ORIGINAL ARTICLE

Setting of an endoscopic nasal reference point for surgical access to the anterior base through an anatomical study on cadavers

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Skull base; Endoscopic surgery; FESS; Paranasal sinuses; Facial sinuses

Abstract

Introduction: Diseases of paranasal sinuses, nasal cavity, and skull base can be treated by endonasal operations using a nasal rigid endoscope. When conducting this kind of surgery, anatomical references are critical for safety.

Objective: To measure the distance from the posterior wall of the maxillary sinus to the skull base, according to socio-demographic characteristics, and to detail an anatomical reference point for paranasal sinus operations and for an access to the anterior skull base, comparing anatomical variations between right and left sides, gender, height, weight, age, and ethnicity in cadavers.

Methods: Measures were taken from the 90° angle (the starting point where deflection of the skull base begins to form the anterior wall of the sphenoid, also known as Δ90°) to the upper, middle, and lower points of the posterior wall of the maxillary sinus. This study used 60 cadavers aged over 17 years, and evaluated these bodies with respect to age, height, BMI, weight, gender, and ethnicity, comparing measurements of right and left sides.

Results: The measurements were >1.5 cm in all cadavers and did not vary with age, height, weight, gender, and ethnicity on their right and left sides. The lack of association between the measurement from Δ90° to the upper, middle, and lower posterior walls of the maxillary sinus (categorical or quantitative) is noteworthy, considering the characteristics studied.

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Conclusion: The methodology defined the nasal point of reference, considering an absence of variation in the cadavers’ characteristics.
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identify the point where the deflection of the skull base begins, to form the anterior wall of the sphenoid, known \( \Delta 90^\circ \) (Fig. 1), and to measure the distance from that point to the upper, middle, and lower points of the posterior wall of the maxillary sinuses.

The dissection was performed with microsurgical material through nasal endoscopy with zero-degree optics coupled with a camera, with DVD recording.

The framework for this study was established in the autopsy room with a video camera, a notebook, a nasal aspirator, a light source, surgical instruments, zero-degree optics, and fiber optic light cable. After the autopsy, the cadavers underwent paranasal sinus dissection, and at this moment the measures were taken.

The following measurements were performed (Fig. 2): upper, middle, and lower parts of the posterior wall of the maxillary sinus to the angle of 90\(^\circ\), based on a previously stipulated protocol.

Covariates height, weight, age, body mass index (BMI), gender, and ethnicity were assessed in relation to the three measures studied.

The descriptive results presented in the Results section were obtained through the use of frequencies and percentages for the characteristics of the various categorical variables, and from the performance of central tendency measures (mean and median) and dispersion measures (standard deviation) for the quantitative variables.
Table 1 Descriptive statistics of the features of the measurement of the distance from \( \Delta 90^\circ \) to the superior (SPW), middle (MPW), and lower (LPW) posterior wall of maxillary sinuses of the studied cadavers on both (right and left) sides.

| Features    | \( n \) | Mean | SD  | Min  | 1Q  | Med | 3Q  | Max |
|-------------|--------|------|-----|------|-----|-----|-----|-----|
| **Right side** |        |      |     |      |     |     |     |     |
| \( \Delta 90^\circ \) (SPW) | 60     | 2.1  | 0.3 | 1.5  | 2.0 | 2.0 | 2.5 | 3.0 |
| \( \Delta 90^\circ \) (MPW) | 60     | 1.9  | 0.5 | 1.0  | 1.5 | 2.0 | 2.0 | 3.0 |
| \( \Delta 90^\circ \) (LPW) | 60     | 1.7  | 0.5 | 0.5  | 1.5 | 1.5 | 2.0 | 2.5 |
| **Left side** |        |      |     |      |     |     |     |     |
| \( \Delta 90^\circ \) (SPW) | 60     | 2.2  | 0.4 | 1.5  | 2.0 | 2.0 | 2.5 | 3.0 |
| \( \Delta 90^\circ \) (MPW) | 60     | 1.7  | 0.4 | 1.0  | 1.5 | 2.0 | 2.0 | 2.5 |
| \( \Delta 90^\circ \) (LPW) | 60     | 1.6  | 0.4 | 0.5  | 1.5 | 1.5 | 2.0 | 2.5 |

\( n \), number of observations; SD, standard deviation; Min, minimum; 1Q, 1st quartile; Med, median; 3Q, 3rd quartile; Max, maximum.

The Pearson correlation coefficient (r) was used to compare the measurements and characteristics in quantitative forms (age, height, weight, and BMI).

Student’s t-test was used for comparisons of measures in quantitative form with gender and ethnicity, since the usual assumptions of this test were met (normality – Shapiro–Wilk test and homoscedasticity – Levene).\(^\text{10}\)

The three selected measures were dichotomized into two groups: \( \geq 2 \) and \( < 2 \), considering that, in surgical practice it was observed that generally the distances were \( \geq 2 \).

**Results**

**Descriptive analysis**

There was a prevalence of male (55%) and white (78.3%) individuals. Mean age, height, weight, and BMI of the cadavers was 64 years; 1.70 m; 67.1 kg, and 22.5, respectively. There was a prevalence of cadavers aged between 48 and 88 years old, with height between 1.70 and 1.75 m, weight between 60 and 80 kg, and BMI between 18 and 26.

![Figure 2](Image)

Figure 2  Performance of measures on the cadavers studied – \( \Delta 90^\circ \) (the starting point where the deflection of the skull base begins to form the anterior wall of the sphenoid).

**Descriptive statistics between right and left sides**

The cadavers had the following measures on their right side: a mean of 2.1 cm from \( \Delta 90^\circ \) to the upper posterior wall of the maxillary sinus; a mean of 1.9 cm from \( \Delta 90^\circ \) to the middle posterior wall of the maxillary sinus; and a mean of 1.7 cm from \( \Delta 90^\circ \) to the lower posterior wall of the maxillary sinus. On the left side, these measures were 2.2 cm, 1.7 cm, and 1.6 cm, respectively (Table 1).

The measure from \( \Delta 90^\circ \) to the upper posterior wall of the maxillary sinus was \( \geq 2 \) cm on both sides in 91.7% of the studied cadavers. When measuring the difference (by side) between the distance from \( \Delta 90^\circ \) to the middle posterior wall of the maxillary sinus and the distance from \( \Delta 90^\circ \) to the lower posterior wall of the maxillary sinus, it was found that in 61.7% of the studied cadavers on the right side and in 51.7% on the left side, the distance from \( \Delta 90^\circ \) to the middle posterior wall of the maxillary sinus was \( \geq 2 \) cm. Furthermore, the distance from \( \Delta 90^\circ \) to the lower posterior wall of the maxillary sinus was \( \geq 2 \) cm in 46.7% and in 41.7% of right and left sides, respectively (Table 2).

| Features      | Right side | Left side |
|---------------|------------|-----------|
| \( \Delta 90^\circ \) upper |            |           |
| \( < 2 \) | 5 | 8.3 | 5 | 8.3 |
| \( \geq 2 \) | 55 | 91.7 | 55 | 91.7 |
| \( \Delta 90^\circ \) middle |            |           |
| \( < 2 \) | 23 | 38.3 | 29 | 48.3 |
| \( \geq 2 \) | 37 | 61.7 | 31 | 51.7 |
| \( \Delta 90^\circ \) lower |            |           |
| \( < 2 \) | 32 | 53.3 | 35 | 58.3 |
| \( \geq 2 \) | 28 | 46.7 | 25 | 41.7 |

\( n \), number of observations.
Table 3  Comparison of the measurement of the distance from $\Delta90^\circ$ to the upper, middle, and lower posterior walls of the maxillary sinus of the studied cadavers by side (right and left).

| Features                      | Side          | Right | Mean | SD  | Med | Left | Mean | SD | Med | p-Value |
|-------------------------------|---------------|-------|------|-----|-----|------|------|----|-----|---------|
| $\Delta90^\circ$ upper        |               |       | 2.1  | 0.3 | 2.0 |      | 2.2  | 0.4 | 2.0 | 0.277<sup>a</sup> |
| $\Delta90^\circ$ middle       |               |       | 1.9  | 0.5 | 2.0 |      | 1.7  | 0.4 | 2.0 | 0.020<sup>a</sup> |
| $\Delta90^\circ$ lower        |               |       | 1.7  | 0.5 | 1.5 |      | 1.6  | 0.4 | 1.5 | 0.417<sup>c</sup> |

SD, standard deviation; Med, median.
<sup>a</sup> Paired t-test.

Table 4  Summary of comparisons among the three evaluated measures and features of interest.

| Variable responses | Features of interest (p-value) | Age | Height | Weight | BMI | Gender | Ethnicity |
|--------------------|--------------------------------|-----|--------|--------|-----|--------|-----------|
| From $\Delta90^\circ$ to the upper posterior wall of the maxillary sinus (categorical or quantitative) | Right | 0.814 | 0.681 | 0.217 | 0.081 | 0.482 | 0.987 |
|                              | Left  | 0.762 | 0.225 | 0.976 | 0.415 | 1.00  | 0.304 |
| From $\Delta90^\circ$ to the middle posterior wall of the maxillary sinus (categorical or quantitative) | Right | 0.268 | 0.643 | 0.746 | 0.916 | 0.585 | 0.802 |
|                              | Left  | 0.480 | 0.342 | 0.194 | 0.347 | 0.517 | 0.501 |
| From $\Delta90^\circ$ to the lower posterior wall of the maxillary sinus (categorical or quantitative) | Right | 0.068 | 0.295 | 0.967 | 0.502 | 0.317 | 0.800 |
|                              | Left  | 0.389 | 0.338 | 0.313 | 0.551 | 0.916 | 0.083 |

In ten (16.7%) of the 60 studied cadavers, the measure from $\Delta90^\circ$ to the upper posterior wall of the maxillary sinus was $<2$ cm and $>1.5$ cm.

**Comparisons between sides**

The measure from $\Delta90^\circ$ to the middle posterior wall of the maxillary sinus showed a variation between sides, with a lower value on the left versus right side, with a difference of 0.2 (1.9–1.7) cm for this feature, with a statistically significant difference. No difference was observed in the other two measures (Table 3).

**Comparisons of features with variable responses by side**

**Right and left sides – quantitative**

The coefficient and p-values of Pearson’s correlation (r) showed no association between measures from $\Delta90^\circ$ to the upper, middle, and lower posterior wall of right and left maxillary sinuses and age, height, weight, BMI, gender, and ethnicity of the cadavers ($p > 0.05$) (Table 4).

**Right and left sides – categorical**

The measure from $\Delta90^\circ$ to the upper, middle, and lower posterior wall of right and left maxillary sinuses was not associated with age, height, weight, BMI, race, and gender of the cadavers ($p > 0.05$).

**Discussion**

This research was developed after an observation, during approximately ten years of nasal endoscopic surgeries, that the anatomical measures discussed were constant. Measures from $\Delta90^\circ$ to the posterior wall of the maxillary sinus were similar, regardless of gender, ethnicity, age, weight, or height; but other measures varied with such features. Observations in surgical practice led the authors to perform these anatomical measurements on cadavers, seeking evidence in favor or against these observations, because the medical literature does not provide definitions on this topic. The corroboration of the regularity of the measures would allow the attainment of a more precise and constant anatomical reference, probably implying greater safety in the approach to posterior paranasal sinuses, chiefly by the fact that this area shows a great anatomic variation. In cases where there is a distortion of the anatomy, as in reoperations, this measure becomes even more useful.

Other measures taken in the nasal cavities of 60 cadavers have shown the influence of personal characteristics. However, there was no change in the distance from $\Delta90^\circ$ to the upper posterior wall of the maxillary sinus, providing evidence in favor of what was already seen in this clinical practice. It was observed that 10% of the measures from $\Delta90^\circ$ to the upper posterior wall of the maxillary sinus were $<2$ cm and $>1.5$ cm; thus, the fixed measure was changed to $\geq 1.5$ cm.
In the measurement of the distance from $\Delta 90^\circ$ to the lower and middle posterior wall of the maxillary sinus, it was found that measures <1.5 cm were outliers. These measures have little accuracy, and are not suitable to be obtained during surgery because of their anatomical position in relation to $\Delta 90^\circ$. Thus, the performance of such measures is not feasible during surgical procedures. Therefore, it was decided to use the 1.5-cm measure with respect to the upper point of the posterior wall of the maxillary sinus to $\Delta 90^\circ$, thanks to its viability and also due to the absence of outlier values.

In surgical cases in which a maxillary sinus approach is not used, other anatomical structures should be used.

**Conclusion**

The analysis of the data presented in this study allows for the conclusion that there is a fixed measurement between the upper posterior wall of the maxillary sinus and $\Delta 90^\circ$. The value found was always greater than 1.5 cm, which can facilitate a safe opening of the posterior paranasal sinuses during nasal endoscopic surgeries with a maxillary sinus approach. The measurements of lower and middle points with respect to the posterior wall of the maxillary sinus should not be used in surgical practice, because of measurement difficulties due to their anatomical position.

Both categorically and quantitatively, there was no statistical association with respect to the difference between the measurements from $\Delta 90^\circ$ to the upper, middle, and lower posterior walls of the maxillary sinus in any of the evaluated characteristics. Thus, there was no impact from age, weight, height, ethnicity, or gender on these measures.

The definition of a fixed measure in paranasal sinus anatomy in an area where there is a greater chance of occurrence of iatrogenic error could impart a sense of greater safety to the surgeon and fewer complications in nasal endoscopic surgery.

**Conflicts of interest**

The authors declare no conflicts of interest.

**References**

1. Karasen M, Kantarcil RM, Alper F, Onbas O, Okur A, Karaman A. Remarkable anatomic variations in paranasal sinus region and their clinical importance. Eur J Radiol. 2004;50:296–302.
2. Luong A, Marple BF. Sinus surgery: indications and techniques. Clin Rev Allerg Immun. 2006;30:217–22.
3. Tan HKK. Sphenoid sinus: an anatomic and endoscopic study in Asian cadavers. Clin Anat. 2007;20:745–50.
4. Scutariu MD, Bâldea V. Neighbouring relations of the posterior ethmoid studied by axial computed tomography. Morphology. 2010;94:51–7.
5. Tan BK, Lane AP. Endoscopic sinus surgery in the management of nasal obstruction. Otolaryng Clin N Am. 2009;42:227–40.
6. Bunzen DL, Campos A, Leão FS, Morais A, Sperandio F, Neto SC. Eficácia da operação endoscópica nasal nos sintomas da rinossinusite crônica associada ou não à polipose. Braz J Otorhinolaryngol. 2006;72:242–6.
7. Stamm A. Operação microendoscópica dos seios paranasais – conceitos básicos. Braz J Otorhinolaryngol. 2002;68:299–302.
8. Stamm AC, Pignatari S, Sebusiani BB, Galati MC, Mitsuda S, Haeting RG. Operação endoscópica nasossinusal e da base do crânio guiada por computador. Braz J Otorhinolaryngol. 2002;68:502–9.
9. Hemmerdinga SA, Jacobs JB, Lebowitz RA. Accuracy and cost analysis of image-guided sinus surgery. Otolaryng Clin N Am. 2005;38:453–60.
10. Triola MF. Introdução a estatística. 9ª ed. Rio de Janeiro; 2005.