Three-Dimensional CT Analysis of Posterolateral Femoral Tunnel in Double Bundle ACL Reconstruction. Comparison of Ourside-in and Transportal drilling Techniques

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Introduction: Optimal mode of femoral drilling technique in anatomic double bundle anterior cruciate ligament (ACL) reconstruction is still controversial. It has been shown that transtibial drilling may pose difficulty in consistently achieving anatomic tunnel placement compared to other techniques such as transportal inside-out and outside-in (OI) drilling methods. In our clinical experiences for anteromedial (AM) bundle femoral tunnel drilling, it has been shown that the risk for inadequate tunnel length or posterior wall breakage was higher in transportal method compared to the outside-in drilling. Therefore, AM femoral tunnel has been drilled with outside-in technique in our practice. By contrast, the risk for those tunnel-related complication is minimal for PL tunnel in both techniques. Consequently, both methods are currently employed for PL femoral tunnel drilling. The purpose of this study was to compare the length, orientation, and intraarticular aperture shape of the PL femoral tunnel between the inside-out drilling via far anteromedial (FAM) portal and outside-in drilling method using three-dimensional image analysis on postoperative CT images.

Methods: Among the patients who underwent anatomic ACL reconstruction in our institutes from November 2010 to September 2013 and met the inclusion criteria, postoperative CT images at 1 week was available for analysis in 38 patients. The inclusion criteria were unilateral injury, use of autogenous semitendinosus grafts. Patients with multiple ligament reconstruction and revision ACL reconstruction were excluded from the study. For the PL femoral tunnel drilling, transportal method via FAM portal was employed in 21 knees (FAM group) while outside-in drilling was performed in 17 knees (OI group). Age at surgery and gender distribution were not significantly different between the groups. CT examination was performed at 1 week after surgery with the knee in full extension. Thereafter, three-dimensional CT image analysis using ZioTerm2009 imaging software was applied to the PL femoral tunnel and the following parameters were evaluated and compared between the groups: position of the PL femoral tunnel center based on the Bernard and Hertel method (% height and depth), tunnel length, shape of the intraarticular aperture (major axis length of the ellipse in relation to the original drilling diameter), bending angle of the graft (angle formed by long axes of the intararticular graft and the femoral bone tunnel). The Mann-Whitney’s U test was used for statistical comparison between the groups with significance level set at p < 0.05. The statistical analysis was performed using SPSS software.

Results: Coalition of the AM and PL femoral tunnels was identified in 3 knees and 1 knee for FAM and OI groups respectively. In the subsequent comparative analysis for tunnel position and aperture shape, these 4 knees were excluded. Assessment of the tunnel center location based on the Bernard and Hertel method showed that anatomic PL femoral tunnel placement could be achieved in both groups without significant difference in percent height and depth values (Fig.1). The mean tunnel length was 28.3 mm ±
4.6 mm (range, 19.2-37.1 mm) in the FAM group and 29.6 mm ± 4.1 mm (range, 23.9-38.1 mm) in the OI group without significant difference. The major axis of the aperture/drill diameter ratio averaged 1.23 ± 0.13(range, 1.09-1.48)in the FAM group and 1.12 ± 0.12(range, 1.00-1.36)in the OI group. The calculated value was significantly larger in the FAM group indicating that the aperture shape was more elliptic in this group (Fig.2). The mean graft bending angle at the femoral tunnel aperture was 63.6° ± 6.9°(range, 49.9°-73.3°)in the FAM group and 99.4° ± 5.4°(range, 90.1°-107.7°)in the OI group showing significant intergroup difference. Therefore, the PL graft exhibited more acute angle at the aperture in the OI group (Fig.3).

Discussion: The present study showed that anatomic placement of the PL femoral tunnel was feasible in both transportal and outside-in techniques. Demonstrated advantages of outside-in technique over inside-out transportal method included less tunnel coalition and more round aperture shape with decreased tunnel-graft gap at the aperture. These factors can help enhance tissue healing at the graft-bone tunnel wall interface; however, the graft bending angle at the tunnel aperture was more acute in the outside-in drilling group, which may increase the mechanical stress at the aperture leading to bone tunnel expansion and damage of the graft. Comparative clinical outcome study including MRI and second-look arthroscopic examinations seems required to identify the consequence of those geometric differences in PL femoral tunnel created with the two drilling techniques.

Significance: Outside-in technique for PL femoral tunnel drilling may have advantage over transportal technique in reducing the gap between the graft and the bone tunnel wall at the intraarticular aperture; however, the graft bending angle at the aperture was more acute in outside-in drilling technique.
Figure 2. Shape of the PL femoral aperture

Figure 3. Bending angle at the aperture