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The Effect of Anesthetic Type on Outcomes of Hip Fracture Surgery

A Nationwide Population-Based Study

Yu-Chi Tung, PhD, Ya-Hui Hsu, MPH, and Guann-Ming Chang, MD, MS

Abstract: Hip fractures are a global public health problem. During surgery following hip fractures, both general and regional anesthesia are used, but which type of anesthesia offers a better outcome remains controversial. There has been little research evaluating different anesthetic types on mortality and readmission rates for hip fracture surgery using nationwide population-based data.

We used nationwide population-based data to examine the effect of anesthetic type on mortality and readmission rates for hip fracture surgery.

Retrospective observational study.

General acute care hospitals throughout Taiwan.

A total of 17,189 patients hospitalized for hip fracture surgery in 2011.

Generalized estimating equation models with propensity score weighting were performed after adjustment for patient, surgeon, and hospital characteristics to examine the associations of anesthesia type with 30-day all-cause mortality, 30-day all-cause readmission, and 30-day specific-cause readmission (including surgical site infection, sepsis, acute respiratory failure, acute stroke, acute myocardial infarction, acute renal failure, deep vein thrombosis, pneumonia, and urinary tract infection).

Of 17,189 patients, 11,153 (64.9%) received regional anesthesia and 6036 (35.1%) received general anesthesia. Overall, the 30-day mortality rate was 1.7%, and the 30-day readmission rate was 12.3%. Regional anesthesia was not associated with decreased 30-day all-cause mortality (odds ratio [OR] 0.89, 95% confidence interval [CI] 0.67–1.18, $P=0.409$), but associated with decreased 30-day all-cause readmission and surgical site infection readmission relative to general anesthesia (OR 0.83, 95% CI 0.75–0.93, $P=0.001$ and OR 0.69, 95% CI 0.49–0.97, $P=0.031$).

Regional anesthesia is not associated with 30-day mortality, but is associated with lower 30-day all-cause and surgical site infection readmission compared with general anesthesia for hip fracture surgery.

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Abbreviations: CI = confidence interval, ED = emergency department, ICD-9-CM = International Classification of Diseases, 9th Revision, Clinical Modification, ICU = intensive care unit, NHIA = National Health Insurance Administration, NHIRD = National Health Insurance Research Database, OR = odds ratio.

INTRODUCTION

Hip fractures are a global public health problem. It is estimated that about 1.6 million hip fractures occur worldwide each year, and 2.6 million will occur worldwide annually by 2025.[1] Hip fractures can lead to death and severe disability.[2,3] With an aging population, hip fractures have been increasing, causing hip fracture-related healthcare costs to rise. Regional anesthesia for hip fracture surgery may reduce postoperative complications.[4–6] Practice guidelines have advocated broader use of regional anesthesia for hip fracture surgery.[7–9] To our knowledge, findings regarding an association between anesthetic types and mortality were inconclusive, and there has been little research evaluating different anesthetic types on readmission rates for hip fracture surgery using nationwide population-based data.

The Agency for Healthcare Research and Quality has regarded hip fracture mortality as an inpatient quality indicator.[10] Both 30-day mortality and 30-day readmission rates are regarded as important outcome indicators for evaluating hospital care.[11] Starting October 1, 2012, the Hospital Readmissions Reduction Program, under the Affordable Care Act, requires the Centers for Medicare & Medicaid Services to reduce payments to hospitals with excessive readmission ratio for applicable conditions.[12] Moreover, the Bundled Payments for Care Improvement initiative for Medicare patient's medical conditions (including hip fracture) was launched in 2013. Thus, it is important to discover which factors are associated with 30-day mortality or 30-day readmission rates for hip fracture patients.

Anesthesia type is hypothesized to be related to mortality among patients undergoing hip fracture surgery, but the influence of anesthesia type on mortality is certainly a controversial issue in the literature. Regional anesthesia has significantly reduced incidences of deep vein thrombosis, surgical site infections, and pulmonary complications. On the other hand, general anesthesia is beneficial in that it has a lower incidence of

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From the Institute of Health Policy and Management (Y-CT), Institute of Health Policy and Management, National Taiwan University, Taipei (Y-HH), Department of Anesthesiology, Chang Gung Memorial Hospital, Taoyuan (Y-HH), Department of Family Medicine, Cardinal Tien Hospital, New Taipei City (G-MC), and School of Medicine, Fu Jen Catholic University, New Taipei City, Taiwan (G-MC).
Correspondence: Yu-Chi Tung, Institute of Health Policy and Management, National Taiwan University, Room 634, No. 17, Xu-Zhou Road, Taipei 100, Taiwan (e-mail: yuchitung@ntu.edu.tw).
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hypotension and cerebrovascular accidents.[6,13–17] To date, there is not enough evidence to show which anesthesia type can best improve outcomes for patients undergoing hip fracture surgery. For hip fracture surgery, a few observational studies have focused on the relationship between anesthesia type and mortality. Some of these studies found that the use of regional anesthesia was associated with reduced mortality,[16,18,19] and others found no difference in mortality between regional and general anesthesia.[6,20–24] Additionally, only 3 studies have attempted to compare readmissions between regional and general anesthesia for hip fracture surgery.[18,20,24]

The aim of this study was to use nationwide population-based data from Taiwan to examine the associations of anesthesia type with 30-day mortality and readmission rates for hip fracture surgery. We hypothesized that regional anesthesia would be associated with better outcomes compared with general anesthesia.

MATERIALS AND METHODS

Database

We collected data from the National Health Insurance Research Database (NHIRD), provided by the National Health Insurance Administration (NHIA) and managed by the National Health Research Institutes. The NHIRD is a national database that contains patient-level demographic, diagnostic, and administrative information across Taiwan. This study was approved by the Institutional Review Board of the National Taiwan University Hospital.

The NHIA is the sole insurer and implemented national health insurance beginning March 1, 1995. The coverage rate of National Health Insurance has reached 99.9%, and almost all healthcare facilities are National Health Insurance contracted providers. Every enrollee is free to go to any hospital or clinic. The NHIA has reimbursed providers mainly on a fee-for-service basis since the implementation of the national health insurance system. To improve efficiency and outcomes of inpatient care, certain major diagnostic categories (such as musculoskeletal system diseases) have been reimbursed mainly by bundled payments based on Taiwan diagnosis-related groups since 2010. Surgeons are employed by hospitals; thus, surgeons responsible for treating patients with musculoskeletal system diseases (eg, hip fractures) are paid by the hospital out of the bundled payment. Related readmissions for 30 days after hospital discharge are not included in the bundled payment amount. The Hospital Readmissions Reduction Program is not implemented. Therefore, Taiwan's healthcare system provides an excellent opportunity to examine the associations of anesthesia type with 30-day mortality and readmission rates for hip fracture surgery under bundled payments.

Study Population

This study population included all patients undergoing hip fracture surgery aged 18 years and older admitted to hospitals in Taiwan in 2011. The study period (2011) was based on admission date. The major inclusion criterion was admission with a principal diagnosis of hip fracture as identified through the patient's principal diagnosis recorded using the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) code 820. We included those admissions who underwent at least one of the following surgical operations based on ICD-9-CM procedure codes: total hip arthroplasty (81.51), hemiarthroplasty (81.52), and internal fixation (79.15, 79.35, 78.55).[25] For patients with multiple hip fracture admissions, the subsequent admissions were excluded. We excluded patients treated by surgeons without cases in 2010 and admitted to hospitals without cases in 2010. We excluded patients who received local or no anesthesia and who received both general and regional anesthesia. Nevertheless, when 30-day readmission was analyzed, we excluded patients who died during hospital stay.[11,26] Because patients died during hospital stay, they had no chance of being readmitted to hospital.[11]

Variables

Dependent Variables

Outcome measures included 30-day all-cause mortality and 30-day all-cause readmission, and 30-day specific-cause readmission. Thirty-day mortality was defined as death in or out of hospital from any cause within 30 days of admission (in hospital and after discharge). Thirty-day all-cause/specific-cause readmission was defined as the occurrence of at least one hospitalization for any cause/specific cause within 30 days of discharge for those surviving to discharge.[11,26] Specific causes of readmission included surgical site infection, sepsis, acute respiratory failure, acute stroke, acute myocardial infarction, acute renal failure, deep vein thrombosis, pneumonia, and urinary tract infection, which were major or common complications after hip fracture surgery.[15,16,19,24,27] All-cause 30-day mortality and readmission rates are standard measurements of the outcomes of care.[11,26] Readmission is chosen in addition to mortality because it is expensive to the healthcare system and commonly represents a preventable adverse event for patients.[26]

Independent Variables

Exposure to a specific anesthesia type was defined by one or more charge codes for general or regional anesthesia. Patients were classified either as having received general anesthesia (if they had charges for general anesthesia) or as having received regional anesthesia (if they had charges for epidural or spinal anesthesia).

The covariates included patient, surgeon, and hospital characteristics. The patient characteristics were sex, age, comorbid conditions, fracture type (intracapsular, extracapsular, other), type of surgical procedure (arthroplasty, internal fixation), multiple trauma (yes/no), admission from emergency department (ED) (yes/no), intensive care unit (ICU) use (yes/no), and length of hospital stay. The age groups were divided into 5 groups: $\leq$50, 51–60, 61–70, 71–80, and $\geq$80 years of age because the transformed scale was strongly associated with patient outcomes.[28] A modified Charlson Comorbidity Index,[29,30] adopted by previous studies on hip fracture surgery,[24,27] was used to identify patients' comorbidities. This modified index was the sum of weighted points based on the presence or absence of 10 different medical conditions. One point was also added for each decade more than 40 years of age.[24,27,31] In addition to a modified Charlson Comorbidity Index, individual comorbidities (including diabetes mellitus, hypertension, hyperlipidemia, chronic obstructive pulmonary disease, heart disease, dementia, and renal disease) were also included.[19] The type of hip fracture was grouped into three major categories based on the location of the fracture as indicated by their ICD-9-CM codes. The type of surgical procedure was defined with principal procedure codes for arthroplasty and internal fixation.

TABLE 1. Characteristics of the Study Population by Anesthesia Type

	Total		Regional Anesthesia		General Anesthesia		
	N	%	N	%	N	%	*P*
No. of patients	17,189	100.0	11,153	100.0	6036	100.0	—
Patient characteristics							
Male sex	6982	40.6	4558	40.9	2424	40.2	0.366
Age, y							
≤50	1063	6.2	471	4.2	592	9.8	<0.001
51–60	1325	7.7	747	6.7	578	9.6	
61–70	2205	12.8	1366	12.2	839	13.9	
71–80	5640	32.8	3695	33.1	1945	32.2	
≥81	6956	40.5	4874	43.7	2082	34.5	
Modified Charlson Comorbidity Index							
≤3	5708	33.2	3351	30.0	2357	39.0	<0.001
4	4581	26.7	3136	28.1	1445	23.9	
≥5	6900	40.1	4666	41.8	2234	37.0	
Diabetes mellitus	4647	27.0	3048	27.3	1599	26.5	0.238
Hypertension	7652	44.5	5037	45.2	2615	43.3	0.021
Hyperlipidemia	144	0.8	97	0.9	47	0.8	0.532
COPD	1037	6.0	755	6.8	282	4.7	<0.001
Heart disease	506	2.9	307	2.8	199	3.3	0.044
Dementia	963	5.6	637	5.7	326	5.4	0.398
Renal disease	356	2.1	236	2.1	120	2.0	0.574
Fracture type							
Intracapsular	1712	10.0	1062	9.5	650	10.8	0.021
Extracapsular	8087	47.0	5302	47.5	2785	46.1	
Other	7390	43.0	4789	42.9	2601	43.1	
Type of surgical procedure							
Arthroplasty	6192	36.0	4096	36.7	2096	34.7	0.009
Internal fixation	10,997	64.0	7057	63.3	3940	65.3	
Multiple trauma	1068	6.2	417	3.7	651	10.8	<0.001
Admission from ED	12,069	70.2	7666	68.7	4403	72.9	<0.001
ICU use	1319	7.7	731	6.6	588	9.7	<0.001
Length of stay, d							
≤6	6280	36.5	3869	34.7	2411	39.9	<0.001
7–8	5270	30.7	3569	32.0	1701	28.2	
≥9	5639	32.8	3715	33.3	1924	31.9	
Surgeon characteristics							
Surgeon volume							
Low	5882	34.2	4014	36.0	1868	30.9	<0.001
Medium	6010	35.0	3920	35.1	2090	34.6	
High	5297	30.8	3219	28.9	2078	34.4	
Orthopedic surgeon	16,794	97.7	10,942	98.1	5852	97.0	<0.001
Surgeon age, y							
≤40	5613	32.7	3627	32.5	1986	32.9	<0.001
41–50	7485	43.5	4751	42.6	2734	45.3	
≥51	4091	23.8	2775	24.9	1316	21.8	
Hospital characteristics							
Hospital volume							
Low	5867	34.1	4521	40.5	1346	22.3	<0.001
Medium	5642	32.8	3484	31.2	2158	35.8	
High	5680	33.0	3148	28.2	2532	41.9	
Hospital level							
Academic medical center	5206	30.3	2940	26.4	2266	37.5	<0.001
Regional	8644	50.3	5482	49.2	3162	52.4	
District	3339	19.4	2731	24.5	608	10.1	
Teaching	14,740	85.8	9239	82.8	5501	91.1	<0.001
Location							
Taipei	5212	30.3	3969	35.6	1243	20.6	<0.001

	Total		Regional Anesthesia		General Anesthesia		
	N	%	N	%	N	%	P
Northern	2419	14.1	1696	15.2	723	12.0	
Central	3476	20.2	2080	18.6	1396	23.1	
Southern	2739	15.9	1400	12.6	1339	22.2	
Kao-Ping	2820	16.4	1779	16.0	1041	17.2	
Eastern	523	3.0	229	2.1	294	4.9	

COPD = chronic obstructive pulmonary disease, ED = emergency department, ICU = intensive care unit.

The surgeon characteristics included surgeon volume (low, medium, high), orthopedic surgeon (yes/no), and age. The hospital characteristics included hospital volume (low, medium, high), hospital level (academic medical center, regional, district), teaching status (yes/no), and hospital location (Taipei, northern, central, southern, Kao-Ping, eastern). Surgeon volume was calculated as the number of cases a given surgeon performed in the calendar year before the year of the patient's admission. Hospital volume was calculated as the number of cases a given hospital performed in the calendar year before the year of the patient's admission. These volumes were then divided into tertiles, as has been done in previous studies.[32–34]

Statistical Analysis

We used generalized estimating equation logistic regression models and propensity score weighting, adjusted for all patient, surgeon, and hospital characteristics, to examine the association of anesthesia type with 30-day all-cause mortality, 30-day all-cause readmission, and 30-day specific-cause readmission for hip fracture surgery.[35–43] The patient was the unit of analysis. Patient outcomes are correlated within surgeons that are, in turn, correlated within hospitals. We used generalized estimating equation models that accounted for the clustering of patients within surgeons and surgeons within hospitals to reduce the potential for biased standard errors and conclusions about the statistical significance.[36–38] We modeled 30-day outcomes as a function of anesthesia type, patient sex, age, comorbid conditions, fracture type, type of surgical procedure, multiple trauma, admission from ED, ICU use, length of stay, surgeon volume, orthopedic surgeon, surgeon age, hospital volume, hospital level, teaching status, and geographic location.

In addition, we used propensity score analyses to reduce the selection bias and the potential baseline differences between the regional anesthesia and general anesthesia groups. Propensity scores were computed by modeling a logistic regression model in which the dependent variable was whether the patient received regional anesthesia. The independent variables were the above-mentioned covariates. Then, each patient was weighted by the inverse propensity score when performing generalized estimating equation models to reduce the selection bias.[39–43]

In sensitivity analysis to examine the robustness of our results, we used Cox proportional hazard models with robust sandwich variance estimates (also called clustered Cox proportional hazard models or clustered survival analysis) and propensity score weighting, adjusted for all patient, surgeon,

TABLE 2. Patient Outcomes by Anesthesia Type

	Total		Regional Anesthesia		General Anesthesia		
	N	%	N	%	N	%	P
No. of patients	17,189	100.0	11,153	100.0	6036	100.0	—
30-Day mortality	293	1.7	189	1.7	104	1.7	0.891
No. of patients	17,122	100.0	11,112	100.0	6010	100.0	—
30-Day readmission							
All-cause	2103	12.3	1332	12.0	771	12.8	0.109
Specific-cause							
Surgical site infection	202	1.2	117	1.1	85	1.4	0.037
Sepsis	145	0.8	96	0.9	49	0.8	0.740
Acute respiratory failure	67	0.4	42	0.4	25	0.4	0.704
Acute stroke	53	0.3	36	0.3	17	0.3	0.644
Acute myocardial infarction	20	0.1	10	0.1	10	0.2	0.162
Acute renal failure	15	0.1	11	0.1	4	0.1	0.494
Deep vein thrombosis	10	0.1	6	0.1	4	0.1	0.745
Pneumonia	218	1.3	159	1.4	59	1.0	0.012
Urinary tract infection	202	1.2	128	1.2	74	1.2	0.646

and hospital characteristics, to examine the association between anesthesia type and 30-day mortality and readmission.[43,44] The models focused on time from admission until death, and time from discharge until the first rehospitalization date during the 30 days of follow-up. Patients were censored on date of death, or 30 days postadmission/postdischarge, whichever came first. All analyses were adjusted for clustering at the surgeon and hospital level with the use of robust sandwich variance estimates.[43,44] The SAS 9.3 (SAS Institute, Cary, NC) was used for the analysis. All statistical testing was 2-sided at a significance level of 0.05.

RESULTS

We identified 19,971 patients undergoing hip fracture surgery aged 18 years and older admitted to hospitals in 2011, of which 1744 were removed for the second admission and thereafter. Data were excluded from patients treated by surgeons without cases in 2010 (N = 784) and admitted to hospitals without cases in 2010 (N = 201). We excluded 19 patients who received local or no anesthesia, and 34 patients who received both general and regional anesthesia. The final dataset consisted of 17,189 patients from 896 physicians and 239 hospitals. Nevertheless, when 30-day readmission was analyzed, we excluded 67 patients who died during hospital stay.

The study population characteristics are reported in Table 1. Of all patients, 64.9% received regional anesthesia, and 35.1% received general anesthesia. In the univariate analysis, Pearson Chi-square analysis showed the comparison of the patients who received regional anesthesia to those who received general anesthesia. Baseline characteristics that differed between the regional anesthesia and general anesthesia groups were patient age, comorbid conditions, fracture type, type of surgical procedure, multiple trauma, admission from ED, ICU use, length of stay, surgeon volume, orthopedic surgeon, surgeon age, hospital volume, hospital level, teaching status, and geographic location.

Patient outcomes are reported in Table 2. The 30-day mortality rate was 1.7%, and the 30-day readmission rate was 12.3%. Pearson Chi-square analysis showed no association of anesthesia type with 30-day mortality and readmission. However, 30-day surgical site infection and pneumonia readmission rates were different between the 2 anesthesia groups. As shown in Figure 1, the Kaplan–Meier analysis and log-rank test showed that patients receiving regional anesthesia had a similar survival rate, but had a marginally significantly higher readmission-free rate compared with patients receiving general anesthesia ($P = 0.097$).

Table 3 presents the results of the generalized estimating equation logistic regression analysis of 30-day mortality and readmission, with weighting by the inverse propensity score of receiving regional anesthesia for adjusting selection bias. Regional anesthesia was not associated with decreased 30-day all-cause mortality (odds ratio [OR] = 0.89, 95% confidence interval [CI]: 0.67–1.18). However, there were significant associations of anesthesia type with 30-day all-cause readmission and 30-day surgical site infection readmission. Patients receiving regional anesthesia had 17% lower odds of 30-day all-cause readmission and 31% lower odds of 30-day surgical site infection readmission compared with those receiving general anesthesia (OR = 0.83, 95% CI: 0.75–0.93 and OR = 0.69, 95% CI: 0.49–0.97, respectively). In sensitivity analysis, our overall results did not change significantly.

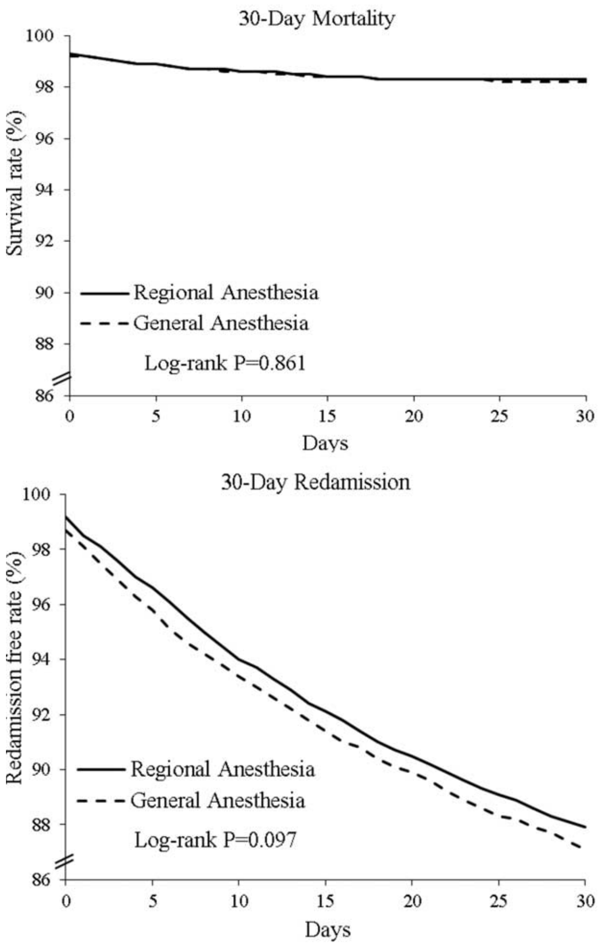

FIGURE 1. Kaplan–Meier curve of 30-day mortality and readmission as stratified by anesthesia type.

DISCUSSION AND CONCLUSIONS

This study was the first research using nationwide population-based data to evaluate the association of anesthesia type with 30-day all-cause mortality, 30-day all-cause readmission, and 30-day specific-cause readmission under bundled payments. We found that regional anesthesia was associated with decreased 30-day all-cause readmission and 30-day surgical site infection readmission, after adjusting for patient sex, age, comorbid conditions, fracture type, type of surgical procedure, multiple trauma, admission from ED, ICU use, length of stay, surgeon volume, orthopedic surgeon, surgeon age, hospital volume, hospital level, teaching status, and geographic location.

In Taiwan, about 65% of patients hospitalized for hip fracture surgery received regional anesthesia. The rate of receiving regional anesthesia in Taiwan was higher than that in the United States (about 10%).[21] The result is possible because all hospitals in Taiwan are closed systems and are reimbursed for inpatient hip fracture surgery by bundled payments based on Taiwan diagnosis-related groups. Physicians only employed by hospitals can be allowed to treat inpatients, and hospitals also use variable pay to encourage staff physicians to provide efficient inpatient services under bundled payments.

TABLE 3. Associations Between Regional Anesthesia and Patient Outcomes

	Univariate Analysis		Multivariate Analysis*					
	Logistic Regression		Logistic Regression		GEE Logistic Regression†		Clustered Cox Proportional Hazards Regression†	
Outcomes	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**HR (95% CI)**	***P***
30-Day mortality (N = 17,189)	0.98 (0.77–1.25)	0.891	0.99 (0.76–1.29)	0.930	0.89 (0.67–1.18)	0.409	0.90 (0.68–1.19)	0.447
30-Day readmission (N = 17,122)								
All-cause	0.93 (0.84–1.02)	0.109	0.87 (0.79–0.97)	0.010	0.83 (0.75–0.93)	0.001	0.85 (0.77–0.94)	0.002
Specific-cause								
Surgical site infection	0.74 (0.56–0.98)	0.037	0.74 (0.55–1.01)	0.055	0.69 (0.49–0.97)	0.031	0.68 (0.47–0.98)	0.037
Sepsis	1.06 (0.75–1.50)	0.740	0.95 (0.65–1.37)	0.771	0.78 (0.51–1.20)	0.258	0.77 (0.49–1.20)	0.250
Acute respiratory failure	0.91 (0.55–1.49)	0.704	0.91 (0.53–1.55)	0.714	0.92 (0.55–1.57)	0.771	0.94 (0.55–1.58)	0.804
Acute stroke	1.15 (0.64–2.04)	0.644	1.05 (0.57–1.93)	0.873	0.98 (0.53–1.81)	0.937	1.01 (0.56–1.83)	0.967
Acute myocardial infarction	0.54 (0.23–1.30)	0.169	0.51 (0.20–1.33)	0.168	0.53 (0.20–1.43)	0.213	0.56 (0.20–1.53)	0.254
Acute renal failure	1.49 (0.47–4.68)	0.496	1.16 (0.34–3.98)	0.809	1.28 (0.40–4.09)	0.683	1.34 (0.52–3.44)	0.542
Deep vein thrombosis	0.81 (0.23–2.88)	0.746	0.86 (0.22–3.33)	0.832	1.02 (0.28–3.69)	0.976	1.10 (0.32–3.82)	0.876
Pneumonia	1.46 (1.08–1.98)	0.013	1.35 (0.97–1.87)	0.074	1.24 (0.85–1.83)	0.266	1.25 (0.85–1.84)	0.254
Urinary tract infection	0.94 (0.70–1.25)	0.646	0.86 (0.63–1.17)	0.339	0.83 (0.60–1.16)	0.279	0.84 (0.60–1.17)	0.295

CI = confidence interval, GEE = generalized estimating equation, HR = hazard ratio, OR = odds ratio.

*The models were adjusted for patient sex, age, comorbid conditions, fracture type, type of surgical procedure, multiple trauma, admission from emergency department, intensive care unit use, length of hospital stay, surgeon volume, specialty, and age, hospital volume, hospital level, teaching, and geographic location.

†The models were weighted by the inverse of a propensity score.

As a result, patients are more likely to receive regional anesthesia in Taiwan.

The finding of no association between anesthesia type and 30-day mortality for hip fracture surgery is consistent with that of 4 previous studies using 30-day mortality as an outcome measure,[6,22–24] and that of 2 previous studies using in-hospital mortality.[20,21] Nevertheless, 1 previous study using 30-day mortality,[18] and 2 previous studies using in-hospital mortality[16,19] found an association between regional anesthesia and lower mortality. One reason for the differences in the findings is that in-hospital mortality is more subject to detection bias than 30-day mortality.[6] Because some patients might have been discharged from the hospital before the potential death.[23,42,45] Research has shown that in-hospital mortality measures systematically favor hospitals with shorter lengths of stay.[46] Thirty days is a standard time frame that can be strongly influenced by hospital care; therefore, the 30-day outcome time frame is necessary so that outcomes for each patient are measured consistently.[11] The result of outcomes research using 30-day mortality is more valid than that using in-hospital mortality.

Another reason is whether selection bias from observational studies is corrected. Only 1 observational study using 30-day mortality found the association between regional anesthesia and lower mortality.[18] The limitation of Radcliff et al's study was the lack of a correction for selection bias due to the nonrandom selection of patients for one form of anesthesia or another.[22] To overcome the limitation, recent related studies used propensity score methods to correct for the selection bias and provide more valid analysis results.[15,16,19,20,22,24,27] Regarding the studies using 30-day mortality and a propensity score method, the finding of this study is consistent with that of the other studies.[22,24] If a beneficial impact of regional anesthesia on short term mortality exists, it is likely to be more modest than previously reported.[21]

The notable finding was that regional anesthesia was associated with lower 30-day all-cause readmission. This finding of an association between regional anesthesia and lower 30-day readmission is consistent with Mesko et al[47] regarding total hip and knee arthroplasty. Mesko et al[47] infer that the mechanism underlying the association is through lower 30-day complications based on previous studies finding an association between regional anesthesia and reduced 30-day complications. However, the finding is inconsistent with 3 previous studies.[18,20,24] In Radcliff et al's and Le-Wendling et al's studies,[18,20] there may be a measurement bias because 30-day readmission was determined by whether patients were admitted to a Veterans Health Administration hospital and the same hospital, respectively, rather than any hospital. Basques et al's study population was patients aged 70 years and older in participating hospitals[24] rather than the nationwide population, so whether the finding generalizes to the nationwide population is uncertain.

This finding of an association between regional anesthesia and lower 30-day surgical site infection readmission is consistent with Radcliff et al[18] using 30-day complications, and Chang et al[15] regarding 30-day surgical site infection for total hip or knee replacement. Based on Chang et al's reason for the association between regional anesthesia and lower 30-day surgical site infection,[15] they proposed that compared with general anesthesia, regional anesthesia has a sympathetic blocking effect that improves tissue perfusion and oxygenation,[48,49] increases polymorphonuclear cells at surgical sites,[50] and can better maintain regional normothermia.[51] Thus, regional anesthesia could still contribute to an environment strengthening the host defense against surgical pathogens, leading to reduced 30-day surgical site infection.[15] Therefore, regional anesthesia might be more effective in preventing 30-day surgical site infection readmission for hip fracture surgery.

Our study has 2 limitations. First, in common with other hip surgery studies using administrative databases,[15,16,19,21,22] no information on certain relevant clinical details (eg, body mass index, operation time)[17,24,27] was available for risk adjustment. Nevertheless, we controlled for patient sex, age, comorbid conditions, admission from ED, and ICU use, which are also important when adjusting for the complexity of the illness.[15,16,19,21,22] Second, because we lacked detailed intraoperative data, we could not examine the degree to which regional anesthesia outcomes might vary based on the type of block performed or the depth of sedation.[52,53]

Anesthetic type does not affect 30-day mortality for hip fracture surgery, but hip fracture surgery patients receiving regional anesthesia have a lower risk of 30-day all-cause readmission and 30-day surgical site infection readmission than those receiving general anesthesia. These findings may support the notion that recent practice guidelines have advocated greater use of regional anesthesia for hip fracture surgery.[7–9] Thirty-day readmission is an important indicator when evaluating hospital care. Higher readmission rates signal concerns about outcomes of hospital care. The management of hip fracture surgery using regional anesthesia may offer benefits in terms of 30-day readmission, especially under the implementation of bundled payments including related readmissions for 30 days after hospital discharge, or the Hospital Readmissions Reduction Program.

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