

Navigated anterior cruciate reconstruction: radiological validation of a non-image based system

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Introduction: During anterior cruciate ligament (ACL) reconstruction, appropriate location of the insertion sites of the graft is critical for an adequate control of the anterior laxity. Conventional techniques with visual alignment according to intra-articular landmarks involve substantial deviation from the expected goal. Intra-operative navigation might improve the precision and accuracy of ACL reconstruction. The goal of the study was to compare the intra-operative navigated measurement of the location of both tibial and femoral tunnels to the post-operative measurement performed on standard plain X-rays. We hypothesized that these two measurement techniques will give different results.

Material: Inclusion criterion was a clinically or MRI proved ACL insufficiency requiring surgical reconstruction. There were no exclusion criteria. 56 consecutive patients operated on for an arthroscopic-assisted ACL reconstruction have been selected: 35 men and 21 men, with a mean age of 24.5 years.

Methods: The navigation software works with intra-operative anatomic and cinematic data registration. Relevant anatomic landmarks were palpated with a navigated stylus: anterior, posterior, medial and lateral borders of the proximal tibia, and most anterior and posterior points of the Blumensaat line. The position of the center of the tibial and femoral tunnels was measured by the navigation system in comparison to these landmarks. Post-operative antero-posterior and lateral plain X-rays were performed after the reconstruction, and the location of the center of the tunnels was assessed according to the same landmarks than the intra-operative assessment. Following comparisons between navigated and X-ray measurements were made: antero-posterior and medio-lateral position of the tibial tunnel, antero-posterior position of the femoral tunnel. Data were compared with a paired Student t-test at a 5% limit of significance. The linear correlation coefficient between navigated and X-ray measurement was calculated. The agreement between navigated and X-ray measurement was assessed according to the Bland-Altman technique.

Results: The center of the tibial tunnel was located at 39% of the medio-lateral tibia dimension for navigated measurement, and at 41% of the medio-lateral tibia dimension for the radiological measurement. This difference was not significant ($p=0.37$). There was a significant correlation between the two measurements ($r^2=0.63$, $p<0.01$). The agreement between the two measurements was considered as good.

The center of the tibial tunnel tibial was located at 32% of the antero-posterior tibia dimension for navigated measurement, and at 36% of the antero-posterior tibia dimension for radiological measurement. This difference was significant ($p=0.05$). There was a significant correlation between the two measurements ($r^2=0.69$, $p<0.01$). The agreement between the two measurements was considered as good.

The center of the femoral tunnel was located at 78% of the antero-posterior femur dimension for navigated measurement, and at 76% of the antero-posterior femur dimension for radiological measurement. This difference was not significant ($p=0.37$). There was a significant correlation between the two measurements ($r^2=0.58$, $p<0.01$). The agreement between the two measurements was considered as moderate.

Discussion & Conclusion: There was significant correlation between navigated and radiological measurements. The correlation was weaker for femur measurements, probably because of the lack of precision and accuracy of the radiological measurement (the center of the screw may be different from

the center of the tunnel). The navigation system allows a more exact measurement of the location of the tunnels after ACL reconstruction than standard X-rays.

Summary: The navigation system allows a more exact measurement of the location of the tunnels after ACL reconstruction than standard X-rays.