STEM EXTENSION OF THE FEMORAL COMPONENT IN REVISION KNEE ARTHROPLASTY - AN IN VITRO RADIOSTEREOPHOTOGRAFMETRIC STUDY

+*Verdonschot, N; *Van Loon, C; *De Waal Malefijt, M; *Kyriazopoulos, A; *Buma, P; *Huiskes, R
+Orthopaedic Research Lab, University of Nijmegen, The Netherlands. Orthopaedic Research Lab, University of Nijmegen, P.O. Box 9101, 6500 HB Nijmegen, The Netherlands, +31 24 3613366, Fax: +31 24 3540555, n.verdonschot@orthp.azn.nl

Introduction: Prosthetic stability of femoral components used in revision total knee arthroplasty (TKA) is often compromised by adverse bone remodeling due to stress shielding and the loosening process of the implant. At the revision procedure stability of the reconstruction may be enhanced by restoring bone loss with impaction grafting techniques [1] and the use of stemmed femoral components. The extent to which these methods contribute to prosthetic stability and how this is affected by the quality of the host bone is unknown. A critical assessment of the necessity of the use of intra-medullary stems is required, as it has been shown that these stems cause a considerable increase of stress shielding, thereby jeopardizing long-term survival of the revised implant [2]. Hence, these stems should be used only in cases when it is really required.

The questions addressed in this study were:
1) Does stem extension of femoral TKA components significantly influence stability under loading?
2) Does impacted morcellized bone graft (MBG) used for reconstruction of unicompartmental, uncontained bone defects contribute to stability of the femoral component?
3) To what extent does the quality of the host bone play a role in prosthetic stability relative to the effect of stem extension?

To answer these questions an in vitro radiostereophotogrammetric analysis (RSA) study of dynamic loading experiment was performed.

Materials and methods: Ten freshly frozen human distal femora, of which the BMD was measured at the femoral neck, were prepared to fit a cemented femoral component with an uncemented stem (PFC, Johnson&Johnson). A cyclic axial load of 750 N was applied to the medial part of the femoral component (test I). The loading test was repeated after creation of a standard, unicompartmental, uncontained medial bone defect (volume approximately 10.5 cm3, test II), after reconstruction of the defect with impacted MBG taken from femoral heads (test III), after disconnection of the stem from the component (test IV), and after removal of the MBG (test V). The MBG was firmly impacted into the defect, using a punch, while the femoral component remained in situ.

Results: The virtual no effect of the presence of a unicompartmental defect (Test II) and reconstruction of this defect with MBG (Test III) as long as the intra-medullary stem was connected to the implant (Fig. 2). However, a significant increase in rotation and translation of the femoral components was found after disconnection of the stem from the implant (tests IV and V). The femoral component rotated significantly into varus (p=0.0076) and internal rotation (p=0.014), and the tip of the stem translated significantly laterally (p=0.0069), after disconnection of the stem. The significance was primarily caused by bones with a relatively low BMD value. It seemed as if there was a threshold value of 0.6 g/cm2 beyond which stability was only moderately affected by femoral stem removal but below which prosthetic stability was adversely affected considerably. Restoration of the defects by MBG provided only a minor contribution to stability, regardless whether a stem was present (compare tests II and III) or absent (compare tests V and IV), compared to the contribution of a intra-medullary stem (compare tests III and IV).

Discussion: In this study the contribution of stem extensions and bone restoration with MBG to prosthetic stability was investigated. The results were obtained with distal femurs having a unicompartmental defect. In a revision situation, however, both condyles may be affected and the general peri-prosthetic bone quality may be less optimal than used in this study. Despite this limitation, the results do show that although generally prosthetic stability is enhanced by extending the femoral component with an intra-medullary stem, in some cases the stem may not be required. The advantage of that being a more natural load-transfer is obtained, resulting in a better preservation of the bone stock on the longer term [2]. Hence, an assessment of the host-bone quality in combination with the type and scale of defect at a pre-planning stage may provide guidelines to critically determine whether a stem extension is really required for adequate stability.

Conclusions:
1) Stem extension of femoral components in TKA significantly increases mechanical stability under loading.
2) Impacted MBG used for reconstruction of unicompartmental, uncontained femoral bone defects gives only a minor contribution to stability compared to the effect of a stem extension.
3) In the presence of a unicompartmental, uncontained bone defect, a femoral neck BMD value of less than 0.6 g/cm2 may indicate inadequate stability of the femoral component. Then a stem extension is required; beyond this BMD value prosthetic stability will be adequate.