Summary

Chapter 1 is the introduction. The aim of the thesis is presented: to assess if cementless implants can be used safely in total hip arthroplasty in rheumatoid patients, and to assess if the use of cementless implants could be beneficial for the rheumatoid patient.

To investigate the aims of this thesis four research questions were formulated: (1) can we make a computer model to investigate the relationship between biomechanical properties of bone and fixation of cementless implants, and can we predict which type of fixation type is best in relation with the quality of the bone? (2) What are the results of cementless cup designs (threaded and press-fit) and a cementless stem in rheumatoid arthtritis (RA) patients compared to osteoarthritis (OA) patients in our own institute, with special emphasis on four mechanical complications: peri-operative fracture, component migration, aseptic loosening and dislocation? (3) What are the results in the literature of cemented THA in RA? (4) What are the results in the literature of cementless THA in RA?

Chapter 2 gives an overview of demographics of hip involvement in RA, history of surgical treatment, technical considerations on hip replacement and potential complications facing hip arthroplasty in rheumatoid arthritis patients.

Standard cemented THA has been for many years the treatment of choice in destructive hip disease in RA. Patients with RA are generally considered to be more prone to complications after hip replacement due to the nature of the disease with its deleterious effects on the bone and soft tissues, and due to the side effects of anti-rheumatic drug treatment. Perioperative management includes cautiousness for cervical spine instability, management of anti-rheumatic medication, and preoperative surgical planning to prevent malpositioning of implants. Timing of the operation is the key to success in RA surgery.

Chapter 3 reports the results of investigations with a finite element computer model of the pelvis on the fixation strength of press-fit cups in relationship to the quality of the acetabular bone and the geometry of the cup. In addition, the effects of interference fit, friction and implant material were analyzed. Cups were introduced into an FEA model of a human pelvis with simulated subchondral bone plasticity. The models were loaded with a loading configuration simulating two cycles of normal walking, during which contact stresses and interfacial micromotions were monitored. Subsequently, a lever-out simulation was performed to assess the fixation strength of the various cases.

The results show that different ways of fixation were found for the non-hemispherical, flattened cup with polar clearance, and the hemispherical implant designs. The cup with a polar clearance acquired pressfit fixation due to high contact stresses at the peripheral rim as in the physiological situation. The fixation of the hemispherical cup is based on a non-physiological larger contact area between the pole of the cup and the dome of the acetabulum. In the situation with poor bone quality, the model showed that the cup with polar clearance and interference fit of 2mm provided the highest lever-out force with maximal contact stresses at the rim. However, in this situation the interfacial micromotions increased (more than 500μm), at the pole and locally at the rim.

In *chapter 4* the long-term results of a retrospective clinical study are presented. The study was performed in The Slotervaartziekenhuis in Amsterdam, a reference centre for inflammatory arthritis patients. Cementless THA in RA patients is being performed here since 1986. The results of cementless THA in RA patients are compared to the results of the same prostheses in OA patients.

The aim of this study was to assess the outcome of primary cementless total hip arthroplasty in rheumatoid arthritis patients and to compare the results with osteoarthritis patients. Sixty-four patients (77 hips) with rheumatoid arthritis and 120 patients (135 hips) with osteoarthritis with a conical-shaped Zweymueller threaded cup and a tapered, rectangular Zweymueller stem were assessed after an average of

12.5 years. The endpoints for survival analysis were failure of one or both components due to radiographic loosening or revision. Revision was defined as exchange of cup, stem or both. When the PE-insert or the ceramic ball head were exchanged leaving cup and stem in place, e.g. for PE-wear or dislocation, this was not considered a revision but a re-intervention.
The results showed no differences in survival rates; however, in the rheumatoid arthritis group there was an increased rate of malposition of the cup, avulsions of the greater trochanter, and increased bone resorption in the trochanteric region. This study shows that despite altered biomechanical properties of rheumatoid bone, mechanical stability and osseous integration of cementless prosthesis are not compromised and, although a higher complication rate did occur, long-term survival is excellent.

In *chapter 5* a second clinical study from The Slotervaartziekenhuis is presented. In this study the results of a new type of press-fit acetabular components were analyzed in a prospective study again with a comparison between cementless THA in RA and OA patients.

A flattened cup was designed to create a more physiological load transfer to the pelvic bone compared to hemispherical cups, and to allow more bone contact compared to 'low-profile' spherical cups. To investigate these theoretical advantages and the potential influence of the quality of the acetabular bone, a clinical study was performed in patients with osteoarthritis (OA) and inflammatory arthritis (IA). The aims of the study were (1) to evaluate the fixation of the cup, postoperatively and later when osseous integration should have taken place, (2) to assess perioperative complications such as acetabular fractures and (3) to monitor the polar gap, a potential risk factor for osteolysis.
A prospective study was performed on all consecutive OA and IA patients with an indication for primary total hip arthroplasty (THA). Three hundred and nine OA patients (340 hips) and 65 IA patients (76 hips) were included. The acetabular component was the flattened press-fit EPF-PLUS® cup, the femoral component the tapered cementless Zweymueller SL-PLUS® stem. All revisions and complications

were recorded. Clinical and radiographical evaluation was performed on regular basis during 6–10 years.

The incidence of early loosening of the cup was 0 out of 340 in the OA group and 1 out of 76 in the IA group. The incidence of acetabular fractures was 7 out of 340 in the OA group and 3 out of 76 in the IA group. Failure rate for the acetabular component due to aseptic loosening or osteolysis after 6–10 years was 0% in the OA group and 4.8% in the IA group. In all cases available for follow-up the polar gap had disappeared and full osseous integration had taken place in both the groups.

This study shows that the flattened press-fit acetabular component creates adequate initial mechanical stability to allow osseous integration and that the cup can be safely used in both OA and IA patients. However, after 6–10 years, in the IA group failure of the cup due to aseptic loosening occurred once and failure due to osteolysis occurred three times, while these type of failures did not occur in the OA group.

In *chapter 6* a third clinical study is presented; a prospective study to analyze the alleged increased risk on post-operative hip dislocation in RA patients compared to OA patients. We carried out a prospective study assessing the incidence of dislocation within 2 years after surgery for patients diagnosed with inflammatory arthritis (IA) and osteoarthrosis (OA). One single type of prosthesis was implanted using a lateral approach. Both diagnostic groups were compared by univariate analysis with respect to dislocation, sex, age, diagnosis, prior hip surgery, experience of the surgeon and malposition of the acetabular component. In a multivariate logistic regression approach, the difference in dislocation incidence was assessed after adjusting for the effect of the potential confounders given above. Between 1996 and 1999, 410 THA were performed: 70 in IA and 340 in OA. After 2 years no patients were lost to follow-up, but 12 patients had died, and 5 revisions were carried out for reasons other than dislocation.

The dislocation rate in patients with IA was higher than in patients with OA: 10% (7 hips) in the IA group and 3% (10 hips) in the OA group ($p = 0.006$). No significant differences were found among the risk factors for dislocation between the two groups. Multivariate logistic regression analysis showed that IA is an independent risk

factor for dislocation (odds ratio (OR) 3.7, 95% CI 1.3-11), together with malposition of the cup in more than 55 degrees abduction (OR 7.7, CI 2.3-26) and increased ant version (OR 7.6, CI 1.4-42.4).

Our findings clearly suggest that inflammatory arthritis has to be considered as an independent risk factor for dislocation after primary THA.

Chapter 7 is a review of the literature on cemented THA in RA focused on infections, dislocation and aseptic loosening of cup and stem. Twenty-one case series and eight reports on four implant registries were included. The quality of most studies was poor.

The reported rates of infection and dislocation were conflicting in the case series and the arthroplasty registries proved unsuitable for providing reliable data. There is a risk of underestimation of incidences in both types of studies.

Increased rates of aseptic loosening were reported in ten out of twenty case series on the cup and in six out of nineteen on the stem (when compared to the criteria of the National Institute of Clinical Excellence (NICE)). Nearly all of these were based on series implanted before 1980. None of the registries reported a significantly increased risk of aseptic loosening of cup or stem.

Despite the limitations of this review, and considering the relatively frequent reports of increased infection rates in combination with the potential underestimation of infection rates in the included studies, and taking into account the results of other reports, we believe that RA patients have a mild increased risk of post-operative infection and dislocation after THA compared to OA patients.

Although there used to be an increased risk of cup and stem failure due to aseptic loosening in RA patients, there is no evidence that this increased risk is still significant today.

Chapter 8 is a systematic review on the literature on cementless THA in rheumatoid arthritis with special emphasis on complications such as peri-operative fractures, implant migration, aseptic loosening and survival.

Twenty-three case series and five studies of implant registries were included. Acetabular fractures and/ or migration of the cup were reported in 9 out of 22 studies of the cup. Proximal femoral fractures and/or subsidence of the stem were reported in 14 out of 20 studies of the stem. Six studies compared failure rates of uncemented and cemented components due to aseptic loosening. The overall failure rate ratio (uncemented/cemented) for the cup was 0.6 (95% CI: 0.14–2.60) and for the stem 0.71 (95% CI: 0.06–8.55), both favoring uncemented fixation. The failure rates in case series without a control group were compared to the NICE criteria (failure rate/1). The overall failure rate for the cup was 0.97 (95% CI: 0.50–1.88) and for the stem 0.79 (95% CI: 0.44–1.41). Failure rates of aseptic loosening of higher than 1 (favoring cemented fixation) were reported in 6 out of 26 studies of the cup and in 2 out of 25 studies of the stem. In all these studies, the inferior implant designs were blamed, and not the type of fixation or the quality of the bone. Despite substantial rates of mechanical stem complications, no evidence was found to establish that cementless components perform less well than cemented components. The results justify the use of cementless THA in RA patients.

Chapter 9 is the general discussion. The finite element computer model shows that in a situation with poor bone quality, the flattened cup with high interference fit provides sufficient physiological rim fixation in the acetabulum. The fixation of the hemispherical cup is based on a non-physiological larger contact area between the pole of the cup and the dome of the acetabulum.

The first two clinical studies and the review study on cementless THA in RA show that despite altered biomechanical properties of rheumatoid bone, mechanical stability and osseous integration of cementless prostheses are not compromised. However, cementless stems are associated with increased rates of mechanical complications. The third clinical study shows that RA has to be considered as a risk factor for dislocation.

The review study in cemented THA in RA shows that aseptic loosening of the cup used to be the limited factor for long-term survival but recent studies report excellent survival of both cemented cup and stem. Overall it can be stated that the quality of most studies on cemented and uncemented THA in RA is poor. The risk on post-operative infection and dislocation seems to be increased in RA.

The increased rates of mechanical complications, especially on the femoral side, suggest that some concerns on cementless THA in RA are being confirmed. However, these types of complications are not specific for RA patients as they are reported in OA patients with cementless THA as well (Hailer et al. 2010). Considering this similarity with the OA population it seems that the discussion whether to use cemented or uncemented components in RA patients is not about the quality of the bone but about the quality of the prostheses. Before it can be stated that cementless implants are the treatment of choice for the rheumatoid (and the osteoarthritis) patient, improvement of long-term survival compared to cemented THA will have to outweigh the increased complication rate.