



# Clinical results of anterior cruciate ligament reconstruction with ligament remnant tissue preservation: A systematic review

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## Abstract

**Purpose:** To clarify the effects of ACL remnant tissue preservation on the clinical outcome of ACL reconstruction.

**Methods:** This is a systematic review.

**Results:** The majority of the reviewed articles suggested that remnant preservation significantly improved knee stability after ACL reconstruction, although there was some controversy. In addition, it was suggested that the degree of initial graft coverage significantly affected postoperative knee stability. Remnant preservation did not increase the occurrence rate of cyclops lesion.

**Conclusion:** Sufficient coverage of the graft with remnant tissue improves postoperative knee stability without any detrimental effects on the subjective and functional results.

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**Keywords:** anterior cruciate ligament reconstruction; remnant tissue preservation; remnant-preserving procedure; single-bundle reconstruction; double-bundle reconstruction

## Introduction

Arthroscopic single-bundle procedures have been commonly used to reconstruct the injured anterior cruciate ligament (ACL). However, Lewis et al<sup>1</sup> systematically reviewed 1024 outcomes after single-bundle ACL reconstruction, which were previously reported in the randomized clinical trials, and reported that the Lachman test was positive in 59% of the cases, and that the side-to-side differences of the anterior laxity were more than 5 mm in 16% of the cases. One of the final goals of ACL reconstruction is the complete restoration of normal knee stability in all patients. From this viewpoint, many orthopaedic surgeons are not fully satisfied

with the clinical results after the commonly performed ACL reconstruction. Therefore, many investigators have made effort to improve the clinical results of single-bundle ACL reconstruction using various approaches.<sup>2–6</sup> One approach is to preserve the ACL remnant tissue during ACL reconstruction, because the remnant tissue preservation has several potential advantages to improve the clinical results of ACL reconstruction: Namely, the remnant preservation may enhance recovery of proprioceptive sensation,<sup>7–10</sup> accelerate cell repopulation and revascularization in the tendon graft,<sup>11</sup> reduce the incidence and the degree of tunnel enlargement,<sup>12</sup> and reconstruct a nearly normal attachment of the graft.<sup>13</sup> Several types of remnant-preserving ACL reconstruction procedures have been developed to date.

In 2000, Adachi et al<sup>2</sup> reported on the first ACL remnant tissue preserving procedure to reconstruct the ACL using the

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over-the-top route method (Figure 1). Although they named this procedure “ACL augmentation”, this procedure could be regarded as a remnant tissue-preserving ACL reconstruction procedure for the ACL insufficiency. In 2006, Lee et al<sup>14</sup> reported a remnant-preserving single-bundle procedure for the standard single-bundle ACL reconstruction with a femoral tunnel and a tibial tunnel (Figure 2). A criticism on this procedure is that the remnant tissue was detached from the femoral attachment by a surgeon to visualize the lateral condyle. To solve this issue, Ahn et al<sup>15,16</sup> tried to re-apply a tension to the remnant tissue, which was detached from the femoral attachment, by pulling up the femoral end of the remnant tissue towards the femur with a few PDS threads. Recently, however, Jung et al<sup>17</sup> reported that re-tensioning of the preserved ACL remnant tissue could not improve the results of the remnant-preserving ACL reconstruction. In 2009, Kim et al<sup>18</sup> described a remnant-preserving double-bundle reconstruction procedure, in which one tibial tunnel and 2 femoral tunnels were created, using a split quadriceps tendon-bone graft. A criticism on this procedure is that they also detached the femoral end from the femur or the PCL, similarly as in the above-described Lee's single-bundle procedure. Recently, Yasuda et al<sup>13</sup> reported a remnant-preserving procedure for the standard anatomic double-bundle ACL reconstruction, in which 2 tibial and 2 femoral tunnels were created at the center of the AM and PL bundle attachments (Figure 3A). A specific feature of this procedure in comparison with the previously reported single- and double-bundle procedures is that the proximal attachment of the ACL remnant tissue is not detached from the femur or the posterior cruciate ligament (Figure 3B).

However, it has been unclear about the clinical utility of the remnant tissue preservation in ACL reconstruction. In addition, there has been expectation that the remnant preservation may reduce tunnel enlargement after ACL reconstruction.<sup>13</sup> On the other hand, there has been some apprehension that remnant preservation may increase the occurrence rate of cyclops

syndrome, which shows a serious loss of knee extension caused by a hard nodule around the reconstructed ACL, or cyclops lesion, which is a soft synovial tissue mass around the reconstructed ACL without any clinical symptom.<sup>19</sup> Therefore, it is needed to carefully review the previous clinical literature to clarify the effect of the remnant tissue preservation on the clinical outcome of ACL reconstruction. The purpose of this systematic review is to clarify effects of the ACL remnant tissue preservation on the clinical outcome of single- and double-bundle ACL reconstruction. The specific hypotheses are as follows: 1) The ACL remnant tissue preservation may improve the knee stability after single- and double-bundle ACL reconstructions. 2) The degree of initial graft coverage with the ACL remnant tissue may affect the postoperative knee stability. 3) The ACL remnant tissue preservation may not increase the occurrence rate of cyclops lesion. 4) The ACL remnant tissue preservation may reduce postoperative tunnel enlargement.

## Methods

In this systematic review, previous literature on ACL reconstruction with preservation of the ACL remnant tissue was searched in the PubMed database in December 2015, using keywords related to this study's purpose, such as “ACL remnant tissue”, “remnant tissue preservation”, “ACL reconstruction with remnant preservation”, and “remnant tissue preserving ACL reconstruction”. A total of 191 articles were identified. After duplicates were removed, 163 articles were screened. A total of 121 articles were excluded because of the following reasons: 73 articles dealing with ligaments different from the ACL and 48 technical or biomechanical articles that did not report any clinical results after ACL reconstruction (Figure 4). Subsequently, 42 full-text clinical articles were assessed for eligibility. The following types of clinical studies were excluded from our review. First, studies that compared a remnant-preserving single-bundle procedure with a remnant-resecting double-bundle procedure were excluded because it was logically impossible to clarify the effect of the ACL remnant preservation on a certain ACL reconstruction procedure. Second, studies on so-called “selective” single-bundle ACL reconstruction<sup>3,20,21</sup> for “isolated” one bundle tear were excluded because the preserved ACL tissue was not regarded as the “remnant” tissue in these procedures. Thus, we selected 10 articles in which the clinical results of a remnant-preserving ACL reconstruction procedure were compared with those of the same ACL reconstruction procedure without remnant tissue preservation, in order to detect the effect of the remnant tissue preservation on the ACL reconstruction (Figure 4).

## Results

### 1 Does ACL remnant tissue preservation improve clinical outcome and knee stability after ACL reconstruction?

Hong et al<sup>22</sup> conducted a randomized controlled trial using 90 consecutive patients to compare the clinical outcome of single-bundle ACL reconstruction using an allograft between

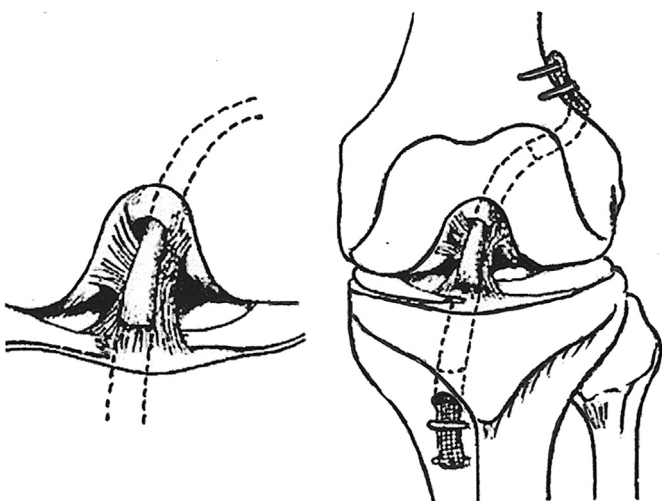


Figure 1. The remnant-preserving single-bundle procedure reported by Adachi et al.<sup>2</sup> An autogenous hamstring tendon graft or an allogenic fascia lata graft was placed through the femoral over-the-top route. (Figure 1 is reprinted from Reference 2 with permission from Springer Science and Business Media.)

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