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Influence Of Head Size In THR For ROM, Bone Impingement And Material Impingement - A 3D Dynamic Analysis Based On CT Scans

Orthopaedics / Pelvis, Hip & Femur / Joint Replacement - Primary

Philipp Rehbein, Karl Philipp Kutzner, Dominik Pfeil, Joachim Pfeil

Orthopaedic Department St. Josefs Hospital, Wiesbaden, Germany

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Introduction

Preoperative planning is mandatory for the preparation of an THR surgery and is helpful in the selection of implants and their sizes. Most of these plans are planned analogue or digitally based on a two-dimensional X-ray with matching templates. In contrast to these static two-dimensional planning systems a 3d-planning system can be used now to predict impingement situations with a dynamic analysis.

Objectives

The question of the ideal head size and material combination for THR is still in discussion. For head sizes =28 mm benefits are good biomechanical properties with increased resistance against abrasion. In contrast characteristics of head sizes =32 mm are increased security against dislocation with a better ROM. The aim of this study is a movement analysis of THR planning on a three-dimensional dynamic planning system with a comparison between the head sizes 28 mm and 32 mm.

Methods

Study design is a virtual ROM analysis with 12 patients based on 3D-dynamic planning and simulation. For each patient a CT scan was performed from the iliac crest to the knee joint. CT data were imported into a 3D planning software (ZedHip, Lexi). All patients were planned and simulated standardized with a modular cementless cup and a short stem prosthesis so that positioning of center of rotation, acetabular offset, femoral offset and leg length were optimized. The movement analysis was performed for the head sizes of 28 mm and 32 mm. Determined movement directions were a) unidirectional (flexion / extension, abduction / adduction and external rotation / internal rotation) and b) multidirectional (combined flexion / adduction / internal rotation and combined extension / adduction/ internal rotation).

Results

1. The accuracy of the proposed implant sizes with the implant sizes actually used in the operation is very high and correlated with 0.97.
2. The endpoints were the incidence of impingement (bone impingement = FP vs. implant impingement = SC). In all simulations FP-impingement occurs earlier than SC-impingement. The values for ROM to reach the FP-impingement do not differ when comparing the groups between head size 28 mm and head size 32 mm and are identical with significance.
3. If bone impingement (FP) is suppressed to reach implant impingement (SC), application of physiological ROM-values in the unidirectional movements demonstrates no differences between the groups with head size 28 mm and head size of 32 mm. With application of multi-directional combined movements are the differences with minimal tendency benefits for the group with head size 32 mm.

Conclusions

A comparison with a recent clinical study (EFORT14-2384) also confirmed this 3D-dynamic simulation that physically calculated benefits of head sizes = 32 mm are not measurable in the clinical situation.The focus for further investigations must be directed to differentiation of head sizes and clinical mid-term results of ROM and clinical behaviour in dependence of the pre-computed values for ROM, FP-Impingement and SC-Impingement. Furthermore radiological wear analysis and specific measurements of these patients will give clues whether the findings can give recommendations for the future application of THR-Implants in relation to the head sizes.