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Research Article

Post-Operative Outcomes in Obese Vs. Non-Obese Children with Adolescent Idiopatic Scoliosis Undergoing Posterior Spinal Deformity Surgery: An ACS-NSQIP Analysis

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Abstract

Background: While obesity is on the rise in the pediatric population, there is a paucity of literature concerning the effect obesity may have on post-operative outcomes. Posterior spinal fusion for the treatment of Adolescent Idiopathic Scoliosis is one of the most common spinal procedures in the pediatric population. However, the role obesity may play on outcomes following this extensive surgery is poorly understood.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database for children was queried to identify pediatric patients who underwent spinal deformity correction surgery. Patients who had undergone an anterior surgical approach were excluded from the analysis. Children were categorized as Obese if their BMI exceeded 95th percentile for their age group in months. They were then stratified into cohorts based on their obesity status (Obese vs. Non-Obese) and compared in regard to demographics, pre-operative comorbidities, intra-operative, and post-operative outcomes. Propensity score matching was then performed to limit confounders between the two cohorts. Statistical analysis was performed utilizing independent t-tests for continuous variables and chi-square analysis for categorical data. Statistical significance was set at <0.05.

Results: A total of 1702 patients met the inclusion criteria for the study, 851 obese and 851 non-obese. Pre-operatively, the mean age of both the non-obese and obese patients was 14 years (p=0.481). The mean weight was 48.62 kg for non-obese patients, and 83.06 for obese patients (p<0.001), while BMI was 20.46 in the non-obese group and 36.99 in the obese group (p<0.001). Both cohorts had a majority of female patients (non-obese: 75.3% vs. obese: 74.6%, p=0.780). The most common ASA score in both groups was 2 (non-obese: 71.0% vs. obese: 70.2%, p=0.899). White patients underwent fusion more often in the non-obese and obese groups (71.7% vs. 70.9%, p=0.820). Intra-operative findings demonstrated obese patients spent a significantly longer time in the operating room (272.75 minutes vs. 293.10 minutes, p<0.001). Non-obese patients had a significantly longer LOS than obese patients (5.75 days vs. 4.59 days, p<0.001). There was a significantly higher incidence of superficial SSI in obese patients (0.2% vs. 1.2%, p=0.038). Non-obese patients had significantly more bleeding needing transfusions than obese patients (67.0% vs. 61.6%, p=0.023), and had more total blood transfused (335.94 mL vs. 222.02 mL, p<0.001). Obese patients had a higher 30-day readmission rate (2.6% vs. 5.2%, p=0.008). No other differences were observed in demographics, medical conditions, or post-operative complications.

Conclusion: Obesity significantly increases the risk for early complications in pediatric patients undergoing spinal deformity surgery. Obese patients are at increased risk for longer operative time, postoperative superficial infection and 30-day readmission. As such, spine surgeons should be cognizant of these potential adverse outcomes and should consider the benefits of prophylactic protocols.

Abbreviations: AIS: Adolescent idiopathic scoliosis; BMI: Body Mass Index; SSI: Surgical Site Infection; ASA: American Society of Anesthesiology; SSI: Surgical Site Infection; LOS: Length of Stay; UTI: Urinary Tract Infection; DVT: Deep Vein Thrombosis;

Introduction

Adolescent idiopathic scoliosis (AIS) is the most common variant of scoliosis, with an incidence of 2% - 5% and a strong preponderance for women [1-3]. In this population, the increasingly common treatment for AIS is multilevel posterior spinal fusion. There have been numerous improvements to the procedure allowing for better long-term outcomes [4,5]. Some studies suggest a peri-operative complication rate of about 0.2% - 5% depending on the patient population and severity of AIS, among other things [1,6,7]. Numerous studies have demonstrated the increased risk associated with obese patients undergoing spinal surgery. Basques et al showed that obese patients developed more adverse events following PSF [1]. Patel et al identified a correlation between increasing BMI and perioperative complications in patients undergoing spinal fusion [8]. The role obesity may play on outcomes, and the underlying pathophysiology, following this extensive surgery is poorly understood. Furthermore, the vast majority of the literature focuses on the adult population. While obesity is on the rise in the pediatric population, there is a paucity of literature on the effect obesity may have on post-operative outcomes. This study aims to compare the peri-operative outcomes between obese and non-obese patients with AIS undergoing posterior spinal deformity surgery using relevant variables including, surgical site infection (SSI), unplanned reoperation and 30-day readmission.

Methods

Data source

The American College of Surgeons National Surgical Quality Improvement Program Pediatric (ACS NSQIP Peds) database was utilized for this study. The ACS NSQIP Peds provides information on patients under the age of 18 that undergo major surgical procedures at participating hospitals (https://www.facs.org/quality-programs/childrens-surgery/pediatric/overview). Approximately 94 data points are collected on patients and compiled from most pediatric surgical specialties at acute care children's hospitals, specialty children's hospitals, children's hospitals within a larger hospital, and pediatric wings of acute care hospitals. Outcomes for 30-days post-procedure are also included.

Patient selection

The ACS NSQIP Peds was retrospectively reviewed for all patients between January 1, 2012 and December 31, 2016. Patients were included if they had a diagnosis of idiopathic scoliosis (ICD codes: 737.32, 737.30, M41.114, M41.115, M41.116, M41.119) and a spinal fusion (CPT codes: 22800, 22802, 22804). Patients were excluded if they had a diagnosis of neuromuscular scoliosis or were under the age of 5 years. A total of 7,517 patients were identified.

Data Collection

Demographic factors such as age, weight by kilogram, body mass index (BMI), gender, American Society of Anesthesiology (ASA) physical status score, and race were collected for each patient. Patient BMI was calculated utilizing weight and height data made available in the NSQIP database. Obesity was calculated based upon patient weight in kilograms and age at the time of surgery, with patients having a weight in the 95th percentile for their age classified as obese. Operative time, total length of stay (LOS) and surgical complications in the 30-day period after spinal fusion were compared between non-obese and obese patients. The complications assessed included superficial surgical site infection (SSI), deep SSI, organ space SSI, wound dehiscence, sepsis, urinary tract infection (UTI), postoperative pneumonia, bleeding needing transfusion, total blood transfused, deep vein thrombosis (DVT), pulmonary embolism, acute renal failure, nerve injury, unplanned reoperation and 30-day readmission.

Statistical Analysis

Propensity score matching was performed to limit confounders between non-obese and obese patients. Patients were matched on age, gender, ASA score and race. Continuous variables were compared using t-tests, while categorical variables were compared using chi-square or Fisher's exact tests. Statistical significance was set at 0.05. All statistical analyses were performed using SPSS version 25 (IBM Corporation, Armonk, New York, USA).

Results

There were a total of 1,702 patients included for analysis after propensity score matching, 851 non-obese patients and 851 obese patients (Table 1). The mean age of both the non-obese and obese patients was 14 years (p=0.481). The mean weight was 48.62 kg for non-obese patients, and 83.06 for obese patients (p<0.001), while BMI was 20.46 in the non-obese group and 36.99 in the obese group (p<0.001). Both cohorts had a majority of female patients (non-obese: 75.3% vs. obese: 74.6%, p=0.780). The most common ASA score in both groups was 2 (non-obese: 71.0% vs. obese: 70.2%, p=0.899). White patients underwent fusion more often in the non-obese and obese groups (71.7% vs. 70.9%, p=0.820).

Compared to non-obese patients, obese patients spent a significantly longer time in the operating room (272.75 minutes vs. 293.10 minutes, p<0.001) (Table 2). Conversely, non-obese patients had a significantly longer LOS than obese patients (5.75 days vs. 4.59 days, p<0.001). There was a significantly higher incidence of superficial SSI in obese patients (0.2% vs. 1.2%, p=0.038). No significant difference was seen between non-obese and obese patients in deep SSI (0.6% vs. 1.2%, p=0.300), organ space SSI (0.2% vs. 0.1%, p=0.999), wound dehiscence, (0.9% vs. 0.9%, p=0.999), sepsis (0.6% vs. 0.4%, p=0.726), UTI (0.8% vs. 0.5%, p=0.547), postoperative pneumonia (0.6% vs. 0.2%, p=0.452), DVT (0.0% vs. 0.0%), PE (0.0% vs. 0.0%), acute renal failure (0.1% vs. 0.0%, p=0.999), nerve injury (0.5% vs. 0.4%, p=0.999) or unplanned reoperations (2.5% vs. 3.8%, p=0.162). Non-obese patients had significantly more bleeding needing transfusions than obese patients (67.0% vs. 61.6%, p=0.023), and had more total blood transfused (335.94 mL vs. 222.02 mL, p<0.001). Obese patients had a higher 30-day readmission rate (2.6% vs. 5.2%, p=0.008).

Table 1: Demographics for non-obese and obese scoliosis patients.

	Non-obese	Obese	p-value
Number of Patients	851 (50.0%)	851 (50.0%)	
Mean Age (SD)	13.7 (2.23)	13.6 (2.0)	0.481
Mean Weight by Kg (SD)	48.62 (12.41)	83.06 (17.32)	<0.001
Mean BMI (SD)	20.46 (6.10)	36.99 (92.60)	<0.001
Gender			
Male	210 (24.7%)	216 (25.4%)	0.780
Female	641 (75.3%)	635 (74.6%)	
ASA score			
1	135 (15.9%)	128 (15.0%)	0.899
2	604 (71.0%)	597 (70.2%)	
3	109 (12.8%)	123 (14.5%)	
4	2 (0.2%)	2 (0.2%)	
Race			
White	610 (71.7%)	603 (70.9%)	0.820
Black	155 (18.2%)	163 (19.2%)	
Asian	8 (0.9%)	6 (0.7%)	
Native American or Alaska Native	5 (0.6%)	2 (0.2%)	
Native Hawaiian or Pacific Islander	1 (0.1%)	2 (0.2%)	
Unknown	72 (8.5%)	75 (8.8%)	

SD: Standard Deviation

Kg: Kilograms

BMI: Body Mass Index (kg/m^2)

ASA: American Society of Anesthesiology physical status score

Table 2: Surgical complication rates between non-obese and obese scoliosis patients.

	Non-obese	Obese	p-value
Mean Total Operative Time (minutes) (SD)	272.75 (101.89)	293.10 (103.29)	<0.001
Length of Total Hospital Stay (days) (SD)	5.75 (7.16)	4.59 (4.87)	<0.001
Superficial Surgical Site Infection	2 (0.2%)	10 (1.2%)	0.038
Deep Incisional Surgical Site Infection	5 (0.6%)	10 (1.2%)	0.300
Organ Space Surgical Site Infection	2 (0.2%)	1 (0.1%)	0.999
Wound Dehiscence	8 (0.9%)	8 (0.9%)	0.999
Sepsis	5 (0.6%)	3 (0.4%)	0.726
Urinary Tract Infection	7 (0.8%)	4 (0.5%)	0.547
Postoperative Pneumonia	5 (0.6%)	2 (0.2%)	0.452
Bleeding needing transfusion	570 (67.0%)	524 (61.6%)	0.023
Total Blood Transfused (mL) (SD)	335.94 (511.90)	222.02 (554.87)	<0.001
Deep Vein Thrombosis	0 (0.0%)	0 (0.0%)	---
Pulmonary Embolism	0 (0.0%)	0 (0.0%)	---
Acute Renal Failure	1 (0.1%)	0 (0.0%)	0.999
Nerve Injury	4 (0.5%)	3 (0.4%)	0.999
Unplanned reoperation	21 (2.5%)	32 (3.8%)	0.162
30-day readmission	22 (2.6%)	44 (5.2%)	0.008

BMI: Body Mass Index (kg/m^2)

Discussion

The obesity epidemic has tremendous fiscal implications for the US healthcare system. Obesity accounts for over 300,000 deaths and over $100 billion in healthcare costs annually [9]. Additionally, the incidence of obesity is also increasing in Europe demonstrating the global nature of this issue [10,11]. The pathophysiological changes associated with obesity have been well documented in the literature. Obese patients demonstrate significant impairment in both cardiac and pulmonary function [10,12,13]. Furthermore, obesity predisposes patients to numerous comorbidities including hypertension, diabetes, and coronary artery disease.13 As such, these patients have demonstrated an increased risk for the development of postoperative complications such as infection [14]. However, the vast majority of the literature has analyzed the risk of complications in the adult population following general surgery. The prevalence of obesity in children 2-19 years of age is 16.9% [15]. The goal of our study was to assess the additional risk, if any, pediatric patients with AIS may incur while undergoing spine surgery.

The obese cohort demonstrated a significantly longer total operative time (272.75 minutes vs. 293.10 minutes, p<0.001) compared to non-obese patients. As such, these patients are placed at greater risk of postoperative complications. Peersmen performed a retrospective analysis of 6489 who underwent total knee arthroplasty in order to assess the role of operative time on rates of infection.16 Their study demonstrated an increased risk of infection in association with increased operative time.16 Additionally, they identified weight, body mass index, comorbidity burden as risk factors for increased operative time [16]. Furthermore, our cost-conscious healthcare environment seeks to reduce healthcare spending. However, longer operative times most certainly result in the utilization of more hospital resources. As such, surgeons may benefit from counseling patients on weight loss prior to surgery if possible.

Obese patients also demonstrated a significantly higher risk of superficial ((0.2% vs. 1.2%, p=0.038) surgical site infection (SSI). Numerous studies have demonstrated an increased risk of infection in obese patients undergoing spine surgery. Wound infection rates of 4% for clean surgical sites have been reported for non-obese patients while the literature reports rates as high as 40% for clean contaminated sites in obese patients [17-21]. Olsen et al performed a retrospective case control study on 219 patients in order to assess the risk of SSI following spine surgery [21]. They identified postoperative incontinence, posterior approach, tumor resection, and morbid obesity as independent risk factors for SSI [21,22]. Obese patients in this study had a higher 30-day readmission rate (2.6% vs. 5.2%, p=0.008). While there was no statistical difference in early reoperation, the higher incidence of readmission in the obese cohort may be explained by the higher incidence of superficial surgical site infection requiring IV antibiotics.

Non-obese patients in this study had a significantly longer length of stay (LOS) (5.75 days vs. 4.59 days, p<0.001). They also had significantly more bleeding needing transfusions than obese patients (67.0% vs. 61.6%, p=0.023), and had more total blood transfused (335.94 mL vs. 222.02 mL, p<0.001). This is counter to what previous studies have found [23]. Further long-term prospective studies will be needed to see if these results are repeatable. There are limitations to this analysis. This analysis was performed using a national database consisting of self-reported data. Hospitals with higher incidences of complications may be more reserved about sharing their outcomes. Therefore, this data may be skewed towards better outcomes. Also, these procedures were conducted at multiple hospitals by different surgeons who may all utilize different perioperative protocols. Therefore, these findings may not be generalizable to all patients in all regions of the US. As such, prospective standardized studies are warranted to clearly identify the additional risk, if any, obese patients may incur.

Conclusion

Obesity significantly increases the risk for adverse outcomes in pediatric patients undergoing spinal deformity surgery. Obese patients are at increased risk for longer operative time, postoperative superficial infection and 30-day readmission. These potential complications contribute significantly to morbidity and may even be life threatening. As such, spine surgeons should be cognizant of these potential adverse outcomes and should consider the benefits of increased patient counseling. In addition, prospective standardized studies should be conducted to elucidate the risk obesity may play in the development of adverse outcomes following spinal deformity surgery in the pediatric population.

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