Simultaneous Reconstruction of the Anterior and Posterior Cruciate Ligaments with Leeds-Keio artificial ligament - A Long-term Follow-up Study -

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Abstract

Long-term results of simultaneous reconstruction of the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) using the Leeds-Keio artificial ligament were reviewed. Fifteen cases were involved and the average follow-up period was 8 years and one month. Supracondylar fractures of the femur or tibial plateau fractures were combined in four cases, and other ligament injuries in seven cases. Limitation of the range of motion (ROM) was observed in 10 cases. The operation was carried out by arthrotomy and extra-articular stabilization was added. At follow-up, positive Lachman sign was observed in 2 joints (13%), anterior drawer sign in 2 (13%), pivot shift sign in 0 (0%), and posterior drawer sign in 4 (27%). Limitation of ROM was found in 5 joints (33%), quadriceps atrophy in 11 (73%), and osteoarthritic changes in 9 (60%). Thirteen cases (87%) experienced pain during activities, and eight (27%) complained of pain in daily life. From the results, a relatively satisfactory stability was obtained with the ACL reconstruction but not with the PCL reconstruction. This is partially because the operative technique had not been established in the first few cases, but there are also several fundamental difficulties in the PCL reconstruction: sharp bending of the running route, difficulty in obtaining sufficient thickness and strength of the substitute, and posteriorly sagging force from gravity. Therefore, further improvement in the PCL reconstruction technique is required in order to achieve better posterior stability with this procedure. In addition, other elements of the clinical results such as limitation of ROM, quadriceps atrophy, osteoarthritic changes and subjective pain, were not as satisfactory as expected. This is mainly because of the severity of this type of injury and also because of high incidence of the combined injuries. However, it is also true that the operative stress onto the joint is much higher with this simultaneous reconstructive procedure than the other ligament reconstructions. Therefore, it was also concluded that operative stress should be minimized in order to improve the outcome of this procedure.

key words: knee, anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), reconstruction

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INTRODUCTION

It is generally recognized that although sporting activities are often impeded by knee ligament injuries, the activities of daily life are not severely influenced1,10). However, a combined injury of the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) sometimes causes severe instability and often hinders even activities of daily life9). We have been carrying out simultaneous reconstructions of the two ligaments using the Leeds-Keio artificial ligament when severe instability was observed both objectively and subjectively. In this paper, the long-term results of this procedure are analyzed, and strategies for treatment of this type of injury are discussed.

MATERIALS AND METHODS

Fifteen cases which underwent simultaneous reconstruction of the ACL and PCL with the Leeds-Keio artificial ligament were involved in this study. The follow-up period was between five years and 13 years six months (average ; 8 years one month). There were 13 males and two females, and age at time of operation was between 17 and 55 years (average ; 27 years ). Nine patients were injured by traffic accident and the other 6 by sports activities. Only two cases were competitive athletes.

Most of the patients had several combined injuries besides the ACL and PCL : supracondylar fracture of the femur in two cases, tibial plateau fractures in two, medial collateral ligament (MCL) injuries in six, and avulsion fracture of the lateral collateral ligament (LCL) injury together with peroneal nerve injury in one. They had received various initial treatments for these combined injuries : open reduction and internal fixation of the combined fractures in two cases, primary suture of the MCL in two, and immobilization of the joint with cast in seven.

The subjective complaint at the first was a typical giving way in six cases, a vague feeling of instability of the joint (feeling the knee unstable) in nine cases. Limitation of the range of motion (ROM) was observed in 10 cases : i.e. limitation in extension by 5 degrees in one case, that by 20 degrees in another one, and limitation in flexion within 20 degrees in six, and of about 50 degrees in the remaining two.

In all the cases, simultaneous reconstruction of the ACL and PCL was carried out by arthrotomy together with extra-articular stabilization using the Leeds-Keio artificial ligament (Fig. 1)2). Medial meniscal injury was observed in four cases and lateral in two. Partial meniscectomy was carried out on all the six cases. Bone tunnels for the PCL substitute were firstly made using the guiding system at the anterior edge within the physiological attachment of the PCL on the femur, and just distal to the over-hang of the posterior condyle of the tibia. Bone tunnels for the ACL substitute were then made at the isometric point (posterior-superior corner within the physiological attachment of the ACL) on the femur and at the center of the physiological attachment on the tibia. Artificial ligaments for both the ACL and PCL were passed through each tunnel, and were firmly fixed to the tibia with bone plugs and staples. The artificial ligament for the PCL was then fixed to the femur firmly with bone plugs and staples under the maximum tension applied to it manually. That for the ACL was finally fixed to the femur in the same manner as the PCL fixation. The residual portion of the artificial ligament for the ACL, which came out from the femoral bone tunnel, was pulled down to the Gerdy’s tubercle of the tibia as it passed...
just below the subcutaneous tissue and above the LCL. It then passed through another bone tunnel which had been made from Gerdy’s tubercle to the medial surface of the tibia and fixed with double stapling technique. In six cases which involved MCL injury, the MCL was also reconstructed with the artificial ligament. In one case with an avulsion fracture of the LCL injury, the LCL was fixed to the fibular head with a pull-out wire.

After the operation, the joint was immobilized with a cast for four weeks in 10 of the 15 cases. The joint was then mobilized with a continuous passive motion (CPM) device. Weight bearing was allowed at six weeks post-operatively. In the other five joints, no external immobilization was employed and the joint was mobilized with a CPM device at the second post-operative day. Weight bearing was allowed at three weeks post-operatively. Sporting activities were allowed at three months after the operation.

RESULTS

At follow-up, manual examination showed that Lachman sign was (+) in 2 joints (13%), (±) in 5 (33%), (−) in 8 (53%); anterior drawer sign (ADS) was (+) in 2 joints (13%), (±) in 5 (33%), (−) in 8 (53%); pivot shift sign was (+) in 0 joints (0%), (±) in 1 (7%), (−) in 14 (93%); and posterior drawer sign (PDS) was (+) in 4 joints (27%), (±) in 3 (20%), (−) in 8 (53%) (Fig. 2). Regarding ROM, limitation in extension by 5° was found in 2 joints (13%), and limitation in flexion by 10 to 20° was found in 3 joints (20%). Quadriceps atrophy which was determined by more than 1 cm of right-left difference in thigh thickness, was observed in 11 joints (73%) (Fig. 3). Osteoarthritic changes in the plain radiograms were observed in 9 joints (60%), and most of these were narrowing of the joint space following meniscectomy. A complication, a small ectopic ossification in the quadriceps muscle, was found in one case, but no serious clinical disability due to the ossification was found.

Subjectively, 13 cases (87%) experienced pain during activities, and eight of them complained of it even in daily life (Fig. 4). None of the patients were involved in competitive sporting activities at follow-up, and only four
Fig. 2  Findings of the manual examination at follow-up.
ADS : anterior drawer sign, PDS : posterior drawer sign.

Fig. 3  ROM, quadriceps atrophy and osteoarthritic changes at follow-up.
Quad at. : Quadriceps atrophy, OA : osteoarthritic changes.

Fig. 4  Incidence of subjective pain and return ratio to sports activities.
There are several opinions regarding the treatment of combined injury of the ACL and PCL, conservative treatment\textsuperscript{12}, solitary ACL reconstruction\textsuperscript{4}, two-stage reconstruction of the ACL and PCL\textsuperscript{3}, and simultaneous reconstruction of both ligaments\textsuperscript{8}. Several theoretical bases for choosing conservative treatment or solitary ACL reconstruction are listed: 1) posterior instability due to the PCL injury has a lesser subjective effect on knee function\textsuperscript{11,13}; 2) secondary changes in articular cartilage or menisci are less frequent with the PCL injury\textsuperscript{5}; 3) activities of the patients who had this type of injury are low fundamentally, since most of the cases are caused by traffic accident rather than sports\textsuperscript{8}. However, one of the reasons to take a passive attitude for PCL reconstruction seems to be that it is difficult to supply two substitutes simultaneously to reconstruct both the ACL and PCL.

We have been using the Leeds-Keio artificial ligament for this type of injury in order to utilize the advantage of the artificial ligament\textsuperscript{6}. From the results of this long-term follow-up study, relatively satisfactory stability was obtained with the ACL reconstruction, although it was not as good as that obtained with a solitary ACL reconstruction\textsuperscript{7}. Particularly, the antero-lateral rotatory instability (pivot shift sign) was almost perfectly controlled with this procedure. This may be partially due to the additional effect of extra-articular stabilization.

On the other hand, no satisfactory stability was obtained with the PCL reconstruction. This is partially because the operative technique had not been established in the first few cases. However, there are also several fundamental difficulties in PCL reconstruction: 1) sharp bending of the running route of the PCL substitution at both the tibial and femoral attachments, which may cause a cheese-cut phenomenon of the attachment site during the knee movement, 2) difficulty in obtaining a sufficient thickness and strength of the substitute, as the original PCL is twice as thick and strong as the ACL, 3) posteriorly directed force onto the tibia by gravity, which may cause a stretching the substitute during the post-operative rehabilitation. Therefore, a further improvement in the PCL reconstruction technique is required in order to achieve a better posterior stability with this procedure.

In addition, other elements of the clinical results besides instability were not as satisfactory as expected: Limitation of ROM was found in 5 joints (33%), quadriceps atrophy in 11 joints (73%), osteoarthritic changes in 9 joints (60%), and subjective pain in 13 cases (87%). This is mainly because of the severity of this type of injury and also because of the high incidence of the combined injuries, such as fractures and other ligament injuries. However, it is also true that operative stress placed on the joint is much higher with this simultaneous reconstructive procedure than with other ligament reconstructions. This is enhanced by the additional extra-articular stabilization (series-2). Therefore, it is also concluded that operative stress should be minimized in order to improve the outcomes of the combined reconstruction of the ACL and PCL.

**SUMMARY**

1. Satisfactory anterior stability was obtained with the simultaneous reconstruction of both the ACL and PCL, but satisfactory posterior stability was not achieved in some cases.
2. Limitation of range of motion, quadriceps atrophy, osteoarthritic changes and subjective pain were not as satisfactory as expected.

3. It is important not only to establish a reliable PCL reconstructive technique, but also to minimize the operative stress to further improve combined reconstruction of the ACL and PCL.

REFERENCES


