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Survival of Bi-Metric femoral stems in 77 total hip arthroplasties for juvenile chronic arthritis

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Abstract The survival of 77 cementless total hip arthroplasties using a Bi-Metric femoral stem and two types of acetabular components was analysed in 55 patients with juvenile chronic arthritis. The patients were treated between 1986 and 1996. Their mean age was 8.0 years at the onset of the disease and 28.1 years at the time of surgery. The mean follow-up period was 9.6 years. Follow-up evaluations were conducted 3 months and 1, 4, 8, 12 and 16 years post-operatively. The endpoints of survival analysis were revision surgery, death of the patient or the end of the year 2002. The 10-year survival was 77.6% for the Romanus cup and 49.1% for the TTAP-ST cup. In contrast to these inadequate outcomes, the cementless Bi-Metric stem yielded excellent results with a survival rate of 100% for aseptic loosening during a mean follow-up period of 10 years.

Résumé La survie de 77 arthroplasties de la hanche totale non cimentée qui utilise un tige fémorale Bi-Métrique et deux types de composants acétabulaires a été analysé chez 55 malades avec une arthrite chronique juvénile. Les malades ont été opérés entre 1986 et 1996. Leur âge

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The study was conducted at the Rheumatism Foundation Hospital.

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moyen était 8.0 années au début de la maladie et 28.1 années à la chirurgie. La période de suivi moyen était 9.6 années. Les évaluations des résultats ont été conduites à 3 mois et 1, 4, 8, 12 et 16 années postopératoires. Le point final de l'analyse de la survie était la chirurgie de révision, le décès du malade ou la fin de l'année 2002. La survie à 10 années était 77.6% pour la cupule acétabulaire Romanus et 49.1% pour la cupule acétabulaire TTAP-ST. Par contraste avec ces résultats insuffisants, la tige Bi-Métrique non cimentée a montré des résultats excellents avec un taux de survie de 100% pour le descellement aseptique pendant une période de suivi moyenne de 10 années.

Introduction

Juvenile chronic arthritis (JCA) [4] is an important cause of disability in children. Approximately 60% of patients with JCA have attained remission after 10 years [7], but 10% of patients are left with severe disability and functional impairment due to deformities and loss of motion [4, 7]. The hip joint is involved in 20–40% of patients during the course of JCA [11]. Patients are frequently young at the time of operation, and durability of arthroplasty is required for extended periods. Only a few series with a relatively small number of patients have been published [5, 8, 12, 13, 16, 18].

Cementless acetabular components may have a high rate of success in total hip arthroplasties (THA) on patients with rheumatoid arthritis. However, there may be a high rate of subsidence and osteolysis with first-generation cementless femoral components [24]. Second-generation cementless femoral components were designed to provide more reliable in-growth and to limit distal osteolysis by incorporating circumferential proximal in-growth surfaces. The use of second-generation cementless femoral components has shown excellent results at both short- and intermediate-term follow-up intervals [1]. To our knowledge, there has been only one other report in the literature concerning the outcome of cementless THA in patients

with JCA [12]. We present the survival of cementless hip replacement using the same stem design and two different cups in a relatively large series of patients with JCA.

Patients and methods

Seventy-seven THAs on 55 patients (45 women) fulfilling the criteria for JCA [2] were performed at the Rheumatism Foundation Hospital during the period 1986–1996. Mean follow-up period was 9.6 (4.2–15.8) years, mean patient age was 8.0 (2–16) years at the onset of the disease and 28.1 (14–60) years at the time of surgery, and mean patient weight was 55 kg (26–96 kg). Patient characteristics are presented in Table 1. Glucocorticoids were used by 47 patients and cytotoxic agents by 20 patients at the time of THA.

According to the prevailing general treatment recommendations at the time, cementless fixation was used in young patients. All patients were operated on using the cementless Bi-Metric femoral stem (Biomet, Inc., Warsaw, Indiana, USA) and one of two cementless acetabular components [14, 21, 23]. The stem was of the same overall design during the series, apart from a slight modification in 1989. The stem is straight, made of titanium and has a proximal porous coating. Two cup types were used: 17 TTAP-ST cups (1986–1989) and 60 Romanus cups (1989–1996) (both from Biomet, Inc., Warsaw, Indiana, USA). The TTAP-ST cup is threaded, smooth, hemispherical and made of titanium alloy. The Romanus cup is threaded, porous-coated and made of titanium alloy. All TTAP-ST liners had a Hexloc [25] fixation. Of the Romanus liners, 59 had a Hexloc and one a Ringloc [25] fixation. The liners used were manufactured from extruded bar polyethylene raw material and sterilised in air using gamma radiation or were polyethylene manufactured by compression moulding technique and sterilised in Argon gas using gamma radiation. THAs were performed using a direct lateral approach [9]. Bone defects were filled with cancellous bone from the resected femoral head. The patients were instructed to have limited weight bearing for 6–8 weeks; thereafter, full weight bearing was allowed. Antibiotic prophylaxis consisted of either methicillin or

cephalosporin for 3 days. Pre-operative destruction of the hip joint was assessed by the Larsen method [15].

Radiographs were taken pre-operatively and 2 or 3 days post-operatively. The patients visited the outpatient department at 3 months for clinical evaluation and then 1, 4, 8, 12 and 16 years post-operatively for clinical and radiographic evaluation. All 55 patients (77 hips) attended the 4-year, 43 patients (58 hips) the 8-year, 14 patients (21 hips) the 12-year and two patients (four hips) the 16-year follow-up evaluation. The inclination of the socket and the thickness of the bottom of the acetabulum were measured.

The endpoints for survival analysis were a revision procedure, the death of the patient or the end of the year 2002. Five patients died during the follow-up, but the causes of death were unrelated to hip replacement. All data used in this investigation were collected from the patient documents available. Additionally, the National Arthroplasty Register was used to determine the longevity of the prosthesis [20], and thus all deaths and all revision surgeries performed at other hospitals could be recorded. Survival analysis was based on the standard Kaplan–Meier method with confidence intervals. The Mantel–Cox test was used to determine whether the differences between the survival curves were significant, and the proportional hazards model was used to determine the effect of various variables on the risk of loosening of THA prostheses.

Results

The combined survival of acetabular and femoral components was 96.1% (95% CI 88.4–98.7) at 5 years and 70.0% (95% CI 57.3–79.2) at 10 years (Fig. 1). Of the acetabular components, the TTAP-ST cup had a survival of 88.2% (95% CI 60.6–96.2) at 5 years and 49.1% (95% CI 23.1–70.7) at 10 years and the Romanus cup 98.3% (95% CI 88.8–99.8) and 77.6% (95% CI 63.7–86.7) (Fig. 2), respectively. Both the TTAP-ST and the Romanus cup had an angle median (IQR) of 50 (45.5)°. Details of the factors that influenced the loosening of the prosthesis are presented in Table 2.

The survival of the femoral component was 98.7% (95% CI 91.1–99.8) at 5 years and 97.4% (95% CI 90.0–

Table 1 Demographic, clinical and radiographic characteristics of the patients with juvenile chronic arthritis (JCA) undergoing total hip arthroplasty (THA). *SD* standard deviation

	Male (n=10)	Female (n=45)	All (n=55)
Number of hips	10	67	77
Mean age in years (SD)	39 (9)	27 (9)	28.1 (10)
Mean weight in kg (SD)	65.3 (6.0)	53.7 (17.0)	55.2 (16.4)
Therapy			
Use of glucocorticoids, <i>n</i> (%)	7 (70)	40 (60)	47 (61)
Use of cytotoxic agents, <i>n</i> (%)	2 (20)	18 (27)	20 (26)
No drugs, <i>n</i> (%)	2 (20)	15 (23)	17 (22)
Preoperative Larsen grade of hip joint <i>n</i> (%)			
2	1 (10)	0 (0)	1 (1)
3	1 (10)	10 (15)	11 (14)
4	2 (20)	20 (30)	22 (29)
5	6 (60)	37 (55)	43 (56)

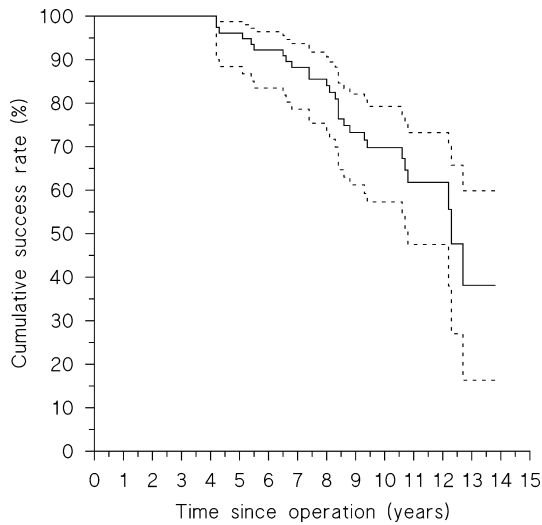


Fig. 1 Combined survival of both the Bi-Metric stem and the acetabular component with 95% confidence interval in patients with juvenile chronic arthritis (JCA)

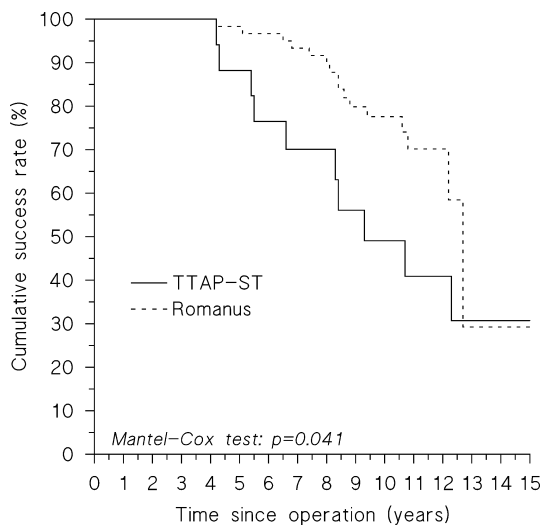


Fig. 2 Survival curves of TTAP-ST and Romanus cups in juvenile chronic arthritis (JCA)

99.3) at 10 years. The survival of the Bi-Metric stem was 100% at 10 years with respect to aseptic loosening. One deep infection was encountered 2.5 years post-operatively following septicaemia caused by an infected cervical spine

procedure. In that case, both components were removed. Twenty-nine THAs were revised before the end of year 2002. Of them two were for femoral and 27 for acetabular components. One stem was revised because of a periprosthetic fracture and the other for an infection mentioned above. Eleven TTAP-ST cups were revised, all because of loosening of the shell (Fig. 3). Sixteen Romanus cups were revised, 13 because of excessive polyethylene wear (Fig. 4), two because of loosening of the shell and one for infection. All revised Romanus cups had the Hexloc type of liner fixation.

Discussion

The cementless Bi-Metric stem proved to be a good choice for a femoral component in young patients with JCA. Our results—100% survival of the stem in terms of aseptic loosening during a mean follow-up period of 10 years—are very good compared with other reports on this subject [5, 6, 8, 12, 16, 18, 22]. Among 1,047 THA for primary osteoarthritis, aseptic loosening of the Bi-Metric or Integral stem requiring revision surgery occurred in 6% [21]. Cementless stems have also proved to have favourable outcome in some studies with young patients [6, 19, 22]. Nevertheless, cemented fixation has also yielded good results in series of patients with JCA. Lehtimäki et al. published a series of 186 cemented Charnley prostheses in JCA, reporting a combined survival rate of 92% for the prosthesis, 96% survival for the femoral component and 95% survival for the acetabular component at 10 years [16]. In a study of 17 THA (13 cemented and four cementless) in patients with JCA, five of the cemented hips were radiographically definitely loose with impending failure after a mean follow-up period of 9 years, whereas the four cementless ones were functioning well [18].

Cementless cup fixation appeared to yield poor results in our series. Many of the threaded TTAP-ST cups loosened after 5 years showing a mean survival rate of only 49% at 10 years. The problem with the Romanus type of threaded cup is not the fixation of the shell—only two of 16 re-operations were performed because of shell loosening. The unstable Hexloc liner is associated with excessive wear and osteolysis in the acetabular region. The number of cup revisions increased abruptly after 8 years

Table 2 Proportional hazards model to determine the effect of various variables on the risk of loosening of total hip arthroplasty (THA) prostheses. CI confidence interval

Variables	Hazard ratio (95% CI) ^a	p value
Age (per 10 years)	0.34 (0.13–0.85)	0.021
Gender (male)	2.22 (0.42–11.87)	0.35
Weight (per 10 kg)	1.23 (0.83–1.80)	0.30
Pre-operative Larsen grade of hip joint	1.34 (0.75–2.38)	0.32
Use of glucocorticoids	0.88 (0.30–2.57)	0.81
Use of cytotoxic agents	1.33 (0.47–4.00)	0.59
Cup type (TTAP-ST versus Romanus)	2.78 (1.08–7.14)	0.041
Socket inclination angle (not 45°)	3.12 (0.92–11.98)	0.067
Thickness of acetabular wall (<6 mm)	0.66 (0.24–1.78)	0.41

^aRobust estimate of variance.

Fig. 3 **a** Radiograph of a patient with juvenile chronic arthritis (JCA) at the age of 44 years showing hip joint destruction. **b** Same hip after cementless replacement using Bi-Metric stem and TTAP-ST cup. **c** TTAP-ST cup with loosening 8 years post-operatively

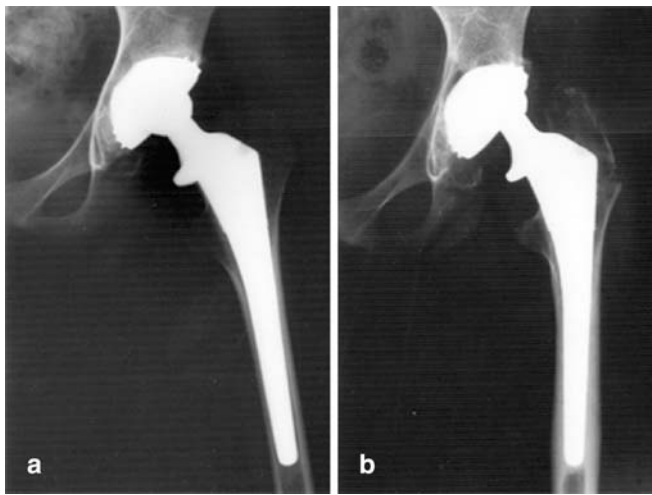
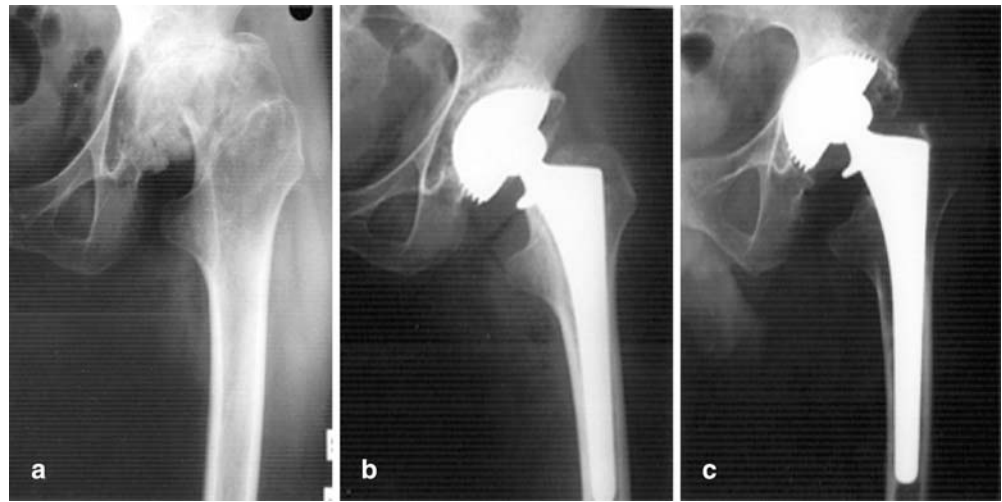


Fig. 4 **a** Post-operative hip radiograph of a juvenile chronic arthritis (JCA) patient at the age of 16 years after cementless replacement with Bi-Metric stem and Romanus cup (Hexloc fixation). **b** Same hip 8 years post-operatively showing severe wear of the liner

causing the survival rate to drop from 98% at 5 years to 78% at 10 years. Puolakka et al. [21] reviewed the outcome of cementless Biomet cups (361 Mallory-Head, 148 Romanus, 302 TTAP, 236 Universal) reporting a 6-year survival of 65% for all Biomet cups, only 58% for the TTAP cup and 85% for the Romanus cup.

Today, despite the young age of patients, the safest solution in JCA may be the cemented socket, even though the development of cementless metal-backed acetabular components has given favourable result and additional benefit because of the modularity of the component. In a recently published study, Harris [10] summarised the results of the use of cementless acetabular components and recommended their use in all patient groups. Non-hole cups with secure liner fixation without back-wear and pelvic osteolysis may further increase their survival rate [25].

Only the age of patient and cup type used (TTAP-ST versus Romanus) proved to be a significant risk factors in this study. Medication used, socket inclination angle, pre-

operative destruction of the hip or gender were not significant factors. Although patients with JCA are young, they are generally considered to be low-demand patients. However, they still face the rigours of completing an education, beginning a career, and seeking a spouse, which generally are not faced by older patients and which probably increase the demands on a prosthetic hip [5]. Deformities and functional deficits due to JCA may have adverse effects on the patient's physical and emotional development [3]. These young patients enter a period of their lives when education and socialisation are crucial, and they have high demands for ambulation. Only restorative surgery is able to help them achieve these social needs. Patients with JCA have low body weight and they usually put only moderate strain on their replaced joints due to disability of other joints with reduced mobility. This may enhance the success of THA. Patients may have multiple joint involvement and they probably have to undergo many joint reconstructions. Lyback et al. [17] presented in the series of 77 total knee arthroplasties in patients with JCA that 70% of the patients had also undergone hip, 17% elbow and 13% shoulder replacement during the follow-up.

The Bi-Metric stem is one of the second-generation cementless stems and has excellent results. It can be recommended even for young patients. Old-fashioned threaded cups yielded really poor results. Hexloc type of liner fixation is unstable causing excessive wear with pelvic osteolysis and high revision rate. Cementless cups should be followed regularly both clinically and radiographically to avoid the development of unexpected and often symptomless cup wear with excessive pelvic osteolysis and difficulties in revision surgery.

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