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Research Paper

The influence of obesity on operating room time and perioperative complications in cochlear implantation

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Abstract *Objective:* The rising incidence of obesity in the United States is associated with increased healthcare expenditures and resource allocation. Obesity has been associated with prolonged operating times during surgical procedures. The primary objective of this study is to compare body mass index (BMI) to length of surgery during cochlear implantation.
Methods: A retrospective case control study from a tertiary academic referral center was performed. Patients included were adults who underwent primary, single-sided cochlear implantation with documented BMI and operating room (OR) times from January 2009 to July 2015. The following data were collected: BMI, total operating room time (TORT), surgical operating room time (SORT), ASA status, perioperative and postoperative complications, age, and gender.
Results: Two hundreds and thirty-four patients were included and stratified into obese (BMI >30) and non-obese (BMI < 30) categories. Statistical analysis was performed comparing TORT against the obesity category along with other variables. Independent sample *t*-test demonstrated that obesity increases TORT and SORT by 16.8 min ($P = 0.0002$) and 9.3 min ($P = 0.03$), respectively, compared to the non-obese group. Multivariate linear regression analysis demonstrated no statistically significant impact of gender, or ASA status on total operating or surgical time. Obesity was associated with increased perioperative complications (odds ratio [*OR*], 6.21; 95% *CI*, 1.18–32.80; $P = 0.03$) and postoperative complications (*OR*, 3.97; 95% *CI*, 1.29–12.26; $P = 0.02$).

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Conclusions: Obesity leads to longer TORT and SORT during primary cochlear implant surgery. Obesity is also associated with increased perioperative and postoperative complications compared to non-obese patients. These data have implications with utilization of operating room resources.

Introduction

The rising epidemic of obesity in the United States (U.S.) has great implications on healthcare resource allocation. Currently the World Health Organization estimates that approximately 66% of the adult population in the U.S. above the age of 60 years is overweight or obese.[1] In addition, the epidemic is expected to increase by greater than 33% over the next twenty years.[2] The U.S. currently spends over $200 billion in cost related to obesity, which is 20% of the total annual healthcare cost.[3] As part of rising medical costs associated with obesity and associated comorbidities, obese patients undergoing surgical procedures have shown an increased risk of postoperative complications and higher hospital readmission rates.[4] It has been shown that obese patients undergoing total hip arthroplasty have increase operating room (OR) times and increased duration of hospitalization stays following surgery.[5,6] These findings have also been demonstrated in patients undergoing thoracic surgery.[7] This has tremendous economic healthcare implications. A 2005 study of 100 U.S. hospitals found that OR charges averaged $62 per min (range: $22/min to $133/min).[8] The increased costs associated with obese surgical patients are usually covered by the facility caring for these patients and are not covered by increased payments from third parties. This can place a burden of financial risk on these facilities.[9]

The objective of this study was to compare the relationship between obesity in patients undergoing unilateral cochlear implantation and its impact on the duration of OR time. Secondary objectives were to determine if obesity is associated with increased perioperative and postoperative complications after cochlear implantation.

Materials and methods

Subjects

The study was approved by the Institutional Review Board at the Medical University of South Carolina (MUSC; #48185). The MUSC Cochlear Implant Database was used to identify subjects who underwent cochlear implantation from January 1, 2006 to June 30, 2015. Inclusion criteria were: adults 18 years or older, with documented BMI or weight and height, American Society of Anesthesiologists Physical Status Classification (ASA), OR time, procedure time and a post-operative follow up. Exclusion criteria included: bilateral implantation, revision implantation, second-sided implantation, history of meningitis, inner ear abnormalities or exclusion to the use of mono-polar cauterization (i.e. implantable defibrillators, pacemakers or other such devices). These exclusions were thought to increase operating time and could be confounding variables.

Subjects were divided into obese (BMI $\geq$ 30) and non-obese (BMI $<$ 30) groups. The following data were collected: age, gender, surgeon, ASA status, perioperative complications, postoperative complications. Complications were graded from 0 to 2, with 0 being no complication. Perioperative complications deemed a "1" included minor postoperative bleeding, excessive postoperative nausea and vomiting, dizziness, or others. If a patient required inpatient admission or observation for comorbidities, hypoxia, dizziness or excessive nausea and vomiting, this was deemed a perioperative complication score of "2". Postoperative complications were similarly defined by a score of 0 to 2. A postoperative score of "1" was given if a patient called their surgeon complaining of persistent dizziness, headache, recurrent epistaxis or if antibiotics were given due to concern for surgical site infection. A postoperative complication score of "2" was given for emergency department visits, admissions, revision surgery, or other significant events within 30 days after surgery.

The primary outcome variables of the study were total OR time (TORT) and surgical OR time (SORT). TORT was determined by the time the subject entered the OR to the time they exited the OR. SORT was defined as the start of the procedure to the placement of the dressing. All the data points regarding TORT and SORT were collected by the perioperative nursing staff and entered into the electronic medical record (EMR). The nursing staff was not involved in the study as this data was reviewed retrospectively. The two senior authors (PRL and TAM) perform the cochlear implantation using a similar technique. Both authors perform a mastoidectomy and utilize a well to help secure the device. The facial recess is opened and the cochlear implant is inserted through the round window membrane. Intraoperative device testing is performed in conjunction with wound closure.

Statistical analysis

Out of 367 patients, 234 subjects met inclusion criteria for this study. The top 1% and the bottom 1% of TORT and SORT were excluded to remove possible incorrect data points entered in the EMR and to remove outliers that could skew results. Two-tailed tests were run to compare the obese and non-obese patient populations. The patients were further divided into different BMI categories and the average TORT and SORT was calculated and step-wise comparisons were performed between the different BMI groups. Multivariate linear regression analysis was used to compare the effect of BMI category, age, gender, surgeon, ASA status, perioperative and postoperative complications against TORT and SORT.

Results

Overview

The average age was 62.8 years, with 115 females and 119 males. Patients were stratified into obese ($n = 73$) *vs.* non-obese ($n = 161$) groups and further sub-divided by BMI category (normal, overweight, class I obesity, class II obesity and morbidly obese) (see Table 1).

Total operating room time (TORT)

The mean TORT for all patients was 166.11 min. Using linear regression, TORT was compared directly against BMI controlling for age, gender, ASA status and. The calculated β for BMI was 0.77 ($P = 0.043$), indicating that for each unit of BMI increase, TORT was predicted to rise by 0.77 min, or 46 s. No other variables significantly impacted TORT. TORT was also mapped against BMI as a binary operator, with patients stratified into "obese" (BMI > 30) and "non-obese" (BMI < 30) categories and a Welch's two sample *t*-test was ran to compare mean TORT across the two groups. The mean TORT for the obese group was significantly higher than that for the non-obese group (175.4 min and 158.6 min, respectively, $P = 0.0002$).

Surgical operating room time (SORT)

The mean SORT for all patients was 156.5 min. Using linear regression, SORT was also compared directly against BMI controlling for age, gender, ASA status and device type. There was no statistically significant impact of BMI on SORT. SORT was then mapped against BMI using the previously defined obese and non-obese categories and a Welch's two sample *t*-test was run to compare mean times for each group. The mean SORT for the obese group and non-obese groups was significantly different, with the obese group showing an average time of 123.0 min *vs.* 113.7 min for the non-obese group ($P = 0.03$).

Perioperative and postoperative complications

Six point eight percent of obese and 1.7% of non-obese patients had perioperative complications; however, there was no significant difference between these groups using a Welch's two sample *t*-test. Twelve point three percent of obese patients and 3.1% of non-obese patients had postoperative complications. There was a significant difference in the number of postoperative complications between groups (obese group *mean* = 0.03 *vs.* non-obese group *mean* = 0.164, $P = 0.015$). Obesity was associated with a 6-fold higher risk of perioperative complications (odds ratio [*OR*], 6.21; 95% *CI*, 1.18–32.80; $P = 0.0314$) and an almost 4-fold increased risk of postoperative complications (*OR*, 3.97; 95% *CI*, 1.29–12.26; $P = 0.0166$). Details regarding complications may be seen in Table 2.

Discussion

The increasing incidence of obesity across the U.S. will continue to have a negative impact on healthcare. This study of 234 patients undergoing primary CI found that obesity lengthens TORT and SORT. The increase in TORT was expected and most likely due to variables including patient positioning, induction and intubation. The increase in SORT may be best explained by the technical challenges including limited neck mobility, shorter distance from the patient's shoulder to their ear (thereby affecting the surgeons' position) and soft tissue thickness, which could interfere with exposure and/or device placement. This finding of increased TORT and SORT is similar to patients undergoing hip replacement.[6,10]

Our study showed a statistically significant difference in the TORT between obese and non-obese patients of close to 12 min. While 12 min may seem insignificant clinically, the economic impact is less subtle. As mentioned above, the

Table 2 Perioperative and postoperative complications in obese and non-obese patients.

	Total	Obese (BMI $\geq$ 30)	Non-obese (BMI $<$ 30)
Total number of patients	234	73	161
Perioperative complications (*n*, %)	7, 3.0	5, 6.8	2, 1.2
Postoperative bleeding			1
Required admission		4	1
Same-day ED visit		1	
Postoperative complications (*n*, %)	14, 6.0	9, 12.3	5, 3.1
Persistent dizziness or headache		4	3
Epistaxis		1	
Antibiotics given		2	1
ED visit $<$ 30 days after surgery		2	
Syncopal event			1

Note: BMI = body mass index; ED = emergency department.

Table 1 Characteristics of patients undergoing cochlear implantation (*Mean* ± *SD*).

Groups	*n*	ASA $\geq$ 2 total (percent)	Age (years)	Total OR time (min)	Surgical time (min)
Non-obese	161	143 (88.8)	66.8 ± 14.8	158.6 ± 31.5	113.7 ± 29.1
Obese	73	71 (97.2)	66.1 ± 14.3	175.4 ± 31.7	123.0 ± 33.0
t (X^2) value		(4.49)	0.34	3.77	2.17
P value		0.03	0.73	0	0.03

Note: Non-Obese = BMI 18.5–29.9; Obese = BMI 30–40+.

estimated cost of 1 min of OR time can be as high as $133 dollars per min, with an average of $62 dollars per min.[8] An additional $700-$1500 dollars per patient is a substantial cost for facilities and practices. While cochlear implantation in general tends to have low complication rates, we found that obese patients were more likely to have a perioperative or postoperative complications, which can burden the resources of healthcare facilities and practices. Multiple studies of obese patients undergoing cholecystectomy or appendectomy found increased rates of complications and were associated with increased postoperative costs.[6,10,11] However, pay-for-performance reimbursements currently do not take obesity into consideration.[11,12] This may secondarily lead to penalizations of surgeons and hospitals that treat a greater number of obese patients as well as institutions absorbing the extra associated costs.

This study has limitations including the retrospective method of data collection. The various times that were recorded by the OR staff may contain errors but those errors should affect both groups equally. Lastly, because complications after cochlear implantation are in general low, this study may under represent perioperative and postoperative complications.

Conclusions

TORT and SORT are longer in patients with obesity undergoing routine cochlear implantation. This has financial implications for institutions as the cost per min in the operating room may be as high as $133/min. Obesity is also associated with increased perioperative and postoperative complications after cochlear implantation when compared to non-obese patients.

Conflict of interest

The authors declare that they have no conflict of interest.

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