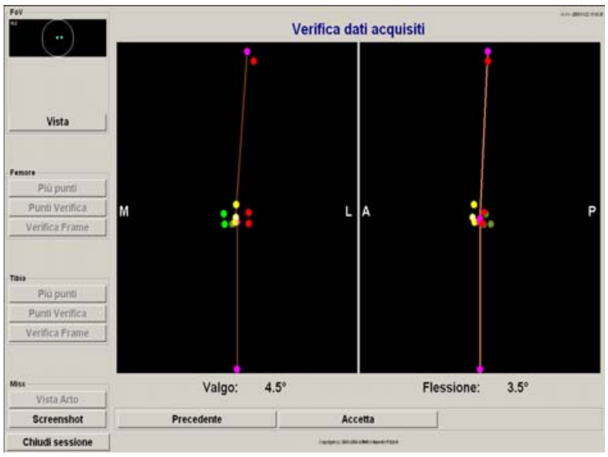
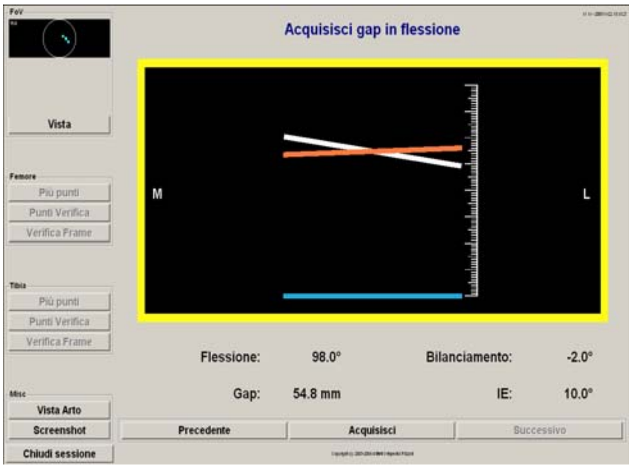
NAVIGATED REVISION TOTAL KNEE ARTHROPLASTY

Total Knee Arthroplasty Revision (TKA Revision) is a skill-demanding intervention due to the complexities that exists after the removal of the failed prosthesis: bone deficiencies and lack of anatomical references make it difficult to understand the normal knee kinematic and adequately plan the intervention.
On the other side accurate soft tissue balancing, proper restoration of limb alignment and joint line height are necessary to achieve a successful outcome. Since main landmarks are not available, the surgeon use some secondary parameters that if contemporarily considered provide precise indications for implant positioning.
Using computer assisted navigation systems can be potentially very helpful since they allow the contemporary control of several parameters.
On the other side, most of existing navigated techniques for TKA Revision use navigation systems developed for primary TKA[1] [2], using imprecise data and disregarding those useful indications provided by secondary parameters.
A computer assisted technique developed in our lab for TKA Revision is presented. It is based on the use of a navigation system, RTKANav compound by a commercial optical localizer (Polaris Northern Digital Inc.), a dedicated software specifically done for TKA Revision and some navigated tools developed for this application.
The surgery starts performing surgical incision and fixing navigation markers to the femur and the tibia.
After prosthesis removal, surgeon detects several anatomical landmarks (12 points) for the computer system to construct the 3-dimensional representation of the patient's lower limb, by registering in space critical biomechanical landmarks.
After reaming the medullary canal of both tibia and femur, two dedicated navigated tools developed to acquire the canals directions are inserted into the bones. The appropriate cutting level is determined by the surgeon considering the bone quality; in case of differences between medial and lateral cuts, these data are manually inserted into the system.
On the system interface, patient anatomy model is represented with dots and lines corresponding to the acquired landmarks and data derived from it (femoral and tibial mechanical axes, transepicondylar line); angles between the mechanical axes can be controlled and monitored at any time.



To correctly perform soft tissue balance, space between the tibial navigated plane and the femoral one with the knee in extension (extension space) and the distance between the tibial navigated plane and the femoral stem insertion (flexion space) with the ligament correctly tighten are estimated

using a dedicated tool. During these acquisitions, graphical tools indicate to the surgeon if the current gap is rectangular or not allowing him to estimate the possible need of ligament release.
Moreover, during flexion space acquisition the actual relationship between the femoral component position and the transepicondylar line is reported.



Even if during acquisition phase some specific points (e.g one or both the epicondyles) can not be identified, since for each prosthetic component several criteria to set each degree of freedom are considered and compared, the system is able suggest an intervention plan.
A range of acceptability for the joint line level is determined related to the medial and lateral epicondyle height, the patella pole and the fibular head. The final joint line height is set considering the determined interval and the measured extension space, providing also indications about the tibial polyethylene insert size and if any femoral augmentation is needed.
The IE rotation of the femoral component is set considering the transepicondylar line or the femoral neck axis and the flexion space.
The femoral components size is determined considering the prosthesis properties, the distance between the navigated stem and the anterior femoral shaft and the flexion space.
On tibial side, the component size is set considering the estimation of the tibial plateau done through points acquisition; IE rotation is determined related to the tibial tuberosity position.
The system provides the surgeon with tools to analize and modify the proposed plan monitoring the behaviour of the residual joint gap in flexion and in extension.
Once refined the intervention plan, the system provide the surgeon with tools to navigate the cutting guides to reproduce the plan on the patient. The final position of the tibial and femoral implants can be checked by displaying the postoperative leg alignment and residual joint gap.

Computer guidance showed early promising results providing the surgeon with useful indications achieve a satisfactory prosthesis implant. Future works concern system validation assessing system accuracy and comparing the navigated technique with the traditional one.