Dislocation and bicruciate lesions of the knee: Epidemiology and acute stage assessment in a prospective series

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KEYWORDS
Knee dislocation; Bicruciate lesions

Summary
Introduction: Knee dislocation and bicruciate lesions are rare. Assessments of results from retrospective series carry an insufficient level of evidence. A prospective multicenter study was therefore set up, under the auspices of the French Society of Orthopedic Surgery.

Material and methods: The inclusion period covered the whole of 2007. Clinical, imaging (dynamic X-ray and MRI) and vascular (angiogram and arteriography) assessment was performed systematically. In patients over the age of 60 years, ligament lesions were always managed non-surgically; in those under the age of 60 years, surgery was considered in the absence of associated vascular lesion or open dislocation and if there was frontal laxity exceeding 15° or a posterior drawer test greater than 10 mm. The posterior cruciate ligament (PCL) and peripheral ligament tears were repaired or reinforced under arthroscopy or by arthrotomy. The anterior cruciate ligament was never operated on. In all other cases, management was conservative.

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Results. — Sixty-seven knees were included (55 male, 11 female; mean age: 37 years). Fifteen patients (25.4%) had bicruciate lesion, and 44 (74.6%) knee dislocation. Mean trauma-to-reduction interval was 3 hrs 50 min. Only one of the nine cases of popliteal artery lesion exhibited discernible distal pulse wave. Only three of these patients underwent vascular surgical repair. Twelve knees (five bicruciate lesions, seven dislocations) had isolated common peroneal nerve damage.

Discussion. — This prospective study detailed the epidemiology and treatment of the lesions encountered, with the option of PCL and peripheral ligament reconstruction. The results, however, still require long-term analysis.

Level of evidence. — Level IV prospective epidemiologic study.

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Introduction

Knee dislocation and bicruciate lesion are a severe traumatic pathology that threatens functional prognosis or even the conservation of the affected limb. It is rare, but commonly underestimated due to spontaneous reduction before initiation of care (in 50% of cases, according to Washer et al. [1]). There have been many publications (more than 100 in the last 15 years), but most have been of retrospective series with a level of proof generally insufficient to define diagnostic and treatment strategy. In 2002, in a retrospective series of 91 dislocations and bicruciate lesions, the Western French Orthopedic Society (Société orthopédique de l’Ouest [SOO]) showed that emergency ligament suture was inefficient, that neurologic lesions had a crucial impact on functional prognosis, and that vascular lesions may be found on angiography, even where peripheral pulse can be detected. In 1998, the European Society of Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA) had also reported a retrospective series of 273 dislocations and bicruciate lesions, highlighting the importance of high-quality X-ray assessment, and presenting a classification and description of mechanisms; posterior cruciate ligament (PCL) reconstruction was shown to be vital for peripheral stability, but the diversity of the techniques covered in this retrospective design posed a serious study limitation.

All reports agreed on the importance of preoperative assessment, but failed to enable good practice to be defined. A prospective study on the assessment and treatment of dislocation and bicruciate lesion of the knee was therefore set up by the French Society of Orthopedic Surgery and Traumatology (SOFCOT), under the direction of P. Neyret and P. Rosset. Treatment options were decided in the light of the hypotheses put forward at the ESSKA and SOO meetings.

Patients and methods

Inclusion criteria

Twelve references centres throughout France participated in the study. All patients admitted for bicruciate lesion and dislocation of the knee between January 1st and December 31st, 2007, were included. Inclusion criteria associated clinically diagnosed dislocation or, for bicruciate lesions, severe frontal laxity of the knee in extension, and a complete imaging protocol. The prospective design, drawn up by all the participants in the SOFCOT symposium (Table 1), was validated by a methodological physician (E. Leray, Rennes Teaching Hospital, France), specifying the criteria of inclusion, treatment and follow-up.

Preoperative assessment

Antero posterior (AP) and lateral X-ray views of the knee were taken as part of the initial check-up, prior to reduction of any dislocation (Fig. 1).

Clinical examination prior to anesthesia explored associated vascular, neurological and cutaneous lesions. AP and lateral X-ray was repeated after reduction, and a second examination under general anesthesia was performed to test sagittal and frontal laxity. Stress X-ray assessed:

- laxity in varus/valgus;
- anterior and posterior translation;
- medial and lateral translation;
- hyperextension (maximal and comparative to the healthy limb).

Vascular status was assessed clinically and explored systematically, preferably by angioscan or else by angio-MRI or angiography.

Figure 1 Dislocated knee before reduction (X-ray).
MRI was prescribed to detail ligament, meniscus and cartilage lesions (Fig. 2).

**Indications**

Three types of situation were distinguished.

**Extreme emergency (< 6 hrs)**

In case of associated vascular lesion or open dislocation, vascular surgery or irrigation/debridement was performed in extreme emergency. The dislocation was reduced and stabilized by cast or external fixator; ligament surgery was not undertaken.

**Emergency (D0—D1)**

Diaphyseal (femur or tibia) fracture or irreducible lesion requiring emergency osteosynthesis and open reduction of dislocation. Associated lesion (visceral or neurological), secondary vascular lesion, extensor apparatus tear or joint fracture were likewise treated by reduction, cast and, if need be, minimal surgery. Later ligament surgery remained an option.

**Late emergency (D5—D21)**

For isolated ligament lesions, indications depended on the degree of laxity and on age. For < 15° frontal laxity and < 10 mm posterior drawer, ligament reconstruction was not performed. In > 15° frontal laxity and > 10 mm posterior drawer, age was factored in, surgery not being considered for patients over the age of 60 years.

**Surgical techniques**

Regarding the central pivot, only the PCL was repaired. The peripheral (medial and lateral) ligament were repaired or reinforced if need be. No anterior cruciate ligament (ACL) reconstruction was considered in first intention.

All procedures could be arthroscopic or open.

**Postoperative course**

After orthopedic treatment (without ligament surgery), immobilization by external fixator or cast was imposed for 6 weeks, without weightbearing in the operated limb for 8 weeks. After surgical treatment, early mobilization was initiated, but with 45 days' non-weightbearing.

**Assessment**

Results were assessed at 6 months postsurgery. Clinical examination explored the same items as preoperatively: knee aspect, work and sports activity, mobility, neurological and vascular status, and laxity.
Associated functional assessment used IKDC functional scores and SF-36. X-ray assessment, identical to that performed preoperatively, explored residual laxity and any degenerative evolution.

Results

Sixty-seven knees were included for epidemiological analysis. For treatment analysis, eight of these files were excluded: two amputations and six patients with isolated ACL plasty. Six of the 59 “analyzable” knees did not conform to the protocol: three patients had been operated on although over 60 years old, two had isolated peripheral ligament reconstruction, and one 35-year-old patient was treated without ligament reconstruction. In all, a homogeneous series of 53 knees fully respecting the treatment protocol could be formed (Fig. 3).

Patient characteristics

There were 55 male and 11 female patients (35 left knees, 30 right knees and one bilateral involvement). Mean age at trauma was 37 years (range, 19–78 yrs). Mean body-mass index (BMI) was 24.1 (range, 17.9—49.4); 29 patients could be considered obese (BMI > 25; see Table 2). On the ASA classification, 54 patients were ASA I, 10 ASA II and one ASA IV.

In terms of occupation at time of trauma (n=64): four patients were retired, 24 had sedentary jobs, 17 had jobs involving considerable walking, and 19 had jobs involving heavy labor.

In terms of sport at time of trauma (n=58): 16 patients were inactive and 15 had mild, 16 moderate and 11 intense sports activity.

Circumstances of accident (n = 59)

There were 24 road accidents (three pedestrians, 19 two-wheel vehicles, two cars), 15 sports accidents, 10 falls, six accidents involving a machine, two home accidents and two non-specified.

Nine cases were work accidents.

68% of traumas were high-energy.

Associated lesions

In 13 cases (19%) the ligament lesion was an element in multiple trauma (one abdominal, five cranial, and seven thoracic traumas). Thirty-four percent of cases had associated fracture (17% involving the same limb). Six patients had open dislocation (always associated with high-energy trauma) (Table 3).

Table 2  Ligament lesions according to body mass index (BMI) (n = 58).

<table>
<thead>
<tr>
<th>Ligament lesions</th>
<th>BMI &lt;25</th>
<th>BMI &gt;25</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated ACL + PCL</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>ACL intact, PCL tear</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>PCL intact, ACL tear</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>ACL + PCL + medial plane</td>
<td>4</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>ACL + PCL + lateral plane</td>
<td>10</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>ACL + PCL + medial + lateral plane</td>
<td>10</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>29</td>
<td>58</td>
</tr>
</tbody>
</table>

ACL: anterior cruciate ligament; PCL: posterior cruciate ligament.

Table 3  Associated lesions (full series, n = 67).

<table>
<thead>
<tr>
<th>Associated lesion</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amputation</td>
<td>2</td>
</tr>
<tr>
<td>Vascular lesion</td>
<td>9</td>
</tr>
<tr>
<td>Neurological lesion</td>
<td>12</td>
</tr>
<tr>
<td>Open dislocation</td>
<td>6</td>
</tr>
<tr>
<td>Extensor system lesion</td>
<td>14</td>
</tr>
<tr>
<td>Osteochondral lesion (MRI)</td>
<td>18</td>
</tr>
<tr>
<td>Multiple trauma</td>
<td>23</td>
</tr>
<tr>
<td>Ipsilateral lower limb fracture</td>
<td>8</td>
</tr>
<tr>
<td>Associated fracture around the knee</td>
<td>16</td>
</tr>
</tbody>
</table>
Immediate care \((n = 59)\)

Fifteen patients (25.4%) had bicruciate lesions, and 44 (74.6%) had knee dislocation. One dislocation proved irreducible, and Table 4 shows the location of reduction for the other 43 cases. 50.8% of patients were transferred to hospital (11.9% not requiring reduction, 25.4% after reduction and 13.6 without reduction).

For the 41 non-spontaneous reductions, the mean trauma-to-reduction interval was 2 hrs 45 min (S.D. 4 hrs; range, 0—21 hrs).

Four ligament lesions were diagnosed late (>24 hrs).

### Ligament lesions \((n = 53)\)

Table 5 presents the ligament lesions diagnosed (on X-ray and clinical examination) and treatment (with or without ligament reconstruction). Table 6 presents the characteristics of the two treatment groups.

**Without ligament reconstruction \((n = 12)\)**

Mean age was 41 years (range, 17—78 yrs); 10 male, two female.

There were four open dislocations, four vascular and three neurological lesions associated.

Lesions fell into four groups: isolated ACL + PCL in two patients (16.7%); ACL + PCL + medial plane in three patients (25%); ACL + PCL + lateral plane in two patients (16.7%); ACL + PCL + medial and lateral planes in five patients (41.7%).

**With ligament reconstruction \((n = 41)\)**

Mean age was 34 years (range, 18—56 yrs); 36 male, five female.

There was one open dislocation, and four vascular and seven neurological lesions associated.

Lesions fell into six groups: ACL intact, PCL tear in four patients (9.8%); PCL intact, ACL + medial plane tear in one patient (2.4%); isolated ACL + PCL in one patient (2.4%); ACL + PCL + medial plane in 14 patients (34.1%); ACL + PCL + lateral plane in 13 patients (31.7%); ACL + PCL + medial and lateral planes in eight patients (19.5%).

### Vascular lesions

At admission, pulse was abnormal in eight of the 67 cases. Vascular exploration found nine cases of vascular lesion (12%): one complete tear, one intimal tear, three spasms and four thromboses. In one case, the lesion was in the distal popliteal artery and in eight in the mid popliteal artery. There was one case with associated venous thrombosis.

Only one lesion (mid popliteal artery thrombosis) was found in association with normal pulse.

One of the nine patients had not had a neurological examination; in four of the other eight, findings were normal and four had isolated common peroneal nerve damage.

Repair in four cases was surgical (one amputation for critical ischemia, one endovascular intervention for spasm, one graft for thrombosis, and one graft for complete rupture). The other five cases were managed by simple surveillance (three thromboses, one spasm, one intimal tear).

Ligament lesion assessment found: isolated ACL + PCL in one patient (11.1%); ACL + PCL + medial plane in two patients (22.2%); ACL + PCL + lateral plane in four patients (44.4%);
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ACL + PCL + medial and lateral planes in two patients (22.2%).

Ligament treatment was surgical for four patients (ligament surgery at four days in three patients, and vascular plus ligament surgery at a few days in one patient) and orthopedic for five (vascular surgery plus immobilization in two patients, and simple immobilization for three patients).

Neurologic lesions

Twelve of the 67 knees (17%) presented neurological lesion, all isolated lesions of the common peroneal nerve (five incomplete and seven complete).

These 12 lesions were associated in five cases with bicruciate lesion and in seven cases with dislocation. In four cases (33.3%), there was an associated vascular lesion: one complete popliteal artery rupture, and three thromboses.

Peroperative data were available for 10 patients. All involved bicruciate lesion, except for one case of PCL lesion and one in which the ACL was non-interpretable. There was lateral plane involvement in 80% of cases (one case having no record and one being non-interpretable). Emergency repair was performed in four cases; and late surgery in three cases (two neurolyses and one graft with associated suture).

Other associated lesions

The two cases of amputation

One patient had associated complex fracture around the ipsilateral knee.

The second patient had multiple trauma with extensor apparatus lesion associated with vascular lesion (thrombosis, non-amenable to surgery due to an associated central neurological problem).

Table 7 Treatment of ligament and associated lesion.

<table>
<thead>
<tr>
<th>Associated lesion</th>
<th>With ligament surgery</th>
<th>Without ligament surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated fracture</td>
<td>12 (36.4%)</td>
<td>1 (9.1%)</td>
</tr>
<tr>
<td>Ipsilateral lower limb fracture</td>
<td>4 (12.1%)</td>
<td>3 (27.3%)</td>
</tr>
<tr>
<td>Osteochondral lesion</td>
<td>14 (42.4%)</td>
<td>2 (18.2%)</td>
</tr>
<tr>
<td>Open dislocation</td>
<td>2 (6.1%)</td>
<td>4 (36.4%)</td>
</tr>
<tr>
<td>Extensor system lesion</td>
<td>9 (27.3%)</td>
<td>3 (27.3%)</td>
</tr>
<tr>
<td>Multiple trauma</td>
<td>14 (42.4%)</td>
<td>4 (36.4%)</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>11</td>
</tr>
</tbody>
</table>

Discussion

Difficulty of implementing a prospective multicenter design

The number of exclusions meant that not all the data recorded for the study period were analyzed, and this may appear important: 12 of the 67 knees failed to meet the full set of predefined treatment criteria (17.9% "non-protocol"), despite agreement on protocol design and prior information.

Epidemiology

The mechanisms implicated in this series were all traumatic, at high or low energy. There were no cases of spontaneous dislocation associated with morbid obesity, as reported by Sharma, Shetty and Pace [2—4].

There were three dislocations in which one of the two cruciate ligaments was intact, as in the papers by Cooper, Shelbourne and Tzubarksis [5—7].

Of the peripheral lesions associated with bicruciate lesion, 17 were medial, 15 lateral and 13 both. Liow et al. [8], in a series of 22 dislocations, found seven lateral collateral ligament (LCL) and five medial collateral ligament (MCL) lesions. Harner et al. [9], in a series of 33 dislocations, found nine LCL and 15 MCL lesions. Both reports contained no associated lesions of both peripheral planes.

Twaddle et al. [10], in a prospective series of 63 dislocations, found 29% isolated lesions of a single cruciate ligament; there were 28 MCL and 39 LCL lesions and in four cases both cruciate ligaments and both peripheral planes were involved.

Associated lesions

Nineteen percent of dislocations in the present series were associated with multiple trauma, which is consistent with the 11 to 26% range found in the literature [11—13].

Thirty-four percent of knees had multiple fracture, and 17% of dislocations were associated with ipsilateral limb fracture or other trauma, which is again consistent with the data from retrospective series: 3–53% associated multiple fracture, and 14–25% associated ipsilateral limb fracture [11—13]. The most frequent associated fractures were of the femoral condyle [14], femoral shaft [15] or femoral and tibial shaft ("floating knee") [16].

The present series contained 9% open dislocation, consistent with the 5.5–17% range in recent retrospective series [11—13]. In a series of 19 open dislocations, Wright et al. [17] found 50% vascular tears, 50% common peroneal nerve palsies and three amputations, whereas in the present series no open dislocations were associated with vascular lesion and only one case showed neurological involvement.

There was one case of irreducible dislocation with MCL incarceration. Chirpaz-Cerbat et al. and [18] Kontakis et al.
Vascular lesions

The rate of vascular lesion in the present series was 12%, close to that found in the literature: 7.5% for Rios et al. [13] and 14% for Twaddle et al. [9]. Our findings confirmed the importance of systematic vascular exploration, even in case of conserved pulse, as one associated vascular lesion was discovered without suggestive clinical symptoms. This attitude was equally advocated by Witz et al. [20] and Barnes et al. [21]. The present series contained only one amputation in nine cases of closed popliteal artery lesion, which was less than in the series reported by Yahya et al. [22], with a 23% amputation rate in case of closed popliteal artery lesion.

Neurological lesions

In the present series, neurological lesions were diagnosed clinically or during exploration for lateral plane ligament repair. We did not use ultrasonography as a diagnostic tool, as advocated by Gruber et al. [23] especially to specify the type of anatomic neurological lesion. The present series contained 17% common peroneal nerve lesions: five incomplete and seven complete. This is consistent with the 14—25% range found in the literature [9, 13, 24]. The recovery rate was 50% in incomplete lesions, with only one total recovery among the seven complete lesions. These findings confirm the poor prognosis associated with complete neurological lesions [24, 25].

Conclusion

The present prospective multicentre study, despite the small size of the final series, has the advantage of homogeneity guaranteed by a precise treatment protocol for these complex and rare ligament lesions. It provides precious information on epidemiology, associated lesions and type of ligament lesion encountered. Subsequent medium-term assessment of the orthopedic and surgical treatments in the series will in the near future provide supplementary data on treatment for these patients.

Conflicts of interest

None.

References