Introduction

Single-bundle auto-graft is now the most widespread technique of anterior cruciate ligament (ACL) reconstruction and gives good clinical results that are acceptable in most cases. There is, however, an appreciable failure rate that may necessitate revision surgery and some cases that are partially successful, including a group of patients who have a residual ‘pivot-glide’ (14–30% of cases [10, 14, 15]). In an effort to address this, there has been a recent interest in trying to reconstruct the ACL in a manner that better replicates the native anatomy. The ACL is often considered to be made up of a number of functional fiber bundles. Some authors have recognized three groups [2] but most distinguish only two: the posterolateral bundle (PLB) and the anteromedial bundle (AMB) [9, 13, 28]. These may be reconstructed individually using hamstring tendon auto-grafts. Although cadaveric work has demonstrated that two bundles can replicate the function of the native ligament more effectively than a single bundle [18, 28], a recent clinical study did not show any advantage in a double-bundle reconstruction over a single-bundle reconstruction in terms of knee stability [1]. However, this study used two femoral tunnels and only a single tibial tunnel. It has been suggested that knee kinematics following reconstruction might be improved by using two tibial tunnels to increase the area of the tibial “footprint” [22].

Abstract

We reviewed 33 patients who underwent anterior cruciate ligament (ACL) reconstruction using a two-bundle, four-tunnel technique. The posterolateral bundle (PLB) and anteromedial bundle (AMB) were individually reconstructed with gracilis and semitendinosus tendon auto-grafts, respectively, using separate tibial and femoral tunnels. At final follow-up (24 months post surgery, range 18–31) the International Knee Documentation Committee’s (IKDC) objective final evaluation scores were 69 A, 19 B, 12% C. The mean global subjective IKDC score was 86±12 points. Ninety-four percent of the patients had returned to sport after an average of 9 months following surgery and 75% returned to their preinjury sporting level. One patient had suffered a graft rupture as a result of a further sports injury. Eighty-four percent of the patients had a negative pivot shift (IKDC A), 9% a glide (IKDC B), and 6% a “clunk” (IKDC C). The mean postoperative side-to-side laxity, measured with KT1000 arthrometry at manual maximum, was 0.9 mm (SD 1.9). Eighty-one percent of the patients had less than 3 mm difference, with only one patient having greater than 5 mm. Our early experience with this new technique appears to demonstrate satisfactory results that are at least equivalent to other techniques and show an apparent trend towards improved control of anterior laxity.

Keywords

ACL reconstruction · Hamstring tendon · Double-bundle · Four-tunnel
Since this type of reconstruction appears more anatomical, it may function more physiologically, thus improving knee stability and the quality of clinical results.

This study presents the results of a two-bundle, four-tunnel ACL reconstruction technique at an average of 23.7 months postoperative follow-up. Gracilis and semitendinosus tendon auto-grafts were used to reconstruct the PLB and AMB, respectively, with each graft having its own femoral and tibial tunnels.

**Material and methods**

**Patients**

Between June 2001 and October 2002, 456 patients underwent ACL reconstruction in our clinic. In 35 patients, (8%) a two-bundle, four-tunnel technique was used and these patients were subsequently followed-up. The indication for surgery was a patient diagnosed with ACL rupture by both clinical examination and MRI, who suffered instability symptoms. None of the patients had advanced chondral lesions (greater or equal to ICRS stage II) or concomitant peripheral ligamentous injuries. Four patients had undergone a previous minor arthroscopic procedure: three partial meniscectomies and one diagnostic arthroscopy performed in another unit. All the patients were operated upon by a single surgeon and underwent the same postoperative rehabilitation protocol. In all patients, the diameter of the two-strand gracilis graft was greater than 5 mm, and semitendinosus graft greater than 6.5 mm. Smaller tendon diameters were reconstructed using a single-bundle technique. This occurred in three patients in whom a two-bundle reconstruction had been planned. No additional extra-articular surgery (e.g., osteotomy or rotatory stabilization) was performed in addition to the ACL reconstruction.

**Operative technique**

We used a two-bundle, four-tunnel technique previously described in a technical note [3]. The tourniquet time was measured from its inflation just prior to the first skin incision, to the placement of the final skin suture. An arthroscopy was performed to evaluate the menisci and articular surfaces. Subsequently the gracilis and semitendinosus tendons were harvested using a tendon stripper, which allowed the whole length of the tendons to be taken. After removing the residual muscle from the tendons, each was doubled over a continuous loop EndobuttonCL® (Smith and Nephew, Mansfield, MA, USA). A 30 mm EndobuttonCL® was used for the semitendinosus graft and a 15 mm EndobuttonCL® for the gracilis. The doubled tendons were whipstitched, with an absorbable number 1 suture, over 40 mm of their length and their diameter was then measured (grafts and the corresponding tunnel diameters were sized in 0.5 mm increments). Following this, the two femoral tunnels were prepared via the anteromedial portal. The guide wire for the AMB tunnel was placed in the “11 o’clock” position in the right knees (“1 o’clock” in the left knees) and 5 mm from the posterior edge of the lateral condyle in the intercondylar notch. After drilling the AMB tunnel, a femoral PLB guide (Fig. 1) was used to position the PLB tunnel. The appropriate size guide, corresponding to the size of the AMB femoral tunnel, was introduced into the AMB tunnel and then
rotated so that the PLB tunnel was started more laterally, at the “half-past-two” position in the notch. The guide allowed the PLB tunnel to be drilled so that the two femoral tunnels diverged at 15° and a 2 mm bony bridge was left between them in the intercondylar notch. The length of the PLB tunnel was, therefore, relatively shorter.

The tibial PLB tunnel was then drilled from a point just anterior to the medial border of the tibia to emerge in the joint at the edge of the lateral border of the medial tibial spine. The AMB tibial tunnel was started anterolaterally to the PLB tunnel, with the entry point just medial to the tibial tuberosity. The tunnels converged to leave a 2 mm bony bridge between them as they emerged into the knee joint (Fig. 2). The diameter of the tunnels corresponded to the respective diameters of the grafts.

The gracilis graft was drawn into the PLB tunnels first, and then the semitendinosus graft into the AMB tunnels (Fig. 3). Tibial fixation was performed with oversized bioabsorbable screws (Bio-RCI HA® Smith and Nephew, Mansfield) to optimize interference fixation: 7 mm×20 mm for PLB and 9 mm×30 mm for AMB tunnels. Graft tensioning was undertaken manually. The PLB was fixed at 20° of knee flexion and the AMB at 90° of flexion.

Postoperative care

The patients were allowed to bear weight as much as tolerable immediately postoperation, in a hinged knee brace allowing a protected range of motion from 0 to 60° for the first 3 weeks, then 0 to 90° until the brace was discarded at 6 weeks. Patients performed bicycling exercises for the first 2 postoperative months, began jogging at 3 months, and at 3 to 6 months multidirectional activities were progressively introduced into the supervised rehabilitation program. At 6 months postop, isokinetic testing was performed and return to sporting activities was allowed if the hamstrings and quadriceps deficits of the operated knee were within 15% of that of the uninjured knee.

Outcome evaluation

The patients were evaluated pre- and postoperatively for knee function and stability according to the guidelines of the International Knee Documentation Committee (IKDC). The IKDC knee examination form was completed for all the patients preoperatively and at final follow up. Results compared included knee effusion, range of motion, patello-femoral compartment findings, ligamentous laxity, and a functional test. An effusion was assessed for by balloting the knee. Passive range of motion was assessed using a goniometer and the lack of hyperextension and/or flexion recorded. Patello-femoral joint pain and crepitus were assessed by extension against resistance and graded. The one-leg
The hop test was used to assess function. The test was performed three times and the maximum distance achieved was recorded. Anterior laxity was assessed clinically by a Lachman test and measured in the injured and uninjured knee using KT1000 arthrometry (MEDmetric, San Diego, CA, USA) at 30 lb and at manual maximum. Pre- and postoperative side-to-side differences were compared. Radiographic assessment by the Telos system (measuring the anterior displacement of the posterior edge of the medial tibial plateau with a 250 N anterior load applied to the tibia on a plain lateral radiograph) was also performed preoperatively and at final follow-up.

Intra-operative and postoperative complications such as graft failures, wound complications, and the management of postoperative stiffness were recorded. Plain antero-posterior and lateral radiographs were taken at the final follow-up to assess for bone tunnel enlargement. The width of the tunnel was measured in both views and the pattern of tunnel enlargement (conical, fusiform, or parallel), if present, was noted. The AMB tunnels were considered enlarged if their diameters exceeded 10 mm, and the PLB greater than 8 mm, at any point along their lengths.

All the patients also completed an IKDC Subjective Knee Evaluation Form preoperatively and at final follow-up to assess symptoms, sports activities, and function. A 10-point score assessed current knee function. Patients were also asked at final follow-up whether they had returned to their preoperative sporting level. This was assessed as “competition” (high level sportmen, professional or amateur, with more than two official training sessions per week), “recreational” (sportmen playing regularly, at a good level, but less intensely), or “active” (occasional sportmen performing an activity involving either pivoting, running or jumping).

Statistical analysis

Differences between pre- and postoperative laximetry data were examined for statistical significance with a two-tailed paired Student t-test using the Statsview software package (Statsnet sprl, Brussels, Belgium). Significance was defined as $P=0.05$ for a 95% alpha level.

Results

Demographic data

Of the 35 patients, 2 patients were lost to the final follow up and excluded from the study. The study cohort therefore, comprised 33 patients, average age being 30 years (range, 18–42 years). There were 27 men (81.8%) and 6 women. The right knee was injured in 21 patients (64%) and the left in 12. Thirty-two patients (97%) played sport preoperatively: 25 (79%) were “competition” level athletes and 7 (21%) played sport at a “recreational” level. The most frequently played sport was soccer (17 patients, 52%), with the next most common sports being handball, rugby, tennis, and cycling. Twenty-nine patients (88%) sustained their ACL injury whilst playing sport. Our patients were essentially those with chronic ACL insufficiency: the average length of time from injury to operation was 14.5 months (range, 28 days–73 months) and 29 patients (88%) underwent surgery at greater than 3 months after injury. The average duration of postoperative follow-up was 23.7 months (range, 18.2–31 months). One patient, a 20-year-old man, re-ruptured his graft 8 months postoperatively when he was tackled whilst playing soccer. His subjective IKDC results and laxity measurements at final follow up were therefore excluded from comparative analysis.

Surgical findings and associated procedures at reconstruction

We found nine lateral meniscal lesions (of which five were resected and four were left), and nine medial meniscal lesions (of which two were stable and left). In three cases we performed meniscal suturing. Seven patients were found to have grade II cartilage lesions, two in the lateral compartment and five in the medial compartment. Hamstrings graft diameters used varied between 6.5 and 7.5 mm for the AMB and between 5 and 6 mm for the PLB (Table 1). The mean tourniquet time for the procedure was 45 min (range 37–55 min).

IKDC subjective assessment

Final follow-up subjective IKDC scores were obtained from 32 patients. The patient who underwent a revision procedure prior to final follow-up was excluded. Twenty-four patients (73%) rated their knees as greater than 8 out of 10, 5 patients (16%) scored 7 out of 10, and 3 patients less than 5 out of 10. Five patients (16%) complained of some pain (between 6 and 7 out of 10 for severity). Three patients (9%) complained of some knee swelling (moderate or greater), and six patients (19%) noticed some knee instability, three with very strenuous activities, two with strenuous activities, and one with moderate activities. Five patients had difficulties kneeling and six had difficulties while crouching, all complained of either mild or moderate anterior knee pain. The mean global subjective IKDC score was $86 \pm 12$.
(range, 54–100), with 81% of the patients scoring 80 points or greater and eight patients (25%) scoring the 100-point maximum.

**IKDC objective assessment**

**Group grades**

The postoperative objective IKDC group grades for knee effusion, passive motion deficit, ligament examination, and the functional test are shown in Table 2. The passive motion deficit group grade was determined from the lack of extension and flexion. The ligament examination group grade was determined from the IKDC scores for the anterior drawer, Lachman end-point, instrumented Lachman test (KT 1000 at 30 lbs), posterior drawer, medial and lateral joint opening at 20°/C176, pivot shift and reverse pivot shift tests. For each patient, their worst group grade score determined the final overall evaluation score. The most common reason for patients achieving overall grades B or C was due to knee laxity.

**Range of motion**

Patients’ preoperative range of motion was good, with 91% of the patients scoring A or B for flexion and 97% scoring A or B for extension. At final follow-up, all the patients scored either A or B for flexion and extension, except one patient (3%) who showed an extension deficit of 5° or more (IKDC C).

**Ligament laxity**

Pre- and postoperative manual and instrumented laxity data are shown in Table 3. At final follow-up, the Lachman test on the operated knee was negative in 28 patients (85%), 1+ in 3 patients (9%), and 2+ in 1 patient. Twenty-seven patients had a negative pivot shift test (IKDC A), three patients had a 1+ “glide”, and two patients a 2+ “clunk”. Preoperatively and final follow-up side-to-side differential instrumented laxity data were compared in 27 patients. Six patients were excluded: the patient who re-ruptured and underwent revision surgery, two patients who had sustained previous contralateral ACL ruptures, and three patients who sustained contralateral ACL ruptures postoperatively and prior to final follow-up. Preoperatively, average side-to-side differential laxity was 7.3 mm (SD 2.8) using KT 1,000 at 30 lb, and 7.7 mm (SD 2.7) at manual maximum. Postoperatively, average side-to-side differential laxity was 0.9 (SD 1.7) at 30 lb and 0.9 (SD 1.9) at manual maximum ($P < 0.001$). Eighty one percent of the patients had less than 3 mm side-to-side difference at manual maximum, with only one patient having greater than 5 mm. The mean improvement in laxity, between the preoperative assessment and final follow-up, measured by KT 1000 at 30 pounds was 6.9 mm (SD 3.3).

**Functional test**

Preoperatively, the maximum distance achieved on the injured knee was less than 50% (IKDC D) of that for the uninjured limb in 24 cases (80%). Postoperatively, all the 32 patients achieved greater than 90% (IKDC A) of the other limb.

**Radiographic findings**

The radiographic appearances were satisfactory, with only one case showing minor osteolysis around a tibial screw. At final follow-up 87% of the tibial tunnels showed no enlargement. There was one case of conical enlargement and two cases of parallel enlargement. On the femoral side seven tunnels had balloon type

### Table 1 Graft diameters used for the two-bundle, four-tunnel reconstruction ($n=33$)

<table>
<thead>
<tr>
<th>Graft diameter (mm)</th>
<th>AMB</th>
<th>PLB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of patients %</td>
<td>No. of patients %</td>
</tr>
<tr>
<td>5</td>
<td>17</td>
<td>55</td>
</tr>
<tr>
<td>5.5</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>6.5</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>14</td>
<td>43</td>
</tr>
<tr>
<td>7.5</td>
<td>9</td>
<td>27</td>
</tr>
</tbody>
</table>

### Table 2 Objective IKDC group grade scores at final follow up ($n = 32$)

<table>
<thead>
<tr>
<th>IKDC group grade</th>
<th>Effusion</th>
<th>Passive motion deficit</th>
<th>Ligament examination</th>
<th>Functional test</th>
<th>Final overall evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of patients %</td>
<td>No. of patients %</td>
<td>No. of patients %</td>
<td>No. of patients %</td>
<td>No. of patients %</td>
</tr>
<tr>
<td>A (Normal)</td>
<td>30</td>
<td>94</td>
<td>29</td>
<td>91</td>
<td>23</td>
</tr>
<tr>
<td>B (Nearly normal)</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>C (Abnormal)</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D Severely abnormal</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
Table 3 Comparison of preoperative and final follow-up laximetry data

<table>
<thead>
<tr>
<th></th>
<th>A Normal</th>
<th>B Nearly</th>
<th>C Abnormal</th>
<th>D Severely</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0–2 mm</td>
<td>3–5 mm</td>
<td>&gt; 10 mm</td>
<td></td>
</tr>
<tr>
<td>Preop Lachman</td>
<td>3</td>
<td>20</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Pivot shift (n=32)</td>
<td>2</td>
<td>29</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ant. drawer (n=32)</td>
<td>2</td>
<td>4</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>KT 30 lb (n=27)</td>
<td>9</td>
<td>14</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>KT MM (n=27)</td>
<td>6</td>
<td>15</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Telos (n=27)</td>
<td>5</td>
<td>5</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>PostOp Lachman</td>
<td>28</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Pivot shift (n=32)</td>
<td>27</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Ant. drawer (n=32)</td>
<td>27</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>KT 30 lb (n=27)</td>
<td>23</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>KT MM (n=27)</td>
<td>22</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Telos (n=27)</td>
<td>13</td>
<td>8</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

enlargement (mostly the AMB tunnel). There was no evidence of fixation material migration in any patient.

Using the Telos radiographic method to assess anterior laxity, average preoperative side-to-side differential laxity was 9.1 mm (SD 5.1). At final follow-up, the mean side-to-side difference between the operated and nonoperated knee was 0.7 mm (SD 2.8, P < 0.001). Pre-and postoperative results by IKDC grade are shown in Table 3.

Return to sport

At final follow-up, 30 patients (94%) had returned to sports. 19 (76%) of the “competition” level athletes reported that they had returned to their preinjury sporting level, five (21%) had dropped to a “recreational” level, and one patient had given up sports. The return to sport was at an average of 9 months (range, 5–21 months) postop.

Complications

There was one graft failure as a result of a new trauma. This patient went on to revision surgery using a single-bundle technique. There were no wound complications, deep infections, cyclops lesions, or tendonitis, and no patient complained of pain or irritation at the graft harvest site. There were two cases of reflex sympathetic dystrophy, both of which recovered spontaneously. Two patients had difficulty in regaining joint range of motion in flexion: one required manipulation under general anesthesia and the other required an arthroscopic arthrolysis. Two patients required further arthroscopy, one for failed meniscal suture, which was treated by meniscectomy, and the other for the appearance of a tibial cyst, presumably due to the synovial fluid passing through the cannulated screw. This screw was removed 1 year postoperatively without any adverse effect on knee stability.

Discussion

Several authors have proposed two-bundle ACL reconstruction grafts using either one or two tunnels in the femur and one or two tibial tunnels [3, 8, 11, 12, 18, 20, 22, 27]. The position of the AMB is well represented by the classic single-bundle ACL reconstruction and the graft behaves in a biomechanically similar way. However, whilst the AMB better restrains anterior tibia translation at greater than 45° of knee flexion [17, 25] the PLB is less isometric and is a more important restraint towards full extension [5]. The PLB may also have a role in limiting tibial rotation due to its greater excursion around a vertical axis in the center of the joint [28] and previous cadaveric experiments have demonstrated that the two-bundle grafts are more effective at restraining anterior translation and rotation of the tibia than single-bundle reconstructions [18, 28].

As early as 1983, Mott [21] began describing clinical experience with “anatomical” ACL reconstructions and Zaricznyj [29] reported 14 cases employing a single femoral tunnel and two tibial tunnels. Pederzini et al. [23], in a technical note, proposed the use of the quadriceps tendon graft with similar tunnels, whilst Takeuchi et al. [27] used a bone–hamstring–bone composite graft with the semitendinosus, in two strands, doubled over two bony plugs, twisted round each, other and fixed with two interference screws. This was again a technical note and without any clinical follow-up results. Two other similar techniques were reported by Hara et al. [12] and Marcacci et al. [20] in which the PLB was passed over a loop above the lateral condyle with a single tibial tunnel. However, prospective clinical trials comparing single and double-bundle techniques (using one tibial tunnel and two femoral tunnels) have concluded that the two different techniques provide satisfactory stability and failed to show any significant differences between subjective results, laxity measurements, or joint position sense [1, 11]. Nevertheless, Muneta et al. [22] suggested that two separate drill holes in both the tibia and femur are needed to regain a structure that both morphologically and functionally resembles a normal ACL. A larger tibial “footprint” may also improve graft healing by increasing the area of the bone–tendon junction. He reported results of 54 patients at 2 years follow-up using hamstring tendons in four separate tunnels, employing
taped endobuttons for femoral fixation and sutures tied round a screw for tibial fixation. Postoperatively, 11% of the patients had a 1+ Lachman test. The pivot shift was a glide (1+) in 18.5% of the cases and frank (2+) in one patient. Laximetry with KT 1000 at 20 lb was 1.2 mm on average (±1.8 mm) and at manual maximum was 2 mm (±1.9 mm). In general, these results were equivalent to those reported for single-bundle techniques but the authors suggested a better trend with respect to the control of anterior laxity.

In our study, we found the average postoperatively side-to-side differential laxity was 0.9 (SD 1.7) with KT 1000 at 30 lb and 0.9 (SD 1.9) at manual maximum and only one patient having greater than 5 mm difference. This reduced laxity may have been due to the difference in the rigidity of the fixation methods [19] that we used compared to those used by Muneta et al. However, the tendency towards improved anterior laxity that they showed was replicated, with the postoperative side-to-side differences in anterior instrumented laxity being less than that reported in some contemporary single-bundle series: between 1.4 and 2 mm [6, 7, 26]. The persistence of a pivot shift in 16% of the patients (9% 1+ “glide” and 7% 2 + “clunk”) was comparable with single-bundle techniques [10, 14, 15] and it still remains to be seen whether the two-bundle, four-tunnel reconstruction better controls this more complex instability.

There have been concerns voiced that performing a reconstruction with four tunnels may lead to problems with bone stock, in cases of tunnel enlargement resulting in considerable technical difficulties with revision surgery should it be required. However, in a previous analysis of 200 reconstructions with a single-bundle fixed with interference screws (RCI, Smith and Nephew) we reported 45% tibial tunnel widening and 40% femoral tunnel enlargement [6], and other authors have reported 25 and 28%, respectively [16]. In the double-bundle technique reported here, there was 13% tibial and 21% femoral tunnel widening, indicating that performing a four-tunnel technique does not appear to constitute a significant risk to bone loss.

Not only has there been worry about the possible further downsides of the increased number of fixation devices, some surgeons have expressed concern about the extra time required to perform two-bundle reconstruction, and the potential increased risk of stiffness due to the additional trauma to the knee. Although two patients in our study did require further interventions for difficulty in regaining motion, the mean tourniquet time was 45.3 min, which was shorter than that used for single-bundle ACL reconstruction techniques in some recently published papers [4, 24].

This study does have some inherent weaknesses. The use of hamstring tendons appears to be ideal for this technique but patients with small tendon diameters were excluded. This may have introduced selection bias that may favor this technique when compared historically to other hamstring techniques. It is possible that the preparation of the graft could be adapted in patients with poor quality grafts, by forming a triple strand graft for each tendon, thereby enhancing graft dimension. It also would have been useful to have compared laximetry measurements throughout the range of flexion (using for example a Rolimeter) to demonstrate if the recruitment of different bundles at different degrees of flexion improved AP stability at all degrees of flexion.

The study must also be interpreted with some caution due to the small number of patients. Nevertheless, it represents important data on this relatively new concept in ACL reconstructive surgery. These patients represent a consecutive series, which introduces a component of “learning curve bias” experienced by any surgeon performing a new technique, and the results of this study may be less favorable than a subsequent group of patients. Although the surgery is more demanding and requires specific instrumentation to perform, we are encouraged that our initial experience with this more anatomical type of reconstruction showed knee stability at least equivalent to traditional techniques and suggested a trend towards improved control of anterior laxity. Whether a four-tunnel, two-bundle technique has longer term benefits is yet to be seen.

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