Do Monoblock Cups Improve Survivorship, Decrease Wear, or Reduce Osteolysis in Uncemented Total Hip Arthroplasty?

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Abstract

Background Monoblock acetabular components used in uncemented total hip arthroplasty (THA) have certain mechanical characteristics that potentially reduce acetabular osteolysis and polyethylene wear. However, the degree to which they achieve this goal is not well documented.

Questions/purposes The purpose of this study was to use a systematic review of controlled trials to test the hypothesis that monoblock cups have superior (1) polyethylene wear rate; (2) frequency of cup migration; (3) frequency of acetabular osteolysis; and (4) frequency of aseptic loosening compared with modular components used in uncemented THA.

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Methods A systematic search was conducted in the Medline, Embase, and Cochrane electronic databases to assemble all controlled trials comparing monoblock with modular uncemented acetabular components in primary THA. Included studies were considered “best evidence” if the quality score was either $\geq 50\%$ on the Cochrane Back Review Group checklist or $\geq 75\%$ the Newcastle-Ottawa quality assessment scale. A total of seven publications met our inclusion criteria.

Results Best evidence analysis showed no difference in polyethylene wear rate, the frequency of cup migration, and aseptic loosening between monoblock and modular acetabular components. No convincing evidence was found for the claim that lower frequencies of acetabular osteolysis are observed with the use of monoblock cups compared with modular uncemented cups.

Conclusions The purported benefits of monoblock cups were not substantiated by this systematic review of controlled studies in that polyethylene wear rates and frequencies of cup failure and acetabular osteolysis were similar to those observed with modular implants. Other factors should therefore drive implant selection in cementless THA.

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

Introduction

Data from national joint registries show that in the last decade, the incidence of uncemented THA is increasing [25, 33]. Despite the increasing popularity of uncemented fixation techniques, data from the Swedish Hip Arthroplasty

Register show inferior survival rates of uncemented total hip implants compared with cemented total hip implants, mainly as a result of the poorer performance of uncemented acetabular components [10, 25, 33]. However, in a systematic review of the literature conducted by Pakvis et al. [28], the authors concluded that there is no evidence for the superiority of either cemented or uncemented acetabular component fixation.

Aseptic loosening of the acetabular is the most frequently reported reason for revision and is therefore the single most important limiting factor to the survival of uncemented THA [2, 10]. Aseptic loosening of acetabular components is a long-term complication in THA that is induced by osteolysis and polyethylene wear. Monoblock cups are a specific subset of acetabular components that provides possible solutions to these long-term challenges in THA.

Monoblock cups are nonmodular uncemented acetabular components in which the polyethylene liner and shell are factory-preassembled into a single solid construct. Therefore, locking mechanisms and dome holes are absent in monoblock acetabular components. These characteristics provide them with various advantages such as optimal liner-shell conformity, thicker polyethylene, and the elimination of liner-shell micromotion thereby eliminating the risk of backside wear [3, 39]. Furthermore, the absence of dome holes prevents the possibility of polyethylene wear debris particles to directly access the subchondral bone, thereby eliminating the associated risk of acetabular osteolysis [13]. However, there is disagreement about the degree to which the purported benefits of monoblock cups are achieved in clinical practice [35, 39].

We therefore systematically reviewed the literature to determine the (1) polyethylene wear rate; (2) frequency of cup migration; (3) frequency of acetabular osteolysis; and (4) frequency of aseptic loosening of monoblock cups compared with modular components used in uncemented THA reported in the literature.

Materials and Methods

Search Strategy and Selection Criteria

We conducted a systematic review to assemble all (randomized) controlled trials comparing uncemented monoblock cups with modular acetabular components used in primary THA. According to the PRISMA statement [20] and MOOSE guidelines [32], a systematic search was conducted in the Medline, Embase, and Cochrane electronic databases on October 4, 2012, using the precise syntax as displayed in Appendix 1.

The search syntax was built by the first author (JJH) to search for relevant terms in the title and abstract of all publications in the Medline, Embase, and Cochrane databases. The first half of the search syntax was built up from the term “acetabular component” combined with synonyms—singular and plural—using “OR”. In the other half of the search syntax, the term “monoblock” or synonyms and known monoblock cup names such as “one piece”, “hedrocel”, “morscher”, “RM” and “iso elastic” were used, also combined with the “OR” function. The final search syntax is synthesized by combining the results of the two performed searches using “AND”. We did not use field limits or any limits with regard to publication date. Furthermore, we did not use “mapping”, “explosion search”, or “MESH” terms.

The search results were exported to an online Refworks account. All duplicates were identified and subsequently removed from the Refworks database. Only publications written in English, German, French, or Dutch were considered for review. The following predetermined inclusion criteria were used: clinical studies, reporting on uncemented monoblock acetabular components used in primary THA, reporting polyethylene wear, cup migration, osteolysis, and/or aseptic loosening as outcome measures. Titles and abstracts of all unique publications were screened for inclusion criteria. All publications that were considered eligible were subsequently retrieved in full text and the full-text publications were screened using our predetermined exclusion criteria. We excluded all studies that failed to meet our inclusion criteria, all animal studies, all noncomparative case series, case reports and expert opinions, and all studies with a duration of followup of less than 2 years. If multiple publications reported on the evaluation of a single cohort, only the publication with the longest duration of followup was included. Abstracts and unpublished series were also excluded. Of all remaining articles, the reference lists were checked to search for additional relevant publications. The study selection and the cross-checking of reference lists were done by one of the authors (JJH) with direct consultation of another author (AdG) in difficult cases. Agreement was reached in all cases.

Study Quality Assessment and Best Evidence Synthesis

Study quality was appraised using the checklist from the Cochrane Back Review Group [6] for randomized controlled trials and the Newcastle-Ottawa quality assessment scale [36] for nonrandomized studies. All studies that scored “yes” on 50% or more of the items of the Cochrane Back Review Group checklist or 75% or more on the Newcastle-Ottawa quality assessment scale were considered “best evidence” (Tables 1, 2).

Table 1. Characteristics of studies comparing monoblock cups with modular uncemented cups

Study	Cup	Design	Number	Mean followup (years)	Lost to followup (deceased)	CBRG checklist	Newcastle-Ottawa scale	Outcome measures (wear/migration/osteolysis/aseptic loosening)
Krismer et al., 1994 [17]	HA-coated RM cup versus PCA cup (Howmedica, Rutherford, NJ, USA)	RCT	61 RM cups versus 59 PCA cups	5.2	24.6% (3.3%)	< 50% (41.6%)		-/+/-/+
Krismer et al., 1996 [18]	Noncoated RM cup versus PCA cup (Howmedica)	RCT	60 monoblock versus 59 modular cups	8	0% (11.6%)	66.6%		-/+/-/+
Young et al., 2002 [39]	One-piece cup versus modular Durabloc cup (DePuy, Johnson and Johnson, Warsaw, IN, USA)	Match paired study	49 monoblock versus 41 modular cups	5.3 versus 5.5	N/A		87.5%	+/-/+/-
GonzalezDella Valle et al., 2004 [8]	Implex cup versus Trilogy cup (Zimmer, Warsaw, IN, USA)	Match paired study	65 monoblock versus 64 modular cups	5.65 (5–8)	N/A		87.5%	+/-/+/-
Kitamura et al., 2005 [16]	One-piece cup versus modular cups	Case series	11 monoblock versus 115 modular cups (of 6 different designs)	10.9 (5.1–19.1)	N/A		< 75% (62.5%)	-/-/+/-
Baad-Hansen et al., 2011 [3]	Trabecular Metal cup versus Trilogy cup (Zimmer)	RCT	30 monoblock versus 30 modular cups	2	8.3%	91.6%		-/+/+/-
Weiss et al., 2012 [35]	Morscher and Trabecular Metal cup versus Trilogy cup (Zimmer)	Stratified prospective case series	210 monoblock versus 1130 modular cups	5	0%		75%	-/-/+/-

HA = hydroxyapatite; CBRG = Cochrane Back Review Group; RCT = randomized controlled trial; N/A = not available.

Table 2. Outcome of studies selected as 'best evidence' of controlled trials

Study	Wear	Migration	Acetabular osteolysis	Aseptic loosening
Krismer et al., 1996 [18]	N/A	Monoblock versus modular: 0.65 mm versus 0.77 mm at 2-year followup (p = 0.6)	N/A	Monoblock versus modular: 86% versus 88% survival (p = 0.16)
Young et al., 2002 [39]	Monoblock versus modular: 0.11 mm/year versus 0.16 mm/year (p = 0.22)	N/A	Monoblock versus modular: 2% versus 22% (p = 0.01)	N/A
Gonzalez Della Valle et al., 2004 [8]	Monoblock versus modular: 0.07 mm/year versus 0.08 mm/year (p = 0.99)	N/A	Monoblock versus modular: 0 versus 1.5% (p = N/A)	N/A
Baad-Hansen et al., 2011 [3]	N/A	Less rotation along transverse axis with monoblock (p = 0.04)	N/A	0%
Weiss et al., 2012 [35]	N/A	N/A	N/A	95% survival for any revision (p = 0.6)

N/A = not available.

The actual close-reading and quality assessment of all relevant publications were done by two of the authors (JJH, AdG) independently. The final quality score for each publication was awarded in consensus.

Our search yielded a total of 374 publications. After removal of duplicates, 203 unique publications remained. Titles and abstracts of all publications were screened for our predetermined inclusion criteria, after which 51 publications were considered eligible. These 51 publications were then obtained in full text. After applying our exclusion criteria, a total of six unique publications remained. Checking the reference lists of all eligible publications yielded one other publication meeting our in- and exclusion criteria as described previously (Fig. 1).

Of the remaining studies, three were randomized controlled trials and four were nonrandomized comparative studies. One randomized study scored less than 50% on the Cochrane Back Review Group checklist and was therefore excluded from the "best evidence" assembled in this review [17]. One nonrandomized study was scored less than 75% on the Newcastle-Ottawa quality assessment scale and also excluded from the "best evidence" [16].

The remaining "best evidence" was assessed for heterogeneity by two of the reviewers (JJH, AdG).

Results

There were no differences in acetabular polyethylene wear rates between monoblock and modular cups in the two comparative series that reported on this end point. Those studies, both matched-pair case-control studies comparing monoblock cups with modular uncemented cups [8, 39], found no significant differences in polyethylene wear rate at intermediate-term followup (mean, 5.3 years, range, 3.8–8.0 years and mean, 5.65 years, range 5.0–7.8 years).

Migration rate was also similar between monoblock cups and modular uncemented cups. In a stratified prospective case series, no significant difference in mean total migration rate within the first 2 years of followup was found between a noncoated monoblock cup and the modular porous-coated anatomic cup (PCA cup; Howmedica, Rutherford, NJ, USA) [18]. Total migration rate of > 1 mm within the first 2 years was found to be highly predictive for late aseptic loosening [18]. Furthermore, in the randomized controlled trial between the monoblock Trabecular Metal (Zimmer, Warsaw, IN, USA) cup and the modular Trilogry (Zimmer) cup, radiostereometric analysis, no significant differences in migration were found with regard to translation at 2 years followup. However, the monoblock cup showed significantly less rotation along the transverse axis at 2 years followup [3].

Fig. 1 From the 203 unique publications that were found in the systematic literature search, only five publications were selected as “best evidence” of controlled trials.

The comparison for frequency of osteolysis yielded mixed results. The two previously mentioned matched-pair case-control studies also reported frequency of acetabular osteolysis at intermediate-term followup (approximately 5 years, as noted earlier) [8, 39]. One study found a significant difference in favor of the monoblock cups [39], whereas in another slightly larger study, this difference was relatively small and not significant [8]. This first study by Young et al. [39] reported a frequency of acetabular osteolysis of 2% versus 22% for the monoblock and modular

cup, respectively ($p = 0.01$). In the other study by Gonzalez Della Valle et al. [8], there was only one case of acetabular osteolysis in the modular group and only one case of osteolysis of the femoral calcar in the monoblock group [8]. The authors therefore conclude that there is no significant difference in periprosthetic osteolysis.

There were no differences in implant survival using aseptic loosening as the end point. In a previously mentioned study comparing survival for aseptic loosening of a noncoated monoblock cup with the modular PCA cup, no

significant difference was found after 8 years of followup [18]. In another study evaluating data from the Swedish Hip Arthroplasty Register comparing monoblock cups with a modular uncemented cup, no significant difference in the risk of revision for any reason was found at intermediate-term followup (4 and 6 years) [35]. However, this result is difficult to interpret because the two groups differed significantly on several baseline characteristics, including age, duration of followup, the percentage of previous pediatric hip disease, and the distribution of highly crosslinked polyethylene (versus ultrahigh-molecular-weight polyethylene).

Discussion

The specific properties of monoblock acetabular components theoretically reduce polyethylene wear and acetabular osteolysis, thereby increasing their longevity. We conducted a systematic review of controlled trials to test the hypothesis that monoblock cups used in uncemented THA have superior (1) polyethylene wear rate; (2) frequency of cup migration; (3) frequency of acetabular osteolysis; and (4) frequency of aseptic loosening compared with modular uncemented acetabular components.

This study had a number of limitations. First, the quality of this systematic review is limited by the quality of the primary studies, mostly Level III nonrandomized controlled trials, which could suffer from selection bias. Second, the limited number of relevant studies, their heterogeneous designs, and differences in reporting the outcome measures of interest prevented the pooling of data to be able to perform a meta-analysis. This complicates the interpretation and generalization of the results found in this systematic review. Third, quality assessment checklists

were used to select the “best evidence” from the studies identified in this review. Although the use of quality checklists is under debate [38], we found that the use of these checklists was a helpful tool in the critical appraisal of the included studies. A 50% threshold is established for the Cochrane Back Review Group checklist [6]. For the Newcastle-Ottawa quality assessment scale [36], we used a 75% threshold for inclusion. Although this 75% cutoff is arbitrary, we found that it discriminated well between studies that were methodologically well designed and those that were not. The study that failed to meet the 75% threshold had a demonstrably poorer quality mainly as a result of inappropriate patient selection and the consequently lacking representativeness and comparability of the groups under study [16]. We reviewed the performance of “true” monoblock uncemented acetabular components in THA. The PCA cup and Anatomic Medullary Locking Trispike cup (DePuy, Johnson and Johnson, Warsaw, IN, USA) were not considered a monoblock cup. These two acetabular components are nonmodular in the sense that they are factory-preassembled and do not allow for liner exchange. However, these cups are not monoblock cups because they lack liner-shell conformity and are still connected through a locking mechanism, thereby allowing for micromotion between the liner and shell to generate backside wear. Furthermore, a dome hole is present in the PCA cup. In this review, the remaining true monoblock cups have been grouped together based on these principles and we believe this is justified. However, monoblock cups from different manufacturers have substantially different designs (Table 3) with different degrees of radiodensity and different ways of osseointegration. For, example the Morscher cup has a titanium mesh backing, which allows for both bone in- and ongrowth, where the RM classic cup with a thin titanium coating predominantly allows for bone

Table 3. Short and full names and description of the design of monoblock acetabular components

Short name	Full name	Description	Manufacturer
RM cup	RM Classic cup	Hemispherical or beveled, with two pegs, either noncoated, HA-or titanium-coated, monoblock cup	Mathys, Bettlach, Switzerland
One-piece cup	One-piece cup	Hemispherical, solid metal-backed, porous-coated, monoblock cup	DePuy, Warsaw, Indiana, USA
Implex Monoblock cup	Elliptical Implex Monoblock cup	Elliptical, solid titanium alloy shell, bead-blasted outer surface, monoblock cup	Implex, Allendale, NJ, USA
Hedrocel cup	Hedrocel cup	Elliptical, porous tantalum shell, monoblock cup	Implex
Trabecular Metal cup	Trabecular Metal Monoblock cup	Elliptical, trabecular tantalum outer surface, monoblock cup	Zimmer, Warsaw, IN, USA
Morscher cup	Morscher press-fit cup	Hemispherical or beveled, with a single spigot, titanium mesh outer surface, monoblock cup	Sulzer Orthopaedics, Baar, Switzerland

HA = hydroxyapatite.

ongrowth. Furthermore, the materials used in monoblock cups, either tantalum or titanium, have different mechanical properties (ie, elastic modulus and frictional coefficient) resulting in differences in fixation strength and stress-shielding with subsequent changes in bone mineral density of the acetabular host bone [23]. These structural differences among monoblock cups could be confounders in the assessment of acetabular osteolysis and the radiological assessment of cup loosening.

The evidence from this systematic review of controlled trials shows no difference in the polyethylene wear rate between monoblock and modular acetabular components at intermediate-term followup [8, 39]. Although monoblock cups have the theoretical advantage of eliminating backside polyethylene wear, this does not lead to a decrease in polyethylene wear rate compared with modular cups. This could be explained by the fact that backside wear is estimated to be at least three orders of magnitude (1000 times) less than the polyethylene wear at the articular surface [19]. Therefore, clinically relevant polyethylene wear is not affected by modularity of the acetabular component. In a case series evaluating 158 titanium-coated RM cups (monoblock cups) at 13.2 years followup (10–18 years), a polyethylene wear rate of 0.11 mm/year was reported [27]. In the same study, polyethylene wear was reported as the primary reason for revision in 4.4% of all cases and femoral osteolysis in the presence of polyethylene wear was reported as the primary reason for revision in another 4.4% of all cases [27]. Therefore, further improvements in polyethylene durability are still needed to eliminate the clinical problems resulting from polyethylene wear. Current developments, like the stabilization of highly crosslinked polyethylene with vitamin E, could possibly provide the solution for polyethylene wear in the future [5, 26, 37].

Best evidence analysis showed no difference in migration between monoblock and modular acetabular components with regard to translation (= migration in the horizontal or vertical plane) [3, 18]. Primary stability is the prerequisite for osseous in- and ongrowth, which is necessary to achieve long-term fixation in uncemented THA [31]. Total migration rate of > 1 mm within the first 2 years after implantation was found to be highly predictive for late aseptic loosening [18] and migration rates well below this threshold were reported on different monoblock cups in several uncontrolled case series [22, 27]. The fact that the best evidence of controlled trials showed no difference in migration between monoblock and [8] modular cups could predict that long-term survival will not be different. In one of the primary studies, a monoblock cup showed significantly less rotation along the transverse axis compared with a modular cup at 2 years of followup [3]. However, the clinical implications of this finding are not well

documented. We hypothesize that the surface roughness and the quality of the press fit, rather than modularity of the cup, will be of major influence on primary stability and subsequent migration of an uncemented acetabular component.

The best evidence assembled in this systematic review comparing frequency of osteolysis between monoblock and modular cups yielded contradictory results (Table 2). One matched-pair case-control study found a significant difference in favor of the monoblock cups (2% versus 22%, $p = 0.01$) [39], whereas in another slightly larger matched-pair case-control study, this difference was relatively small and not significant (0% versus 1.5%, $p =$ not available) [8]. Therefore, it is not feasible to draw conclusions on the difference in frequency of osteolysis between monoblock and modular cups. Moreover, substantially different rates of osteolysis were reported on different monoblock cups in noncomparative case series, ranging from 0% to 15% reported for monoblock cups with 10 to 20 years of followup [4, 7, 9, 11, 12, 21, 24, 27]. As noted earlier, the different designs and material properties of monoblock cups from different brands could be confounding factors, having different degrees of radiodensity, different mechanical properties, and different ways of osseointegration (osseous in- or ongrowth). The RM classic cup is in the vast majority of cases fixated with supplementary screws [1, 11, 12, 14, 15, 24, 27], where other monoblock cups are press fit implanted without using supplementary screws. Former research showed that supplementary screw fixation is associated with increased rates of acetabular osteolysis [30].

Best evidence analysis showed no difference in implant survival using aseptic loosening as the end point. However, in the only “best evidence” study reporting survival with aseptic loosening as the end point, a modular PCA cup was compared with a noncoated RM cup [18]. The RM cup was introduced as a noncoated uncemented acetabular component. As shown by Roffman and Kligman [29], the noncoated RM cup proved inferior compared with the coated cups (either with hydroxyapatite or titanium). The noncoated RM cup showed poor osseointegration and high rates of aseptic loosening [29, 34] and is therefore currently abandoned. Therefore, this “best evidence” study [18] is not representative of the current generation of monoblock acetabular components. The Swedish Hip Arthroplasty Register Annual Report 2010 indicates that the 10-year survival of all uncemented implants is 97.7% with revision for aseptic loosening as the end point [33]. Long-term results from uncontrolled (noncomparative) case series that have been published on several monoblock cups of the current generation (ie, the titanium-coated RM cup, the Morscher cup, and the Trabecular Metal cup) show a 10-year survival for aseptic loosening within the range or higher than the survival reported in the Swedish Hip

Arthroplasty Register [4, 7, 9, 11, 12, 14, 21, 24, 27, 33]. Those studies represent the potentially good clinical results with the use monoblock cups in clinical practice. However, uncontrolled case series tend to inflate apparent benefits of treatment because they suffer terribly from selection and publication bias and to draw any conclusions from them with regard to the comparison with modular cups would be unjust. Another “best evidence” study found no significant difference in the all-cause survival rate of monoblock versus uncemented modular cups [35]. However, the study by Weiss et al. [35] had important selection bias, because the groups differed significantly in baseline characteristics such as age, duration of followup, and the percentage of previous pediatric hip disease. Also highly crosslinked polyethylene was not available for the monoblock acetabular components included in the study. Furthermore, the relatively small size of the monoblock group as well as relatively short followup compared with the reference group increased the risk of type II error (unjustly fail to reject the null hypothesis). Therefore, it remains impossible to conclude whether monoblock cups have superior frequency of aseptic loosening compared with modular acetabular component in uncemented THA. Further research in the form of randomized controlled trials might be able to answer this question.

In summary, best evidence analysis in this systematic review of controlled trials showed no difference in polyethylene wear rate and frequency of cup migration and aseptic loosening between monoblock and modular acetabular components [3, 8, 18, 35, 39]. Furthermore, there was no convincing evidence for a difference in the frequency of osteolysis between monoblock and modular uncemented cups [8, 39]. The purported benefits of monoblock cups seem to be largely theoretical. Therefore, implant choice in uncemented THA should be based on other factors rather than implant modularity.

Appendix 1. Search Syntax

PUBMed:

(((((“acetabulum”[Title/Abstract]) OR “acetabular component”[Title/Abstract]) OR “acetabular components”[Title/Abstract]) OR “cup”[Title/Abstract]) OR “cups”[Title/Abstract]) OR “socket”[Title/Abstract]) OR “sockets”[Title/Abstract]

AND

(((((((((“monobloc”[Title/Abstract]) OR “monoblock”[Title/Abstract]) OR “non modular”[Title/Abstract]) OR “nonmodular”[Title/Abstract]) OR “1 piece”[Title/Abstract]) OR “one piece”[Title/Abstract]) OR “morscher”[Title/Abstract]) OR “rm”[Title/Abstract]) OR “hedrocel”[Title/Abstract]) OR “isoelastic”[Title/Abstract]) OR “isoelastic”[Title/Abstract]

EMBASE

‘acetabulum’:ab,ti OR ‘acetabular component’:ab,ti OR ‘acetabular components’:ab,ti OR ‘cup’:ab,ti OR ‘cups’:ab,ti OR ‘socket’:ab,ti OR ‘sockets’:ab,ti

AND

‘monobloc’:ab,ti OR ‘monoblock’:ab,ti OR ‘non modular’:ab,ti OR ‘nonmodular’:ab,ti OR ‘1 piece’:ab,ti OR ‘one piece’:ab,ti OR ‘morscher’:ab,ti OR ‘rm’:ab,ti OR ‘hedrocel’:ab,ti OR ‘iso elastic’:ab,ti OR ‘isoelastic’:ab,ti

COCHRANE

“acetabulum”:ti,ab,kw OR “acetabular component”:ti,ab,kw OR “acetabular components”:ti,ab,kw OR “cup”:ti,ab,kw OR “cup”:ti,ab,kw OR “socket”:ti,ab,kw OR “sockets”:ti,ab,kw

AND

“monobloc”:ti,ab,kw OR “monoblock”:ti,ab,kw OR “non modular”:ti,ab,kw OR “nonmodular”:ti,ab,kw OR “1 piece”:ti,ab,kw OR “one piece”:ti,ab,kw OR “morscher”:ti,ab,kw OR “rm”:ti,ab,kw OR “hedrocel”:ti,ab,kw OR “iso elastic”:ti,ab,kw OR “isoelastic”:ti,ab,kw

References

1. Ali MS, Kumar A. Hydroxyapatite-coated RM cup in primary hip arthroplasty. *Int Orthop*. 2003;2:90–93.
2. Australian National Joint Replacement Registry annual report 2011. Available at: http://www.dmac.adelaide.edu.au/aoanjrr/documents/AnnualReports2011/AnnualReport_2011_WebVersion.pdf. Accessed October 20, 2012.
3. Baad-Hansen T, Kold S, Nielsen PT, Laursen MB, Christensen PH, Soballe K. Comparison of trabecular metal cups and titanium fiber-mesh cups in primary hip arthroplasty: a randomized RSA and bone mineral densitometry study of 50 hips. *Acta Orthop*. 2011;2:155–160.
4. Berli BJ, Ping G, Dick W, Morscher EW. Nonmodular flexible press-fit cup in primary total hip arthroplasty: 15-year followup. *Clin Orthop Relat Res*. 2007;461:114–121.
5. Bracco P, Oral E. Vitamin E-stabilized UHMWPE for total joint implants: a review. *Clin Orthop Relat Res*. 2011;469:2286–2293.
6. Furlan AD, Pennick V, Bombardier C, van Tulder M, Editorial Board, Cochrane Back Review Group. 2009 updated method guidelines for systematic reviews in the Cochrane Back Review Group. *Spine (Phila Pa 1976)*. 2009;18:1929–1941.
7. Garavaglia G, Lubbeke A, Barea C, Roussos C, Peter R, Hoffmeyer P. Ten-year results with the Morscher press-fit cup: an uncemented, non-modular, porous-coated cup inserted without screws. *Int Orthop*. 2011;7:957–963.
8. Gonzalez Della Valle A, Su E, Zoppi A, Sculco TP, Salvati EA. Wear and periprosthetic osteolysis in a match-paired study of modular and nonmodular uncemented acetabular cups. *J Arthroplasty*. 2004;8:972–977.
9. Gwynne-Jones DP, Garneti N, Wainwright C, Matheson JA, King R. The Morscher press fit acetabular component: a nine- to 13-year review. *J Bone Joint Surg Br*. 2009;7:859–864.
10. Hailer NP, Garellick G, Karrholm J. Uncemented and cemented primary total hip arthroplasty in the Swedish Hip Arthroplasty Register. *Acta Orthop*. 2010;1:34–41.
11. Horne G, Culliford N, Adams K, Devane P. Hybrid total hip replacement: outcome after a mean follow up of 10 years. *ANZ J Surg*. 2007;8:638–641.

12. Horne G, Devane PA, Dalton DJ. Does pelvic osteolysis occur with a nonmodular uncemented acetabular component? *J Arthroplasty*. 2006;2:185–190.
13. Huk OL, Bansal M, Betts F, Rimnac CM, Lieberman JR, Huo MH, Salvati EA. Polyethylene and metal debris generated by non-articulating surfaces of modular acetabular components. *J Bone Joint Surg Br*. 1994;4:568–574.
14. Ihle M, Mai S, Pfluger D, Siebert W. The results of the titanium-coated RM acetabular component at 20 years: a long-term follow-up of an uncemented primary total hip replacement. *J Bone Joint Surg Br*. 2008;10:1284–1290.
15. Ihle M, Mai S, Siebert WE. Treatment for acetabular dysplasia using the uncemented RM acetabular component—a 20 year follow-up. *Hip Int*. 2010;1:94–101.
16. Kitamura N, Leung SB, Engh CA Sr. Characteristics of pelvic osteolysis on computed tomography after total hip arthroplasty. *Clin Orthop Relat Res*. 2005;441:291–297.
17. Krismer M, Fischer M, Mayrhofer P, Stockl F, Bittner C, Trojer C, Stockl B. A prospective study of the migration of two acetabular components. PCA versus RM cups. *Int Orthop*. 1994;1:23–28.
18. Krismer M, Stockl B, Fischer M, Bauer R, Mayrhofer P, Ogon M. Early migration predicts late aseptic failure of hip sockets. *J Bone Joint Surg Br*. 1996;3:422–426.
19. Kurtz SM, Ochoa JA, Hovey CB, White CV. Simulation of initial frontside and backside wear rates in a modular acetabular component with multiple screw holes. *J Biomech*. 1999;9:967–976.
20. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, Ioannidis JP, Clarke M, Devereaux PJ, Kleijnen J, Moher D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ*. 2009;b2700.
21. Macheras G, Kateros K, Kostakos A, Koutsostathis S, Danomaras D, Papagelopoulos PJ. Eight- to ten-year clinical and radiographic outcome of a porous tantalum monoblock acetabular component. *J Arthroplasty*. 2009;5:705–709.
22. Macheras GA, Kateros K, Koutsostathis SD, Tsakotos G, Galanakos S, Papadakis SA. The trabecular metal monoblock acetabular component in patients with high congenital hip dislocation: a prospective study. *J Bone Joint Surg Br*. 2010;5:624–628.
23. Meneghini RM, Ford KS, McCollough CH, Hanssen AD, Lewallen DG. Bone remodeling around porous metal cementless acetabular components. *J Arthroplasty*. 2010;5:741–747.
24. Nagi ON, Kumar S, Aggarwal S. The uncemented isoelastic/isotitan total hip arthroplasty. A 10–15 years follow-up with bone mineral density evaluation. *Acta Orthop Belg*. 2006;1:55–64.
25. National Joint Registry of England and Wales annual report 2010. Available at: <http://www.njrcentre.org.uk/njrcentre/portals/0/njr%207th%20annual%20report%202010.pdf>. Accessed November 1, 2012.
26. Oral E, Christensen SD, Malhi AS, Wannomae KK, Muratoglu OK. Wear resistance and mechanical properties of highly cross-linked, ultrahigh-molecular weight polyethylene doped with vitamin E. *J Arthroplasty*. 2006;4:580–591.
27. Pakvis D, Biemond L, van Hellemond G, Spruit M. A cementless elastic monoblock socket in young patients: a ten to 18-year clinical and radiological follow-up. *Int Orthop*. 2011;10:1445–1451.
28. Pakvis D, van Hellemond G, de Visser E, Jacobs W, Spruit M. Is there evidence for a superior method of socket fixation in hip arthroplasty? A systematic review. *Int Orthop*. 2011;8:1109–1118.
29. Roffman M, Kligman M. Cementless coated and noncoated Mathys acetabular cups: radiographic and histologic evaluation. *Orthopedics*. 1999;1:39–41.
30. Rohrl SM, Nivbrant B, Strom H, Nilsson KG. Effect of augmented cup fixation on stability, wear, and osteolysis: a 5-year follow-up of total hip arthroplasty with RSA. *J Arthroplasty*. 2004;8:962–971.
31. Soballe K, Hansen ES, B-Rasmussen H, Jorgensen PH, Bunger C. Tissue ingrowth into titanium and hydroxyapatite-coated implants during stable and unstable mechanical conditions. *J Orthop Res*. 1992;2:285–299.
32. Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, Moher D, Becker BJ, Sipe TA, Thacker SB. Meta-analysis Of Observational Studies in Epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. *JAMA*. 2000;15:2008–2012.
33. Swedish Hip Arthroplasty Register annual report 2010. Available at: <http://www.shpr.se/Libraries/Documents/AnnualReport-2010-2-eng.sflb.ashx>. Accessed November 1, 2012.
34. Trebse R, Milosev I, Kovac S, Mikek M, Pisot V. Poor results from the isoelastic total hip replacement: 14–17-year follow-up of 149 cementless prostheses. *Acta Orthop*. 2005;2:169–176.
35. Weiss RJ, Hailer NP, Stark A, Karrholm J. Survival of uncemented acetabular monoblock cups: evaluation of 210 hips in the Swedish Hip Arthroplasty Register. *Acta Orthop*. 2012;3:214–219.
36. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, Tugwell P. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analyses. Available at: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp. Accessed October 20, 2012.
37. Wolf C, Lederer K, Pfragner R, Schauenstein K, Ingolic E, Siegl V. Biocompatibility of ultra-high molecular weight polyethylene (UHMW-PE) stabilized with alpha-tocopherol used for joint endoprotheses assessed in vitro. *J Mater Sci Mater Med*. 2007; 6:1247–1252.
38. Wright RW, Brand RA, Dunn W, Spindler KP. How to write a systematic review. *Clin Orthop Relat Res*. 2007;455:23–29.
39. Young AM, Sychterz CJ, Hopper RH Jr, Engh CA. Effect of acetabular modularity on polyethylene wear and osteolysis in total hip arthroplasty. *J Bone Joint Surg Am*. 2002;1:58–63.