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Ten to 15-Year Outcomes of Monoblock Uncemented Dual Mobility Cups

Excellent Survival Rate and Outcome in Primary Total Hip Arthroplasty

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Background: Dual mobility cups (DMCs) have effectively prevented dislocations after total hip arthroplasty (THA). However, use of these cups in primary THAs remains controversial, especially in young patients. This study aimed to determine the long-term survival rate and functional outcomes of a contemporary DMC used in primary THA.

Methods: This retrospective multicenter study identified a cohort of 614 primary THAs performed with the same uncemented monoblock DMC between 2007 and 2010. Survival analysis included 572 THAs, while clinical analysis involved 394 THAs at a minimal follow-up of 10 years. The mean follow-up was 11.1 ± 1.2 years. The mean age was 71.4 ± 11.7 years, with 4.2% of patients under 50 years old. The mean body mass index was 27.0 ± 5.3 kg/m^2. The 10-year Kaplan-Meier survival rate was calculated based on cup removal for any reason or cup revision for an aseptic reason as the end point. Harris hip scores were collected at the last follow-up.

Results: The cup-revision-free survival rate was 98.6% at 10 years and 96.2% at 13 years. No cup revisions were reported due to aseptic loosening or dislocation. The cup revisions were due to infection (7 of 572; 1.2%), acetabular fracture (1 of 572; 0.17%), and psoas impingement due to cup malpositioning (n = 1 of 572; 0.17%). Only 3 dislocations (0.52%) were observed, and they did not require revision. The mean Harris hip score significantly improved from 54.1 ± 14.4 preoperatively to 88.0 ± 14.3 at the last follow-up ($p < 0.0001$). For patients under 50 years old at the time of surgery, the mean Harris hip score showed significant improvement from 53.0 ± 10.2 preoperatively to 89.7 ± 12.8 at the last follow-up ($p < 0.0001$), with no significant difference compared with the older patients ($p = 0.50$). No revision or complication was reported in the younger patient population at 13 years of follow-up.

Conclusions: The monoblock uncemented DMC demonstrated excellent survival rates with no DMC-specific complications during a minimum 10-year follow-up. The dislocation rate was very low, and a younger age was not identified as a risk factor for failure. Therefore, monoblock cementless DMCs can be safely used, even in primary THA.

Level of Evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

Dislocations represent a major postoperative complication of total hip arthroplasty (THA), with prevalences of 0.2% to 7% in primary THA and 10% to 25% in revision THA[1]. Additionally, the risk of THA dislocation reportedly increases by 1% to 1.39% for every 5 years of implant survival[2]. The dual mobility cup (DMC) was conceived to decrease this risk of dislocation.

The DMC combines 2 fundamental concepts. The large diameter of the polyethylene component, which is the same size as the cup, increases the jump distance and hip stability. Based on Charnley's low-friction arthroplasty concept, the femoral head is small to decrease the risk of wear. DMCs have proven effectiveness in decreasing dislocation risk[3,4]. However, their use in primary THA remains controversial worldwide. Specific complications related to the DMC and its polyethylene wear, such as intraprosthetic dislocation[5] and cup aseptic loosening[6], have been reported. However, these specific complications have become uncommon with the evolution of the design and materials of DMCs, such as surface coating combining hydroxyapatite and

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titanium by plasma projection or highly cross-linked polyethylene[3]. Broader use of the DMC, including for younger patients, is becoming increasingly frequent, with satisfying outcomes[7]. Nevertheless, most studies have reported results for patients with high-risk factors for dislocations, such as femoral neck fracture or THA revision[3,4,7]. Few have assessed the long-term results and survival of the last generation of DMC in a population with elective primary THAs[8,9].

The aims of this study were to report the long-term survival rate and functional outcomes of a contemporary DMC used in primary THA and to compare the survival rate and outcomes in a younger patient population (<50 years old) with those in an older population (≥50 years old).

Material and Methods

All procedures were performed in accordance with the ethical standards of the institutional and/or national research committee, the 1964 Helsinki Declaration and its later amendments, or comparable ethical standards. Data collection and analysis were carried out in accordance with MR004 Reference Methodology from the Commission Nationale de l'informatique et des Libertés (Ref. 2229975V0) obtained on May 6, 2023. The study was registered and filed on the Health Data Hub website.

Patients

This retrospective multicenter study included all primary THAs performed using the same uncemented contemporary monoblock DMC (Novae Sunfit; Serf) between 2007 and 2010 in 4 orthopaedic departments. The exclusion criteria were femoral neck fracture, revision THA, and follow-up of <10 years. The indications for use of a DMC were an age older than 70 years or a high risk of dislocation (such as due to epilepsy, Parkinson disease, extensive arthrolysis, previous surgery for an acetabular fracture, spinal fusion, or a body mass index [BMI] of >35 kg/m^2). Of the 614 patients meeting these criteria, 42 were lost to follow-up before 10 years. One hundred and seventy-eight patients died with their original implant in place and without dislocation before 10 years of follow-up. Survival analysis included 572 THAs, while clinical analysis involved 394 THAs at a minimal follow-up of 10 years (Fig. 1).

The mean follow-up (and standard deviation) was 11.1 ± 1.2 years (range, 10 to 15.3 years), with 99 THAs (17%) followed for at least 13 years. The mean age was 71.4 ± 11.7 years (range, 21 to 108 years), with 4.2% (24) of the patients under 50 years old at the time of surgery. The mean BMI was 27.0 ± 5.3 kg/m^2 (range, 13.8 to 48.4 kg/m^2) (Table I). The etiology was mainly primary hip osteoarthritis (86.4%) (Table I).

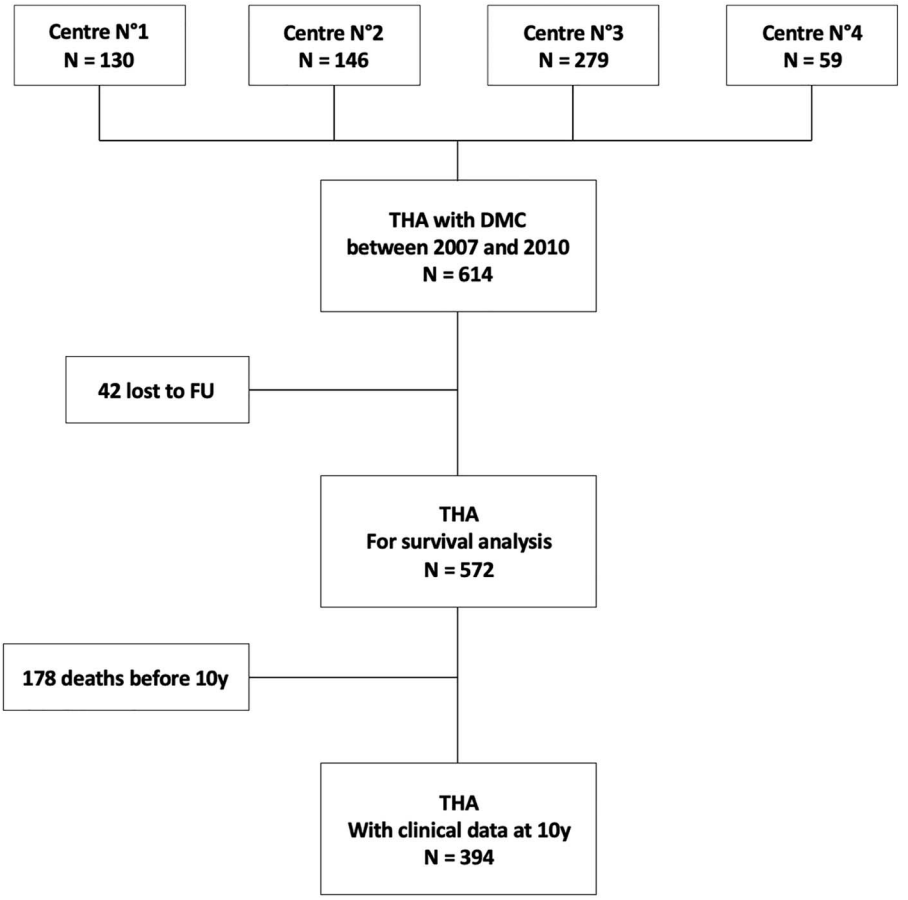

Fig. 1
Flowchart of study enrollment and follow-up (FU).

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Implants and Surgery

The patients were operated on in 4 orthopaedic departments specializing in hip surgery. All patients had a posterolateral approach. The same uncemented contemporary monoblock DMC (Novae Sunfit) was used for all of the patients. It is made of X18M25W (ISO5832-1) stainless steel with a dual coating of titanium spray (thickness, 150 ± 30 μm) and hydroxyapatite (thickness, 70 ± 20 μm). The polyethylene liner is 5/8 of a sphere and features a narrowed section where the head is secured using a bearing press.

The prosthetic head had a diameter of 28 mm for 466 patients (81.4%) and 22.2 mm for 106 patients (18.5%).

Data Assessment

The preoperative data were collected retrospectively from the patients' files. At the last follow-up, patients were assessed by telephone or during a physical consultation by an independent observer who recorded complications, additional interventions, the Harris hip score (HHS), and the Oxford Hip Score. If the patient was deceased, their trusted support person was contacted to confirm the date of death and if the patient had died with the original cup in place.

Statistical Analysis

All statistical analyses was performed using XLSTAT (2021; Addinsoft). Continuous variables were described using means, standard deviations, and ranges. Categorical variables were described using counts and percentages. Categorical outcomes were compared using the Fisher exact test and the chi-square test. Normally distributed continuous variables were compared using the Student t test. For non-normally distributed continuous variables, the Mann-Whitney test was used. The significance threshold was set at 5%. The Kaplan-Meier method was used to estimate the survival rate and 95% confidence interval (CI) at 10 and 13 years with cup revision for any reason and cup revision for aseptic reasons as the end points.

Results

The cup-revision-free survival rate with cup revision for any reason as the end point was 98.6% at 10 years and 96.2% at 13 years (Fig. 2-A). The cup-revision-free survival rate with cup revision for an aseptic reason as the end point was 100% at 10 years and 99.1% at 13 years (Fig. 2-B). No cup revisions were

TABLE I Demographic Data and Preoperative Characteristics*

	Entire Cohort (N = 572)	Cohort for Clinical Data (N = 394)	≥50 Years Old (N = 548/370†)	<50 Years Old (N = 24)	P Value
Age (mean ± SD [min.; max.]) *(yr)*	71.4 ± 11.7 [21; 108]	69.6 ± 11.8 [21; 108]	73.0 ± 9.3 [52; 108]	41.2 ± 8.5 [21; 50]	NA
BMI (mean ± SD [min.; max.]) *(kg/m²)*	27.0 ± 5.3 [13.8; 48.4]	27.0 ± 4.7 [17.6; 45.4]	27.0 ± 5.3 [13.8; 48.4]	25.9 ± 4.1 [19.4; 32.8]	0.467
Male sex *(no. [%])*	250 (43.7%)	164 (41.6%)	235 (42.9%)	15 (62.5%)	0.092
Etiology *(no. [%])*					**<0.0001**
Primary osteoarthritis	494 (86.4%)	339 (86.0%)	483 (88.1%)	11 (45.8%)	
Osteonecrosis	51 (8.9%)	34 (8.6%)	46 (8.4%)	5 (20.8%)	
Posttraumatic osteoarthritis	13 (2.3%)	7 (1.8%)	11 (2.0%)	2 (8.3%)	
DDH	14 (2.4%)	14 (3.6%)	8 (1.5%)	6 (25%)	
ASA grade *(no. [%])*					**<0.0001**
1	99 (17.3%)	92 (23.4%)	90 (16.4%)	9 (37.5%)	
2	280 (49.0%)	219 (55.6%)	266 (48.5%)	14 (58.3%)	
3	172 (30.1%)	80 (20.3%)	171 (31.2%)	1 (4.2%)	
4	21 (3.7%)	3 (0.76%)	21 (3.8%)	0	
Preop. Harris hip score (mean ± SD [min.; max.])	54.1 ± 14.4 [4; 97]	55.2 ± 14.6 [4; 97]	54.1 ± 14.6 [4; 97]	53.0 ± 10.2 [30; 69]	0.639
Posterolateral approach *(no. [%])*	572 (100%)	394 (100%)	548 (100%)	24 (100%)	1
Head size *(no. [%])*					
22.2 mm	106 (18.5%)	59 (15.0%)	102 (18.6%)	4 (16.7%)	1
28 mm	466 (81.4%)	335 (85.0%)	446 (81.4%)	20 (83.3%)	

*SD = standard deviation, min. = minimum, max. = maximum, DDH = developmental hip dysplasia, NA = not appropriate, ASA = American Society of Anesthesiologists. †N values for entire cohort/cohort for clinical data.

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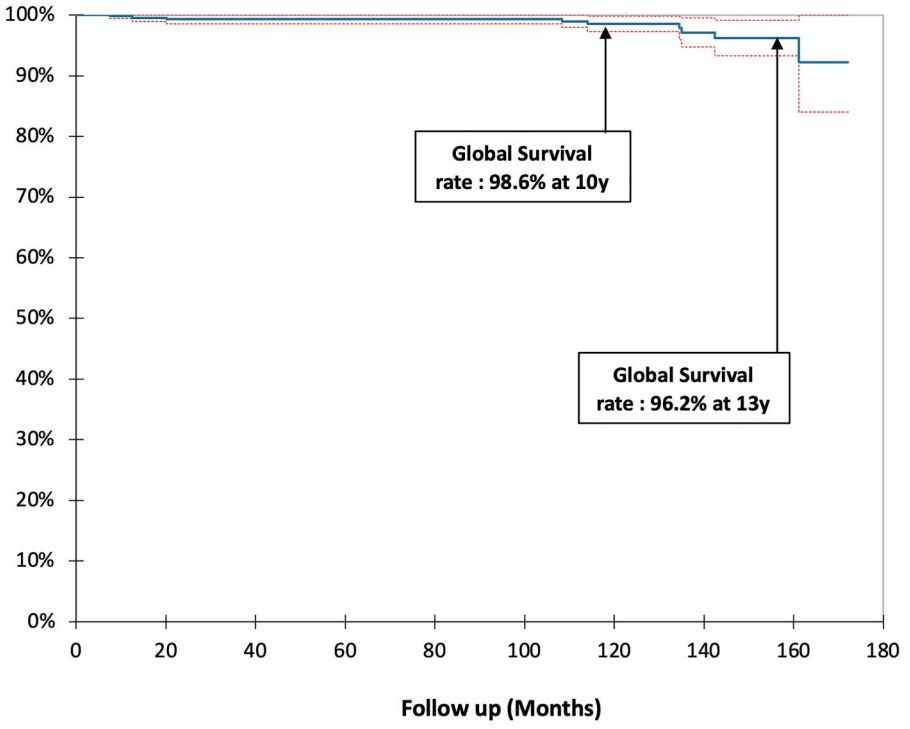

Fig. 2-A

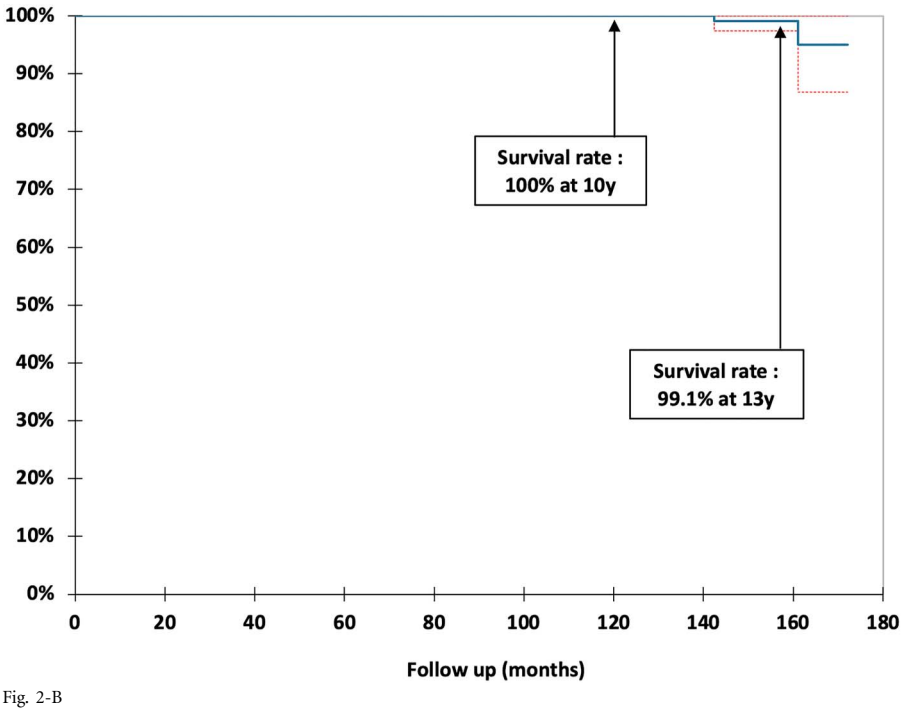

Fig. 2-B

Fig. 2-A Kaplan-Meier survival curve (and 95% CI) with cup revision for any reason as the end point in the entire cohort. **Fig. 2-B** Kaplan-Meier survival curve (and 95% CI) with cup revision for aseptic reasons as the end point in the entire cohort.

reported due to aseptic loosening or dislocation. The cup revisions were due to infection (7 of 572; 1.2%), acetabular fracture (1 of 572; 0.17%), and psoas impingement due to malpositioning (1 of 572; 0.17%) (Table II). Only 3 dislocations (0.52%) were observed, and they did not require revision.

The cup-revision-free survival rate was 100% in the younger patient population at 10 and 13 years, without significant differences compared with the older group ($p = 0.62$) (Fig. 3). No revision or complication was reported in the younger patient population at 13 years of follow-up. There was

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TABLE II Functional Outcomes, Complications, Revisions, and Survival Rate at the Last Follow-up*

	Entire Cohort (N = 572/394†)	≥50 Years Old (N = 548/370†)	<50 Years Old (N = 24)	P Value
Follow-up (mean ± SD [min.; max.]) *(mo)*	133.7 ± 14.9 [120; 184]	133.8 ± 14.5 [120; 184]	132.2 ± 12.8 [120; 172]	0.714
Postop. Harris hip score (mean ± SD [min.; max.])	88.0 ± 14.3 [9; 100]	87.9 ± 14.4 [9; 100]	89.7 ± 12.8 [54; 100]	0.503
Postop Oxford hip score (mean ± SD [min.; max.])	22.5 ± 13.2 [0; 50]	22.6 ± 13.1 [0; 50]	23.9 ± 13.6 [12; 48]	0.812
Acetabular revision *(no. [%])*	9 (1.6%)	8 (1.5%)	1 (4.2%)	0.322
Infection	7 (1.2%)	7 (1.3%)	0	
Acetabular fracture	1 (0.17%)	1 (0.18%)	0	
Malpositioning	1 (0.17%)	0	1 (4.2%)	
Complications *(no. [%])*	25 (4.4%)	24 (4.4%)	1 (4.2%)	1
Infection	7 (1.2%)	7 (1.3%)	0	
Dislocation	3 (0.52%)	3 (0.55%)	0	
Sciatic nerve injury	1 (0.17%)	1 (0.18%)	0	
Psoas impingement	5 (0.87%)	4 (0.73%)	1 (4.2%)	
Femoral loosening	2 (0.35%)	2 (0.36%)	0	
Femoral fracture	7 (1.2%)	7 (1.3%)	0	
Cup survival rate *(%)*				0.615
At 10 yr	98.6%	98.5%	100%	
At 13 yr	96.2%	96.1%	100%	

*SD = standard deviation, min. = minimum, max. = maximum. †N values for entire cohort/cohort for clinical data.

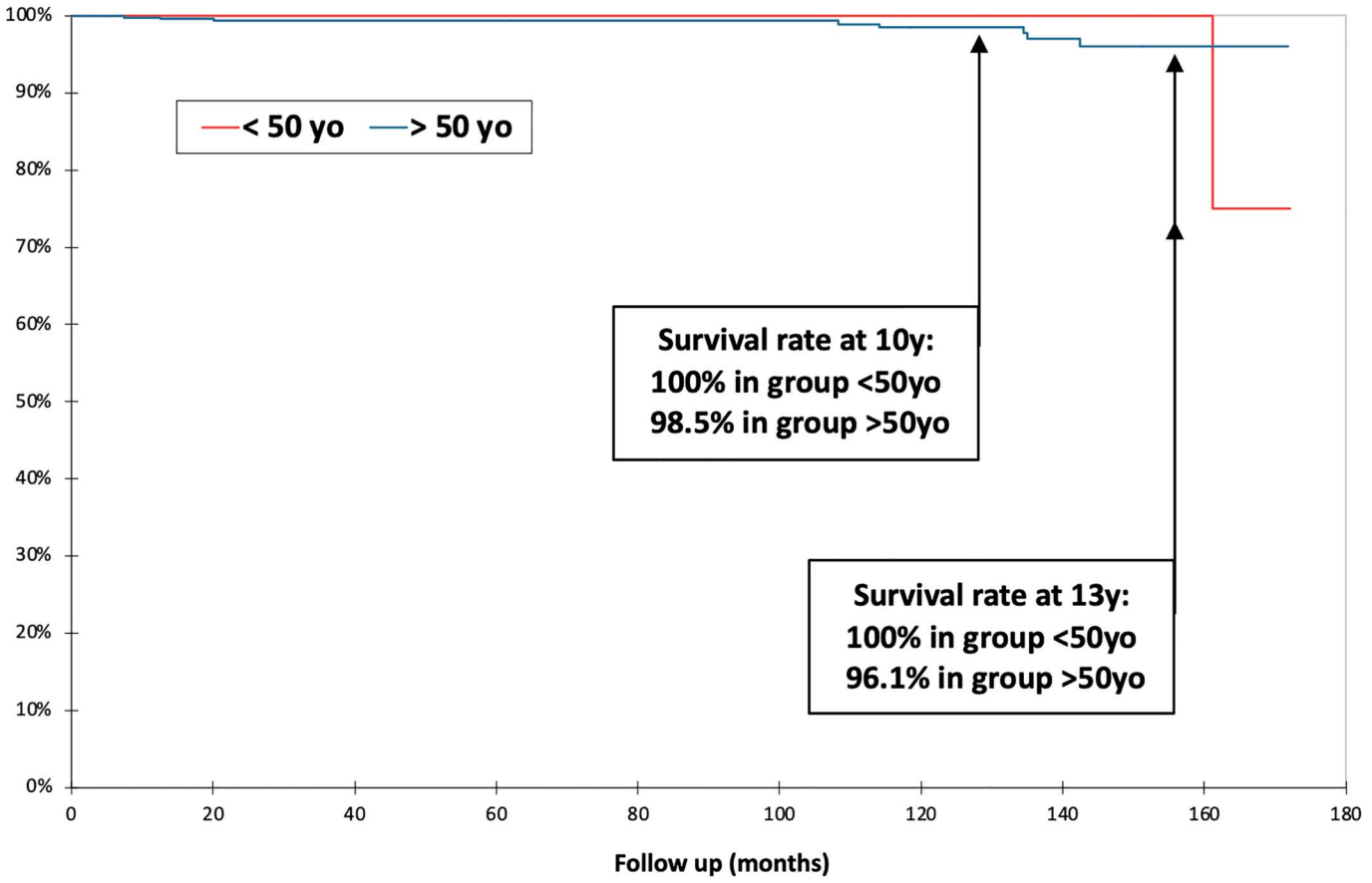

Fig. 3

Kaplan-Meier survival curve (and 95% CI) with cup revision for any reason as the end point in the younger patient population compared with the older population.

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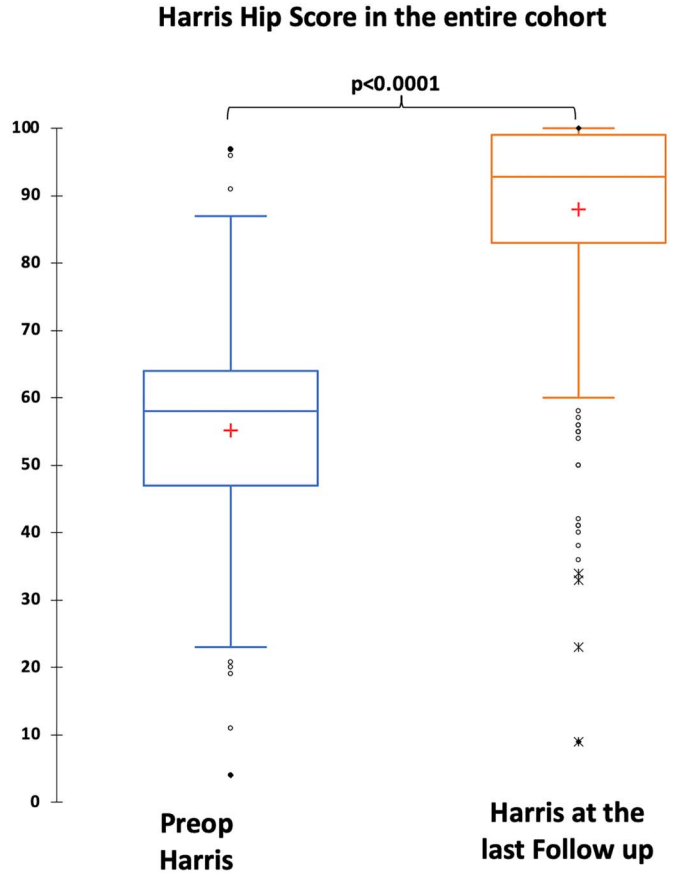

Fig. 4-A

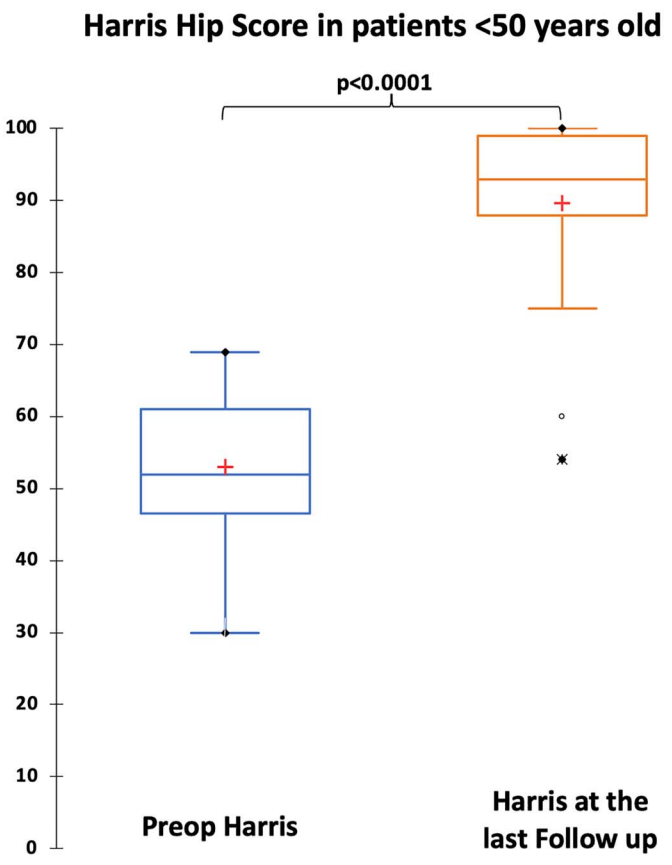

Fig. 4-B

Figs. 4-A and 4-B Harris hip score preoperatively and at the last follow-up in the entire cohort (**Fig. 4-B**) and the younger group (**Fig. 4-B**). The interquartile range (IQR) is indicated by a box. A line within the box indicates the median. A red cross indicates the mean. The whiskers extend 1.5 times the IQR from the top and bottom of the box. If the data do not extend to the end of the whiskers, then the whiskers extend to the minimum and maximum data values. Black dots indicate the outliers.

1 cup revision in the younger group at 161 months postoperatively due to cup malpositioning with psoas impingement.

The mean HHS significantly improved from 54.1 ± 14.4 preoperatively to 88.0 ± 14.3 at the last follow-up ($p < 0.0001$) (Fig. 4-A). The mean Oxford hip score at the last follow-up was 22.5 ± 13.2. For patients under 50 years old at the surgery, the mean HHS showed significant improvement from 53.0 ± 10.2 preoperatively to 89.7 ± 12.8 at the last follow-up ($p < 0.0001$) (Fig. 4-B), with no significant difference compared with older patients ($p = 0.50$). The mean Oxford hip score in the younger patients was 23.9 ± 13.6 at the last follow-up, without a significant difference compared with older patients ($p = 0.81$).

Discussion

The main finding of this study was the high 10 and 13-year survival rates of an uncemented monoblock DMC used in elective primary THA, without revision for aseptic loosening or dislocation, even in a young population.

Most studies of uncemented monoblock DMCs reported the long-term survival of the first and second generations of these implants. In these studies, the effectiveness of the implants for preventing dislocation was very satisfactory[10]. However, the risks of loosening and liner wear were substantial, particularly for the first generation of DMCs. Philippot et al. described a long-term survival rate of the cup of 94% ± 6% at 20 years, with a 3.8% rate of acetabular loosening[11]. In a study of 205 patients, Boyer et al.[10] reported that 8.3% had aseptic loosening of the cup after 11 years, with a survival rate of 80% at 22 years with cup revision as the end point. These revisions were predominantly in patients younger than 50 years old. The older generations of DMCs had a surface coating of alumina and hydroxyapatite, explaining the lower rate of bone integration of the cup. The "contemporary" DMC demonstrated a higher survival rate in the short and mid-term[12-14]. This current study has demonstrated an excellent cup-revision-free survival rate with revision for aseptic reasons as the end point of 100% at 10 years and 99.1% at 13 years after elective primary THA. These results were similar to the long-term results in recent studies of the last generation of monoblock DMCs, which described a survival rate of ≥98% at 10 years[3,9,15]. There was no aseptic loosening at long-term follow-up in our study, despite use of a monoblock cup design without acetabular screws. These results confirmed the satisfactory bone fixation of uncemented monoblock DMCs with a titanium spray and hydroxyapatite coating. The modular DMC allows the use of acetabular screws,

but they are associated with specific complications such as malseating of the modular dual mobility liner[16] or metallosis[17]. Their use has been predominantly in revision THA.

Young patients have been described as being more at risk for complications and revisions after primary DMC[10]. Nevertheless, recent studies reported satisfactory outcomes and survival in a young population. In an international multicenter study on 321 patients under 55 years of age, the survivorship of uncemented DMCs at 5 years was 99.7%[18]. There were no dislocations and no cases of aseptic loosening. The 2 revisions were for cup impingement. A systematic review of uncemented DMCs in patients under 55 years found a 4.8% rate of revisions due to aseptic loosening at a mean follow-up of 11 years[19]. This rate of aseptic loosening can be explained by the use of the first generation of monoblock DMCs, whose surface coating was not optimal, in some studies. Puch et al., in a prospective case-control study comparing the results of second-generation DMCs between patients <55 and >55 years old, reported no dislocations, no difference in the functional results, and no difference in survival (1.6% and 1.1% rates of cup loosening, respectively, with a cup survival rate of 98.4%) at a mean follow-up of 11 years[20]. The survivorship of "contemporary" DMCs in younger populations has ranged between 99% and 100% at 10 years of follow-up[18,19,21]. Our study reported an excellent survival rate (100% at 13 years) for an uncemented monobloc DMC in a younger population. The indications for the use of uncemented DMCs in young patients are limited to a high risk of dislocation, such as previous acetabular fracture[22], neurologic diseases[23], and obesity[24]. The DMC can also be indicated for patients at risk due to activities such as sailing or rock climbing.

The specific complications that have been associated with the DMC were uncommon in this study. There were no intraprosthetic dislocations in our or any other study on "contemporary" DMCs, thanks to the cross-linked polyethylene[3]. Due to the cylinder-spheric design, some studies described a higher rate of psoas impingement related to an overhang of the cup or the polyethylene[18,25]. Only 1 case of psoas impingement (a rate of <1%) required a revision in our cohort. Correct DMC positioning is crucial to avoid this complication, which remains uncommon in orthopaedic departments that perform a large number of THAs with DMCs[26]. Optimal hip stability is the main aim of DMC use. The rate of dislocations in our cohort was <1% at 10 years, and there were no revisions due to dislocation. Similar results were described in the literature, in which the dislocation rate was <1%[3]. The risk of dislocations was not higher in an active and young population with high expectations, particularly with regard to sporting activities, in either the literature[3] or our study.

THA is known to offer fast recovery and excellent functional outcomes. The DMC does not negatively impact these functional outcomes, as described in the literature[9]. These results were also reported for young and active patients, who usually have higher expectations[9]. Epinette et al. reported a mean total HHS of 93.60 ± 8.48 for patients <55 years old[18]. A systematic review of DMCs in patients younger than 55 found that the mean HHS increased from 50.9 preoperatively to 91.6 after surgery[19].

Our study has several limitations. First, it was retrospective. However, the main aim was to determine the survival and complication rates, data that were easily obtained from clinical files or telephone calls. Second, we did not have clinical data for every patient due to the high death rate. Nevertheless, we obtained data on revision and complications for every deceased patient via their families. Third, we did not obtain radiographs for every patient to analyze the cup positioning and signs of loosening. However, those were not the aims of this study. Finally, the absence of some demographic data (such as ethnicity and race) is a limitation that may affect the study's generalizability.

Conclusions

The uncemented monoblock DMC demonstrated excellent survival rates with no DMC-specific complications during a minimum 10-year follow-up. The dislocation rate was very low, and younger age was not identified as a risk factor for failure. Therefore, this DMC can be safely used, even in primary THA. ■

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