Impact of Resident Participation on Operative Time and Outcomes in Otologic Surgery

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Abstract

Objectives. To describe the impact of resident involvement in tympanoplasty on operative time and surgical complication rates.

Study Design. Case series with chart review.

Setting. Tertiary medical center.

Subjects and Methods. Current Procedural Terminology codes were used to identify patients in the 2011-2014 public use files of the American College of Surgeons National Surgical Quality Improvement Program who underwent a tympanoplasty or tympanomastoidectomy. Cases were included if the database indicated whether the operating room was staffed with an attending alone or an attending with residents. Categorical and continuous variables were compared with chi-square, Fisher’s exact, and Mann-Whitney U tests. Generalized linear models with a log-link and gamma distribution were used to examine the factors affecting operative time.

Results. Overall, 1045 cases met our study criteria (tympanoplasty, n = 797; tympanomastoidectomy, n = 248). Resident involvement increased mean operative time for tympanoplasties by 46% (107 vs 73 minutes, \(P < .001\)) and tympanomastoidectomies by 49% (175 vs 117 minutes, \(P < .001\)). While controlling for confounding factors, the variable with the largest impact on operative time was resident involvement. There were no significant differences observed in the rate of surgical complications between attending-alone and attending-resident cases.

Conclusion. Resident involvement in tympanoplasty and tympanomastoidectomy did not affect the surgical complication rate. Resident involvement increased operative time for tympanoplasties and tympanomastoidectomies; however, the specific reasons for the increase are not explained by the available data.

Keywords
resident, resident participation, operative time, otologic surgery, tympanoplasty, tympanomastoidectomy

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The ideal forum for surgical education is the operating room. Residents begin as observers and progress toward operative autonomy during the course of their training. Resident progress is best achieved through a balance of supervision and independence with feedback from faculty. While surgical education is necessary to produce future generations of surgeons, the learning process is not without cost. Recent studies based on the database of the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) showed that resident participation in thyroid surgery, laryngectomy, neck dissection, oral resection, salivary gland resection, and tonsillectomy was not associated with an increase in surgical morbidity. However, resident participation has been shown to increase operative time in pediatric and general otolaryngology as well as a variety of other specialties: bariatric surgery, plastic surgery, ophthalmology, general surgery, and orthopedic surgery. Increased operative time leads to increased costs in the operating room.

In this study, we sought to describe the impact of resident involvement on operative time and surgical complications for 2 common otologic procedures: tympanoplasty and tympanomastoidectomy.
Table 1. Characteristics of the Population Undergoing Otologic Surgery Based on the Participation of Residents.a

<table>
<thead>
<tr>
<th></th>
<th>Tympanoplasty (n = 797)</th>
<th>Tympanomastoidectomy (n = 248)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Attending Alone (n = 463)</td>
<td>Attending Resident (n = 334)</td>
</tr>
<tr>
<td>Age, yb</td>
<td>48.4 ± 16.2</td>
<td>45.6 ± 16.8</td>
</tr>
<tr>
<td>Male</td>
<td>206 (44.5)</td>
<td>155 (46.5)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>43 (9.3)</td>
<td>25 (7.5)</td>
</tr>
<tr>
<td>Cardiac history</td>
<td>18 (3.9)</td>
<td>14 (4.2)</td>
</tr>
<tr>
<td>Pulmonary history</td>
<td>14 (3.0)</td>
<td>7 (2.1)</td>
</tr>
<tr>
<td>Alcohol history</td>
<td>8 (1.7)</td>
<td>13 (3.9)</td>
</tr>
<tr>
<td>Smoking history</td>
<td>78 (16.8)</td>
<td>78 (23.4)</td>
</tr>
<tr>
<td>ASA 3/4</td>
<td>60 (13.0)</td>
<td>50 (15.0)</td>
</tr>
<tr>
<td></td>
<td>50.4 ± 16.3</td>
<td>46.9 ± 16.4</td>
</tr>
<tr>
<td></td>
<td>68 (55.3)</td>
<td>72 (57.6)</td>
</tr>
<tr>
<td></td>
<td>15 (12.2)</td>
<td>14 (11.2)</td>
</tr>
<tr>
<td></td>
<td>9 (7.3)</td>
<td>11 (8.8)</td>
</tr>
<tr>
<td></td>
<td>6 (4.9)</td>
<td>5 (4.0)</td>
</tr>
<tr>
<td></td>
<td>2 (1.6)</td>
<td>2 (1.6)</td>
</tr>
<tr>
<td></td>
<td>22 (17.9)</td>
<td>33 (26.4)</td>
</tr>
<tr>
<td></td>
<td>29 (23.6)</td>
<td>27 (21.6)</td>
</tr>
</tbody>
</table>

Abbreviation: ASA, American Society of Anesthesiologists physical status.

Values are presented as n (%) unless noted otherwise.

Mean ± SD.

Materials and Methods

Data Source

This retrospective study is based on a cohort from the 2011-2014 ACS NSQIP database. The ACS NSQIP is a nationally validated, risk-adjusted, and outcomes-based program created for the purpose of measuring and improving surgical quality care.\(^{12,13}\) The ACS NSQIP is a de-identified data set that meets exemption criteria established by the University of Kansas Medical Center Institutional Review Board.

Statistical Analysis

The principal Current Procedural Terminology code was used to identify patients undergoing tympanoplasty (69631-33) or tympanomastoidectomy (69635-37, 69641-46). Patients were excluded if the principal diagnosis code referenced cholesteatoma (International Classification of Diseases, Ninth Revision, Clinical Modification 385.21, 385.30-33, 385.35) due to the inherent additional operative time and possible group heterogeneity. Myringoplasties were not included in the study due to significantly lower complexity associated with this procedure as compared with tympanoplasty. Cases were included if the database contained staffing details—namely, whether the operating room was staffed with an attending alone or an attending with residents. A case was noted to have a surgical complication if it cited a wound infection (ACS NSQIP variables: SUPINFEC, WNDIFND, ORGSPCSII), wound disruption (DEHIS), transfusion (OTHBLEED), or graft failure (OTHGRAFL).

Categorical variables with large cell counts (≥10) were compared with chi-square tests, and comparisons involving a small cell count (<10) were performed with Fisher’s exact tests. Continuous variables were compared with Mann-Whitney U tests. A generalized linear model was used to analyze the variables affecting operative time.\(^{14}\) The model type consisted of a log-link function and a gamma distribution. The analysis considered the following factors: advanced age (≥50 years), sex, American Society of Anesthesiologists physical status, cardiac history, pulmonary history, alcohol use, resident participation, and smoking status within the last year. The adjusted ratio of operative time for each factor relative to its reference category was assessed by exponentiating the estimated model parameter for operative time.\(^{15}\) The adjusted operative time ratio for each variable was reported with the 95% CI. Two-tailed significance was set at α = 0.05.

Results

Overall, 1045 cases met our study criteria (tympanoplasty, n = 797; tympanomastoidectomy, n = 248). The characteristics of each surgical category’s population are presented in Table 1.

Resident involvement increased mean operative time for tympanoplasties by 46% and tympanomastoidectomies by 49% (P < .001; Figure 1). There were no significant differences in the rate of surgical complications between attending-alone and attending-resident cases (tympanoplasty: 1.7% vs 1.8%, respectively, P > .999; tympanomastoidectomy: 0.8% vs 2.4%, P = .622).

Multivariate analysis was performed to examine operative time (Figure 2). Results are expressed as the adjusted operative time ratio with 95% CI. Points to the right of 1.0 reflect an increase in the operative time relative to the indicated reference category; points to the left reflect a decrease. The variable with the largest impact on operative time was resident involvement (adjusted operative time ratios: tympanoplasty, 1.46 [95% CI, 1.36-1.56], P < .001; tympanomastoidectomy, 1.49 [95% CI, 1.32-1.69], P < .001).

Discussion

The presence of a resident may increase operative time for any of several reasons, which are not evaluated by the ACS NSQIP data. Resident presence may slow a case passively if one participates in portions of the operative procedure. The database does not include this detailed information regarding the extent of resident participation. The ACS NSQIP database does provide data regarding which postgraduate year level (1-11) is involved in each
case, but this data point proved to be scant in our cohort. It would be interesting to know whether the resident’s level and the extent of the resident’s role in surgery affected operative time. Unfortunately, these analyses are beyond the scope of this study due to the limited sample size.

The analysis lacks insight into the way in which resident presence slows down operative cases, but it is reasonable to assume that some of these cases are slowed by a resident operating less efficiently or less effectively than an attending would operate. Surgical dexterity is a learned skill, and learning takes time. The temporal bone laboratory is one option for otolaryngology residents to have the opportunity to practice operative skills on cadaveric specimens to specifically prepare for otologic cases. Previous studies of temporal bone drilling describe the benefit of practice in the laboratory. Mowry and Hansen identified a statistically significant correlation between the number of cadaveric temporal bone dissections and a resident performed and his or her performance on a standardized skill assessment instrument. Temporal bone dissection grading instruments have been established, including the Welling Scale.

Traditionally, temporal bone laboratory practice was limited to cadaveric bones; however, as technology advances, adjunctive training devices continue to improve, including 3-dimensionally printed bone, virtual reality (VR) drilling, a chicken egg, and a virtual temporal bone dissection simulator. Technical skills in mastoidectomy were transferable from the VR simulation environment to cadaveric dissection with significant improvement in performance after directed, self-regulated training in the VR temporal bone simulator. Hands-on exploration of the anatomy and repetition provide value for the trainee, while mental practice alone was not found to have significant benefits versus controls for mastoidectomy.

One limitation of our study is the classification of complications. The ACS NSQIP database logs data on generic types of complications that can be applied to multiple types of surgical procedures. The database does not include otology-specific complications, such as hearing outcomes, facial nerve function, or tympanic membrane perforation. Perhaps a comparison of these complications would show a difference among outcomes between the attending-alone and attending-resident groups.

Another limitation is that the study’s retrospective nature prevents ideal case-control matching. A possible confounder for the difference in operative time is the degree of difficulty for each case. On occasion, more complex cases are sent to academic centers where residents are more likely to be present for an operative case. We attempted to limit the heterogeneity of the patient populations by excluding cases with the International Classification of Diseases, Ninth Revision, Clinical Modification diagnosis of cholesteatoma.

Resident presence in tympanoplasty and tympanomastoidectomy cases did not appear to influence the surgical complication rate. However, resident presence in these cases did significant correlation between the number of cadaveric temporal bone dissections and a resident performed and his or her performance on a standardized skill assessment instrument. Temporal bone dissection grading instruments have been established, including the Welling Scale.

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Resident presence in tympanoplasty and tympanomastoidectomy cases did not appear to influence the surgical complication rate. However, resident presence in these cases did
significantly increase operative time by approximately 50%. In this study, resident involvement in cases was found to increase operative time; however, the specific reasons for the increase are not explained by the available data. Certainly, surgical dexterity is a learned skill, and any surgical practice outside the operating room in the temporal bone laboratory should improve operative efficiency and dissection skills. Such practice could affect operative times when attending surgeons are accompanied by trainees. Future studies may consider exploring the ways in which resident presence increases operative time.

Author Contributions
Thomas Muelleman, concept, design, data acquisition and analysis, data interpretation, draft, revision, editing, approval; Matthew Shew, concept, design, data acquisition and analysis, revision, editing, approval; Robert J. Muelleman, design, data acquisition and analysis, data interpretation, draft, revision, editing, approval; Mark Villwock, design, data acquisition and analysis, data interpretation, draft, revision, editing, approval; Kevin J. Sykes, design, data acquisition and analysis, data interpretation, revision, editing, approval; Hinrich Staecker, concept, data interpretation, draft, revision, editing, approval; James Lin, concept, data interpretation, draft, revision, editing, approval.

Disclosures
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References