Virtual reconstruction planning during revision total knee replacement

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**Introduction:** An optimal reconstruction of the joint anatomy and physiology during revision total knee replacement (RTKR) is technically demanding. The standard navigation systems were developed for primary procedures, and their adaptation to RTKR is difficult. Especially, the standard navigation systems are not able to deal with a significant malposition of the index prosthesis or with the bone defects after prosthesis removal. We present a new navigation software dedicated to RTKR. The rationale of this new software was to allow a virtual planning of the joint reconstruction just after removal of the primary prosthesis.

**Material:** The new software was developed on the basis of a non-image based navigation system which has been extensively validated for implantation of a primary TKR. Following changes have been implemented:

1) to define and control the vertical level of the joint space on both tibia and femoral side, and to allow performing the potential change decided prior to the revision procedure according to the preoperative imaging planning;

2) to measure the tibio-femoral gaps independently in flexion et en extension on both medial and lateral tibio-femoral joints;

3) to virtually plan and control the vertical level and the orientation of the tibia component;

4) to virtually plan and control the sizing and the 3D positioning of the femoral component;

5) to virtually plan and control the potential bone resection;

6) to virtually plan and control the potential bone defects and their reconstruction (bone graft or augments);

7) to virtually plan and control the size, the length and the orientation of the stems extensions independently on the femoral and on the tibia side.

**Methods:** The validity of the concept has been tested by 20 patients operated on for RTKR for any reason, with a routine reconstruction with a cemented, unconstrained revision implant. The accuracy of the experimental software was assessed 1) during the procedure after implantation of the RTKR by measuring the medial and lateral laxity in full extension and 90° of knee flexion with the navigation system, and 2) on post-operative radiographs: coronal tibio-femoral angle, coronal and sagittal orientation of both tibia and femur components, vertical level of the reconstructed joint space, patella height, quality of the bone-prosthesis contact of both tibia and femur components.

**Results:** No system failure was observed. The virtual planning of the reconstruction was possible in all cases. The intra-operative control of the different reconstruction steps was possible in all cases. The mean coronal tibio-femoral angle was 0±3°, and no outlier was observed. Coronal and sagittal orientation of the prosthetic components was considered satisfactory in all directions for 16 cases. The desired vertical level of the joint space was achieved in all cases. The desired patella height was achieved in 15 cases. The measurement of the knee laxity was satisfactory in 16 cases. A good bone-prosthesis contact was achieved in 17 cases for the tibia, but it was not possible to analyze accurately this criterion for the femur.
**Discussion:** The software used in the current study allowed performing a straightforward reconstruction of the knee joint anatomy and physiology during RTKR. The virtual planning prevented to perform repetitive trials with different technical solutions which are often necessary during conventional RTKR. The operating time may be consequently decreased.

**Conclusions:** A multicentric validation study is mandatory to assess the generalization of these results in other centers and by other surgical teams.