Original article

Congenital dislocation of the knee at birth – Part 2: Impact of a new classification on treatment strategies, results and prognostic factors

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\textbf{ABSTRACT}

\textit{Introduction:} An original classification of congenital dislocation of the knee (CDK) was drawn up, based on neonatal hematology. The objective of the present study was to assess impact on treatment decision-making and prognosis.

\textit{Material and methods:} Fifty-one CDKs in 40 patients were classified neonatally into 3 types: I, reducible (n = 28); II, recalcitrant (n = 16); and III, irreducible (n = 7). Number of anterior skin grooves, range of motion (RoM), flexion deficit and reduction stability were recorded. Depending on reducibility, treatment comprised: physiotherapy with splints, traction with cast immobilization, or surgery. At follow-up, knees were assessed in terms of RoM and stability.

\textit{Results:} Mean age at first consultation was 5.6 days (range: 0–30). Mean age at follow-up was 9 years (range: 1–26). Physiotherapy with splinting achieved stable reduction in all type-I knees. Five type-II knees (31%) required traction, none of which needed surgery. Four type-III knees (57%) required surgery. Outcome was good or excellent in 82% of type-I knees, good in 68% of type II and poor in all type-III knees.

\textit{Conclusion:} The study confirmed the relevance of the present neonatal classification to treatment, with increasing rates of surgical indication and decreasing rates of satisfactory outcome from types I to III. Therapeutic attitude can be graded according to severity of CDK.

\textit{Level of evidence:} IV, single-center retrospective series.

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1. Introduction

A original classification of congenital dislocation of the knee (CDK) was drawn up, based on neonatal hematology [1]. It distinguishes 3 types: I, reducible; II, recalcitrant; and III, irreducible. As well as being of prognostic value, it can serve to guide treatment.

Several treatment options have been described in the literature, from physiotherapy alone to open reduction, depending on the etiology and severity of CDK [2–10]. Indications, however, are not precise.

The objective of the present article was to assess the application of this classification in the treatment and prognosis of the

3 types of CDK. The study hypothesis was that the classification allows neonatal choice of adapted treatment.

2. Material and methods

2.1. Patients

Forty patients (51 dislocated knees) were examined by a single surgeon (RS) during the first month of life, before any treatment. Follow-up was a minimum 1 year after start of treatment.

CDK was type I, II and III in 28, 16 and 7 cases respectively.

2.2. Treatment

In types I and II, primary treatment systematically involved physiotherapy (anterior stretching) and an anterior full-leg splint,
which was regularly readapted (Fig. 1), to progressively increase knee flexion and maintain reduction. Treatment duration was 4 weeks in type I and 6–8 weeks in type II.

In type III and in case of treatment failure in type II, 1 week’s progressive reduction with cutaneous limb traction was applied (Fig. 2). Initially, axial traction distracted the tibiofemoral space; a postero-anterior traction band was then positioned behind the distal femur: anterior translation of the femur combined with progressive knee flexion thus reduced the tibiofemoral dislocation. In unilateral CDK, the child was positioned in lateral decubitus (Fig. 2b); in bilateral CDK, positioning was in dorsal decubitus, either in maximum external rotation of the hip if possible (crossed traction) (Fig. 2a) or else, if external rotation was insufficient, in neutral rotation on the edge of the bed to obtain knee flexion. Daily clinical examination assessed and adapted traction. Once reduction was achieved and the knee was in 90° flexion (as checked on lateral X-ray), cast immobilization in the reduction position was performed under general anesthesia and maintained for 3 weeks.

The cast was then replaced by an anterior splint (or Pavlik harness in case of associated hip dislocation), for 4–6 weeks.

If traction failed, surgery was proposed. Using a lateral approach, VY quadriceps lengthening VY [10] or quadriceps release [11,12] was performed, associated as necessary to anterior tibiofemoral arthrolysis. Reduction was stabilized with a tibiofemoral crossed K-wire and 3 weeks’ cast immobilization. After K-wire ablation, a full-leg splint was fitted for 2 months, alternating complete extension and 90° flexion.

2.3. Assessment of results

At the last consultation, joint stability and range of motion (RoM) were recorded. Uni- and multi-directional instability were distinguished. Results were assessed as excellent, good, moderate or poor according to the criteria shown in Table 1.

Statistical analysis used Chi² and Kruskal-Wallis tests on StatView software (SAS, Cary, NC, USA). The significance threshold was set at 0.05.

3. Results

Table 2 presents the treatment options enabling reduction. Non-operative treatment by manipulation and splinting achieved reduction in all type-I cases and in 11 out of 16 type-II knees: i.e., 76.4% of the series as a whole.

<table>
<thead>
<tr>
<th>Result</th>
<th>Range of motion</th>
<th>Instability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>Normal</td>
<td>None</td>
</tr>
<tr>
<td>Good</td>
<td>Normal</td>
<td>Sagittal</td>
</tr>
<tr>
<td>Moderate</td>
<td>Limited flexion (90–140°)</td>
<td>None</td>
</tr>
<tr>
<td>Poor</td>
<td>Limited flexion (50–90°)</td>
<td>Multidirectional</td>
</tr>
</tbody>
</table>

Table 1

Outcome assessment criteria.

Fig. 1. Anterior splint.

Fig. 2. Traction. A. Bilateral CDK with good external rotation of the hip, allowing supine positioning on the bed for crossed traction. B. Unilateral CDK with limited external rotation of the hip, requiring positioning in lateral decubitus.
Mean traction duration was 7 days (range: 5–9). It achieved reduction in the 5 type-II cases in which manipulation failed and in 3 type-III cases; i.e., 15.6% of the series as a whole.

Surgery was performed in 4 type-III knees, consisting in anterior capsulotomy with VY quadriceps lengthening in 2 cases and quadriceps release in the other 2 [11,12].

Mean age at last consultation was 9 years (range: 1–26). Mean follow-up was 9.3 years (range: 1–26), independently of CDK type.

On last examination, there were significant differences in results according to type (P<0.001). Outcome (Table 3) was excellent or good in 23/28 (82%) type-I knees; the 5 moderate results were due to multidirectional instability. Outcome was good in 11/16 (68%) type-II knees. All type-III knees, whether operated on or not, had poor outcome due both to limited RoM and to multidirectional instability.

Table 4 shows ranges of motion at last follow-up. There were significant differences according to type in flexion (P<0.0001) and global RoM (P<0.0006), whereas residual hyperextension was comparable between types. Table 5 presents residual instability, which was comparable between types I and II but significantly greater in type III.

Finally, the rate of moderate or poor results in types II and III was significantly greater in case of associated syndrome (P<0.001). Only 1 type-III patient (with Larsen syndrome) required orthoses for walking, due to severe bilateral multidirectional instability.

### 4. Complications

Three tibial plastic deformations in flexion following rehabilitation or splitting [3] resolved completely. One type-III patient showed transient common peroneal nerve palsy after maladapted traction, with complete spontaneous recovery. There were no traction-related skin problems. No patients required revision surgery.

### 5. Discussion

The study hypothesis was confirmed: the classification was relevant to the type of management implemented and to the result, with heavier treatment and poorer outcome according to CDK type.

In the last 6 years, only 5 articles on CDK, all concerning surgical results, have been published in reference journals [2–4,13,14]. This may be a reflection of the rarity of the pathology [4], and heterogeneity of associated syndromes, but also of the relatively unsatisfactory results of the surgical treatments usually employed. To our knowledge, the present series is the largest for a single-center study. In 1987, Bensahel et al. [15] reported a larger series, of 46 children; but theirs was a multicenter study, with wide heterogeneity, not specifying age at inclusion.

#### 5.1. Treatment options

Closed reduction by physiotherapy and splint or cast immobilization is the first and principal option in the literature [3,5,8,15]. The success rate of manipulation is 18–85%, depending on the report [3,8], in line with the present rate of 77%. With this high initial success rate, there is no consensus as to how to proceed in case of failure. Traction and cast immobilization was suggested as an alternative by Laurence in 1967 [5], but there have been no subsequent reports of results. In the present series, progressive reduction by traction followed by cast immobilization (implemented for failure of manipulation in type II and as primary attitude in type III) gave satisfactory results in case of failure of outpatient management by physiotherapy and splint or cast immobilization, and thus appears as an effective option in calcific type-II knees, reducing indications for surgery. In case of surgery, numerous options have been described [2–4,6,9,12–16], generally inspired by extensive quadriceps mobilization, following Fisher and Curtis [6], with occasional simplifications to avoid skin closure problems [3,9,13,14]. In these reports, surgery was always the first-line treatment, without prior attempts at closed reduction. An interesting intermediate solution is to associate successive casts followed by percutaneous quadriceps tenotomy at the age of 2 months [2,3,9,17]; Shah et al. [3] reported 69% excellent results, but at very short follow-up (33 months); moreover, the technique was implemented regardless of severity, as can be seen in the photographs, where 2 cases of deep skin groove suggest that non-operative treatment would have met with success. The mediocre results of surgery in the present series reflect the fact that surgery was reserved to the initially severest cases (irreducible type III).

### Table 2

<table>
<thead>
<tr>
<th>Treatment option achieving reduction and stability according to type (number of knees and percentage).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1 (n = 28)</td>
</tr>
<tr>
<td>Manipulation + splints</td>
</tr>
<tr>
<td>Traction + casts</td>
</tr>
<tr>
<td>Surgery</td>
</tr>
</tbody>
</table>

### Table 3

<table>
<thead>
<tr>
<th>Type</th>
<th>Associated pathology</th>
<th>Result (last follow-up)</th>
<th>Excellent</th>
<th>Good</th>
<th>Moderate</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I n = 28</td>
<td>Isolated (85%)</td>
<td>19 (68%)</td>
<td>4 (14%)</td>
<td>1 (4%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Reducible</td>
<td>Non-isolated (15%)</td>
<td>0</td>
<td>0</td>
<td>4 (14%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Type II n = 16</td>
<td>Isolated (62.5%)</td>
<td>0</td>
<td>10 (62.5%)</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Recalcitrant</td>
<td>Non-isolated (37.5%)</td>
<td>0</td>
<td>1 (6.25%)</td>
<td>5 (31.25%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Type III</td>
<td>Isolated (14.3%)</td>
<td>0</td>
<td>0</td>
<td>1 (14.3%)</td>
<td>6 (85.7%)</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4

<table>
<thead>
<tr>
<th>Initial and final ranges of motion according to CDK type.</th>
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</thead>
<tbody>
<tr>
<td>Range of motion</td>
</tr>
<tr>
<td>Initial</td>
</tr>
<tr>
<td>Hyperextension</td>
</tr>
<tr>
<td>Global</td>
</tr>
<tr>
<td>Final</td>
</tr>
<tr>
<td>Hyperextension</td>
</tr>
<tr>
<td>Global</td>
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</tbody>
</table>

### Table 5

<table>
<thead>
<tr>
<th>Residual instability according to CDK type (number of knees and percentage).</th>
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</thead>
<tbody>
<tr>
<td>Stable, n (%)</td>
</tr>
<tr>
<td>Sagittal instability, n (%)</td>
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<tr>
<td>Multidirectional instability, n (%)</td>
</tr>
</tbody>
</table>
One interest of this classification is to guide treatment as of birth. In the light of the present findings, we recommend initiating management non-operatively (but not forgetting traction) in type-I and -II knees, reserving surgery for traction failure. In type III, on the other hand, surgery should be the first-line attitude.

5.2. Relevance of the classification and prognostic factors

This is the first study to correlate a neonatal classification with prognostic factors, which, moreover, have been little analyzed in the literature [3,15].

CDK reducibility and stability on primary neonatal examination are major prognostic factors, and form the basis of the present classification. The prognostic value is clear: poorer results occurred in forms (type III) that were irreducible at birth, which alone required surgery.

Other factors of poor prognosis emerged:

- associated general syndrome;
- knee flexion <50° (related to severe quadriceps retraction);
- and absence of anterior skin groove.

In our experience, skin grooves (not mentioned in the literature) are a factor of good prognosis, in contrast to certain reports in which cases judged severe showed several anterior grooves in the accompanying illustrations [3,15].

In conclusion, the present neonatal classification displayed 2 advantages. Therapeutically, it was predictive of outcome, and guided treatment decision-making, with progressive intensification before resorting to surgery. Prognostically, it revealed difficulty or impossibility of reduction, knee flexion < 50°, absence of anterior skin grooves and associated general syndrome as factors of poor prognosis.

Disclosure of interest

The authors declare that they have no competing interest.

References