THE ABC CARBON AND POLYESTER PROSTHETIC LIGAMENT FOR ACL-DEFICIENT KNEES

EARLY RESULTS IN 31 CASES

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We treated 39 knees with chronic deficiency of the anterior cruciate ligament by reconstruction using the ABC carbon and polyester prosthetic ligament; 31 (79.5%) were reviewed at an average follow-up of 34 months. There had been four complete failures requiring revision. The remaining 27 were studied in detail.

On the Lysholm rating, only 11 knees (41%) had good results with a score of over 76. The mean anterior drawer movement was reduced from 7.6 mm before operation to 5.8 mm at review. The mean difference from the opposite uninjured knee was 3.9 mm before operation, 1 mm (in 21 patients) at mean follow-up of 7.4 months and 2.5 mm (in 27 patients) at 34 months, indicating progressive loss of effect.

In our opinion the results are unsatisfactory: we do not recommend the use of this prosthetic ligament.

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Many operations have been described for the stabilisation of an anterior cruciate (ACL)-deficient knee. Methods of intra-articular reconstruction include the use of autogenous tissue such as the iliotibial band, the patellar tendon and the pes anserinus tendons, and attempts have been made to use the meniscus. Most of these procedures involve the sacrifice of normal structures, no one procedure has been completely satisfactory (Kennedy et

al 1980), and the long-term success of biological grafts is questionable (Noyes et al 1984).

An alternative approach is to use prosthetic ligaments, which have the advantages of supplementing normal tissue and being available in many sizes. The ideal prosthetic ligament should restore stability for a lifetime without inducing adverse reactions.

As early as 1914, Corner used a loop of silver wire but in the last three decades many different prosthetic ACL substitutes have been studied, including flexible carbon fibre (Jenkins 1978; Rushton, Dandy and Naylor 1983) and the polyester Leeds-Keio (Fujikawa 1988; Seedhom 1988) and Gore-Tex ligaments (Collins 1988).

The Surgicraft ABC prosthetic ACL (Surgicraft Ltd, Redditch, UK) has carbon and polyester fibres combined in a partial braid by a zigzag assembly, giving mechanical characteristics which are believed to be suitable for the replacement of the human adult ACL (Strover et al 1989). Previous reports on the short-term use of this ligament indicated good results (Tarachand 1990; O'Brien et al 1991), but these came from the centres at which the ligament had been developed. We now report our experience.

PATIENTS AND METHODS

Over a five-year period from January 1986, 39 patients with chronic ACL deficiency were treated by the ABC ligament. The indication was symptomatic instability incompatible with activities of daily living, sporting expectations or work, due to arthroscopically confirmed ACL deficiency. Meniscal or other intra-articular lesions were recorded and treated when necessary.

After operation, patients were reviewed at varying intervals, and 22 of them had arthrometric measurements at an average follow-up of 7.4 months (6 to 11). Of the 39 patients, 31 (79.5%) were reviewed at a minimum follow-up of 13 months (mean 34, SD 11.8). There were 27 men and four women; their mean age was 27.5 years (20 to 34). Of the eight patients not reviewed, five had moved from our area, two refused to attend and one could not be traced.

Operative technique. All the operations were performed by the senior author (MLH) who has a special interest in

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knee surgery. The ligaments were inserted by an open technique according to the following principles:

- 1) adequate notchplasty when necessary;
- 2) central to posterior placement of the tibial tunnel;
- 3) an 'over-the-top' route;
- 4) retrosynovial positioning of the prosthesis; and
- 5) optimum manual tensioning of the ligament with the knee at 20° flexion.

Postoperatively, the leg was immobilised in a back splint until suture removal at about two weeks, and then by a plaster cylinder cast for a further four weeks. Partial weight-bearing was allowed during these six weeks. The patients then had a six-week course of physiotherapy with emphasis on hamstring strength. Sport was banned for six months, and only light sport was allowed for the next six months. We did not actively encourage patients to take up contact sports; none of them was a professional sportsman, and the long-term implications of failure in young patients were considered to be too great to take unnecessary risks.

Patient assessment. At review, four patients (12.9%) with complete failures of their ABC ligaments had undergone revision procedures: two had had rupture of the prosthetic ligament and two had had unacceptable stretching. These knees were excluded from further analysis and the other 27 patients had a detailed evaluation as follows:

Lysholm score (Table I). We recorded a score of over 76 points as a good result, 76 to 68 as a fair result, and under 68 as a poor result (Lysholm and Gillquist 1982).

Anterior drawer laxity (ADL). This was measured at 20° of knee flexion using the Leicester arthrometer. The ADL of the injured knee was compared with preoperative values, and comparison was also made with the contralateral, uninjured knee.

Knee stiffness. The Leicester arthrometer was used to measure knee stiffness in the anteroposterior plane.

Pivot shift test. This was performed without anaesthesia.

Subjective assessment. The patient assessed his knee by choosing one of the options shown in Table II.

The Leicester arthrometer. This apparatus is a rigid, chair-like structure with an attached adjustable frame, which holds the thigh and ankle while anterior drawer measurements are performed on the knee (Fig. 1). The framework can be adjusted to hold the knee securely at 20° of flexion during measurement. The leg is secured by Velcro straps but it is difficult to eliminate all movement other than that of the knee. To minimise possible errors, readings are taken as the difference in displacement between one linear displacement transducer on the patella and another on the tibial tubercle (Fig. 2). The output from these transducers passes through a difference amplifier which monitors only relative motion between the two. The transducers are positioned accurately by vernier carriages attached to the supporting frame and adjustable in three planes. Anterior drawer laxity is displayed on a conventional chart recorder.

Patients were encouraged to relax and trial readings

Table I. Lysholm scores by number and percentage of patients

	Poor <68	Fair 68 to 76	Good >76
Preoperative (n=27)	17 63	6 22	4 15
Review (n=27)	10 37	6 22	11 41

Table II. Patients' opinions of their results at a mean follow-up of 34 months

	Number
Much better	11
Slightly better	11
No change	2
Slightly worse	1
Worse	2

Fig. 1

The Leicester arthrometer in use.

Fig. 2

Linear displacement transducers placed against the patella and the tibial tubercle to measure anterior drawer laxity.

were performed. Displacement was manual, by pressure from the tester's hand placed behind the leg at a level just below the tibial tubercle. A strong pull was applied to elicit maximum displacement, three measurements being made of both the injured and uninjured knees. The instrument was regularly calibrated by moving one of the transducers a known distance along its vernier scale against a firm surface.

Anteroposterior knee stiffness was assessed by the addition of a force transducer to the displacement transducers, placed at the site of manual pressure (Fig. 3) and calibrated with a spring balance for a pull up to a maximum of 100 N. The gradient of the resultant force-displacement curve is the stiffness of anteroposterior movement of the knee in N/mm.

All measurements were made by one observer: reliability and reproducibility were validated by previous unpublished studies, and the stiffness results for acute knee injuries have been reported previously (Learmonth et al 1991).

RESULTS

Arthroscopic findings. Medial meniscus lesions were found in 13 of the 31 knees, lateral meniscus lesions in two and lesions of both menisci in three. Eleven patients had some damage to the articular surface. One patient had grade I laxity of the medial collateral ligament and another had grade I laxity of the lateral collateral ligament.

Lysholm scores. The mean Lysholm score before operation was 59 ± 16 (SD) (25 to 87); at review it was 71 ± 19 (28 to 99). The improvement was statistically significant (paired *t*-test, $p < 0.001$), but the mean increase was only 12 ± 9.9 (-3 to 33). The distribution of Lysholm scores before operation and at review is shown in Table I. Only 11 of 27 patients (41%) had good results.

Anterior drawer laxity (ADL). The ADL of the injured knees before operation was 7.6 ± 3.0 mm (3.4 to 12.4), and at review 5.8 ± 2.0 mm (1.8 to 9.5). The mean decrease in ADL was 1.8 ± 2.8 mm (-3.4 to 8.5); by the paired *t*-test, $p < 0.003$.

The mean difference in ADL between the injured and uninjured knees before operation was 3.9 ± 2.0 mm (0.6 to 7.9). For the 22 patients who had arthrometric measurements soon after operation, after a mean interval of 7.4 months, this difference was 1.0 ± 0.54 mm (range -0.2 to 2.0), indicating a mean improvement in the side-to-side difference of 2.9 mm ($p < 0.001$, unpaired *t*-test).

At later review, after a mean interval of 34 months, the ADL difference had a mean value of 2.5 ± 2.5 mm (-2.9 to 6.4). The mean loss from the initial improvement was 1.5 mm ($p < 0.006$, unpaired *t*-test), leaving mean improvement from the preoperative value of 1.4 ± 1.6 mm (-2.2 to 4.9); paired *t*-test, $p < 0.001$.

Knee stiffness. The mean anteroposterior stiffness of the injured knees at review was 12 ± 5 N/mm (8 to 26), less

Fig. 3

Use of a transducer hooked around the upper tibia to assess the anteroposterior stiffness of the knee in Newton/millimetres from a force-displacement curve.

than half the 27 ± 11 N/mm (9 to 56) of the uninjured knees, with a mean difference of 15 ± 12.8 N/mm (8 to 46), SD 12.8, (paired *t*-test, $p < 0.001$).

Pivot shift test. Preoperatively, 25 (93%) of the 27 knees had a positive pivot shift test. At review, four (15%) knees had a positive and 12 (44%) a negative test. For 11 knees (41%) the result was equivocal because patients were unable to relax sufficiently to allow a proper test.

Subjective impressions. The patients' views of the results are shown in Table II. Eleven patients (41%) said that they had obtained significant improvement.

Revisions. Two patients had revision for a complete rupture of the ligament. In one, rupture resulted from a twist while playing football, and the other occurred while climbing stairs. In the case notes of one the rupture was noted to be near the tibial exit hole, but the site of the other was not recorded. In two patients the ligaments had stretched enough to allow instability incompatible with daily living activities.

DISCUSSION

The two previous reports on the results of the use of the ABC carbon and polyester ligament alone for chronic ACL deficiency (Tarachand 1990; O'Brien et al 1991) were on patients treated by the originators of the prosthesis. Good results were obtained, but were at a mean follow-up of less than three years. It is now accepted that valid assessment of the results of ACL reconstruction using prosthetic implants requires a minimum follow-up of about six years. Table III, however, shows that our population and follow-up are comparable with those of the previous studies.

Tarachand (1990) reported an increase in the mean Lysholm score from 33.5 to 82.8, with 62.5% scoring over 83. O'Brien et al (1991) found an increase in the mean

Table III. Three reports on the use of the ABC prosthetic ligament

	Number		Mean follow-up (mth)	Age range (yr)	Meniscal lesions (per cent)	Articular lesions (per cent)
	Male	Female				
Tarachand (1990)	37	3	29.7	20 to 43	63	50
O'Brien et al (1991)	75	12	35	—	—	—
Mody et al (1993)	27	4	34	20 to 34	66	41

Lysholm score from 66 to 94, with 76% scoring over 90. Both reviews used a higher level for a good result (we used > 76) but still had a higher proportion of good results than our 41%.

In addition, Tarachand (1990) reported that only 25% of her patients had a positive pivot shift test at review. In our study only 12 (44%) patients were definitely negative. Tarachand (1990) described six ruptures (15%) and O'Brien et al (1991) reported 20 cases of unacceptable stretching (17%); we found four failures in our group of patients (12%).

This prosthetic ligament appears to be associated with a high failure rate, and in our hands it has failed to yield a satisfactory level of good clinical results. It could be argued that the results depend more on the surgeon's skill, and that the prosthesis itself is not to blame. All our patients were operated on by an experienced consultant with a special interest in the treatment of ACL deficiency. If, indeed, the prosthesis is so sensitive to surgical technique, then it cannot be recommended for general use by the average orthopaedic surgeon.

We conclude, on these early results, that the ABC prosthetic ACL should not be used for the surgical treatment of chronic ACL insufficiency.

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