1.6 Results Obtained for 474 Cementless Hip Endoprostheses using Ceramic/Ceramic Components

M. Böhler, R. Meizer and H. Plenk

In this study the authors investigated the results of different designs of cementless THRs using ceramic/ceramic components. The authors analyzed the clinical results taking into account the age of the patients and of the type of implants used and also developed some basic considerations with regard to the interaction between Al_2O_3 ceramics and human tissue.

Clinical results obtained for 474 cementless hip endoprostheses using different designs with ceramic/ceramic components:

Materials and Methods

In the study, a number of cementless hip endoprostheses implanted beginning in 1992 utilizing a Biolox® or Biolox forte® wear couple in different design acetabular components were investigated. The group of patients involved consisted of 296 females and 178 males with the average age of the patients being 61.2 years (17 - 89 years) at the time of the operation. The patients diagnosis were: idiopathic arthrosis in 69.5% (n =329) of the patients, followed by patients with hip dysplasia (12.9 % ; n= 61) and necrosis of the femoral head (11.4%; n=54).

All of the femoral components used were made of Titanium alloy with a rectangular section and a corundum-blasted surface. The acetabular components were made of pure titanium of a either a rounded or a truncated threaded design (type A and B)(43.5%; n=206) or of a hemispherical porous coated design with either pegs or adjunctive screw fixation utilizing a press-fit technique (type C and D)(56.5%; n= 268) (Fig.1). Regardless of the type of implant utilized, the wear articulating surfaces were always either Biolox® or Biolox forte® ceramic ball heads and inserts. There were 9 special extended collar heads providing an extra long neck offset. The reason why such extralong femoral heads were used will be discussed later (see below).

Follow up was performed after a minimum interval of 2 years using the Harris Hip Score either on personal follow-up examinations or by way of telephone interviews. The x-rays which were analyzed and evaluated in accordance with the stability criteria for cementless implants of DeLee and Gruen [1,2]. Statistical analysis using the method developed by Kaplan & Meier [3] however was performed of different aspects such as age of the patients and types of prostheses used.

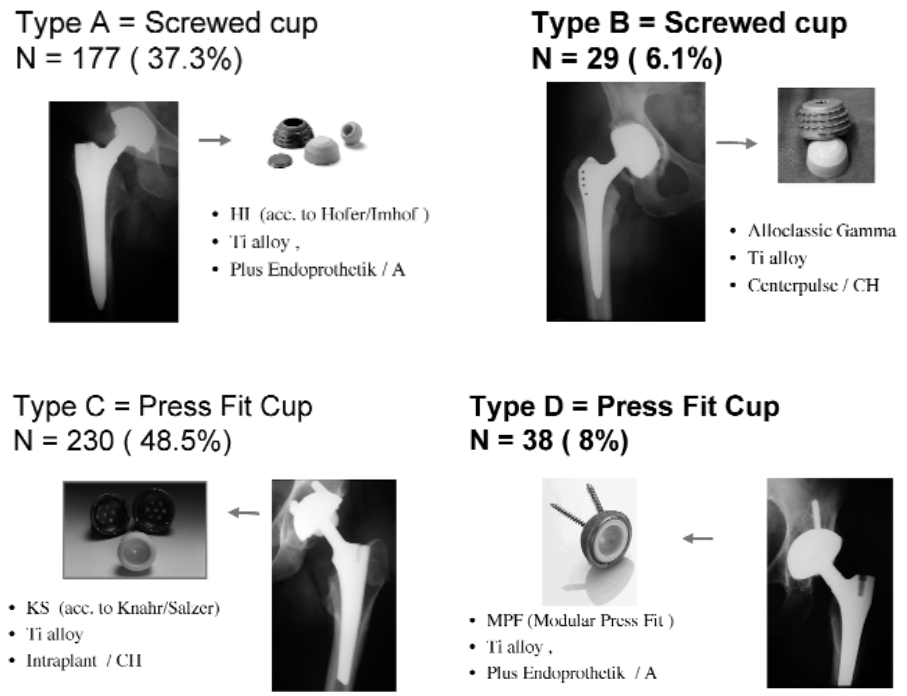

Figure 1

Results

After an average follow-up period of 4 years (1 month to 15 years), 412 patients (86.9%) were re-examined. 27 patients (5.7%) had died and 35 patients (7.4%) were not available for follow up.

During the period of observation (Ø 73 months; 12 to 149 months), 12 patients were reoperated because of mechanically loosened prosthetic cups, 2 patients because of loosened stems and acetabular cups, and one patient because of a loosened stem-type prosthesis. 6 other reoperations were performed because of recurrent luxations (n=4) or deep implant infections (n=2). In 5 cases, the complications were due to fracture of the femoral head. Among these heads were 4 of 9 XL collar-type heads and 1 of 176 L heads with the latter having been implanted in combination with a small attachable adaptor. The fractures occurred after an average period of 26 months (16 – 35 months) from the date of implantation and were not caused by any adequate traumata. The average age of the patients concerned (female = 1, male = 4) was 58 years and the patients were still young and active.

An analysis of the revision data of the type of prostheses used was that 12 of the 13 prosthetic cups which were replaced were type C acetabular components (spherical press-fit cup of the Knahr & Salzer type), and one was a type A prosthesis (tapered screw cup HI). The rest of the acetabular components were found to be stable which was confirmed by the radiographs and clinical examinations. The statistical survival analysis can be seen from fig. 2 and yields a

survival rate of 99.4% (type A) or 100% (types B and D) for screwed type A and B cups and for the type D press-fit cup after an average follow-up period of 18, 27 and 30 months. The survival rate for the spherical cup of the Knahr & Salzer type demonstrated a survival rate of 59.8% after an average follow-up period of 70 months.

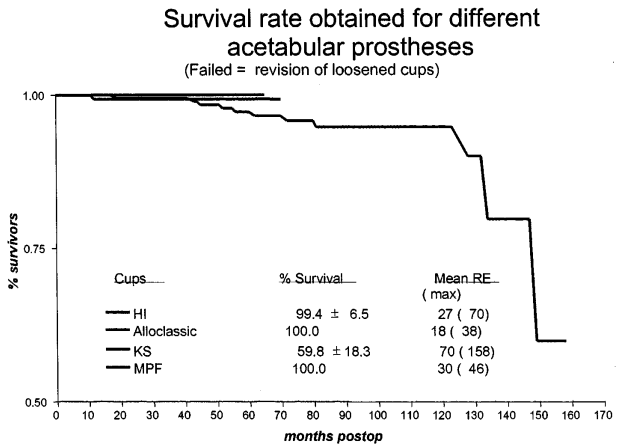

Figure 2

The results of the analysis of revisions depending on the age of the patients were divided into 3 age groups (patients < 50 years (n=62) , 51 to 65 years (n=215), > 65 years (n=197)). The revision rates were 4.8% (3 of 62) in the group of patients < 50 years; 3.2% (7 of 215) in the group of the 51 to 65 old and 1.5% (3 of 197) in the group of patients older than 65 years. Revision operations were performed after an average period of 57 months in the group of patients < 50 years, after an average period of 94 months in the group of the 51 to 65 years old, and after an average period of 72 months in the group of patients > 65 years.

Interaction between Al_2O_3 ceramics and the human tissue

In addition to the well known benefits of low abrasion and high tissue compatibility of the particles produced by the tribological system offered by the ceramic articulation of Al_2O_3 ceramics, the authors would like to point out to another important aspect which consists in the effect of the Al_2O_3 particles - i.e. of the corundum - used in the surface treatment and roughening of the titanium surfaces. Corundum is used in the production of all cementless titanium prostheses available in the market in order to provide a rougher surface for apposition to bone. Surface contamination of the implant surface by the roughening media, corundum, has been proven by scanning electron microscopy [4]. These corundum particles released from the surface invade the periprosthetic tissue at different concentration levels withsome of the smallest particles even finding their way into the articulating surfaces where they cause three-body wear. The exact migration mechanisms have not been clearly defined yet.

In addition abrasive wear of femoral heads caused by third body particles originating from hydroxy-apatite-coated porous coated stems - have already been described for prostheses systems using metal/PE component configurations [5]. Abrasive damge to the surface of metal femoral heads and metal cups caused by Al_2O_3 particles has been proven by the authors previously for prostheses using metal/metal component designs [6]. The end results of these mechanisms and their effect on wear rates can only be estimated at this point in time with the absolute extent of abrasion on both the polyethylene and the metal, we must proceed under the assumption that the periprosthetic tissues are exposed to high particle quantities under these conditions. In the case of ceramic/ceramic component configurations, the risk of three-body wear caused by mechanisms which are similar to the ones described above can be neglected because the hardness of the particles and of the prosthetic components are the same.

Conclusions

The results from the study conducted by the authors concluded that the use of Al_2O_3 ceramic components in different cementless prosthetic systems proved to be successful in all implants which followed a desing conept that provided immediate primary stability in bone to be achieved. A high number of loosened prostheses and revisions resulted from the use of one acetabular design (spherical cup of the Knahr – Salzer type) clinically. Such poor medium-term results could reasonably have been expected against the background of previous migration analyses [7]. All other implants that were followed up were found to be radiologically and clinically stable. In the investigated group of patients, there were not any resorption edges on the proximal femur or early reoperations of stable implants because of heavy pain independent of any strain conditions as have been observed recently to an increasing extent for prostheses with high-carbide and low-carbide metal/metal component configurations.

In the author's opinion, if both, the implant and the component configuration are selected correctly and if the implantation is carried out properly, the use of Al_2O_3 ceramics in cementless THR systems will provide reliable clinical results in the future in great part due to its excellent wear properties.

References

1. DeLee J., Charnley J.: (1976) Radiological demarcation of cemented sockets in total hip replacement. Clin.Orthop. 121 20-32
2. Gruen T.A., McNeice G.M., Amstutz H.C.: (1979) Modes of failure of cemented stem-type femoral components. A radiographic analysis of loosening. Clin.Orthop. 141 17-27
3. Kaplan EL,Meier (1958) P. Nonparametric estimation from incomplete observations. J Am Stat Assoc. ;53:457-81
4. A Kolb, (2002) Aluminiumoxidkeramik-Partikelrückstände auf der Oberflächenrauhigkeit von rauhgestrahlten Femurschäften [Alumina ceramic residues on the surface of coarse-blasted femoral shanks]. Dissertation a.d.Univ. Wien
5. TW Bauer et al (1996) Abrasive Three Body Wear of Polyethylene Caused by broken Filament Cables of a total hip Prosthesis. Journ Bone Joint Surg. Vol 78A,1244-7

6. M Böhler et al. (2002)Adverse tissue reactions to wear particles from Co-alloy articulations increased by alumnia blasting particle contamination from cementless Ti – blasted total hip implants. Journ Bone Joint Surg. Vol 84AB,128-36
7. Böhler M, Krismer M, Mayr G, Mühlbauer M, Salzer M : (1998)
Migration -Measurement of cementless acetabular components Value of clinical and radiographic data Orthopedics,21,No.8,897