Profile total hip arthroplasty

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7 Summary

The idea of total hip prosthesis was born in the 1950s. Later the prosthesis developed into a truly total hip prosthesis with a stem and an acetabular component. Charnley developed his cemented low-friction total hip prosthesis in the early 1960s. This prosthesis is still the 'gold standard' in prosthetic replacement of the hip. In recent years new techniques using uncemented prostheses have replaced cemented prostheses, which produced unsatisfactory results, particularly in young patients.

Total hip arthroplasty is, at present, a well-known and developed technique to reduce pain in arthrotic and arthritic hips. One of the latest developments in total hip arthroplasty is the uncemented technique with the use of hydroxylapatite coating. The design of the prosthesis influences the outcome of the arthroplasty *in vivo*. This includes the fixation method, with or without cement. The applied coating on uncemented prostheses, the used metal for the stem and the design of it are important components that determine the outcome of the prosthesis. The surgical technique is an important factor as well. A perfect prosthesis can fail when it is positioned improperly. During implantation of a total hip prosthesis several possibilities exist for problems to occur, think about fractures, faux routes, infections, etcetera. Even after the operation itself problems like heterotopic ossifications, dislocations and late infections may occur.

Wear is an important factor in failure of prostheses, as is aseptic loosening, which is an indication for revision surgery in 1 to 20 % of the primary total hip arthroplasties. Aseptic loosening of a total hip prosthesis is the result of a combination of biomechanical and chemical factors.

1. Weakening of the bone resulting from bone resorption because of particle disease;
2. Material strain in the interface of prosthesis and bone;
3. Failure of the ingrowth in improperly fitting uncemented prostheses;
4. Inadequate stress transfer of prosthesis to bone.

Osteolysis, which is a result of aseptic loosening, in cemented and uncemented components has different patterns leading to loosening in cemented cups and to bone loss without loosening in uncemented cups and stems

The bone-prosthesis interface is subject to significant stress, resulting in wear between the prosthesis and the bone. In loosened prostheses the amount of wear increases and metal particles could be released from the prosthesis to the adjacent tissues.

The presence of a loosened hip prosthesis may, through its metal ion dissemination, increase the incidence of neoplasms in the proximity of the prosthesis. Reintroduction of metal-on-metal hip prostheses needs careful surveillance for, although the risk of leukaemia and lymphomas is not proven to be higher, it tends to be slightly increased in the earlier (prior to1973) metal-on-metal prostheses.

Several studies have been conducted on the bone density around total hip prostheses. The two DEXA measuring instruments currently on the market have been tested in the presence of an uncemented stem of a total hip prosthesis. This led to different methods of measurement in different regions of interest around a total hip arthroplasty.

Bone scintigraphy has been used in cemented prostheses to evaluate loosening. In uncemented total hip arthroplasty this is not applicable.

As people age, the femoral bone grows more rigid, while the prosthesis does not. The prosthesis may become too flexible for the patient. DEXA and bone scintigraphy may not be useful to detect loosening of the prosthesis, but they can be used to evaluate the bone remodelling process around the prosthesis. This remodelling includes a decrease of bone density with an increase in bone width. The observed changes in bone mineral content, bone mineral density and bone width over time are confirmed by the increased activity of the bone on the Technetium scan.

This thesis describes the clinical study of an anatomically shaped, proximally hydroxylapatite-coated, uncemented hip prosthesis with a hemispherical, porous-coated, uncemented acetabular component. Since there is no literature addressing this prosthesis, an extensive literature study was conducted, which is described in Part 1.2. Every aspect of design, material and coating of the prosthetic stem and the cup is described. In addition, the eventual short-term complications, including fracture, infection and heterotopic ossifications, and long-term sequelae, such as wear, dislocation and loosening, are addressed. Several methods of evaluating the performance of total hip arthroplasty are available, but not all of them are applicable to every total hip arthroplasty. In the past a range of methods was developed to evaluate cemented total hip arthroplasty. Many of these methods are also used to evaluate the performance of uncemented arthroplasty, although these methods have not been tested for their applicability to uncemented total hip arthroplasty. This dilemma is addressed briefly in the literature study.

The methods used in this thesis are X-ray analysis, bone densitometry (DEXA), radioisotope study (bone scan) and metal level analysis in blood and serum. All of the methods are discussed in the literature study mentioned above.

Part 2 shows the results of the clinical and radiological follow-up study, the DEXA study, the Tc-isotope study and the metal study.

The study was designed as a prospective study. The medium-term survival of the Profile® total hip prosthesis was studied. The method used for the evaluation of the clinical performance is the Harris Hip Score. The radiological follow-up was standardised with the method of Massin while we used the Gruen and the DeLee zones to qualify the bone reaction around the prosthesis.

The clinical and radiological analyses of the patient population show good results of the prosthetic stem after a mean of 6.3 years with a revision rate of 0.04%. The acetabular component shows a loosening rate of 13.3%, which is rather high. This depends on several factors, none of which is the acetabular position. The most important factors influencing the acetabular component survival are the femoral canal width and the femoral component position.

The DEXA study shows a decrease in bone density around the stem except in Gruen zones 1 and 3. This decrease in density is combined with an increase in width in all zones except Gruen zones 4 and 5. The changes in bone mineral density and width result in an altered bone mineral content. All zones except 3 and 4 show a decreased mineral content. Whether this is the result of a change of bone morphology has not been studied, but may explain these data.

The Tc-scan study shows that this method is not useful in the evaluation of loosening of this type of total hip prosthesis if patients are not individually followed-up by bone scans. There is no correlation with the DEXA scans, which makes the combination of the two techniques not useful either.

The metal study was designed to evaluate the use of metal traces in blood and serum for the detection of prosthetic loosening. Almost all patients with total hip arthroplasty proved to have metal traces in their blood and serum; the serum samples were more conducive to analysis than the blood samples. The metal levels in neither serum nor blood increased when the prosthesis loosens. The metal levels of loose prostheses are as high as those of well-fixed prostheses.

The prosthesis under consideration has a good survival rate and a low revision rate for the stem. The acetabular component needs careful follow-up in the near future because it has a high loosening rate with large central osteolysis. The methods studied to diagnose loosening proved not to be valuable. The evaluation of metal traces in serum may be important in light of future developments to perform total hip arthroplasty in younger patients. It is not known what effects metal traces and accumulation of metals from arthroplasties may cause in the long term.