Special instrument or computer navigation for knee replacement surgery – whenever or when?

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Introduction: Stryker computer navigation system has been used for knee replacement procedures since October 2008 at the Russian Ilizarov Scientific Centre for Restorative Traumatology and Orthopaedics.

Computer navigation allows for accurate (perpendicular to the biomechanical axis of the limb) orientation of the distal femoral and proximal femur cuts; determining the size and position of the femoral component (when Stryker implants used); adequate rotation alignment of the femoral component; biomechanical axis of the limb with various flexion and extension; size and shape of flexion and extension gaps; stability of the knee joint with various flexion and extension before and after implantation; orientation of the cuts without exposure of the medullary canal.

Material and Methods: There have been 126 computer assisted total knee replacement procedures that accounted for 11.5% of primary TKR within this period. Arthritis of the knee joints (primary, secondary with rheumatoid arthritis, dysplasia, posttraumatic) with evident pain syndrome was an indication to TKR surgery. Arthritis of the knee joint of 27 patients (21.4%) was accompanied by femoral deformity of various etiology with debris found in the medullary canal in several cases. The rest 99 patients (78.6%) were regular cases of primary TKR.

Results: We compared the results of correction of lower limb biomechanical axis with TKR employing navigation and without computer assistance. Regular TKR procedures showed no substantial difference in the correction of biomechanical axis. Complete correction (varus/valgus of 0°) using computer navigation was achieved in 85% of the cases versus 79% of the patients without navigation. Postoperative varus or valgus deformity of 3° developed in 14% of navigated cases and in 17% of the cases without computer assistance.

An error of deformity correction was 3-5° in 4% of the cases without computer navigation. Those were cases of challenging primary TKR. So the advantages of computer navigation have become evident with greater deformities, and in the cases when intramedullary guide can hardly be used due to severe deformities in the femoral metaphysis and diaphysis, after several operative procedures of osteosynthesis with deformed, obliterating bone marrow canal or presence of debris. So, complete correction (varus/valgus of 0°) using computer navigation was achieved in 85.2% cases versus 42.8% patients without navigation. Postoperative varus of 3° was developed in 14.8% cases (valgus or varus deformity of 3° developed in 28.6% of the cases without computer assistance).

Radiographs showed mismatch between limb realignment and navigator parameters in several cases. In our opinion, it occurred due to inaccurate marking of bone landmarks. In addition to that, inaccurate centering of rotation of the femoral head can occur with limited range of motion in the hip joint with deformed femoral head. An error of the distal femoral cut resulted in valgus deformity of 15° in a patient with contracture of the hip joint, although navigator showed femoral component being in varus/valgus of 0°.

Conclusion: What is better: special instrumentation or navigation?

Current instrumentation can provide regular mechanical control of the limb axis and is based on the principles of intramedullary, extramedullary and even double guide placement. Image-free navigation and
standard surgical techniques can equally be used for simple cases of primary TKR. Same landmarks (femoral condyles, mid condyles and Whiteside line) are used when special instrumentation is employed. These landmarks are determined by a surgeon quite subjectively and can lead to inadequate usage of special instrumentation and computer navigation. Control of resection block placement must be performed. Proper pelvis fixation and greater ROM are needed to identify a center of rotation of the femoral head. Any pelvis displacement or limited ROM in the hip can result in a center of rotation of the femoral head being inadequately identified by navigation system that would lead to improper placement of implant components.

However, computer navigation should be used in the cases when intramedullary guide can hardly be used due to severe deformities in the femoral metaphysis and diaphysis, after several operative procedures of osteosynthesis with deformed, obliterating bone marrow canal or presence of debris. Special instrumentation can fail in setting a valgus angle needed with extraarticular femoral deformity. This is very important for the cases when there is a difficulty with identifying the rotation using posterior femoral condyles (posttraumatic condition, hypoplastic condyles).

Assessment of ligament balance can be rather subjective when special instrumentation is used. Application of computer navigation is helpful to obtain objective assessment since it allows for measurements of flexion and extension gaps.

Application to computer navigation for TKR is to be considered for the cases when intramedullary guide cannot be placed evident extraarticular deformity, for patients with considerable articular deformity with signs of hypoplastic articular formation. Computer navigation is contraindicated for contractures and ankyloses of the hip joint. For the rest of the cases the choice of instrumentation is a surgeon’s decision.