What Effect Does Anterior Cruciate Ligament Tibial Guide Orientation Have on Tibial Tunnel Length?

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Purpose: To evaluate the effects of alteration in tibial guide pin insertion angle and external starting point on tibial tunnel length for anterior cruciate ligament (ACL) reconstruction. **Methods:** Ten cadaveric tibial specimens were used. One pin was placed at each of variable insertion angles (55°, 50°, and 45°) of the tibial targeting device aimed at the center of the tibial ACL footprint. These 3 pins started externally along the anterior border of the superficial medial collateral ligament. A fourth pin at 50° was placed at a different external tibial starting point 1.5 cm anterior to the anterior border of the superficial medial collateral ligament. The intraosseous length of each pin was measured. Statistic analyses were performed with the Kruskal-Wallis test, with significance set at $P < .05$. **Results:** The mean length for the 55° tibial tunnel was 50.3 mm (range, 42 to 56 mm); for the 50° tunnel, it was 48.9 mm (range, 44 to 55 mm); for the 50° anterior tunnel, it was 47.6 mm (range, 39 to 55 mm); and for the 45° tunnel, it was 47.3 mm (range, 41 to 52 mm). Changing the angle of the tibial guide did not significantly affect the length of the tibial tunnel ($P = .18$). Changing the external tibial starting point did not affect the length of the tibial tunnel ($P = .39$). **Conclusions:** Changing the tibial guide angle between 45°, 50°, and 55° does not appreciably change tibial tunnel length. Moving the starting point anterior 1.5 cm toward the tibial tubercle also has no effect on the tibial tunnel length. The lack of significant changes in tunnel length with these interventions may reflect the associated changes that occur in proximal tibial morphometry with change in external tibial starting position. **Clinical Relevance:** Changing tibial tunnel length in ACL reconstruction likely requires more distalization of the external tibial starting point than is achieved simply by altering the tibial aiming guide angle by 10° or less.

Successful outcomes of anterior cruciate ligament (ACL) reconstruction require properly placed tibial and femoral tunnels to optimize the alignment of the graft.[1,2] A common intraoperative complication during ACL reconstruction with a bone–patellar tendon–bone autograft is graft-tunnel length mismatch.[3-7] Recent studies have shown that anatomic reconstruction techniques using an anteromedial arthroscopic portal result in shorter femoral tunnel lengths.[8,9] The use of this anatomic reconstruction technique has consequently increased the concern of graft-tunnel mismatch with bone–patellar tendon–bone grafts.

Adjustment in tibial tunnel length has historically been used to manage graft-tunnel mismatch. Commonly advised techniques include shortening or increasing the length of the tibial tunnel to adjust for graft length mismatch by adjustment of the external tibial starting point or the pin insertion angle. There is limited information in the literature, however, on the correlation between these surgeon-controlled

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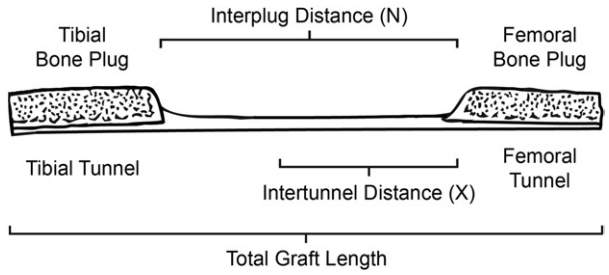

Figure 1. Typical bone–patellar tendon–bone graft. The total length of the graft includes bone plugs from the patella and tibia, as well as the patellar tendon length (N).

variables and the intraosseous tibial tunnel length. Defining a clear relation between these technical factors and their impact on tunnel length would be of value for surgeons to avoid the technical complications of fixation in the setting of graft-tunnel mismatch. Multiple studies in the literature propose different methods to determine the optimal pin insertion angle for tibial tunnel preparation (Fig 1). These methods are anecdotally based.[7,10] One method uses the formula N + 7 (interplug length + 7°), which attempts to provide a reasonable way of judging the optimal tibial guide angle.[11] Other methods estimate tibial tunnel length. One method estimates the length of the tibial tunnel (total graft length – 50 mm) and then uses a calibrated drill guide to determine the starting point for the predetermined graft length.[12] Another method uses the formula N + 2 mm, which calculates the tibial tunnel length based on actual intra-articular measurements of the graft length.[13]

Similar recommendations have been made with regard to the external tibial starting position for tibial tunnel preparation. Most surgeons who use a transtibial technique for femoral tunnel preparation recommend starting at the anterior border of the superficial medial collateral ligament (MCL), or halfway from the anterior aspect of the tibial tubercle to the posteromedial border of the tibia.[14] However, starting the guide more anterior and thus closer to the tibial tubercle may produce a longer tibial tunnel.[15-17]

The purpose of our study is to define the relation between tibial tunnel length and the variables of tibial guide pin insertion angle and external tibial starting point. We hypothesized that progressively larger tibial guide angles and a more anterior external starting point would be associated with correspondingly longer tibial tunnels.

METHODS

We used 10 preserved cadaveric tibial specimens (5 left and 5 right) for this study. There were 6 male specimens and 4 female specimens with a mean age of 85.7 years (range, 78 to 92 years). The specimens were not matched. Each specimen underwent a tibiofemoral disarticulation to allow direct visualization and demarcation of the ACL tibial footprint as described by Colombet et al.[18] With the exception of the superficial MCL, we cleared all soft tissues from each specimen to expose the underlying tibial cortex. The center of the tibial footprint (combined anteromedial and posterolateral bundle) was defined by bisecting the medial-lateral and anterior-posterior dimensions.

For each specimen, an ACL tip-aiming tibial guide (Smith & Nephew, Andover, MA) directed to the previously marked center of the ACL tibial footprint was used to drill 4 consecutive guide pins into the proximal-medial tibia. We drilled the first 3 pins using an external tibial starting point located along the anterior border of the superficial MCL. A pin was placed in the tibia by use of each of 3 tibial guide angles (45°, 50°, and 55°). Finally, the fourth pin was drilled with the guide set at 50° and the tibial starting point moved 1.5 cm anterior to the anterior border of the superficial MCL (Figs 2 and 3). We chose only to test the more anterior external tibial starting point at 50° because it was the middle of the 3 angles. Our goal was to test

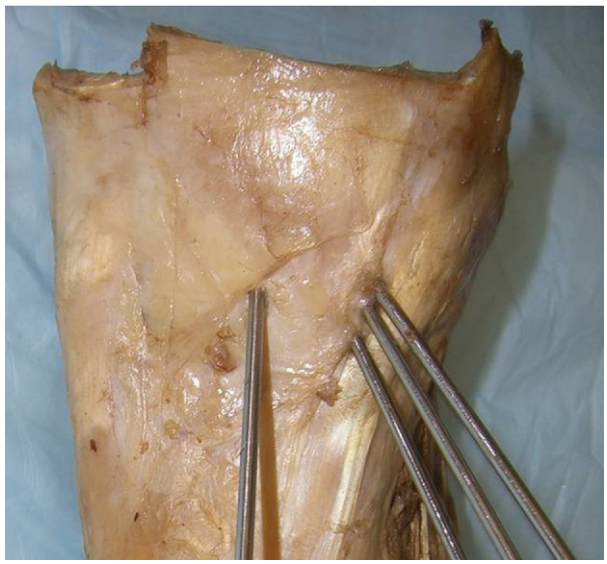

Figure 2. Anterior proximal tibia with all 4 guide pins in place. The starting point for each guide pin does not move much distally as the guide pin angle changes.