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CLINICAL RESEARCH

Is Total Hip Arthroplasty after Hip Arthrodesis as Good as Primary Arthroplasty?

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Abstract

Background Conversion of hip arthrodesis to a THA reportedly provides a reasonable solution, improving function, reducing back and knee pain, and slowing degeneration of neighboring joints associated with a hip fusion. Patients generally are satisfied with conversion despite the fact that range of mobility, muscle strength, leg-length discrepancy (LLD), persistence of limp, and need for assistive walking aids generally are worse than those for conventional primary THA.

Questions/purposes We compared THA after hip arthrodesis and primary THA to determine whether these procedures would be associated with similar functional scores, maintenance of scores with time, complications and failures, survivorship of the arthroplasty, and patient satisfaction.

Patients and Methods We retrospectively matched 48 patients undergoing conversion of a fused hip to a THA between January 1980 and January 2000, with 50 patients receiving a primary THA during the same period. We prospectively followed all patients between January 2000 and January 2010. The changes in function and pain after THA were compared between the two cohorts using the Harris hip score (HHS) and the Rosser Index Matrix (RIM). The Oxford hip score (OHS) and the SF-36 also were used to assess quality of life (QOL) during followup. Complications were collected and survivorship of the THA was evaluated. Patient satisfaction was assessed using the Robertsson and Dunbar questionnaire. The minimum followup was 10 years (mean, 17 years; range, 10–29 years).

Results At last followup, hip function and health-related QOL were similar for patients having conversion of hip arthrodesis to THA and for patients having a routine THA. Scores diminished overall in the two groups between 2000 and 2010, but without a difference for the HHS, RIM QOL, and OHS in the study cohort. The rate of complications, THA survival, and patient satisfaction were similar in both groups.

Conclusions Conversion of hip arthrodesis to a THA provides substantial improvement of hip function and health-related QOL, with an acceptable rate of complications, good expectancy of survival for the arthroplasty, and high level of patient satisfaction comparable to those of primary THA.

Level of Evidence Level III, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.
Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent was obtained.
This work was performed at Instituto de Cirugía Ortopédica y Traumatología de Barcelona and at Hospital de Cabueñes de Gijón.

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Introduction

Functional impairment, and pain and degeneration of the neighboring joints are frequent problems associated with a long-term fused hip [12, 52, 63, 64, 68, 70]. Between 35%

and 60% of patients with fused hips complain of knee pain and between 57% and 65% complain of low back pain [12, 68, 70]. Many surgeons consider disability resulting from a fused hip, pain in the surrounding joints, malpositioned ankylosis, or painful pseudarthrosis as indications to convert a fused hip to a THA [12, 45, 52, 62–65, 68–70, 72, 74, 77, 78].

The results of such a technically demanding procedure have been assessed using traditional hip scoring systems. Complete or near complete relief is noted in 73% to 80% of patients with preoperative back pain [30, 40] and in 66% of patients with knee pain [40]. Regarding pain and function in the surgically treated hip, 79% to 85% of hips are pain-free or with minimal pain [36, 45, 64], 79% have "good-to-excellent" ROM [36], and 83% have "good-to-excellent" function [36], obtaining an average postoperative hip flexion between 70° and 102° [29, 40, 45, 49, 54, 65] and improvement in walking [29]. Overall function and walking improves after conversion [54, 55, 58]. Survival of the converted THA ranges from 74% to 96% at 10 years [29, 36, 53, 57] and 73% at 26 years [36]. Between 75% and 100% of patients are satisfied with the procedure [29, 36, 40, 45, 49, 55, 57, 62, 65, 73], and they generally are pleased with the outcome even if factors such as range of mobility, muscle strength, LLD, persistence of limp, and need of assistive walking aids are less satisfactory in converted hips compared with hips that had conventional primary THA [40, 52, 55, 69]. A patient's satisfaction with the obtained outcome may be related more to the global change achieved in QOL than to 'objective' data assessed by the surgeon.

Richards and Duncan [57] compared changes achieved in QOL after conversion of fused hips to THA and after primary THA (PTHA) using self-administered, health-related, QOL outcome questionnaires [57]. QOL was lower after conversion of hip arthrodesis than after conventional PTHA in contrast to reports that conversion may achieve a success rate similar to that of a PTHA [36, 40, 49]. They reported no differences observed either in functional scores between conversion of fused hips to THA and revision THA, as observed by Peterson et al. [53], or in patient satisfaction between the three studied cohorts [57].

To address this controversy and provide useful information regarding the expected result of this procedure, we compared conversion of a fused hip to a THA and PTHA to answer the following questions: (1) Are the functional scores and QOL similar in both groups? (2) Are the improvements in functional scores and QOL similar to those of primary THA? (3) Are the complication and failure rates similar in these procedures? (4) Is the survivorship of the THA after hip fusion similar to that of PTHA? (5) Is patient satisfaction similar in the two cohorts to long term?

Patients and Methods

This cohort study was based on a cohort of 65 patients with fused hips and a control cohort of 55 patients with a PTHA. We retrospectively reviewed 65 patients with 67 fused hips who underwent conversion surgery to a THA in our two centers between January 1, 1980 and January 1, 2000. We excluded patients having fusion before skeletal maturity or secondary to systemic rheumatologic diseases (Fig. 1). Two patients died and three others were lost to followup before January 2000. The 55 remaining patients (55 hips) were included in the study cohort. For all these patients, the conversion to THA was performed before June 1999. Therefore, they had a minimum 6-month followup from the conversion surgery to January 2000 when they were included in the study cohort and followed prospectively from that moment until the last review in January 2010. Between January 2000 and the end point of the study in January 2010, three patients died and four were lost to followup. Thus, 48 patients (48 hips) were fully assessed with a minimum 10-year followup from conversion (mean, 17 years; range, 10–29 years) and constitute the material of this study (Table 1).

Eighteen patients had spontaneous ankylosis and 30 had operative arthrodesis. Conversion was performed at a mean of 26 years (range, 3–47 years) from fusion and after more than 30 years in 14 patients. At the time of conversion, the mean age of the patients was 52 years (range, 31–68 years). Fifteen were younger than 50 years and 40 were younger than 60 years. The major complaints were ipsilateral knee pain in 30 patients (62%) and low back pain in 28 patients (58%). The hip was fused in malposition in 11 patients (23%).

Previous data to conversion, details of surgical procedures, complications, and followup data until January 2000 were extracted from patient charts by clinical audit personnel and one orthopaedic registrar (AT). From the medical records we extracted remarks regarding pain, muscle strength evaluated by manual testing, LLD measured clinically and radiographically, limp, walking capacity estimated using the HHS [31] criteria, and use of supportive devices. LLD was assessed clinically by measuring both limbs with a tape from the anterior-superior iliac spine to the tip of the medial malleolus, while the patient was in the supine position [26], and radiographically by orthoroentgenography [1, 27], measuring the femoral length from the superior margin of the acetabulum to the distal end of the lateral femoral condyle, and the tibial length from the proximal aspect of the lateral tibial plateau to the midpoint of the tibial plafond, to estimate leg length as accurately as possible, avoiding the difficulties resulting from the pelvic obliquity, an extremely abnormal position, or a flexion deformity [40]. All patients had

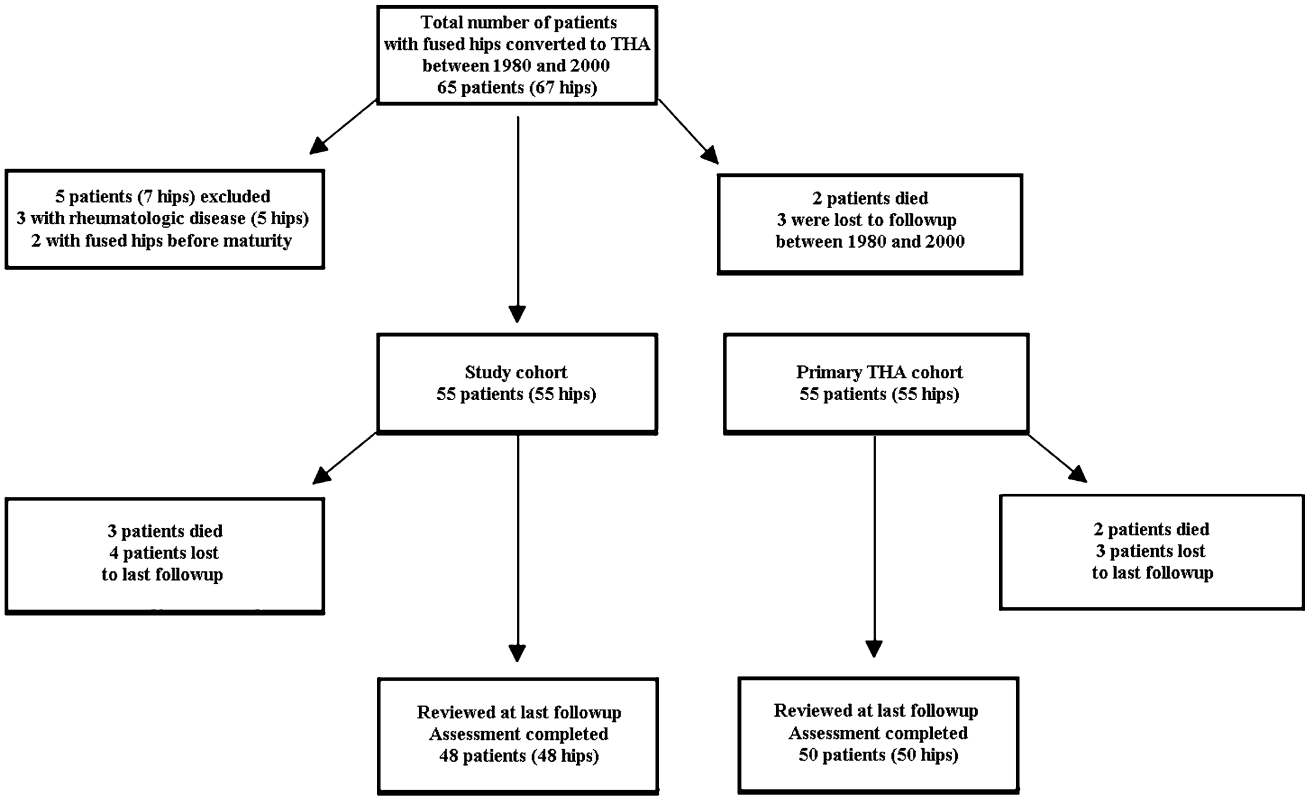

Fig. 1 A flow diagram shows the method of patient inclusion and exclusion in the study and control cohorts.

perceptible contraction of the abductor muscles on palpation. A Charnley class [13] was assigned to each patient based on his or her condition before THA. The HHS was used for all patients before and after the THA. From 1990, medical records included the questionnaire proposed by the Hip Society [35].

A control cohort of 55 patients undergoing unilateral PTHA between January 1, 1980, and January 1, 2000, was extracted from the database of our hospitals to compare with the study cohort. Patients needed a complete medical record and were included only after expressing their willingness to participate in the study and to complete the followup. Multivariable matching was 1:1 for gender, age at THA (± 5 years), Charnley class before THA, fixation of the implanted prosthesis, and followup from THA (± 2 years). We always used a 28-mm diameter head and a metal ultrahigh molecular weight polyethylene bearing couple. In January 2010, two of the 55 patients in the PTHA cohort had died and three others were lost to followup. Fifty patients remained available to be fully assessed. Data from patients who died or were lost to followup were not used in this study.

At surgery we attempted to place the prosthesis in an anatomic position and with an appropriate orientation to restore normal biomechanics. In the study cohort, the approach was posterolateral in 12 patients, anterolateral in 21, and transtrochanteric in 15. In the control cohort, the approach was posterolateral in 29 patients and anterolateral in 21. Femoral neck osteotomy was performed on the preoperatively planned site and direction. The inferior margin of the acetabulum, obturator foramen, and ischial tuberosity were identified to determine the position of the acetabulum. Intraoperative radiographic control is recommended to confirm the exact location of the acetabulum. A suitable cavity was prepared by deepening the medial acetabular wall. Neck length and offset of the prosthesis were selected to confer a convenient soft tissue tension, stable reduction, and adequate limb length. Care was taken to preserve the greater trochanter and hip abductors during stem implantation. An adductor tenotomy was performed in 22 of 48 hips at the end of the conversion procedure, only when the hip could not be passively abducted greater than 15°.

All patients received antibiotic prophylaxis at the time of THA and 3 weeks of postoperative antithrombotic prophylaxis with unfractionated heparin until 1993; we used low molecular weight heparin after 1993. When fusion was related to tuberculosis, specific drugs were prescribed for 6 months to avoid reactivation of the disease [29]. Measures to prevent heterotopic ossifications were not used.

Table 1. Demographic and perioperative clinical data

Variable	Study cohort	PTHA cohort	p Value
Number of patients/hips	48/48	50/50	
Number of males/females	34/14	33/17	0.6§
Age at fusion (years)*	26 (17–41)		
Primary diagnosis (number of patients)			
Tuberculosis	18 (37%)	2 (4%)	
Septic arthritis	9 (19%)	0	
Posttraumatic arthritis	8 (17%)	11 (22%)	
Developmental dysplasia	10 (21%)	18 (36%)	
Sequelae - epiphysiolysis	2 (4%)	5 (10%)	
Sequelae - Perthes disease	1 (2%)	5 (10%)	
Necrosis femoral head	0	9 (18%)	
Time from fusion to THA (years)*	26 (3–47)		
Age at THA (years)*	52 (31–68)	53 (40–69)	0.6‖
PreTHA Charnley class (number of hips)			0.5§
A	6 (12%)	7 (14%)	
B	9 (19%)	14 (28%)	
C	33 (69%)	29 (58%)	
Abductor muscle strength (manual-testing grade)			< 0.001§
0	0	0	
1	5	0	
2	9	2	
3	18	19	
4	16	19	
5	0	10	
Leg-length discrepancy (cm)*	3.4 (0–6.6)	0.9 (0–2.5)	
PreTHA HHS (0–100 worst to best)†, ‡	60.2 ± 6.7	62.0 ± 6.3	0.18¶
	60.5 (47–78)	62 (48–73)	
PreTHA RIM QOL‡	0.87 (0.7–0.95)	0.87 (0.7–0.95)	0.7¶
Type of THA implanted (number of patients)			0.91§
Fully cemented	12 (25%)	14 (28%)	
Hybrid	10 (215)	9 (18%)	
Fully uncemented	26 (54%)	27 (54%)	
Followup from THA (years)*	17 (10–29)	16 (10–27)	0.3‖

* Values are expressed as mean, with range in parentheses; †values are expressed as mean ± SD; ‡values are expressed as median, with range in parentheses; §crosstabulation; ‖Student's t test; ¶Mann-Whitney test; HHS = Harris hip score; RIM = Rosser Index Matrix; QOL = quality of life.

Immediately after the operation, passive motion exercises and isometric and isotonic exercises for hip abductor and flexor muscles were started with the assistance of a physiotherapist. Patients progressed from partial to full weightbearing using two crutches for 4 weeks, one crutch for 4 weeks, and one cane for at least 3 months postoperatively.

In January 2000, a consultant orthopaedic surgeon (VQ), not involved in the surgeries and without information from the medical records, interviewed and examined all patients. They were followed prospectively from this point and asked to return every 2 years thereafter for clinical and radiographic evaluations until the last review in January 2010. Followup data were collected prospectively using the above-mentioned questionnaire and the HHS.

One of us not involved in the surgical procedure (AM Jr) and an experienced radiologist (AM) examined, independently and blinded to each other, preoperative and postoperative AP radiographs of the pelvis, and serial AP in neutral rotation and lateral radiographs of the hip, taken between the time of surgery and 2010. The ratio between abductor and body weight moment arms and height of the acetabulum were measured and compared with the contralateral side [40]. We assessed the position of the center

Table 2. The Rosser Index Matrix

Grade	Description
Disability (function)	
I	No disability
II	Slight social disability
III	Severe social disability and/or impairment of performance at work
IV	Choice of work or performance at work severely limited
	Housewives and old people are able to do light housework only but able to go shopping
V	Unable to undertake any paid employment
	Unable to continue any education
	Old people confined to home except for escorted outings and short walks and unable to do any shopping
VI	Confined to chair or wheelchair or able to move around in the house only with support from an assistant
VII	Confined to bed
VIII	Unconscious
Distress (pain)	
A	No distress
B	Mild
C	Moderate
D	Severe

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Table 3. Quality of life score for each Rosser Index Matrix distress/disability combination

Disability	Distress			
	A	B	C	D
I	1.000	0.995	0.990	0.967
II	0.990	0.986	0.973	0.932
III	0.980	0.972	0.956	0.912
IV	0.964	0.956	0.942	0.870
V	0.946	0.935	0.900	0.700
VI	0.875	0.845	0.680	0.000
VII	0.677	0.564	0.000	−1.486
VIII	−1.028			

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of rotation of the arthroplasty, inclination angle of the cup and femoral offset [41], loosening (using the criteria of DeLee and Charnley for the acetabular component [19], and the criteria of Engh et al. [22], Gruen et al. [28], and Harris et al. [32] for the femoral component), wear using the method of Livermore et al. [44], and heterotopic ossification using the classification of Brooker et al. [10]. There were no missing radiographs for any patient. Interobserver variability was determined and expressed using the κ coefficient. The reproducibility of measurements was 0.88 for the joint center location, 0.93 for orientation of the acetabular component, 0.84 for femoral offset, 0.81 for interpreting radiolucencies, 0.79 for magnitude of wear, and 0.95 for grade of heterotopic ossification.

Patients, assisted by a trained interviewer (NG) without physician input, completed the evaluation questionnaires in 2000 and 2010. Patients were reassured comments would be kept strictly confidential. The RIM [61] was used to assess QOL of the patients. The RIM (Table 2 allows the HHS to be translated directly into the RIM categories to derive QOL scores (from −1.486 indicating a state worse than death to 1.000 indicating complete normality) (Table 3) [60]. To calculate changes in QOL between before and after surgery, information was obtained by reprocessing the preoperative collected data and from the questionnaires completed by patients at the followup.

The SF-36 [48, 75, 76], translated into Spanish, validated and normalized to the Spanish population [2, 3], also was used as a patient-based generic evaluation tool to assess health-related QOL. The eight domains of SF-36 were completed and the Physical Component Summary (PCS) score and Mental Component Summary (MCS) score [75] were generated. The OHS was used as a THA-specific tool to evaluate health-related QOL [16].

All complications and failures were collected from medical records and from patient followup. We classified complications as minor and major. A major complication was one that had the potential for permanent morbidity or disability, or needing revision (failure) of the THA [14].

Finally, in 2010, all patients were personally interviewed regarding their level of satisfaction with their arthroplasty using the questionnaire proposed and validated by Robertsson and Dunbar [59]. Three questions were asked: the first asked if there were any reoperations to the index hip; the second if there was disease in other joints; and the third requested the patient indicate how satisfied he or she is with the surgically treated hip by choosing either (I) very satisfied, (II) satisfied, (III) uncertain, or (IV) unsatisfied [59].

Descriptive statistics were used for distribution of data. Scores were reported as medians and ranges and means and SDs for comparison with published studies. We determined differences in age of the patients at THA, years of followup from THA, and points gained in the HHS and RIM QOL from before the THA to the 2000 followup, between the

study cohort and the PTHA cohort using Student's t test. We determined differences in patient gender, Charnley class before the THA, type of prosthesis implanted, postoperative Trendelenburg sign, limp and need for ambulatory aids, complications and failures, and patient satisfaction between the two cohorts using cross-tabulation. We determined differences in HHS, RIM QOL, OHS, and SF-36 scores, between both cohorts using the Mann-Whitney test. We determined differences in HHS, RIM QOL, OHS, and SF-36 scores, between the two followup dates in each cohort using the Wilcoxon signed-rank test. An actuarial life table was constructed and survival data were calculated using the Kaplan-Meier method. Revision for any cause was the end point. Curves were compared using log-rank tests. A post hoc power calculation was performed recognizing a difference of means of 7 points and a difference in SD of ± 13 in HHS as a clinically important change, with significance of 0.05 in a one-tailed test. Power of the study was 85%. Statistical analyses were performed with Statgraphics® Centurion XVI.I (Statpoints Technologies Inc, Warrenton, VA, USA).

Results

The HHS and RIM QOL increased ($p < 0.001$) from before to after THA in both cohorts. In the study cohort the mean HHS increased from 60.2 ± 6.7 at the time of conversion to 83.3 ± 13.0 at the 2000 followup, and in the PTHA cohort, the mean HHS increased from 62.0 ± 6.3 at the time of conversion to 80.9 ± 13.2 at the 2000 followup. There was no difference ($p = 0.14$) in this increase after THA between the cohorts nor the increase ($p = 0.92$) of RIM QOL after THA between cohorts. There were no differences in the HHS, RIM QOL, OHS, and SF-36 subscales scores between cohorts in either 2000 or 2010, except for a higher ($p = 0.02$) Role Physical score in the study cohort than in the PTHA cohort at the 2000 followup and higher ($p = 0.03$ in 2000 and $p = 0.003$ in 2010) Role Emotional and MCS scores in the study cohort than in the PTHA cohort at both followups (Table 4).

Scores diminished somewhat overall in both groups from 2000 to 2010. However, in the study cohort this reduction was not significant for HHS ($p = 0.06$), RIM QOL ($p = 0.31$) and OHS ($p = 0.2$) between 2000 and 2010. In the PTHA cohort, the HHS and RIM QOL scores decreased ($p = 0.02$ and $p = 0.001$, respectively) between 2000 and 2010. In the SF-36, the General Health score decreased ($p = 0.03$) between 2000 and 2010, as did the Vitality ($p = 0.02$), Social Function ($p < 0.001$), Role Emotional ($p = 0.01$), and the PCS scores ($p < 0.001$). In this group the OHS increased ($p = 0.01$) between 2000 and 2010.

In 2010, 43 patients had no pain related to the converted hip. Twenty-five of 30 patients (86%) experienced complete or nearly complete relief (83%) of knee pain and 24 of 28 (86%) had complete or nearly complete relief of back pain. Five patients required an ipsilateral TKA from 17 to 69 months after conversion. No surgery has been needed for back or contralateral hip pain. The mean LLD was 1.3 cm (range, 0.8–2 cm) after conversion surgery. Strength of the abductor muscle was graded as 4 in 30 patients, 3 in 11, 2 in five, and 1 in two using the standard scale for manual muscle-testing (from 0 to 5 points) after conversion, and 5 in 10 patients, 4 in 23, 3 in sixteen, and 2 in one after PTHA. Strength of the abductor muscle was greater ($p = 0.002$) in the PTHA cohort than in the study cohort. Eighteen patients (37%) in the study cohort and 21 (42%) in the PTHA cohort had a positive Trendelenburg sign. There was no difference ($p = 0.64$) in positive Trendelenburg sign between patients of the study and PTHA cohorts. Twenty patients (42%) in the study cohort and 23 (46%) in the PTHA cohort walked with a totally normal gait, 10 patients (21%) in the study cohort and 12 (24%) in the PTHA cohort had a limp but were able to walk without aids, 11 (23%) in the study cohort and seven (14%) in the PTHA cohort had a moderate limp and needed a cane to walk long distances, four (8%) in the study cohort and six (12%) in the PTHA cohort had a marked limp and used a cane often, and three (6%) in the study cohort and two (4%) in the PTHA cohort had a severe limp and always used a cane. There were no differences in limp ($p = 0.66$) or use of ambulatory aids ($p = 0.6$) between the two cohorts.

Ten minor complications occurred in patients in the study cohort: peroneal nerve palsy that fully resolved in one, phlebitis in one, detachment of the greater trochanter in one, painful trochanteric wires in two, and Brooker Classes I to III heterotopic calcifications without functional limitations in five. In the PTHA cohort there were six minor complications: postoperative respiratory distress in one, phlebitis in three, superficial infection in one, and Brooker Class II heterotopic calcification without limitation of mobility in one. Two patients in the study cohort and none in the PTHA cohort experienced an infection. Three cases of aseptic loosening of two cemented and one noncemented acetabular component occurred in the study cohort, and five cases involving two cemented and one noncemented acetabular component and two cemented femoral stems occurred in the PTHA cohort. Four patients in the study cohort and three in the PTHA cohort showed wear greater than 0.2 mm per year, and two and four patients, respectively, showed wear and osteolytic lesions. No patients in the study cohort and one in the PTHA cohort experienced a dislocation. The overall rate of complications was 21 in the study cohort and 19 in the PTHA cohort, with no difference ($p = 0.56$) between cohorts.

Table 4. Comparison of outcomes between the study and primary THA cohorts at 2000 and 2010 followups

Scoring parameter	Study cohort (1)			Primary THA cohort (2)			p Value (1 vs 2)	
	January 2000	January 2010	p Value	January 2000	January 2010	p Value	2000	2010
HHS (0–100 worst to best)[*,†]	83.3 ± 13.0	80.9 ± 13.2	0.06[‖]	81.1 ± 13.9	79.4 ± 15.4	0.02[‖]	0.47[¶]	0.92[¶]
	89.5 (43–98)	85.5 (43–96)		85 (50–97)	85.5 (40–97)			
RIM QOL[‡]	0.986 (0.039)	0.986 (0.044)	0.31[‖]	0.986 (0.039)	0.971 (0.03)	0.001[‖]	0.95[¶]	0.8[¶]
OHS (12–60 least to most difficulties)[*,†]	21.4 ± 9.3	22.9 ± 9.4	0.2[‖]	22.9 ± 9.1	24.4 ± 10.4	0.01[‖]	0.37[¶]	0.54[¶]
	19 (12–51)	20 (12–52)		20.5 (12–47)	22 (12–52)			
SF-36 scores (0–100 worst to best)[*,†]								
Physical Function	69.8 ± 24.1	63.1 ± 20.7	0.002[‖]	65.3 ± 26.6	63.8 ± 26.3	0.07[‖]	0.63[¶]	0.5[¶]
	75 (10–100)	65 (10–90)		70 (20–100)	70 (15–95)			
Role Physical	64.7 ± 27.0	54.3 ± 23.1	0.004[‖]	50.7 ± 28.3	49.2 ± 30.3	0.51[‖]	0.02[¶]	0.53[¶]
	75 (0–100)	50 (0–100)		50 (0–100)	50 (0–100)			
Bodily Pain	54.7 ± 19.8	53.8 ± 20.5	1[‖]	63.8 ± 32.9	57.1 ± 27.4	0.0009[‖]	0.08[¶]	0.23[¶]
	62 (12–74)	62 (0–74)		65.5 (0–100)	65.5 (0–100)			
General Health	68.9 ± 28.5	63.9 ± 28.0	0.04[‖]	66.2 ± 29.4	64.6 ± 29.3	0.03[‖]	0.49[¶]	0.81[¶]
	82 (5–100)	77 (0–97)		79.5 (0–97)	77 (0–97)			
Vitality	59.7 ± 16.5	58.64 ± 17.2	0.48[‖]	57.5 ± 14.7	56.2 ± 13.6	0.02[‖]	0.3[¶]	0.18[¶]
	65 (20–80)	62.5 (20–80)		60 (20–75)	60 (20–75)			
Social Function	61.7 ± 28.1	59.6 ± 26.8	0.66[‖]	57.8 ± 34.4	51.3 ± 29.8	0.0001[‖]	0.79[¶]	0.23[¶]
	75 (0–100)	75 (0–100)		62.5 (0–100)	50 (0–100)			
Role Emotional	82.5 ± 24.7	80.5 ± 26.4	0.5[‖]	66.9 ± 35.7	62.3 ± 33.1	0.01[‖]	0.03[¶]	0.003[¶]
	100 (0–100)	100 (0–100)		66.7 (0–100)	66.7 (0–100)			
Mental Health	78.5 ± 19.9	77.3 ± 21.2	0.72[‖]	73.9 ± 21.3	73.1 ± 21.2	0.057[‖]	0.12[¶]	0.09[¶]
	90 (24–96)	90 (24–96)		84 (24–100)	84 (20–96)			
PCS	41.9 ± 9.7	39.8 ± 8.4	0.004[‖]	42.3 ± 11.2	40.8 ± 10.9	0.0001[‖]	0.58[¶]	0.31[¶]
	46.3 (20.4–54.5)	38.9 (20.4–52.3)		44.9 (20.9–57.7)	42.5 (18.8–56.1)			
MCS	51.3 ± 9.0	51.5 ± 9.9	0.06[‖]	47.8 ± 10.3	46.6 ± 9.7	0.057[‖]	0.01[¶]	0.001[¶]
	55.6 (25.7–60.3)	56.9 (25.2–60.7)		52.1 (27.9–60.2)	51.9 (27.9–57.2)			
Patients satisfied (number of patients)								
Very satisfied		28 (58%)			28 (56%)			
Satisfied		11 (23%)			14 (28%)			
Uncertain		3 (6%)			1 (2%)			
Unsatisfied		6 (12%)			7 (14%)			0.7[§]
Revision (number of patients)	4 (8%)	11 (23%)		3 (6%)	13 (26%)			0.72[§]
Infection	1	2		0	0			
Aseptic loosening	2	3		3	5			
Wear	0	4		0	3			
Wear and osteolysis	1	2		0	4			
Recurrent dislocation	0	0		0	1			

* Values are expressed as mean ± SD; [†]values are expressed as median, with range in parentheses; [‡]values are expressed as median, with interquartile range in parentheses; [§]crosstabulation; [‖]Wilcoxon signed-rank test; [¶]Mann-Whitney test; VAS = visual analog scale; PCS = Physical Component Summary; MCS = Mental Component Summary; OHS = Oxford Hip Score; HHS = Harris hip score; RIM = Rosser Index Matrix; QOL = quality of life.

The revision rate was 23% in the study cohort and 26% in the PTHA cohort, with no difference (p = 0.72) between cohorts.

Thirty-seven arthroplasties remained unrevised in our two cohorts in 2010. Survivorship analysis of THA in the study cohort predicted a probability of survival of 93% at

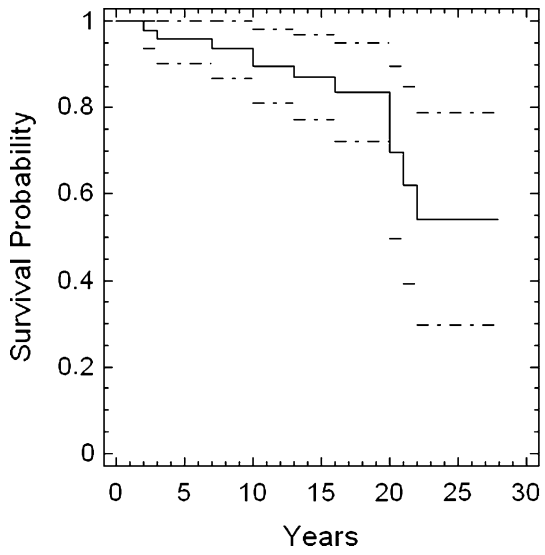

Fig. 2 A Kaplan-Meier survival curve of the study cohort shows a probability of survival of 93% at 10 years, 83% at 20 years, and 52% at 30 years. Confidence intervals are represented as the dashed lines.

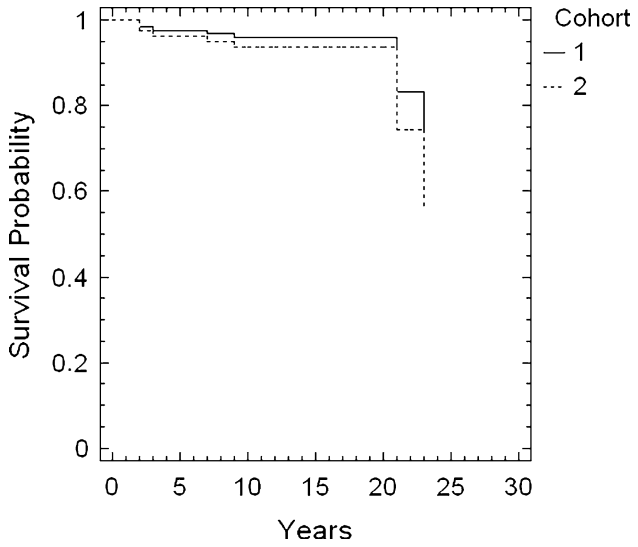

Fig. 3 In a comparison of survival probabilities between cohorts, no difference (p = 0.26) was found using Cox proportional hazards analysis. Cohort 1 = study cohort; Cohort 2 = control cohort.

10 years, 83% at 20 years, and 52% at 30 years (Fig. 2). In the PTHA cohort the probability of survival was 96% at 10 years, 70% at 20 years, and 39% at 30 years. Comparison of survival between cohorts (Fig. 3) did not show a difference (p = 0.25).

There was no difference (p = 0.7) in patient satisfaction between the study cohort and the PTHA cohort. In the study cohort, 28 patients were very satisfied, 11 were satisfied, three were uncertain, and six were unsatisfied. In the PTHA cohort, these figures were 28, 14, one, and seven patients, respectively.

Discussion

Between 10% and 21% [12, 63, 64, 70] of patients with fused hips eventually request conversion to a THA, unwilling to accept the functional effects of ankylosis in daily living and the associated symptoms attributable to progressive deterioration of the neighboring joints. However, some authors believe that function, range of mobility, muscle strength, persistence of limp, and need for assistive walking aids are less satisfactory after conversion of a fused hip to a THA compared with a conventional PTHA [40, 52, 53, 55, 57, 62, 69], with a rate of major complications ranging from 15% to 54% [40, 53, 55, 57, 62, 65, 73, 74]. However, some consider it a satisfactory procedure [30, 36, 54, 62], achieving similar improvement of symptoms, success rate, patient satisfaction, and survivorship as a PTHA [4, 40, 49]. To address this controversy, we compared THA after hip arthrodesis and PTHA to determine whether these procedures would produce similar (1) functional results, (2) maintenance of scores, (3) complications and failures, (4) survivorship of the arthroplasty, and (5) patient satisfaction.

We note some limitations. First, data gathered before 2000 were obtained by retrospective review of data existing in the medical records at that time. SF-36 and OHS scores previous to THA were not available because these questionnaires were not used in this study before 2000. However, all followup data relevant to the study were collected prospectively and there were no missing data. Second is the possibility of reporting bias. Although patients were reassured regarding confidentiality of their answers, it is possible they were inclined to report more favorable scores during the interview [43, 52]. It also is possible patients lost to followup were dissatisfied with the outcome of their THA and therefore discontinued care at our institutions. These factors would bias the scores upward but would not necessarily influence the relationship between the parameters studied. Third, translation of existing HHS data into Rosser categories could be a source of error and subjectivity [15]. Finally, the relatively small size of the cohorts might limit the ability to draw meaningful conclusions. However, samples of patients with fused hips are scarce. Only Joshi et al. [36] and Sirikonda et al. [65] have reported more patients than in our study (Table 5). We used clinical rating systems with high responsiveness and effect size [17, 33, 51]. Strict patient matching, achieving no differences in demographic and perioperative clinical data between the two cohorts, exact adherence to the study protocol, length of followup, and the combination of a surgeon-administered hip-specific score measuring hip function and a patient self-administered health-related QOL survey enhance the validity of data [43]. Richards and Duncan [57] used only

Table 5. Literature summary on conversion of hip ankylosis to THA

Study (year)	Number of patients/hips	Years fusion-THA*	Age at conversion (years)*	Followup THA (years)*	HHS before and after conversion*	Number (% THA) of minor/major complications	Survival rate (95% CI)	% of patients satisfied
Kilgus et al. [40] (1990)	38/41	28.2	53 (24–75)	7 (2–16)	UCLA hip-rating score	9 (22%)/ 10 (24%)	96% at 13 years	87
Reikerås et al. [55] (1995)	46/46	17 (7–28)	58 (33–75)	8 (5–13)	69 (51–83)/ 78 (53–93)	not reported/ 7 (15%)	7 revisions	85
Rittmeister et al. [58] (2000)	13/13	29 (14–56)	60 (29–86)	3 (0.7–7)	55 (23–82)/ 87 (75–96)	not reported		
Schäfer et al. [62] (2000)	15	31 (2–61)		5 (2–13)	not reported/ 86 (70–99)	1 (7%)/ 5 (33%)	4 revisions	100
Hamadouche et al. [29] (2000)	45/45	36 (3–65)	56 (28–80)	8 (5–21)	Merle d'Aubigné score	not reported/ 5 (11%)	91% (78.6%–100%) at 10 years	91
Joshi et al. [36] (2002)	187/208	27 (10–69)	51 (20–80)	9 (2–26)	Merle d'Aubigné score	16 (8%)/ 20 (10%)	96% (91.5%–98.2%) at 10 years 90% (85.3%–96.1%) at 15 years 73% (36%–90.6%) at 26 years	100
Schuh et al. [64] (2005)	34	30 (5–66)	57 (32–74)	6.4 (2–17)	not reported/ 84 (69–100)	2 (6%)/ 8 (24%)	4 revisions	
Lustig et al. [45] (2007)	17/17	36 (7–59)	53 (32–74)	6 (2–15)	Merle d'Aubigné score	3 (18%)/ 6 (35%)		80
Morsi [49] 2007	18/19	21 (5–41)	51 (38–62)	7 (5–9)	54 (19–76)/ 93 (81–98)	not reported/ 1 (5%)	1 revision	
van Biezen et al. [74] (2007)	10	15 (2–50)	45 (21–62)	5 (0–18)	not reported/ 75 (45–99)	5 (50%)/ 5 (50%)		90
Sirikonda et al. [65] (2008)	67/68	32 (12–54)	49 (24–74)	18 (13–27)	Merle d'Aubigné score	1 (1.5%)/ 11 (16%)	93% (92.7%–100%) at 18 years	100
Peterson et al. [53] (2009)	30/30	32 (1–42)	52 (27–70)	10 (2–20)	Mayo Clinic hip score	not reported/ 7 (23%)	86% (80%–100%) at 5 years 75% (59%– 95%) at 10 years	
Rajaratnam et al. [54] (2009)	15/16	36 (3–65)	52 (16–75)	10 (5–19)	70 (SD 3.4) 83 (SD 4.4)	3 (18%) 1 (6%)		

Table 5. continued

Study (year)	Number of patients/hips	Years fusion-THA*	Age at conversion (years)*	Followup THA (years)*	HHS before and after conversion*	Number (% THA) of minor/major complications	Survival rate (95% CI)	% of patients satisfied
Richards and Duncan [57] (2010)	26/26	20 (18–28)	49 (25–74)	9 (2–21)	OHS, SF-36, WOMAC, UCLA scores	not reported/ 14 (54%)	74% (55.4%–93%) at 10 years	75
Current study (2010)	48/48	26 (3–47)	52 (31–68)	17 (10–29)	60 (47–78)/ 85 (43–96)	10 (20%)/ 11 (23%)	93% (87.3%–100%) at 10 years 83% (60%–95.1%) at 20 years 52% (29.8%–79.1%) at 30 years	81

* Values are expressed as mean, with range in parentheses; SD = standard deviation; 95% CI = 95% confidence interval.

self-administered QOL outcome questionnaires in their study, but we think the combination of a surgeon-administered hip-specific score (HHS) measuring hip function, and a patient self-administered health-related QOL survey allows for a more global assessment of patients [43].

Our data confirm that of other studies [29, 36, 40, 49, 54, 58, 65] documenting improved function and QOL after conversion and similar to the improvements after a PTHA (Table 5). The HHSs achieved by our patients after conversion were similar to those reported in other studies [53, 58, 62] and, although lower than those for the PTHA for the general population [37, 42], they were comparable or better than those obtained in other particular populations such as young patients, patients with high demands, or patients with an important handicap secondary to multivariate hip disorders or polyarticular impairment [43, 56]. The change in HHS after THA was greater in our series than in other studies [54, 55]. We further observed a change in QOL from before THA to after THA. The magnitude of change of QOL achieved after conversion in our study cohort was halfway between the values obtained by Robinson et al. [60] after PTHA and after revision THA. In our study cohort, after conversion surgery scores in physical domains were higher than those reported by Richards and Duncan [57] and van Biezen et al. [74]. We found similar PCSs and MCSs after conversion to those after PTHA in our control group and those reported in the literature [5, 39, 43, 71].

Functional outcomes and QOL of patients varied in our study with time. We observed an improvement in scores for some patients. This may be attributable to the long period needed to achieve a definitive result, estimated as at least 2 years and often 5 years or more [29, 49]. Nevertheless, the tendency was for an overall decrease in scores between 2000 and 2010 but a smaller decrease than that for the PTHA cohort and without significant differences for HHS, RIM QOL, and OHS in the study cohort. The decline of most functional and health-related QOL scores with time after THA has been recognized as attributable more to the change in patient's age and/or medical condition than to any factor related to the hip arthroplasty [8, 43, 50].

The complication and failure rates for our study cohort were similar to those for the PTHA cohort and to those reported for conversion [40, 53, 64]. However, our rates were lower than some reported rates for this type of procedure [45, 57, 62, 73, 74] or for PTHA in young patients [67].

The revision rate and survival of THA after hip fusion were similar to those reported in other studies of conversion for hip ankylosis [29, 36, 40, 62, 73], better than those reported by Peterson et al. [53] and Richards and Duncan [57], and similar or better than those achieved with PTHA in young or particular populations as mentioned above

[6, 23, 66, 67]. Kilgus et al. [40] reported that young age of patients does not have a negative effect on the survival of the conversion of a fused hip to THA.

We agree with Bourne et al. [7] that the patient's opinion regarding outcome is one of the most important issues. Patient satisfaction has been included in the assessment of THA in many studies [9, 18, 20, 25, 38, 43, 47, 49]. Some authors have compared satisfaction after THA with satisfaction after TKA [7], and others have evaluated satisfaction after total joint replacement, pooling THAs and TKAs [46]. The assessment of these procedures is standardized and may be done in a similar way using generic tools for both procedures [11, 46]. We used the questionnaire proposed by Robertsson and Dunbar [59] because it is short and simple, and validated against the SF-36 and Oxford-12 scores. Patient satisfaction correlates well with the specific and generic health outcome measures, with the highest correlation to the domains related to pain and function [59]. The different levels of patient satisfaction substantially reflect the changes in the mentioned scores [17, 20]. The satisfaction rate and level of satisfaction with conversion were similar between our study cohort and reported rates [36, 45, 55, 57], and with reported rates after PTHA [9, 20, 24, 47, 76]. Patient satisfaction depends on a mixture of different factors and patient expectations [16, 21, 43, 47], and patients in a worse preoperative condition tend to be more satisfied after THA than those in better condition [17, 20, 21, 47]. The most important factors contributing to satisfaction after conversion are reportedly relief of knee or back pain, improvement of function, greater mobility of the hip, and correction of LLD [40]. Pain and walking ability have more influence on satisfaction after PTHA [9, 24] or after revision THA [21, 24, 34]. These parameters showed similar improvements in our two study cohorts after the THA.

Our study confirms conversion of a fused hip to a THA improves hip function and satisfaction similar to that for a PTHA.

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