

Cementless Hip Arthroplasty in Southern Iran, Midterm Outcome and Comparison of Two Designs

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Abstract

Background: Cementless hip prosthesis was designed to provide biologic fixation, without the use of cement. The second generation components have shown more reliable bone ingrowths and survival rates. We are reporting a midterm result of two designs of cementless prosthesis in a unique culture with different social habits and expectations.

Methods: 52 primary cementless total hip arthroplasty in 42 patients with the mean age of 48.8 years were retrospectively studied. Two groups of prosthesis had been implanted: Harris-Galante II (HGII) in 15 and Versys-Trilogy (V-T) in 37 hips, both from Zimmer company. The patients were assessed clinically, radiographically and with Harris hip score, SF36, WOMAC, and MACTAR questionnaires, with 65 months (26-136) mean follow-up.

Results: All the V-T prostheses had survived well. Eight of HG II were revised by the last follow-up in 19-102 months. All had undergone acetabular revision and 2 combined with femoral revision. Broken tines of HGII cups were seen in 4 radiographs. The 65 months overall survival was 96.2% for femoral and 84.6% for acetabular components. 90% had good or excellent Harris hip scores. The functional scores were poorer in the HG II group. Pain relief and improved walking were the two main patients' expectations fulfilled in 97.6% and 92.8%, respectively.

Conclusions: The outcome of cementless total hip arthroplasty (THA) is satisfactory and comparable with the literature based on the results of function and survival of this small comparative group. The use of HGII acetabular component should be abandoned.

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Introduction

Total joint arthroplasty, in particular THA, has had a revolutionary role in improving the quality of life.¹ The use of bone cement for the implant stability versus biologic fixation with bone ingrowth in cementless THA has been a controversial issue for years. While immediate cement fixation in very old people or in those with poor bone stock might provide a quicker return to daily activity, cementless implants have gained more popularity over the years. The relative superiority of cementless acetabular component over

cemented ones is nowadays a well-accepted fact.² The femoral stem, however, has very good long-term reports both in cemented and cementless forms.^{3,4}

Aseptic loosening is a long-term complication of THA.⁵ Efforts to decrease the rate of loosening have included the use of newer materials, improvement in the design of the implant; and modification of operative techniques.⁶ After the midterm follow-up results of cementless THA, the long-term results with impressive survival rates, are being reported more and more.⁷⁻⁹ The purpose of this study is to evaluate the efficacy and prosthesis survival in an Iranian society, with its unique cultural lifestyle and social differences from western societies.

Materials and Methods

The cases of cementless total hip arthroplasty performed in Nemazee hospital by a single surgeon from May 1997 to June 2007 were included in a retrospective outcome study. From the total of 63 hips in 52 consecutive patients, 3 patients had died at the time of the last follow up due to problems unrelated to the operation and 7 patients could not be reached. Therefore, 52 hips (42 patients) comprised the study group. The information from medical records of all the cases, including radiographs, was collected and the patients were called in for an interview, physical examination, and radiographic assessment. The patients filled the general-health assessment form, Short Form 36 (SF-36); the arthritis specific functional instrument WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index), and patient reference disability questionnaire MACTAR (McMaster Toronto Arthritis). Harris hip rating scale was also filled for all the hips, (where 90-100 points would be excellent, 80-89 good, 70-79 fair, and below 70 is assumed a poor result).¹⁰⁻¹³

The radiographic assessment was by measurement of the cup and stem alignment in the immediate post-operative anteroposterior and frog-lateral views. The same views in the final follow-ups were specifically evaluated for any possible change in cup orientation, loosening in cup or stem (based on Gruen classification for zones of the femoral stem and Martell et al. modification of DeLee and Charnely for acetabular component). Osseous integration of the acetabular and femoral components were assessed using the proposed criteria of Moore et al. Considering the five criteria of absence of radiolucent lines, superolateral and inferomedial buttressing, medial stress-shielding, and radial

trabeculae for acetabular shell and stem bony ingrowth according to Engh et al. Osseointegration in stem was evaluated by the presence of spot welds, cortical hypertrophy; and absence of radiolucent lines, and pedestal formation.¹⁴⁻¹⁷ Ectopic ossification, using Brooker classification was also noted.¹⁸

Two types of prosthesis had been used in these cases. Harris-Galante II (HG II) porous-coated prosthesis (HGP, Zimmer, Warsaw, Indiana) was implanted in 15 and Versys-Trilogy (V-T) system (Zimmer, Warsaw, Indiana) in the remaining 37 hips.

The HG II is a modular prosthesis. The straight stem is TIVANIUM® Ti-6 AL-4V alloy with a proximal pure titanium fiber metal mesh coating; with a collar and a modular Morse tapered neck, which is available in three lengths. There are porous pads, made of commercially pure titanium wire, proximally on the anterior and posterior surfaces and a small medial pad immediately distal to the collar. The shell is a partial hemisphere made of titanium alloy with fiber metal mesh coating with variable number of holes for screw fixation. The shell with several titanium tines captures the polyethylene cup. The modular heads are chrome-cobalt mainly 28-millimeter heads.¹⁹

Versys femoral stem (Zimmer, Warsaw, Indiana) is a collarless proximally and circumferentially coated prosthesis for cementless use. Trilogy shells are coated with commercially pure titanium fiber metal, which is clinically proven to enhance fixation through bone ingrowths. It is diffusion-bonded to a Tivanium® Ti-6Al-4V Alloy substrate.

All the cases were done by anterior hip exposure with the lateral Hardinge incision.²⁰ Infection prophylaxis was with cephalosporin and gentamicin at the time of surgery and 48 hours post-surgery. Thromboembolic prophylaxis was mostly by warfarin for 6 weeks with the intended INR (international normalized ratio) of 1.7 to 2. Early mobilization and first post-surgery day ambulation and crutch walking for 6 weeks were the uniform care received by all the patients.

The prosthesis survivorship limit was defined as implant life span and revision-ready state with progressive symptoms. Loosening of the component was defined as "definite" when subsidence, varus, or valgus orientation change was observed in femoral component and angle change, or migration of two millimeter or more seen in two views for the acetabular component. The polyethylene wear was assessed by direct visual observation of serial radiographs.

Results

The 42 patients (52 hips) included fourteen males (33.3%) and twenty-eight females (66.7%), with the mean age of 48.83 years (± 13 years, range 22-75) at surgery.

Harris-Galante II prosthesis was used in 15 cases and Versys-Trilogy prosthesis in 37 hips. The average duration of follow-up was 65 months (range 26-136). The HG II group of prostheses had a longer follow-up of 105 months (range 52-136). This figure was 49 months for Versys-Trilogy group (range 26-78). The overall mean follow-up was 65 months (± 32 , range 26-136).

The overall arthroplasty survival (i.e., well-functioning prosthesis with no clinical or radiographic evidence of wear, loosening, infection, etc.), which would suggest the need for revision was 65 months. Therefore, 43 hips in 34 patients were in good and functional status by the time of last follow-up. The overall survival rate in the present series was 96.2% for femoral components and 84.6% for acetabular components in 5.5 years.

Post-operatively, hips had a mean flexion arc of 114 degrees and 9 degrees of flexion contracture. The mean abduction and rotation were 25 and 50 degrees, respectively.

The overall HHS with a mean of 85 (± 15 , range 24-100) was excellent in 65.9%, good in 27.3%, fair in 4.5% and poor in 2.3% of cases.

The WOMAC score had a mean of 22.7 (± 13 , range 3-62), with 3 being the best and 62 the worst case scenario. The pain subscore of WOMAC was 2.87, joint stiffness 2.21 and functional subscore 17.62. The items in the function, which were of most concern to the patients were, in a descending order: inability in stair climbing; sitting or getting up from the floor or from flat-top toilets; picking up objects from the floor; and putting on or taking off socks.

SF 36 measurement had a total mean score of 61.33 (range 18-95). Out of the 8 items in SF 36, the best score was for "social functioning" and the worst was for "role limitation due to physical problems" (74.6 and 50.6, respectively).

The patient expectation questionnaire of MACTAR had the following findings:

Pain relief was achieved in 41 cases (97.6%), improvement in walking in 39 (92.8%), and improved ability in performing daily living activities in 37 (88%). The correlation of the above scoring system in this group of patients was evaluated. A close correlation between Harris Hip Score and total WOMAC score was found (correlation coefficient $r=0.38$). These correlations were strong in "pain" and "function"

items, but not as much with "stiffness" item in WOMAC (P values 0.002, 0.001 and 0.45, respectively).

SF 36 and Harris Hip Score were closely correlated and value of r was 0.67. Pain item of HHS had no correlation with SF36 scores. SF 36 was more closely correlated with "pain" and "function" subscores of WOMAC ($r=-0.77$ and 0.78, respectively).

There was no infection, and no thromboembolic event in any of the 52 hips. In the last follow-up assessments, 44 hips (84.6%) were functional and well fixed; 8 cases had undergone revision and one patient is suspected of the early stage of loosening and is being followed.

All surviving hips showed radiographic signs of being stable in both components. However, "pedestal" was seen in 3 (7%) stems, and 1-2 millimeter non-progressive radiolucent lines in 20% of femurs and 4.5% of acetabular components.

Heterotopic ossification as a late complication was found in 35 hips (67.3%), 29 (82.7%) of which were Brookers' I and II, 5 Brookers' III and one Brookers' IV.

Since there were two groups of prostheses from the same company used in this study, they also were separately evaluated:

Among the 15 cases of Harris-Galante II prosthesis, with average follow-up of 105 months (range 52-136), 8 cases had developed problems, all of which had been already revised. All of the revised cases had problems in the acetabulum with cup wear, loosening, and polyethylene fracture and two of them had a simultaneous femoral loosening and osteolysis secondary to polyethylene wear debris. The etiology of hip disease in these 8 revisions, included five acetabular dysplasia, one avascular necrosis and systemic lupus erythematosus, one multiple epiphyseal dysplasia, and one primary osteoarthritis. In reviewing the original radiographs, no initial radiographic malposition was present and the stems were in normal orientation and mean shell inclination angle was 47 degrees (range 40-57 degrees), which was not statistically different from the Versys-Trilogy group ($P=0.51$).

The primary etiology of hip disease, in terms of distribution in these two groups, was different (Table 1).

Broken tines of fiber metal-coated acetabular shells were seen in 5 patients, all in the failed acetabular components (Figure 1).

The Harris Hip Score, WOMAC and SF36 in the 15 HG II cases were significantly poorer than the 37 cases with Versys-Trilogy prosthesis: Harris Hip Score of 66 versus 92,

Table 1: Comparison of etiology of hip replacement in two groups

Etiology	Harris-Galante II	Versys-Trilogy	Total (%)
Primary osteoarthritis	3	13	16 (30.8)
Inflammatory arthritis	7	15	22 (42.3)
Post traumatic	1	4	5 (9.6)
Hip dysplasia	3	2	5 (9.6)
Avascular necrosis	0	1	1 (1.9)
Miscellaneous	1	2	3 (5.8)
Total	15	37	52 (100)

**Figure 1:** Broken tine of the cup is seen in radiography.

WOMAC 30 versus 20; and SF36 of 49 versus 66 (P value 0.009).

The Versys-Trilogy prostheses are all surviving in a mean follow-up of 49 months (range 26-78) with no radiographic or clinical evidence of loosening or wear. The five early complications, mentioned above, were all in this group of prostheses.

Discussion

This is a small group of cases with a midterm follow-up on porous-coated hip arthroplasty in a society with unique social habits and customs.

The all cemented prostheses have long time tract record of over 20 years. The Charnley prosthesis reported by Ranawat had 90% survival of the femoral component, while Harris had about 80% survival with revision mainly on the acetabular side.²¹

Porous-coated implants were used with the idea of removing the so-called "weak link" in the hip replacement from 1971. This has survived as a very good hip arthroplasty option for young active individuals with good bone stock.^{22,23}

The results with non-circumferential proximal porous-coating prosthesis like porous-coated anatomic, PCA (Howmedica, Rutherford, New Jersey) and Harris-Galante I (Zimmer, Warsaw, Indiana) were not satisfactory: failures

of 43% and only 57% survival in 8 years. Kim recently reported that PCA prosthesis (Howmedica) had 21% revision in 20 years for the acetabular component and 9% for femoral component. These two prostheses are not in use anymore.²⁴

After generally satisfactory short and midterm results of the second generation of cementless implants (with proximal circumferential porous-coating), Clohisy and Harris reported a 96% 10-year survival rate for acetabular component⁶ and Archibeck et al. in a study of 92 patients with the same follow-up had a 96.4% survival rate for acetabular and 100% for femoral components.²⁵ Most studies have evaluated the functional results with HHS with 83-95 points on average. Shetty et al. reported 100% ten years survival in a hydroxyapatite-coated, proximally and circumferentially coated prosthesis.²⁶ Engh et al., using an extensively coated prosthesis reported on 5-year, 10-year, and 15-year follow-ups.²⁷ The incidence of thigh pain was, however, more with more extensive coating.

The acetabular component in most reports is the one with more problems and the responsible section for loosening (Kim, Engh, Archibeck).^{10,28-29} The threaded shells seem to have lesser chance of Osseointegration and therefore more failures. The number of holes for temporary screw fixation has also been a point of concern, as more holes might provide better access for migration of polyethylene debris behind the shell and into the femoral canal.³⁰

The locking of the polyethylene cup into the metal shell is variable in different designs of prostheses. Poor locking mechanism can cause micromotion between the liner and the shell, causing more wear and subsequent dislodgment of the liner.³¹

The survival rate in the present series with 96.2% for the femoral component and 84.6% for the acetabular component in 5.5 years is not a very promising result. The high revision rate of 15.4% was primarily in the HG II components and all were related to the acetabular side with wear, breakage, and dislodgment of polyethylene liner.

Others have also reported the problem with HG II cups. Louwerse et al. in 1999 reported 26 cases of liner failure, 13 of which belonged to HG cups.³² Gonzalez in 2001 had 17 liner dislodgments in HG II cups.³³ Curry et al. in a 10-year follow-up reported 271 cases of HG II prosthesis in 2008. They encountered 48 acetabular failures, 67% of them were due to liner dissociation.³¹

Our HG II group of arthroplasty in 9 years average follow-up had 46.7% overall prosthesis

survival. The femoral stems were revised in only two cases that had severe bone lyses secondary to the acetabular liner problem, and the remaining 50 (96.2%) stems are stable and functioning well.

Although the revised cups, except one, did not have primary osteoarthritis or inflammatory arthritis, the numbers are too few to draw any conclusion as to whether the primary etiology could have had any bearing on the high rate of liner problem in HG II cups.

The average time interval until revision was 5.5 years. This is similar to findings of Curry et al. The appearance of broken tines was visible on radiographs, one to two years before the hips became symptomatic. Broken tines are probably early warning signs of instability. Excessive motion will cause wear of the liner and material debris will initiate retro acetabular and proximal femoral osteolysis. This would eventually lead to failure.³³

At the same time, the Trilogy cups (Zimmer, Warsaw, Indiana) with Versys circumferentially coated stems have 100% survival in 4 years average follow-up. The locking mechanism in the Trilogy is split-ring mechanism, which has been used in several other designs with a good track record.

The Harris Hip Score in the V-T group and surviving HG II (not revised) were excellent or good in 93.2% and good in, but in the total group including the revised hips were 85.

The adjusted general health measures (SF36) and disease specific outcome measures (WOMAC) and patients' expectations have been previously studied for knee arthroplasty in this region, but not for hip arthroplasty.³⁴ These measures showed good correlations with our Harris Hip Scores. The HG II group had, understandably, a significant drop in their WOMAC and SF36 scores due to the inclusion of the 15.6% revision. Expectations of the patients, that were mainly relief of pain and ability to walk comfortably, were fulfilled in nearly all the patients (97.6% and 92.8%, respectively). Some preoperative problems relatively unique to our culture, flatfoot toilet and cross-legged sitting on the floor, were not the expectations of the patients and seem to be modified after surgery by the patients.

The radiographic evaluation in the present paper showed good positioning of cups and stems in accordance with established standards. The ones that required revision also had well-placed components. The osseous integration was also satisfactory in the surviving prostheses. The radiolucent lines and pedestal formation in those few cases were not indicative of loosening.^{16,17}

There were only 4 cases (9.3%) of thigh pain in this series that had no correlation with the size of the femoral stem. The incidence of thigh pain, which is related to the stability of the prosthesis, is reported between 0 and 28% in different articles.^{10,24,28,29}

In spite of the literature report of 0.28-4% infection and 2.2-14.7% thromboembolic events, none of these complications were observed in the present series. The early dislocation in two cases is similar to the literature. The ulnar nerve injuries were in the contralateral upper limbs from arm malpositioning during anesthesia. The tibial and peroneal nerve injuries from the traction effect of lengthening observed in this report is a recognized problem, and has been reported in the literature with an incidence of 0.3-3.7% in hip arthroplasty, usually associated with lengthening of over 1.7 centimeters.³⁵⁻³⁷

The main limitations of the present study are its retrospective nature and small numbers of cases, however, the merits are that it is a single surgeon's experience with uniform technique and post-operative care and being a unique study in Iran with the special cultural and daily living habits.

Conclusion

The generally satisfactory results of hip arthroplasty as demonstrated by Harris Hip Scores and functional assessments with WOMAC, SF 36 and MACTAR are shown in Iranian society in spite of some cultural and social differences. The outcome of cementless THA is satisfactory and comparable with the literature based on the results of function and survival of this small comparative group. The use of HGII acetabular component should be abandoned, because of the poor locking mechanism of the shell with the liner.

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Conflicts of Interest: None declared.

References

1. Pulido L, Rachala SR, Cabanela ME. Cementless acetabular revision: past, present, and future. Revision total hip arthroplasty: the acetabular side using cementless implants. *Int Orthop*. 2011;35:289-98. doi: 10.1007/

- s00264-010-1198-y. PubMed PMID: 21234562, PubMed PMCID: PMC3032100.
2. Toossi N, Adeli B, Timperley AJ, Haddad FS, Maltenfort M, Parvizi J. Acetabular components in total hip arthroplasty: is there evidence that cementless fixation is better? *J Bone Joint Surg Am.* 2013;95:168-74. doi: 10.2106/JBJS.K.01652. PubMed PMID: 23324965.
 3. Ling RS, Charity J, Lee AJ, Whitehouse SL, Timperley AJ, Gie GA. The long-term results of the original Exeter polished cemented femoral component: a follow-up report. *J Arthroplasty.* 2009;24:511-517. doi: 10.1016/j.arth.2009.02.002. PubMed PMID: 19282139.
 4. Firestone DE, Callaghan JJ, Liu SS, Goetz DD, Sullivan PM, Vittetoe DA, et al. Total hip arthroplasty with a cemented, polished, collared femoral stem and a cementless acetabular component. A follow-up study at a minimum of ten years. *J Bone Joint Surg Am.* 2007;89:126-32. PubMed PMID: 17200319.
 5. Callaghan JJ, Dysart SH, Savory CG. The uncemented porous-coated anatomic total hip prosthesis. Two-year results of a prospective consecutive series. *J Bone Joint Surg Am.* 1988;70:337-46. PubMed PMID: 3346261.
 6. Paterson M, Fulford P, Denham R. Loosening of the femoral component after total hip replacement. The thin black line and the sinking hip. *J Bone Joint Surg Am.* 1986;67:392-7. PubMed PMID: 3733803.
 7. Ranawat CS, Atkinson RE, Salvati EA, Wilson PD Jr. Conventional total hip arthroplasty for degenerative joint disease in patients between the ages of forty and sixty years. *J Bone Joint Surg Am.* 1984;66:745-52. PubMed PMID: 6725322.
 8. Kim YH. Long-term results of the cementless porous-coated anatomic total hip prosthesis. *J Bone Joint Surg Br.* 2005;87:623-7. doi: 10.1302/0301-620X.87B5.15554. PubMed PMID: 15855361.
 9. Engh CA Jr, Culpepper WJ 2nd, Engh CA. Long-term results of use of the anatomic medullary locking prosthesis in total hip arthroplasty. *J Bone Joint Surg Am.* 1997;79:177-84. PubMed PMID: 9052537.
 10. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care.* 1992;30:473-83. PubMed PMID: 1593914.
 11. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J Rheumatol.* 1988;1:95-108. PubMed PMID: 3068365.
 12. Tugwell P, Bombardier C, Buchanan WW, Goldsmith CH, Grace E, Hanna B. The MACTAR Patient Preference Disability Questionnaire--an individualized functional priority approach for assessing improvement in physical disability in clinical trials in rheumatoid arthritis. *J Rheumatol.* 1987;14:446-51. PubMed PMID: 3305931.
 13. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J Bone Joint Surg Am.* 1969;51:737-55. PubMed PMID: 5783851.
 14. Martell JM, Pierson RH 3rd, Jacobs JJ, Rosenberg AG, Maley M, Galante JO. Primary total hip reconstruction with a titanium fiber-coated prosthesis inserted without cement. *J Bone Joint Surg Am.* 1993;75:554-71. PubMed PMID: 8478383.
 15. Engh CA, Massin P, Suthers KE. Roentgenographic assessment of the biologic fixation of porous-surfaced femoral components. *Clin Orthop Relat Res.* 1990;257:107-28. doi: 10.1097/00003086-199008000-00022. PubMed PMID: 2199114.
 16. Gruen TA, McNeice GM, Amstutz HC. "Modes of failure" of cemented stem-type femoral components: a radiographic analysis of loosening. *Clin Orthop Relat Res.* 1979;141:17-27. doi: 10.1097/00003086-197906000-00002. PubMed PMID: 477100.
 17. Moore MS, McAuley JP, Young AM, Engh CA Sr. Radiographic signs of osseointegration in porous-coated acetabular components. *Clin Orthop Relat Res.* 2006;444:176-83. doi: 10.1097/01.blo.0000201149.14078.50. PubMed PMID: 16523139.
 18. Brooker AF, Bowerman JW, Robinson RA, Riley LH Jr. Ectopic ossification following total hip replacement. Incidence and a method of classification. *J Bone Joint Surg Am.* 1973;55:1629-32. PubMed PMID: 4217797.
 19. Archibeck MJ, Berger RA, Jacobs JJ, Quigley LR, Gitelis S, Rosenberg AG, et al. Second-generation cementless total hip arthroplasty. Eight to eleven-year results. *J Bone Joint Surg Am.* 2001;83:1666-73. PubMed PMID: 11701789.

20. Hardinge K. The direct lateral approach to the hip. *J Bone Joint Surg Br.* 1982;64:17-9. PubMed PMID: 7068713.
21. Rasquinha VJ, Ranawat CS. Durability of the cemented femoral stem in patients 60 to 80 years old. *Clin Orthop Relat Res.* 2004;419:115-23. doi: 10.1097/00003086-200402000-00019. PubMed PMID: 15021141.
22. Harris WH. A new total hip implant. *Clin Orthop Relat Res.* 1971;81:105-13. PubMed PMID: 5133028.
23. Parvizi J, Campfield A, Clohisy JC, Rothman RH, Mont MA. Management of arthritis of the hip in the young adult. *J Bone Joint Surg Br.* 2006;88:1279-85. doi: 10.1302/0301-620X.88B10.17859. PubMed PMID: 17012414.
24. Kim YH. The results of a proximally-coated cementless femoral component in total hip replacement: a five- to 12-year follow-up. *J Bone Joint Surg Br.* 2008;90:299-305. doi: 10.1302/0301-620X.90B3.20096. PubMed PMID: 18310749.
25. Clohisy JC, Harris WH. The Harris-Galante porous-coated acetabular component with screw fixation. An average ten-year follow-up study. *J Bone Joint Surg Am.* 1999;81:66-73. PubMed PMID: 9973056.
26. Shetty AA, Slack R, Tindall A, James KD, Rand C. Results of a hydroxyapatite-coated (Furlong) total hip replacement: a 13- to 15-year follow-up. *J Bone Joint Surg Br.* 2005;87:1050-4. doi: 10.1302/0301-620X.87B8.16011. PubMed PMID: 16049237.
27. McAuley JP, Culpepper WJ, Engh CA. Total hip arthroplasty. Concerns with extensively porous coated femoral components. *Clin Orthop Relat Res.* 1998;355:182-8. PubMed PMID: 9917603.
28. Engh CA, Bobyn JD, Glassman AH. Porous-coated hip replacement. The factors governing bone ingrowth, stress shielding, and clinical results. *J Bone Joint Surg Br.* 1987;69:45-55. PubMed PMID: 3818732.
29. Kim YH, Kim VE. Results of the Harris-Galante cementless hip prosthesis. *J Bone Joint Surg Br.* 1992;74:83-7. PubMed PMID: 1732272.
30. Fox GM, McBeath AA, Heiner JP. Hip replacement with a threaded acetabular cup. A follow-up study. *J Bone Joint Surg Am.* 1994;76:195-201. PubMed PMID: 8113253.
31. Curry HG, Lynskey TG, Frampton CM. Harris-Galante II acetabular cup: a survival analysis. *J Orthop Surg (Hong Kong).* 2008;16:201-5. PubMed PMID: 18725673.
32. Louwerse RT, Heyligers IC. Late failure of the polyethylene liner fixation in an uncemented total hip arthroplasty. *J Arthroplasty.* 1999;14:391-6. doi: 10.1016/S0883-5403(99)90070-0. PubMed PMID: 10220198.
33. González della Valle A, Ruzo PS, Li S, Pellicci P, Sculco TP, Salvati EA. Dislodgment of polyethylene liners in first and second-generation Harris-Galante acetabular components. A report of eighteen cases. *J Bone Joint Surg Am.* 2001;83:553-9. PubMed PMID: 11315784.
34. Shahcheraghi GH, Javid M, Mahmoodian B. Functional Outcome Study in Total Knee Arthroplasty. *Iran J Med Sci.* 2004;29:151-6.
35. Phillips JE, Crane TP, Noy M, Elliott TS, Grimer RJ. The incidence of deep prosthetic infections in a specialist orthopaedic hospital: a 15-year prospective survey. *J Bone Joint Surg Br.* 2006;88:943-8. doi: 10.1302/0301-620X.88B7.17150. PubMed PMID: 16799001.
36. Huo MH, Parvizi J, Gilbert NF. What's new in hip arthroplasty. *J Bone Joint Surg Am.* 2006;88:2100-13. doi: 10.2106/JBJS.F.00595. PubMed PMID: 16951129.
37. Farrell CM, Springer BD, Haidukewych GJ, Morrey BF. Motor nerve palsy following primary total hip arthroplasty. *J Bone Joint Surg Am.* 2005;87:2619-25. doi: 10.2106/JBJS.C.01564. PubMed PMID: 16322610.