Introduction
Minor anatomical variations in the shape of our knee may make a big difference in terms of joint wear patterns. Tibial patho-morphology has been described as a factor that predisposes to medial compartment osteoarthritis of the knee (anteromedial-OA), yet this is limited to 2D analysis. We aimed to describe the 3D morphology of both the tibial and femoral components of the medial compartment of the knee. We hypothesized that morphological differences do exist between normal knees and those predisposed to osteoarthritis.

The study was approved by the institutional review board conforming to the state laws and regulations.

Method
A total of 20 normal (group A) and 20 pre-OA knees (group B) were included. Group A consisted of contra lateral knees of young patients (<55 years) awaiting hip surgery and group B of asymptomatic contra lateral knees of patients awaiting unicompartmental knee arthroplasty (UKA).

Using 3D reconstructions from CT scans, we analyzed the tibiotalvaroartorial joint, which consists of the femoral condyles and the tibial plateau.

Femoral measurements
The femur was aligned to the transcondylar and anatomical axes. The medial femoral extension facet (MFEF) was modeled as a segment of a sphere. The offsets between the MFEF centre and the medial femoral flexion facet centre were measured. The MFEF radius and the MFEF 2D arc angle in the sagittal plane were also measured.

Tibial measurements
The tibias were aligned for flexion-extension and varus-valgus to a flat portion of the flexion facet (flexion facet plane), which lie’s roughly perpendicular to the tibial mechanical axis. To control for axial rotation, the anatomical tibial axis was used. A model of analysis was developed by rotating several increments towards and away from the midline to obtain several sagittal section images. For each sagittal section the medial tibial extension facet (MTEF) slope angle, its length, and the medial tibial submeniscal plane (MTSP) angle and length were analyzed. The relative length proportions of the MTEF, medial tibial flexion facet and MTSP were also measured.

Results
The MFEF was larger and more offset in pre-OA knees. Pre-OA knees also had a significantly larger MFEF arc angle than normals (p<0.05). The MTEF appeared similar between normal and pre-OA knees. The submeniscal plane was highly variable between subjects but on average horizontally inclined (median 0°, range -15–14°) and formed a crescent shape anteriorly. There was no significant difference in tibial measured parameters between normal and pre-OA tibias (p>0.05).

The method showed good reproducibility using intraclass correlation coefficient (ICC value>0.9) and Bland-Altman plot analysis39.

Discussion
We have found evidence of a predisposing patho-morphology to medial-OA in the femoral condyle, but not the tibia. There is evidence of an enlarged flatter extension facet on the medial femoral condyle in the pre-OA knees, with no significant difference in the geometry of the medial tibial plateau, which is now reliably defined based upon a flexion plateau frame of reference.

Our improved 3D model of knee morphology has marked clinical implications in osteoarthritis prevention and management, particularly with respect to knee kinematics and implant design.