Comparison of metal on metal versus polyethylene–ceramic bearing in uncemented total hip arthroplasty in patients with haemophilic arthropathy

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Abstract

Purpose We report the results of a consecutive series of 12 cases with haemophilic hip arthropathy treated with uncemented total hip arthroplasty (THA). Our hypothesis was that THA results in the haemophilic group would be inferior to those in the nonhaemophilic group.

Methods The clinical histories of 12 consecutive THAs in eight patients (all men) with hereditary bleeding disorders (haemophilia A and B and von Willebrand disease) were reviewed retrospectively. The results were compared with an age- and sex-matched control group without haemophilia, with special emphasis on bearing surfaces (Metasul metal-on-metal; polyethylene–ceramic articulation).

Results The mean follow-up of the control group was 9.7 (range five to 24) years and was similar to the haemophilia group, with 10.4. Survival in the Metasul haemophilic group was 22.2 % after 18 years, which significantly differed from the Metasul control group (100 % after 24 years). Survival of the polyethylene–ceramic haemophilic group was similar to the control group (100 % after seven years in both groups).

Conclusions The metal-on-metal bearing surface in patients with haemophilia gave inferior results compared with nonhaemophilic patients. The use of metal-on-metal bearings in haemophilia is debatable.

Keywords Haemophilia · Hip arthroplasty · Bearing surface · Metasul

Introduction

The most common sites for bleeding episodes in patients with haemophilia are the knee, the ankle and the elbow [1, 2]. The hip is rarely affected but secondary changes due to haemophilia commonly lead to hip osteoarthritis [1, 3–5]. Advanced haemophilic arthropathy can seriously reduce function, quality of life because of pain, impairment and loss of mobility [6, 7]. Previous reports described varying results of cemented, uncemented and hybrid total hip arthroplasty (THA) in haemophilic patients, with revision rates ranging from 11.7 % to 36.4 % at a mean follow-up of five to ten years (Table 1) These failure rates are inferior compared with nonhaemophilic patients [5, 2, 1, 6, 4, 8]. More encouraging results with a decreased revision rate of 7.4 % on 27 uncemented implants were reported by Yoo et al. [7].

Patients and methods

Our study reports on the results of a consecutive series of 12 cases with haemophilic hip arthropathy treated with uncemented THA compared with an age- and sex-matched control group without haemophilia, with a special emphasis on bearing surfaces: metal-on-metal and polyethylene (PE)–ceramic articulation. Our hypothesis was that results in the haemophilic group would be inferior to those in the nonhaemophilic group.

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Table 1 Summarized data of results reported in the literature and in our study

Publication	Year	Fixation type	Surface bearing	Number of implants	Mean follow-up (years)	Revision
Sikkema et al. [12]	2010	NA	NA	6	7.5 (0.2–14.6)	NA
Yoo et al. [7]	2009	Cementless	Metal/PE 21 Ceramic/ceramic 6	27	7.7 (5–13)	2 (7.4 %)
Löfqvist et al. [8]	1996	Cemented	NA	13	7 (1–13)	4 (30.7 %)
Heeg et al. [1]	1998	Cemented	NA	3	5	1 (33 %)
Habermann et al. [6]	2007	Cemented Cementless Hybrid	NA	15	11 (1–30)	2 (13.3 %)
Miles et al. [4]	2008	Cemented 16 Cementless 4 Hybrid 10 Revision 4 (cementless)	Metal/PE 31 Ceramic/ceramic 3	34	6.25 (1–17)	4 (11.7 %)
Kelley et al. [2]	1995	Cemented 26 Cementless 6 Hybrid 1 Bipolar 1	NA	34	8 (1–15)	6 (23 %) acetabular 6 (21 %) femoral 3 (8.8 %) infection
Nelson et al. [5]	1992	Cemented	NA	22	7.6 (2.7–13.1)	5 (22.7 %)
Present study	2013	Cementless	Metasul 6 PE/ceramic 6	12	10.4 (5–24)	3 (25 %) all Metasul

Study design

The study was conducted as a retrospective consecutive case series with matched controls.

Patients

Patient acquisition was performed using the database of all THAs performed in a tertiary care department for orthopaedic surgery. Clinical histories of 12 consecutive THAs in eight patients (all men) with hereditary bleeding disorders (haemophilia A and B and von Willebrand disease) were reviewed retrospectively (haemophilic group). All patients were treated by a single senior orthopaedic surgeon (HW) and followed up regularly by the first (JP) and senior (HW) authors. Data included type and severity of the bleeding disorder, presence of inhibitors, type of endoprosthesis, pre- and postoperative functional parameters, infection, and revision surgery. Two patients without haemophilia or other bleeding disorders on whom a THA was performed in the same year as for haemophilic patients were selected as a control group (nonhaemophilic group) for each haemophilic patient. Patients were matched for implant type, both bearing surfaces, surgeon, gender, year of surgery and closest age to the haemophilic patients in a 2:1 relationship. Indications for surgery in the control group were primary osteoarthritis in 12 patients, avascular necrosis of the femoral head in five, adult hip dysplasia in three and posttraumatic arthritis of the hip in two.

The study was approved by the local ethics committee.

Radiographic assessment

Radiographs were classified with the use of the Gruen and DeLee and Charnley systems [9, 10]. The Zicat method was used to determine osteolytic lesions size [11]. Additionally, the lateral opening of the acetabular component was measured.

Surgical technique and postoperative care

All THA procedures were performed in a laminar-flow operating theatre by a senior surgeon with the patient under general anaesthesia. A modified (lateral) transgluteal approach, with the patient in a supine position, was used. A subtotal capsulectomy was performed regularly. The acetabular component was a conical screw cup made of commercially pure titanium (CSF; Sulzer, Winterthur, Switzerland) in 11 cases and a hemispheric cup (also titanium) (Allofit, Zimmer, Winterthur) in one case. The stem was a tapered rectangular implant made of titanium–aluminium–niobium alloy (Zweymüller-Alloclassic, Zimmer) in all cases. Two different articulation surface systems were used: in six cases, surface-bearing surfaces were second-generation metal on metal (Metasul), with a 28-mm ball head made of a wrought cobalt-based cobalt (Co)-28 chromium (Cr)-6Mo alloy, with a carbon content of 0.2 %. In the other six cases, the articulation surface consisted of an ultra-high-molecular-weight PE cup that was gamma sterilized in an inert gas atmosphere. The 32-mm femoral-head ball was of alumina oxide (Sulox; Feldmuehle Nobel, Stuttgart, Germany). Fixation of femoral components was achieved by press-fit implantation into a

precisely prepared osseous bed. The same type of implant was used for the control group. Antibiotics were administered intravenously 30 minutes before surgery (cefazolin 2 g or clindamycin 600 mg) and continued at eight hourly intervals until drains were removed, at a maximum 72 hours postoperatively. Routine prophylaxis against heterotopic bone formation was administered. After surgery, intensive physical therapy was initiated, and patients were mobilised with crutches with weight bearing for six weeks. Neither young age nor hepatitis C or HIV infections were considered as exclusion factors for surgery.

Haematological management

The perioperative factor-substitution regimen was prescribed by haemophilia experts from the Department of Medicine I and the Clinical Division of Haematology and Haemostaseology. One patient (with low-titer inhibitors after therapy according to the Malmö protocol) had continuous infusion with factor VIII (FVIII) 500 IU h⁻¹. One patient with high-titer inhibitors received recombinant FVII (rFVIIa) (Novoseven®/Novonordisk) as bolus therapy, according to the prescribed regimen. The other factor substitutions were administered via bolus therapy. All patients received the same product already being used for outpatient treatment. At surgery, the peak level of FVIII was kept at about 100 % for patients with haemophilia A and of FIX at 60 % for patients with haemophilia B. Antithrombotic prophylaxis was not used after surgery in the haemophilic group.

Statistical analysis

The Wilcoxon signed-rank test was used to compare follow-up, age and lateral opening values. Prosthetic survival was assessed using Kaplan–Meier survivorship analysis. The endpoint was defined as component removal due to infection or for any other reason. Comparison of survival curves was performed with the log-rank test. A *p* value <0.05 was considered statistically significant. Statistical analysis and graphical visualisation were performed using GraphPad Prism®, Version 5.0 for Mac (GraphPad Software, La Jolla, CA, USA) and IBM SPSS Statistics®, Version 21 for Mac (SPSS Inc, Chicago, IL, USA).

Results

Patients

One patient was excluded from the report because follow-up was only two years. Five patients had haemophilia A (one with inhibitors, one with a combined FV deficiency), two had haemophilia B and one had von Willebrand disease type III.

Mean follow-up was 10.4 (range five to 24) years. Six patients were seropositive for hepatitis C and four had hepatitis B; no patient was seropositive for HIV. Two patients died of liver failure during the follow-up period. The mean follow-up of the control group was 9.7 (range five to 24) years and was similar to the haemophilia group at 10.4 (range four to 24) years (*p*=0.95). Mean age at the time of surgery was 48.5 (range 27–81) years for the haemophilic and 49.5 (range 31–79) years for the control (*p*=0.85) group. There were no significant differences between groups.

Survival analysis

When infection was considered to be the endpoint, the cumulative probability of infection-free survival was 85.7 % after ten years and 28.6 % after 18 years. When component removal for any reason was defined as the endpoint, the cumulative survival probability was 23.8 % after 18 years. Median overall survival was 11 years. Deep infection occurred in two patients (one with bilateral prosthesis) seven, 11 and 17 months after index surgery and required prosthetic removal in both endoprosthesis of the bilateral procedure and bearing-component change in the other patient. Both patients had metal-on-metal bearing surfaces. One patient required revision due to cup migration; this patient also had a metal-on-metal bearing surface. The control group had a survival rate of 100 % after 24 years. In Kaplan–Meier analysis, there was a significant difference in survival rates between haemophilic and control groups (*p*=0.001). TKA component survival in the Metasul haemophilic group was 22.2 % after 18 years and significantly differed from the Metasul control group (100 % after 24 years) (*p*=0.001). Component survival in the PE–ceramic haemophilic group was similar to the control group (100 % after seven years in both groups).

Eleven radiographs of haemophilic and 21 radiographs of control group patients were available for review. At the latest follow-up, various degrees of osteolysis were observed around femoral components in three cases (in patient with implant removal, the latest radiographs before removal were evaluated) in the haemophilic group and in two cases in the control group and around the acetabular component in two cases in the haemophilic group; there were none in the control group. Osteolysis of the femoral component was seen in Gruen zones 1, 7, 8 and 14 in one hip; zones 1, 7, 8, 9 and 14 in one hip, zone 1 in one case in the haemophilic group, zones 1 and 7 in one hip, and zones 1 and 2 in one hip in the control group. Osteolysis of the acetabulum was seen in Gruen zones 1 and 4 in one hip and zone 1 in one case in the haemophilic group. Osteolysis were seen only in the proximal zone of the femoral component and were only observed with metal-on-metal bearing surface. Radiolucent lines >1 mm in width were observed for the femoral component in one case (zones 2, 3, 5, 6) and for the acetabular component in one case

(zone 2) in the haemophilic group (all metal-on-metal bearing). Radiolucent lines for the femoral component were found in two cases (zones 1 and 7 and zone 1 and 2) in the control group (one metal on metal and one ceramic–PE). The acetabular component in the control group showed no radiolucent lines (Figs. 1 and 2).

The average femoral lesion size was 9.77 (range, 4.56–21.1) cm² for the haemophilic and 2.4 (range 0.25–4.98) cm² for the control group. The average acetabular lesion size was 15.0 (range 8.61–18.55) cm² (haemophilic group). Mean lateral opening in the haemophilic group was 43.0 (range 36.8–47.7) and did not differ from the control group, at 43.8 (range 35.9–49.9)° ($p=0.86$).

Discussion

THA has been performed for several years in patients with hereditary bleeding disorders, with varying results in terms of infection and revision rates. Results of previous studies are summarized in Table 1 and compared with our study. To the best of our knowledge, no special emphasis has been given to surface bearing components to date. Only one small series (six THAs) has been compared with other patient populations [12]. We are aware of the inherent limitations of this retrospective study and the small sample size; however, the strength of our study is the use of a control group of patients without a bleeding disorder and a minimum follow-up of five years, which is important for detecting periprosthetic osteolysis [7].

The success of THA in haemophilic patients lags behind the excellent results in patients with primary osteoarthritis [4, 13]. Miles et al. [4] reported an association of bleeding and

Fig. 2 Haemophilic group metal on metal: two of 11 (Gruen zones I, IV and I. Haemophilic group polyethylene–ceramic: 0. Control group metal on metal: 0. Control group polyethylene–ceramic: 0 [254×190mm (72×72 DPI)]

concurrent viral disease (hepatitis C, HIV) with poor outcomes and that favourable arthroplasty depends on successful attachment of the implant in the bone. All incidences of revision in their study had to be performed in patients with hepatitis C [4]. Pour et al. [14] reported that patients with hepatitis C undergoing joint arthroplasty had a higher rate of surgical complications but stated that the reason was not known.

In our series, the worst results were observed in the patient group with the Metasul surface bearing. Osteolysis was seen only in the proximal zone of the femoral component. Osteolysis was only observed in metal-on-metal bearing surfaces. Nevertheless, the matched control group had good result with this bearing surface. A large series of nonhaemophilic patients at our centre was reported by Gröbl et al. [15] in 2007. The probability of a revision-free survival of ten years was 98.6 % [95 % confidence interval (CI) 96–100 %]. In the group with PE–ceramic bearing surfaces, results were comparable with the control group. Several reasons for unfavourable outcomes of arthroplasty in patients with hereditary bleeding disorders have been proposed. Beaulé et al. [16] discussed the possibility that elevated intracapsular joint-fluid pressure can be transmitted to periprosthetic bone and play a role in the pathophysiology of osteolysis in total joint arthroplasties and may be an example for the “effective joint space” described by Schmalzried et al. [17]. Kinov et al. [18] suggest that high oxidative stress may play a role in fibrous membrane formation observed at revision of loose hips. The fibrous pseudocapsule is probably related to high intra-articular pressure and expansion of the effective joint space [18].

Fig. 1 Haemophilic group metal on metal: three of 11 (Gruen zones 1, 7, 8, 14; 1, 7, 8, 9, 14; 1). Haemophilic group polyethylene–ceramic: 0. Control group metal on metal: two of 21 (Gruen zones 1, 7 and 1, 2). Control group polyethylene–ceramic: 0 [254×190 mm (72×72 DPI)]

Based on the results of this retrospective study, we hypothesize that metal bearings in patients with haemophilia lead to inferior results due to a combination of several factors (metal wear, bleeding episodes due to haemophilia, fibrous membrane) that cause increased effective joint space and consecutive early loosening. The metal-on-metal bearing surface in patients with haemophilia gave inferior results when compared with nonhaemophilic patients. The use of metal-on-metal bearings in haemophilia thus is debatable.

In conclusion, we recommend the use of uncemented fixation with a surface bearing other than metal on metal. The use of PE–ceramic bearings appears to be a good option for achieving good THA results in haemophilic patients.

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