

# **Gait and motion analysis of hip arthroplasty**

## *Validity, reliability and long-term results*

AKADEMISK AVHANDLING

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademien,  
Göteborgs universitet kommer att offentligens försvaras i R-aulan,  
Sahlgrenska Universitetssjukhuset, Mölndal

Fredag den 8 december 2017 kl. 09.00

av

**Roland Zügner**

Leg. Sjukgymnast, specialistkompetens i fysioterapi inom ortopedi

Fakultetsopponent:

**Docent Anders Wykman**

Institutionen för kliniska vetenskaper, Lunds universitet, Lund, Sverige

### **Avhandlingen baseras på följande delarbeten**

- I. **Validation of gait analysis with dynamic radiostereometric analysis (RSA) in patients operated with total hip arthroplasty.**  
Zügner R, Tranberg R, Lisovskaja V, Shareghi B, Kärrholm J.  
J Orthop Res. 2016 Sep 3. doi: 10.1002/jor.23415.
- II. **Different inter-observer reliability of instrumented gait analysis between patients with unilateral hip osteoarthritis, unilateral hip prosthesis and healthy controls.**  
Zügner R, Tranberg R, Lisovskaja V, Kärrholm J.  
In manuscript
- III. **One stage bilateral total hip arthroplasty operation in 22 patients with use of short and standard stem length on either side. Gait analysis in 22 patients one and two years after bilateral THA.**  
Zügner R, Tranberg R, Poretic G, Kärrholm J.  
Hip international. 2017 Ref.: Ms. No. HIPINT-D-17-00162R1 DOI: 10.5301/hipint.5000596
- IV. **Stable fixation but unpredictable bone remodelling around the lord stem: minimum 23-year follow-up of 66 total hip arthroplasties.**  
Zügner R, Tranberg R, Herberts P, Romanus B, Kärrholm J.  
J Arthroplasty. 2013 Apr;28(4):644-9. doi: 10.1016/j.arth.2012.07.041. Epub 2012 Nov 8.
- V. **Validation of inertial measurement units with optical tracking system in patients operated with total hip arthroplasty.**  
Zügner R, Tranberg R, Timperley J, Hodgins D, Mohaddes M, Kärrholm J.  
In manuscript

**SAHLGRENKA AKADEMIN  
INSTITUTIONEN FÖR KLINISKA VETENSKAPER**



# Gait and motion analysis of hip arthroplasty

## *Validity, reliability and long-term results*

Roland Zügner

Institute of Clinical Sciences, Department of Orthopaedics,  
Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden, 2017

### Abstract

**Introduction:** Walking is one of the most fundamental activities of daily living in humans, when the hip joints transfer power between the lower extremities and the pelvis. Hip osteoarthritis (OA) will more or less influence this function and is increasing in an ageing population. Total hip arthroplasty (THA) is a common treatment for patients diagnosed with hip osteoarthritis when non-surgical treatments have failed. Optical tracking systems (OTS) based on cameras and force plates mounted in the floor have been used since the 1960s. The technique includes attachment of reflective markers with double-adhesive tape to the skin of the patient. Marker positions are recorded when the patient walks through a calibrated measurement volume.

**Material and methods:** In Study I, hip joint movements were measured with two different dynamic motion analysis systems, an optical tracking system and roentgen stereophotogrammetric analysis (RSA) in 16 patients with THA. In Study II, three patient groups were examined to study if the reproducibility of measured values differs depending on whether the hip joint is normal, has developed OA or has been replaced with a THA. The aim of Study III was to investigate the gait in 22 patients operated bilaterally with two different types of stems at the same occasion. In Study IV, 62 patients operated with a Madreporic Lord hip prosthesis between 1979 and 1986 were followed for an average period of 26 years. In Study V, gait analysis was performed using two different motion analysis systems, one based on an optical tracking system and one based on accelerometers. Forty-nine THA patients were simultaneously evaluated with both methods.

**Results:** During active hip motions soft-tissue displacements caused an underestimation of the true skeletal motion (Study I). In Study II the hip motions in patients with OA showed inferior repeatability between different investigators compared with THA patients and healthy controls. The gait pattern in the THA patients had not returned to normal one to two years after the operation. Study III showed no differences in speed, step length and frequency, or regarding kinematics or kinetics between short and conventional stems. Although both hip joints were operated during one-stage bilateral THA, there was still a difference between gait patterns two years after surgery compared with controls. In Study IV, the follow-up showed an average HHS of 81 (SD 14) and a pain score of 41 (SD 5), despite that more than half of the patients had undergone a revision of the acetabular cup. Some hips, but not all showed pronounced loss of bone mineral density around the stem. In Study V the accelerometer system measured movements of the pelvis and knee joint that did not differ from the optical system. However, significantly smaller flexion-extension was recorded.

**Conclusion:** This dissertation shows that the deviation from skeletal movements measured using OTS is smallest when measuring hip flexion-extension in patients with THA. OTS is able to distinguish patients with hip osteoarthritis and patients with THA from a healthy control group while walking. The walking ability of patients with THA was still affected at least two years after surgery. A long-term follow-up of patients with an uncemented hip prosthesis revealed good function, despite that the acetabular component had been replaced in almost 50% of cases. The accelerometer-based motion analysis system that was examined had good validity when measuring pelvis and knee movements in the sagittal plane, but underestimated hip joint flexion and extension.

**Keywords:** Gait analysis, Hip arthroplasty, Kinematics, Radiostereometric analysis, Hip osteoarthritis

ISBN: 978-91-629-0278-0 (Print)

ISBN: 978-91-629-0279-7 (Pdf)

<http://hdl.handle.net/2077/53611>