A follow-up arthroscopy after anterior cruciate ligament reconstruction using the patellar tendon augmented by woven polyester

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Abstract

Follow-up arthroscopy was performed on 92 patients who had undergone anterior cruciate ligament (ACL) reconstruction with patellar tendon augmented by woven polyester. The interval between surgery and arthroscopy ranged from 6 to 26 months, with a mean of 13.1 months. The patients were classified into 4 grades according to the arthroscopical findings as follows: grade I, ligamentous tissue ruptured or not observed; grade II, loose and thin ligamentous tissue observed; grade III, thick and taut ligamentous tissue observed, but some ligamentous strands exposed from the synovial tissue; grade IV, thick and taut ligamentous tissue with a synovial tissue observed, as in normal ACL.

Based on the arthroscopical findings, 4 of the 92 patients were rated as grade I, 11 as grade II, 24 as grade III, and 53 as grade IV. Correlation between the arthroscopical and functional test results indicated that the mean injured-to-uninjured differences of KT-1000 measurements were significantly smaller in the grade IV group than in the grade I and grade II groups (p < 0.05). These results suggest that postoperative anterior knee laxity correlate significantly with arthroscopical results, and is a useful parameter for evaluating ACL reconstruction. (J Nippon Med Sch 1997; 64: 512–517)

Key words: anterior cruciate ligament, arthroscopy, artificial material

Introduction

Patellar tendon (PT) grafts have been widely used for anterior cruciate ligament (ACL) reconstruction, but varied success rates have been reported. Recently, several ligament augmentation devices, such as woven polyester and polypropylene, have been developed in ACL reconstruction. The use of ligament augmentation devices may allow early mobilization and weight bearing after surgery, resulting in acceptable outcomes. The goal of ACL reconstruction is morphological and functional restoration of damaged ligamentous tissue, but there have been few morphological studies on human subjects.

The purpose of this study was to evaluate arthroscopically composite grafts with patellar tendons augmented by woven polyester after ACL reconstruction, and to determine the extent of correlation between arthroscopical and functional test results.

Materials and Methods

Patient population

Between 1987 and 1994, 92 patients underwent follow-up arthroscopic examinations after ACL reconstruction. These examinations were performed with the patients' consent at the time of hardware removal to determine the condition of the transplanted ACL grafts, and to provide the patients with practical guidelines for subsequent
physical and sporting activity.

There were 52 males and 40 females examined with a mean age of 24.6 years (range: 14-57 years). Seventy-two of the patients had associated injuries: 51 had meniscal tears, and 24 had medial collateral ligament injuries.

Surgical procedure and rehabilitation programs

One-third of PT with bone blocks on both ends was harvested, and tubed with absorbable sutures (Fig. 1). Woven polyester (Leeds-Keio augmentation device) was sutured tightly around PT to make a composite graft with a diameter of 8 mm. The graft was passed through the tibial and femoral tunnels, and fixed to the femur with 2 staples, and to the tibia with a screw.

On the third postoperative day, ROM exercises on the CPM device were begun. Partial weight bearing was allowed 2 weeks after surgery, increasing to full weight bearing at 8 weeks. Isotonic muscle exercises were started at 2 weeks, and isokinetic muscle exercises with ARIEL-CES (180 deg/sec) at 4 weeks.

Arthroscopical and functional evaluations

The mean interval between surgery and arthroscopy ranged from 6 to 26 months, with a mean of 13.1 months. Twenty-two arthroscopical examinations were carried out less than 12 months postoperatively, 68 between 12 months and 24 months, and 2 after more than 24 months. The patients were classified into 4 grades according to the arthroscopical findings as follows: grade I, ligamentous tissue ruptured or not observed; grade II, loose and thin ligamentous tissue observed; grade III, thick and taut ligamentous tissue observed, but some ligamentous strands exposed from the synovial tissue; grade IV, thick and taut ligamentous tissue with a synovial tissue observed, as in normal ACL (Fig. 2).

Postoperative knee function was evaluated by KT-1000 arthrometer measurement for anterior knee laxity, range of motion (ROM) and loss of thigh circumference. The KT-1000 arthrometer measurement was performed at 20 knee flexion with 90 N of force. Statistical analysis was performed by variance and chi square tests, and p=0.05 was accepted as the minimum level of significance.

Results

Based on the arthroscopical findings, 4 of the 92 patients (4.3%) were rated as grade I, 11 (12.0%) as grade II, 24 (26.1%) as grade III, and 53 (57.6%) as grade IV. The relationship between the arthroscopical findings and time after surgery is shown in Table 1.

Postoperative KT-1000 arthrometer measurements showed that the mean injured-to-uninjured difference in anterior knee laxity was 1.8 ± 1.7 mm (range: -2.6 to 6 mm). Seventy-eight patients had a difference of 3 mm or less, 12 patients 3 to 5 mm, and 2 patients 5 to 7 mm. The mean knee extension was -0.4 ± 1.9°, and 4 patients had a limitation of 10°. The mean knee flexion was 148.9 ± 3.7°; 6 patients had a limitation of 10°, and one 20°. The mean ROM was 148.4 ± 4.5°, and 87 patients (94.6%) had full range motion. The mean loss of thigh circumference was 1.2 ± 1.0 cm (range: 0 to 5 cm), and a loss of 1 cm or less was obtained in 47 of the patients (51.1%).

Correlation between arthroscopical and func-
grade I

grade II

grade III

grade IV

Fig. 2 Arthroscopical evaluation of grafts after reconstruction
Arthroscopical results were classified into 4 grades as follows: grade I: ligamentous tissue ruptured or not observed; grade II: loose and thin ligamentous tissue observed; grade III: thick and taut ligamentous tissue observed, but some ligamentous strands exposed from the synovial tissue; grade IV: thick and taut ligamentous tissue with a synovial tissue observed, as in normal ACL.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Time (months) 6-12</th>
<th>12-18</th>
<th>18-24</th>
<th>24-</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>2</td>
<td>8</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>III</td>
<td>6</td>
<td>16</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>IV</td>
<td>14</td>
<td>36</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>63</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2 Correlation between arthroscopical results and post-operative KT-1000 measurement

<table>
<thead>
<tr>
<th>Grade</th>
<th>mean injured-to-uninjured difference</th>
<th>cases with a difference of 3 mm or less</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>3.9 ± 0.9 mm</td>
<td>0/4 (0%)</td>
</tr>
<tr>
<td>II</td>
<td>2.4 ± 1.7 mm</td>
<td>6/11 (54.5%)</td>
</tr>
<tr>
<td>III</td>
<td>2.2 ± 1.9 mm</td>
<td>17/24 (70.8%)</td>
</tr>
<tr>
<td>IV</td>
<td>1.3 ± 1.6 mm</td>
<td>49/53 (92.4%)</td>
</tr>
</tbody>
</table>
| Total | 1.8 ± 1.7 mm                         | 72/92 (78.2%)                           | (*p < 0.05)

Table 3 Correlation between arthroscopical results, ROM, and loss of thigh circumference

<table>
<thead>
<tr>
<th>Grade</th>
<th>ROM</th>
<th>loss of thigh circumference</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>146.3 ± 4.8°</td>
<td>1.1 ± 1.0 cm</td>
</tr>
<tr>
<td>II</td>
<td>149.1 ± 3.0°</td>
<td>1.2 ± 0.9 cm</td>
</tr>
<tr>
<td>III</td>
<td>149.4 ± 2.2°</td>
<td>1.5 ± 0.9 cm</td>
</tr>
<tr>
<td>IV</td>
<td>148.0 ± 5.5°</td>
<td>1.1 ± 1.1 cm</td>
</tr>
<tr>
<td>Total</td>
<td>148.5 ± 4.5°</td>
<td>1.2 ± 1.0 cm</td>
</tr>
</tbody>
</table>

No correlation was demonstrated between arthroscopical results, ROM, and loss of thigh circumference.

Tensional test results was investigated, and the mean injured-to-uninjured differences in anterior knee laxity were 3.9 ± 0.9 mm in the grade I group, 2.4 ± 1.7 mm in the grade II group, 2.2 ± 1.9 mm in the grade III group, and 1.3 ± 1.6 mm in the grade IV group (Table 2). The mean injured-to-uninjured differences in anterior knee laxity were,
therefore, significantly smaller in the grade IV group than in the grade I and grade II groups (p < 0.05). Moreover, the percentage of cases with a difference of 3 mm or less was 0% in the grade I group, 54.5% in the grade II group, 70.8% in the grade III group, and 92.4% in the grade IV group, with significant differences between the groups (p < 0.05). However, no correlation was found between the arthroscopical results and the ROM or thigh circumference data (Table 3).

Discussion

Morphological evaluation of the grafts after ACL reconstruction is one of the most critical factors in determining practical guidelines for patient physical activity and rehabilitation, indeed, in determining the usefulness of the surgical procedures. Numerous morphological and histological studies of ACL reconstruction in animals have been reported. Clancy et al. reported that in rhesus monkeys, transplanted PT transformed into ACL-like structures between 9 and 12 months postoperatively. Similar findings were also demonstrated by Drez et al. in a study of PT allografts in goats.

The development of arthroscopy has made postoperative intra-articular observation easy, but it requires the patients' consent to an invasive diagnostic procedure. Therefore, arthroscopy has been performed mainly on patients with suspected graft ruptures or reinjuries. The results of these examinations have reflected a negative selection not representative of the general outcome. A representative group of patients needed to be studied to obtain more general results.

Arthroscopic follow-up at the time of hardware removal is a diagnostic procedure tolerable to patients, and it is ideal for determining morphological results. Yasuda et al. reported that in ACL reconstruction using PT, 20 of 38 patients (52.6%) who underwent arthroscopic examinations more than 12 months after reconstruction showed ligamentous tissue resembling ACL. Kaneko et al. reported that in reconstruction using iliotibial bands, 11 of 20 patients (55%) had the same favorable results in a 13.6 month-follow-up. In our study, 14 of 22 patients (63.6%) who were examined arthroscopically between 6 and 12 months postoperatively obtained grade IV results, suggesting that composite grafts with PT augmented by woven polyester transform into ACL-like structures during this period.

Rehabilitation after ACL reconstruction plays an important role in the functional outcome of the knee. The advantage of using a ligament augmentation device was that it allowed a more quick recovery of physical and sporting activities, however serious complications, such as chronic synovitis or effusion of the knee, were reported. Olson et al. suggested that particles generated from artificial materials have the potential to induce chronic synovitis. The woven polyester used in their study appeared to evoke synovial inflammatory reactions during the early postoperative period. However, the present study demonstrated that the woven polyester became covered by synovial tissue with time after reconstruction, and that, especially in the patients with grade III or IV results, no significant inflammatory responses to the woven polyester were observed arthroscopically. In contrast, proliferation of synovium in grade I and II patients suggested that there were occasional inflammatory reactions to woven polyester among such patients. Clinically, there was no chronic synovitis or effusion during the follow-up period. However, further investigations will be needed to see how these patients will be in the future.

Regarding correlation between arthroscopical and functional test results, Kohn reported that in reconstruction using PT, only 3 of 19 patients showed ligamentous tissues similar to ACL in a 15-month follow-up examination. Moreover, he found no correlation between the arthroscopical results and KT-1000 arthrometer measurements, and postulated that some other factors such as limitations of ROM or the strength of the thigh muscles had more influence on anterior knee laxity than the morphological condition of the graft.

The present study was inconsistent with these findings, and demonstrated that the patients with the higher grade in arthroscopical results had a greater degree of decreased anterior knee laxity. Aglietti et al. noted that a difference of 3 mm or less in anterior knee laxity would indicate normal stability. In this study, the percentage of patients with a difference of 3 mm or less was significantly
higher in the grade IV group than in the grade I or II groups, with no patients showing a difference of 3 mm or less in the grade I group.

KT-1000 arthrometer measurements are the most accurate and objective method of evaluating anterior knee laxity after ACL reconstruction. However, Shelbourne noted that postoperative ROM had an impact on knee laxity, and that the presence of joint stiffness, especially when it causes a limitation of extension, leads to low KT-1000 arthrometer measurements. Limitation of extension is a well-recognized and disturbing complication following ACL reconstruction using autogenous grafts, and its reported incidence ranges from 13.6% to 32.3%. In the present study, the incidence of limitation of extension was only 4.3%, which may mean that it had little influence on our KT-1000 arthrometer measurements to evaluate the function of the grafts in preventing anterior knee laxity.

It was concluded that reconstruction using PT augmented by woven polyester results in a ligamentous tissue resembling the ACL in the majority of patients. Our arthroscopical results significantly correlated with postoperative anterior knee laxity, and should be regarded as a useful parameter for evaluating ACL reconstruction.

References


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