Similar mortality with general or regional anesthesia in elderly hip fracture patients

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Submitted 2015-07-27. Accepted 2015-11-05.

Background and purpose — There is continuing confusion among practitioners with regard to the optimal choice of anesthetic type for repair of hip fractures. We investigated whether type of anesthetic was associated with short-term mortality after hip fracture surgery.

Patients and methods — We conducted a retrospective cohort study of patients with surgically treated hip fractures, performed between January 1, 2009 and December 31, 2012. Exposure of interest was anesthesia type (general, spinal/neuroaxial, and mixed). Endpoints were 30-, 90-, and 365-day post-surgery mortality. Multivariable conditional logistic regression models were used and odds ratios (ORs) and 95% confidence intervals (CIs) are reported.

Results — Of the 7,585 participants, 5,412 (71%) were women and the median age was 80 (IQR: 72–85) years old. Of the total cohort, 4,257 (56%) received general anesthesia, 3,059 (40%) received spinal/neuroaxial, and 269 (4%) received mixed anesthesia. Overall, the incidence of 30-, 90-, and 365-day mortality was 4% (n = 307), 8% (n = 583), and 15% (n = 1,126), respectively. When compared with general anesthesia, the 365-day odds of mortality was marginally lower in patients with spinal/neuroaxial anesthesia (OR = 0.84, CI: 0.70–1.0), but it was similar in patients with mixed anesthesia (OR = 1.3, CI: 0.70–2.3). No other statistically significant differences were observed.

Interpretation — Regarding mortality, this study does not support specific recommendations regarding the type of anesthetic in surgery of fractured hips.

The 1-year mortality rate after a hip fracture has been 17–27% in numerous prospective studies (Bentler et al. 2009, Brauer et al. 2009, Leblanc et al. 2011, Panula et al. 2011, Lo et al. 2015). Identification of modifiable risk factors that could reduce morbidity is therefore of importance. Choice of anesthetic type for surgery of hip fractures is one modifiable risk factor that could affect patient mortality. Historically, there has been debate on the benefits of the different types of anesthetic modalities. A Clinical Practice Guideline suggested that there was no difference between general and regional anesthesia for hip fracture surgery (Brox et al. 2015). An internal unpublished consensus-based guideline finalized in November 2014 recommended priority for regional anesthetic. In older studies, going back to the 1970s (McLaren et al. 1978), regional anesthetic was reported to be safer for hip fracture patients. More contemporary studies (O'Hara et al. 2000, Neuman et al. 2014, Patorno et al. 2014, Pugely et al. 2014) and a Cochrane Collaborative review (Parker et al. 2004) have concluded that there is no clinically important difference between regional and general anesthetic. However, in 2008 Radcliff et al. reported lower 30-day mortality associated with spinal and regional anesthetic. This finding was supported by a study by Neuman et al. (2012).

Basing our work on elderly patients undergoing surgery for hip fracture, we therefore investigated whether the type of anesthetic used for the surgery was associated with a difference in short-term mortality after hip fracture repair.

Patients and methods

Study design, setting, and data sources

We conducted a retrospective cohort study. We used a hip fracture registry to identify patients who underwent surgical procedures for hip fractures at Kaiser Permanente, a large integrated US healthcare system, between January 2009 and December 2012. Data collection, participation, and other details of the hip fracture registry have been published elsewhere (Inacio et al. 2015). Briefly, this virtual registry identifies patients with surgically treated hip fractures and their demographic variables—characteristics such as comorbidities, detailed intraoperative information (e.g. anesthesia information), implant information, and information on outcome (e.g. mortality)—using electronic medical records, administrative

DOI 10.3109/17453674.2015.1128781

databases, and other institutional databases within the integrated healthcare system (e.g. regional diabetes registries, geographically enriched member sociodemographics). The hip fracture registry had 21,826 cases entered as of August 2014, and its coverage is 100% of surgically treated hip fractures that occur in this healthcare system.

Study sample

Operatively treated hip fracture cases that occurred in 3 of the geographical regions of Kaiser Permanente (i.e. Southern California, Northern California, and Hawaii) were included in our study. Specifically, hip fractures with the following International Classification of Diseases, Ninth Revision, Clinical Modification (ICD9) codes were included: 820.00, 820.01, 820.02, 820.03, 820.09, 820.20, 820.21, 820.22, 820.8, and 821.00. Open fractures had the following ICD9 codes: 808.10, 820.10, 820.11, 820.12, 820.19, 820.30, 820.31, 820.32, 820.9, and 821.10. Pathological fractures had ICD9 codes 733.1, 733.10, 733.11, 733.12, 733.13, 733.14, 733.15, 733.19, and 733.96. Cases where multiple fractures were treated at the time of the hip fracture surgery (identified from cases that had ICD9 codes 800-829 at the same time as the hip fracture) were not included in the study. Patients with diagnosis of renal disease (identified with codes from Elixhauser algorithm (Quan et al. 2005) of ICD9: 585.3, 585.4, 585.5, 585.6, 585.9, 586, V42.0, V45.1, V45.11, V45.12, V56.0, V56.1, V56.2, V56.31, V56.32, and V56.8) were also excluded from the study because this subset of patients with renal disease has different prognosis and expected outcome.

Exposure of interest

Anesthesia type was the exposure of interest and the following groups were evaluated: general, spinal/neuroaxial, and mixed anesthesia. Patients were classified as having general anesthesia if they had general anesthesia exclusively. Patients were considered to have spinal/neuroaxial anesthesia if they had either exclusively epidural, femoral nerve block, nerve block, regional, or spinal anesthesia; or spinal with a combination of epidural or nerve block. Finally, patients were considered to have mixed anesthesia if they had monitored anesthesia care (MAC) plus one or a combination of the following: epidural, nerve block, regional, spinal; or general plus one or a combination of the following: epidural, nerve block, regional, spinal.

Outcome of interest

The study outcome was 30-, 90-, and 365-day post-surgery mortality. All patients were followed for 1 year (the end of study follow-up period was December 2013).

Covariates

Patient covariates consisted of age (55–64, 65–74, 75–89 years old), sex, race (white vs. other), 4 body mass index (BMI) categories (underweight (< 18.5), normal (18.5–24.9), overweight (25.0–29.9), obese (> 30)), American Society of Anaesthetists (ASA) score (< 3 vs. ≥ 3), and patient comorbidities, which were identified using the integrated healthcare system's diabetic registry and the Elixhauser algorithm (1998). See the footnote to Table 3.

Statistics

Sample characteristics among anesthesia groups were compared using Pearson's chi-squared test for categorical variables and the Kruskal-Wallis test for continuous variables. The crude post-surgery mortality within 30, 90, and 365 days were compared among anesthesia groups with Pearson's chi-squared test. To evaluate association between anesthesia type and likelihood of mortality, crude and adjusted conditional logistics models were fitted. Use of conditional logistic regression implicitly controls for all stable surgeon characteristics. In the model, the surgeon-identifying variable was modeled as a nuisance parameter in strata, and the patient-level characteristics were modeled as explanatory variables, thus providing information about the effect of anesthesia type on mortality risk after having adjusted for the individual surgeon effects. Odds ratios (ORs) along with 95% confidence intervals (CIs) for mortality—for the particular choice of anesthesia—are reported. Patient age, sex, race, BMI, and ASA score were considered to be confounders and were added to the model. Additionally, Elixhauser comorbidities were included in the model as confounders if any standardized mean difference among anesthesia groups was over 0.1. Patients with missing anesthesia information (n = 589, 7.2%) were excluded from the final analysis. These patients were not significantly different from patients with anesthesia information regarding the characteristics included in the final analysis and crude mortality incidence. To account for missing values in the other variables (BMI, n = 35 (0.5%); race, n = 23 (0.3%); and ASA score, n = 634 (8.4%)), Markov chain Monte Carlo multiple imputations were performed to create 20 versions of the analytic dataset. Each dataset was separately analyzed using the same model and the results were combined using Rubin's rules. The imputation model included all variables. Analyses were performed using R version 3.1.2, and alpha = 0.05 was the statistical significance threshold used for the study.

Ethics

This study was approved by our institutional review board (#6375) before its commencement.

Results

7,585 patients underwent surgery for hip fracture repair during the study period, involving 447 surgeons and 32 hospitals. 5,412 of the patients (71%) were women, 6,040 (80%) were

Table 1. Characteristics of patients who received general, spinal/neuroaxial, and mixed anesthesia for hip fracture surgery, 2009–2012 (n = 7,585). Values are % (n) unless otherwise specified

	Total n = 7,585	General n = 4,257	Spinal/neuroaxial n = 3,059	Mixed n = 269	p-value
Sex					0.2
Female	71.4 (5,412)	70.7 (3,008)	72.5 (2,217)	69.5 (187)	
Age, years					
Median age (IQR)	80 (72–85)	79 (71–84)	80 (73–85)	79 (71–84)	< 0.001
55–64	10.6 (804)	11.7 (496)	9.0 (274)	12.6 (34)	< 0.001
65–74	20.7 (1,571)	21.4 (912)	19.6 (599)	22.3 (60)	
75–89	68.7 (5,210)	66.9 (2,849)	71.5 (2,186)	65.1 (175)	
Race [a]					0.08
White	79.8 (6,040)	78.9 (3,349)	80.8 (2,469)	82.5 (222)	
Non-white	20.2 (1,526)	21.1 (893)	19.2 (586)	17.5 (47)	
BMI [a]					
Median BMI (IQR)	23.7 (20.8–27.1)	23.8 (20.8–27.2)	23.5 (20.6–26.8)	23.4 (20.7–26.6)	0.004
< 18.5 (underweight)	9.7 (735)	9.2 (391)	10.2 (311)	12.3 (33)	0.02
18.5–24.9 (normal)	50.5 (3,812)	49.8 (2,111)	51.1 (1,554)	54.9 (147)	
25.0–29.9 (overweight)	27.8 (2,099)	28.1 (1,191)	27.9 (849)	22.0 (59)	
≥ 30.0 (obese)	12.0 (904)	12.9 (546)	10.8 (329)	10.8 (29)	
ASA score [a]					
Median score (IQR)	3 (2–3)	3 (2–3)	3 (2–3)	3 (2–3)	0.002
1 or 2	33.7 (2,473)	32.4 (1,270)	35.9 (1,006)	37.3 (90)	0.008
3 or more	66.3 (4,857)	67.5 (2,639)	64.1 (1,795)	62.7 (151)	
Comorbidity [b]					
Any	93.9 (7,120)	93.8 (3,994)	94.0 (2,875)	93.3 (251)	0.9
Total [c], median (IQR)	3 (2–4)	3 (2–4)	3 (2–4)	3 (2–4)	0.4
Valvular disease	9.2 (696)	10.3 (439)	7.5 (230)	10.0 (27)	< 0.001
Paralysis	4.7 (353)	5.7 (242)	3.3 (100)	4.1 (11)	< 0.001
Neurological disorders	19.7 (1,496)	21.3 (905)	17.9 (548)	16.0 (43)	< 0.001
Chronic pulmonary disease	22.3 (1,692)	19.5 (829)	25.5 (780)	30.9 (83)	< 0.001
Hypothyroidism	18.2 (1,380)	17.1 (730)	19.7 (604)	17.1 (46)	0.02
Metastatic cancer	2.2 (168)	2.2 (93)	2.1 (64)	4.1 (11)	0.1
Coagulopathy	7.0 (533)	7.6 (322)	6.4 (196)	5.6 (15)	0.1
Chronic blood-loss anemia	4.0 (305)	3.4 (144)	4.9 (149)	4.5 (12)	0.006
Diabetes [d]	22.5 (1,703)	23.0 (977)	22.1 (676)	18.6 (50)	0.2
Procedure					< 0.001
Internal fixation	61.3 (4,653)	63.4 (2,699)	58.4 (1,785)	62.8 (169)	
Total hip arthroplasty	3.0 (229)	2.7 (114)	3.3 (101)	5.2 (14)	
Hemiarthroplasty	35.2 (2,667)	33.4 (1,422)	38.1 (1,165)	29.7 (80)	
Other	0.5 (36)	0.5 (22)	0.3 (8)	2.2 (6)	

IQR: interquartile range; BMI: body mass index; ASA: American Society of Anaesthesiologists.
[a] Missing data: BMI, n = 35 (0.5%); race, n = 23 (0.3%); ASA score, n = 634 (8.4%).
[b] Identified using the Elixhauser comorbidy index algorithm.
[c] Total number of Elixhauser comorbidities (i.e. comorbidity burden). Comorbidities included: congestive heart failure, valvular disease, pulmonary circulation disease, peripheral vascular disease, paralysis, neurological disorders, chronic pulmonary disease, diabetes with and/or without chronic complications, hypothyroidism, liver disease, peptic ulcer disease with bleeding, acquired immune deficiency syndrome, lymphoma, metastatic cancer, solid tumor without metastasis, rheumatoid arthritis, coagulopathy, obesity, weight loss, fluid and electrolyte disorders, chronic blood-loss anemia, deficiency anemia, alcohol abuse, drug abuse, psychoses, depression, and hypertension.
[d] Data reported are from the Kaiser Permanente regional diabetes registries.

white, the median age was 80 (IQR: 72–85) years old, the median number of comorbidities was 3 (IQR: 2–4), and the cohort was mainly treated with internal fixation procedures (n = 4,653, 61%) and hemiarthroplasties (n = 2,667, 35%). Of the total, 4,257 patients (56%) received general anesthesia, while 3,059 (40%) received spinal/neuroaxial anesthesia and 269 (4%) received mixed anesthesia (Table 1).

Within 30 days of surgery, 177 deaths (4%) occurred in patients who received general anesthesia, 113 (4%) in patients with spinal/neuroaxial anesthesia, and 17 (6%) in patients with mixed anesthesia. Within 90 days of surgery, 336 deaths (8%) occurred in patients who received general anesthesia, 224 (7%) in those with spinal/neuroaxial anesthesia and 23 (9%) in patients with mixed anesthesia. Within 365 days of surgery, 661 deaths (16%) occurred in patients who received general anesthesia, 424 (14%) in patients with spinal/neuroaxial anesthesia and 41 (15%) in patients with mixed anesthesia (Table 2).

There was an unadjusted 12% lower odds of 365-day mortality (OR = 0.88, CI: 0.77–1.0) in patients who underwent

Table 2. Mortality in patients who received general, spinal/neuroaxial, and mixed anesthesia for hip fracture surgery, 2009–2012. Values are % (n)

Mortality within	Total n = 7,585	General n = 4,257	Spinal/neuroaxial n = 3,059	Mixed n = 269	p-value
30 days	4 (307)	4 (177)	4 (113)	6 (17)	0.1
90 days	8 (583)	8 (336)	7 (224)	9 (23)	0.6
365 days	15 (1,126)	16 (661)	14 (424)	15 (41)	0.1

Table 3. Odds ratios (OR) for mortality and 95% confidence intervals (CI) for patients who received spinal/neuroaxial anesthesia and mixed anesthesia compared to those who received general anesthesia for hip fracture surgery, 2009–2012 (n = 7,585)

	Unadjusted mortality within			Adjusted [a] mortality within		
Anesthesia type	30 days OR (CI)	90 days OR (CI)	365 days OR (CI)	30 days OR (CI)	90 days OR (CI)	365 days OR (CI)
General	Reference	Reference	Reference	Reference	Reference	Reference
Spinal/neuroaxial	0.88 (0.70–1.12)	0.92 (0.77–1.10)	0.88 (0.77–1.00)	0.88 (0.64–1.20)	0.93 (0.74–1.18)	0.84 (0.70–1.00)
Mixed	1.56 (0.93–2.60)	1.09 (0.70–1.70)	0.98 (0.69–1.38)	1.28 (0.70–2.34)	0.91 (0.54–1.53)	0.82 (0.55–1.23)

[a] Model adjusted for sex, age, race, BMI, ASA score, comorbidities (valvular disease, paralysis, neurological disorders, chronic pulmonary disease, hypothyroidism, metastatic cancer, coagulopthy, chronic blood loss, and anemia).

spinal/neuroaxial anesthesia rather than general anesthesia. After adjusting for surgeon effect and patient sex, age, race, BMI, ASA score, and comorbidities, a 16% lower odds of 365-day mortality was observed (OR = 0.84, CI: 0.70–1.0). There was no statistically significant difference in 30-day or 90-day mortality across the anesthetic groups in adjusted models (Table 3).

To examine the effect of general anesthesia while resolving the limitation of small sample size in the mixed anesthesia group (n = 269), we repeated the analysis combining the spinal/neuroaxial and mixed anesthesia groups and compared it with that in those who received general anesthesia alone. The results were consistent with those in the 3-group analysis (data not shown).

We investigated whether there was an interaction between ASA score and type of anesthetic for the outcomes evaluated (30-, 90-, and 365-day mortality), and this was not observed (data not shown). This meant that the effects of anesthesia were not significantly different across ASA subgroups. We also repeated the analysis for groups with an ASA score of 1–2 and 3–5, and found no statistically significant differences between the 3 anesthetic modalities for 30-, 90-, and 365-day mortality in ASA subgroups (data not shown).

Discussion

In this large sample of patients, captured with a dedicated hip fracture registry in a large integrated healthcare system, we found similar 30-, 90-, and 365-day mortality rates in patients who had received different anesthetic modalities.

While the literature is inconsistent regarding what type of anesthesia is preferable for hip fracture patients, our findings are consistent with at least 4 previous studies (O'Hara et al. 2000, Neuman et al. 2014, Patorno et al. 2014, Pugely et al. 2014). In particular, Patorno et al. (2014) reported that "in-hospital" mortality in 73,284 patients was not significantly different when regional and general anesthesia were compared. O'Hara et al. (2000) reported on 9,375 patients regarding 30-day mortality and found no significant difference between regional and general anesthesia. Lastly, Neuman et al. (2014) reported on 56,729 patients regarding 30-day mortality and found no significant difference between regional and general anesthesia.

Our findings differ from those in and older study by McLaren et al. (1978) and in the large recent study Neuman et al. (2012). In a randomized, controlled trial involving 55 patients, McLaren et al. reported a statistically significant reduction in 14- and 28-day mortality with spinal anesthesia as compared to general anesthesia. This study was conducted before 1977 and techniques of patient care and anesthesia have changed significantly since that time, negating the relevance of their findings. Neuman et al. (2012) reported on 18,158 patients where the 29% who received regional anesthetic had a lower degree of in-hospital mortality than those who received general anesthesia (OR = 0.71, CI: 0.54–0.93). It is possible that the effect they observed is only present with respect to in-hospital mortality, but that in other short-term mortality evaluations it is no longer apparent, as we found in our study. Furthermore, in the study by in Neuman et al. (2012), there were confounding differences in the case volume and geographic locations (i.e. rural/urban status) of hospitals that reported anesthetic type compared to those that did not report it, which could also have led them to different conclusions from ours. Based on a study with 5,683 hip fracture patients, Radcliff et al. (2008) reported that general anesthesia was related to a higher, although borderline, risk of 30-day mortality (OR = 1.3, CI: 1.0–1.6) than in patients who received spinal or epidural anesthesia. The important differences between the study by Radcliff et al. (2008) and the present study include the fact that they reported ASA 1–2 at 8%, as compared to 34% in our study. The study by Radcliff et al. was conducted between 1998 and 2003, with a 30-day mortality of 8–9%, whereas the present study was conducted 10 years later, with an overall 30-day mortality of 4%.

It has been suggested that certain biological mechanisms favor the use of spinal or regional anesthesia instead of general anesthesia in hip fracture patients. Specifically, it has been suggested that by using the mechanism of delirium reduction and prevention (Chow et al. 2012), a patient's risk of death would be reduced. However, we did not observe this in our large and representative cohort of patients, and other current evidence also suggests that there may not be a basis for the assumption that different anesthetic modalities could be associated with different risk of death after surgical repair of hip fracture. It is more likely that excess mortality after hip fractures is linked to the occurrence of complications such as pulmonary embolism, infection, postoperative pulmonary complications, heart failure, and the risk of further falls or fractures after surgery (Roche et al. 2005, Panula et al. 2011).

Our study had several limitations. Firstly, because of the data source of our study, it is difficult to discern what constitutes a general anesthetic rather than a spinal anesthetic with sedation. Currently, the type of anesthesia is recorded by the anesthesia provider without information about airway management or other data that would help to determine the differences between general and spinal anesthetic with sedation. Secondly, possible confounders of the anesthesia and mortality pathway could not be evaluated because they are not regularly collected by the data source we used. Some of these possible confounders include: preoperative delirium, preoperative cognition/mental status, pre-injury functional mobility status, type of care (i.e. orthopedic geriatric care and care coordination/liaison services), and the possibility of comorbid dementia. Thirdly, our findings are limited to generic assessments of anesthetic modalities. No information regarding specific anesthetic agents, and how they were monitored and administered, was available—so we cannot comment on the effect of these on the outcome evaluated. Lastly, the current data source does not have detailed information on hip fracture types, so that could not be evaluated.

One of the strengths of our study was the large and representative sample of patients, surgeons, and hospitals included. Because of the community-based setting of this large integrated healthcare system, which was the framework for sampling, a large number of patients were covered. The population of this large integrated healthcare system has been shown to be socioeconomically and demographically representative of the geographical area it covers (Koebnick et al. 2012), making our findings most probably representative of other patients in the region. In addition, having 447 surgeons in 32 hospitals in various settings probably makes this a representative sample of orthopedic providers and hospitals. Another strength was the use of a hip fracture registry to obtain the information about the procedures, patients, and hospitals—and also outcomes associated with these hip fractures. This registry prospectively collected the information used for this study, strengthening the internal validity of the data presented. Furthermore, in the study we have been able to report 30-, 90-, and 365-day mortality, which are important time extensions to the very short-term outcomes other authors have reported. A final strength has been the inclusion of more detailed clinical data for assessment of confounding (i.e. BMI and patient comorbidities) than in most other administrative data studies on this topic.

In conclusion, this study does not support any recommendation regarding the type of anesthesia in surgical repair of fractured hips. Other variables such as sex, patient comorbidities, age, and other factors are probably more strongly associated with patient mortality after surgery. We recommend additional research into specific types of anesthesia, their duration, incidence of delirium, and management modalities.

All the authors contributed to the study design and contributed substantially to collecting the data, interpreting the results, drafting the article, and revising it for important intellectual content. PHC and GC performed the statistical analysis.

We are grateful to all the Kaiser Permanente orthopedic surgeons who contribute to the national implant registries, and to the Surgical Outcomes and Analysis department, which coordinates registry operations. No outside funding was obtained for the performance of this study.

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