HSSJ (2012) 8:245–250
DOI 10.1007/s11420-012-9295-7

HOSPITAL FOR SPECIAL SURGERY

Is it Time for Cementless Hip Resurfacing?

Julien Girard, MD, PhD

Received: 6 December 2011/Accepted: 22 June 2012/Published online: 13 September 2012

Abstract
Background: Metal-on-metal bearing with cemented femoral component and cementless acetabular fixation is the current standard in surface replacement arthroplasty (RSA) of the hip. Because of concerns about the long-term survivorship of cemented stems in conventional hip arthroplasty, it seems logical to achieve cementless fixation on the femoral side with RSA.
Questions/Purposes: The goals of this review were to evaluate clinical and radiological data reported from previously published cementless RSA series. In addition, we intend to review author's preliminary experience with Conserve Plus cementless devices specifically assessing the clinical outcomes, the complications rate, the survivorship, and the metallic ions levels measured in follow-up.
Methods: A references search was done with PubMed using the key words "cementless hip resurfacing", "cementless hip resurfacing prosthesis", and "femoral cementless hip resurfacing". Additionally, the clinical outcomes, the complications rate, the survivorship, and the metallic ions levels were measured in 94 cementless Conserve Plus© devices in 90 patients (68 males and 22 females) with a mean age of 41.1 years (18–59). Mean follow-up was 13.1 months (8–16).
Results: No revision was performed during the observed follow-up. Neither radiological signs of loosening nor neck narrowing >10% were evident. Chromium and cobalt levels in whole blood samples rose respectively from 0.53 μg/l (0.1–1.7) to 1.7 μg/l (0.6–2.9) and from 0.54 μg/l (0.1–1.4) to 1.98 μg/l (0.1–2.8).
Conclusions: Cementless "fit and fill" femoral-side fixation, which seems to be potentially evolved and design-related, should be considered for future hip-resurfacing device generations.

Keywords hip resurfacing · cementless device · cement · bone necrosis

Level of Evidence: Level IV: therapeutic study.

J. Girard, MD, PhD (✉)
Department of Orthopaedic Surgery, Roger Salengro Hospital,
University of Lille,
2 avenue Oscar Lambret,
Lille, France
e-mail: j_girard_lille@yahoo.fr

J. Girard, MD, PhD
Department of Sports Medicine,
University of Lille 2,
Lille cedex 59037, France

Introduction

Metal-on-metal bearing with cemented femoral component and cementless acetabular fixation is the current standard in hip surface replacement arthroplasty (RSA). Cement provides immediate fixation, while biological fixation with cement-less components requires a minimum 6 months of bone in-growth before it is considered well-fixed. Because of concerns about the long-term survivorship of cemented stems in conventional hip arthroplasty [2, 18], some authors have estimated that it is logical to achieve cementless fixation on the femoral side with RSA [7–10, 22, 23]. Moreover, it is clear that cemented implants gradually loosen from bone (due to cement failure), which has been highlighted in young, active patients exposed to high shear stress forces [1, 8].

Actually, cement can cause serious thermal damage in RSA [21]. Depending on the cementing procedure employed, cement penetration is very important and might explain the occurrence of femoral head collapse [22]. Scheerlinck et al. [22] have suggested that the cementing technique determines the amount of cement residing within a resurfacing head, the cement mantle homogeneity, the presence of cement defects, and cement-implant separation. With implant-filling techniques (low or medium viscosity), large quantities of cement are pressurized into cancellous bone, producing a thick cement mantle [1]. The polymerization properties of cement can affect temperature [19]. On the other hand, with the cement-packing technique, the cement mantle is thinner and the implant contains less cement. Additional in vitro investigations have identified potential disadvantages with cemented devices. In a 3-D finite element model, Watanabe et al. [27] detected peak stress concentration just below the tip of the stem with stress

shielding at the antero-superior part of the femoral neck. In line with these conclusions, de Waal Malefijt and Huiskes [3] determined that bonding distribution between the implant and head increased stresses on the neck with cemented devices.

To avoid problems with cement (collapse, excessive cement penetration, fatigue failure, potential for thermal necrosis, etc.) and to accomplish long-term biological fixation, cementless head components appear to be an attractive option [1, 17]. Early experience with uncemented femoral components was unfavorable. Two studies, analyzing cementless femoral components for hip resurfacing, generated poor clinical results [14, 27]. They were correlated with inadequate press fit and poor taper design which did not allow adequate femoral head fixation. More accurately, the original McMinn RSA device had a grit-blasted chromium and cobalt surface, and the Wagner cementless femoral component had a grit-blasted titanium surface [14, 27]. However, it is noteworthy that the addition of hydroxyapatite (HA) coating on the undersurface of McMinn femoral components attained 100% survivorship in six patients at 3.3 years [14]. Because of poor preliminary results and the recent improvements made in cementless stems for conventional hip arthroplasty, bone in-growth, bone on-growth, and osteo-integration are better understood [5] and modern cementless hip arthroplasty fixation designs usually include titanium plasma spray and/or HA coating [6]. They have given birth to a second generation of cementless femoral components for RSA, with several recent studies demonstrating good clinical and radiological outcomes [9, 16]. On the other hand, these studies were limited by their short- to mid-term follow-up.

The goals of this review were to evaluate clinical and radiological data reported from previously published cementless RSA series. Additionally, we wish to analyze the author's preliminary experience with Conserve Plus cementless devices (Wright Medical Technology, Arlington, TN, USA) implanted using the "fit and fill" technique with respect to the clinical outcomes, the complications rate, the survivorship, and the plasma metallic ions levels measured in follow-up.

Methods: Literature Review

A references search was done with PubMed using the key words "cementless hip resurfacing", "cementless hip resurfacing prosthesis", and "femoral cementless hip resurfacing" with the following limit: English language. Of the 39 papers selected, 33 were discarded because they only compared hybrid hip resurfacing to cementless hip arthroplasty, leaving six articles that are the basis of the current review (Table 1).

Patients and Methods

In 2010, the author performed 298 RSAs. In 94 cases, the Conserve Plus cementless device (Wright Medical Technology, Arlington, TN, USA) was implanted using the "fit and fill" technique cementless devices (31.9%) in 90 patients (68 males and 22 females) with a mean age of 41.1 years (18–59). Mean follow-up was 13.1 months (8–16). For this cementless group, the pre-operative diagnosis was osteoarthritis in 72 cases (80%), dysplasia in eight cases, epiphysiolysis in six hips, osteochondromatosis in one, and post-traumatic sequelae in three hips.

In order to qualify for the cementless device, there presenting diagnosis had to be osteoarthritis without evidence of pre-operative avascular necrosis. In addition, full contact had to be achievable between the trial and femoral heads, and circumferential femoral head bleeding had to be present.

The Conserve Plus cementless device differed from the cemented device only in the presence of porous coating on the under-surface of the femoral component (HA coating on grit-blasted plasma spray). The stem was polished, uncoated, and unloaded (Fig. 1). To prevent rotation between the implant and the femoral head, three antirotational spikes were added to the cementless design. Femoral sizes were 38–60 mm with 2-mm increments. Femoral component fixation was achieved through a tight-press fit due to taper angle on the femoral component (Figs. 2 and 3). The surgical technique preparing the femoral head for the cementless femoral component was exactly the same as for the cemented version. Initial implant seating by manual impaction led to a 2-cm distance from final implantation. Then, with hammer impaction, the implant was placed in the same position that had been identified with the trial head [15].

The post-operative management was the same for both cohorts regardless of the RSA type. Crutches were prescribed initially if pain felt. Full weight bearing was encouraged and physiotherapy was instituted for the first four post-operative weeks. A gradual return to all daily activities, including impact sports without any restrictions was then permitted [3].

Table 1 Survivor ship, mean follow-up, and cases numbers of the cementless hip resurfacings studies

Authors	Cementless RSA device	Cases number	Follow up (years)	Global survivorship rate (%)	Femoral survivorship rate (%)
Lilikakis et al. [16]	Cormet	70	2.3	97.1	98.6
Gross and Liu [9]	Cormet 200	18	7.4	89.5	100
Hull and al. [12]	Cormet	135	2.9	100	100
Spencer and UK group [24]	Cormet	747	5	95	99.1
Gross and Liu [8]	ReCap	100	2.9	98	98
Gross [10]	ReCap	1,300	2	99	99.2

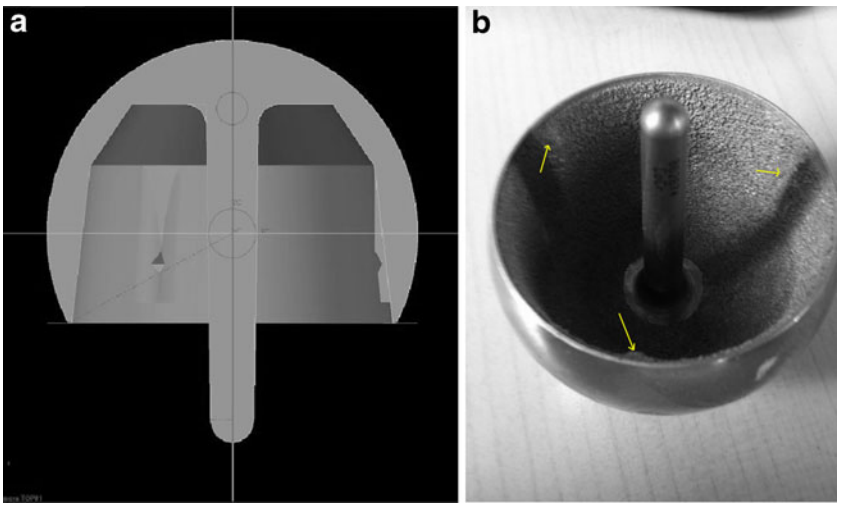

Fig. 1. The length of the Conserve Plus cement-less femoral stem was uncoated and varied from 2.9 to 5.4 cm with a taper angle for press fit fixation (**a**). Three additional spikes (*yellow arrows*) were added to prevent rotational mobility (**b**)

Hip function was assessed by Postel–Merle d'Aubigné score and the Harris hip score. All patients were evaluated yearly and reviewed by one independent observer who did not participate in the surgery.

Standardized anteroposterior and lateral radiographs were taken post-operatively, annually, and at last follow-up. Variation of cup inclination over 2 mm between follow-up radiographs was considered as migration. Narrowing of the femoral neck was assessed with the method of Hing et al. [11]. The chromium and cobalt metallic ions level were evaluated in whole blood samples by inductively coupled plasma mass spectrometry for all the patients during the preoperative period and at the last follow-up.

Results

To literature review suggests that the short and mid-term survival rate observed after cementless RSA seems not differs from those observed after cemented device (Table 1). In

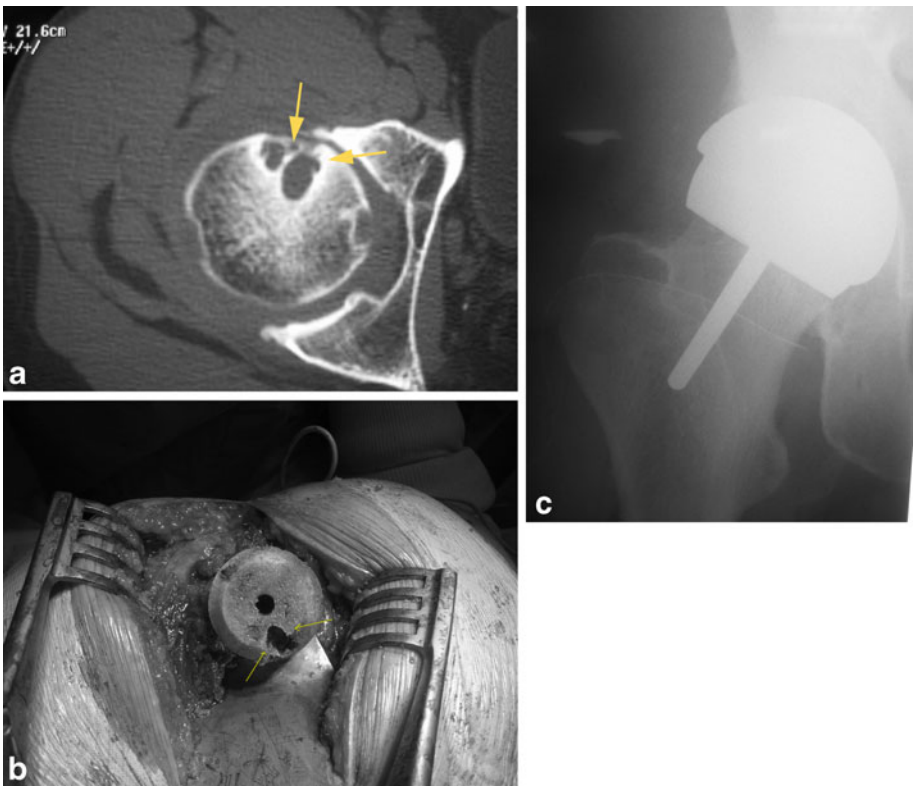

Fig. 2. Case example of right osteoarthritis in a 41-year-old man. Preoperative computed tomography revealed a cyst in the femoral head (*yellow arrows*; **a**). The surgical procedure confirmed this defect which led to impossible full contact (*yellow arrows*) between the femoral component and the head (**b**). A conventional cemented femoral component was inserted according to these data (**c**)

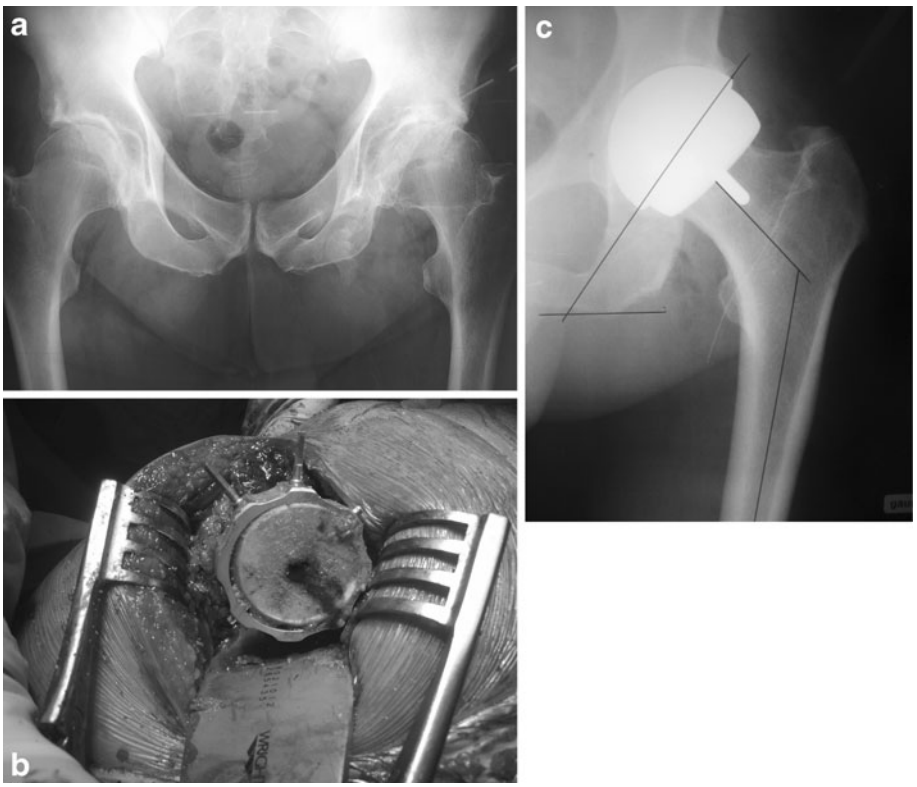

Fig. 3. Case example of left osteoarthritis secondary to femoro-acetabular impingement in a 32-year-old man (**a**). During surgery, the femoral head was fully bleeding with perfect contact between femoral instrumentation and the head (**b**). A cementless femoral component was implanted (**c**)

our clinical series, patients were all clinically improved following cementless RSA. The Postel–Merle D'Aubigné hip score increased from 11.3 to 17.6 points and the Harris hip score from 43.9 to 94.3 points.

Two complications occurred. There was one transitory sciatic nerve palsy in a patient with hip dysplasia which fully recovery within 3 months, and one deep venous thrombosis. At the latest follow-up, no revisions were required.

At a mean follow-up of 13.1 months (8–16), no signs of loosening, e.g., cup migration or radiolucent lines were observed. The change in the femoral neck diameter was <10% in all hips.

The mean cobalt metallic ions level rose from 0.53 μg/l (0.1–1.7) during the pre operative period to 1.7 μg/l (0.6–2.9) at 10 months of follow-up. The mean chromium metallic ions level increased from 0.54 μg/l (0.1–1.4) to 1.98 μg/l (0.1–2.8).

Discussion

Cement is the weak link when long-term femoral component fixation is considered [14]. On the other hand, it is a shock absorber between the prosthesis and bone, absorbing the relatively high stiffness of metal alloys and harmoniously distributing weakness on bone [16]. Because of a concern about the survivor ship of hybrid RSA systems, some authors advocated that a cementless fixation on the femoral side with a RSA seems an attractive option [8]. The purpose of this study was to review current literature experience with cementless RSA as well our own experience using the Conserve Plus device.

This study had several limitations. The first is that the follow-up was short. A longer follow up seems necessary to address the viability of the femoral head under the femoral cementless component. In addition, cemented and cementless RSA were implanted during the inclusion according to preoperative data. The series reported here was highly selected and avoided high-risk scenarios (Fig. 2) [7, 13] [14]. Moreover, the RSA device was always the same and only one experimented surgeon with the same surgical approach and the same surgical procedure made all the cases.

The complications and survivorship rates seems low with a cementless RSA and at least equal to cemented series. For Lilikakis et al. [16], no cases of femoral loosening, femoral neck fracture, or radiolucencies around the stem were noticed. Only two revisions were made (one acetabular cup revision and one infection). For Hull et al. [12] on 135 cementless RSA, no patient required revision. For the others studies, complications rate range from 0 to 20% (Table 1). According to these authors, uncemented femoral fixation may be comparable to cemented fixation (Table 1). This was highlighted in a large study performed by different UK centers with the Cormet device [24]. The surgical approaches were different, as they depended on the surgeons' experience. The survivorship rate was 95% at 5 years of follow-up and was superior to that achieved by the same group of surgeons with cemented femoral fixation (91% at 8 years of follow-up). Among 747 cementless procedures, 24 failures related to five aseptic cup loosening (22%), two head collapsus (8.5%), one subluxation (4.2%), one acetabular fracture (4.2%), three neck fractures (12.5%), six

unexplained groin pains (25%), two sepsis, one articular damage-causing hardware, one cup malposition, and one case of metallosis from adverse reaction to metal debris were noticed. Other experience with Biomet Recap hybrid and porous-coated devices (full coating of titanium plasma spray on the entire under-surface of the femoral component) achieved a similar failure rate (2%) in the uncemented and cemented groups (19). According to these authors, uncemented femoral fixation may be comparable to cemented fixation.

But other authors reported slightly better survivorship in the uncemented group. In large series of more than 1,000 uncemented Biomet RSAs, Gross found a survivorship of 98.5% with six femoral neck fractures (0.6%), two femoral head osteonecrosis (0.2%), and three acetabular in-growth failures (0.3%) [10]. Comparison between cemented femoral components (740 cases) and cementless devices (1,300 cases) revealed a better survivorship in cementless group (99 versus 98% at 2 years). Moreover, this study highlighted the fact that these results were achieved in an unselected group of patients. Hence, the outcome could be improved by preselecting candidates. In our study, we selected only the cases which filled the three peroperative data for a "fit and fill" cementless RSA impaction.

Less narrowing of the femoral neck in the hips with an uncemented component may theoretically be observed but the accuracy of this finding seems unclear [28]. For Hing et al. [11], with 2- to 6-year follow-up of hybrid hip resurfacing, the rate of neck narrowing was 77%. Moreover, this narrowing was considered as significant and exceeded 10% in more than one quarter of cases. These authors concluded that neck narrowing did not progress after a 3-year follow-up period. Some neck narrowing risk factors were identified: female gender and pre-operative femoral neck valgus. Moreover, no adverse clinical data related to this radiological finding were obtained at latest follow-up. With cementless femoral components, Gross and Liu found significant neck narrowing in only one patient with risk factors (a woman with femoral neck valgus) [9]. Hing et al. [11] did not observe progression of neck narrowing after 3-year follow-up and correlation with the clinical results. Similar data were reported by Lilikakis et al. [16] with a radiological neck narrowing rate of 27%. Fern and Norton [4] investigated a continuous series of 273 cementless Cormet femoral components implanted via the Ganz trochanteric flip approach. They found only one neck narrowing case in 50 months of follow-up. Villar [26] analyzed the neck narrowing rate between cemented and cementless femoral components and did not discern any differences. According to these data and to our results, the neck thinning observed after cementless hip resurfacing is similar to that observed with cemented RSA systems and is not a major concern [25].

Metallic ion evaluation after the implantation of a metal on metal bearing serves as an indicator of tribological performance. Nevertheless, acceptable cobalt and chromium levels have not yet been adopted by the orthopedics community. Both cobalt and chromium metallic ion levels increase up to 15 months after implantation of a hip-resurfacing device. Then, they decrease toward but do not return to preoperative levels. With a mean 10 months of follow-up, our results appeared to be at the end of this running wear period and were comparable with others studies analyzing cementless or cemented RSA. In most of the series, no difference was observed between cementless and cemented RSA

In summary, all cementless femoral components in this series seem to have achieved excellent bone fixation without radiological abnormalities. A longer follow-up (more than 10 years) of cementless femoral components is required to assess the potential superiority of cementless designs over cemented devices. However, in 2012, it appears that the orthopaedic community has reached a relative consensus on cementless stem and cup fixation in total hip arthroplasty, especially among young and active patients, to avoid cement fatigue failure [2, 20]. Surprisingly, the same philosophy was not applied to hip-resurfacing arthroplasty. However, cementless "fit and fill" femoral-side fixation, which seems to be potentially evolved and design-related, should be considered for future RSA device generations [23].

Disclosures Each author certifies that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

References

1. Baker R, Whitehouse M, Kilshaw M, Pabbruwe M, Spencer R, Blom A, Bannister G. Maximum temperatures of 89 °C recorded during the mechanical preparation of 35 femoral heads for resurfacing. Acta Orthop. 2011; 82: 669–73
2. Chandler HP, Reineck FT, Wixson RL, McCarthy JC. Total hip replacement in patients younger than thirty years old. A five-year follow-up study. J. Bone Joint Surg. Am. 1981; 63: 1426–34
3. de Waal Malefijt MC, Huiskes R. A clinical, radiological and biomechanical study of the TARA hip prosthesis. Arch Orthop. Trauma Surg. 1993; 112: 205–20
4. Fern ED, Norton MR. Is neck resorption a problem after hip resurfacing? Read at the 2007 Young Arthritic Hip Meeting, October 11–13, 2007, Vienna, Austria
5. Girard J, Bocquet D, Autissier G, Fouilleron N, Migaud H. Metal-on-Metal hip arthroplasty in patients thirty years of age or younger. J. Bone Joint Surg. Am. 2010; 92: 2419–26
6. Girard J, Glorion C, Bonnomet F, Fron D, Migaud H. Risk factors for revision of hip arthroplasties in patients younger than 30 years. Clin. Orthop. Relat. Res. 2011; 469: 1141–7
7. Gross TP, Liu F. Is there added risk in resurfacing a femoral head with cysts? J. Orthop. Surg. Res. 2011; 17: 55–6
8. Gross TP, Liu F. The first 100 fully porous-coated femoral components in hip resurfacing. Bull. N.Y.U. Hosp. Jt. Dis. 2011; 69: 30–5
9. Gross TP, Liu F. Metal-on-metal hip resurfacing with an uncemented femoral component. A seven-year follow-up study. J. Bone Joint Surg. Am. 2008; 90: S32–7
10. Gross TP. Variations and new designs. Uncemented heads. Read at the 4th Hip Resurfacing Course, June 16–19, 2010, Gand, Belgium
11. Hing CB, Young DA, Dalziel RE, Bailey M, Back DL, Shimmin AJ. Narrowing of the neck in resurfacing arthroplasty of the hip: a radiological study. J. Bone Joint Surg. Br. 2007; 89: 1019–24
12. Hull P, Baxter JA, Lewis C, Kordas G, Foguet P, Prakash U. Metal-on-metal hip resurfacing with uncemented fixation of the femoral component. A minimum 2 year follow up. Hip Int. 2011; 21: 475–8

13. Johnson AJ, Zywiel MG, Hooper H, Mont MA. Narrowed indications improve outcomes for hip resurfacing arthroplasty. Bull. N.Y.U. Hosp. Jt. Dis. 2011; 69: 27–9
14. Katrana P, Crawford JR, Vowler S, Lilikakis A, Villar RN. Femoral neck resorption after hip resurfacing arthroplasty—a comparison of cemented and uncemented prostheses. J. Bone Joint Surg. Br. 2006; 88: S234
15. Lerch M, Olender G, Angrisani N, Rittershaus D, Meyer-Lindenberg A, Thorey F, Windhagen H, Hurschler C. The impact of seating forces from a cementless femoral component in hip resurfacing arthroplasty on the femoral head—a cadaver study using μ-CT analysis. Technol. Health Care 2011; 19: 29–36
16. Lilikakis AK, Vowler SL, Villar RN. Hydroxyapatite-coated femoral implant in metal-on-metal resurfacing hip arthroplasty: minimum of two years follow-up. Orthop. Clin. North Am. 2005; 36: 215–22
17. Little JP, Gray HA, Murray DW, Beard DJ, Gill HS. Thermal effects of cement mantle thickness for hip resurfacing. J. Arthroplasty 2008; 23: 454–8
18. Lord GA, Hardy JR, Kummer FJ. An uncemented total hip replacement: experimental study and review of 300 madreporique arthroplasties. Clin. Orthop. Relat. Res. 1979; 141: 2–16
19. Mazzullo S, Paolini M, Verdi C. Numerical simulation of thermal bone necrosis during cementation of femoral prostheses. J. Math. Biol. 1991 29: 475–94
20. Migaud H, Putman S, Krantz N, Vasseur L, Girard J. Cementless metal-on-metal versus ceramic-on-polyethylene hip arthroplasty in patients less than 50 years of age: a comparative study at 12- to 14-year follow-up. J. Bone Joint Surg. Am. 2011; 93: 137–42
21. Mjöberg B. Loosening of the cemented hip prosthesis. The importance of heat injury. Acta Orthop. Scand. 1986; 221:1–40
22. Scheerlinck T, Delport H, Kiewitt T. Influence of the cementing technique on the cement mantle in hip resurfacing: an in vitro computed tomography scan-based analysis. J. Bone Joint Surg. Am. 2010; 92: 375–87
23. Spencer RF. Evolution in hip resurfacing design and contemporary experience with an uncemented device. J. Bone Joint Surg. Am. 2011; 93: 84–8
24. Spencer RF. Hip resurfacing, UK experience. Eighth Symposium on Joint Preserving and Minimally Invasive Surgery of the Hip, June 10–12, 2010, Ottawa, Canada
25. Takamura KM, Yoon J, Ebramzadeh E, Campbell PA, Amstutz HC. Incidence and significance of femoral neck narrowing in the first 500 Conserve® Plus series of hip resurfacing cases: a clinical and histologic study. Orthop. Clin. North Am. 2011; 42: 181–93
26. Villar R. BHR versus Cormet hip resurfacing masterclass. Read at the Hip Resurfacing Symposium, July 5–6, 2007, Oswestry, U.K.
27. Wagner M, Wagner H. Preliminary results of uncemented metal on metal stemmed and resurfacing hip replacement arthroplasty. Clin. Orthop. Relat. Res.1996; 329: S78–88
28. Watanabe Y, Shiba N, Matsuo S, Higuchi F, Tagawa Y, Inoue A. Biomechanical study of the resurfacing hip arthroplasty: finite element analysis of the femoral component. J. Arthroplasty 2000; 15: 505–11