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## Knee Functions and a Return to Sports Activity in Competitive Athletes Following Anterior Cruciate Ligament Reconstruction

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### Abstract

We investigated knee functions and a return to sports in 50 competitive athlete patients treated with arthroscopic anterior cruciate ligament reconstruction using double-looped STG augmented by woven polyester at a 1-year follow-up. There were 25 males and 25 females with a mean age of 24.3 years (range: 19–39 years). The majority of preinjury sports were basketball, volleyball and soccer. Athletic rehabilitation including agility training and sports-specific training was started at 12 weeks. Forty patients (80%) was rated as normal or nearly normal on the assessment of International Knee Documentation Committee postoperatively. Forty-eight patients (96%) obtained full range of motion, and the mean quadriceps muscle strength of the injured side was 91.3% of that of the uninjured side. As for a return to sports, 46 patients (92%) were able to do fully competitive sports at a mean of 8.1 postoperative months. These results suggest that arthroscopic reconstruction using augmented double-looped STG allows early athletic rehabilitation, and lead satisfactory outcome as well as a reliable and early return to preinjury level of sport activity for the majority of the competitive athlete patients. (J Nippon Med Sch 2000; 67: 172–176)

**Key words:** athletic rehabilitation, anterior cruciate ligament reconstruction, hamstring grafts

### Introduction

Numerous surgical methods<sup>1–3</sup> have been performed for the treatment of patients with torn anterior cruciate ligament (ACL). Recently, minimum invasive technique<sup>4–6</sup> has been introduced into meniscal surgery as well as into ligament reconstruction. Arthroscopic technique<sup>7</sup>, use of strong grafts and athletic rehabilitation program with agility training and sports-specific training can be expected to improve the outcome of ACL reconstruction as well as to lead a reliable and early return to sports<sup>8</sup> for competitive athletes.

The purpose of this study is to investigate knee functions and a return to sports in competitive athlete patients at a 1-year follow-up after arthroscopic ACL reconstruction.

### Materials and Methods

#### (1) Study population

Between 1995 and 1998, 50 competitive athlete patients who had undergone arthroscopic ACL reconstruction had a 1-year follow-up examination. There were 25 males and 25 females with a mean age of 24.3 years (range: 19–39 years). The majority of preinjury sports were basketball, volleyball and soccer, and

Table 1 Preinjury sport (N = 50)

Sport	No. of patients
Basketball	14
Volleyball	10
Soccer	7
Skiing	6
Judo	3
Other	10

Table 2 Summary of athletic rehabilitation program after ACL reconstruction

1. Closed kinetic chain training
side step
squat
knee-bended walking
pivot
2. Jogging
3. Jump training
light jumping
combination jumping
plyometric jumping
4. Agility training
running in zigzags
running-stop-turn
turn dash
5. Sports-specific training
6. Return to sports
practice
competition

the predominant mechanism of ACL injury was a noncontact force (Table 1).

### (2) Surgical procedure

Semitendinosus and gracilis tendons (STG) were harvested through a 3 cm skin incision. Woven polyester<sup>9</sup> (Leeds-Keio, Biomet, Bridgend, UK) was sutured tightly around double-looped STG to make a composite graft with a diameter of 8~10 mm. A Tibial bone tunnel was made in the posteromedial portion to the center of the anatomic ACL insertion and femoral bone tunnel in the posterosuperior margin of the lateral intercondylar notch. The graft was passed through these bone tunnels, and were fixed to the femur and tibia with 2 staples. After fixation of the graft, the knee was moved through a full range of motion (ROM) to ensure proper tightness of the graft. A notch plasty was performed if the graft was im-

pinged in the intercondylar notch.

### (3) Rehabilitation program

All patients underwent the same rehabilitation program postoperatively. Passive motion using a continuous passive motion device was begun on the second postoperative day. Partial weight bearing was allowed at 1 week, increasing to full weight bearing from 2 to 4 weeks. Closed kinetic chain training such as squat and knee-bended walking was begun at 2 weeks. Light athletic rehabilitation such as jogging and light jumping was started at 8 weeks (Table 2). Agility training and sports-specific training were started at 12 weeks. A return to sports practice was allowed at 5 months, and a return to fully competitive sports activities was permitted at 5~12 months.

### (4) Clinical evaluation

Postoperative clinical results were evaluated by assessment of International Knee Documentation Committee<sup>10</sup> (IKDC). Each category in IKDC assessment is graded as A (normal), B (nearly normal), C (abnormal) and D (severely abnormal). Symptoms were evaluated at following 4 activity levels: 1) strenuous activity (jumping, pivoting and hard cutting), 2) moderate activity (heavy manual work, skiing and tennis), 3) light activity (light manual work, jogging and running) and 4) sedentary activity (housework and ADL). Overall evaluation is determined by the worst grade in the following 4 categories: 1) patient subjective assessment, 2) symptoms (pain, swelling and giving way), 3) range of motion (ROM) extension/flexion and ligament evaluation (Lachman test, pivot shift test and arthrometer measurements).

Arthrometer measurement using KT-2000 for anterior knee displacement was performed at 25° knee flexion with 90 N of force. Thigh circumference was measured at 10 cm proximal to the patella, and isokinetic quadriceps muscle strength (peak torque, 60 deg/sec) was measured by CYBEX 6000 dynamometer (CYBEX Corp., NY, USA).

## Results

### 1. IKDS assessment

In overall results of IKDS assessment, 20 of 50 ath-

Table 3 Results of IKDC assessment at 1-year follow-up (N = 50)

Rating	Subjective assessment N (%)	Symptoms N (%)	ROM N (%)	Ligament evaluation N (%)	Overall N (%)
A (normal)	42 (84)	47(94)	48 (96)	26 (52)	20 (40)
B (nearly normal)	4 ( 8)	1 ( 2)	1 ( 2)	15 (30)	20 (40)
C (abnormal)	4 ( 8)	1 ( 2)	1 ( 2)	9 (18)	9 (18)
D (severely abnormal)	0 ( 0)	1 ( 2)	0 ( 0)	0 ( 0)	1 ( 2)

lete patients (40%) were rated as normal (A), 20 as nearly normal (B), 9 as abnormal (C) and 1 as severely abnormal (D) (Table 3).

## 2. Patient subjective assessment

Forty-six patients (92%) graded their knee function as normal (A) or nearly normal (B).

## 3. Symptoms

Forty-seven patients (94%) had no significant symptoms (A) at their highest activity levels. Forty-seven of 50 patients (94%) reported no pain during moderate or strenuous activities, and remaining 4 patients had anterior knee pain. Forty-eight patients (98%) had no swelling and giving way of the knee.

## 4. Range of motion

Full extension or a limitation of 3° or less (A) was recorded in 48 of 50 patients, and full flexion or a limitation of 5° or less (A) in 48 of 50 patients. Mean ROM was 159.2 ± 3.8° and 47 patients (94%) had full range of motion.

## 5. Ligament evaluation

In Lachman test for 50 patients, 49 patients (98%) was rated as negative (A), and in pivot shift test, 45 patients (90%) as negative (A). KT 2000 arthrometer measurement showed that the mean side-to-side difference in anterior knee displacement was 2.6 ± 2.9 mm (range: -3.3 to 9.0 mm). Twenty-six patients (52%) had a difference of -1 to 2 mm (A), 15 patients 3 to 5 mm or < -1 to -3 mm stiff (B), 9 patients 6 to 10 mm or < -3 mm stiff (C) and none of patients showed a difference of more than 10 mm (D).

Table 4 Thigh circumference and quadriceps muscle strength at 1-year follow-up (N = 50)

	Loss of thigh * circumference N (%)	Quadriceps muscle ** strength N (%)
≤ 1cm	33 (66)	≥ 90% 32 (64)
1—2cm	15 (30)	90—75% 14 (28)
2—4cm	2 ( 4)	75—50% 3 ( 6)
> 4cm	0 ( 0)	< 50% 1 ( 2)

\* Thigh circumference was measured at 10cm proximal to the patella.

\*\* Isokinetic quadriceps muscle strength (peak torque, 60 deg/sec) of the injured side was compared with that of uninjured side.

## 6. Thigh circumference and quadriceps muscle strength

The mean loss of thigh circumference was 1.1 ± 0.9 cm (range: 0 to 4 cm), and loss of 1 cm or less was obtained in 33 patients (66%) (Table 4). The mean quadriceps muscle strength of the injured side was 91.3 ± 14.1% of that of the uninjured side (range: 45.4 to 122.7%), and 32 patients (64%) restored the muscle strength of 90% or more.

## 7. Return to sports

Forty-six of 50 patients (92%) returned to their preinjury level of sport activity. Remaining 4 patients were able to do sports at a lower level of activity because of symptoms of giving way or pain, or apprehension with regards to possible reinjury. The mean interval from surgery to sports practice and to fully competitive sports activities was 5.7 ± 1.5 months (range: 3~10 months) and 8.1 ± 2.3 months (range: 5~12 months) respectively.

## 8. Complications

During follow-up, there were no serious complications<sup>11</sup> such as chronic synovitis, effusion, infection or failure of the grafts.

## Discussion

Accelerated rehabilitation program<sup>12</sup> with early motion exercise and weight bearing has been successful in decreasing joint contracture and muscle atrophy after ACL reconstruction. However some athlete patients, despite of adequate ROM and muscle strength, are not able to return to preinjury level of sport activities, or choose not to participate in sports. Aglietti et al.<sup>13</sup> reported in ACL reconstruction with standard accelerated rehabilitation program that only 50% of athletes returned to their preinjury level in STG group and 66% in patellar tendon group.

Shelbourne et al.<sup>14</sup> noted that athletic rehabilitation as more functionally accelerated program is needed to lead to an earlier and more reliable return to sports for athletes. We introduced arthroscopic reconstruction using double-looped STG for the treatment of the athletes with torn ACL in 1995, with an incorporation of the athletic rehabilitation program including agility training and ports-specific training. In the present study, 92% of 50 competitive athletes returned to fully competitive sports activities at a mean of 8.1 postoperative months.

Wilson et al.<sup>15</sup> reported in a biomechanical study of the grafts that ultimate tensile strength of double-looped STG graft was significantly higher than that for PT graft, but PT had a higher elastic modulus than STG. They concluded that with proper fixation, STG graft is a sufficiently strong graft for ACL reconstruction when trying to reproduce normal knee kinematics.

In a clinical comparative study of two grafts, Marder et al.<sup>16</sup> found that STG graft tended to be inferior to PT graft in terms of knee stability by arthrometer testing. In contrast Corry et al.<sup>17</sup> reported that no significant difference was found in any of the parameters evaluated between 2 grafts. In our data, as compared with PT graft used in our previous study<sup>18</sup>, no difference in knee stability and quadriceps muscle strength was found between 2 grafts, but

there was a trend toward better ROM with STG graft. Furthermore, in our clinical impression, ACL reconstruction using STG is less painful during the early postoperative period.

Anterior knee pain is the most common problem<sup>19</sup> after ACL reconstruction, especially when PT is harvested. Hsieh<sup>20</sup> stated that a pain may result from the donor site morbidity, including scarring and contracture of PT<sup>21</sup>. O'Brien et al.<sup>22</sup> reported that 30% of patients had anterior knee pain after ACL reconstruction using PT. They noted that this remained an unsolved problem. In contrast, its incidence in STG grafts was only 7% in a study of Corry and 6% in our study. These results suggest that use of STG grafts is a solution to anterior knee pain after reconstruction.

In summary, we evaluated knee functions and return to sports in 50 athlete patients at a 1-year follow-up after arthroscopic reconstruction using double-looped STG augmented woven polyester. Arthroscopic reconstruction using augmented double-looped STG allows early athletic rehabilitation, and leads satisfactory outcome as well as a reliable and early return to preinjury level of sport activity for the majority of the competitive athlete patients.

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