Hemiarthroplasty or total hip arthroplasty for displaced femoral neck fractures in the elderly?

Paul T.P.W. Burgers, MD[1]; Michel P. J. van den Bekerom, MD[2]; Elsa F. Hilverdink, MSc[2]; Esther M. M. van Lieshout, PhD[1]; Rudolf W. Poolman, MD, PhD[3]; Ernst L. F. B. Raaymakers, MD, PhD[4]

[1] Trauma Research Unit Dept. of Surgery, Erasmus MC, University Medical Center Rotterdam, Rotterdam, the Netherlands

[2] Academic Medical Center, Department of Orthopedic Surgery, Amsterdam, The Netherlands

3 Joint Research, Dept. of Orthopedic Surgery, Onze Lieve Vrouwe Gasthuis, Amsterdam, The Netherlands

[4] Academic Medical Center, Trauma Unit, Department of Surgery, Amsterdam, The Netherlands

Abstract

The worldwide incidence of femoral neck fractures is expected to increase enormously with aging of populations globally and increasing industrialization and urbanization. The scientific debate and discussions during morning reports which type of arthroplasty to use for femoral neck fractures in the fit elderly, reflect the ongoing controversies of this topic.

The following relevant outcome parameters in decision making between the 2 types of arthroplasties will be discussed: functional outcomes, rates of complications, acetabular erosion, dislocations, revisions, surgical volume, and (in) direct costs as these are relevant in deciding between total hip arthroplasty and hemiarthroplasty.

Key words

Femoral neck fractures, treatment, operative procedures, total hip arthroplasty, hemiarthroplasty

Introduction

About half of the fractures of the proximal femur are located in the femoral neck. The incidence of femoral neck fractures will increase enormously due to aging of populations globally and increasing industrialization and urbanization.[10]

The aim of hip fracture management should be the return of the patient in optimal condition to their pre-fracture functional status as quickly as possible. Challenges in the treatment of patients with a fragility fracture of the femoral neck include medical co morbidities, frailty of the elderly patient, osteoporosis, and rehabilitation issues. The optimal surgical treatment of mobile, independent, mentally fit patients who have sustained a displaced intracapsular femoral neck fracture remains controversial. Already in 1958, the Committee on Fractures and Traumatic Surgery of the American Academy of Orthopedic Surgeons issued a report discussing the role of prosthetic replacement, including a discussion of the merits of different prostheses, operative techniques, and postoperative management.[11]

Compared with internal fixation, arthroplasty has a lower risk of revision surgery caused by nonunion, malunion, and osteonecrosis, at the cost of greater blood loss and operative time.[12] Also, arthroplasty is associated with an increased infection rate, dislocation, femoral stem loosening, and onset of buttock or groin pain caused by either acetabular protrusion or acetabular cartilage erosion.[13, 14] Unipolar hemiarthroplasty (HA) has been used for managing femoral neck fractures for more than 50 years. Bipolar prostheses, consisting of a prosthesis-acetabular articulation and a femoral head–polyethylene articulation, were introduced in the 1970s in an effort to avoid wear of the acetabulum. The prosthesis-prosthesis articulation theoretically decreases acetabular wear by shifting some hip movement away from the acetabulum to the internal prosthesis prosthesis articulation. Based on the

literature, there is no consensus either supporting or rejecting the use of bipolar rather than unipolar HA.[15] In this Cochrane search, no advantages, or disadvantages were found of the bipolar prosthesis compared to the unipolar prosthesis.
Today there is consensus that patients with a displaced femoral neck fracture with concurrent acetabular disease (osteoarthritis, rheumatoid arthritis, or Paget's disease) require a total hip arthroplasty (THA).[13, 14] Surgeons have been considering the role of THA as primary management of displaced femoral neck fractures since the 1970s. Already in 1980 authors reported on 112 patients treated with a THA for their femoral neck fracture.[16] THA is currently an accepted treatment for the elderly, cognitive fit patient with a displaced femoral neck fracture but the question is whether or not the patients without acetabular disease will also benefit from a THA.

Surgeons who preferred arthroplasty for displaced femoral neck fractures in sixty to eighty-year-old patients remained discordant in their choice between HA and THA. An international survey suggested that over 90% of the respondents believed that HA (either a unipolar or bipolar prosthesis) is the treatment of choice in elderly patients who sustained a displaced fracture of the femoral neck.[17] The infrequent use of THA for this patient group may be related to surgeon experience, patient health status, or geographic variation.[17]

The objective of this study was to review the current literature on this topic. The most relevant outcome measures which will be important for the surgeon and patient in deciding between HA or THA are: functional outcome, complication rate, rate of acetabular erosion after HA, dislocation rate, revision rate, surgical volume, and the (in)direct health care costs.

Available evidence

In a previous systematic review with meta-analysis we analyzed the results of eight randomized clinical trials,[1-8] summing up to a total of 986 patients.[9] Three were single center trials and five were multicenter trials. One trial used uncemented THAs and the other used cemented THAs. Several types of HAs were used with regard to the use of cement and the use of bipolar or unipolar HA. In the same period two other systematic reviews were published on the same trials.[18, 19] Before the data of the largest trial were available, Hopley *et al.* also included studies with a lower level of evidence.[20] In 2010 Parker *et al.* updated their Cochrane database.[15]

Functional Outcome

Bhandari *et al.* reported that many orthopedic surgeons felt that the short-term outcome following a bipolar HA was comparable with that after a THA.[17] Four trials reported on the Harris Hip Score. This score ranges from 0 to 100 points and includes function, pain, deformity and range of motion. Two of the three latest meta-analyses showed better Harris Hip Scores in patients with a THA compared to the patients with a HA. [9, 19] Sensitivity analysis by sequential omission of individual studies showed no change in significance.[19]

Complications

Authors of the four reviews published in 2012 found no significant difference in general complications and infection rates.[9, 18, 19, 21] Also, Hopley *et al.* did not find a significant difference in general complication rates after either form of arthroplasty.[20] Deep infections occurred in 33 of 1602 patients enrolled in 11 studies. No significant

difference in the pooled relative risks of infection was found when comparing HA with THA.[20]

Dislocation

Dislocation is the major concern after primary total hip arthroplasty for the treatment of intracapsular femoral neck fractures. It is obvious that appropriate restoration of neck length and offset are essential in prevention of dislocations.

Berry *et al.* demonstrated a 1.8-fold increased hazard estimate of dislocation risk when the preoperative diagnosis of hip fracture was compared with osteoarthritis.[22] When patients with a single, early (within four months after surgery) hip dislocation were excluded from dislocation statistics, HA and THA had similar long-term dislocation rates.[23] A recurrent dislocation of the hip arthroplasty in the treatment of patients with femoral neck fractures seems to result in a persisting deterioration in the quality of life, while patients with a single dislocation seem to experience only a temporary deterioration.[24]

Burgers *et al.* included in their meta-analysis seven trials which provided data on dislocation. The overall dislocation rate was 3% in HA patients versus 8% in the THA patients, which was a significant difference.[9] The reported dislocation rates after HA ranged from 0% to 11% and after THA from 0% to 18%. The pooled analysis of Hopley *et al.* showed no significant difference concerning the risk for dislocation between HA and THA. A tendency was, however, noted towards a higher risk for dislocation after THA.[20]

There are two important risk factors for the dislocation rate of THA in patients with femoral neck fractures. The first risk factor is the surgical approach; the posterolateral approach is associated with higher dislocation rates,[1, 24, 25] while other

(antero/anterolateral) surgical approaches have been recommended for patients who are prone to dislocation. With the Hardinge (direct lateral) approach there is a risk of injury to the superior gluteal nerve and it also requires taking down the anterior third of the gluteus medius tendon from the greater trochanter.[26] This detaching of the muscle can cause abductor weakness.[1]

A second risk factor for dislocation is the head size. Larger heads achieve greater stability and result in a better function by the increased impingement free range of motion. A 32 mm head provides a lower dislocation rate than 28mm or 22 mm heads. New options with thin, highly cross-linked polyethylene allow for large heads (≥32 mm) to be used with smaller acetabular cup diameters, enhancing the ability for stable reconstruction in this patient population.[22] A dual-mobility acetabular component, as developed and described by Gilles Bousquet, was developed in order to reduce the incidence of dislocation in patients at risk of instability.[27] It consists of a large, fixed, porous-coated acetabular component and a bipolar femoral component. Although the long-term durability of these implants is not known, this is expected not to be a problem in the patients with a femoral neck who have a higher mortality and morbidity with lower implant demand than in patients with osteoarthritis.[28]

Revision

Patients treated with a hemiarthroplasty have the potential risk for deteriorating of hip function, especially in the highly active patients and in those with a long life expectancy. This is attributed to the articulation of a large metal head on articular cartilage, which is associated with acetabular erosion and groin pain. However, 2 out of 5 available meta-analyses showed no significant difference concerning this topic .This theory is in contrast with clinical practice because when meta-analyzing all

currently available RCTs on this topic no significant difference was observed in two of the five meta-analyses.[9, 18] An overall revision rate of 5% of all arthroplasties is found. When comparing patients below and above the age of 75 years, the hazard ratio was 3.6 (confidence interval: 1.6- 8.2) for patients less than 75 of age..[29] This implicates that younger patients with a better functional status may require an internal fixation or a more durable arthroplasty like a THA.

Acetabular erosion

The main disadvantage of HA is the potential for wear of acetabular articular cartilage and groin pain related to the metallic femoral head against the host acetabulum. This can result in a second operation for placement of an acetabular cup and conversion to THA. Young age and high activity level are generally accepted as the most important factors related to acetabular erosion.[30, 31] The reported rates of acetabular erosion have ranged from 0% to 26% for bipolar designs and from 2.2% to 36% for unipolar designs. [32-34] In elderly patients this wear does not lead to a difference in overall revision rate as already discussed.

Undersizing of the HA head is associated with increased acetabular erosion and pain. Oversized heads are associated with decreased motion and pain of the hip. Active elderly patients with high demand requirements are not completely satisfied with these suboptimal outcomes.

Costs

An important aspect of the treatment of hip fractures in the elderly is the cost of care. Slover *et al.* performed a cost-effectiveness study based on a theoretical cohort of patients aged 70 years old, who sustained a displaced femoral neck fracture.[35] They

used cost data from 2003 and concluded that available data supported the use of total hip arthroplasty as the more cost-effective treatment strategy in active otherwise healthy population. This resulted in an incremental cost-effectiveness ratio of $1,960 for the THA treatment strategy, which was well below the $50,000 threshold used for determining the cost-effectiveness of treatment interventions.[35]

Keating *et al.* performed a cost analysis alongside their randomized trial and suggested that the costs of total hip replacement are lower, but the confidence intervals do not rule out the possibility that it may be more expensive.[36] A systematic review and cost-effectiveness analysis of hospital treatment for the initial and subsequent admissions concluded that THA appears to be more cost-effective than HA, remarking that the follow up was only a 2-year period.[37] Rogmark *et al.* showed that the costs of the material of a THA (US$ 1,274) were US$ 550 higher than for HA (US$ 725).[38] Iorio *et al.* performed a cost-effectiveness analysis during a 2-year postoperative period. Taking into account the complication rates, mortality rates, revision rates, and function, they concluded that THA was more cost-effective than internal fixation, unipolar HA, and bipolar HA.[39]

Surgeon and hospital volume

The association between greater surgeon and hospital procedure volumes and improved patient outcomes has been well established with respect to a variety of procedures and treatments.[40] Surgeon volume had a greater effect on patients than hospital volume for primary and revision joint arthroplasties.[40] Also in the treatment of hip fractures with an arthroplasty surgeon volume and hospital volume seem to be independent factors for patient outcomes.[41-45] The mechanism through which surgeon volume impacts patient outcomes remains unclear. Some surgeons have

better outcomes than others and there can be variations in outcomes between these care providers. Variation in performance is clearly linked to experience, although it is unclear why exactly this experience influences outcomes. Patient selection would seem to be less of a factor in nonelective surgery such as hip fracture fixation.[42] The surgeon-volume relationship is just one of many variables that determine overall quality of care, and many other factors may outweigh any outcome data in determining the appropriate care for the individual patient. There is no consensus on the importance of several variables such as anesthesia staff, nursing staff, hospital protocols, standardized care pathways, and ancillary services like physical therapy.[45]

The association between volume and decreased length of stay and in-hospital cost has been demonstrated in a variety of elective arthroplasty procedures as well as with arthroplasty for hip fracture.[41-45] Length of stay and patient charges are becoming increasingly important and relevant in the current health care environment and could be expected to be a significant area of focus for future research and policy.[42] Additional studies are required to investigate the effects of limiting performance of orthopedic procedures to high-volume providers and identify practical strategies for providing patients and physicians with better information with which to make referral decisions. These studies are needed before any changes can be made in health care policy and resource utilization.

Discussion and Conclusion

Historically, randomized controlled trials have been scarce in orthopedic literature but should play a major role in determining best practices for fracture care.[46] However, all systematic reviews/ meta-analyses, have similar conclusions and state that heterogeneity across the available trials and distinct subgroup effects

preclude definitive statements and require further research in this field. [9, 15, 18-21, 47, 48] Given the large sample size the HEALTH trial (Hip Fracture Evaluation with ALternatives of Total Hip Arthroplasty versus HemiArthroplasty) will have a significant impact on the question which type of arthroplasty is the best solution to treat patients with displaced femoral neck fractures. This is a multi-center randomized trial comparing total hip arthroplasty and hemiarthroplasty on revision surgery and quality of life in patients with displaced femoral neck fractures (registered trial number: NCT00556842).

Based upon the evidence available to date, THA is the preferred treatment for mentally fit patients with a displaced femoral neck fracture below the age of 75 years, patients with a pathological fracture, and patients with diseases of the hip joint like rheumatoid arthritis, osteoarthritis, or Paget's disease. Patients older than 75 years who have a long life expectancy may benefit from a THA because of the better functional outcome at the cost of a higher dislocation rate. Simon *et al.* advised to perform a THA in patients with a life expectancy of 10 years or longer.[49] It is important to recognize there are deficiencies in the literature that limit our present ability to draw strong conclusions concerning the relative merits of modern THA compared with modern HA. Some papers that compared HA with THA, describe the results of an uncemented Austin-Moore implant. We now know that these arthroplasties have inferior results concerning the functional and pain outcomes. [50, 51] The comparison between studies using HAs and THAs can only be relevant when cemented stem designs are compared with new generation of uncemented stem designs. Most trials are performed with mentally competent (*i.e.*, able to sign informed consent), independent, and active patients. This probably means that patients included in the trials are "better" patients with less comorbidity than the

general patients who suffer from a displaced femoral neck fracture. Maybe the better functional results of patients with a THA could be explained by the fact that patients who are less mobile and have less functional demands are not included in the trials. This was indeed the fact in the Arthro trial.[1] Also it is known that the use of the Harris Hip Score as functional outcome has its limits.[52]

It can be concluded that, based on the current literature, HA is the preferable treatment in patients who are “biologically” older than 75 years, because of the lower dislocation rate, shorter operation time and less perioperative blood loss.[1] THA can be considered for active and mentally fit patients below the age of 75 years with a displaced femoral neck fracture. Future research should focus on indentifying predictors for patients who will benefit from a THA for a femoral neck fracture.

References

1. van den Bekerom MP, Hilverdink EF, Sierevelt IN, Reuling EM, Schnater JM, Bonke H, et al. A comparison of hemiarthroplasty with total hip replacement for displaced intracapsular fracture of the femoral neck: a randomised controlled multicentre trial in patients aged 70 years and over. J Bone Joint Surg Br 2010;92:1422-8.

2. Baker RP, Squires B, Gargan MF, Bannister GC. Total hip arthroplasty and hemiarthroplasty in mobile, independent patients with a displaced intracapsular fracture of the femoral neck. A randomized, controlled trial. J Bone Joint Surg Am 2006;88:2583-89.

3. Blomfeldt R, Tornkvist H, Eriksson K, Soderqvist A, Ponzer S, Tidermark J. A randomised controlled trial comparing bipolar hemiarthroplasty with total hip replacement for displaced intracapsular fractures of the femoral neck in elderly patients. J Bone Joint Surg Br 2007;89:160-65.

4. Dorr LD, Glousman R, Hoy AL, Vanis R, Chandler R. Treatment of femoral neck fractures with total hip replacement versus cemented and noncemented hemiarthroplasty. J Arthroplasty 1986;1:21-28.

5. Keating JF, Grant A, Masson M, Scott NW, Forbes JF. Randomized comparison of reduction and fixation, bipolar hemiarthroplasty, and total hip arthroplasty. Treatment of displaced intracapsular hip fractures in healthy older patients. J Bone Joint Surg Am 2006;88:249-60.

6. Macaulay W, Nellans KW, Iorio R, Garvin KL, Healy WL, Rosenwasser MP. Total hip arthroplasty is less painful at 12 months compared with hemiarthroplasty in treatment of displaced femoral neck fracture. HSS J 2008;4:48-54.

7. Mouzopoulos G, Stamatakos M, Arabatzi H, Vasiliadis G, Batanis G, Tsembeli A, et al. The four-year functional result after a displaced subcapital hip fracture treated with three different surgical options. Int Orthop 2008;32:367-73.

8. Skinner P, Riley D, Ellery J, Beaumont A, Coumine R, Shafighian B. Displaced subcapital fractures of the femur: a prospective randomized comparison of internal fixation, hemiarthroplasty and total hip replacement. Injury 1989;20:291-93.

9. Burgers PT, Van Geene AR, Van den Bekerom MP, Van Lieshout EM, Blom B, Aleem IS, et al. Total hip arthroplasty versus hemiarthroplasty for displaced femoral neck fractures in the healthy elderly: a meta-analysis and systematic review of randomized trials. Int Orthop 2012;36:1549-60.

10. Cheng SY, Levy AR, Lefaivre KA, Guy P, Kuramoto L, Sobolev B. Geographic trends in incidence of hip fractures: a comprehensive literature review. Osteoporos Int 2011;22:2575-86.

11. Reynolds FC. Preliminary report of the Committee on Fractures and Traumatic Surgery on the use of a prosthesis in the treatment of fresh fractures of the neck of the femur. J Bone Joint Surg Am 1958;40-A:877-85; discussion 85-6 passim.

12. Bhandari M, Devereaux PJ, Swiontkowski MF, Tornetta P, 3rd, Obremskey W, Koval KJ, et al. Internal fixation compared with arthroplasty for displaced fractures of the femoral neck. A meta-analysis. J Bone Joint Surg Am 2003;85-A:1673-81.

13. Macaulay W, Pagnotto MR, Iorio R, Mont MA, Saleh KJ. Displaced femoral neck fractures in the elderly: hemiarthroplasty versus total hip arthroplasty. J Am Acad Orthop Surg 2006;14:287-93.

14. Masson M, Parker MJ, Fleischer S. Internal fixation versus arthroplasty for intracapsular proximal femoral fractures in adults. Cochrane Database Syst Rev 2003.

15. Parker MJ, Gurusamy KS, Azegami S. Arthroplasties (with and without bone cement) for proximal femoral fractures in adults. Cochrane Database Syst Rev 2010:CD001706.

16. Sim FH, Stauffer RN. Management of hip fractures by total hip arthroplasty. Clin Orthop Relat Res 1980:191-97.

17. Bhandari M, Devereaux PJ, Tornetta P, Swiontkowski MF, Berry DJ, Haidukewych G, et al. Operative management of displaced femoral neck fractures in elderly patients. An international survey. J Bone Joint Surg Am 2005;87:2122-30.

18. Zi-Sheng A, You-Shui G, Zhi-Zhen J, Ting Y, Chang-Qing Z. Hemiarthroplasty vs primary total hip arthroplasty for displaced fractures of the femoral neck in the elderly: a meta-analysis. J Arthroplasty 2012;27:583-90.

19. Yu L, Wang Y, Chen J. Total hip arthroplasty versus hemiarthroplasty for displaced femoral neck fractures: meta-analysis of randomized trials. Clin Orthop Relat Res 2012;470:2235-43.

20. Hopley C, Stengel D, Ekkernkamp A, Wich M. Primary total hip arthroplasty versus hemiarthroplasty for displaced intracapsular hip fractures in older patients: systematic review. BMJ 2010;340:c2332.

21. Liao L, Zhao J, Su W, Ding X, Chen L, Luo S. A meta-analysis of total hip arthroplasty and hemiarthroplasty outcomes for displaced femoral neck fractures. Arch Orthop Trauma Surg 2012;132:1021-9.

22. Berry DJ, von Knoch M, Schleck CD, Harmsen WS. Effect of femoral head diameter and operative approach on risk of dislocation after primary total hip arthroplasty. J Bone Joint Surg Am 2005;87:2456-63.

23. Papandrea RF, Froimson MI. Total hip arthroplasty after acute displaced femoral neck fractures. Am J Orthop (Belle Mead NJ) 1996;25:85-88.

24. Enocson A, Hedbeck C-J, Tidermark J, Pettersson H, Ponzer S, Lapidus LJ. Dislocation of total hip replacement in patients with fractures of the femoral neck. Acta Orthop 2009;80:184-89.

25. Enocson A, Tidermark J, Tornkvist H, Lapidus LJ. Dislocation of hemiarthroplasty after femoral neck fracture: better outcome after the anterolateral approach in a prospective cohort study on 739 consecutive hips. Acta Orthop 2008;79:211-17.

26. Hardinge K. The direct lateral approach to the hip. J Bone Joint Surg Br 1982;64:17-9.

27. Philippot R, Adam P, Farizon F, Fessy MH, Bousquet G. [Survival of cementless dual mobility sockets: ten-year follow-up]. Rev Chir Orthop Reparatrice Appar Mot 2006;92:326-31.

28. Guyen O, Pibarot V, Vaz G, Chevillotte C, Carret J-P, Bejui-Hugues J. Unconstrained tripolar implants for primary total hip arthroplasty in patients at risk for dislocation. J Arthroplasty 2007;22:849-58.

29. van den Bekerom MP, Sierevelt IN, Bonke H, Raaymakers EL. The natural history of the hemiarthroplasty for displaced intracapsular femoral neck fractures. Acta Orthop 2013;84:555-60.

30. Phillips TW. Thompson hemiarthroplasty and acetabular erosion. J Bone Joint Surg Am 1989;71:913-17.

31. Warwick D, Hubble M, Sarris I, Strange J. Revision of failed hemiarthroplasty for fractures at the hip. Int Orthop 1998;22:165-68.

32. Calder SJ, Anderson GH, Jagger C, Harper WM, Gregg PJ. Unipolar or bipolar prosthesis for displaced intracapsular hip fracture in octogenarians: a randomised prospective study. J Bone Joint Surg Br 1996;78:391-94.

33. Soreide O, Skjaerven R, Alho A. The risk of acetabular protrusion following prosthetic replacement of the femoral head. Acta Orthop Scand 1982;53:791-94.

34. Squires B, Bannister G. Displaced intracapsular neck of femur fractures in mobile independent patients: total hip replacement or hemiarthroplasty? Injury 1999;30:345-48.

35. Slover J, Hoffman MV, Malchau H, Tosteson ANA, Koval KJ. A cost-effectiveness analysis of the arthroplasty options for displaced femoral neck fractures in the active, healthy, elderly population. J Arthroplasty 2009;24:854-60.

36. Keating JF, Grant A, Masson M, Scott NW, Forbes JF. Displaced intracapsular hip fractures in fit, older people: a randomised comparison of reduction and fixation, bipolar hemiarthroplasty and total hip arthroplasty. Health Technol Assess 2005;9:iii-iv, ix-x, 1-65.

37. Carroll C, Stevenson M, Scope A, Evans P, Buckley S. Hemiarthroplasty and total hip arthroplasty for treating primary intracapsular fracture of the hip: a systematic review and cost-effectiveness analysis. Health Technol Assess 2011;15:1-74.

38. Rogmark C, Carlsson A, Johnell O, Sembo I. Costs of internal fixation and arthroplasty for displaced femoral neck fractures: a randomized study of 68 patients. Acta Orthop Scand 2003;74:293-98.

39. Iorio R, Healy WL, Lemos DW, Appleby D, Lucchesi CA, Saleh KJ. Displaced femoral neck fractures in the elderly: outcomes and cost effectiveness. Clin Orthop Relat Res 2001:229-42.

40. Shervin N, Rubash HE, Katz JN. Orthopaedic procedure volume and patient outcomes: a systematic literature review. Clin Orthop Relat Res 2007;457:35-41.

41. Ames JB, Lurie JD, Tomek IM, Zhou W, Koval KJ. Does surgeon volume for total hip arthroplasty affect outcomes after hemiarthroplasty for femoral neck fracture? Am J Orthop (Belle Mead NJ) 2010;39:84-89.

42. Browne JA, Pietrobon R, Olson SA. Hip fracture outcomes: does surgeon or hospital volume really matter? J Trauma 2009;66:809-14.

43. Hughes RG, Garnick DW, Luft HS, McPhee SJ, Hunt SS. Hospital volume and patient outcomes. The case of hip fracture patients. Med Care 1988;26:1057-67.

44. Lavernia CJ. Hemiarthroplasty in hip fracture care: effects of surgical volume on short-term outcome. J Arthroplasty 1998;13:774-78.

45. Shah SN, Wainess RM, Karunakar MA. Hemiarthroplasty for femoral neck fracture in the elderly surgeon and hospital volume-related outcomes. J Arthroplasty 2005;20:503-08.

46. Poolman RW, Struijs PAA, Krips R, Sierevelt IN, Lutz KH, Bhandari M. Does a "Level I Evidence" rating imply high quality of reporting in orthopaedic randomised controlled trials? BMC Med Res Methodol 2006;6:44-44.

47. He JH, Zhou CP, Zhou ZK, Shen B, Yang J, Kang PD, et al. Meta-analysis comparing total hip arthroplasty with hemiarthroplasty in the treatment of displaced femoral neck fractures in patients over 70 years old. Chin J Traumatol 2012;15:195-200.

48. Goh SK, Samuel M, Su DH, Chan ES, Yeo SJ. Meta-analysis comparing total hip arthroplasty with hemiarthroplasty in the treatment of displaced neck of femur fracture. J Arthroplasty 2009;24:400-6.

49. Simon P, Gouin F, Veillard D, Laffargue P, Ehlinger M, Bel JC, et al. [Femoral neck fractures in patients over 50 years old]. Rev Chir Orthop Reparatrice Appar Mot 2008;94 Suppl:108-32.

50. Parker MI, Pryor G, Gurusamy K. Cemented versus uncemented hemiarthroplasty for intracapsular hip fractures: A randomised controlled trial in 400 patients. J Bone Joint Surg Br 2010;92:116-22.

51. Schmidt AH, Leighton R, Parvizi J, Sems A, Berry DJ. Optimal arthroplasty for femoral neck fractures: is total hip arthroplasty the answer? J Orthop Trauma 2009;23:428-33.

52. Wamper KE, Sierevelt IN, Poolman RW, Bhandari M, Haverkamp D. The Harris hip score: Do ceiling effects limit its usefulness in orthopedics? Acta Orthop 2010;81:703-7.

Disclosure statement

A modified version of this article will be published in the French journal Maîtrise Orthopédique. The editor gave permission for the current publication.

Acknowledgements

Neither the authors nor a member of their immediate families received payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity. No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, division, center, clinical practice, or other charitable or non-profit organization with which the authors, or a member of their immediate families, are affiliated or associated.