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Evaluation of reconstructive surgery using artificial ligaments in 71 acute knee dislocations

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Abstract This retrospective study assessed the results of 71 patients with knee dislocations who underwent acute combined repair and reconstruction using Ligament Advancement Reinforcement System (LARS) artificial ligaments between June 1996 and May 2008 with a follow-up between two and eight years. The outcome measures used were the Lysholm score, the International Knee Documentation Committee form (IKDC 2000), the Tegner activity level score, the Meyers ratings, Telos stress radiography, range of motion and clinical knee stability testing. When comparing high- versus low-energy dislocations and knee dislocation (KD) II/III versus KD IV injuries, a better Lysholm score for the knee dislocation (KD) II/III group was found compared with the KD IV group. The subjective and objective findings from our study are satisfactory and comparable with the results of other studies of knee dislocations. Our findings suggest that with a mean follow-up of 54 months, acute combined repair and reconstruction with LARS ligaments is a valid alternative for treating knee dislocations.

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Introduction

Knee dislocation, although very rare, remains a devastating injury with many complications because of the complex nature of this trauma. The best treatment for knee dislocation is yet to be determined. Nonoperative treatment, which was once deemed acceptable [1], is now reserved for very-low-demand patients. The introduction of surgical treatment was later shown to be more effective than conservative treatment [2, 3]. It began with the primary repair of the injured ligaments [4–6], then evolved into the era of reconstruction [7–18]. Surgical reconstruction is now the standard of care for most patients, although good results were recently achieved with repair [4]. The optimal surgical treatment remains controversial. The timing of the surgery and the nature of the graft are still a subject of debate. Because of the numerous structures damaged in knee dislocations, surgeons have been successfully using combinations of autografts and allografts for complete knee ligament reconstruction. In the past thirty years, many synthetic prostheses have been used for ligament reconstruction such as the Carbon, the Gore-Tex, the Dacron, the Leeds-Keio artificial ligament and the Kennedy ligament augmentation device. After an initial wave of enthusiasm, disadvantages including poor long-term stability and a propensity to cause synovitis and effusions diminished their popularity and made those implants less suitable for clinical use [19]. Since then, a new generation of artificial ligaments has emerged. The Ligament Advanced Reinforcement System (LARS) (Surgical Implants and Devices, Arc-sur-Tille, France) has shown promising results. It recently has been used in isolated anterior cruciate ligament (ACL) [20, 21] and posterior cruciate ligament (PCL) [22–24] reconstruction and has shown good short- to medium-term results. LARS was also lately used in knee disloca-

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tions for reconstruction of the collateral ligaments [12]. Acute combined repair and reconstruction of both cruciate ligaments, the posterolateral corner (PLC), the lateral collateral ligament (LCL) and the medial collateral ligament (MCL) using LARS ligaments has been the treatment of choice for knee dislocations at our institution. The purposes of the study were to report the results of patients treated with our surgical method and to compare them with those of other surgical reconstruction techniques for knee dislocation.

Patients and methods

From June 1996 to May 2010, 140 patients with acute knee dislocations were admitted to our institution. We reviewed the charts and surgical protocols of all patients treated by the senior author (PR) for knee dislocations. We collected the following data according to a standardised protocol: traumatic events, associated injuries, operative findings, surgical reconstruction and postoperative complications. The follow-ups ranged from two to eight years after the surgical intervention.

We proceeded to the reconstruction of all major structures in the injured knee once the patient was medically stable and when the soft tissues were in sufficiently good condition. A medial parapatellar arthrotomy was done in all cases. After fully assessing the knee joint, meniscal tears that were amenable to repair were repaired first. The ACL and PCL stumps were sutured using a heavy nonabsorbable suture. Once the cruciate ligaments were sutured, the ACL and PCL were reconstructed with LARS ligaments. Patients operated upon prior to June 2001 had only their anterolateral PCL bundle reconstructed. Patients operated upon after June 2001 had both the anterolateral and posteromedial PCL bundles reconstructed using two different artificial ligaments. The collateral ligaments were approached via appropriate medial or lateral incisions. MCL, LCL and PLC avulsions were fixed with intraosseous sutures. Midsubstance tears were sutured and reinforced with LARS ligaments. Depending on the injured structures of the PLC, LARS ligaments were positioned to reconstruct the LCL using bony tunnels in the fibular head and the distal femur and/or the popliteus with bony tunnels in the tibia and the distal femur [25].

Postoperatively, physical therapy was started on the first day and an intensive rehabilitation protocol was followed, as it was shown to be the most important positive prognostic factor following knee dislocation surgery [2]. To prevent heterotopic ossification, indomethacin (25 mg thrice daily for three weeks) was prescribed to patients able to take nonsteroidal anti-inflammatory drugs. The initial phase of rehabilitation was aimed at decreasing swelling and regaining range of motion (ROM) with active and passive exercises. Progressive strengthening and stretching exercises were also introduced. Low-resistance stationary cycling was initiated as soon as ROM permitted it. Daily home exercises were prescribed between physical therapy sessions. An adjustable hinged brace was used for the first 12 weeks to protect collateral ligament reconstructions, and only toe-touch weight bearing was allowed at first. Progressive weight bearing was permitted over this period as muscle strength and dynamic stability were regained. After 12 weeks, full weight bearing was allowed with a functional brace. The next step of the rehabilitation protocol was to progress strengthening to closed-chain exercises and to introduce progressive proprioceptive exercises. Finally, once the swelling had resolved and when adequate ROM, proprioception and strength had been regained, patients started jogging, and plyometric exercises were introduced. They then moved on progressively to sport-specific drills as tolerated. The time of progression through the rehabilitation protocol was highly dependent on the individual patient and associated morbidities. Return to sports was possible with a functional brace at a minimum of six months postoperatively or later upon completion of the protocol.

Functional status was evaluated using the Lysholm score, the International Knee Documentation Committee form (IKDC 2000), the Tegner activity level score and the Meyers ratings. Knees were evaluated for ROM using standardised goniometry techniques. Knee stability was assessed with varus and valgus stress at 0° and 30°, Lachman, pivot shift, anterior drawer, posterior drawer, tibial step-off sign, varus recurvatum and dial test at 30° and 90° of knee flexion. Laxity was compared with the uninjured knee and was classified as normal, grade 1 (difference between 1 and 5 mm), grade 2 (between 5 and 10 mm) and grade 3 (>10 mm). Pivot shift was classified as normal, grade 1 (glide), grade 2 (clunk) and grade 3 (gross). Dial test and varus recurvatum were graded as normal or abnormal. A standardised protocol was used to evaluate knee laxity with Telos stress radiography (Telos, Marburg, Germany). The readings were all done by the same experienced bone radiologist. The ACL was evaluated at 30° of flexion with an anteriorly directed pressure of 15 kPa on the proximal tibia. For the PCL, a posteriorly directed pressure of 15 kPa was used at 30° and 90° of flexion. The same protocol was carried out on the normal side, and results of ligamentous laxity were expressed as side-to-side difference.

Statistical analysis was performed using SPSS version 17.0 (SPSS Inc, Chicago, IL, USA). Descriptive statistics were used to describe the clinical characteristics and functional and radiological outcomes. Bivariate comparisons were made using the chi-square test for dichotomic data. Student's t test was used to compare different groups of patients and to highlight any difference between groups in terms of injury mechanism or ligamentous injury. A p value of <0.05 was considered statistically significant.

Results

One hundred and forty patients with acute knee dislocations were admitted to our institution. Thirty-nine of these patients had not reached the minimal 24 months follow-up at the time of review. Ten patients had to be excluded for the following reasons: five had bilateral injuries, two had chronic lesions over six weeks, two were converted to a total knee arthroplasty (TKA) and one had normal cruciate ligaments upon surgery. Patients with bilateral knee dislocations were excluded, as it was impossible to acquire measurements with the Telos, as a contralateral uninjured knee is necessary to do so. Twenty patients were lost to follow-up. Ten did not come to the evaluation for geographic reasons; these patients lived several hours from our center. Three patients refused to participate, and the rest moved and could not be reached by telephone. Of the 71 patients remaining, including 57 men and 14 women, the mean patient age was 38.5 years [standard deviation (SD) ±13.4]. High-energy trauma was responsible for 48 (67.6%) dislocations and low-energy trauma for the other 23 (32.4%). On average, surgery took place 10.8 days (SD ± 8.0) after injury. Only 12 patients (16.9%) had surgery over 14 days after injury (range 15–49 days). Twenty-four patients (33.8%) had a single-bundle PCL reconstruction, whereas 47 (66.2%) had a double-bundle PCL reconstruction. Average follow-up was 54 months (SD ± 19.9) (range 24–96 months). Injuries were classified according to Schenck classification [26]. All patients had at least a bi-cruciate injury. There were three KD II, 28 KD IIIL, 29 KD IIIM and 11 KD IV.

Mean Lysholm score at follow-up was 78.5 (SD ± 18.5), the IKDC 2000 score obtained for 67 patients was 67.9 (SD ± 19.9) and Tegner activity score for 45 patients was 5.0 (SD ± 1.7). According to the Meyers ratings, of 45 patients, 11 had excellent (score 4), 28 had good (score 3), five had fair (score 2) and one had a poor (score 1) scores, for a mean score of 3.1 (SD ± 0.67). Concerning articular amplitudes, mean flexion was 118.7° (SD ± 10.6°) with an average flexion loss of 14.6° (±11.0°) compared with the uninjured knee. The difference in flexion between the injured and uninjured knees was statistically significant (p= 0.003). Extension was measured as the degrees missing or exceeding 0° of extension, a negative value representing a flexion deformity. Mean extension was 0.6° (SD ± 4.6°), with an average extension loss of 2.6° (SD ± 3.6°) compared with the opposite knee. This difference was also statistically significant (p<0.001). For laxity evaluation, Table 1 shows the results for anterior, posterior, valgus and varus laxity. The dial test was abnormal for five patients at 30° and/or 90°, with three patients having increased knee external rotation at both amplitudes. No patient had varus recurvatum. Mean Telos scores were calculated relative to the contralateral knee. Mean results were 2.4 mm (SD ± 5.8) for the ACL, and 3.8 mm (SD ± 3.6) for the PCL at 30° of flexion and 7.6 mm (SD ± 4.1) at 90° of flexion. Tables 2 and 3 show comparison of results between high- and low-energy trauma and between KD II/III and KD IV injuries. The only result that was statistically significant was a better Lysholm score for the KD II/III group compared with the KD IV group (p=0.023).

There were four open dislocations (5.6%) that were debrided on an urgent basis followed by ligament reconstruction between five and 11 days after the initial surgery.

Table 1 Knee stability

Scores according to Lachman and knee dislocation (KD) evaluations

	Lachman (n=71)	Anterior drawer (n=71)	Pivot shift (n=71)	Posterior drawer (n=71)	Tibial stepoff sign (n=71)
Normal	30 (42.3%)	34 (47.9%)	49 (69.0%)	9 (12.7%)	0 (0%)
Grade 1	35 (49.3%)	30 (42.3%)	17 (23.9%)	39 (54.9%)	36 (50.7%)
Grade 2	4 (5.6%)	5 (7.0%)	3 (4.3%)	22 (31.0%)	27 (38.0%)
Grade 3	2 (2.8%)	2 (2.8%)	2 (2.8%)	1 (1.4%)	8 (11.3%)
	Valgus 0°	Valgus 30°	Varus 0°	Varus 30°	
	KD III-M & KD IV (n=40)	KD IIIM & KD IV (n=40)	KD IIIL & KD IV (n=39)	KD IIIL & KD IV (n=39)	
Normal	27 (67.5%)	16 (40.0%)	26 (66.6%)	14 (35.9%)	
Grade 1	13 (25.0%)	19 (47.5%)	12 (30.8%)	22 (56.4%)	
Grade 2	0 (0%)	5 (12.5%)	1 (2.6%)	3 (7.7%)	
Grade 3	0 (0%)	0 (0%)	0 (0%)	0 (0%)	

Table 2 Knee function for knee dislocations (KD) with all four ligaments ruptured (KD IV) vs two or three ligaments ruptured (KD II and KD III)

Evaluation method (*n*)		KD IV (*n*=11)	KD II and KD III (*n*=60)	*P* value
Lysholm score (71)		66.9	80.6	*0.023
Tegner score (45)		4.4	5.1	0.242
Meyers score (45)		3.0	3.1	0.683
IKDC 2000 score (67)		58.6	69.8	0.089
Telos (71)	ACL:	0.4	2.8	0.208
	PCL 30°	5.1	3.5	0.192
	PCL 90°	9.1	7.4	0.197
ROM (71)	Flexion	116.9	119.1	0.534
	Extension	0.4	0.7	0.835

IKDC 2000 International Knee Documentation Committee, *ROM* range of motion, *ACL* anterior cruciate ligament, *PCL* posterior cruciate ligament

Nine knees (12.7%) had vascular injuries requiring reconstruction by a vascular surgeon, and two patients had a compartment syndrome requiring immediate fasciotomies. Thirteen patients (18.3%) sustained an injury to the peroneal nerve. Associated fractures to ipsilateral lower limbs included fractures to one lateral femoral condyle, four medial femoral condyles, one tibial plateau, five peroneal heads, one tibial pilon, two fractures and dislocations of the hip, one open tibial fracture, one open calcaneum fracture and three patellar tendon avulsions. There were two posterolateral irreducible dislocations and one proximal tibiofibular-joint dislocation. Three patients sustained spinal fractures, and five patients had pelvic fractures (three open). Five others were polytrauma patients. Fourteen patients had fractures to the contralateral lower limb.

Complications

Fourteen patients (19.7%) needed revision for arthrolysis. Fifteen patients (20.8%) developed heterotopic ossification that was visible on the Telos stress radiography. Two patients required ACL revision using the patellar tendon after sustaining a second knee injury. One patient had a screw removal. There was one case of infection among the patients lost to follow-up. This patient was at high risk of infection due to his intravenous drug use.

Discussion

The rarity of high-level evidence studies comparing surgical technique and graft selection in the surgical treatment of knee dislocation results in a lack of evidence-based recommendations. With this study, we evaluated the results of patients who sustained a knee dislocation and were treated with surgical reconstruction using LARS ligaments. The study has some weaknesses. First of all, like almost all studies on knee dislocations, this study was a retrospective case series, which is considered a level IV of evidence. Patient evaluations were not done at the same time; therefore, not all of them completed all subjective questionnaires. However, at least 45 patients completed all subjective evaluations, this number being higher than the majority of the other studies on knee dislocations; it is sufficient to conclude that satisfying and comparable results were obtained with reconstruction using LARS ligaments. Also, 20 patients were lost to follow-up, mainly for geographic reasons. Patients from the entire province, including the northern territories, are referred to our trauma center. It is sometime difficult to reassess those patients several years after their operation. The study of Engebretsen et al [8] was the only one in the literature to have a size similar to ours, with 85 patients, and they reported 36 dropouts out for a total of 121 patients. The major strength of this study is the size of its population, which included the

Table 3 Knee function scores for knee dislocations in high-energy trauma vs low-energy trauma (*n*)

		High-energy (48)	Low-energy (23)	*P* value
Lysholm score (71)		77.5	80.4	0.554
Tegner score (45)		4.9	5.1	0.851
Meyers score (45)		3.0	3.3	0.083
IKDC2000 score (67)		66.2	71.2	0.329
Telos (71)	ACL	1.7	3.8	0.164
	PCL 30°	3.8	3.7	0.959
	PCL 90°	7.6	7.7	0.924
ROM (71)	Flexion	118.0	120.3	0.407
	Extension	0.1	1.7	0.166

largest number of patients with knee dislocations (71) treated acutely (under six weeks) and the second largest after Engebretsen et al [8] (85), which combined acute and chronic patients. As one reviews the literature, the size of the other studies reporting acute reconstruction varies between seven and 50 patients [8, 10–13, 15, 17, 18]. Another strength is that this study presents the longest follow-up for LARS ligament reconstruction, at up to 96 months.

The mean Lysholm score was 78.5. It is within range of those reported in the literature, which varies from 74.7 to 91 for acute reconstruction studies [8, 10–13, 15, 17, 18], from 75 to 87.6 for chronic reconstruction studies [7, 10, 13, 17] and between 83 and 91.2 for a mixed cohort of acute and chronic reconstructions [8, 9]. To our knowledge, the IKDC 2000 score was only used in a single study on knee dislocations by Engebretsen et al [8] and our score of 67.9 (SD ± 19.9) was very similar to theirs of 64 (SD ± 20). Concerning the Tegner activity score, our result of 5.0 (SD ± 1.7) is also comparable with the other scores in the knee dislocation literature, which vary between 3.9 and 5.3 [2, 4, 7–9, 11–13, 15, 17]. Finally, regarding the Meyers rating, 39 of 45 patients (86.7%) had excellent or good scores. This result is also within range of published data for Meyers rating, which range from 74.2% to 87.8% [5, 10–12] for excellent or good scores. When comparing the results of high- vs. low-energy dislocations and KD II/III vs. KD IV injuries, we found a better Lysholm score for the KD II/III group. The difference between the IKDC 2000 score almost reached significance. There was no significant difference between patients who suffered from high- and low-energy dislocations. Engebretsen et al [8] reported significantly worse outcomes for high-energy knee dislocations in terms of Lysholm scores and triple-hop test and for the Knee Outcome Survey Activities of Daily Living Scale (KOS-ADL) and Lysholm score for KD IV injuries.

For assessing stability, clinical examination and Telos stress radiography were used. Most patients had satisfying knee stability on clinical exam ination. Though most studies rely on the KT1000 knee-ligament arthrometer to test knee laxity postreconstruction, Telos measurements were chosen for this study because two comparative studies have shown superior and more precise measurements using the Telos when quantifying PCL stability [27, 28]. A recent review by Pugh et al [29] on the different instrumented knee-laxity-testing devices concluded that the best device to evaluate posterior laxity was the Telos; they suggested using the KT1000 arthrometer or the Rolimeter to assess anterior laxity. The accuracy of the Telos and the KT1000 not being the same, it is difficult to compare the results with the studies that used the KT1000, especially for the PCL. The value of 7.6 mm (SD ± 4.1) for posterior tibial displacement at 90° of flexion seems very high compared with the results obtained in other studies with the KT1000, but it must be considered that Margheritini et al [28] found that the KT2000 (which uses the same components as the KT1000 with the added feature of graphic documentation via an X-Y plotter [29]) underestimated the degree of posterior laxity compared with the Telos and that techniques performed at 90° of knee flexion for assessing posterior knee stability allow for greater posterior tibial displacement and resulted in easier quantification of PCL insufficiency. In terms of complications, 14 of 71 patients (19.7%) in our study needed revision for arthrolysis. This rate is comparable with that acquired in other studies, where it ranged from 4% to 57% [8, 10, 13, 15, 17, 18].

In summary, the subjective and objective results of this study show that acute combined repair and reconstruction with LARS ligaments is a valid alternative for treating knee dislocations. Randomised, prospective trials are now needed to compare graft selection and timing of the surgical reconstruction.

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Conflict of Interest None

Reference

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