Outcomes After Double-Bundle Anterior Cruciate Ligament Reconstruction

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Purpose: To identify the risk factors predicting unsatisfactory postoperative clinical outcomes after double-bundle (DB) anterior cruciate ligament (ACL) reconstruction using multivariate logistic regression. **Methods:** Inclusion criteria were consecutive DB ACL reconstructions from January 2006 to September 2012 with a minimum 3-year follow-up. Exclusion criteria included (1) a delay to surgery from initial injury of more than 4 years (210 weeks); (2) contralateral knee pathology; (3) the lack of postoperative 3-dimensional computed tomography; (4) single-bundle ACL reconstruction; (5) revision ACL reconstruction; (6) meniscus allograft transplantation after total or subtotal meniscectomy; (7) multiple ligament surgeries. According to the overall International Knee Documentation Committee (IKDC) rating at the last follow-up, we sorted all enrolled subjects into superior (IKDC grade A or B) and inferior outcome groups (IKDC grade C or D). Multivariate logistic regression was used to analyze risk factors, including age, gender, body mass index, time from injury to surgery, posterior tibial slope, notch width index, cartilage injury, meniscus injury, and femoral and tibial tunnel positions. **Results:** In comparison between the superior outcome group (n = 240) and inferior outcome group (n = 50), anterior (adjusted odds ratio [OR]: 0.902, 95% confidence interval [CI]: 0.846-0.962) or distal (adjusted OR: 1.025, 95% CI: 1.006-1.060) femoral anteromedial tunnel position was a significant risk factor for the inferior outcomes. Partial meniscectomy of medial (adjusted OR: 49.002, 95% CI: 7.047-340.717) or lateral (adjusted OR: 14.974, 95% CI: 2.181-102.790) meniscus and delayed time from injury to surgery (adjusted OR: 1.062, 95% CI: 1.023-1.102) were also a significant predictor. **Conclusion:** Anterior or distal anteromedial femoral tunnel position, partial meniscectomy of medial or lateral meniscus, and prolonged surgical delay of more than 11.5 weeks from injury were significant risk factors for the inferior clinical outcomes after DB ACL reconstruction. **Level of Evidence:** Level III, retrospective therapeutic case series.

Anterior cruciate ligament (ACL) reconstruction has improved in the past few decades in the aspect of surgical technique. ACL reconstruction provides satisfactory results in the majority of cases. Nevertheless, recently published long-term outcome studies have shown that about 80% of the patients return to their previous level of activity, and approximately 30% of the patients demonstrate degenerative changes on radiographs at 10 years after ACL reconstruction.[1] These data suggest that there is still need for improvement of current treatment protocols and reconstruction techniques.

The double-bundle (DB) ACL reconstruction technique shows better outcomes in rotational laxity, although functional recovery is similar between single-bundle (SB) and DB.[2,3] In the mid- to long-term results of a randomized controlled trial of SB versus DB ACL reconstruction using a semitendinosus tendon, DB reconstruction was significantly better than SB reconstruction regarding anterior and rotational stability during the 3- to 12-year follow-up. However, there were no differences in the clinical subjective findings.[2] Studies of normal ACL anatomy have left questions unresolved regarding where the 2 tunnels should be created for direct and indirect insertions based on normal anatomy.[3]

The many comparative studies about risk factors of unsatisfactory postoperative outcomes have addressed the postoperative results between the different pre-, intra-, and postoperative factors including age, gender,

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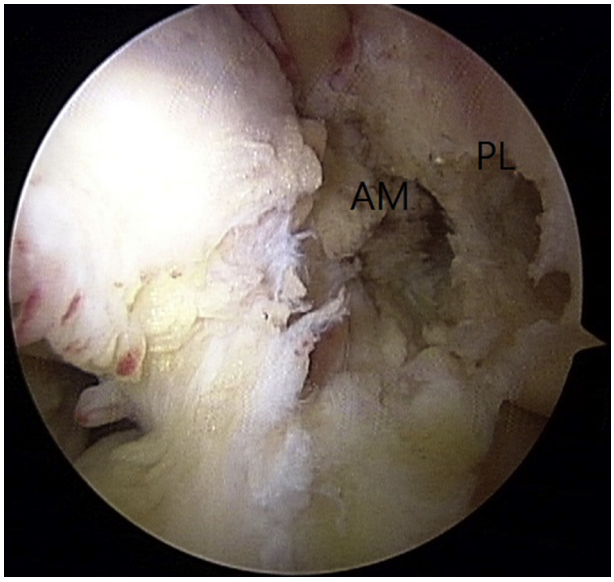

Fig 1. Arthroscopic view of a left knee, using the 70° arthroscope from the anterolateral portal for femoral anteromedial and posterolateral tunnels during anterior cruciate ligament reconstruction. (AM, anteromedial femoral tunnel; PL, posterolateral femoral tunnel.)

operative technique, graft type, and coincident intra-articular pathology.[4-8] However, the postoperative result after ACL reconstruction may be influenced concomitantly by various factors. Thus, there may be an unexpected bias in comparative studies. To estimate the risk factors to influence postoperative results after controlling for confounders, a multivariate logistic regression model can be recommended in a retrospective trial.[9-11]

Regarding the risk factors in DB ACL reconstruction, most previous studies were performed with a focus on the tunnel positions,[12-15] whereas only 1 report described the estimation of the risk factors in DB ACL reconstruction through a multivariate logistic regression model including numerous potential predictors.[16] But this previous study dealt with an objective instability, specifically, rather than overall outcomes after surgery.

The purpose of this study was to identify the risk factors that predict the unsatisfactory postoperative clinical outcomes after DB ACL reconstruction using multivariate logistic regression. We hypothesized that 1 or more risk factors, including femoral or tibial tunnel positions, could reasonably predict inferior clinical outcomes.

Methods

Patients and Inclusion/Exclusion Criteria

After obtaining institutional review board approval for this retrospective trial, we reviewed the medical records of consecutive ACL reconstructions by one surgeon (J.H.A.) from January 2006 to September 2012. We started DB reconstruction since January 2005. Considering the learning period of 1 year and a minimum follow-up duration of 3 years, patients from January 2006 to September 2012 were enrolled. Patients were eligible for enrollment if they were at least 3 years out from DB ACL reconstruction. Exclusion criteria were (1) a delay to surgery from initial injury of more than 4 years (210 weeks); (2) contralateral knee pathology; (3) the lack of postoperative 3-dimensional computed tomography (3D-CT); (4) SB ACL reconstruction; (5) revision ACL reconstruction; (6) meniscus allograft transplantation (MAT) after total or subtotal meniscectomy; and (7) multiple ligament surgeries.

Surgical Technique

All enrolled patients had DB ACL reconstruction performed by the same surgeon at a single center. In all cases, the hamstring autograft tendons were harvested from the affected limb through a longitudinal 4-cm skin incision over the medial aspect of the proximal tibia. The semitendinosus and gracilis tendons were harvested and used to make the anteromedial (AM) and posterolateral (PL) bundle grafts, respectively. Triple strands of the semitendinosus tendon were used for the AM bundle graft, and triple strands of the gracilis tendon were used for the PL bundle graft. The size of each graft was not recorded in all cases. The center of the femoral footprints of both the AM and PL bundles

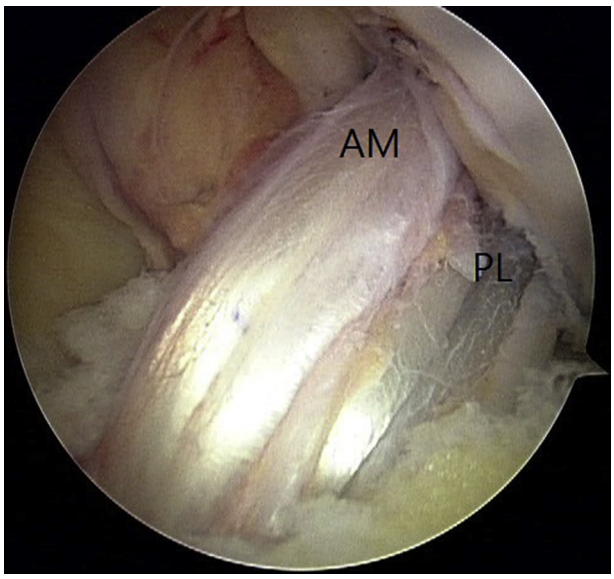

Fig 2. Arthroscopic view of a left knee, using the 30° arthroscope from the anterolateral portal. Arthroscopic findings showed reconstructed anteromedial and posterolateral bundle grafts after double-bundle anterior cruciate ligament reconstruction. (AM, anteromedial bundle; PL, posterolateral bundle.)