



The impact of metabolic syndrome on 30-day outcomes in geriatric hip fracture surgeries

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Abstract

Purpose Past literature has reported metabolic syndrome (MetS) to complicate postoperative care in patients undergoing various surgical procedures. We sought to analyze the impact of MetS on 30-day outcomes following hip fracture surgeries in the geriatric population.

Materials and methods The 2015–2016 ACS-NSQIP database was queried for patients undergoing hip fracture repair using CPT codes for total hip arthroplasty (27130), hemiarthroplasty (27125) and open reduction internal fixation (27236, 27244, 27245). Only patients ≥ 65 years of age undergoing surgery due to a traumatic hip fracture were included in the study. MetS was defined using preset criteria used by other NSQIP studies as the presence of—(1) diabetes mellitus AND (2) hypertension requiring medication AND (3) BMI ≥ 30 kg/m².

Results Out of 31,621 patients, a total of 1388 (4.4%) geriatric patients with MetS underwent hip fracture surgery. Following adjusted analysis, the presence of MetS was associated with higher odds of a prolonged length of stay > 5 days (OR 1.14 [95% CI 1.01–1.29]; $p=0.031$), deep SSI (OR 2.48 [95% CI 1.20–5.14]; $p=0.014$), progressive renal insufficiency (OR 3.27 [95% CI 1.98–5.42]; $p<0.001$), acute renal failure (OR 2.08 [95% CI 1.04–4.15]; $p=0.038$), urinary tract infection (OR 1.43 [95% CI 1.12–1.81]; $p=0.004$), 30-day readmissions (OR 1.28 [95% CI 1.08–1.52]; $p=0.005$) and a non-home discharge (OR 1.42 [95% CI 1.18–1.71]; $p<0.001$).

Conclusion MetS is associated with a significantly increased risk of several postoperative complications, readmissions and non-home discharge dispositions. Providers can utilize these data to promote the need for better perioperative care in these high-risk patients.

Keywords Metabolic syndrome · Hip fracture · Geriatric · Surgery · Repair · Outcomes · NSQIP · MetS · Complications · Readmissions

Introduction

Metabolic syndrome (MetS), defined as the simultaneous presence of a constellation of comorbid factors and medical diagnoses, is known to negatively impact the odds of cardiovascular disease and all-cause mortality in individuals [1]. In the USA, more than 40% of patients above the age of 60 years have been found to be “harboring” MetS [2]. While this proportion may seem alarming, it is not surprising given the widespread urbanization, global adoption of sedentary lifestyles and the worldwide increase in longevity all of which are known risk factors for developing this syndrome [1]. Though the exact definition of MetS still remains a debate, majority of past surgical database studies [3–5] investigating the effect of MetS mutually agree

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on hypertension, diabetes mellitus and obesity being key components of this disorder.

MetS has recently been found to be significantly associated with postoperative morbidity and mortality in patients undergoing various surgeries. Most orthopedic studies on MetS have focused on elective procedures, such as lumbar fusions [3] and total joint arthroplasties [6], and the literature on MetS in orthopedic trauma remains limited to only one study on ankle fractures [7]. Despite numerous studies reporting a link between MetS and accelerated development of osteoporosis and concurrent increased risk of fracture [8], the literature focusing on the impact of MetS on postoperative outcomes following hip fracture surgery remains largely absent. Furthermore, given the rising elderly population, it can be assumed that the number of hip fracture patients presenting with MetS is expected to rise.

In the light of the latter, we sought to analyze a large well-audited national surgical database to study the impact of MetS on 30-day outcomes following geriatric hip fracture surgeries. We hypothesized that based on past findings patients with MetS undergoing hip fracture surgery would be at a higher risk of experiencing a 30-day adverse outcome and longer length of stay.

Materials and methods

Database

This study was a retrospective review of data collated from the 2015–2016 American College of Surgeons–National Surgical Quality Improvement Program (ACS–NSQIP) database. The ACS–NSQIP database is a national surgical dataset that records perioperative and postoperative outcomes-related data up to 30 days following surgeries. Details of the dataset and the variables included have been described previously. Due to a thorough review process carried out by trained surgical and clinical reviewers, as well as an annual auditing protocol, the reliability of the data is reported to be above 95% [9]. Because this study uses de-identified data from a national database, it was exempt from Institutional Review Board approval.

Current Procedural Terminology (CPT) codes were used to query the database for patients undergoing total hip arthroplasty (THA; CPT-27,130), hemiarthroplasty (HA; CPT-27125) and open reduction internal fixation (ORIF; CPT-27236, CPT-27244, CPT-27245) for hip fractures. Records of patients undergoing surgery for degenerative arthritis, hip deformities, mechanical complications of prior prosthesis and periprosthetic fractures were excluded from the study cohort. Additionally, to ensure that the study sample was reflective of isolated geriatric hip fracture surgery

only, patients aged less than 65 years and/or undergoing concurrent surgery for poly-trauma were excluded.

MetS was defined based on preset criteria, previously utilized by other NSQIP studies, consisting of the simultaneous coexistence of (1) diabetes mellitus, (2) hypertension requiring medication and (3) body mass index (BMI) ≥ 30 kg/m². The study cohort was divided into two groups—(1) MetS and (2) No MetS.

Variables included

Variables that were retrieved from the database were divided into the following categories for ease of referral—(1) demographics, (2) comorbidities, (3) preoperative data, (4) intraoperative data and (5) postoperative data. The complete list of variables in each of the categories 1–4 can be found in Table 1. Postoperative data included length of stay and 30-day outcomes. Length of stay was dichotomized into 0–5 days and > 5 days based on the median. 30-Day outcomes that were included in the study were (1) surgical site infection (SSI)—further defined into superficial, deep and organ/space, (2) wound dehiscence, (3) pneumonia, (4) unplanned intubation, (5) ventilator use > 48 h, (6) progressive renal insufficiency, (7) acute renal failure, (8) urinary tract infection (UTI), (9) CVA/stroke, (10) cardiac arrest, (11) myocardial infarction, (12) bleeding requiring transfusion, (13) deep venous thrombosis (DVT), (14) sepsis, (15) septic shock and (16) mortality. Additional outcomes that were assessed as part of the study were 30-day readmissions, 30-day unplanned reoperations and discharge destination (categorized into non-home vs. home).

Statistical analysis

Unadjusted comparison for baseline difference in demographics, comorbidities, preoperative data and intraoperative data was carried out using Pearson–Chi-square test. All variables with a *p* value < 0.1 were defined as covariates that would be adjusted for in logistic regression models. Pearson–Chi-square test was then run to assess for unadjusted significant associations between MetS and postoperative data. All significant associations with a *p* value < 0.05 were then further analyzed using individual multivariate logistic regression models, while adjusting for covariates (age, gender, race, comorbidities [smoking, dyspnea, functional health status, ventilator dependence, history of severe chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF) in 30 days before surgery, acute renal failure, pre-op dialysis, disseminated cancer, open wound/wound infection, chronic steroid use, > 10% bodyweight loss in last 6 months, bleeding disorders], transfer status, American Society of Anesthesiologists (ASA) grade, time to operation, anesthesia type, procedure type and total operative

Table 1 Baseline clinical characteristics between MetS and control (No MetS) groups

Variable	MetS	No MetS	<i>p</i> value
Age (years)			< 0.001
65–79	816 (58.8%)	9572 (31.7%)	
80–89	487 (35.1%)	13,461 (44.5%)	
≥90	85 (6.1%)	7200 (23.8%)	
Gender			< 0.001
Male	487 (35.1%)	8684 (28.7%)	
Female	901 (64.9%)	21,549 (71.3%)	
Race			< 0.001
White	1130 (81.4%)	24,090 (79.7%)	
Black or African American	60 (4.3%)	921 (3.0%)	
Asian	18 (1.3%)	763 (2.5%)	
American Indian or Alaska Native	2 (0.1%)	23 (0.1%)	
Native Hawaiian/Pacific Islander	12 (0.9%)	113 (0.4%)	
Unknown/not reported	166 (12.0%)	4323 (14.3%)	
Body mass index (BMI; kg/m ²)			< 0.001
< 25.00	0 (0%)	18,077 (59.8%)	
25.0–29.99	0 (0%)	8971 (29.7%)	
30.0–34.99	915 (65.9%)	2334 (7.7%)	
≥ 35.0	473 (34.1%)	851 (2.8%)	
<i>Comorbids</i>			
Diabetes			< 0.001
IDDM	688 (49.6%)	1648 (5.5%)	
NIDDM	700 (50.4%)	2622 (8.7%)	
Smoker within past year	109 (7.9%)	2821 (9.3%)	0.063
Dyspnea			< 0.001
At rest	31 (2.2%)	315 (1.0%)	
At moderate exertion	145 (10.4%)	1836 (6.1%)	
Functional status prior to surgery			0.011
Independent	1105 (79.6%)	23,502 (77.7%)	
Partially dependent	237 (17.1%)	5471 (18.1%)	
Totally dependent	28 (2.0%)	1002 (3.3%)	
Unknown	18 (1.3%)	258 (0.9%)	
Ventilator dependent	5 (0.4%)	50 (0.2%)	0.088
History of severe COPD	215 (15.5%)	3378 (11.2%)	< 0.001
Ascites	3 (0.2%)	54 (0.2%)	0.747
Congestive heart failure (CHF) in 30 days before surgery	98 (7.1%)	1134 (3.8%)	< 0.001
Hypertension (HTN) requiring medication	1388 (100%)	20,669 (68.4%)	< 0.001
Acute renal failure	17 (1.2%)	183 (0.6%)	0.004
Preoperative dialysis	58 (4.2%)	498 (1.6%)	< 0.001
Disseminated cancer	12 (0.9%)	464 (1.5%)	0.045
Open wound/wound infection	79 (5.7%)	1104 (3.7%)	< 0.001
Chronic steroid use	103 (7.3%)	1486 (4.9%)	< 0.001
Bleeding disorders	355 (25.6%)	5026 (16.6%)	< 0.001
Transfusion of at least one unit of packed RBCs within 72 h before surgery	61 (4.4%)	1329 (4.4%)	0.999
History of Systemic Sepsis			0.213
Prior sepsis	10 (0.7%)	191 (0.6%)	
Prior septic shock	2 (0.1%)	15 (~0%)	
Prior SIRS	164 (11.8%)	3205 (10.6%)	
> 10% weight loss in last 6 months	8 (0.6%)	481 (1.6%)	0.003

Table 1 (continued)

Variable	MetS	No MetS	<i>p</i> value
<i>Preoperative data</i>			
Transferred from			< 0.001
Home	1011 (72.8%)	22,648 (74.9%)	
Nursing home/chronic care	86 (6.2%)	1488 (4.9%)	
Acute care hospital inpatient	108 (7.8%)	3191 (10.6%)	
Outside ED	168 (12.1%)	2518 (8.3%)	
Other/unknown	13 (0.9%)	307 (1.0%)	
ASA class			< 0.001
I	1 (0.1%)	130 (0.4%)	
II	91 (6.6%)	5007 (16.6%)	
III	933 (67.2%)	19,417 (64.2%)	
IV	359 (25.9%)	5654 (18.7%)	
V	4 (0.3%)	25 (0.1%)	
Time to operation			< 0.001
0–2 days	1244 (89.6%)	28,181 (93.2%)	
> 2 days	144 (10.4%)	2052 (6.8%)	
<i>Operative data</i>			
Anesthesia type			< 0.001
General	1115 (80.3%)	22,041 (72.9%)	
Other	273 (19.7%)	8190 (27.1%)	
Unknown	0 (0%)	2 (~0%)	
Procedure			0.001
THA	71 (5.1%)	1484 (4.9%)	
HA	152 (11.0%)	4422 (14.6%)	
ORIF	1165 (83.9%)	24,327 (80.5%)	

Bold values are statistically significant

time), to study the independent impact of MetS on 30-day outcomes alone. Results from multivariate logistic regression have been reported as adjusted odds ratio (OR) and 95% confidence intervals (CI). Variables with a *p* value < 0.05 from multivariate analysis were considered significant. All statistical analysis was performed using SPSSv22 (IBM, Armonk, NY).

Results

Baseline clinical characteristics

Following inclusion/exclusion criteria, a total of 31,621 patients were included in the study—out of which 1388 (4.4%) had MetS. Detailed description of baseline characteristics of the study population is shown in Table 1. Patients with MetS were likely to have the following characteristics—age of 65–79 years, male gender, white or black/African American ethnicity, dyspneic, have history of severe COPD and CHF preoperatively, pre-op acute renal failure, dialysis dependent, history of chronic steroid use and bleeding disorders. Furthermore, MetS patients

were more likely to be transfer patients and have a higher ASA class and longer time to operation. Interestingly, MetS patients were more likely to experience a longer operating time as compared to their counterparts.

30-day outcomes

Unadjusted comparison between MetS and 30-day outcomes is shown in Table 2. Following adjustment for covariates and/or baseline differences between the two groups from Table 1 in a multivariate logistic regression model, MetS was significantly associated with higher odds of a prolonged length of stay > 5 days (OR 1.14 [95% CI 1.01–1.29]; *p* = 0.031), deep SSI (OR 2.48 [95% CI 1.20–5.14]; *p* = 0.014), progressive renal insufficiency (OR 3.27 [95% CI 1.98–5.42]; *p* < 0.001), acute renal failure (OR 2.08 [95% CI 1.04–4.15]; *p* = 0.038), urinary tract infection (OR 1.43 [95% CI 1.12–1.81]; *p* = 0.004), 30-day readmissions (OR 1.28 [95% CI 1.08–1.52]; *p* = 0.005) and a non-home discharge (OR 1.42 [95% CI 1.18–1.71]; *p* < 0.001) (Table 3).

Table 2 Unadjusted analysis for significant complications developing between the two groups

Variable	MetS	No MetS	<i>p</i> value
<i>Postoperative data</i>			
Length of stay (LOS/days)			< 0.001
0–5	762 (54.9%)	18,683 (61.8%)	
> 5	626 (45.1%)	11,550 (38.2%)	
Superficial SSI	11 (0.8%)	164 (0.5%)	0.219
Deep SSI	9 (0.6%)	65 (0.2%)	0.001
Organ/space SSI	4 (0.3%)	68 (0.2%)	0.629
Wound dehiscence	2 (0.1%)	19 (0.1%)	0.251
Pneumonia	52 (3.7%)	1282 (4.2%)	0.371
Unplanned intubation	24 (1.7%)	363 (1.2%)	0.080
Pulmonary embolism	13 (0.9%)	216 (0.7%)	0.340
Ventilator use > 48 h	14 (1.0%)	182 (0.6%)	0.059
Progressive renal insufficiency	20 (1.4%)	120 (0.4%)	< 0.001
Acute renal failure	10 (0.7%)	86 (0.3%)	0.004
Urinary tract infection	80 (5.8%)	1326 (4.4%)	0.015
CVA/stroke	12 (0.9%)	235 (0.8%)	0.718
Cardiac arrest	20 (1.4%)	243 (0.8%)	0.011
Myocardial infarction	34 (2.4%)	542 (1.8%)	0.074
Bleeding requiring transfusion	373 (26.9%)	7996 (26.4%)	0.725
Deep venous thrombosis/DVT	20 (1.4%)	338 (1.1%)	0.266
Sepsis	12 (0.9%)	341 (1.1%)	0.361
Septic shock	14 (1.0%)	191 (0.6%)	0.087
Mortality	74 (5.3%)	104 (5.6%)	0.630
30-Day readmission	168 (12.1%)	2721 (9.0%)	< 0.001
30-Day unplanned reoperations	40 (2.9%)	826 (2.7%)	0.738
Discharge destination			0.006
Home	144 (10.4%)	3893 (12.9%)	
Non-home	1244 (89.6%)	26,340 (87.1%)	

Bold values are statistically significant

Discussion

Using a large national surgical database, the findings of the current study show that the presence of MetS in geriatric patients undergoing hip fracture surgery is associated with a significantly higher risk of a prolonged length of stay, complications, readmissions and non-home discharge within 30 days of the index procedure. Based on a thorough review of current literature, our study is the first to effectively delineate a negative relationship between MetS and postoperative outcomes in geriatric hip fractures. With an increasing number of hip fracture patients expected to present in hospitals annually, the results stress the need for enhanced perioperative medical optimization in this high-risk group.

Table 3 Multivariate logistic regression assessing the independent impact of MetS on postoperative outcomes

Dependent variables	Odds ratio [95% CI]	<i>p</i> value
Length of stay (LOS/days) > 5	1.14 [1.01–1.29]	0.031
Deep SSI	2.48 [1.20–5.14]	0.014
Progressive renal insuff.	3.27 [1.98–5.42]	< 0.001
Acute renal failure	2.08 [1.04–4.15]	0.038
Urinary tract infection	1.43 [1.12–1.81]	0.004
30-Day readmission	1.28 [1.08–1.52]	0.005
Non-home discharge	1.42 [1.18–1.71]	< 0.001

Adjusted for age, gender, race, comorbidities (smoking, dyspnea, functional health status, ventilator dependence, history of severe COPD, CHF in 30 days before surgery, acute renal failure, pre-op dialysis, disseminated cancer, open wound/wound infection, chronic steroid use, > 10% bodyweight loss in last 6 months, bleeding disorders), transfer status, ASA Grade, time to operation, anesthesia type, procedure type and total operative time

Before discussing the postoperative outcomes in MetS patients in detail, it is necessary to explore the underlying pathophysiological link between MetS and fragility fractures of the hip. While there is no current scientific consensus, numerous recently published population-based studies have shown the presence of MetS to be associated with lower bone mineral density [10, 11] and concurrent higher risk of fragility fractures [12–14]. Numerous factors/causes, such as elevated diastolic blood pressure/arterial hypertension resulting in increased urinary excretion of calcium [15], bigger waist circumference [16, 17], deranged insulin levels [18] and underlying chronic inflammation [19], have been proposed in order to explain the occurrence of this link in this high-risk group.

Similar to previously published literature, female gender was more commonly associated with metabolic syndrome in our hip fracture population. Furthermore, the MetS population had a general higher overall comorbidity burden, as evidenced by higher ASA grades, underlying dyspnea, COPD, CHF, renal failure, dialysis use and bleeding disorders prior to undergoing surgery. MetS patients were more likely to have a delayed time to operation > 2 days as compared to No MetS (10.4 vs. 6.8%), conceivably due to these patients requiring a more detailed medical clearance prior to surgery. It is interesting to note that patients with MetS had longer operative times as compared to those who did not have MetS, most likely due to the altered coagulation profile seen with metabolic syndrome [20] resulting in not only increased bleeding around the fracture, but also impairing visual fields of surgeons.

While studies have assessed the independent impact of diabetes mellitus and BMI on 30-day outcomes following hip fractures, data looking at the clinical impact of MetS remain scarce. Since no current trauma literature exists

exploring the relationship between MetS and hip fracture outcomes, the results of the current study have been compared/contrasted to non-hip fracture trauma and elective orthopedic surgical studies. Menendez et al. [7] assessed discharge data using the National Hospital Discharge Survey (NHDS) and found MetS to be significantly associated with a higher rate in postoperative complications and non-home discharge following ankle fractures. Furthermore, similar to our findings, the authors also found a significant association between MetS and prolonged length of hospital stay [7]. With regard to elective orthopedic surgery, Edelstein et al. [6] analyzed more than 100,000 patients undergoing total joint arthroplasty (TJA) and found MetS to be an independent risk factor for 30-day complications and readmissions. Using the Nationwide Inpatient Sample (NIS) database, Mentsoudis et al. [21], Murphy et al. [22] and Della Valle et al. [23] all reported a higher risk of adverse inpatient outcomes, higher costs, longer length of stays and non-routine discharges in patients undergoing elective lumbar fusions, total shoulder arthroplasties (TSAs) and TJAs, respectively. However, in contrast, Chung et al. [3] found that though the presence of MetS is associated with a higher risk of complications following elective lumbar fusions, the increase in the percentage of adverse events is only slight. Moreover, MetS was found to have no impact on length of stay, 30-day readmissions and mortality in patients undergoing elective lumbar fusions. Possible causes as to why the findings of the Chung et al.'s study differ from those of the current study can be largely explained by the non-elective nature of the hip fracture surgery, requiring providers to expedite preoperative optimization in an attempt to ensure that the injured patient undergoes surgery within a reasonable time frame. Furthermore, underlying inflammation from a traumatic injury such as fracture would also make patients susceptible to adverse outcomes, due to physiological stress [24], when compared to a purely elective spine surgical procedure such as lumbar fusions. It is interesting to note that in the current study, while there no significant differences with regard to 30-day mortality between MetS and No MetS groups, the MetS group interestingly had a slightly lower overall risk of 30-day mortality (5.3%) versus those who did not have MetS (5.6%). One proposed explanation for this phenomenon by Menendez et al. [7] was that due to the higher overall comorbidity burden seen in these patients, providers may already be more "wary" of the risk of death in these patients and therefore place these high-risk patients on a more appropriate postoperative course of care.

There are limitations to the current study, which should be taken into account when applying the findings into practice. Firstly, the NSQIP database only records surgical outcome data up to 30 days following the procedure. This is particularly important as certain complications such as surgical site infections are known to occur well beyond

the 30-day period [25]. Secondly, the database also lacks intraoperative specific clinical data, such as total blood loss, which would be useful for analyzing the impact of MetS on intraoperative bleeding alone. Variations in the definition of MetS have been known to exist, and though we used a preset definition based on previously published orthopedic/spine/general surgery studies [3, 5, 6, 26], it is possible that the use of different definitions may alter patient population significantly. Furthermore, it would be interesting to see if MetS impacted functional outcomes following surgery too. Though the database is a well-audited national surgical dataset containing records from over 500 hospitals, the data are mostly reflective of the academic medical centers currently participating in NSQIP, and therefore, the results may not be generalized to a similar hip fracture population presenting at smaller community hospitals.

Hip fracture surgery in patients with concurrent metabolic syndrome is associated with higher odds of adverse 30-day outcomes, prolonged length of stay, 30-day readmissions and non-home discharge. Surgeons should acknowledge these patients as being a high-risk group and consequently tailor a more appropriate postoperative course of care in these patients, consisting of scheduled follow-ups to avoid the occurrence of adverse outcomes, reduce readmissions and subsequent financial and economic burden to the health-care system.

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Compliance with ethical standards

Conflict of interest Authors Safdar N. Khan and Thuan Ly have received research grants from Spinal Kinetics.

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