Original article

Surgical management of knee dislocations with ligament reconstruction associated with a hinged external fixator


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A R T I C L E   I N F O

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A B S T R A C T

Introduction: Knee dislocations are defined as ligament injuries involving at least two of the four most important knee ligaments. Results from recent studies have shown a tendency towards improvement of the functional outcomes with use of an articulated external fixator during the postoperative period following multiligament reconstruction. Our hypothesis was that good knee stability and early gain of range of motion could be achieved with the use of the external fixator after ligament reconstructions.

Methods: Fourteen patients with knee dislocations were evaluated after multiligament reconstruction in association with use of a lateral monoplanar external fixator for six weeks. Reconstructions were performed using grafts from a tissue bank. Range of motion was measured after one, two, three, six, twelve months and at the final evaluation at a mean time of 49 months. The assessments were made using objective and subjective IKDC, Lysholm and Tegner scales.

Results: The mean scores were 71.7 for the subjective IKDC score, 81.5 for the Lysholm score. No patient was able to return to previous Tegner score. Out of the 45 ligament reconstructions performed, only four failed during the follow-up time. The mean range of motion of the knee presented a progressive increase from the first to the twelfth month, from 67.8° to 115.7°. Two cases of superficial infection on the site of the external fixator pins were observed.

Conclusion: The use of an external fixator enabled early rehabilitation with range of motion gains starting from the first postoperative month, a low rate of reconstruction failure and minimal complications. Nevertheless, none of the patients returned to the level of activity prevailing prior to the injury.

Level of evidence: Level IV, retrospective therapeutic case series.

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1. Introduction

Knee dislocations are defined as ligament injuries involving at least two of the four most important knee ligaments and account for approximately 0.2% of orthopedic injuries [1,2].

Despite their low incidence, these injuries have been widely studied recently because of their high morbidity, the difficulty in returning to the level of activity prior to the injury and the high complication rate [2–4].

For some issues relating to surgical treatment of knee dislocations, there is still no consensus in literature. Among these, are the best time for surgery, the best type of graft and the use of articulated external fixator during the immediate postoperative period [1].

Results from recent studies have shown a tendency towards improvement of the functional outcomes with use of an articulated external fixator during the postoperative period following multiligament reconstruction, although some series also presented good functional results without using these devices [3,5,6].

The type of articulated external fixator has also not been established in the literature. Some studies have used circular or half-ring assemblies that are specific for knee dislocation, while others used monolateral assemblies in the lateral side of the affected limb [7,8].

Monolateral assemblies have shown similar result when compared to bilateral assemblies with regard to tibial translation, in anterior and posterior drawer tests and Lachman tests in Fitzpatrick’s study [9].

The objective of the present study was to present medium-term functional results for patients with knee dislocation treated by means of ligament reconstruction in association with a monolateral articulated external fixator in the immediate postoperative period.
period. Our hypothesis was that good knee stability and early gain of range of motion could be achieved with the use of the external fixator after ligament reconstruction.

2. Methods

A prospective evaluation of a retrospective cohort was conducted on patients with knee dislocation that underwent ligament reconstruction in our department. This study was approved by the research ethics committee of our institution and all patients included gave their informed consent. Inclusion criteria were knee dislocations types III and IV according to Schenck classification with less than three months from the initial trauma [10] and exclusion criteria were vascular repair due to injury of the popliteal artery (1 case), fractures in the knee region in association with ligament lesions (1 case), extension lag and less than 120 degrees of knee flexion. Fourteen patients (mean age 29.3) were included.

Three of the authors in conjunction performed all surgeries. The same surgeons performed postoperative evaluation.

The technique chosen for the reconstructions, and the type of graft used were based on the type of injury presented by each patient. Allografts were used in all cases. The types of lesions are described in Table 1.

To reconstruct the posterior cruciate ligament (PCL), a single band technique with an outside-in tunnel in the femur was used, with inlay fixation in the tibia [11]. If this procedure was associated with medial collateral ligament (MCL) reconstruction, a long Achilles tendon graft with a bone plug was chosen and combined reconstruction with a single femoral tunnel was performed (Fig. 1) [12].

Reconstructions of the anterior cruciate ligament (ACL) were performed with the anatomical outside-in technique and when combined with injuries of the posterolateral corner (PLC), reconstructions were performed with the single femoral tunnel technique for ACL and PLC (Fig. 2) [13–15].

For all the reconstructions, a monoplanar articulated external fixator was used (LRS, Orthofix, Bussolengo, Italy), in the lateral side of the lower limb, with four pins in the tibia and four pins in the femur. Femoral pins were put proximal to femoral tunnels and tibial pins distal to tibial tunnels.

The fixator was assembled using a guidewire at the most isometric femoral point, which referenced placement of femoral and tibial pins. This point for wire insertion was as described by Stannard et al. in their initial series using external fixators for knee dislocations [7]. Immediately proximal to the crossing point of LCL and popliteus tendon, on the lateral condyle; or determined by radioscopy, at a point equidistant from inferior and posterior joint spaces, on the Blumensatt line (Fig. 3) [7].

During the hospital stay, on the first two postoperative days, all patients performed knee range of motion exercises and partial weight-bearing with the aid of crutches was allowed.

After release from hospital, patients continued to receive physiotherapeutic follow-up, with emphasis on gaining range of motion and progression of weight-bearing, according to how well this was tolerated. Normally, full weight-bearing was achieved at eight weeks after surgery.

Strengthening regimen program began with isometric exercises for the first two weeks when limb elevation was started. Open kinetic chains exercises were avoided for four months.

The external fixators were removed at the operation room under sedation after six weeks. No other type of immobilization, like a brace, was used.

Table 1

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (years)</th>
<th>Trauma mechanism</th>
<th>Time between lesion and reconstruction (months)</th>
<th>Follow-up (months)</th>
<th>Lesion type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28</td>
<td>Motorcycle</td>
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<td>58</td>
<td>IIIl</td>
</tr>
<tr>
<td>2</td>
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<td>0.5</td>
<td>58</td>
<td>IIIl</td>
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<tr>
<td>3</td>
<td>38</td>
<td>Run over</td>
<td>3</td>
<td>54</td>
<td>IV</td>
</tr>
<tr>
<td>4</td>
<td>21</td>
<td>Jiu-jitsu</td>
<td>3</td>
<td>54</td>
<td>IIIl</td>
</tr>
<tr>
<td>5</td>
<td>28</td>
<td>Motorcycle</td>
<td>3</td>
<td>52</td>
<td>IIIl</td>
</tr>
<tr>
<td>6</td>
<td>29</td>
<td>Run over</td>
<td>3</td>
<td>52</td>
<td>IIIl</td>
</tr>
<tr>
<td>7</td>
<td>23</td>
<td>Motorcycle</td>
<td>1.5</td>
<td>47</td>
<td>IIIl</td>
</tr>
<tr>
<td>8</td>
<td>27</td>
<td>Motorcycle</td>
<td>3</td>
<td>47</td>
<td>IIIl</td>
</tr>
<tr>
<td>9</td>
<td>29</td>
<td>Soccer</td>
<td>3</td>
<td>47</td>
<td>IIIl</td>
</tr>
<tr>
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<td>31</td>
<td>Motorcycle</td>
<td>3</td>
<td>46</td>
<td>IIIl</td>
</tr>
<tr>
<td>11</td>
<td>36</td>
<td>Run over</td>
<td>3</td>
<td>46</td>
<td>IIIl</td>
</tr>
<tr>
<td>12</td>
<td>43</td>
<td>Motorcycle</td>
<td>3</td>
<td>45</td>
<td>IIIl</td>
</tr>
<tr>
<td>13</td>
<td>22</td>
<td>Motorcycle</td>
<td>3</td>
<td>44</td>
<td>IV</td>
</tr>
<tr>
<td>14</td>
<td>23</td>
<td>Jiu-jitsu</td>
<td>3</td>
<td>41</td>
<td>IV</td>
</tr>
<tr>
<td>Average</td>
<td>29.3</td>
<td></td>
<td>2.53</td>
<td>49.35</td>
<td></td>
</tr>
</tbody>
</table>

IIIl: ACL, PCL and PLC lesion; IIIM: ACL, PCL and MCL; III: ACL, PCL, PLC and LCL lesion; IV: ACL, PCL, PLC and LCL lesion; ACL: anterior cruciate ligament, PCL: posterior cruciate ligament, MCL: medial collateral ligament, LCL: lateral collateral ligament, PLC: posterior lateral corner.
Fig. 2. Schematic drawing showing combined reconstruction of the anterior cruciate ligament (grey ligament) and posterolateral corner with single femoral tunnel. The lateral collateral ligament (red ligament) the popliteus muscle tendon (green ligament) and the popliteofibular ligament (blue ligament) are represented in the figure.

The knees were assessed one, two, three, six, and twelve months after the operation, as well as in the final evaluation. Mean follow-up was 41 months. Evaluation tools were Tegner scale, Lysholm score, objective and subjective IKDC [16,17]. Complications resulting from surgical treatment or any procedures performed during follow-up were documented. Ligament reconstructions with more than 1+ in any laxity test were considered failures.

3. Results

Among the 14 cases, 14 PCLs were reconstructed with two failures (14.2%); 14 ACLs with one failure (7.1%); 12 PLCs with one failure (8.3%); and five MCLs with no failures. Thus, there were 45 reconstructions in total with four failures (8.8%). In relation to patients, only two presented reconstruction failures (14.2%).

Five patients presented some surgical complications. One patient had knee stiffness and required surgical manipulation seven months after the operation. At that time, the patient presented a range of knee motion of 0 to 35 degrees, and reached 100 degrees of flexion after manipulation. Four patients presented superficial skin infection: two at the lateral incision used for reconstruction of the posterolateral structures; and two on the most proximal Schanz pins insertion site on the femur. All of these had full remission with oral antibiotic therapy and local care without need of any surgical procedure as cleaning or debridement.

Postoperative range of motion increased from 67.8 degrees average after the first month to 115.7 average one year after the surgery. In the final evaluation, the range of motion was similar to one-year follow-up, with a mean range of 114.7 degrees (Table 2).

The mean subjective IKDC at the last assessment was 71.7 (ranging from 37.9 to 90.8). According to the objective IKDC score, ten patients were classified as B, three as C and one as D. No patient in this study was classified as having a normal knee (i.e. IKDC A). Lysholm scale mean was 81.5 (ranging from 49 to 95). All patients presented decrease in their activity level according to Tegner scale (Table 2).

4. Discussion

Knee dislocations are pathological conditions for which there is still no consensus in the orthopedic literature. Controversy continues to exist in relation to many situations, and randomized prospective studies from which treatment protocols might be drawn up are difficult to conduct because of the complexity of this injury, the severe associated lesions and their low incidence. In most cases, prognosis is mainly determined by the type of ligament injury rather than the type of surgery [18,19].

One question regarding treatment of knee dislocation relates to whether surgical treatment is needed or conservative management is possible. In a meta-analysis, Deadmond et al. showed that surgical treatment enables a greater range of motion for the knee along with better functional scores. Richter et al., who showed that surgical treatment is necessary for multiligament reconstruction and is important in relation to functional rehabilitation of knee dislocations, shared this conclusion. These authors described this as the most important prognostic factor for these lesions [20,21].

In studies conducted by Stannard et al. and Marconi et al., use of articulated external fixators was recommended in order to enable rehabilitation of greater aggressiveness. Both of the fixators used in those studies are suitable for treating this pathological condition. However, they are not available for routine use in all countries, particularly in third world countries [7,8].

The fixator used in our series is not specific for knee dislocation and was initially designed for limb reconstruction procedures. It can be used for knee dislocations if placed at the knee’s center of rotation. Mooney et al. previously used this system for treating

Table 2

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Average</th>
<th>Standard deviation</th>
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<tbody>
<tr>
<td>Subjective IKDC</td>
<td>71.1</td>
<td>13.3</td>
</tr>
<tr>
<td>LYSHOLM</td>
<td>81.5</td>
<td>12.2</td>
</tr>
<tr>
<td>Range of motion 1 m</td>
<td>67.8</td>
<td>24.2</td>
</tr>
<tr>
<td>Range of motion 2 m</td>
<td>91.4</td>
<td>22.8</td>
</tr>
<tr>
<td>Range of motion 3 m</td>
<td>108.5</td>
<td>25.0</td>
</tr>
<tr>
<td>Range of motion 6 m</td>
<td>110.7</td>
<td>24.4</td>
</tr>
<tr>
<td>Range of motion 12 m</td>
<td>115.7</td>
<td>10.7</td>
</tr>
<tr>
<td>Range of motion final evaluation</td>
<td>114.7</td>
<td>8.4</td>
</tr>
</tbody>
</table>
contractures during knee flexion, in patients with skeletal syndromes with good results [22]. This fixator presents the disadvantage of being larger, thus needing four Schanz pins in the tibia and femur, although this was not considered a problem by our patients while using it. On the other hand, because it is monolateral it does not present the functional disadvantages of a circular fixator in the thigh region, even if small. Fitzpatrick et al. showed that monolateral assemblies are not inferior to bilateral assemblies with regard to joint stability and ligament protection. Despite the known aesthetic and psychological problems that come from using external fixators, none of the patients of our series presented any similar situation [9,23].

The results in our series were slightly more satisfactory than those found by Marcacci et al. from a smaller sample for which external fixators were also used, even though in this series they evaluated complex knee dislocation; and better than those of Ibrahim et al., who recently reported on a series for which external fixators were not used [6,8]. Engebretsen et al., in a series of 85 patients, showed a mean Lysholm of 83, similar to ours 81.5 and a mean IKDC of 64 for all reconstructions, worse than our 71.7, with significantly worse results for KD-IV and high energy injuries [24]. These authors included also KD-II in their series, which certainly improved their results, as we only considered KD-III and KD-IV. Ibrahim et al. performed all surgeries within three weeks from injury and Engebretsen within two weeks [6,24]. Our treatment protocol includes patients with maximum three months after injury, which could also lead to worse results, as stated by Harner et al. and Tzurbakis et al. [25,26]. These authors achieved better results in the group treated within three weeks from trauma. We had three patients treated with less than six weeks after lesion. These patients had no reconstruction failures.

Only one patient (7%) in our series progressed with knee stiffness and required manipulation. According to Robertson et al., stiffness is the most common complication after multiligament reconstructions [2]. Ibrahim et al., without the use of the external fixator, had four cases (20%) of stiffness that required release of adhesions. Engebretsen et al. reported 6% of arthrofibrosis [6,24].

Use of the fixator did not present major complications. Placement of Schanz pins in the lateral region of the femur has not been found to present great morbidity, unlike the tibia, where care in relation to the fibular nerve is required in placing the pins, as shown by Lui et al. [27] and Prakash [28] et al. in anatomical studies on cadavers. Our sample did not present any injury to the fibular nerve through using the fixators.

Complications related to pin insertion site also had few reports. In current literature, this situation is the most frequent complication from use of external fixators. In some recent series, this has affected up to 40% of patients who used external fixators. In our study, only two patients presented superficial infection around pin insertion site and only required local care and oral antibiotic therapy for treatment. Using the fixators for a limited period of six weeks also contributed towards the low level of complications among our patients [29–31].

Although this was only a case series, it was possible to demonstrate that in type III and IV dislocations, the association of a monolateral articulated external fixator with ligament reconstruction presented good functional results and low morbidity as only two patients presented minor complications consequent to the fixator. Although this study was prospective and had a minimum length of follow-up of 41 months, it presented the limitation of not having a control group without a fixator to assess the possible advantages of using this. Other limitations consisted of inclusion of patients up to three months of injury and the small sample size.

**Disclosure of interest**

The authors declare that they have no conflicts of interest concerning this article.

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**References**


