TREATMENT OF SEVERE FLEXION DEFORMITY OF THE KNEE IN CHILDREN AND ADOLESCENTS USING THE ILIZAROV TECHNIQUE

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We have used the Ilizarov technique for severe flexion deformity of the knee in 11 patients (13 knees) between 1986 and 1994 and have followed them up for an average of 4.1 years. The age of the patients at operation ranged from 1.7 to 18.8 years.

The femoral and tibial components were connected by two anterior hinges, medial and lateral, and two posterior distraction rods. The deformity was corrected to a femorotibial lateral shaft angle of less than 20°. A permanent orthosis was applied after removal of the fixator. Fractures occurred in four patients and paralysis of the common peroneal nerve in another. There was a recurrence of the deformity in four patients.

At the last review all patients were able to walk on their operated leg with or without an orthosis.

We have found the Ilizarov method to be helpful in correcting severe fixed flexion deformity of the knee, with relatively few complications, but the basic principles of the method must be carefully followed.

Received 26 April 1995; Accepted 8 June 1995

Two types of flexion contracture of the knee can be distinguished: that associated with joint destruction and ankylosis and that in which joint anatomy and mobility are preserved. In the first type the aim of treatment is to obtain an ankylosed knee in a functional position, and in the second correction of the deformity and preservation of movement. Many types of treatment are available including exercise, an orthosis, casting, soft-tissue release, and osteotomies, alone or in combination. Treatment of the more severe deformities is associated with serious complications such as insufficient correction, skin necrosis, neurovascular problems, leg-length discrepancy, posterior subluxation of the tibia, fractures of the femur or tibia and recurrence of deformity (Heydarian et al 1984).

We made a retrospective study of the uses and benefits of progressive correction of flexion contracture using the Ilizarov apparatus.

PATIENTS AND METHODS

Between 1986 and 1994, we treated 11 patients (13 knees) with severe fixed flexion contracture, using the Ilizarov external fixator (Table I). There were six boys and five girls with a mean age at operation of 12 years (1.7 to 18.8). All were able to walk or had the potential to do so. Posterior subluxation of the tibia was present in six knees. Four patients had undergone previous posterior soft-tissue release operations, one had congenital absence of the fibula and one had had poliomyelitis. The flexion contracture exceeded 90° (90 to 150) in all.

Operative technique. The average duration of the operation was 140 minutes (70 to 240). The type of frame commonly used for the femur included three proximal Hoffman or Schanz screws, two pins on a metaphyseal half ring and one distal epiphyseal pin connected to it. The tibial fixation had a distal ring with two to three Kirschner wires and similar epiphyseal and metaphyseal fixation as the femur. The femoral and tibial components were connected

Table I. The aetiology of the flexion contracture in 11 patients (13 knees)

<table>
<thead>
<tr>
<th>Aetiology</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital absence of the fibula</td>
<td>1</td>
</tr>
<tr>
<td>Popliteal angioma</td>
<td>2</td>
</tr>
<tr>
<td>Myelomeningoecele</td>
<td>2</td>
</tr>
<tr>
<td>Myelomeningoecele + quadriceps aplasia</td>
<td>1</td>
</tr>
<tr>
<td>Multiple pterygium syndrome</td>
<td>1 (bil)</td>
</tr>
<tr>
<td>Complex knee malformation</td>
<td>1 (bil)</td>
</tr>
<tr>
<td>Juvenile rheumatoid arthritis</td>
<td>1</td>
</tr>
<tr>
<td>Poliomyelitis</td>
<td>1</td>
</tr>
<tr>
<td>Electrical amputation of the leg</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
</tr>
</tbody>
</table>
by two anterior hinges, one medial and one lateral, which determined the axis of correction, and two posterior distraction rods, one medial and one lateral.

Correction was obtained at the knee in 12 patients and at the level of a femoral supracondylar osteotomy in one. Tenotomy of the medial and lateral hamstrings was required in three patients with popliteal webbing. Distraction was started as soon as the postoperative pain subsided at an average of 3 to 4 mm per day, with the rate modified according to the patient’s discomfort.

During correction modifications were made to the apparatus, the position of the hinges and the distraction rods being adapted to each case individually. Deformity of the foot was present in three patients and was corrected simultaneously using the Ilizarov apparatus. Diaphyseal lengthening was undertaken after the knee correction in three patients with leg-length inequality. The average duration of the correction was 54 days (5 to 10 weeks), and the average fixation time 105 days (8 weeks to 1 year). After removal of the fixator a long plaster case was applied in maximum extension, followed later by the use of a long-leg brace.

**Other procedures.** At the end of correction of the flexion deformity, five knees were arthrodesed, using femorotibial compression. Three arthrodeses were for popliteal webbing, and two were in one patient with bilateral severe malformation. Total replacement of the knee is planned in one patient with juvenile rheumatoid arthritis after correction of a flexion deformity from 150° to 0° (Fig. 1).

**Fig. 1a**

Juvenile rheumatoid arthritis in an 18-year-old boy. Figure 1a – Flexion contracture of 150°. Figure 1b – The radiograph shows the posterior subluxation of the tibia. Figure 1c – The Ilizarov apparatus with two lateral hinges at the level of the femoral condyles. Distraction of the femoral rods allows progressive correction of the posterior subluxation and of the tibial rods produces distraction of the knee to avoid damage to the articular cartilage during correction. Figure 1d – Radiological appearance at the last follow-up. The posterior subluxation of the tibia is not corrected. A total knee arthroplasty is planned for this patient.
RESULTS

The deformity was corrected to an average contracture of 6.5° (0 to 20). Mild varus occurred in one knee. After removal of the fixator, the knee was stable in 12 patients but unstable in one with congenital absence of the fibula. Of the six cases of posterior subluxation of the tibia, only three were adequately corrected.

Minor complications. During correction acute pain was encountered in three knees due to physometaphyseal fracture, but this did not lead to interruption of the correction. Pin-track infection occurred in five cases; all responded to antibiotic treatment.

Major complications. Paralysis of the common peroneal nerve was seen in a patient with juvenile rheumatoid arthritis and a flexion contracture of 150° two weeks after the beginning of the correction. No recovery had taken place after three months.

A Salter-Harris type-I or type-II fracture occurred in three knees in two patients; bilateral distal femoral fractures and a proximal tibial fracture were seen in the first case and a proximal tibial lesion in the second. These three knees had congenital webbing; one patient had the multiple pterygium syndrome (Escobar et al 1978) with bilateral flexion contractures and the other had a myelomeningocele with unilateral congenital absence of the quadriceps muscle (Fig. 2). In the first patient correction of the contracture occurred both at the fracture site and the knee with a final lateral femorotibial shaft angle of 10° and a bayonet appearance of the knee in the sagittal plane. In the second patient fixation of the epiphysis with a Kirschner wire was undertaken and there was no displacement of the fracture. Ilizarov distraction was not stopped.

Recurrence of the deformity was seen in four patients at
an average of 1.7 years (9 months to 2.9 years) after removal of the fixator. In one patient with a moderate recurrent deformity secondary to a popliteal angioma, treatment was by repeated casting followed by the use of a long-leg brace. The three other recurrences, all with congenital webbing, were due to failure of arthrodessis of the knee for severe and progressive deformity. Repeated Ilizarov distraction was followed by successful compression arthrodessis also using the Ilizarov apparatus.

Late results. We reviewed our patients at a mean follow-up of 4.1 years (3 months to 7.2 years) and at a mean age of 14 years (6.5 to 22.2). All were able to walk on their operated leg, with or without an orthosis or crutches. Bilateral recurrence of the deformity had occurred in the patient with multiple pterygium syndrome. This was more severe on the left side where there was evidence of failure of the knee arthrodessis, but with a stiff knee. Correction was undertaken by supracondylar osteotomy.

No recurrence was seen in the other cases. The mean residual angle of flexion contracture at the last follow-up was 10° (0 to 30). The knee was mobile in eight cases (5° to 50°), and stiff in five with a solid arthrodessis in two. A long-leg brace was used in nine knees.

DISCUSSION

Previous methods for managing flexion contracture of the knee have included casting (Hart 1934; Hughes and Risser 1934), bipolar traction (Queneau 1952), posterior soft-tissue release (Wilson 1929; Eggers 1952; Abraham, Verinder and Sharrard 1977; Heydarian et al 1984), osteotomies (Leong, Alade and Fang 1982; Zimmermann, Smith and Oppenheim 1982), and femoral shortening (Saleh, Gibson and Sharrard 1989). These have been used alone or in combination with various degrees of success depending on the severity of the deformity and its aetiology.

The surgical correction of fixed and severe contracture requires extensive soft-tissue release which may create an unstable knee. Plastic and reconstructive procedures may be needed which may require neural and microvascular reconstruction (Gartsman, Bennett and Cain 1988). Non-operative methods are very demanding and are ineffective in the ankylosis type of contracture.

The Ilizarov technique is an improvement on conserva
tive methods. It allows progressive correction of the most complex deformities of the knee (Damsin and Carlioz 1994), with simultaneous correction of associated foot deformities and limb lengthening. Nevertheless, rigorous application of the basic principles is mandatory (Plawecki 1992; Damsin and Carlioz 1994). A minimum of three Ilizarov femoral and tibial pins, in two different planes, is essential (Bianchi-Maiocchi et al 1983). ‘Olive’ wires are used to prevent slipping and tilting of the rings and should be placed accurately on the convex side near the knee and on the concave side far from it. The rings must be perpendicular to the shaft and of equal diameter to simplify the frame and to facilitate the surgical procedure. The femoral and tibial components are connected by two hinges and two posterior distraction rods. When the contracture is associated with posterior subluxation of the tibia, the axis of rotation, which is determined by the two hinges, is progressively displaced more ante
riorly until correction is obtained.

The rate of correction depends on the severity of the deformity, the degree of contracture of the capsule and the ligaments, the tolerance of pain by the child and the presence of vascular or neural complications. Distraction at a daily rate of 1 mm at the knee should be the aim; this corresponds to a rate of 3 to 4 mm per day at the distraction rod which is located in the concavity far from the knee.

Flexion contracture of the knee secondary to congenital webbing in a young child is the most difficult type to treat. The five fractures in our series were in two children with congenital webbing treated at the ages of 1.7 and 4.8 years of age. The fractures occurred during the correction of posterior subluxation of the tibia and were considered to be due to shearing forces. Primary articular distraction may help to avoid this complication (Damsin and Carlioz 1994) and to facilitate the correction of posterior subluxation. The femoral and tibial epiphyses should be stabilised with wires, placed under radiographic control, to reduce the risk of fracture.

Paralysis of the common peroneal nerve should be pre
tended whenever possible (Aspden and Porter 1994), and the rate of correction must be planned carefully with respect to the severity of the contracture and the distance of the distraction rods from the knee.

Severe, fixed contracture at the knee remains one of the most challenging deformities in children, mainly because of the high risk of recurrence. Arthrodesis of the knee or, at least, the creation of a stiff knee in the most extended position at the end of correction, may be the best solution in some cases. In others the use of a long-leg brace, after removal of the external fixator, allows stabilisation of the correction obtained.

The Ilizarov apparatus is a very effective tool for manag
ing severe cases of knee contracture but careful attention to every detail is required.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

REFERENCES


