**Recurent instability after ACL reconstruction: Preoperative planning using 3-dimensional CT scans**

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**Introduction:** Several factors can influence increased knee joint laxity after ACL reconstruction (1). Tunnel positioning is one of the most common reasons for re-instability after ACL reconstruction resulting in an increased incidence of ACL revisions (2). When planning ACL revision, a one and two staged procedure can be followed. Two main issues need to be addressed in ACL revision strategies: tunnel location and tunnel widening (3). Aim of the current study was to evaluate the benefit of CT scans using 3-dimensional reconstruction in planning of ACL revision and grading the tunnel placement. We hypothesize that 3d CT reconstruction is a reliable and accurate tool to assess the tunnel location.

**Methods:** In 30 prospective collected patients (19 male, 11 female patients; range 17-43 years) suffering re-instability after ACL reconstruction diagnostics were performed using Lachman, pivot shift and Losence tests. Clinical history was collected using the operative protocol of the primary reconstruction. Posterior stress x-rays were performed in all patients to evaluate the integrity of the PCL. For evaluation of enlargement of the femoral and tibial tunnels, CT scans were performed and reconstructed in sagittal, frontal and coronal plane. Additionally, a 3-d reconstruction was performed to visualize the femoral and tibial tunnel placement.

**Results:** Of the 30 patients enrolled in the study, 13 had BPTB and 17 had hamstring graft reconstruction at primary ACL reconstruction. Evaluation of the operation protocol revealed in 26 patients a transtibial tunnel technique and in 4 patients a medial portal technique. CT scans showed significant tunnel enlargement in 12 patients (7 patients tibial, 3 patients femoral, 2 patients femoral and tibial) resulting in a staged surgical procedure with bone grafting (Fig.1).

![Fig.1: Significant tibial tunnel widening in coronal (a) and frontal (b) plane. Debridement of the tibial tunnel (c), bone grafting of the tibial tunnel (d).](image)

In 18 patients, primary revisions were performed. The 3-d reconstruction showed in 14 of these patients a steep femoral tunnel placement in the high noon position outside the anatomic origin of the ACL and the tibial tunnel placement in the posterolateral footprint. In 4 patients, a primary revision using the same tunnel placements as in the first reconstruction could be performed according to the 3-d scans.

The 3d CT analyses showed three different groups of femoral tunnel placements. In most of the cases (20 patients, 66%) the femoral tunnel placement was steep and anterior to the femoral origin of the native ACL (Fig.2c). In 9 patients (30%) the femoral tunnel was in the anatomic origin of the ACL located (Fig.2a,b). Within this group a subgroup was to be found. In 4 patients the anatomic tunnel of the first reconstruction showed no signs of tunnel enlargement (Fig.2c). In 5 patients the anatomic tunnel showed significant tunnel enlargement (Fig.2d). In all of these patients an aperture fixation with interference screws was used. In one patient, a posterior malplacement of the femoral tunnel was to be found (Fig.2d).

![Fig.2: 3d reconstruction of femoral tunnel placement. Anatomic tunnel placement without tunnel widening (a), anatomic tunnel placement with tunnel widening (b), anterior tunnel malplacement (c) and posterior tunnel malplacement (d)](image)

**Discussion:** The results of our study confirm our initial hypothesis that 3-d CT reconstruction is a helpful tool for the planning of ACL revision surgery. Especially on the femoral side the tunnel placement is difficult to assess using plain x-rays (3). The reconstruction in 3 dimensions as used in the current study provides an excellent overview of the femoral tunnel and its relation to the origin of the native ACL. In the clinical setting, this may be very important for the education of the patient before surgery. In our hands, it was reliable to conclude from the 3d CT scans in cases of femoral malplacement (70% of the patients) if a new femoral tunnel could be placed in the anatomic origin. Tunnel enlargement was most prominent at the tibial tunnel. In most of the cases a transtibial tunnel technique with the tibial tunnel in the posterolateral area of the ACL insertion was used.

We conclude that analysis of tunnel placement and enlargement are essential factors in preoperative planning of ACL revision. The results of the current study show that a 3-d reconstruction allows exact visualization of the femoral and tibial tunnel placement preoperatively. This facilitates preoperative planning and the patient can be informed reliable about a primary or staged revision procedure.

**References:**