DYNAMIC AND DISLOCATION BEHAVIOR OF TRIPOLAR HIP ENDOPROSTHESES UNDER PHYSIOLOGICAL CONDITIONS IN COMPARISON TO A STANDARD TOTAL HIP REPLACEMENT DESIGN – A BIOMECHANICAL ANALYSIS

Christian Fabry[1], Michael Kaehler[2], Robert Souffrant[1], Sven Herrmann[1], Christoph Woernle[2], Rainer Bader[1]

[1] Department of Orthopaedics, Biomechanics and Implant Technology Research Laboratory, University Medicine Rostock, Rostock, Germany; [2] Faculty of Mechanical Engineering and Marine Technology, University Rostock, Rostock, Germany

Introduction

In recent years there has been an increased interest in tripolar hip endoprostheses, due to the reduced risk of recurrent dislocation [Guyen 2007, Philippot 2009]. So far, there is no biomechanical study, which provides an evidence for the in vivo dynamic and dislocation behavior of tripolar systems. In this experimental study, the dynamic behavior of two tripolar hip endoprostheses under daily life conditions with lubrication and alternated forces was analyzed. Additionally, the influence on dislocation stability was investigated and compared with a standard total hip replacement (THR) design.

Methods

Several loads and motions of everyday life activities as well as crucial dislocation movements were applied to the tripolar hip endoprostheses (intermediate component with 40mm diameter) and a standard THR with a 40mm femoral head (Fig. 1) by an industrial robot.

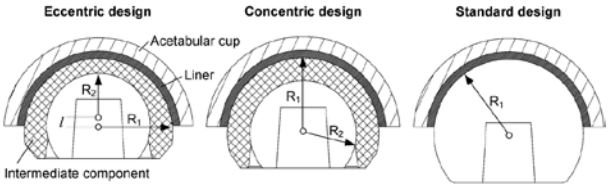

Figure 1: Sectional view of the tested implant designs and their schematic construction

The examined activities included walking, knee bending, stair climbing and a combination of sitting down and standing up from a chair [Fabry 2012]. In order to detect the relative movement of the intermediate component, a contactless stereo camera system Pontos (GOM mbH, Braunschweig, Germany) was used.

Within the dislocation tests the implant-specific range of motion until stem impingement and dislocation was detected along with the maximum resisting torque against subluxation.

Results

Within the investigated everyday life conditions the movements of the tripolar endoprostheses mainly took place between the intermediate component and the femoral head. The relative movements within the concentric implant design are minimal and only occur after contact with the neck of the femoral stem at the intermediate component. In contrast, the advanced self-centering mechanism of the eccentric design can be clearly demonstrated by alternated forces independent from the tested load cases.

Under different dislocation scenarios, the largest resisting torque against dislocation was determined for the eccentric tripolar system. Dislocations of the endoprostheses could not be detected in any cases.

Discussion

Considering the results of this biomechanical study we had proved the reliability and performance of the eccentric tripolar design under different in vivo conditions. From a biomechanical side of view we advise caution with the application of concentric systems due to the tendency of remaining in an extreme varus position.

Factors which indicate the use of eccentric systems as preferable in case of instability conditions are the large effective head size in combination with a small bearing couple and the high resisting torque during subluxation.

References

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