Title of the Highlight:
A new in vivo technique for determination of femoro-tibial and femoro-patellar 3D kinematics in total knee arthroplasty (TKA)

Keywords:
Total knee arthroplasty, magnetic resonance imaging, segmentation, quantitative image analysis, 3D-joint kinematics

Main Message of the Highlight in a Sentence:
Development of a technique for the determination of femoro-tibial and femoro-patellar 3D-kinematics after TKA

Description of the Highlight:
Aim was to develop an in vivo technique which allows determination of femoro-tibial and of femoro-patellar 3D-kinematics in total knee arthroplasty (TKA) simultaneously. The knees of 20 healthy volunteers and of eight patients with TKA were investigated. Kinematics analysis was performed in an open MR-system at different flexion angles with external loads being applied. The TKA components were identified using a 3D-fitting technique, which allows an automated 3D-3D-registration of the TKA. Femoro-patellar and femoro-tibial 3D-kinematics were analyzed by image postprocessing. The validity of the postprocessing technique demonstrated a coefficient of determination of 0.98 for translation and of 0.97 for rotation. The reproducibility yielded a coefficient of variation (CV%) for patella kinematics between 0.17% (patello-femoral angle) and 6.8% (patella tilt). The femoro-tibial displacement also showed a high reproducibility with CV% of 4.0% for translation and of 7.1% for rotation. While in the healthy knees the typical screw-home mechanism was observed, a paradoxical anterior translation of the femur relative to the tibia combined with an external rotation occurred after TKA. The results demonstrate that
the presented 3D MR-open based method is highly reproducible and valid for image acquisition and postprocessing and provides—for the first time—in vivo data of 3D-kinematics of the tibio-femoral and simultaneously of the patello-femoral joint during knee flexion.

**Bezug zur GSF-Strategie:**

biomedical imaging, image processing

**GSF-interne Kooperationspartner, mit denen das Highlight ggf. erarbeitet wurde:**
A new in vivo technique for determination of femoro-tibial and femoro-patellar 3D kinematics in total knee arthroplasty (TKA)

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Purpose

The ultimate goal of total knee arthroplasty is full functional and physiological recovery. Many complications are caused by prosthetic loosening and abnormal axial alignment leading to an unphysiological kinematics of the knee implant. These complications account for up to half of all revision total knee arthroplasties.

To get an idea about the postoperative characteristics of the implant, it is essential to determine the femoro-tibial and femoro-patellar 3D-kinematics of the knee joint. Therefore a method was developed that is able to calculate the position and orientation of the two parts of the implant, visualizes them within the magnetic resonance images and calculates the 3D joint kinematics.
Material, Method

- The knees of 20 healthy volunteers and of eight patients with TKA were investigated by 3D open MRI
- The TKA components were identified using a 3D-fitting technique, which allows an automated 3D-3D-registration of the TKA
- Femoro-patellar and femoro-tibial 3D-kinematics were analyzed by image postprocessing.
Results

• healthy knees show the typical screw-home mechanism
• paradoxical anterior translation of the femur relative to the tibia combined with an external rotation occurred after TKA.

The results demonstrate that the presented 3D MR-open based method is highly reproducible and valid for image acquisition and postprocessing and provides-for the first time-in vivo data of 3D-kinematics of the tibio-femoral and simultaneously of the patello-femoral joint during knee flexion.