MACINTOSH TENODESIS FOR ANTEROLATERAL INSTABILITY OF
THE KNEE

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Fifty patients who underwent a MacIntosh repair for anterolateral instability of the knee have been reviewed after a mean follow-up of two and a quarter years. The repair abolished a positive anterolateral jerk test in 42 out of 50 knees and at the time of review 37 patients (74 per cent) were involved in some form of active sport, having regained functional and clinical stability.

The MacIntosh repair is described in detail and the importance of excluding meniscal lesions as the main cause of instability is emphasised.

Anterolateral laxity of the knee is characterised by abnormal anterior rotary subluxation of the lateral tibial plateau with the knee in a few degrees of flexion. The subluxation tends to reduce spontaneously as the knee is flexed to 30 or 40 degrees. This subluxation can occur when the medially rotated limb is under load, with the knee in a few degrees of flexion. As the knee flexes further, still under load, relocation occurs suddenly to produce symptoms of instability. Anterolateral instability is caused by a torn anterior cruciate ligament.

Various eponymous tests have been described for the diagnosis of anterolateral instability (Galway, Beaupré and MacIntosh 1972; Hughston et al. 1976; Slocum et al. 1976; Losee, Johnson and Southwick 1978). They are essentially similar and depend on the demonstration of abnormal femorotibial movement, by slightly different methods of clinical examination. They should perhaps be referred to more precisely as anterolateral jerk tests, but for brevity, the general term jerk test is used in this paper. Palmer (1938) considered that the “clicking knee” phenomenon was caused by the lateral femoral condyle riding over the posterior horn of the lateral meniscus in the subluxed position.

Lemaire (1967), in discussing the jerk phenomenon, described a repair to control the tibial subluxation using an extra-articular nylon band enclosed in an envelope of fascia lata. The use of an extra-articular, distally based tenodesis using fascia lata is credited to MacIntosh (Galway et al. 1972). The rationale of the operation is to limit anterior movement of the lateral tibial plateau by femorotibial tension in the tenodesis, which is obliquely placed to oppose the subluxation. This paper reports the results of 50 such operations.

MATERIAL AND METHODS

Fifty-five patients who had undergone a MacIntosh type of repair at the Royal National Orthopaedic Hospital in the period 1973 to 1978 were reviewed. Five patients had had an additional Jones or O’Donoghue type of reconstruction, and were excluded from the series. The remaining 50 patients were 39 men and 11 women. The right knee was involved in 32 cases and the left in 18. The age range at operation was 18 to 47 years with a mean of 27 years. All the patients had attributed their symptoms to previous sports injuries, almost half being sustained while playing association football (Table I). In all the

Table I. Sport causing injury

<table>
<thead>
<tr>
<th>Sport</th>
<th>Number</th>
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<tbody>
<tr>
<td>Football</td>
<td>24</td>
</tr>
<tr>
<td>Rugby</td>
<td>8</td>
</tr>
<tr>
<td>Hockey</td>
<td>3</td>
</tr>
<tr>
<td>Badminton</td>
<td>3</td>
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<tr>
<td>Basketball</td>
<td>2</td>
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<tr>
<td>Netball</td>
<td>2</td>
</tr>
<tr>
<td>Lacrosse</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>7</td>
</tr>
<tr>
<td>Road accidents</td>
<td>0</td>
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patients the principal symptom was giving way of the knee; in two-thirds there was associated pain which was often severe, usually on the outer side of the knee, and generally followed by swelling. The duration of symptoms ranged from four months to 10 years with a mean of two years. Physiotherapy had failed to control the symptoms in all cases. Twenty-eight patients had had previous operations on the knee. The medial meniscus had been removed in 25, the lateral meniscus in three, and two had undergone transfer of the pes anserinus. These operations had not cured the instability.
Assessment before operation. Separate assessments were made of the severity of subjective instability and the degree of objective laxity. The arbitrary criteria for subjective grading are shown in Table II. These were based on disability in sporting activities, because this was the main concern of the majority of patients. Usually there is little difficulty in detecting anterolateral laxity in the conscious patient and in arriving at an opinion concerning the need for surgical repair.

Table II. Grading of subjective instability

<table>
<thead>
<tr>
<th>Grade</th>
<th>Symptoms</th>
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<tr>
<td>0</td>
<td>Normal knee</td>
</tr>
<tr>
<td>1</td>
<td>Cannot play football or equivalent sport</td>
</tr>
<tr>
<td>2</td>
<td>Cannot play tennis, squash or equivalent</td>
</tr>
<tr>
<td>3</td>
<td>Cannot run</td>
</tr>
<tr>
<td>4</td>
<td>Knee gives way when walking</td>
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</table>

Objective assessment was based on the degree of jerk demonstrated under general anaesthesia (Table III). The jerk test was, however, also carried out on the conscious patient by the techniques shown in Figures 1 and 2. Figure 1 shows the right foot being lifted and medially rotated. The knee is initially extended. The left hand is placed just distal to the upper end of the fibula and applies a valgus stress as well as flexing the knee. The abnormal movement of tibial relocation, occurring as the knee flexes past approximately 30 degrees, is seen rather than felt by the examiner. The conscious patient usually recognises that the manoeuvre reproduces the unpleasant sensation of his symptoms. Some patients are generally apprehensive when the test is attempted, and react by rolling away from the examiner and by resisting flexion of the knee. However, this response is also seen in some normal individuals and does not necessarily indicate that the test will become positive under anaesthesia. In seven patients a positive jerk test was not demonstrable without anaesthesia.

The method shown in Figure 2 has been found to be more sensitive in detecting a mildly positive jerk (Grade 1). It appears to help the apprehensive patient to relax. The right ankle is firmly held between the examiner’s right upper arm and chest. Both hands are then free to support the knee and apply valgus stress with medial rotation as the knee is flexed. Because the tibia is more firmly held by this method, it is the lateral femoral condyle that appears to move abnormally rather than the tibia. By a reciprocating tibial flexion and extension movement at about the point of relocation and subluxation, particularly when examining under anaesthesia, a striking up and down movement of the femoral condyle can often be produced. If this movement is grinding in character an associated tear of the lateral meniscus is usually present.

As an ancillary method of diagnosis we carried out double-contrast arthrography to exclude meniscal tears as a possible primary cause of instability. The importance of this cannot be overstated. Anterolateral instability is not associated with locking unless there is a meniscal tear. Arthrography was used rather than arthroscopy, because of its greater accuracy in the diagnosis of posterior tears of the medial meniscus (Ireland, Trickey and Stoker 1980).

Operative technique. Preliminary assessment of laxity of the knee is made under general anaesthesia, and if indicated arthroscopy is performed at this stage.

A pneumatic tourniquet is applied as high as possible on the thigh.

Diagram showing the skin incision. (Figures 3 to 12 all depict a right knee.)
The patient lies supine with a small sandbag under the ipsilateral buttock. The limb is prepared and draped, and positioned with the knee in about 60 degrees of flexion.

A skin incision measuring 20 to 25 centimetres follows the midlateral line of the thigh, and then curves across the lateral femoral condyle midway between the patella and the head of the fibula. It crosses the lateral tibial tubercle and ends two centimetres distal to it. Care is necessary not to incise the fascia lata (Fig. 3). The posterior skin flap with its subcutaneous fat is reflected, and the exposed fascia lata cleaned of any residual fat. A strip of fascia lata is prepared approximately 15 centimetres long and 1.0 to 1.5 centimetres wide at its base where it remains attached to the lateral tibial tubercle, narrowing slightly as it follows the line of incision (Figs 4 and 5). It is freed proximally and separated from the vastus lateralis and the lateral articular structures of the knee. A lateral arthrotomy, if indicated, may be conveniently performed at this stage. Access for lateral meniscectomy is much improved by flexing the knee over the lowered end of the operating table.

While the knee is flexed at 60 degrees, the small fossa, just proximal to the lateral femoral condyle, is cleared of fat. Great care is taken to preserve the main band of insertion of the intermuscular septum into the femoral condyle (Kaplan 1958). Constant branches of the superior lateral geniculate vessels emerge deep to the band and require ligation.

The lateral collateral ligament is now defined: it is not easy to see, but is easily identified by rolling beneath the finger. A tiny blood vessel runs along its anterior edge. A tunnel is developed beneath the proximal portion of the ligament, and the strip of fascia lata is passed through it (Figs 6 and 7). A small osteoperiosteal flap, one centimetre square, is cut in the posterior corner of the lateral femoral condyle, it is hinged down with a narrow osteotome and the strip of fascia lata is laid deep to it so as to reach the prepared band of intermuscular septum more directly (Figs 8 and 9). The strip is now passed deep to the band and is looped around it several times (Figs 10 and 11), it is pulled as tight as possible while an assistant holds the foot and tibia in full lateral rotation, and is sutured to the band of intermuscular septum. The osteoperiosteal flap is sutured over the top of the strip. The lateral ligament is then sutured to the strip.

The defect in the fascia lata is closed in all but the distal five centimetres. The wound is closed without drainage, the assistant continuing to hold the leg and foot in full lateral rotation. A padded cast is applied at first from the groin to the ankle with the knee flexed to 60 degrees, and then extended to include the foot which is rotated laterally to 30 degrees (Fig. 12).

After-care. Immediately after operation the leg is supported in elevation by several pillows. Mobilisation without weight-bearing is begun on crutches after a few days, and the patient may be discharged from hospital within, on average, 6 to 10 days. The plaster cast and the skin sutures are removed after six weeks and weight-bearing with crutches is then permitted immediately, crutches usually being discarded within 7 to 10 days. Swimming is also permitted but any turning or twisting movements forbidden. No external support or splinting was employed after removal of the plaster, and no particular rehabilitation programme was advised.

No sport was permitted for six months. All patients were warned that a tenodesis can be torn in active sport as easily as a normal ligament. Although the patient must make his own decision concerning the type of physical activity, strong recommendations were made to change to a non-contact sport where this was applicable.

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<th>Table IV. Criteria for assessment of results</th>
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<td><strong>Results</strong></td>
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<tr>
<td>Excellent</td>
</tr>
<tr>
<td>Good</td>
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<tr>
<td>Fair</td>
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<tr>
<td>Poor</td>
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Physiotherapy was avoided where possible. It was required by 15 patients for a mean period of 3.5 weeks.

**Assessment after operation.** Of the 50 patients reported, 42 were examined personally by one author (JI), three completed postal proformas and five were assessed from case notes. Subjective assessment of instability was based on the criteria used before operation (Table II). Objective assessment of laxity was made by clinical examination. Routine radiographs were taken in the early part of the review but were discontinued because they failed to reveal any significant radiological abnormalities. The results were assessed as excellent, good, fair and poor according to the criteria shown in Table IV.

**RESULTS**

There were complications in only one patient, who developed a wound haematoma. There were no wound infections.

The time taken for the knee to regain full extension
Development of a tunnel beneath the lateral collateral ligament and the prepared band of intermuscular septum.

The fascia lata strip is passed through the tunnel. The osteoperiosteal flap is also shown.

The strip is looped around the band of intermuscular septum and pulled as tight as possible.
varied from a few days to three months, with an average of eight weeks. There was no significant correlation between this time and the quality of the end result. Fifteen patients had a lateral arthrotomy and six underwent lateral meniscectomy simultaneously with the MacIntosh tenodesis. There was no appreciable difference in their recovery time or result. The average period off work was 11 weeks.

**Satisfactory results.** The 14 excellent and 23 good results represented a satisfactory outcome. All considered their operation well worthwhile and were able to enjoy some form of active sport. However, less than half had returned to their pre-injury level of sporting activity. In four patients the instability of the knee before operation had prevented them from working: for two of them (a fireman and a window cleaner) their work involved the use of ladders and the other two were teachers of physical education. All four returned to their previous employment after the operation.

**Fair results.** Of the four patients whose grading was fair, all considered that their knees were more stable. However, a positive jerk test could still be demonstrated.

**Poor results.** In two of the four poor results a positive jerk test was never abolished and their instability was unchanged. In one patient instability was inexplicably worse after operation: no positive jerk was detectable, and although the clinical picture was that of a meniscal lesion, none has been demonstrated by arthroscopy or arthrogram. The other poor result was downgraded because of persistent pain, associated with pre-existing degenerative change.

**Doubtful results.** Four of the five patients whose results were graded as doubtful had had a satisfactory result initially. They subsequently suffered injury at sport, from one to three years later. This was associated with recurrence of a positive jerk test, and in one case an additional torn medial meniscus. The other doubtful result was in a knee that had not been improved by the initial repair, although the positive jerk test was abolished. This patient was found by arthrography to have an oblique tear in the posterior horn of the medial meniscus (Fig. 13). The meniscus had been considered normal at a previous arthroscopy, and no further injury had occurred. After removal of the meniscus the knee became stable.

Table V shows the numbers of patients with associated anteromedial laxity (as assessed at review) in relation to the final results. The arbitrary grading of anteromedial laxity corresponds to the jerk test grading: slight (1+), obvious (2+) and gross (3+). The laxity would be considered gross if the medial tibial condyle could be subluxed anteriorly 1.5 centimetres or more with the knee in 90 degrees of flexion. Table V suggests that mild associated anteromedial laxity is quite compatible with functional stability after a MacIntosh repair.
repair. Kostuik (1977), however, found that medial insufficiency was the main cause of failure in a similar review.

Table VI shows the grading of the initial jerk test in relation to that of the final results. There is no suggestion that knees with an obviously positive (2+) jerk test did better or worse than those with a slightly positive (1+) jerk test. At review, 42 of the 50 patients had a negative jerk test: five of these patients were apprehensive on attempting the test but their knees were functionally stable.

DISCUSSION

Instability of the knee is a complex subjective phenomenon, dependent on many physical factors. Because of differing attitudes to sport and differing national traditions, direct comparison with the results of similar studies from other countries is of doubtful value. Useful analysis of the results of operations for instability is made difficult by the following factors.

Frequent lack of correlation between subjective instability and objective physical signs is difficult to explain. There was no significant correlation in individual patients in this series between the grade of instability before operation and the strength of the jerk test detected.

Simultaneous undertaking of additional surgical procedures may invalidate the apparent efficacy of a ligamentous reconstruction. However, it may be justifiable to undertake this repair at the same time that a torn meniscus is removed provided that the symptoms and clinical signs suggest that both lesions are causing instability. The significance of lateral meniscal abnormalities, in association with anterolateral instability is variable. Degenerative changes of the posterior horn of the lateral meniscus are quite common and are caused by the constant abnormal rotatory movement of the instability (Fig. 14). Minor changes are quite compatible with a good result after repair, without removal of the meniscus. No simultaneous medial meniscectomies were performed in this series. It is our opinion that reconstructive surgery for any associated anteromedial instability should not be undertaken at the same operation.

Further injury may ruin an initially excellent result. Twelve of our patients reported injuries after operation and, as a result, in four of them the knee became unstable.

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REFERENCES


