SURGICAL TREATMENT OF THE FLAIL KNEE AFTER POLIOMYELITIS

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We report our experience of surgical treatment for instability of flail knees after poliomyelitis in 228 patients. We made carefully selective use of soft-tissue release, extension osteotomy of the femur, and a patellar bone block for hyperextension.

After six to nine years follow-up, 87% of the patients had retained significant improvement in stability and walking ability.

Following paralytic poliomyelitis, considerable disability may result from weakness of the muscles controlling the knee (Men et al 1986). Two distinct patterns of instability may occur: the knee may collapse either into flexion or into hyperextension. Collapse into flexion is usually associated with a flexion deformity of the knee (Conner 1970; Zimmerman, Smith and Oppenheim 1982). Stability can sometimes be achieved by the patient exerting manual pressure on the front of the thigh but often sticks or crutches are required for walking.

A mild degree of hyperextension of the knee confers stability due to the anatomical self-locking mechanism, but when hyperextension is excessive, the knee may collapse posteriorly. This deformity is often progressive, as the posterior soft tissues gradually stretch, and it is frequently painful. Whilst hyperextension collapse can be controlled by a caliper many patients find that the additional weight of this makes walking impossible.

Out of a series of over 2000 cases presenting to us with lower limb paralysis or weakness after poliomyelitis, 228 patients with 281 flail knees have been operated on using either an extension osteotomy of the femur (Men et al 1978) or an anterior bone block created by inserting the patella into the anterior intercondylar area of the tibia. In some cases both operations were required to restore stability.

Table I. MRC grades of muscle power in the worse leg in 228 patients after paralytic poliomyelitis

MRC grade	Gluteus maximus	Quadriceps femoris	Hamstrings	Triceps suri
0	137	204	164	163
1	65	20	36	26
2	26	4	28	39

PATIENTS

The 228 patients included 93 males and 135 females. Of these, 170 were aged between 15 and 20 years, 55 were 21 to 25 years old; only three were over 25. In all cases the power was charted for the gluteal muscles, quadriceps, hamstrings and triceps suri. In no operated leg was the power of any group more than MRC grade 2 (Table I).

Table II. Walking function at long-term follow-up (see text)

Before operation		At follow-up				
Function	Number	Two crutches	One crutch	One stick	Hand on thigh	No support
Crawling on knees	4	3	–	–	–	1
Two crutches	44	13	7	7	–	17
One crutch	78	–	14	6	4	54
One stick	11	–	–	1	–	10
Hand on thigh	91	–	–	–	1	90
Total	228	16	21	14	5	172

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0301-620X/91/2106 $2.00
J Bone Joint Surg [Br] 1991; 73-B:195–9.

There were three distinct groups:
Type I, 206 knees with fixed flexion deformities;
Type II, 57 knees with unstable or painful hyperextension;
Type III, 18 knees with a mild flexion deformity which could be corrected passively, but which produced discomfort when the posterior soft-tissue structures were stretched.

Before operation, 44 patients had to use two crutches and 78 used a single crutch. Four could only crawl on their knees (Table II).

INDICATIONS AND SURGICAL TECHNIQUE

Type I

The surgical management of flexion deformity depended on its degree:

a) When the deformity was over 60° a soft-tissue release of the posterior structures was performed first. The leg was then placed in a plaster cylinder which was gradually wedged until the deformity measured less than 25°. A femoral extension osteotomy was then carried out as a second surgical procedure.

b) A flexion deformity of between 25° and 60° was treated by a one-stage procedure in which the soft-tissue release was combined with the osteotomy. The limb was held in a plaster cylinder but only partially corrected. Two weeks later the plaster was divided transversely at the level of the osteotomy and a closed osteoclasis was performed. The plaster was wedged to maintain this position. The reason for performing delayed, closed osteoclasis is that the soft-tissue deformity may recur even after tendon release, if the osteotomy is completed too soon.

c) A flexion deformity of less than 25° was treated by osteotomy alone. Soft-tissue release in these cases is not only unnecessary but can lead to the development of hyperextension.

Soft-tissue release. The soft-tissue release is performed via medial and lateral incisions. Since the knee is flexed both incisions are curved. The lateral incision starts at the head of the fibula, and curves over the joint line and up into the thigh. The iliotibial band is divided and the biceps tendon is elongated by Z-plasty.

On the medial side the incision runs along the posterior margin of vastus medialis to curve down over the joint line and the insertions of the medial hamstrings. The tendons of semitendinosus and semimembranosus are divided at different levels, semimembranosus being divided more proximally. The distal stump of semimembranosus can then be sutured to the proximal end of the semitendinosus, and the proximal end of the semimembranosus is sutured to semitendinosus even more proximally. This results in lengthening of the combined tendons.

Supracondylar osteotomy. The supracondylar osteotomy (Fig. 1) is performed through a midline incision. The atrophic quadriceps and then the periosteum are divided in the line of the incision to expose the femur. With the posterior structures protected by retractors placed subperiosteally, a domed osteotomy is performed, with its convexity facing proximally, about 5 cm above the femoral supracondylar flare. The extension angle should be 5° to 10° greater than the initial flexion deformity, to leave the knee in 5° to 10° of recurvatum. The leg is held in a plaster cylinder which is retained for two months. Varus or valgus deformities can be corrected at the same time. However, any rotation deformity of the tibia should be corrected in the tibia at a second stage once the femoral osteotomy has united. In fact we only needed to correct tibial external rotation in less than 5% of cases.

Type II

Hyperextension was treated by the insertion of an anterior bone block utilising the patella (Fig. 2).

Anterior bone block. Patellectomy is performed through an S-shaped skin incision. The articular cartilage and the anterior cortex are removed from the upper half of the patella. The front of the tibial plateau is cleared of soft-tissue attachments to expose the intercondylar area between the menisci. A transverse slot is cut into the bone and the denuded upper half of the patella is driven in, so that the remaining articular surface faces towards the femoral condyles. The position of the patella is adjusted to allow 5° of hyperextension and it is secured with two cross-screws. A plaster cast is worn for two months. If the proximal part of the articular surface of the patella forms a more congruent contact with the intercondylar area than does the distal surface then the position of the patella may be reversed, and the distal part denuded.

Type III

A small number of knees with a mild flexion deformity could be corrected passively, but the passive correction produced discomfort at the back of the knee. These knees needed both a femoral osteotomy and a bone block (Fig. 3).

Combined procedure. The two operations can be performed simultaneously but considerable skill is required to produce an end result in which the patient has 5° to 10° of hyperextension. The relative failure of one operation may be an indication to carry out the other half of the combined procedure some months later.

RESULTS

Patients were assessed using a functional index based on walking ability:

0) unable to stand or walk, could only crawl or use a wheelchair;
1) able to walk with two crutches;
2) able to walk with a single crutch;
3) able to walk using a single stride;
4) able to walk with one hand on the thigh;
5a) could walk unsupported, but with a severe limp;
5b) could walk normally or with a mild limp.

Results were assessed as excellent in those patients

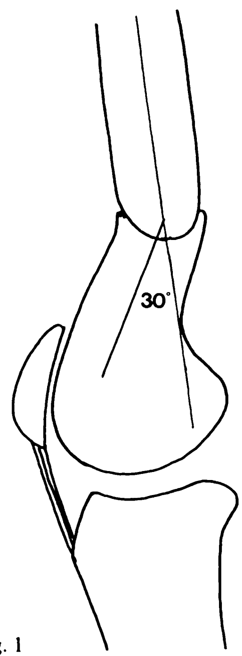

Fig. 1

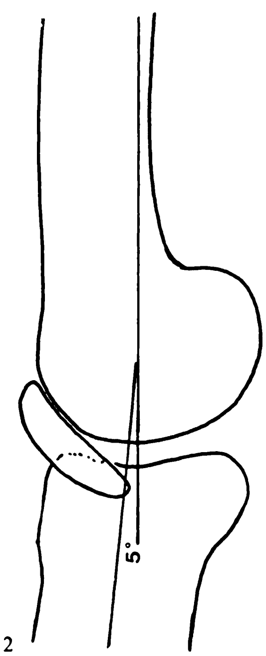

Fig. 2

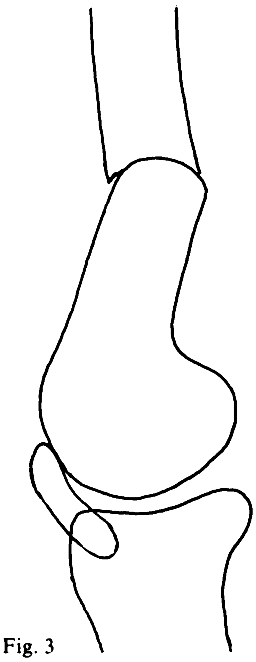

Fig. 3

Figure 1 – Femoral recurvatum osteotomy. A 30° correction has been made for a 25° flexion deformity, to produce 5° of hyperextension. Figure 2 – Patellar bone block, to limit hyperextension to 5°. Figure 3 – The combined operation.

Fig. 4a

Fig. 4b

Fig. 4c

Fig. 4d

Case 1. Both knees required bone blocks. A femoral osteotomy was added on one side, one year later: a, b, before operation; c, after bone block and femoral osteotomy; d, six years later.

who achieved grade 4 or 5, or whose function was improved by at least two grades. Improvement by one grade was considered to be a good result.

The follow-up period was a mean eight years five months (range six years two months to 13 years nine months). The pre- and postoperative functional status is shown in Table II. As defined above, 183 patients (80%) had an excellent result, 16 (7%) had a good result and 29 (13%) were not improved. Once a position of slight hyperextension had been established this seemed to remain stable in most cases throughout the follow-up period of up to 13 years.

However, an increase in hyperextension due to stretching of the posterior soft tissues or secondary to changes in the structure of the anterior bone block was seen in a few cases (less than 5%). It is important to ensure that the patellar bone block is firmly embedded into the proximal tibia otherwise its position may alter during healing with consequent alteration in the position of knee hyperextension. Fracture of the patellar bone block from a fall can occur.

ILLUSTRATIVE CASE REPORTS

Case 1. An 18-year-old girl who had had poliomyelitis at the age of six months, learned to walk pushing a stool at 10 years of age and eventually used two crutches, being unable to bear full weight through either knee (Fig. 4a).

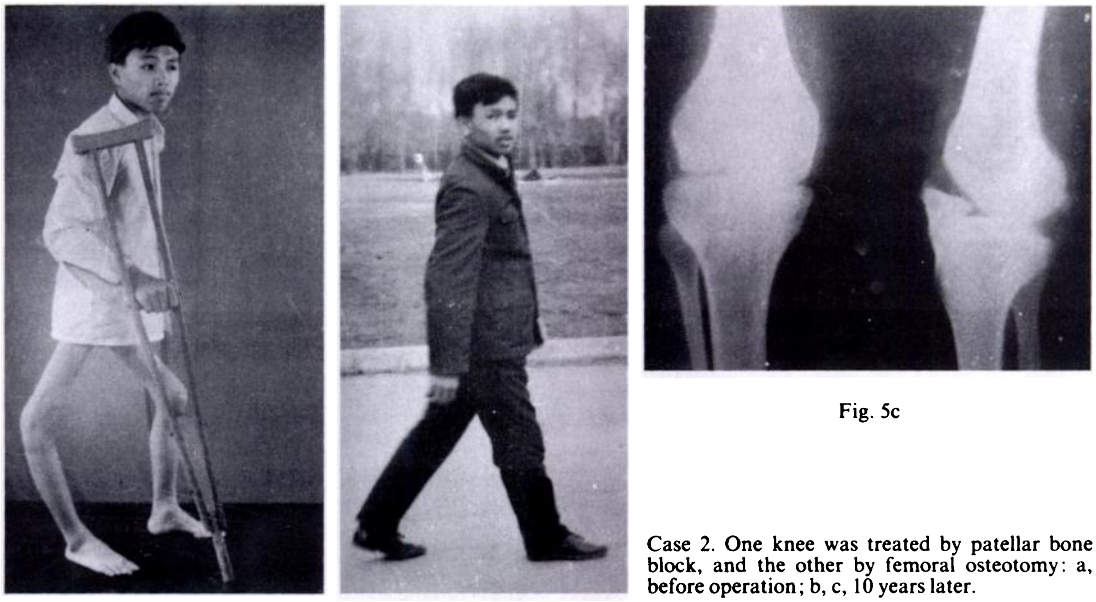

Fig. 5a Fig. 5b Fig. 5c

Case 2. One knee was treated by patellar bone block, and the other by femoral osteotomy: a, before operation; b, c, 10 years later.

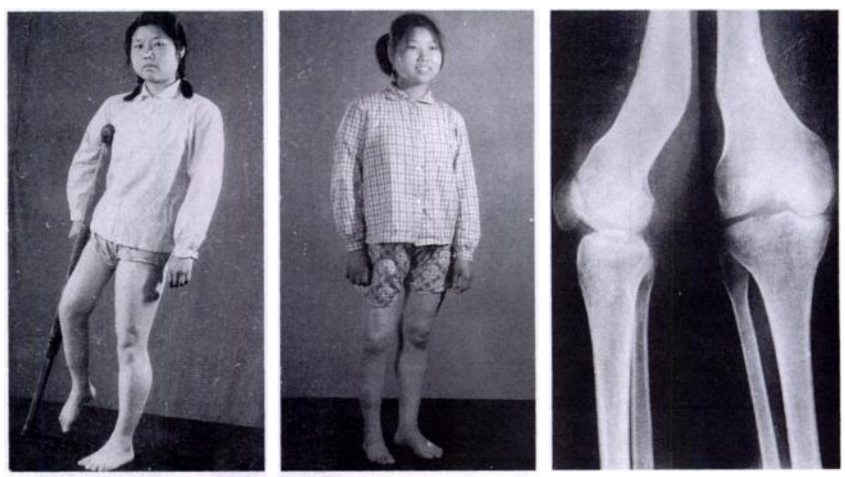

Fig. 6a Fig. 6b Fig. 6c

Case 3. One knee treated by femoral osteotomy: a, before operation; b, c, six years later.

Her quadriceps and hamstrings were completely paralysed; she had grade 2 power (MRC) in the glutei and calf muscles. Both knees were hyperextended (Fig. 4b). Patellar bone block procedures were performed in both knees with a three-month interval between operations. The left knee did well but her right knee tended to collapse in flexion. Consequently, four months later she had a 10° femoral extension osteotomy (Fig. 4c). She also required an upper tibial osteotomy to correct rotational malalignment and a distal fibular lengthening to correct eversion of the foot.

At follow-up, over six years later, she could walk indoors without support; out-doors she used a single crutch (Fig. 4d).

Case 2. A 20-year-old man had bilateral paralysis and was able to walk only with two crutches because of flexion deformity of the left knee and unstable hyperextension of the right knee (Fig. 5a). The flexion deformity was corrected by a femoral osteotomy and the hyperextended knee was treated by an anterior bone block, using the patella. He was then able to walk without support. Ten years later the result was still satisfactory (Fig. 5b) and radiographs showed the bone block with no gross degenerative changes (Fig. 5c).

Case 3. A 21-year-old woman had paralysis in the right leg with power 2 (MRC) in the glutei and hamstrings, and power 0 in the quadriceps and calf muscles. There was a 30° flexion deformity at the knee (Fig. 6a). Femoral osteotomy with posterior angulation and 5° overcorrection was performed, and she was then able to walk without the need to support her thigh with her hand. Good function has been maintained (Fig. 6b). Radiographs at 12 years show the remodelled femur and no degeneration at the knee (Fig. 6c).

DISCUSSION

If there is a flexion contracture of the knee in association with quadriceps muscle power of grade 2 or less, the knee collapses when weight is taken on the leg because the line of body weight passes behind the knee. By performing a distal femoral recurvatum osteotomy the natural anterior bow of the femur is converted into a posterior bow and the knee will then lie behind the line of body weight. Stability is then dependent on the integrity of the posterior soft-tissue structures, which is why soft-tissue release should only be carried out in the presence of a severe flexion contracture; otherwise the knee will collapse into excessive recurvatum. If recurvatum collapse does occur, either following a femoral recurvatum osteotomy or primarily from stretching of the posterior soft tissues, the knee can be stabilised by using the patella as a bone block. Our results show that these two operations, when done for the correct indications, either alone or in combination, can give long lasting results. Once a position of slight hyperextension was established it usually remained stable during follow-up of more than 10 years. Only a few cases had increasing hyperextension secondary to stretching of the posterior soft tissues or due to failure of the bone block.

The authors wish to thank He Zhi-jing and Yu Zhen-jiang for their help in the preparation of this manuscript and for translating it from Chinese into English.

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.

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