The long-term functional and radiological outcome after open reconstruction of the anterior cruciate ligament

We identified a series of 128 patients who had unilateral open reconstruction of the anterior cruciate ligament (ACL) by a single surgeon between 1993 and 2000. In all, 79 patients were reviewed clinically and radiologically eight to 15 years after surgery. Assessment included measurement of the Lysholm and Tegner scores, the ACL-quality-of-life score and the Short Form-12 score, as well as the International Knee Documentation Committee clinical assessment, measurement of laxity by the KT-1000 arthrometer, a single-leg hop test and standardised radiography of both knees using the uninjured knee as a control.

Of the injured knees, 46 (57%) had definite radiological evidence of osteoarthritis (Kellgren-Lawrence grade 2 or 3), with a mean difference between the injured and non-injured knees of 1.2 grades. The median ACL quality-of-life score was 80 (interquartile range (IQR) 60 to 90), the Lysholm score 84 (IQR 74 to 95), the Short Form-12 physical component score 54 (IQR 49 to 56) and the mean Hop Index 0.94 (0.52 to 1.52). In total 58 patients were graded as normal, 20 as nearly normal and one as abnormal on the KT-1000 assessment and pivot-shift testing. Taking the worst-case scenario of assuming all non-attenders (n = 48), two septic failures and one identified unstable knee found at review to be failures, the failure rate was 40%. Only two of the patients reviewed stated that they would not have similar surgery again.

Open reconstruction of the ACL gives good, durable functional results, but with a high rate of radiologically evident osteoarthritis. Rupture of the anterior cruciate ligament (ACL) is common in both elite and recreational athletes. In many of these patients this leads to functional instability because of the loss of the mechanical stabilisation of the ligament and its contribution to proprioception in the knee. The ongoing instability is also associated with increased rates of injury to the menisci, damage to the articular cartilage and ongoing degenerative changes in the joint.

Repair of the ligament is ineffective, and the only surgical solution to the problem of instability is reconstruction, the benefits of which are removal of the instability and protection of the menisci and joint surfaces from further damage. Reconstruction of the ACL may also alter the incidence of osteoarthritis in the longer term.

There has been increasing interest in the development of more anatomical reconstruction, including double-bundle techniques in the belief that the most anatomical reconstruction will provide the best restoration of normal kinematics and, by extrapolation, the best protection of the joint.

We have examined the functional and radiological results in a series of patients who had reconstruction of the ACL by a single surgeon using an open technique between 1993 and 2000.

Patients and Methods
We identified a series of 290 patients who had reconstruction of the ACL by one surgeon (TRS) between 1993 and 2000 using a standard technique comprising the insertion of a bone-patellar ligament-bone autograft through an arthrotomy and was fixed by interference screws. Of these, 128 had an isolated unilateral reconstruction in the absence of any identified injury to the other knee. In two patients sepsis had occurred after reconstruction resulting in the removal of the graft, leaving 126 patients eligible for review. The two patients with sepsis were recorded as failures in the analysis.

Our study had approval from the Local Research Ethics Committee.

The patients were contacted by letter and sent an information sheet inviting them to an appointment for review. On attending they gave informed consent to participate, before completing standardised measures of knee function including the Lysholm knee function test, the Tegner sports activity questionnaire, the
Mohtadi ACL quality of life questionnaire and the general psychosocial function Short form-12 (SF-12) questionnaire, as well as a patient satisfaction questionnaire (Table 1). They were then questioned and examined by one of two appropriately trained, independent physiotherapists (KC, LAA). Clinical examination was according to the standardised International Knee Documentation Committee (IKDC) protocol, and included an instrumented assessment of knee laxity using the KT-1000 arthrometer (MEDmetric, San Diego, California) and a one-leg-hop-for-distance test, which was used to calculate the mean hop index representing the mean of the index leg hops divided by the mean of the contralateral leg hops. The corresponding author (AGS) was present at these clinics to deal with any relevant problems. The senior author/operating surgeon (TRS) took no part in the assessment of the patients.

Standardised weight-bearing anteroposterior (AP) and lateral radiographs of the knee were taken, examined by a single independent observer (MN) and classified according to the Kellgren-Lawrence system for the presence of arthritis. Two separate reviews of the films, two months apart, allowed the calculation of Cohen’s kappa coefficient to test for the reliability of the assessment.

Of the 126 patients who were eligible, 79 (62.7%) attended for review, with a mean age at review of 41 years (22 to 77) and a mean time since surgery of ten years (8 to 15). Of these, 63 (80%) were men.

Statistical analysis. This was supported by the Department of Public Health of the University of Aberdeen, and was undertaken using SPSS version 17.0 software (SPSS Inc., Chicago, Illinois). Outcome scores were assessed for normality using the Shapiro-Wilk’s test, and thereafter analysis was undertaken to compare outcomes scores with the radiological grade and KT-1000 laxity grade using the Kruskal-Wallis test, and with the hop index (p = 0.511) using Pearson’s correlation coefficient. The KR-1000 laxity score was abnormal (clunk, ++).

The mean hop index was 0.95 (0.52 to 1.52). There were strong correlations between the hop index and the functional outcome, as measured by the ACL QoL (Pearson correlation, p < 0.001), the Lysholm test (Pearson correlation, p < 0.001) and the SFPCS (Pearson correlation, p = 0.0015), but not with the SFMS or change in the Tegner score (SF-12 MCS p = 0.908, Tegner p = 0.110).

All patients except for one were normal (58) or nearly normal (20) on the KT-1000 laxity measurement. The one patient graded as abnormal has since undergone a revision procedure. Assuming the worst-case scenario of the 128 patients, there were 49 patients not reviewed and assumed to be failures, two infections, and one known laxity, producing an overall failure rate of 40% (52 of 128 patients). Of those reviewed, there was no correlation between grade of laxity and the radiological grade (chi-squared test, p = 0.769) or outcome score (ACL QoL p = 0.078, Lysholm p = 0.257, SFPCS p = 0.256, SFMS p = 0.240, all Kruskal-Wallis).

The patients were generally satisfied with the results of the surgery (Table 1). Only five (6.3%) recorded that the operation had been only fair or poor in terms of meeting their expectations and a further 15 (19.0%) that it had been good rather than very good or excellent. Only two patients (3%) indicated that they would not wish to have similar surgery again.
Discussion

Our findings have shown that the functional outcome of open reconstruction of the ACL remains good at eight to 15 years. Patients who have had such surgery have an increased tendency to develop osteoarthritis in the operated knee compared with the control knee and this leads to a worse general functional outcome. It has been suggested that the natural history of an untreated disruption is the development of Kellgren-Lawrence grade 3 and 4 osteoarthritis in 60% to 100% of patients at 15 to 20 years, while others have suggested that the rate is lower. One study showed that considerable modification of activity and conservative treatment gave a good radiological and functional outcome with only 13% of patients displaying radiological evidence of osteoarthritis at 15 years, while another suggested that reconstruction of the ACL actually increased the incidence of osteoarthritis, which occurred in 42% of reconstructed knees with Kellgren-Lawrence grade-2 or above changes compared with 25% in non-reconstructed knees at 11 years. There are considerable methodological problems in some of these studies, as was outlined in a recent review, with a lack of consistency of treatment, lack of randomisation when surgical and conservative management was compared and a lack of standardisation of radiological assessment. When reconstruction of the ACL was being introduced, rehabilitation was lengthy and involved periods of casting and bracing. This may have discouraged many patients except the most unstable who would often already have meniscal injuries, which were known to worsen the outcome. It is not clear from the literature, or from our series, if the vertical inclination of the femoral tunnel has a direct effect on the development of osteoarthritis (Fig. 1). It would take a long-term, randomised study of modern techniques of reconstruction and rehabilitation to determine the impact of reconstruction of the ACL compared with conservative management on the development of osteoarthritis. Such a study would present problems of recruitment. Similarly, it is not possible to be certain how far these results from a single-surgeon heterogeneous series can be generalised.

The disease-specific outcome measures used, the ACL QoL and Tegner scale, were designed for use in an active population and, when applied to older, less active patients,

Table I. Details of patient satisfaction with reconstruction of the anterior cruciate ligament

<table>
<thead>
<tr>
<th>How well did the operation:</th>
<th>Excellent (%)</th>
<th>Very good (%)</th>
<th>Good (%)</th>
<th>Fair (%)</th>
<th>Poor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relieve instability</td>
<td>46 (58.2)</td>
<td>25 (31.6)</td>
<td>2 (2.5)</td>
<td>6 (7.6)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Increase regular activities</td>
<td>32 (40.2)</td>
<td>28 (35.4)</td>
<td>11 (13.9)</td>
<td>5 (6.3)</td>
<td>3 (3.8)</td>
</tr>
<tr>
<td>Allow heavy work/sport</td>
<td>21 (26.6)</td>
<td>29 (36.7)</td>
<td>16 (20.3)</td>
<td>7 (8.9)</td>
<td>6 (7.6)</td>
</tr>
<tr>
<td>Meet expectations</td>
<td>30 (38.0)</td>
<td>30 (38.0)</td>
<td>12 (15.2)</td>
<td>2 (2.5)</td>
<td>2 (2.5)</td>
</tr>
</tbody>
</table>

Fig. 1a  Anteroposterior a) and lateral b) radiographs of a patient ten years after open reconstruction of the anterior cruciate ligament showing the vertical position of the screws and the development of early osteoarthritis.
should be interpreted with some care. In our series, radiological evidence of osteoarthritis was associated with a worse outcome on these scores.

We have shown good results in terms of clinical examination, with only two patients having an extension deficit in excess of 5° and five a flexion deficit of greater than 15°. All except one patient had a normal or nearly normal pivot-shift test. The research physiotherapists involved were experienced in the examination techniques, and we believe were particularly good at assessing the range of movement. The pivot-shift test is, however, more subjective, and it may be that these results are better than might be found by an experienced orthopaedic surgeon. They do, however, reflect the good functional results achieved by our patients.

The advantages of arthroscopic techniques are twofold. The avoidance of an arthrotomy allows more rapid rehabilitation and arthroscopy gives a much more accurate visualisation of the ACL attachments, permitting more precise placement of the tunnels. The midline arthrotomy approach tends to result in a much more vertical placement of the graft, with the femoral tunnel in particular being in the roof of the notch and outside the ACL footprint (Fig. 1), which may result in less complete correction of the pivot shift, although this was not found to be the case in our study. While detailed understanding of the anatomy of the ACL has led to the development of the concept of anatomical reconstruction, using a double-bundle technique, there is as yet no convincing evidence that this will lead to improved functional results over single-bundle arthroscopic techniques.22-24 The arthroscopic technique presented considerable technical challenges to those learning the procedure, and the double-bundle technique produces a further increase in complexity. Open surgery, which is now largely discredited in technical terms, provided a good long-term outcome functionally albeit with a high rate of radiologically evident osteoarthritis.

Our patients were generally satisfied with the results of surgery, with 83% to 92% scoring at least ‘good’ on the various questions, with the lowest score being on the ability to avoid lateral rotation of the tibia. However, the laxity/failure rate in those who were satisfied was less than 1% (1 of 79 patients).

Open reconstruction of the ACL gives durable functional improvement against which new innovations should be measured.

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References