury and varus knee deformity were included in this study between October 2011 and October 2014. There were eight men and two women. The patient age at the time of surgery was 29 years [17–40 years]; the mean follow-up period was 3 years [2–4 years] (Table 1).

The Lysholm knee scoring system was used to evaluate subjective symptoms. The Lyshlom score was 53 points preoperatively, while the postoperative score was 91 points. After at a minimum of 2 years follow-up, 6 of the 10 patients [60%] had excellent results, and 2 patients [20%] had good results. In case of the other 2 patients, 1 patient [10%] was of fair and 1 patient was of poor result [10%]. According to the Lyshlom scores, there is a significant improvement by comparing the preoperative and postoperative scores (Tables 2 and 3).

Activity levels preoperatively and at the final follow-up were evaluated using the International Knee Documentation Committee (IKDC) scale. According to the IKDC, the 10 patients included in the study [100%] were graded as grade C (abnormal) or D (sever abnormal) preoperatively, while 8 of the 10 patients [80%] were graded as grade A (normal) or B (nearly normal), and 2 patients [20%] were rated as abnormal grade C at final follow-up scoring. Statistically significant improvement was achieved (Table 2).

Preoperatively, only 1 of the 10 [10%] patients was able to do moderate daily activity, at the same time 4 of the 10 patients [40%] was able to do light activities and 5 of the 10 patients [50%] had no activities. On the final follow-up evaluation, 8 [80%] of the 10 patients had marked-to-moderate activity, and the remaining 2 patients [10%] had light activity. So patients' activity levels showed significant improvement after the operation (Table 2).

By comparison with the preoperative condition, 8 patients [80%] had knee function as normal or near normal. Eight patients [80%] had no pain during moderate or severe physical activities and full range of motion. Less than 15° flexion deficit from the contralateral limb was found in 1 [10%] patient. One patient [10%] lost the last 15° flexion .

All patients had complete range of knee extension postoperatively.

Table 1 Clinical profile of the studied patients

Patients	No. (%)
Age (years)	28.3±8.1 (17–40)
Sex	
Male	8 (80.0)
Female	2 (20.0)
Lesion side	
Left	7 (70.0)
Right	3 (30.0)
+Ve posterior drawer test	10 (100.0)
Varus malalignment+PCL tear	10 (100.0)

Table 2 Knee scoring and deformity correction preoperatively and postoperatively

Scoring	Preoperative	Postoperative	*P*-value
IKDC			
A–B	0	8 (80.0)	0.00* of McNemar test
C–D	10 (100.0)	2 (20.0)	
Physical activity			
No	5 (50.0)	0 (0.0)	0.00*
Light	4 (40.0)	2 (20.0)	0.05 of McNemar test
Moderate	1 (10.0)	8 (80.0	0.00*
Mechanical axis action	12.5±2.1	7.3±2.1	00.00* of paired *t* test
	10–15 varus	5–10 valgus	
Posterior tibial sagittal slope	7.5±1.9	10.5±2.3	0.01* of paired *t* test
Lysholm knee scoring system	53.4±11.8	91.9±18.1	0.00* of paired *t* test
Ant drawer test			
0–5	0	7 (70.0)	Of McNemar test
6–10	0	2 (20.0)	0.00*
>10–<15	10 (100.0)	1 (10.0)	0.05

IKDC, International Knee Documentation Committee.

Posterior drawer test preoperatively was positive in all patients with ligamentous laxity from 10 to 15 mm or more, while postoperative examination showed that 7 [70%] of the patients had 0–5 mm ligament laxity. Two patients [20%] had 6–10 mm ligament laxity and 1 patient [10%] showed a 10–15 mm ligament laxity.

At the last follow-up visit, 8 of the 10 patients [80%] reported satisfaction with their results. They felt that another operation for ligament reconstruction of the PLC was not necessary. None of these patients required a brace for activities. Two patients required a brace during activities.

Radiologically, the mechanical axis point passed within the medial tibial plateau with varus deformity ranging from 10 to 15°in our cases, while the postoperative mechanical axis point passed through the mid of tibial plateau, with full correction of the deformity with valgus angle ranging from 5 to 10°. The preoperative posterior tibial sagittal slope angle was 7.8°, while the postoperative angle was 10.5° (Table 2).

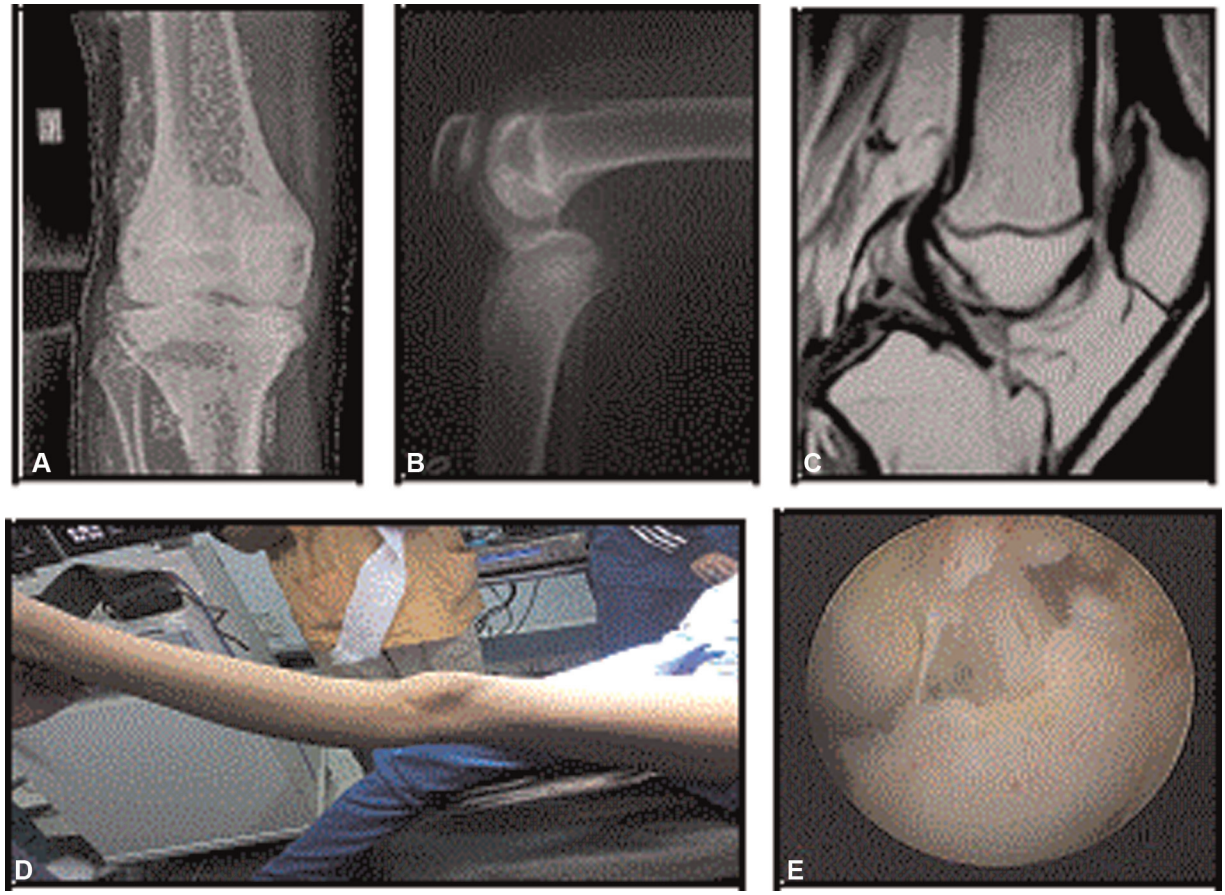
Complications

One patient had infection after the second operation that was treated by arthroscopic debridement and copious irrigation; this patient had more than 15° flexion loss and unsatisfactory result. Two patients had pain and tenderness at the site of the graft that resolved at last follow-up visit. (Table 3 and Figs 1 and 2).

Table 3 Patient satisfaction and final results

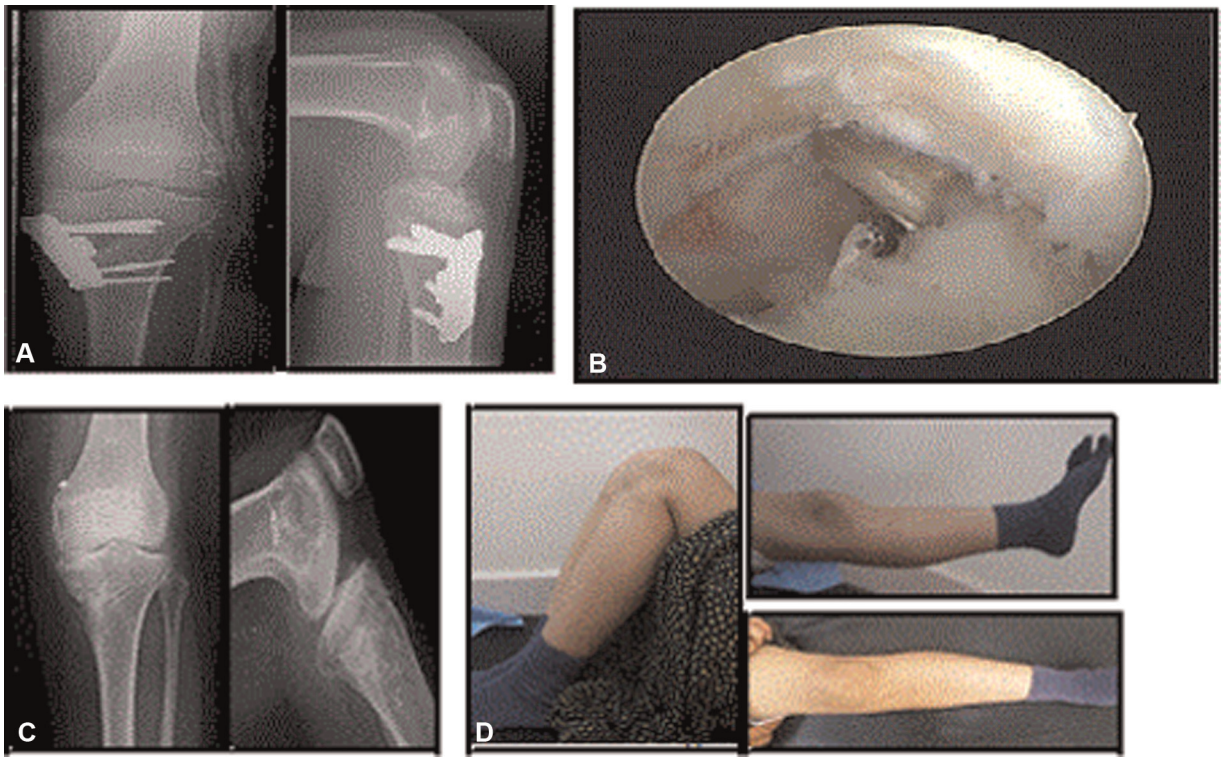
Clinical result	No. (%)
Patient satisfaction	
Satisfied	8 (80)
Not satisfied	2 (20)
Outcome	
Excellent	6 (60)
Good	2 (20)
Fair	1 (10)
Poor	1 (10)
Complications	
Infection	1 (10)
Moderate tenderness	2 (20)

Figure 1



(a) Preoperative plain x-ray AP showed depression of the medial tibial plateau. (b) Stress lateral radiographs showed posterior cruciate ligament insufficiency. (c) MRI showed that the posterior cruciate ligament was completely torn. (d) Clinical photo showed posterior sagging of the tibia. (e) Arthroscopic view shows PCL injury.

Figure 2



(a) Postoperative AP and lateral view x-ray showing open wedge high tibial osteotomy fixed by medial plate. **(b)** Arthroscopic view of reconstructed PCL. (**c)** AP and lateral radiograph after plate removal and PCL reconstruction with endobutton fixation and final flexion. (d) Photo showing knee extension and flexion range and alignment.

Discussion

PLC knee injuries are often followed by bad knee functions if left without operative treatment as it does not heal spontaneously. Patients with chronic PLC injuries associated with varus deformity mostly require correction of varus deformity before ligamentous reconstruction. Some patients have associated varus deformity and chronic PLC injury, correction of the varus knee deformity alone without ligamentous reconstruction had sufficient knee function and stability, and the need for second-stage soft tissue operations for ligament reconstruction is not required [5,6].

Failure to diagnose an associated PLC injury in cases of ACL or PCL injuries is sometimes followed by graft failure or knee instability. Failure to correct varus deformity will often be followed by failure of the repair or reconstruction, so it is essential to assess the mechanical axis of the limb before the operation [7,8].

In patients with varus deformity, the inherent instability of the lateral compartment becomes more worse because the weight-bearing axis that passes within the medial knee compartment adds more stress on soft tissue graft used for PLC and graft stretching leading to varus thrust gait pattern, lastly graft failure and functional instability [9,10].

Badhe and Forster [11] performed their study on 14 patients with PLC injuries and varus knee deformity. There were nine patients who had a PLC injury with or without a PCL injury. Six of them were treated with high tibial osteotomy followed by ligament reconstruction, the other three patients were treated with high tibial osteotomy alone, without ligament reconstruction, and they showed good functional results and improvement and required no second operation. They concluded that, if the ligamentous injury was laxity alone without complete ligamentous disruption, high tibial opening wedge medial osteotomy was sufficient, whereas if there is complete ligament tear ligamentous reconstruction is mandatory.

LaPrade and Wentorf [12] and Baker *et al.* [13] found in their studies that in cases of acute PLC injuries if neglected for more than few weeks the primary repair becomes difficult, is often followed by failure due to tissue necrosis and retraction and development of scar tissue, and these patients should be managed as patients with chronic PLC knee injury. They

concluded that chronic ligamentous injuries more than 3 months before diagnosis should have long leg standing x-ray film to evaluate the mechanical axis before any surgical intervention for ligamentous reconstruction. They had good results in significant number of their patients in their study by correcting the varus deformity and also correcting the axis of the limb from varus alignment to neutral or slight valgus alignment [12,13].

Medial opening wedge proximal tibial osteotomy, in comparison to a lateral closing wedge proximal tibial osteotomy, has the advantage of increasing posterolateral stability by making the posterior capsule and oblique popliteal ligament complex more tight. In a biomechanical cadaveric study, it was found that the varus external rotation and sagittal stability were increased by opening wedge proximal tibial osteotomy, so it can be used to manage instability associated with ACL or PCL injuries [14,15].

Ligamentous reconstruction alone, without correction of the alignment of the lower limbs, is often followed by poor results. Other studies have concluded that reconstruction of the PCL without repair or reconstruction of the PLC is usually followed by poor results [16,17].

Some studies found that closing lateral wedge high tibial osteotomy reduces posterior tibial slope, while opening wedge high tibial osteotomy increases posterior tibial slope with anterior tibial translation. So they advised performing closing lateral wedge high tibial osteotomy in ACL-deficient knee associated with varus deformity [18,19]

In this study, all our patients could not perform mild activities with the injured knee preoperatively, while postoperatively 8 out of 10 patients returned to the preinjury level of activities. One patient only had less than 15° flexion loss and was unable to perform moderate activities and was considered as fair result. The last patient still had knee instability with flexion loss more than 15° that is explained by us as postoperative infection, which may destroyed the graft leading to knee instability and is considered poor result. So our results by this technique were comparable with the results of other authors who performed the same technique.

Conclusion

Two-stage reconstruction of the knee in cases with PLC injuries associated with varus knee, starting by proximal tibial medial opening wedge osteotomy followed by reconstruction of PCL, is a valuable technique that has good results.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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