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Original article

Outcomes of obese patients hospitalized with COVID-19: the impact of prior bariatric surgery

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Abstract

Background: Obesity and several obesity-related co-morbidities are risk factors for severe COVID-19 disease. Because bariatric surgery successfully treats obesity-related conditions, we hypothesized that prior bariatric surgery may be associated with less severe COVID-19 disease.

Objectives: To examine the association between prior bariatric surgery and outcomes in patients with obesity admitted with COVID-19.

Setting: United States

Methods: The Vizient database was used to obtain demographic and outcomes data for adults with obesity admitted with COVID-19 from May 2020 to January 2021. Patients were divided into 2 groups: those with and those without prior bariatric surgery. The primary outcome was in-hospital mortality. Secondary outcomes were mortality by age, sex, race/ethnicity, and co-morbidity; intubation rate; hemodialysis rate; and length of stay. Because the database only provides aggregate data and not patient-level data, multivariate analysis could not be performed.

Results: Among the 124,699 patients with obesity admitted with COVID-19, 2,607 had previous bariatric surgery and 122,092 did not. The proportion of patients ≥ 65 years of age was higher in the non-bariatric surgery group (36.0% versus 27.6%, $P < .0001$). Compared with patients without prior bariatric surgery, patients with prior bariatric surgery had lower in-hospital mortality (7.8 versus 11.2%, $P < .0001$) and intubation rates (18.5% versus 23.6%, $P = .0009$). Hemodialysis rate (7.2% versus 6.9%, $P = .5$) and length of stay (8.8 versus 9.6 days, $P = .8$) were similar between groups. Mortality was significantly lower in the bariatric surgery group for patients 18–64 years of age (5.9% versus 7.4%, $P = .01$) and ≥ 65 years of age (12.9% versus 17.9%, $P = .0006$).

Conclusions: This retrospective cohort study found that inpatients with obesity and COVID-19 who had prior bariatric surgery had improved outcomes compared with a similar cohort without prior bariatric surgery. Further studies should examine mechanisms for the association between bariatric surgery and less severe COVID-19. (*Surg Obes Relat Dis* 2022;18:35–40.) © 2021 American Society for Bariatric Surgery. Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

Keywords:

Bariatric surgery; COVID-19; Coronavirus; Obesity; Outcomes

Obesity is one of the most common and costly diseases in the United States. More than 40% of the adult population has obesity, and prevalence has been increasing over time

[1]. Obesity-related conditions, such as type 2 diabetes (T2D) and heart disease, are some of the leading causes of preventable premature deaths in the United States. Though

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the obesity epidemic has posed a substantial burden for the U.S. healthcare system for decades, 2020 brought on a new magnitude of strain to the healthcare system with the novel coronavirus pandemic. By the end of 2020, COVID-19 became one of the leading causes of deaths in the United States [2]. Obesity and many obesity-related co-morbidities, such as T2D, heart disease, hypertension, and chronic pulmonary disease, have been associated with an increased risk of severe illness and death from COVID-19 [3–6].

Bariatric surgery is the most effective intervention for patients with morbid obesity to achieve and maintain weight loss. When compared with standard medical therapy alone, bariatric surgery has also been shown to be more effective in improving or even eliminating T2D, hypertension, obstructive sleep apnea, and hyperlipidemia [7,8]. Because bariatric surgery is so successful in treating these conditions that are also implicated as risk factors for severe COVID-19, it is plausible that a history of bariatric surgery may have a protective effect in patients infected with the novel coronavirus. A nationwide retrospective study from France evaluated patients with obesity admitted with COVID-19 and found that patients with a history of bariatric surgery had significantly lower rates of intubation and mortality [9]. Another study from Italy reported a lower rate of COVID-19 hospitalizations in patients with obesity who had a history of bariatric surgery [10]. A single-institution study in Cleveland also found a lower rate of hospital admission in patients with COVID-19 with a history of bariatric surgery [11]. To our knowledge, there has not been a large-scale study in the United States evaluating the association between bariatric surgery history and COVID-19 illness severity. The aim of this study was to compare the characteristics and outcomes of patients with obesity hospitalized with COVID-19 with and without a history of bariatric surgery.

Methods

Data were obtained using the Vizient clinical database, which contains data for all inpatients admitted to U.S. academic medical centers that are members of Vizient, as well as their affiliated hospitals [12]. The database reports in-hospital outcomes data and not post-discharge follow-up data. The data are based on billing records and include demographics, lengths of stay, and in-hospital mortality rates. Data can be selected according to many criteria, including International Classification of Diseases (ICD) diagnosis and procedure codes. The use of this database was approved by Vizient Inc. This study was considered exempt by the Institutional Review Committee at the University of California, Irvine Medical Center because the database does not contain identifiable patient-level data. Patient informed consent was waived by the institutional review committee.

We obtained demographic and outcomes data for all inpatients with the admission diagnosis of COVID-19 (ICD-10 code U071) and obesity (ICD-10 codes E6609, E6601, E660, E668, and E669) from May 1, 2020, to January 31, 2021. The months of March and April 2020 were excluded because during this time many U.S. hospitals were overwhelmed and had limited resources to treat patients with COVID-19. This is illustrated by the exceedingly high mortality rates during those initial months of the pandemic, followed by more consistent mortality rates beginning in May 2020 [13]. In addition, because of the limited testing capabilities in March and April 2020, COVID-19 diagnoses during that time may not be accurate. Patients <18 years of age were also excluded. Demographics included sex, age group, race/ethnicity, and co-morbidities. The co-morbidities evaluated were hypertension, diabetes, chronic pulmonary disease, congestive heart failure, and renal disease. Patients were separated into 2 groups: The bariatric surgery group included those with a history of bariatric surgery (ICD-10 code Z98.84), and the non-bariatric surgery group included those without a history of bariatric surgery (bariatric surgery status excluded). The primary outcome measure was overall in-hospital mortality. Secondary outcome measures were in-hospital mortality by age, sex, race/ethnicity, and co-morbidity, the proportions of patients who required mechanical ventilation and hemodialysis, and mean hospital length of stay.

Continuous variables were reported as means and standard deviations, and categorical variables were reported as numbers and percentages. Categorical data were compared between groups using Pearson's χ^2 test, and between-group means were compared using Student's *t* test. A *P* value <.05 was considered significant. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology reporting guidelines.

Results

There were 124,699 adults with obesity who were admitted with COVID-19 from May 2020 through January 2021. Of these patients, 2607 (2.1%) had a history of bariatric surgery, and 122,092 (97.9%) did not. There were significant differences between groups in all demographic categories (Table 1). Patients admitted for COVID-19 with a history of bariatric surgery were more often female than those without a history of bariatric surgery (72.4% versus 52.4%, *P* < .0001). Most patients with and without a history of bariatric surgery were <65 years of age (72.4% and 64.0%, respectively). The non-bariatric surgery cohort had a higher proportion of patients older than 65 years than the bariatric surgery group (36.0% versus 27.6%, *P* < .0001). In terms of race and ethnicity, the makeup of the bariatric surgery and non-bariatric surgery groups was similar. The bariatric surgery group had a slightly higher proportion of white patients (55.3% versus 47.9%, *P* < .0001), whereas

Table 1
Summary of characteristics of patients with obesity and COVID-19 with versus without a history bariatric surgery

Characteristic	Without a history of bariatric surgery (n = 122,092)	With a history of bariatric surgery (n = 2,607)	P Value*
Sex, no. (%)			<.0001
Female	63,925 (52.4)	1,888 (72.4)	
Male	58,167 (47.6)	719 (27.6)	
Age group, no. (%)			<.0001
18–64 yr	78,132 (64.0)	1,888 (72.4)	
≥65 yr	43,960 (36.0)	719 (27.6)	
Race/ethnicity,† no. (%)			
White	58,542 (47.9)	1,441 (55.3)	<.0001
Black	29,169 (23.9)	666 (25.6)	.05
Hispanic	24,516 (20.1)	344 (13.2)	<.0001
Asian	1,501 (1.2)	15 (0.6)	.004
Other or unknown	8,363 (6.9)	140 (5.4)	.003
Existing co-morbidities, no. (%)			
Hypertension	81,838 (67.0)	1,765 (67.7)	.5
Diabetes	58,734 (48.1)	1,130 (43.3)	<.0001
Chronic pulmonary disease	31,516 (25.8)	788 (30.2)	<.0001
Renal disease	25,030 (20.5)	537 (20.6)	.9
Congestive heart failure	21,178 (17.3)	487 (18.7)	.08

* χ^2 tests.

† Hispanic includes white Hispanic, black Hispanic, Asian Hispanic, and other Hispanic. Other races/ethnicities listed are non-Hispanic white, black, and Asian

the non-bariatric surgery group had higher proportions of Hispanic (20.1% versus 13.2%, $P < .0001$) and Asian (1.2% versus .6%, $P = .004$) patients. The proportion of

black patients was not significantly different between groups (23.9% in the non-bariatric surgery group versus 25.6% in the bariatric surgery group, $P = .05$). Rates of

Table 2
Outcomes for patients with obesity and COVID-19 with versus without a history of bariatric surgery

Outcome	Without a history of bariatric surgery (n = 122,092)	With a history of bariatric surgery (n = 2,607)	P Value*
Overall in-hospital mortality, n (%)	13,648 (11.2)	204 (7.8)	<.0001
In-hospital mortality by sex, n (%)			
Female	6121 of 63,925 (9.6)	131 of 1888 (6.9)	.0001
Male	7527 of 58,167 (12.9)	73 of 719 (10.2)	<.0001
In-hospital mortality by age group, n (%)			
18–64 yr	5771 of 78,132 (7.4)	111 of 1888 (5.9)	.01
≥65 yr	7877 of 43,960 (17.9)	93 of 719 (12.9)	.0006
In-hospital mortality by race/ethnicity,† n (%)			
White	6859 of 58,542 (11.7)	125 of 1441 (8.7)	.0004
Black	2668 of 29,169 (9.1)	35 of 666 (5.3)	.0007
Hispanic	2813 of 24,516 (11.5)	28 of 344 (8.1)	.07
Asian	147 of 1,501 (9.8)	0 of 15 (0.0)	NA‡
Other or unknown	1162 of 8,363 (13.9)	16 of 140 (11.4)	.5
In-hospital mortality by co-morbidity, n (%)			
Hypertension	10,903 of 81,838 (13.3)	151 of 1765 (8.6)	<.0001
Diabetes	8107 of 58,734 (13.8)	92 of 1,130 (8.1)	<.0001
Chronic pulmonary disease	4057 of 31,516 (12.9)	71 of 788 (9.0)	.002
Renal disease	4922 of 25,030 (19.7)	72 of 537 (13.4)	.0004
Congestive heart failure	4053 of 21,178 (19.1)	68 of 487 (14.0)	.005
Intubation/mechanical ventilation, n (%)	28,807 (23.6)	482 (18.5)	<.0001
Hemodialysis, n (%)	8380 (6.9)	189 (7.2)	.5
Length of stay, d, mean \pm SD	9.6 \pm 11.6	8.8 \pm 11.8	.8

* χ^2 or Student's t tests with unequal variance.

† Hispanic includes white Hispanic, black Hispanic, Asian Hispanic, and other Hispanic. Other races/ethnicities listed are non-Hispanic white, black, and Asian.

‡ NA: insufficient frequency to calculate P value.

hypertension, renal disease, and congestive heart failure did not vary significantly between groups. Chronic pulmonary disease was more prevalent in the bariatric surgery group (30.2% versus 25.8%, $P < .0001$), whereas diabetes was more prevalent in the non-bariatric surgery group (48.1% versus 43.3%, $P < .0001$).

Overall in-hospital mortality was significantly lower in patients with a history of bariatric surgery than in those without a history of bariatric surgery (7.8% versus 11.2%, $P < .0001$) (Table 2). When examining in-hospital mortality according to age group, patients with a history of bariatric surgery had significantly lower in-hospital mortality rates than those without a history of bariatric surgery for both the 18- to 64-year age group (5.9% versus 7.4%, $P = .01$) and the ≥ 65 -year age group (12.9% versus 17.9%, $P = .0006$). In-hospital mortality rates for every race and ethnicity were lower for patients with a history of bariatric surgery, but this only reached statistical significance in patients who identified as white or black. In-hospital mortality rates based on co-morbidity were significantly lower in patients with a history of bariatric surgery compared with those without prior bariatric surgery (Table 2). The rate of mechanical ventilation was significantly higher for the group without prior bariatric surgery compared with the group with prior bariatric surgery (23.6% versus 18.5%, $P < .0001$). There was no significant difference in the rate of patients with obesity admitted with COVID-19 requiring hemodialysis between groups (6.9% for those without bariatric surgery versus 7.2% for those with prior bariatric surgery, $P = 0.5$). Hospital length of stay did not vary between groups (Table 2).

Discussion

Bariatric surgery is recognized as the most effective intervention for patients with obesity to achieve sustained weight loss and to improve or resolve obesity-related co-morbidities. Bariatric surgery is an invaluable tool in combating the obesity epidemic, and we evaluated how these procedures may also play a role in the COVID-19 pandemic. In this retrospective study of 124,699 adults with obesity admitted with COVID-19 at U.S. academic medical centers, those with a history of bariatric surgery had improved outcomes with significantly lower rates of overall in-hospital mortality and mechanical ventilation than patients without a history of bariatric surgery.

The demographics of our bariatric surgery cohort closely mirror national numbers for those who undergo bariatric surgery. We found that 2.1% of patients with obesity admitted with COVID-19 had a history of bariatric surgery, which is similar to reports that approximately 1.1% of patients who qualify for bariatric surgery in the United States actually undergo surgery [14]. In addition, a prior systematic review found that approximately 72.6% of patients who underwent bariatric surgery were women, which is

almost identical to our finding of 72.4% of women in the bariatric surgery cohort [7]. The systematic review also found that patients undergo bariatric surgery at an average age of 39 years, which is consistent with our finding that patients in the bariatric surgery cohort were mostly younger than 65 years of age [7].

The reasons for the improved outcomes in patients with obesity and a history of bariatric surgery may be related to the fact that bariatric surgery effectively treats obesity and T2D, which have emerged as risk factors for severe illness and death from COVID-19 [3–6]. Obesity was also implicated as a risk factor for intensive care unit admission and mortality during the 2009 H1N1 influenza pandemic [15]. There are several reasons why obesity and its related conditions may adversely affect outcomes in pulmonary infections. First, obesity leads to several adverse changes in pulmonary physiology, including decreased respiratory compliance, increased airway resistance, increased work of breathing, and less efficient respiration [16,17]. Patients with obesity may also develop obstructive sleep apnea and/or obesity hypoventilation syndrome, leading to hypoxia and subsequent pulmonary artery hypertension [16]. This suggests that patients with obesity have decreased pulmonary reserve and are more susceptible to severe disease when confronted with pulmonary infections. A prior meta-analysis found that bariatric surgery significantly improved overall pulmonary function scores in patients with morbid obesity [18]. Some hypothesize that increased angiotensin-converting enzyme 2 (ACE2) expression may play a role in increased COVID-19 severity in patients with obesity and T2D. ACE2, which has increased expression in patients with obesity and T2D, has been identified as the functional receptor of SARS-CoV-2 and provides the virus entry into human cells [19–22]. It is possible that patients with prior bariatric surgery have decreased ACE2 expression, leading to improved COVID-19 outcomes. Interestingly, even among patients with co-morbidities associated with severe COVID-19 disease, we found that a history of bariatric surgery was independently associated with decreased in-hospital mortality. This could be because the obesity-related co-morbidities may be less severe in the bariatric surgery cohort. Another possible explanation is that bariatric surgery has been proven to decrease systemic markers of inflammation, including interleukin-6 and tumor necrosis factor- α [23]. These inflammatory markers are also involved in the damage caused by the COVID-19 cytokine storm, and levels are increased in patients with more severe disease [22].

Unfortunately, when the COVID-19 pandemic began ramping up in the United States, patient access to bariatric surgery quickly came to a halt. On March 13, 2020, the American College of Surgeons recommended postponing elective operations in response to the anticipated COVID-19 surge to conserve hospital resources and protect patients and personnel [24]. The delay of bariatric surgery that

happened as a result will undoubtedly result in a substantial burden of disease in patients who would have been bariatric surgical candidates. Bariatric surgery has many proven benefits, including the treatment of obesity and its related conditions and reducing cancer risk, and several studies on all-cause mortality have found that patients who have had bariatric surgery live longer than matched patients without a history of bariatric surgery [25]. We now show, similar to a French database study, that a history of bariatric surgery is associated with lower rates of in-hospital mortality and intubation in patients hospitalized with COVID-19, further highlighting the important role of bariatric surgery [9]. While classified as elective surgeries, bariatric operations have significant implications for controlling diseases that cause substantial burden to our patients and healthcare system. These operations should be classified as time sensitive, because delaying bariatric surgery is associated with lower T2D remission rates [25]. Unfortunately, it has been reported that at the height of the pandemic in the United States, bariatric operative volume was reduced by 98% [26]. As hospitals and surgeons start to tackle the backlog of operations that were delayed during the pandemic, bariatric surgeries should be given strong consideration for prioritization.

There are several limitations to this study. Because it is a retrospective database study, there is an intrinsic risk for selection bias and ICD coding errors. In addition, the database is limited to reporting in-hospital mortality only. Therefore, our results may underreport overall mortality. Also, while the database allowed us to determine in-hospital mortality by co-morbidity, it did not provide information on the severity of each co-morbidity. This information could have been helpful in determining why in-hospital mortality and intubation rates were lower in the bariatric surgery group. Another limitation is that the database does not provide patient-level data, precluding multivariate analysis. It is notable that the non-bariatric surgery cohort had a higher proportion of patients in the ≥ 65 age group than the bariatric surgery cohort, which could lead to overestimating the overall mortality of the non-bariatric surgery group. However, it is important to note that mortality rates in the bariatric surgery group were significantly lower for patients in both the 18–64 and ≥ 65 age groups. In addition, this study only examined COVID-19 patients who were sick enough to require hospitalization, and our data cannot be extrapolated to patients managed in the outpatient setting. However, other studies from Italy and Cleveland found decreased rates of hospital admission in patients with COVID-19 who had a history of bariatric surgery, further suggesting that a history of bariatric surgery is associated with less severe COVID-19 disease [10,11]. Despite these limitations, this study is the largest to date examining a cohort of hospitalized COVID-19 patients with obesity, showing improved outcomes in patients with a history of bariatric surgery.

Conclusions

The obesity epidemic has plagued the United States for decades, and the COVID-19 pandemic has further highlighted the vulnerabilities of patients with obesity and obesity-related co-morbidities. Bariatric surgery is an important and effective tool in combating the obesity epidemic, and our findings suggest that bariatric surgery also may play a role in the severity and outcome of COVID-19 illness. In this retrospective study of adults with obesity admitted to the hospital with COVID-19 in the United States, we demonstrated that prior bariatric surgery is associated with decreased rates of in-hospital mortality and mechanical ventilation. Further studies should examine possible mechanisms that explain the association between bariatric surgery and COVID-19 disease severity and the implications of postponing of bariatric surgeries during the pandemic. As elective surgeries resume, bariatric surgery should be given a strong consideration for prioritization.

Disclosure

Ninh T. Nguyen reported serving as a speaker for Olympus and Endogastric Solutions. The remaining authors have nothing to disclose.

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Editorial comment

Comment on: Outcomes of obese patients hospitalized with COVID-19: the impact of prior bariatric surgery

Few are unaware of the global pandemic caused by a novel coronavirus that has impacted our planet for the past 2 years. Health factors such as obesity, even without associated medical conditions, are associated with more severe disease and mortality in patients infected with COVID-19 [1]. The manuscript by Purdy et al. is a timely review of a topic that many in our field believed to be true but had little data to support: that the improvement of obesity and weight-related health conditions through metabolic surgery would likely have a protective effect on patient outcomes after severe COVID-19 infection. Of note, however, a similar (although smaller) study from France found that among post-bariatric surgery patients, persistence of type 2 diabetes at the most recent follow-up visit increased the likelihood of such patients having more severe disease episodes if later hospitalized with COVID-19 infection [2]. This emphasizes the additive effects of obesity-related co-morbidities on the severity of COVID-19 infection.

Papers by Aminian et al., published during the pandemic, alerted us that patients with undiagnosed COVID-19 infection who then underwent uncomplicated “elective” operations had an excessively high mortality rate [3]. The publication by Doglietto et al., describing a 20% mortality rate among patients known to be COVID-positive prior to

surgery, had a chilling effect on surgical practice [4]. The rapid pandemic lockdown and cessation of all nonurgent surgery, followed by staged reopening and the requirement for preoperative viral testing was necessary until we had more data. Unfortunately, this likely had the unintended consequence of delaying much-needed medical care for untold numbers of patients [5].

The “Safer Through Surgery” editorial in this journal [6], along with articles such as that by Prachand et al. [7], were calls for us to parse out the difference between what is truly elective surgery and that which is more time-sensitive and medically necessary. Looking at the relationship between COVID-19, patients with severe obesity, and bariatric surgery, Vosburg et al. published their series of patients with severe obesity who underwent bariatric surgery after full recovery from COVID-19 infection [8]. Data on 53 patients who had previously been diagnosed with COVID-19 infection of any severity showed that after resolution of that illness, the rate of complications after metabolic surgery was no higher than that of the general bariatric population. These authors concluded that “Bariatric surgery should not be considered elective in the setting of this pandemic as patients with obesity are at increased risk of mortality and the surgery can be conducted safely both before and after infection.”