All-in-one management of chronic traumatic multiligament knee injury: 2–5-year follow-up

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Received 19 February 2012
Accepted 5 March 2012

Egyptian Orthopedic Journal
2013, 48:117–121

Background
Dislocation of the knee is a relatively rare injury; with modern arthroscopic techniques, operative reconstruction has become the standard of care. Simultaneous reconstruction of the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL), and repair or reconstruction of the medial and lateral structures have been recommended.

Objectives
The purpose of this study was to evaluate the clinical results of all-in-one reconstruction of chronic multiligamentous knee injuries using an autogenous graft.

Patients and methods
Fifteen patients (nine men and six women) underwent all-in-one reconstruction. Six patients had all-in-one ACL, PCL, and medial collateral ligament reconstruction. ACL, PCL, and lateral and/or posterolateral structures were reconstructed in five patients. The average duration of the time from injury to surgical intervention was 4.8 months.

Results
Function of the operated knee was evaluated according to the Lysholm knee scale. Thirteen of 15 patients showed good outcome. The average patient age at surgery was 34 years and the average postoperative follow-up period was 53 months, with a median of 60 months. Only two patients had loss of extension up to 10°. One patient had knee stiffness and required arthroscopic adhesolysis at 6 months postoperatively. The average Lysholm score was 81.

Conclusion
The results showed the effectiveness and safety of all-in-one reconstruction of combined chronic multiligamentous knee injuries that can adequately restore satisfactory knee stability and function.

Keywords:
anterior cruciate ligament, knee dislocation, posterior cruciate ligament

Egypt Orthop J 48:117–121

1110-1148

Introduction

Dislocation of the knee is a relatively rare injury; it constitutes 0.02–0.2% of orthopedic injuries [1–4]. However, the actual incidence of this injury is most likely underestimated because a certain number of knee dislocations reduce spontaneously before presentation [5–8]. The definition of knee dislocation has been expanded to include injuries with at least two of the four major ligaments of the knee disrupted from a single traumatic episode [7,9–12].

The first to publish on knee dislocations was Sir Astley Cooper in 1824; he stated 'of this I have only seen one instance, and I conclude it therefore a rare occurrence' [1,13].

Because the incidence of this injury is so low, early literature led to controversy on the optimal treatment. Historically, traumatic dislocation of the knee has been managed with prolonged immobilization, which has been associated with variable outcomes, including loss of motion, residual instability, and poor knee function [3]. Although some authors recommended cast immobilization [13], others advocated operative repair [12]. With modern arthroscopic techniques, operative reconstruction has become the standard of care [12,14–17]. Although some authors still recommend staged reconstruction, beginning with the posterior cruciate ligament (PCL), and later the anterior cruciate ligament (ACL) if necessary [8,18], today, early simultaneous reconstruction of the ACL and PCL, and repair or reconstruction of the medial and lateral structures are recommended [1]. Allogenous tendon grafts have been recommended specifically for combined ligament injuries as a reproducible procedure [5–6,17,19] because of some advantages: the lack of donor site morbidity, reduction of operating time, and the strength of the large grafts. However, allograft materials are not always available in every country, and certain issues should be considered in terms of allograft usage, including possible disease transmission, cost, and delayed graft remodeling. The use of an autogenous tendon graft minimizes these concerns as well as ethical and legal issues [20]. The primary aim of

this study was to prospectively follow a series of patients who presented to us at Ain Shams university hospitals with chronic traumatic knee dislocation (>6 weeks) and to assess the results of all-in-one arthroscopically assisted surgical reconstruction and/or repair of injured knee ligaments using autogenous grafts in these patients.

Patients and methods

From 2005 to 2008, we performed 15 multiligament knee reconstruction surgeries for patients with chronic traumatic multiligament knee injury. The duration from the time of injury to the time of surgery ranged from 3 to 18 months, with a mean of 4.8 months.

The age of the patients ranged from 25 to 55 years, with a mean of 34 years.

There were nine men and six women; the right side was affected in eight patients and the left side was affected in seven patients, six patients had injury to ACL, PCL, and medial collateral ligament (MCL) (one patient had dislocated medial meniscus that was reduced and repaired), three patients had injury to ACL, PCL, and lateral collateral ligament (LCL), two patients had injury to ACL, PCL, and posterolateral corner (PLC), one patient had injury to ACL, PCL, MCL, and patellar tendon, one patient had injury to ACL and PCL, one patient had injury to ACL, PCL, PLC, and MCL, and one patient had injury to ACL, PCL, LCL, and posterior cruciate ligament (PMC) (this patient had injury to the poplitial artery and common peroneal nerve injury). The poplitial artery was repaired by a saphenous vein graft. The common peroneal nerve showed recovery after 12 months.

The preoperative evaluation of the patients included assessment of history and physical examination, assessment using the Lysholm score, standard radiographs (Fig. 1), and MRI.

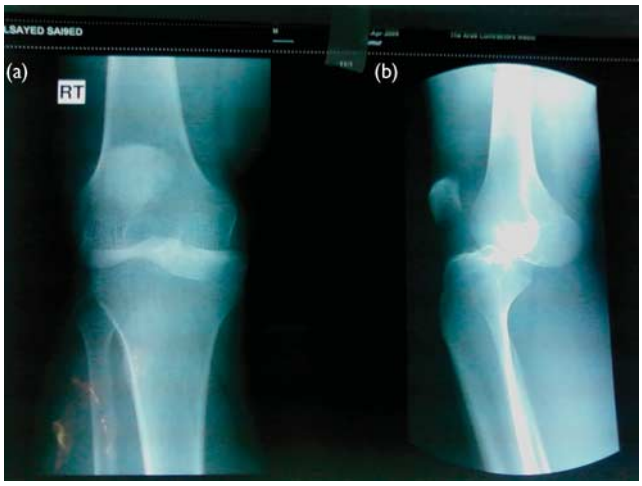
Surgical technique

After induction of anesthesia (eight general anesthesia and seven spinal anesthesia), the patient was positioned supine on the operating room table. An examination under anesthesia was performed. The ligamentus status of the injured knee was compared with the uninjured knee.

The ACL was evaluated using the Lachman test, the anterior drawer test, and the pivot shift test. The PCL was evaluated using the posterior drawer test at 90° and the reverse pivot shift. Varus and valgus laxity was evaluated at 0 and 30°. The PLC structures were evaluated using the dial test.

A tourniquet was placed around the proximal thigh. After sterile preparation and draping, diagnostic arthroscopy was performed, the status of the cartilage in all compartments was evaluated, and the medial and lateral menisci were examined. The ACL and PCL were evaluated to confirm their injured status. Following completion of the diagnostic arthroscopy, the tendon grafts were harvested through a midline skin incision.

Figure 1



Preoperative radiograph of case number 6. (a) Anteroposterior view, (b) lateral view.

For the PCL reconstruction, an ipsilateral bone patellar tendon bone graft was used; for the ACL reconstruction, ipsilateral semitendinosis was used as a triplet graft.

For both ACL and PCL reconstruction, we used the single tunnel technique with fixation of the grafts using interference screws. The graft for the PCL reconstruction was passed first with fixation of the graft at the femoral tunnel, and then the graft for ACL reconstruction was passed and fixed at the femoral tunnel. Then, the PCL graft was secured to the tibial tunnel with the knee at 90° flexion; finally, the ACL was secured to the tibial tunnel with the knee at full extension.

The ipsilateral gracilis tendon (three cases) and contralateral semitendinosis (four cases) were used for reconstruction of the lateral collateral or posterolateral corner through a separate lateral incision; the graft was passed through the fibular head and fixed in the femoral tunnel using interference screws (Fig. 2).

Delayed repair of the MCL was performed through the same midline incision, the femoral attachment was repaired using screw and washer, and the tibial attachment was repaired using staples.

In case number 11 (a 55-year-old diabetic male patient), the tibial tunnel for the ACL and PCL communicated with each other at the middle part of both tunnels; we fixed the grafts for ACL and PCL using biodegradable interference screws. We performed extra fixation for the PCL graft using screw and washer (Fig. 3).

Follow-up evaluation and postoperative rehabilitation

After surgery, all the patients were placed in a hinged knee brace locked in full extension for 3 weeks, and then gradual increase in flexion of 30° weekly was performed to achieve 90°of flexion by 6 weeks.

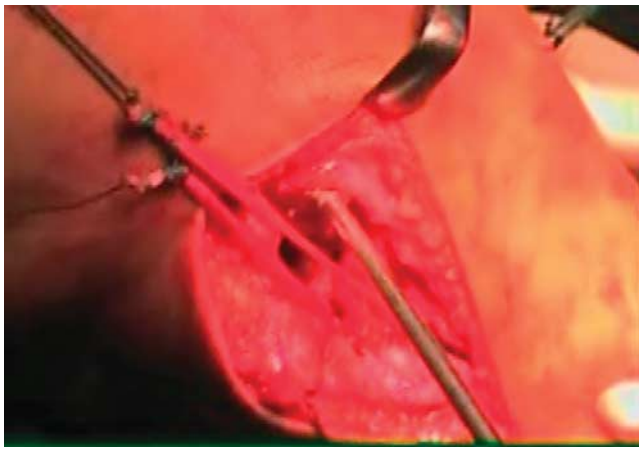
During the first 6 weeks, the patients were partial weight bearing with the assistance of crutches. Patients also

performed isometric quadriceps exercises and straight leg raising exercises with the knee protected in the brace.

After 6 weeks, the brace was discontinued and the knee range of motion exercises in addition to active assisted and full active range of motion were continued. The patients progressed from partial weight bearing to full weight bearing, and strengthening exercises for quadriceps, hamstring, and calf muscles were introduced. Patients were allowed to return to full activity when they achieved a minimum of 80% quadriceps muscle strength compared with the uninjured limb.

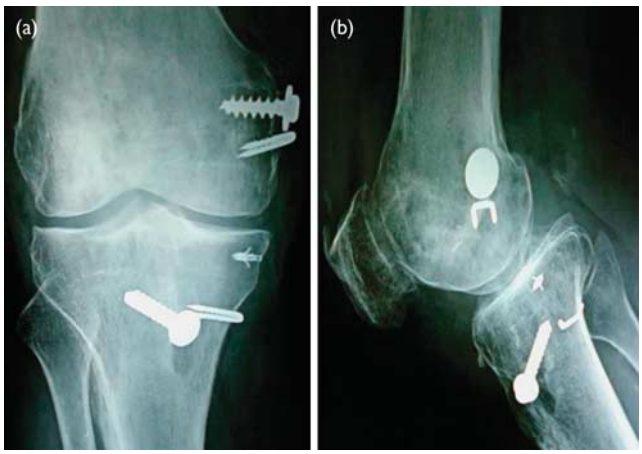
The Lysholm score was used to evaluate the postoperative knee function after 6 months for pain, limp, giving way, use of crutches during walking, squatting, climbing stairs, swelling, as well as locking sensation of the knee.

Figure 2



Intraoperative picture of a patient showing graft passage during PLC reconstruction.

Figure 3



Postoperative radiograph of case number 11. (a) Anteroposterior view, (b) lateral view.

Results

The study included patients with 15 knee dislocations. Their ages ranged from 25 to 55, mean age 34 years and median 31 years.

The left to right ratio was 7 : 8. More men had knee dislocation than women, 9 : 6.

One patient had vascular injury to the poplitial artery and this was repaired by a saphenous vein graft and had common peroneal nerve injury, which showed recovery after 12 months.

Six patients had injury to ACL, PCL, and MCL (one patient had associated medial meniscal dislocation that required reduction and repair), three patients had injury to ACL, PCL, and LCL, two patients had injury to ACL, PCL, and PLC, one patient had injury to ACL, PCL, MCL, and patellar tendon (healed at time of surgery), one patient had injury to ACL and PCL, one patient had injury to ACL, PCL, PLC, and MCL, and one patient had injury to ACL, PCL, LCL, and PMC.

The duration of the time from injury to surgical intervention ranged from 3 to 12 months, with a mean of 4.8 months and a median of 4 months.

The duration of follow-up ranged from 26 to 64 months, with a mean of 53 months and a median of 60 months.

At the 12-month follow-up visit at the outpatient clinic, the median extension was 0°, with a range of 0–10°, and the median flexion was 110°, with a range of 90–120° (Table 1).

One patient had knee stiffness and required arthroscopic adhesolysis at 6 months postoperatively.

The patients were assessed using the Lysholm score; the minimum preoperative operative score was 25 and the maximum was 38, with a mean of 33.3 and a median of 34. The minimum postoperative score was 72; the maximum was 90, with a mean of 81 and a median of 80 (Fig. 4).

Discussion

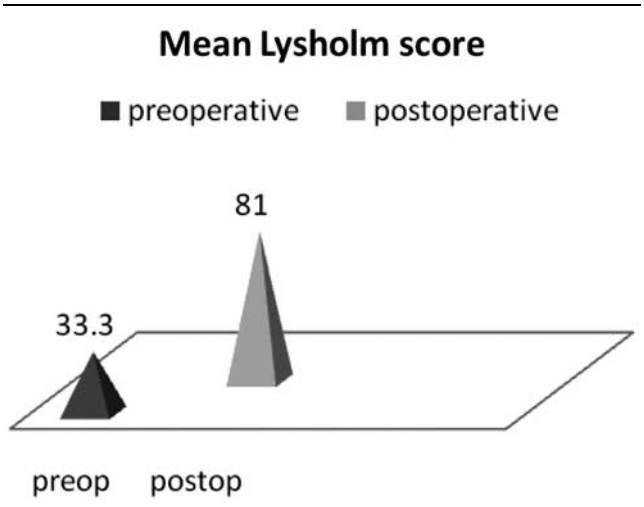
The treatment for combined ligament injuries is controversial especially in terms of the timing of surgery [5,8,17,20,21].

Historically, knee dislocations have been an area of considerable controversy. Early controversy focused on whether to treat these injuries conservatively or surgically. The concern in terms of operative treatment was that of postoperative stiffness.

Table 1 Outcomes on the basis of range of motion

Outcome	Range of motion (°)	Patients (%)
Satisfactory	10–90	13
Good	0–130	87
Normal	>130	0

Figure 4



Preoperative and postoperative mean Lysholm score.

In 1972, Taylor *et al.* [13] studied 43 patients with knee dislocation, with an emphasis on conservative treatment [1].

Wong *et al.* [14] carried out a retrospective study comparing operative treatment versus closed immobilization of knee dislocations. They evaluated 29 consecutive patients, 26 of whom were available for follow-up. Eleven patients were treated with closed immobilization, whereas 15 patients were treated with surgery. They reported better range of motion in the nonoperative group (137 vs. 129°) [1].

Ligaments with acute injuries have good healing potential, but may also cause arthrofibrosis if surgical intervention is performed during this phase. Therefore, most authors recommend a delay of surgery or two-stage reconstruction unless there is an absolute surgical indication [1,18,20,21].

However, knees with chronic multiligamentous injuries have less risk of causing postoperative arthrofibrosis. One-stage reconstruction of combined ligament injuries can restore adequate knee stability; specifically, simultaneous reconstruction of both cruciate ligaments is more advantageous than two-stage reconstruction to regain a stable knee and also achieve a correct rotation axis [20].

Fanelli *et al.* [22] reported their experience with 35 arthroscopically assisted combined ACL/PCL reconstructions with follow-up ranging from 2 to 10 years. The authors concluded that combined arthroscopic ACL/PCL reconstruction is a reliable surgical procedure. They believed that the ACL reconstruction part of the procedure was more reliable than the PCL reconstruction. They did not believe that multiligament reconstruction needed to be staged. Engebretsen *et al.* [1] also examined combined arthroscopically assisted ACL and PCL reconstruction in 15 patients using a bone–patellar–bone autograft for the PCL and double hamstring tendons for the ACL reconstruction. Four patients had acute injuries, whereas 11 patients had chronic injuries. Postoperative evaluation indicated full extension in all patients and an average flexion of 118° (range 105–135°). One patient required arthroscopic lysis of adhesions. They concluded that combined ACL/PCL reconstruction could be performed without significant risk of postoperative stiffness [1].

We had performed one-stage reconstruction in our 15 cases because all of them were chronic cases (>6 weeks).

In 2008, Hayashi *et al.* [20] reported on a follow-up series of 19 patients who sustained chronic multiligamentus knee injuries and underwent combined arthroscopically assisted ACL and PCL reconstruction; they noted undesirable residual laxity after surgery in some patients even though all ligaments were reconstructed simultaneously.

The choice of grafts is one of the most important issues in reconstructing multiple ligaments. Allogenous tissues may be useful for combined ligament reconstruction; however, they are not always available in every country [20].

Therefore, we have used the autograft for ligament reconstructions. For the PCL reconstruction, an ipsilateral bone patellar tendon bone graft was used and for the ACL reconstruction, ipsilateral semitendinosis was used as a triplet graft. The ipsilateral gracilis tendon was used for reconstruction of the lateral collateral or posterolateral corner in three cases and contralateral semitendinosis was used in four cases. Delayed repair of the MCL was performed. One of the critical issues when using the autograft is potential graft site morbidity as more than two graft constructs are needed in combined ligament reconstruction. Although we could use multiple grafts safely, we were very careful not to induce postoperative functional disability of the knee.

There are some other issues with one-stage reconstruction that should be improved. Regaining the appropriate femur–tibia position is the most important aspect, but it is very difficult in combined knee instabilities because the only way to control the femur–tibia position is by tensioning the grafts [23]. The importance of tensioning and fixation of the graft on clinical outcome has been reported in isolated ACL or PCL reconstruction procedures because improper tensioning may cause graft failure or functional loss of the knee joint. As combined ligament injuries are uncommon, there are no controlled or randomized studies to clarify how much tension should be used at the time of the graft fixation [20].

For reconstruction of multiple ligaments, some authors recommend that PCL should be tensioned first at 70–90° of knee flexion because it is the primary stabilizer [2,6,24].

Hayashi *et al.* [20] used a simultaneous tensioning technique of both cruciate ligaments at 90° of knee flexion and made sure of the anatomical position by radiographs during surgery.

We tensioned the PCL graft with the knee at 90° flexion; finally, the ACL was secured to the tibial tunnel with the knee at full extension.

One of the most important issues in combined ligament reconstruction is postoperative rehabilitation.

After simultaneous ACL and PCL reconstruction, many studies reported that a moderate residual posterior laxity was common during follow-up examination. Shapiro and Freedman [5] recommended that a range of knee motion from 0 to 70° be allowed for the first week after surgery, followed by an increase of 10° of flexion every week. Shelbourne *et al.* [21] advocated that full extension of the knee was most important during the early phase after surgery and recommended a protective range of knee motion exercise. Wascher *et al.* [6] proposed a careful postoperative rehabilitation between 20 and 70° of non-weight-bearing knee flexion for 6 weeks in a hinged brace. These previous studies proposed a careful rehabilitation program to minimize PCL graft forces during the early postoperative phase. Hayashi *et al*. placed the knee in almost full extension in a brace for 2 weeks and then started a range of knee motion exercise between 0and 90°of knee flexion for the following 2 weeks. Patients continued to achieve range of motion of between 0and 120° by 8 weeks after surgery [20].

We placed the patients in a hinged knee brace locked in full extension for 1 month; the gradual increase of flexion of 30° weekly was performed to reach 90°of flexion by 7 weeks.

During the first 8 weeks, the patients were partial weight bearing with the assistance of crutches. Patients also performed isometric quadriceps exercises and straight leg raising exercises with the knee protected in the brace.

After 8 weeks, the brace was discontinued and the knee range of motion exercises in addition to active assisted and full active range of motion were continued. The patients progressed from partial weight bearing to full weight bearing, and strengthening exercises for quadriceps, hamstring, and calf muscles were introduced. Patients were allowed to return to full activity when they achieved a minimum of 80% quadriceps muscle strength compared with the uninjured limb.

All our patients were assessed using the Lysholm score preoperative and 6 months postoperatively, the mean preoperative score was 33.3 and the mean postoperative score was 81.

A total of 13% of the patients showed satisfactory outcome, 87% showed good outcome, and no patient had normal range of motion. We attributed this to the long duration between the injury and the time of presentation of the patients to have surgical intervention with a mean duration of 4.8 months.

Conclusion

All-in-one reconstruction of a chronic multiligament injured knee is a safe and effective but technically demanding procedure. Great care should be exercised in planning the site of an autogenous graft harvest to avoid postoperative morbidity.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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