The Influence of Segond Fracture on Outcomes After Anterior Cruciate Ligament Reconstruction

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Purpose: To determine the prevalence of Segond fractures using computed tomography (CT) and to investigate the effects of Segond fractures on the outcomes of primary anterior cruciate ligament (ACL) reconstruction for isolated ACL injuries. **Methods:** Between January 2010 and July 2015, we retrospectively evaluated 383 patients who underwent primary ACL reconstruction, who underwent CT scans immediately after surgery, and who were available at 2 years of follow-up. The absence or presence of a Segond fracture was confirmed using CT. The following parameters were evaluated in all patients at the 2-year follow-up visit: clinical scores (International Knee Documentation Committee subjective score, Lysholm score, and Tegner activity score) and knee joint stability (anterior drawer test, Lachman test, pivot-shift test, and side-to-side difference in anterior tibial translation on Telos stress radiographs). **Results:** Among 383 patients with primary ACL tears, a Segond fracture was confirmed in 8.9% (n = 34) using 3-dimensional CT. We placed 349 patients into the group with ACL tears without Segond fractures (group A) and the other 34 into the group with ACL tears with Segond fractures (group B). Between the 2 groups, there were no significant differences in the postoperative International Knee Documentation Committee subjective score ($P = .97$), Lysholm score ($P = .17$), or Tegner activity score ($P = .95$). No significant differences in the anterior drawer test ($P = .28$), Lachman test ($P = .45$), pivot-shift test ($P = .14$), and side-to-side difference in anterior tibial translation on Telos stress radiographs ($P = .93$) between the 2 groups were found preoperatively and postoperatively. **Conclusions:** The presence of a Segond fracture did not affect knee joint stability in patients with ACL tears. Moreover, the 2 groups did not show significant differences in clinical scores or knee joint stability after undergoing ACL reconstruction. **Level of Evidence:** Level III, retrospective comparative study.

Until 2013, Segond fractures were not a consideration during primary anterior cruciate ligament (ACL) reconstruction.[1] Before 1879, when radiographs were not available, a French surgeon named Paul Segond first reported a characteristic avulsion fracture of the proximolateral tibia when an internal rotation force was applied to cadaveric human knees.[2] Since then, the Segond fracture has been defined as an avulsion injury of the iliotibial band and lateral joint capsule[3] and has become accepted as a potential indicator of anterolateral rotatory instability of the knee and the likelihood of severe ligamentous injury, most typically to the anterior cruciate ligament.[4,5]

The anterolateral ligament (ALL) is a recently discovered ligamentous structure that originates from the lateral femoral epicondyle and inserts into the anterolateral tibia.[1,6] Among ALL injuries, 27% occur in the posterolateral capsule, 22% occur at the tibial insertion site, and 9% to 10% are accompanied by bony tibial avulsion,[7,8] also known as a Segond fracture.

Therefore, a Segond fracture suggests an ACL tear accompanied by ALL injury, and several biomechanical studies have recently reported that such an injury has a significant effect on rotational control during pivot-shift testing.[9-11] In addition to a significant increase in internal rotation, these injuries are reported to affect anteroposterior stability.[9-11] On the basis of these results, Sonnery-Cottet et al.[9] included Segond fractures as one of the decisive criteria for ALL reconstruction, together with ACL revision, high-grade pivot shift, athletes participating in pivoting sports, and generalized laxity.

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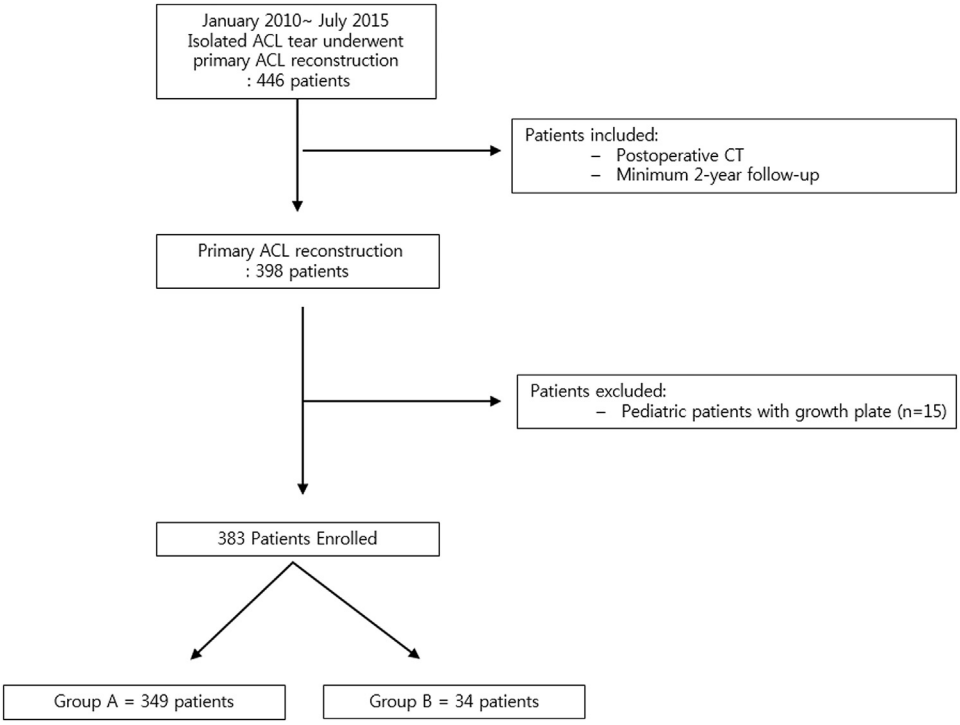

Fig 1. Participant flowchart. Group A comprised patients with anterior cruciate ligament (ACL) tears without Segond fractures, whereas group B comprised patients with ACL tears with Segond fractures. (CT, computed tomography; 3D, 3-dimensional.)

Until recently, we had achieved satisfactory outcomes without significant treatment of Segond fractures during ACL reconstruction. However, the paradigm of ACL reconstruction has shifted from isometric reconstruction to anatomic reconstruction, and with the existence of the ALL being shown, Segond fractures have received renewed attention. Yet, given that ACL reconstruction has been performed successfully for decades, routine reconstruction of the ALL in addition to ACL reconstruction, to achieve greater anatomic restoration, may not be necessary for ACL tears with Segond fractures, which had previously been overlooked. The purposes of this study were to determine the prevalence of Segond fractures, which were detected using computed tomography (CT) in isolated ACL injuries, and to investigate whether concomitant Segond fractures affected the outcomes of primary ACL reconstruction for isolated ACL injuries. We hypothesized that the presence of a Segond fracture would not have a significant effect on preoperative knee joint stability and that there would be no difference in postoperative clinical scores and knee joint stability between patients with ACL tears with and without preoperative Segond fractures after undergoing ACL reconstruction only.

Methods

After obtaining institutional review board approval, we retrospectively evaluated 446 patients who had been diagnosed with an isolated ACL tear[12] and underwent primary ACL reconstruction at our institution between January 2010 and July 2015. An isolated ACL tear indicates that no other evidence of combined ligamentous injury was observed.[12] The diagnosis of an ACL tear was confirmed by a physical examination and magnetic resonance imaging (MRI). The 2 inclusion criteria were patients who had undergone CT scans immediately after surgery and a minimum follow-up period of 2 years after the index surgical procedure. Pediatric patients with growth plates were excluded. Three hundred eighty-three patients met all inclusion and exclusion criteria (Fig 1). The presence or absence of a Segond fracture was confirmed using CT. CT examination was performed 3 days after surgery, just after removal of the Hemovac drain (Zimmer Biomet, Warsaw, IN). The CT scans were reviewed by 2 radiologists with special expertise in musculoskeletal imaging, who were blinded to this study.

Surgical Procedures and Rehabilitation

Regardless of Segond fractures, all ACL reconstructions were performed by the same surgeon (K.H.Y.), who used the same type of tibial fixation and the same technique, using a single bundle in all patients. The tibial tunnel was made on the anatomic ACL footprint. Then, the femoral tunnel was placed in the anatomic ACL footprint according to the bony landmarks and arthroscopic findings of the ACL footprint and remnant fiber position by the anteromedial