

# Wear and migration in total hip arthroplasty measured with Radiostereometric Analysis

Methodological aspects and clinical studies

## Akademisk avhandling

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademien, Göteborgs universitet kommer att offentligens försvaras i R-aulan, Sahlgrenska Universitetssjukhuset, Mölndal, fredagen den 9 februari 2018 kl.09.00

av

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Avhandlingen baseras på följande delarbeten

- I. **Shareghi B, Johanson PE, Kärrholm J.** Femoral Head Penetration of Vitamin E-Infused Highly Cross-Linked Polyethylene Liners: A Randomized Radiostereometric Study of Seventy Hips Followed for Two Years. *J Bone Joint Surg Am.* 2015 Aug. doi: 10.2106/JBJS.N.00595.
- II. **Shareghi B, Johanson PE, Kärrholm J.** Wear of Vitamin E-Infused Highly Cross-Linked Polyethylene at Five Years. *J Bone Joint Surg Am.* 2017 Sep. doi: 10.2106/JBJS.16.00691.
- III. **Shareghi B, Johanson PE, Kärrholm J.** Clinical Evaluation of Model-Based Radiostereometric Analysis to Measure Femoral Head Penetration and Cup Migration in Four Different Cup Designs. *J Orthop Res.* 2017 Apr. doi: 10.1002/jor.23177.
- IV. **Shareghi B, Mohaddes M, Kärrholm J.** Pelvic tilt between supine and standing after total hip arthroplasty. 106 patients examined with RSA up to seven years after the operation.  
In manuscript.
- V. **Shareghi B, Galea VP, Kärrholm J, Malchau H, Rolfson O.** Migration of uncemented cups and development of radiolucent lines. Radiostereometric evaluation of 92 cups with either porous titanium or plasma sprayed surface coating up to five years.  
In manuscript.

**SAHLGRENKA AKADEMIN  
INSTITUTIONEN FÖR KLINISKA VETENSKAPER**



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## Abstract

Roentgen stereophotogrammetric analysis (RSA) is a highly accurate technique that enables three-dimensional measurements of skeletal or implant micromovement with respect to the host bone *in vivo*. The method has been used in clinical research for the evaluation of penetration of the femoral head into the acetabular component as a result of polyethylene creep and wear. Wear has been identified as a common cause of aseptic implant loosening and late revision. The RSA method has the ability to accurately measure bone and implant movements, rendering it a very useful tool in the evaluation of new implants and surgical techniques.

In Study I, femoral head penetration into cups with liners made of either vitamin E-infused highly cross-linked polyethylene (E1) or compression-annealed polyethylene, ArComXL, was evaluated in 61 patients (70 hips) in a randomised, clinical study. At two years, the femoral head penetration did not differ between the groups.

Study II aimed to evaluate differences in the femoral head penetration rate between E1 and ArComXL with the emphasis on changes occurring between two and five years after total hip arthroplasty (THA). The penetration rate was significantly lower for the E1 compared with the ArComXL liners.

In Study III, wear and migration in four uncemented cups with various geometries were evaluated. Further, the influence of cup design on the precision of model-based RSA (MBRSA), using marker-based RSA as a reference, was also evaluated. Our findings indicated that the resolution of MBRSA may vary depending on the geometry of the implant or the surface coating.

In Study IV, the change in pelvic tilt angle (PA) in a supine position and between supine and standing positions was evaluated in 106 patients up to seven years after THA using RSA. The pelvic tilt changed over time both when supine and when rising from supine to standing. In individual patients, this change reached about 11.0° degrees when supine and 18.0° degrees when standing.

In Study V, the migration of cups coated with a porous titanium layer (Regenerex) was recorded using a porous plasma-sprayed cup (RingLoc) as a reference in 92 patients. We also evaluated any possible associations between the occurrence of progressive radiolucent lines and the migration of the acetabular component up to five years measured with RSA. The migration pattern differed between the two cups with different surface coatings, but the differences of observed median migration values were all less than 0.2 mm. We also observed an association between progressive radiolucent lines and anterior/posterior migration.

**Keywords:** Total hip arthroplasty, radiostereometry, femoral head penetration, highly cross-linked polyethylene, polyethylene wear, radiolucent lines and pelvic tilt angle