RESEARCH ARTICLE

Early Outcomes of THA using Uncemented Dual-Mobility Cups with Additional Fixation Screws

Authors

Jean-Charles Rollier, MD [a, b], Julien Chouteau, MD, PhD [a, b], Luca Nover, MSc [c], Giuseppe Toro, MD [a], Mo Saffarini, MEng, MBA, FRSM [c], Laurent Jacquot, MD [a, b], Tarik Ait-Si-Selmi, MD [b,d]

Affiliations

[a)] Ramsay Santé, Department of Orthopaedic Surgery, Clinique d'Argonay, Annecy, France
[b)] Artro Group Institute, Annecy le Vieux, France
[c)] ReSurg SA, Nyon, Switzerland
[d)] Ramsay Santé, Hôpital Privé Jean Mermoz, Centre Orthopédique Santy, Lyon, France.

Correspondence

Mo Saffarini, MEng, MBA, FRSM
ReSurg SA
Rue Saint Jean 22
1260 Nyon, SWITERLAND
Email: journals@resurg.eu

Abstract

Background: The use of fixation screws with uncemented cups is controversial particularly for dual mobility (DM) cups where perforation of the articular surface could compromise implant longevity. We aimed to compare outcomes of total hip arthroplasty (THA) using uncemented DM cups with supplementary screw fixation versus simple press-fit fixation.

Methods: From 235 consecutive THAs performed using uncemented DM cups, 203 were fixed by simple press-fit and 32 fixed with additional screws. The Oxford hip score (OHS) and EuroQol 5 Dimensions (EQ-5D) score were available at 3.3±1.1 years. To enable direct comparison, each screw fixation cup was matched to three simple press-fit cups using propensity scores, based on age, sex and bone quality.

Results: The two groups had equivalent age, body mass index, gender distribution, femoral morphology and bone quality. Compared to the press-fit group (n=96), the screw fixation group had more surgical antecedents (p=0.032), higher femoral neck angles (p=0.028), and received slightly larger cups (p=0.036). Revision was required for two (6%) screw fixation cups (only one implant-related) and one (1%) press-fit cup (none implant-related). There were no differences between OHS (19±8 vs 18±7, p=0.682) nor EQ-5D (0.63±0.37, p=0.257).

Conclusions: Revision rates were greater for DM cups fixed with additional screws than for those fixed by simple press-fit, but clinical scores were equivalent. There was only one implant-related revision (acetabular fracture) in the screw fixation group and it is unclear whether this is related to the additional screws or to patient/surgical factors.

Level of evidence: Level IV, retrospective case series.

Keywords: THA; dislocations dual-mobility cup; uncemented; cementless; press-fit; screw fixation.

1. Introduction

Dislocation following total hip arthroplasty (THA) is a matter of concern, particularly in elderly patients, as well as those operated for femoral neck fractures or congenital deformities.[1-3] Dual-mobility (DM) acetabular cups are designed with an advantageous femoral head-to-neck ratio and two articulations to prevent dislocation.[4-7] Uncemented DM cups have proven effective at preventing hip dislocations while granting satisfactory long-term clinical outcomes and survival rates.[8-10]

Uncemented DM cups have a thin metal shell, with porous coating on the outer surface to favour bone ingrowth, and mirror-polished at the inner surface to minimize articular friction against a large-diameter polyethylene (PE) insert, which in-turn assembles with a small-diameter retentive femoral head.[11-13] Unlike conventional cups that serve as a metal-backing for static PE inserts, DM cups have articular surfaces that accommodate mobile PE inserts. Most uncemented DM cups are therefore fixed by simple press-fit within the reamed acetabulum, but some designs can accommodate additional fixation screws for cases with osteoporosis, bone loss or substantial deformities.[14,15]

The use of fixation screws with acetabular cups remains controversial,[16] particularly for DM cups where perforations to accommodate screws within the articular metal shell could compromise PE wear and implant longevity. The purpose of this study was therefore to compare early complication rates and clinical scores of THA with uncemented DM cups using supplementary screw fixation versus simple press-fit fixation. The hypothesis was that supplementary screw fixation does not increase the risks of complications nor compromise clinical scores in patients with equivalent demographics and bone quality.

2. Methods

The authors retrospectively reviewed the records of 235 consecutive THAs performed using uncemented DM cups in 215 patients (20 bilateral) by three surgeons (JC, JCR and LJ) between August 2012 and June 2015, using an uncemented femoral stem (Corail, Depuy, Leeds, UK) and two types of uncemented DM cups: 203 fixed by simple press-fit (Novae SunfitTH, Serf, Décines-Charpieu, France) and 32 fixed with additional screws (Novae EvolutionTH, Serf, Décines-Charpieu, France). The authors implant DM cups systematically in patients aged over 70 years, or in patients under 70 if they had femoral neck fractures, congenital hip dysplasia, neuromuscular deficits or American Society of Anesthesiologists (ASA) score >2. All three surgeons used SunfitTH cups by default and only used EvolutionTH cups where acetabular shape or bone quality were deemed suboptimal during progressive reaming. Two surgeons used the posterior approach while one surgeon used the anterolateral (Watson-Jones) approach.

The clinical and radiographic outcomes were available for all hips at a mean follow-up of 3.3±1.1 years (median 3.1, range 2.0–7.2) as they were part of a previously published study.[17] The outcomes available in the database covered intraoperative and postoperative complications (including

periprosthetic cracks/fractures, intra-prosthetic dislocation, extra-articular dislocation, implant failure), Oxford hip score (OHS),[18] and EuroQol 5 Dimensions (EQ-5D) score.[19]

All outcomes had been collected as part of routine assessment, and patients had given written informed consent for the use of their data and images for research and publication.

Statistical analysis

To render the outcomes of the two types of DM cups directly comparable, a logistic regression model was used to assign propensity scores using age, sex and bone quality (femoral canal bone ratio), to match each screw fixation cup to three simple press-fit cups. A 1:3 optimal matching algorithm was applied to match 'exposed' and 'non-exposed' cases on their corresponding propensity scores and yielded two groups of equivalent age, sex distribution and bone quality (Figure 1).

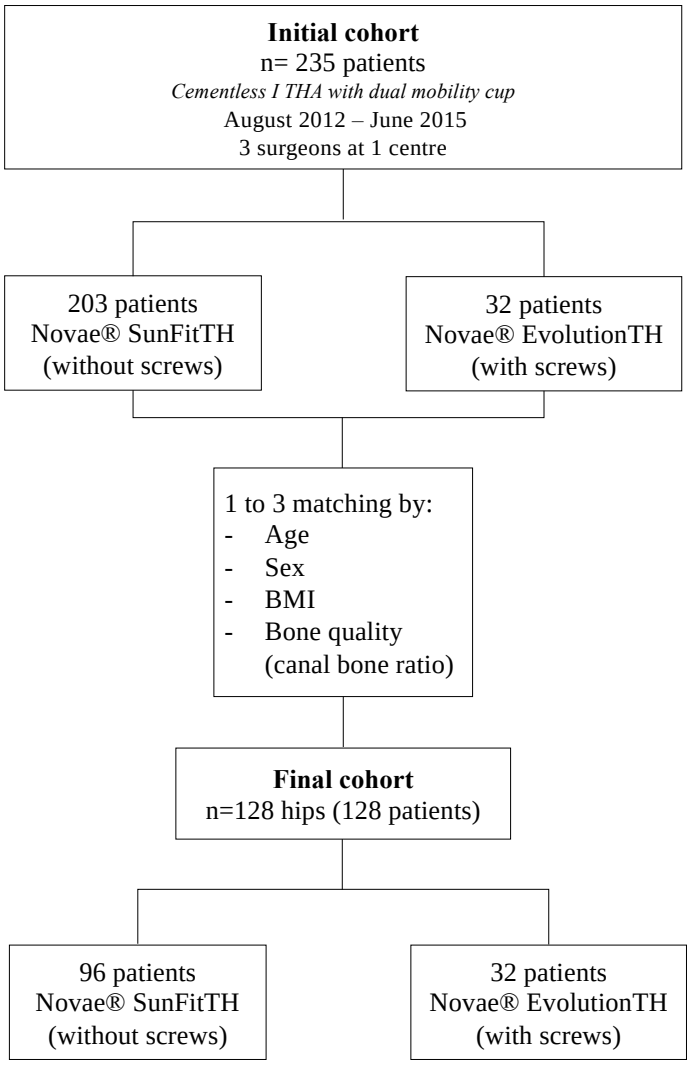

Figure 1: Flowchart of the study cohort

Descriptive analyses were performed for continuous and categorical variables. Shapiro–Wilk tests were used to assess the normality of distributions. For non-Gaussian continuous data, differences between groups were evaluated using Wilcoxon rank-sum tests (Mann–Whitney U test). For categorical data, differences between groups were evaluated using Fisher exact tests. Statistical analyses were performed using R version 3.6.3 (R Foundation for Statistical Computing, Vienna, Austria). P-values <0.05 were considered statistically significant.

3. Results

The propensity matching yielded two groups, the first included the 32 cups fixed with additional screws, and the second included 96 cups fixed by simple press-fit. The two groups were equivalent in terms of age, body mass index (BMI), gender distribution, femoral morphology (canal flare index) and bone quality (canal bone ratio and canal calcar ratio)(Table 1). Compared to the press-fit fixation group, the screw fixation group had more surgical antecedents (53% vs 30%, p=0.032) and higher femoral neck angles (129°±7° vs 126°±6°, p=0.028). The screw fixation group also received acetabular cups of slightly larger diameter (52±3mm vs 51±3mm, p=0.036) and had a greater proportion of hips operated by the posterior approach (84% vs 49%, p<0.001).

Table 1: Baseline data of propensity-matched groups (by age, sex, BMI and canal bone ratio)

	Screw fixation (Evolution, n=32)		**Simple press-fit fixation (Sunfit, n=96)**		
	Mean ±SD N %	(range)	Mean ±SD N %	(range)	*p-value*
Age *(years)*	77 ± 8.3	(53 - 95)	77 ± 5.3	(70 - 88)	*0.832*
BMI	27 ± 6.7	(18 - 42)	27 ± 4.7	(18 - 43)	*0.848*
Women	26 81%		75 78%		*0.806*
Indications					*0.279*
Primary arthritis	22 69%		76 79%		
Secondary arthritis	6[a] 19%		12[b] 13%		
Avascular necrosis	3 9%		8 8%		
Rheumatoid arthritis	1 3%				
Surgical antecedents	17 53%		29 30%		***0.032***
Surgical approach					***<0.001***
Posterior	27 84%		47 49%		
Anterolateral (Watson-Jones)	5 16%		49 51%		
Cup size	52 ± 3.3	(47 - 59)	51 ± 2.9	(45 - 61)	***0.036***
Femoral neck angle	129 ± 7	(117 - 146)	126 ± 6	(114 - 141)	***0.028***
Canal bone ratio	0.47 ± 0.09	(0.33 - 0.78)	0.46 ± 0.07	(0.32 - 0.79)	*0.718*
Canal flare index	3.4 ± 0.87	(1.9 - 5.3)	3.1 ± 0.55	(1.8 - 5.3)	*0.051*
Canal calcar ratio	0.69 ± 0.10	(0.48 - 0.84)	0.69 ± 0.08	(0.52 - 0.90)	*0.998*

[a] 2 acetabular protrusio, 2 arthritis due to congenital dysplasia, and 2 spontaneous destructive arthritis

[b] 5 post-traumatic arthritis, 4 acetabular protrusio, 2 arthritis due to congenital dysplasia, and 1 arthritis due to acetabular cyst

Postoperative complications (Table 2) were noted in three hips (9%) from the screw fixation group, of which two (6%) required revision surgery (due to acetabular fracture at six weeks and to deep sepsis also at five weeks), and in five hips (5%) from the press-fit fixation group, of which only one (1%) required revision surgery (due to deep sepsis at 4 months) and one (1%) required reduction under general anaesthesia (due to dislocation by traumatic fall).

Table 2: Descriptive data of patients who presented complications

Complication	Time *(months)*	Treatment	Age *(yrs)*	Sex	BMI	CBR	OHS	EQ-5D
Screw fixation (Evolution, n=32)								
Pulmonary Embolism	0.1	Hospitalization and medication	73	M	42.2	0.36	20	0.16
Deep Sepsis	1.4	Revision of PE insert	82	M	25.5	0.52	20	0.79
Acetabular fracture	1.5	Revision of acetabular cup	76	F	34.9	0.43	35	0.34
Simple press-fit fixation (Sunfit, n=96)								
Subcutaneous effusion	0.5	Antibiotics	75	F	29.4	0.79	20	0.56
Subcutaneous effusion	0.7	Antibiotics	78	F	22	0.49	35	0.28
Dislocation due to traumatic fall	0.7	Reduction under general anesthesia	70	F	28	0.41	37	0.22
Periprosthetic fracture	4.0	Conservative treatment	71	M	26.7	0.46	12	0.58
Deep sepsis	4.3	Revision of all components	85	M	24.5	0.41	38	-0.24

Abbreviations: BMI, Body Mass Index; CBR, Canal Bone Ratio; OHS, Oxford Hip Score; EQ-5D, EuroQol 5 Dimensions score

The four hips that underwent revision surgery or reduction under general anaesthesia were excluded from further analysis. For the remaining 30 hips fixed with additional screws and the remaining 94 hips fixed by simple press-fit, there were no differences between their clinical scores, neither in terms of the OHS (19±8 vs 18±7, p=0.682) nor the EQ-5D (0.63±0.37, p=0.257) (Table 3).

Table 3: Postoperative outcomes of propensity-matched groups (by age, sex, BMI and canal bone ratio)

	Screw fixation (Evolution, n=30)		Simple press-fit fixation (Sunfit, n=94)		
	Mean ±SD	(range)	Mean ±SD	(range)	*p-value*
Oxford Hip Score	19 ± 8	(12 - 36)	18 ± 7	(12 - 47)	*0.682*
EuroQol 5 Dimensions score	0.63 ± 0.37	(-0.27 - 1.00)	0.72 ± 0.31	(-0.24 - 1.00)	*0.257*

4. Discussion

The use of fixation screws with acetabular cups is controversial,[16] as the benefits of increased stability[20] must be weighed against the risks of neurovascular damage,[21] increased access for wear particles, and appearance of radiolucent lines around the screws.[22] The risks could be greater for DM cups because the perforation of the articular metal shell,

necessary to accommodate screws, could compromise PE wear and implant longevity.

The present case-matched study revealed that the rates of early postoperative complications and revisions are greater for DM cups fixed with additional screws (9% and 6%, respectively) than for those fixed by simple press-fit (5% and 1%, respectively), but that the functional scores and quality of life scores were equivalent among the two groups (Table 3). Therefore, the hypothesis that supplementary screw fixation does not increase the risks of complications nor compromise clinical scores could not be confirmed, but the question merits further scrutiny.

Despite propensity matching by age, sex and bone quality, the screw fixation group had more surgical antecedents (53% vs 30%, p=0.032) and higher femoral neck angles (129°±7° vs 126°±6°, p=0.028). The screw fixation group also received acetabular cups of slightly larger diameter (52±3mm vs 51±3mm, p=0.036) and had a greater proportion of hips operated by the posterior approach (84% vs 49%, p<0.001). It is therefore unclear whether the difference in revision rates are related to the additional screws or to the baseline patient factors that led the surgeon to opt for screw fixation rather than standard simple press-fit.

Two of the hips in the screw fixation group (6%) required revision, one due to early acetabular fracture which could be related to the acetabular cup and/or its fixation screws, but the other was for early sepsis which did not seem to be related to implant design. By contrast, only one of the hips in the press-fit fixation group (1%) required revision, for early sepsis which did not seem to be related to implant design. With this premise, there was only one implant-related revision in the screw fixation group (3%), compared to none in the simple press-fit group (0%). And while inferences cannot be made based on one observation, the single acetabular fracture observed could be due to a multitude of reasons relating to patient characteristics, likely due to the tendency to oversize cups in acetabula with poor bone quality or unusual acetabular morphology.[20]

Uncemented DM cups are effective at preventing hip dislocations while granting satisfactory long-term clinical outcomes and survival rates.[8-10] They are designed with a thin metal shell, with porous coating on the outer surface to favour bone ingrowth, and mirror-polished at the inner surface to optimise articulation against a large-diameter PE insert, which assembles with a small retentive femoral head.[11-13] Unlike conventional cups, DM cups have articular surfaces, and the use of additional fixation in only recommended for cases with osteoporosis, bone loss or substantial deformities.[14,15]

The present study has several limitations by virtue of its retrospective design. First, the sample size of the screw fixation group is insufficient to draw conclusions regarding rare events, such as complications or revisions. Second, the minimum follow-up of two years is insufficient for survival analysis, for which long-term studies are required. Third, despite propensity matching by age, sex and bone

quality, the two groups differed in terms of surgical antecedents, femoral neck angles, cup diameters and surgical approach, which casts doubts as to whether the different rates of complications and revision are related to fixation screws or to patient and surgical factors. The present study is nevertheless the first to compare the outcomes of two dual-mobility cup designs fixed by simple press-fit versus supplementary screws, and could provide the equipoise and rationale for a randomised controlled trial to provide greater evidence on the issue of fixation in DM cups that are implanted increasingly worldwide.[10]

5. Conclusions

The present case-matched study revealed that revision rates are greater for DM cups fixed with additional screws (6%) than for those fixed by simple press-fit (1%), but clinical scores were equivalent among the two groups. There was only one implant-related revision (acetabular fracture) in the screw fixation group (3%) versus none in the simple press-fit fixation group (0%), and it is unclear whether the difference in revision rates are related to the additional screws or to patient and surgical factors.

6. References

1. Boukebous B, Boutroux P, Zahi R, Azmy C, Guillon P. Comparison of dual mobility total hip arthroplasty and bipolar arthroplasty for femoral neck fractures: A retrospective case-control study of 199 hips. Orthop Traumatol Surg Res 2018; 104 (3):369-375.

2. Terrier A, Latypova A, Guillemin M, Parvex V, Guyen O. Dual mobility cups provide biomechanical advantages in situations at risk for dislocation: a finite element analysis. Int Orthop 2017; 41 (3):551-556.

3. Ozden VE, Dikmen G, Beksac B, Tozun R. Dual-mobility bearings for patients with abductor-trochanteric complex insufficiency. Hip Int 2018; 28 (5):491-497.

4. De Martino I, D'Apolito R, Soranoglou VG, Poultsides LA, Sculco PK, Sculco TP. Dislocation following total hip arthroplasty using dual mobility acetabular components: a systematic review. Bone Joint J 2017; 99-b (ASuppl1):18-24.

5. Horriat S, Haddad FS. Dual mobility in hip arthroplasty: What evidence do we need? Bone Joint Res 2018; 7 (8):508-510.

6. Klingenstein GG, Yeager AM, Lipman JD, Westrich GH. Computerized range of motion analysis following dual mobility total hip arthroplasty, traditional total hip arthroplasty, and hip resurfacing. J Arthroplasty 2013; 28 (7):1173-1176.

7. Reina N, Pareek A, Krych AJ, Pagnano MW, Berry DJ, Abdel MP. Dual-Mobility Constructs in Primary and Revision Total Hip Arthroplasty: A Systematic Review of Comparative Studies. J Arthroplasty 2018.

8. Chughtai M, Mistry JB, Diedrich AM, Jauregui JJ, Elmallah RK, Bonutti PM, et al. Low Frequency of Early Complications With Dual-mobility Acetabular Cups in Cementless Primary THA. Clin Orthop Relat Res 2016; 474 (10):2181-2187.

9. Ferreira A, Prudhon JL, Verdier R, Puch JM, Descamps L, Dehri G, et al. Contemporary dual-mobility cup regional and private register: methodology and results. Int Orthop 2017; 41 (3):439-445.

10. Fessy MH, Jacquot L, Rollier JC, Chouteau J, Ait-Si-Selmi T, Bothorel H, et al. Midterm Clinical and Radiographic Outcomes of a Contemporary Monoblock Dual-Mobility Cup in Uncemented Total Hip Arthroplasty. J Arthroplasty 2019; 34 (12):2983-2991.

11. Dangin A, Boulat S, Farizon F, Philippot R. Prevention of Dislocation Risk During Hip Revision Surgery with the Dual Mobility Concept; Study of a New Generation of Dual Mobility Cups. Surg Technol Int 2016; 29:314-319.

12. Ko LM, Hozack WJ. The dual mobility cup: what problems does it solve? Bone Joint J 2016; 98-b (1 Suppl A):60-63.

13. Noyer D, Caton JH. Once upon a time.... Dual mobility: history. Int Orthop 2017; 41 (3):611-618.

14. Haen TX, Lonjon G, Vandenbussche E. Can cemented dual-mobility cups be used

without a reinforcement device in cases of mild acetabular bone stock alteration in total hip arthroplasty? Orthop Traumatol Surg Res 2015; 101 (8):923-927.

15. Spaans EA, Koenraadt KLM, Wagenmakers R, van den Hout J, Te Stroet MAJ, Bolder SBT. Midterm survival analysis of a cemented dual-mobility cup combined with bone impaction grafting in 102 revision hip arthroplasties. Hip Int 2018; 28 (2):161-167.

16. Engh CA, Hopper RH, Jr., Engh CA, Jr. Long-term porous-coated cup survivorship using spikes, screws, and press-fitting for initial fixation. J Arthroplasty 2004; 19 (7 Suppl 2):54-60.

17. Toro G, Bothorel H, Saffarini M, Jacquot L, Chouteau J, Rollier JC. Uncemented total hip arthroplasty in octogenarian and nonagenarian patients. Eur J Orthop Surg Traumatol 2019; 29 (1):103-110.

18. Delaunay C, Epinette JA, Dawson J, Murray D, Jolles BM. Cross-cultural adaptations of the Oxford-12 HIP score to the French speaking population. Orthop Traumatol Surg Res 2009; 95 (2):89-99.

19. EuroQol G. EuroQol--a new facility for the measurement of health-related quality of life. Health Policy 1990; 16 (3):199-208.

20. Garcia-Rey E, Garcia-Cimbrelo E, Cruz-Pardos A. Cup press fit in uncemented THA depends on sex, acetabular shape, and surgical technique. Clin Orthop Relat Res 2012; 470 (11):3014-3023.

21. Barrack RL. Neurovascular injury: avoiding catastrophe. J Arthroplasty 2004; 19 (4 Suppl 1):104-107.

22. Rohrl SM, Nivbrant B, Snorrason F, Karrholm J, Nilsson KG. Porous-coated cups fixed with screws: a 12-year clinical and radiostereometric follow-up study of 50 hips. Acta Orthop 2006; 77 (3):393-401.

