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## Original Article

# Preoperative assessments completed for anterior cruciate ligament reconstructions with remnant preservation



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## ABSTRACT

The purpose of this study was to investigate the preoperative characteristics that are necessary to be able to perform reconstructions of the anterior cruciate ligament (ACL) with remnant preservation. The preoperative period was significantly shorter for patients in patients who received a reconstruction with remnant preservation than for those without remnant (3.9 months vs 16.0 months,  $p < 0.01$ ). The cut-off time to be able to reconstruct an ACL with remnant preservation were 2.5 months. The preoperative period is important to perform an ACL reconstruction with remnant preservation.

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## 1. Introduction

According to Crain et al, arthroscopic examinations completed for anterior cruciate ligament (ACL) reconstructions have revealed that several types of ACL remnants exist in the intercondylar notch.<sup>1</sup> Changes in anterior laxity were associated with a specific pattern of scar formation within the notch. ACL reconstruction with remnant preservation contributes to the prevention of anterior laxity,<sup>2–6</sup> preserves the ACL remnant's neural elements and mechanoreceptors,<sup>2,7–12</sup> and provides a favorable effect on vascularity and reinnervation of the graft.<sup>13–15</sup>

There have so far been very few reports on the preoperative assessment of survival for ACL remnant. The purpose of this study is to investigate the preoperative characteristics that are necessary to be able to reconstruct ACL with remnant preservation.

## 2. Patients and methods

Between September 2006 and July 2010, a total of 640 ACL reconstructions were performed. ACL remnant was tried to preserve the remnant as much as possible. After insertion

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of the graft, preservation of the remnant was considered possible if following condition were met: (1) the graft was covered with synovial tissues and had abundant blood vessels, (2) coverage of more than 75% of the graft from the tibial attachment, and (3) presence of a bridge between the femur and tibia.<sup>16</sup> One hundred patients received a reconstruction with remnant preservation during the period (group R), while the other 540 patients received a conventional reconstruction without remnant preservation. One hundred patients were extracted randomly among the patients who received a conventional reconstruction without remnant preservation (group C). Every patient reported knee trauma with rapid swelling and disability. The MRI was positive for ACL disruption in every patient. All of the patients suffered from an incapacity to resume their previous levels of activity due to the instability of their symptoms, and all were scheduled to receive complete ACL reconstructions. Five surgeons (M.K, Y.T, M.I, Y.S, H.K) performed the operations in this study. Prior to performing the ACL reconstructions, a thorough arthroscopic evaluation of each patient was performed. The arthroscopic evaluations identified four different patterns of ACL morphology, classified according to the criteria of Crain et al; group 1: ACL scarring to the PCL, group 2: ACL healing to roof of the notch, group 3: Attenuated ACL remnant healed to the lateral wall more anterior and distal than its anatomic origin, and group 4: Resorption of the torn ACL.<sup>1</sup> The ACL reconstructions were performed with semitendinosus tendon in all cases. We attempted to perform ACL reconstructions with remnant preservation whenever possible.

In every case, the amount of time between the patient's first injury of the ACL and the reconstruction operation (called the preoperative period) was noted. Differences in the preoperative period were assessed for each group (group R and group C). In addition, the cut-off time to be able to reconstruct an ACL with remnant preservation was determined.

Gender, age, injury type (contact or non-contact), amount of antero-posterior instability (measured using KT-2000, 30lbs), pivot shift test grade, rate of meniscus injury (medial meniscus, lateral meniscus, or bilateral meniscus injury), and the rates of four ACL remnant groups were assessed for each group.

### 3. Statistical analysis

A Mann–Whitney *U* test (two tailed) was applied to evaluate the differences in the parameters of each operation. A Receiver Operating Characteristic (ROC) curve was applied to evaluate the sensitivity and specificity needed to be able to reconstruct an ACL with remnant preservation. All data analysis was performed with SPSS software, version 16.0.1 (SPSS, Chicago, IL).

### 4. Results (Table 1)

There were no significant differences for gender, age, injury type (contact or non-contact), or rate of meniscus injury between group R and group C.

**Table 1 – Result for preoperative patient's status of each group.**

	Group R	Group C	p-value
Preoperative period (month)	3.9 ± 4.5	16.0 ± 16.0	<0.01 <sup>a</sup>
Gender (male, %)	70 ± 46.1	59 ± 49.4	N.S.
Age (year)	24.7 ± 8.3	25.4 ± 8.6	N.S.
Injury type (contact injury rate, %)	24 ± 42.9	19 ± 39.4	N.S.
KT-2000 (mm)	4.4 ± 2.0	5.3 ± 2.0	<0.01 <sup>a</sup>
Pivot shift test grade 1 (%)	14 ± 35.0	9 ± 28.8	N.S.
Pivot shift test grade 2 (%)	94 ± 108.1	77 ± 42.3	N.S.
Pivot shift test grade 3 (%)	3 ± 17.1	14 ± 34.9	<0.01 <sup>a</sup>
Medial meniscus injury (%)	12 ± 32.7	21 ± 40.9	0.087
Lateral meniscus injury (%)	16 ± 36.8	14 ± 35.0	N.S.
Bilateral meniscus injury (%)	3 ± 17.1	4 ± 19.8	N.S.
ACL remnant group 1 (%)	33 ± 47.3	27 ± 44.6	N.S.
ACL remnant group 2 (%)	52 ± 50.2	12 ± 32.7	<0.01 <sup>a</sup>
ACL remnant group 3 (%)	15 ± 35.9	10 ± 30.2	N.S.
ACL remnant group 4 (%)	0 ± 0.0	51 ± 200.1	<0.01 <sup>a</sup>

Values are presented as means ± standard deviation.

Group R: patient reconstructed with remnant preservation; group C: patient reconstructed without remnant.

<sup>a</sup> Statistically significant difference at 0.05 level.

The preoperative period was significantly shorter for patients in group R than for those in group C (3.9 months in group R, 16.0 months in group C;  $p < 0.01$ ). The cut-off time to be able to reconstruct an ACL with remnant preservation was 2.5 months (sensitivity 0.790, specificity 0.500).

The amount of antero-posterior instability, measured using KT-2000, was significantly lower for patients in group R than for those in group C. The incidence of pivot shift test grade 3 was lower for patients in group R than for those in group C (3% in group R, 14% in group C;  $p < 0.01$ ).

The rates of four ACL remnant groups in a total 200 cases was 30%, 32%, 12.5% and 25.5% in group 1, 2, 3, and 4 respectively. In group R, the rates of four ACL remnant groups was 33%, 52%, 15%, and 0% in group 1, 2, 3 and 4, respectively. Otherwise, in group C, the rates of four ACL remnant groups 27%, 12%, 10% and 51% in group 1, 2, 3 and 4, respectively. The rate of group 2 ACL remnants (ACL healing to roof of the notch) was significantly higher in group R than in group C, and the rate of group 4 ACL remnants (Resorption of the torn ACL) was significantly lower in group R than in group C.

### 5. Discussion

According to Crain, arthroscopic examinations completed for anterior cruciate ligament (ACL) reconstructions have revealed that several types of ACL remnants exist in the intercondylar notch.<sup>1</sup> In that study, 38% of patients had ligament scarring on the posterior cruciate ligament, 8% of patients had scar tissue that appeared to extend from the ACL fibers to the roof of the notch, 12% of patients appeared to have healed scarring on the lateral wall of the notch or the medial aspect of the lateral femoral condyle in a position anterior and distal to the ACL anatomic footprint, and 42% of patients had no identifiable ligament tissue remaining. In many cases, the femoral attachment of the ACL remnant is

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