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Influence of Trainee Participation on Operative Times for Adult and Pediatric Cochlear Implantation

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Abstract

Objective—Few studies have examined operative times for cochlear implantation (CI) using multivariable linear regression analyses to identify predictors of case length. Herein, we assess whether trainee participation, among other factors, influences OR times.

Methods—We retrospectively reviewed total OR and procedural times for isolated unilateral implants over a five-year period (2009–2013) in children and adults. Cases performed by 14 different surgeons at a single tertiary care center were evaluated. Total operating and procedural times were compared. Multivariable linear regression analyses were used to identify predictors of procedural time, including presence of trainee (resident or fellow), American Society of Anesthesiologists (ASA) physical classification, age, gender, and surgeon identity.

Results—We identified a total of 455 unilateral CI procedures (n = 35 pediatric, n = 420 adult). Mean total OR time was 193.6 min (SD = 58.9 min) and mean procedural time was 147.1 min (SD = 56.2). The presence of trainees was associated with a significant difference in procedure time (149.9 min [SD = 54.9] with trainees vs. 136.6 min [SD = 59.9] without, p=0.0375). Trainee involvement did not significantly increase total OR time (196.3 minutes [SD=56.9] with residents, 183.8 minutes [SD=65.0] without, p=0.0653). Surgeon identity was also associated with differences in procedural time (p<0.001). Patient age, gender, ASA classification, pediatric designation had no significant impact on length of case.

Conclusions—Major predictors of longer procedural OR times for CI are surgeon identity and trainee participation. Few published data exist on length of cochlear implantation in an academic setting using multivariable linear regression analyses. Our data may be instructive for comparative analyses and has implications for operative planning and surgical education.

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Conflicts of interest: None

Keywords

cochlear implantation; operative times; otolaryngology education

Introduction

Healthcare spending in the United States is expected to increase by 6.2% over the next 10 years, and projected to be 20% of the gross domestic product by 2022.¹ Operating room (OR) time has been estimated to cost between \$5-42 per minute depending on the location and specialty.²⁻⁶ Identifying sources of inefficiency in the OR has been the subject of substantial interest and study both in the business and biomedical literature.⁷⁻¹³

Multiple studies in the otolaryngology⁵ and non-otolaryngology^{2-4,6,14,15} literature have focused on the inefficiencies associated with surgical education in the OR. Few studies, however, have examined the impact of trainees on the duration of cochlear implantation, a procedure necessitating meticulous operative technique and the use of expensive neuroprosthetic devices.^{16,17} An accurate estimate of duration of cochlear implant surgery and discrete analysis of which factors may increase operative times is valuable for operative planning, cost-benefit analysis, and reimbursement fees. Shorter surgical times translate into decreased duration of general anesthesia and potentially decreased cost. Indeed, as implant technology improves and the indications increase for implantation, making it more applicable for new patient groups, it is important to have standardized data on operative characteristics of the procedure.

While prior studies have examined OR time for cochlear implantation in an academic setting, these studies are limited in scope as they occurred in discrete patient populations, such as older patients¹⁸, different hospital locations¹⁶, and were not primarily designed to assess the impact of trainee participation on OR times.¹⁷ Furthermore, prior studies largely used univariable models for statistical analysis, limiting their ability to account for perioperative confounders.

To address whether surgical trainee participation in CIs results in differential total or procedural operative times, we retrospectively assessed total OR and procedural times for isolated unilateral implants over a five-year period (2009-2013) in children and adults. We developed a multivariable linear regression model using additional perioperative predictors beyond trainee participation to exclude potential confounders. Our investigation builds upon previous studies on perioperative factors of CI and offers a more robust model to delineate the impact of trainees on operative times.

Methods

This study was granted institutional review board approval by the Massachusetts Eye and Ear Infirmary (MEEI) Human Studies Committee. The MEEI operating room log was reviewed to identify cases of isolated unilateral cochlear implantation between January 2009 and December 2013. All procedures included were supervised or performed by one of 14 academic surgeons, including academic otologist/neurotologists and pediatric

otolaryngologists. All cases were performed at the MEEI main hospital. Cases were grouped according to the presence or absence of a surgical trainee (Group 1 = attending surgeons with trainee participation, Group 2 = attending surgeons alone).

Descriptive analyses were performed to characterize patient demographics (age, gender, and ASA class), and operative times including total OR time (defined as the time when the patient enters the OR prior to intubation to when the patient leaves the OR after extubation) and procedure time (defined as the time from when the procedure starts, typically skin incision, to when the surgeon designates the procedure as complete). Scheduled OR time is defined as the length of time for which the case is booked, usually weeks to months in advance. Variables examined included presence of trainee (otolaryngology resident or otology/neurotology/pediatric fellow), American Society of Anesthesiologists (ASA) physical classification, age, gender, and surgeon identity (anonymized).

In univariable analysis, means were compared by two-sided unpaired Student's T-test and proportions compared by two-sided chi-square test. A multivariable linear regression analysis was performed to determine the contribution of a surgical trainee to procedural time for CI while adjusting for all patient demographics and other case characteristics included in the univariable analysis. Surgeon identity was used as a proxy for all fixed effects associated with difference in surgeon volume. Statistical analyses were performed with STATA v.13 (StataCorp LP, College Station, TX).

Results

Overall patient demographics and mean operating room times

A total of 455 cases met inclusion criteria. Overall case characteristics are summarized in Table 1. Of note, average patient age was 54.4 years with 7.7% pediatric implants and 92.3% adult implants. The majority of patients were female (52.3%). Anesthesia evaluation revealed 10.1% (n=46) were rated ASA class 1, 72.3% (n=329) ASA class 2, and 17.6% (n=80) ASA class 3. We found that trainees participated in 78.7% of cases (Group 1, n = 358) versus 11.3% of cases without trainees (Group 2, n=97). (Table 1). Among all groups, we found that the average total OR time was 193.3 minutes and total procedural time was 147.1 minutes. (Table 1) We found that ages, gender and ASA classification between the two study groups were evenly matched. (Table 2).

Mean total operating room time and procedural time comparing Group 1 and Group 2

There was no statistically significant difference in total OR times between groups with and without trainee involvement (Group 1: 183.8 min versus Group 2: 196.3 min, p=0.0653). However, total procedure time was increased by 13.3 min with trainee involvement (149.9 min for Group 1 vs. 136.6 min for Group 2, p=0.0375). There was also no significant difference between scheduled OR time between Group 1 and Group 2 (188.5 min for Group 1 and 193.1 for Group 2, p=0.3281). (Figure 1). Pediatric designation was not associated with a significant difference in total OR time or total procedural time (Figure 2).

Additional factors modifying mean procedural time

We identified several additional predictors of procedural time for CI cases in multivariable analysis (Table 3). These included attending surgeon identity ($p < 0.0001$) and trainee involvement remained significant in multivariable analyses ($p < 0.0001$). Age, gender, pediatric designation, and ASA classification were not significantly associated with longer procedural times. (Table 3)

Discussion

To our knowledge, this study offers the largest single institutional analysis of trainee impact on CI procedure times using multivariable regression analysis to adjust for important perioperative confounders. Our data demonstrate that procedure times for unilateral CI were significantly longer when performed with the assistance of a surgical trainee. Procedure times at our institution were comparable to those previously reported.¹⁶⁻¹⁸ Although our data suggest that trainee involvement in the OR comes at the “cost” of a longer procedure time, total operating room time is similar between two study groups. Based on our data, any delay in efficiency related to trainee participation is potentially balanced by greater potential efficiency in pre- and post-procedure patient care.

In previous studies, surgeon identity as a predictor of OR length was not well characterized. We found that surgeon identity is a significant predictor of operative time. Indeed, our report is notable as it evaluated a significant number of attendings and trainee surgeons at a single institution, enabling this type of robust analysis of a relatively homogenous study population. This is an important finding, as previous studies described in the Introduction point to surgical education as a major “cost” both in terms of increased OR times and opportunity cost. The fact that attending surgeons operate at different speeds bolsters the argument that case length is multifactorial and trainee participation is not always a rate limiting factor. Further, our study specifically included all CI case types, including revisions and various surgical techniques, as we wanted to focus on perioperative factors from an institutional level. Surgeon identity is a proxy for variation in technique, experience and volume and inclusion of these variables in regression could potentially confound results.

Finally, there is also an ongoing discussion regarding surgeon experience, volume, and patient outcomes.¹⁹⁻²³ While our study was not designed to address this question directly, our data suggests that there is a wide range of operating room times, potentially indicating differences in volume and experience. Previous studies have also found an association between surgeon experience and operating room time^{16,19-23}. Additional research should clarify the impact of volume and participation of trainees on CI outcomes.

There are several limitations of our study. At our institution, all residents (PGY2-5), otology/neurotology fellows, and pediatric otolaryngology fellows are involved in otologic procedures. It is unclear if differences in Group 1 and Group 2 procedure times depend on trainee level. There may be additional variables not quantified in our analysis, such as anesthesiologist identity and availability of circulating nurses, that may further influence operative times. Our analysis is also strictly limited to operative time without detailed

investigation of how OR time influences post-operative outcomes. However, this latter question may be the subject of future studies.

Conclusions

We provide a focused analysis using multivariable regression to determine the impact of perioperative factors, including trainee participation, on CI case lengths. We determined that trainee participation in CI cases increases procedure time with little or no significant difference in total OR time. Our findings have implications for CI at academic medical centers, and may be instructive for comparative analyses, operative planning, and surgical education.

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Figure 1. Comparison of Scheduled, Total, and Procedural OR Time
Group 1 group included attendings and trainees. Group 2 included attendings alone.

Figure 2. Adult versus Pediatric Operative Times

Figure 3. Additional factors modifying mean procedural time

Table 1

Case characteristics

	All Patients (N=455)
Age (years), Mean (SD)	54.4 (21.2)
Age categories	
Pediatric (age ≤18), No. (%)	35 (7.7)
Adult (age > 18), No. (%)	420 (92.3)
Gender	
Male, No. (%)	217 (47.7)
Female, No. (%)	238 (52.3)
ASA Classification	
I, No. (%)	46 (10.1)
II, No. (%)	329 (72.3)
III, No. (%)	80 (17.6)
Resident or fellow trainee	
Yes	358 (78.7)
No	97 (21.3)
Total OR Time (minutes), Mean (SD)	193.6 (58.9)
Total Procedure Time (minutes), Mean (SD)	147.1 (56.2)
Schedule OR Time (minutes), Mean (SD)	189.5 (41.0)

Table 2

CI case characteristics stratified by attending surgeon and resident surgeon.

Characteristic	Attending Surgeon (Group 2) (N=97)	Resident/fellow Assistance (Group 1) (N=358)	P-value
Age (years), Mean (SD)	54.8 (19.4)	54.3 (21.7)	0.8546
Age categories			0.290
Pediatric (age <=18), No. (%)	92 (94.9)	328 (91.6)	
Adult (age > 18), No. (%)	5 (5.2)	30 (8.4)	
Gender			0.278
Male, No. (%)	51 (52.6)	166 (46.4)	
Female, No. (%)	46 (47.4)	192 (53.6)	
ASA Classification			0.518
I, No. (%)	7 (7.2)	39 (10.9)	
II, No. (%)	71 (73.2)	258 (72.1)	
III, No. (%)	19 (19.6)	61 (17.0)	

Table 3

Linear regression with outcome of total procedural time.

Characteristic	Beta Coefficient	95% Confidence Interval	P-value
Age (per 1 additional year)	−0.09	−0.31 to 0.12	0.394
Pediatric (vs. adult)	+4.45	−12.6 to 21.5	0.608
Male (vs. female)	+5.09	−1.52 to 11.70	0.131
ASA Classification			
II (vs. I)	−0.09	−12.34 to 12.18	0.989
III (vs. I)	+10.75	−4.08 to 25.57	0.155
Trainee (vs. attending alone)	+15.01	+6.70 to +23.32	<0.0001
Surgeon identity	NA	NA	<0.0001