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Track 4: Implants for Trauma and Orthopedics-Joint ESB Track
4.2 Hip Endoprosthetics

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Model-based-RSA of a hip stem using geometrical shape models

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Introduction: Roentgen-stereophotogrammetry(RSA) measures micromotion of orthopaedic implants. For this, markers are inserted in the bone and attached to the implant. Because of regulatory issues, attaching markers to implants is a difficult and tedious task. To prevent the use of implant markers model-based-RSA techniques have been developed. Another alternative uses elementary geometrical shapes(EGS), such as balls and cylinders, to represent the implant. The aim of our study was to validate and compare the two model-based-RSA techniques to determine micromotion of a Mallory-Head hip stem.

Methods: The two model-based-RSA methods were validated by an in vitro phantom experiment and compared using RSA-radiographs from a clinical study. In the in vitro experiment, twelve RSA-radiographs of a phantom were obtained in random, clinically relevant orientations. Migration was measured between the component and the phantom bone using standard marker-based-RSA and both model-based-RSA techniques. For successive RSA-radiographs, the mean of the migrations indicates the systematic errors. The standard deviation(SD) indicates the accuracy of zero-motion, or precision of the RSA-algorithm. The in vivo experiment was done with 19 RSA-examinations of seven patients from a historical cohort. We calculated the migration between the model of the hip stem and the three markers attached to the hip stem.

Results: The phantom experiment showed that the accuracy of model-based-RSA using surface models is the same as the accuracy of marker-based-RSA, however, the precision is lower. No significant differences in accuracy and precision were found between the EGS-model-based-RSA algorithm and marker-based-RSA. In contrast to the results from the phantom experiment, the clinical data did not show large differences between the two model-based-RSA algorithms.

Discussion: We are convinced that both model-based-RSA algorithms are a possible replacement for marker-based-RSA. However, because of its higher precision for this hip stem, EGS-model-based-RSA provides the best alternative for marker-based-RSA