Risk Factor Analysis for 30-Day Mortality After Primary THA in a Single Institution

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Abstract The purpose of this study was to determine the prevalence of, and associated risk factors for, 30-day perioperative death following primary total hip arthroplasty (THA). Data of all the patients were compiled from the computerized total joint registry at a single institution. Between May 1993 and May 2006, 3,232 consecutive primary THA (2,453 elective and 779 nonelective) were performed. Eleven deaths occurred during the first month after surgery (0.34 %). Thirty-day mortality rate after elective THA was 0.08 % (two of 2,453 IC 95 % (0–0.4)). The 30-day mortality rate after nonelective THA was 1.15 % (nine of 779 IC 95 % (0.7–2.4)). To analyze the factors that could have contributed with death, we conducted a 4-to-1 nested case-control study. Control cases were strictly matched by sex, age, surgeon, prosthesis fixation mode, and date of surgery. Conditional logistic regression was used to evaluate the association of risk factors with mortality. Elective surgery was associated with a lower risk of mortality with an odds ratio (OR) of 0.07 (95 % CI 0.008–0.6); $p=0.015$. American Society of Anesthesiologists (ASA) score III–IV increased the mortality risk 13 times (OR 13.7; 95 % CI 1.6–114.8). Cardiovascular disease increased the risk for mortality eight times (OR 8.83 (95 % CI 1.78–43.6)). Time delay before surgery showed a trend towards significance ($p=0.06$). Aggressive vs. nonaggressive thromboembolism prophylaxis and the amount of blood transfusions required were not associated with a higher risk of death. Patients undergoing a THA due to fractures, patients with high ASA score, and those with cardiovascular disease were the highest risk factors for 30-day mortality after primary THA.

Keywords mortality · total hip arthroplasty

Introduction

Total hip arthroplasty (THA) constitutes one of the most reliable, safe, and cost-effective surgical procedures [1–3]. In spite of this, it carries a death risk which has been well documented in the past [1, 4, 5]. The perioperative mortality rates associated with THA's ranges from less than 1 % to almost 30 % [6, 7]. The associated risk factors have also been described elsewhere. Mortality after THA has been associated with gender, advanced age, history of cardiorespiratory, and renal and cerebrovascular diseases [8–10]. Most of this data originated from leading orthopedic centers from the United States of America or Europe. There is, however, a paucity of mortality data associated with THA emanating from other areas [11]. The aim of this study was to determine the prevalence, the associated risk factors, and the 30-day mortality rate following primary THA in a single institution and compare it to those described previously.

Material and Methods

Between May 1993 and May 2006, 3,232 primary THAs were performed in a single institution. Two thousand four hundred fifty-three were elective surgeries and 779 surgeries were nonelective procedures due to displaced femoral neck fractures. Two thousand three hundred eighty-one patients underwent cemented fixation, which was the most frequent fixation mode utilized in this series. Hybrid fixation was used in 793 cases and uncemented fixation in 58 patients. General data were compiled from our own computerized total joint arthroplasty registry. Extensive data of each surgery performed at our institution and any follow-up contact with the patients are recorded in this registry. We chose the 30-day perioperative mark according to the criteria proposed by Parvizi et al. [9, 10]. Mortality related data of the whole series of patients included in this study was obtained and analyzed.

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The cause of death described in Table 1 was obtained from death certificates in all the patients. In those patients who died during hospital stay information was also obtained from the in-patient charts.

We analyzed the mortality rate after THA in our institution. A retrospective 4-to-1 nested case-control study was designed in order to determine the factors that could have been related to the cause of death. Each case consisted of a patient that has died in the 30-day period after surgery and four patients that remained alive in the same period after surgery were controls for that case. The matching was strictly performed according to sex, age, mode of fixation of the reconstruction, type of operating surgeon (staff, fellowship, or resident), and the same 3-month period of the year of surgery. As they were chosen as matching variables, these parameters were excluded from further analysis. Risk factors for death were analyzed, taking into account the following parameters: elective vs. non elective surgery, simplified preoperative ASA score (American Society of Anesthesiologists) [12] dividing it into two groups: I–II (lower risk) and III–IV (higher risk), presence of severe cardiac disease (coronary artery disease, congestive cardiac failure, chronic or acute arrhythmias, and history of myocardial infarction), time to surgery after admission (variable which mostly applies to fracture cases) which was divided it into two groups (more than 72 h or less than 72 h), units of blood transfusion during the hospitalization (more or less than 2 U of blood), and thromboembolic prophylaxis used. Multimodal prophylaxis method defined by Salvati et al. at Hospital for Special Surgery [13] is regularly employed in our institution. This method consists in a series of safe preventive measures applied before, during, and immediately after surgery to reduce the risk of venous thromboembolism. In our institution, patients who undergo THA are operated under hypotensive epidural anesthesia with intraoperative heparin. We do not use immediate postoperative intermittent pneumatic compression, but all the patients use elastic stockings and they are early mobilized (emphasizing repeated and vigorous active dorsiflexion of ankles). Postoperative pharmacologic prophylaxis is classified as aggressive (warfarin, heparin, and low molecular weight heparins), applied in patients with predisposing factors, and nonaggressive (aspirin) in patients without predisposing factors who mobilize promptly, avoiding the risk of bleeding associated with the use of anticoagulants.

To allow a matched analysis, conditional logistic regression was used to evaluate the multivariate association of type of surgery (elective or nonelective) with mortality. A significance level was defined as $p=0.05$.

Results

Global mortality prevalence was 0.34 % (11 dead patients from 3,232 THA's performed). Patients' data and causes of death are shown in Table 1. The most frequent cause of death was related to cardiac events (seven of 11 (63 %)). The cardiac events leading to death were: acute myocardial infarction (three patients), heart failure (two patients), heart pacemaker failure (one patient), and congestive heart failure (one patient).

Fatal pulmonary embolism occurred in four patients of 3,232 (0.12 %). Three of these four patients had nonelective surgery. Therefore, rate of fatal pulmonary embolism in the nonelective group was 0.38 % (three patients of 779).

Mortality rate after primary elective THA was 0.08 % (two of 2,453 CI 95 % (0–0.4)). Mortality rate after primary nonelective THA was 1.15 % (nine of 779 CI 95 % (0.7–2.4)). Elective surgery was associated with a lower risk of mortality with an odds ratio (OR) of 0.07 (95 % CI: 0.008–0.6), $p=0.015$, and higher risk ASA score (grades III–IV) significantly increased the mortality risk 13 times (OR: 13.7; 95 % CI: 1.6–114.8), $p=0.015$. History of cardiovascular disease significantly increased the mortality risk eight times (OR: 8.83 (95 % CI: 1.78–43.6); $p=0.008$. Time delay before admission and surgery greater than 72 h showed a tendency towards a higher risk for mortality ($p=0.06$). The amount of blood requirement during hospitalization ($p=0.139$) and the type of postoperative thromboembolic prophylaxis applied ($p=0.571$) were not significantly associated with the risk of dying. Table 2 shows the conditional logistic regression for 30-day mortality after primary THA adjusting the type of surgery with different variables.

Discussion

Our study reports the overall mortality rate after primary THAs performed from 1993 to 2006 in a single institution. In this period of 13 years, the global 30-day mortality rate was 0.34 %. We also performed a risk factor analysis between different variables and their association with death. Patients

Table 1 Data of patients who died are shown. The patients are identified by a number, age, sex (*F* female and *M* male), preoperative diagnoses (AVN femoral head avascular necrosis) and time between surgery (hours) and death assessing those patients who died at home (AH). Causes of death: *HF* heart failure, *AMI* acute myocardial infarction, *HPMF* heart pacemaker failure, *CHF* congestive heart failure, *PE* fatal pulmonary emboli

Patient	1	2	3	4	5	6	7	8	9	10	11
Age (years)	77	65	91	82	78	74	83	81	86	78	77
Cause of death	HF	AMI	HPMF	CHF	AMI	PE	PE	PE	HF	AMI	PE
Time between surgery and death	30 days (AH)	11 days (AH)	4 h	3 days	7 days	11 days (AH)	8 h	48 h	11 days (AH)	4 days	48 h
Sex and reason for surgery	M Fracture	F Fracture	M Fracture	M Osteoarthritis	M Fracture	M Fracture	F Fracture	F Fracture	F Fracture	M Fracture	F AVN

Table 2 Conditional logistic regression for 30-day mortality after primary THA adjusting type of surgery, cardiac disease, time to surgery, and thromboembolism prophylaxis

Variable	Odds ratio	95 % CI	P value
Elective surgery	0.0174	0.0006–0.466	0.016
Cardiovascular disease	22.83	1.461–351	0.026
Time delay before surgery	0.4	0.023–6.892	0.632

ASA score was not adjusted due to low number of event and colineality

undergoing a nonelective THA due to displaced femoral neck fractures, patients with high ASA score, and those with cardiovascular disease were the highest risk factors for 30-day mortality after primary THA. We consider that such analysis could be useful in order to identify those patients with high risk of death after a primary THA.

The most important limitation of the present study is its retrospective nature as differences or variability in the accuracy of data recording can be present. Another limitation may relate to the real prevalence of selected comorbidities and associated risk factors in our population, as we analyzed those patients who died and their respective control group (nested case–control study) and not the whole population of primary THA.

We utilized the criteria proposed by Parvizi et al. to analyze mortality within a period of 30 days after surgery [9, 10]. They defined that a shorter period may have missed deaths that were directly related to the hip surgery and a longer period would have detected an increasing number of deaths that were not directly related to the hip procedure. The global 30-day mortality rate in our study is similar to those reported by other authors (Table 3) [4, 9, 10, 14]. Memtsoudis et al. [8], using national in-patient data collected between 1990 and 2004, provided representative data on the characteristics of patients who died after hip and knee arthroplasty in the US. The cumulative in-hospital mortality rate was 0.35 % in an estimated 6,901,324 procedures. Liu et al. [14] reported a 158 % increment in the number of THAs performed in the United States between 1990 and 2004. They also found that even though the study population had more comorbidities, the in-hospital mortality rates after primary THAs remained low and slightly decreased from 0.32 % to 0.29 % in the study period.

The mortality rate was significantly higher in patients undergoing a primary THA after fractures of the femoral neck. Unlike other centers where THAs due to displaced femoral neck fractures are managed by trauma surgeons, at our institution, these patients are treated by our hip adult reconstruction

team. Therefore, patients with fractures are part of our whole population undergoing a primary THA. Other authors [1, 5, 9, 10, 15, 16] also reported similar findings comparing THAs performance due to trauma with those performed electively due to other orthopedic pathology. Several reasons could be cited to explain this association. Femoral neck fractures usually occur in the elderly. This group of patients often has a history of multiple comorbidities [17]. It is not infrequent that the fracture was the consequence of other risk factors (osteoporosis, instable gait, muscle weakness, etc.) or it is associated with an acute pathology that predisposed the patient to fall. The urgent nature of the fracture treatment may also reduce the time to study and properly stabilize those acute preoperative medical conditions, increasing perioperative risk of complications in this group of patients.

Liu et al. [14] compared different periods of interest within the entire 14-year follow-up period in his study. He found that a patient operated later during his follow-up had a greater number of risk factors and comorbidities such as hypertension, diabetes, coronary artery disease, and obesity.

The ASA score is a widely used and accepted system to quantify preoperative medical conditions [12]. In our series, patients with ASA III–IV showed a significantly greater risk of death than patients classified as ASA I–II. Patients categorized as ASA III–IV are those with severe systemic disease under treatment without an incapacitated condition (grade III, for example, stable coronary artery disease) or with an incapacitated condition that is a constant threat to life (grade IV, for example, unstable coronary artery disease or acute myocardial infarction).

Patients with a history of severe cardiac disease also showed significant risk for death. Parvizi et al. [9] in looking at patients undergoing THA after hip fractures, found that more than one-third of their deaths were associated with sudden cardiopulmonary arrest following hip surgery. They believe that most of these events could be explained as late sequelae of intraoperative embolization of marrow and fat elements [18–20].

Table 3 Comparison of mortality rate after THA's reported by different authors

Author	Number of THA's and period of study	Type of surgery: elective or nonelective procedures	% mortality and follow up period
Parvizi et al. [10]	30,714 (32 years)	Elective primary THA's	0.29 (30 days)
Parvizi et al. [9]	7,774 (32 years)	Nonelective primary THA's	2.4 (30 days)
Liu et al. [14]	2,288,579 (14 years)	All primary THAs discharges from The National Hospital Discharge Survey	0.32 (in-hospital mortality)
Dearborn and Harris WH [4]	2,736 (27 years)	Primary and revision, elective and nonelective THA's	0.3 (90 days)
Present study	3,232 (13 years)	Primary elective and nonelective THA's	0.34 (30 days)

In our series, a cardiac event was the most frequent cause of death after THA (63 %). This finding was opposite to our expectation due to the historical relationship between fatal pulmonary embolism as a cause of death after THA [21]. However, other authors [5, 22] also found, with different levels of evidence, that fatal embolism is not the most frequent cause of death after joint replacement. Based on that finding, Shepherd et al. applied in their patients mechanical methods to prevent fatal pulmonary embolism and they did not recommend the routine use of chemoprophylaxis following joint replacement [22].

Different prophylactic modalities have been described in an attempt to reduce deep venous thrombosis and fatal pulmonary embolism associated to a THA. Despite the increased use of anticoagulants for thromboprophylaxis, the mortality of patients undergoing THA has remained constant during the last decade [23]. Therefore, the use of aggressive anticoagulation is questionable [5] as these agents have potential life-threatening side effects from systemic and local bleeding complications [24–29]. Murray et al. [30] performed a meta-analysis of all studies on hip replacement which included information about death or fatal pulmonary embolism. The fatal pulmonary embolism rate ranged from 0.1 % to 0.2 %; even in patients who received no prophylaxis. They also reported a mortality rate ranging from 0.3 % to 0.4 %, and neither heparin nor any other prophylactic agent caused a significant decrease of these rates. Aynardi et al. [31] analyzed the 90-day mortality after THA and the causes of death they reported are consistent with our findings. They described cardiovascular events as the most common cause of death (16 of 41 deaths in 7,478 THAs) and only two patients with a death associated with fatal pulmonary embolism. We apply the protocol of prophylaxis defined by Salvati et al. who recently published their conclusions after 30 years of experience [13]. It consists of a multimodal approach that uses anticoagulation in high-risk patients and aspirin in the vast majority of patients who have no predisposing factors and who mobilize promptly [13]. In our series of patients in whom we applied these principles, death after THA occurred independently of the type of postoperative drugs utilized.

Time delay between admission and surgery has been reported as a factor of high-risk death and other major complications after hip surgery [32]. In spite of being a variable which mostly applies to fracture cases, we found a tendency towards a higher risk of death comparing those patients who underwent hip surgery before and after 72 h of the hospital admission. Probably, a significant association would also have been found in a larger patient series. In our institution, time delay is not a consequence of material resources (implants, OR availability, etc.), and it is always related to a patient's medical condition. Surgery is delayed until the best possible clinical status is reached, in order to tolerate major surgery such as THA. Moran et al. [32] reported that patients with medical comorbidities that delayed surgery had 2.5 times the risk of death within 30 days after the surgery compared with patients without comorbidities that delayed surgery. They also described an overall significantly increased mortality when a delay of more than 4 days occurred.

Other risk factors for mortality like male sex has been reported by other authors [8, 10]. In this study, sex of the patients was one of the matching variables to define the control group, so no conclusions could be drawn on this variable.

The present study describes the rate of mortality after THA in a single institution. Risk factors related to this undesirable event were also identified. Those patients with a nonelective surgery (fractures), classified as ASA III–IV, with history of a severe cardiovascular disease showed a high risk of dying in a 30-day period after THA. Our findings are consistent with those reported previously by leading orthopedic centers. In spite of being infrequent, mortality after a THA is a real concern for the orthopedic surgeon. We hope these findings could be helpful to optimize health care in patients undergoing a primary THA.

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Each author certifies that his or her institution has approved the reporting of the case and that all investigations were conducted in conformity with the ethical principles of research.

References

1. Mullen JO, Mullen NL. Hip fracture mortality. A prospective, multifactorial study to predict and minimize death risk. *Clin Orthop Relat Res.* 1992(280):214–22.
2. Surin VV, Sundholm K. Survival of patients and prostheses after total hip arthroplasty. *Clin Orthop Relat Res.* 1983(177):148–53.
3. Taylor HD, Dennis DA, Crane HS. Relationship between mortality rates and hospital patient volume for Medicare patients undergoing major orthopaedic surgery of the hip, knee, spine, and femur. *J Arthroplasty.* 1997;12(3):235–42.
4. Dearborn JT, Harris WH. Postoperative mortality after total hip arthroplasty. An analysis of deaths after two thousand seven hundred and thirty-six procedures. *J Bone Joint Surg Am.* 1998;80(9):1291–4.
5. Fender D, Harper WM, Thompson JR, Gregg PJ. Mortality and fatal pulmonary embolism after primary total hip replacement. Results from a regional hip register. *J Bone Joint Surg Br.* 1997;79(6):896–9.
6. Schoning B, Schulitz KP, Pfluger T. Statistical analysis of perioperative and postoperative mortality of patients with prosthetic replacement of the hip joint. *Arch Orthop Trauma Surg.* 1980;97(1):21–6.
7. White RH, McCurdy SA, Marder RA. Early morbidity after total hip replacement: rheumatoid arthritis versus osteoarthritis. *J Gen Intern Med.* 1990;5(4):304–9.
8. Memtsoudis SG, Della Valle AG, Besculides MC, Esposito M, Koulouvaris P, Salvati EA. Risk factors for perioperative mortality after lower extremity arthroplasty: a population-based study of 6,901,324 patient discharges. *J Arthroplasty.* 2010;25(1):19–26.
9. Parvizi J, Ereth MH, Lewallen DG. Thirty-day mortality following hip arthroplasty for acute fracture. *J Bone Joint Surg Am.* 2004;86-A(9):1983–8.
10. Parvizi J, Johnson BG, Rowland C, Ereth MH, Lewallen DG. Thirty-day mortality after elective total hip arthroplasty. *J Bone Joint Surg Am.* 2001;83-A(10):1524–8.
11. Tsuboi M, Hasegawa Y, Suzuki S, Wingstrand H, Thorngren KG. Mortality and mobility after hip fracture in Japan: a ten-year

- follow-up. *J Bone Joint Surg Br.* 2007;89(4):461–6. doi:[10.1302/0301-620X.89B4.18552](https://doi.org/10.1302/0301-620X.89B4.18552)
12. Little JP. Consistency of ASA grading. *Anaesthesia.* 1995;50(7):658–9.
 13. Salvati EA, Sharrock NE, Westrich G, Potter HG, Valle AG, Sculco TP. The 2007 ABJS Nicolas Andry Award: three decades of clinical, basic, and applied research on thromboembolic disease after THA: rationale and clinical results of a multimodal prophylaxis protocol. *Clin Orthop Relat Res.* 2007;459:246–54.
 14. Liu SS, Della Valle AG, Besculides MC, Gaber LK, Memtsoudis SG. Trends in mortality, complications, and demographics for primary hip arthroplasty in the United States. *Int Orthop.* 2009;33(3):643–51.
 15. Jensen JS, Holstein P. A long term follow-up of Moore arthroplasty in femoral neck fractures. *Acta Orthop Scand.* 1975;46(5):764–74.
 16. Lung HR. The role of prosthetic replacement of the head of the femur as primary treatment for subcapital fractures. *Injury.* 1971;3(2):107–13.
 17. Visuri T, Pulkkinen P, Paavolainen P, Koskenvuo M, Turula KB. Causes of death after hip arthroplasty in primary arthrosis. *J Arthroplasty.* 1997;12(4):397–402.
 18. Orsini EC, Byrick RJ, Mullen JB, Kay JC, Waddell JP. Cardiopulmonary function and pulmonary microemboli during arthroplasty using cemented or non-cemented components. The role of intramedullary pressure. *J Bone Joint Surg Am.* 1987;69(6):822–32.
 19. Breed AL. Experimental production of vascular hypotension, and bone marrow and fat embolism with methylmethacrylate cement. Traumatic hypertension of bone. *Clin Orthop Relat Res.* 1974(102):227–44.
 20. Wheelwright EF, Byrick RJ, Wigglesworth DF, Kay JC, Wong PY, Mullen JB et al. Hypotension during cemented arthroplasty. Relationship to cardiac output and fat embolism. *J Bone Joint Surg Br.* 1993;75(5):715–23.
 21. Johnson R, Green JR, Charnley J. Pulmonary embolism and its prophylaxis following the Charnley total hip replacement. *Clin Orthop Relat Res.* 1977(127):123–32.
 22. Shepherd A, Mills C. Fatal pulmonary embolism following hip and knee replacement. A study of 2153 cases using routine mechanical prophylaxis and selective chemoprophylaxis. *Hip Int.* 2006;16(1):53–6.
 23. Howie C, Hughes H, Watts A. Venous thromboembolism associated with hip and knee replacement over a ten-year period: a population-based study. *J Bone Joint Surg Br.* 2005;87(12):1675–80.
 24. Freedman K, Brookenthal K, Fitzgerald RJ, Williams S, Lonner J. A meta-analysis of thromboembolic prophylaxis following elective total hip arthroplasty. *J Bone Joint Surg Am.* 2000;82(7):929–38.
 25. Heit J, Elliott C, Trowbridge A, Morrey B, Gent M, Hirsh J. Ardeparin sodium for extended out-of-hospital prophylaxis against venous thromboembolism after total hip or knee replacement. A randomized, double-blind, placebo-controlled trial. *Ann Intern Med.* 2000;132(11):853–61.
 26. Handschin AE, Trentz O, Kock HJ, Wanner GA. Low molecular weight heparin-induced skin necrosis—a systematic review. *Langenbecks Arch Surg.* 2005;390(3):249–54.
 27. Lilikakis AK, Papapolychroniou T, Macheras G, Michelinakis E. Thrombocytopenia and intra-cerebral complications associated with low-molecular-weight heparin treatment in patients undergoing total hip replacement. A report of two cases. *J Bone Joint Surg Am.* 2006;88(3):634–8.
 28. Sanchez-Ballester J, Smith M, Hassan K, Kershaw S, Elsworth CS, Jacobs L. Wound infection in the management of hip fractures: a comparison between low-molecular weight heparin and mechanical prophylaxis. *Acta Orthop Belg.* 2005;71(1):55–9.
 29. Sharrock NE, Gonzalez Della Valle A, Go G, Lyman S, Salvati EA. Potent anticoagulants are associated with a higher all-cause mortality rate after hip and knee arthroplasty. *Clin Orthop Relat Res.* 2008;466(3):714–21.
 30. Murray DW, Britton AR, Bulstrode CJ. Thromboprophylaxis and death after total hip replacement. *J Bone Joint Surg Br.* 1996;78(6):863–70.
 31. Aynardi M, Pulido L, Parvizi J, Sharkey PF, Rothman RH. Early mortality after modern total hip arthroplasty. *Clin Orthop Relat Res.* 2009;467(1):213–8. doi:[10.1007/s11999-008-0528-5](https://doi.org/10.1007/s11999-008-0528-5).
 32. Moran CG, Wenn RT, Sikand M, Taylor AM. Early mortality after hip fracture: is delay before surgery important? *J Bone Joint Surg Am.* 2005;87(3):483–9.