Jaw Opening Decreases Window to the Deep Parotid Lobe

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Abstract
To describe the relationship between jaw opening and access to the deep parotid window, we identified the following distances in 10 human skulls: symphysis to angle of mandible, mastoid tip to angle of mandible, angle of mandible to condylar process, and mastoid tip to condylar process. With the jaw closed and open, these distances were measured with 1 to 3 wooden blocks, each measuring 1 cm, between the upper and lower incisors. The triangular deep parotid area formed by the last 3 distances was calculated. A repeated measures analysis of variance showed a significant decrease in the deep parotid area with increasing interincisal distance (P < .01). A generalized estimating equation model demonstrated a statistically significant decreasing area of the deep parotid window with increasing interincisal distance. These results suggest that nasal intubation may improve access to the parotid window.

Keywords
deep parotid lobe, nasotracheal intubation, anatomic study

Acknowledgments and Competing Interests
Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

Methods
This study was exempt from review by Stanford University’s Institutional Review Board. The following distances were measured in 10 cadaveric human skulls (Figure 1): symphysis to angle of mandible (S-A), angle of mandible to condylar process (A-C), mastoid process to angle of mandible (M-A), mastoid process to condylar process (M-C), mastoid process to ramus of mandible (M-R), and the angle created by the A-C and M-C with the jaw closed. Measurements were taken with the jaw closed and open at 9.7, 19.4, and 29.1 mm, with wooden blocks each measuring around 10 mm. These measurements were recorded with a metric caliper and protractor.

The area of the deep parotid window was calculated with 3 formulas. Formula 1 is Heron’s formula, which is A = \sqrt{s(s-a)(s-b)(s-c)} \text{, where } A \text{ is area; } a, b, \text{ and } c \text{ are sides of the triangle; and } s = \frac{a+b+c}{2}. \text{ The sides of the triangle correspond to M-A, M-C, and A-C. Formula 2 is } A = \text{base} \times \text{height} \text{, where base is A-C and height is M-R. Formula 3 is } A = \frac{\text{side} \times \text{base} \times \sin\text{angle}}{2}, \text{ where side is M-C, base is A-C, and angle is that formed by M-C and A-C in radians.}

We performed a repeated measures analysis of variance to detect differences in the area of the deep parotid window with the jaw closed and open at various degrees. In addition, we fitted a generalized estimating equation model with an exchangeable correlation matrix to analyze the relationship

Bibliography

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between interincisal distance and deep parotid window, accounting for individual variations in the distance from the symphysis to the angle of the mandible (S-A). Heron’s formula was used because the measurements of the sides seemed most precise as compared with the less precise measurement of the orthogonal M-R and angle formed by M-C and A-C. Given that S-A was the only measurement that was not directly correlated with the calculation of the parotid area, we included this as a covariate in the model in addition to the interincisal distance as a continuous variable.

Results

With the jaw closed, the mean area of the deep parotid window, as calculated with formula 1 (Heron’s formula), was 646 mm², which progressively decreased with increasing interincisal distance (Figure 2). The areas calculated with formulas 1 and 2 also decreased with increasing interincisal distance. Repeated measures analysis of variance showed an inverse association between interincisal distance and the following measurements: M-A, angle between M-C and A-C, and all areas that were calculated with the 3 formulas (Table 1). In the generalized estimating equation model with interincisal distance and S-A as independent predictors, the area of deep parotid window decreased by 8.9 mm² (95% CI, 7.7-10.1 mm²) with every 1-mm increase in the distance between the incisors (P < .01). Skulls with S-A distance 1 standard unit greater than the average S-A distance had a larger area of the deep parotid

Table 1. Measured Distances.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Interincisal Distance, Mean ± SDa</th>
<th>P Valueb</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-A: symphysis to angle of mandible</td>
<td>80.8 ± 4.3</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>A-C: angle of mandible to condylar process</td>
<td>53.3 ± 5.7</td>
<td>98</td>
</tr>
<tr>
<td>M-A: mastoid process to angle of mandible</td>
<td>38.9 ± 2.9</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>M-C: mastoid process to condylar process</td>
<td>33.6 ± 3.2</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>M-R: mastoid process to ramus of mandible</td>
<td>22.5 ± 2.6</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Angle between M-C and A-Cc</td>
<td>44.9 ± 4.8</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Area 1(c): (\sqrt{(s - a)(s - b)(s - c)})</td>
<td>646 ± 77</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Area 2(d): (0.5 \times \text{base} \times \text{height})</td>
<td>599 ± 85</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Area 3(d): (0.5 \times \text{side} \times \text{base} \times \sin(\text{angle}))</td>
<td>631 ± 105</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

aAll data are shown in millimeters unless noted otherwise.
bResults from repeated measures analysis of variance.
cIn degrees.
dIn mm².
window by 48.5 mm² (95% CI, 10.3-86.7 mm²) with the jaw closed (P = .01).

**Discussion**

Our study shows that the area of the deep parotid space increases with decreasing interincisal distance. While nasotracheal intubation has been suspected to increase parotid space access, this study provides anatomic evidence to support that assertion. The standard 7-mm endotracheal tube used at our institution has an outer diameter of 9.5 mm (Covidien, Minneapolis, Minnesota). Our findings suggest that the surgeon loses 84.6 mm² of precious surgical field when operating in the deep parotid space in a patient orotracheally intubated with a 7-mm endotracheal tube. Nasotracheal intubation allows the jaw to remain closed and may increase access to the deep parotid window. This may be combined with mandibular subluxation to improve access to the parapharyngeal space in cases with extensive parapharyngeal space involvement.5 While nasotracheal intubation is associated with increased risk of epistaxis, the potential benefits of improved exposure of the surgical field outweigh the minimal risks.

Our study has several limitations. While the distance of symphysis to angle (S-A) was significantly associated with a larger area of the parotid window when the interincisal distance is 0, the interaction of this distance and increasing interincisal distance was not significant. However, this interaction is difficult to interpret, as S-A may be inherently correlated with the other measured distances on the skull. Furthermore, our study is limited by the use of cadaveric skulls, which does not account for the effects of surrounding soft tissue on parotid space access.

**Conclusions**

We found a progressive decrease in deep parotid space access when increasing the opening of the jaw. These results suggest that nasotracheal intubation may improve access to the deep parotid space. Further studies are needed in fresh cadavers and live patients to confirm this.

**Author Contributions**

Yu-Jin Lee, design, acquisition, analysis, interpretation of data; drafting, final approval, accountability for all aspects of the work; Uchechukwu Megwalu, analysis and significant revision for important intellectual content; final approval and accountability for all aspects of the work; Erick Melara, acquisition and interpretation of data; drafting, final approval and accountability for all aspects of the work; Vasu Divi, analysis and significant revision for important intellectual content; final approval and accountability for all aspects of the work; Vinay T. Fernandes, conception, interpretation of data; significant revision for important intellectual content; final approval and accountability for all aspects of the work; Davud Sirjani, conception and design of the work; interpretation and significant revision for important intellectual content; final approval and accountability for all aspects of the work.

**Disclosures**

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**References**