INTRODUCTION

Located in the carotid sheath, the vagus nerve is in the middle of two large vessels: the common carotid artery and the internal jugular vein.1,2 Dissections in that area, such as the one performed in neuronomonitoring for thyroidectomies, expose the vagus nerve and may affect large and important vessels whose injuries will lead to complications.

Thyroidectomies technical precision has been especially marked by the preservation of the laryngeal nerves integrity.3,4 In a thyroidectomy procedure, proper technique and knowledge of structural anatomy enable the identification and maintenance of those branches. However, in spite of having precise technique, there are many reports of microstructural neural injuries as consequences of surgical manipulation.5–7

Applying neurophysiological monitoring apparatus on vagus nerve ensures security, comfort, and efficiency for surgical steps.8–10 If the laryngeal nerves are harmed during manipulation, the conduction is detected. This initiative has been considered one of the most reliable ways to analyze the integrity of laryngeal nerves.11

It is easy to understand, therefore, the interest in learning the syntopy of vagus nerve in detail to apply it when handling the carotid sheath during thyroidectomies. Anatomical data should be provided to help surgeons approach the nerve during surgery.

MATERIALS AND METHODS

To study vagus nerve syntopy in the carotid sheath, 50 dissections were performed in adult human cadavers of both sexes less than 24 hours postmortem, by the discipline of Human Structural Study Topography in Service of Death Verification of the Faculty of Medicine, University of São Paulo (SVO). All the procedures were regulated and followed ethical standards from the University of São Paulo Medical School Ethical Committee.

Previous surgeries or cervical previous treatments were exclusion factors. Goiters above 50 mL were also excluded from the study.

Dissection Routine
1. Inventory specimen determination of the anthropometric characteristics (brevilineal, normolineal, and longelineal) considering subcostal angle bigger, equal, or smaller than 90°; 2. Biacromial and retail incision; 3. Dissection of the superficial cervical fascia, side-release of the sternocleidomastoid muscle to display the intersection of the two parts of omohyoid muscle;
4. Bilateral dissection of the carotid sheath, 1 cm above the cricoid to the collarbone;
5. Determination of vagus nerve position in the sheath using the common carotid artery as a reference (Figs. 1 and 2);
6. Paper reports from all observations.

To locate the vagus nerve, the common carotid artery was divided into anterior and posterior parts, considering an imaginary transverse section. The nerve’s position was classified as anterior, middle, or posterior, whether it was found superficial, coincident, or behind the coronal section, respectively (Fig. 3).

The internal jugular vein was not used as reference for the following reasons: size variability—even between the right and left sides of the same individual—and state of distension, according to the cause of death.

In contrast to an anterior position in relation to the carotid artery, a posterior position of the vagus nerve implies in greater circumference of vessels to be dissected.

To obtain the standard deviation (SD) and the standard error (SE) of the vagus nerve anatomical distribution, both on right and left sides, 20 cadaveric dissections participated in a pilot study that revealed the left vagus nerve SD of 0.67 and SE of 0.95. The right vagus nerve presented values of 0.59 and 0.83, respectively.

Sample size formula determination indicates 50 dissections as an ideal number for a descriptive study.

Data Analysis
Continuous variables (numerical data) received descriptive analysis. Categorical variables (right/left, posterior/anterior) were compared using Fisher’s exact test, considering significant \( P = 0.05 \).

Also considering the weight, height, anthropometry, and the positions of right and left vagus nerve, multivariate and univariate regressions were performed for each possible anthropometric parameter. The definitions of brevilineal, normolineal, or longilineal were taken into account.

RESULTS
Description of Sample
Table I shows the characteristics of the sample.

### Table I. Studied Population Description.

| Characteristic          | Value          |
|-------------------------|----------------|
| Number of cadavers      | 50             |
| Age (years) (average ± SD) | 68.51 ± 12.7  |
| Height (cm) (average ± SD) | 165.10 ± 10.99|
| Weight (kg) (average ± SD) | 66.54 ± 16.01 |
| Sex                     |                |
| Female                  | 46%            |
| Male                    | 54%            |
| Ethnicity               |                |
| White                   | 72%            |
| No White                | 28%            |
| Anthropometry           |                |
| Brevilineal             | 18%            |
| Normolineal             | 26%            |
| Longilineal             | 56%            |

SD = standard deviation.

Vagus Nerve Position
As shown, the transverse section of the carotid artery was taken as a reference to establish the vagus
nerve syntopy in the carotid sheath: anterior, posterior, or middle positions (Fig. 4). Figure 5 shows the frequency of these findings, as well as their statistical significance (Fisher test).

**Symmetry and Anthropometric Characteristics**
Comparing the presence of symmetry of vagus position on both sides of the neck, in 37 out of 50 subjects, the right vagus nerve position is different from the left’s, representing 74% of the cases ($P < .001$).

When comparing anthropometric data, such as weight and height, in our multivariate analysis, no statistical significance was found on the position of vagus nerve in the carotid sheath.

Anterior and posterior vagal positions in the carotid sheath were analyzed separately in the brevilineal and in the longelineal groups, respectively, and there was no statistical significance.

**DISCUSSION**
Analyzing previous data in the literature concerning the syntopy of vagus nerve in the carotid sheath, the conclusion is simplistic: vagus nerve is located between the carotid artery and jugular vein.12

Similar to our results presented here, Dionigi et al11 found higher proportion of posterior vagus nerve location, but nothing was reported about the difference between left and right sides. This might be because they performed lobectomies in more than 10% of their surgeries and it is not clearly described on their paper whether the contralateral side was approached.

According to our data, when the nerve is observed anterior to the carotid, neither vessels (carotid artery and internal jugular vein) will have their circumferences dissected. When it is observed in the intermediate and posterior positions, on the other hand, it will require dissection of at least part of the circumference of these vessels. In this unusual vascular exposure, neuromonitoring would increase surgical morbidity.

This anatomical study shows the need of a critical thinking on the dissection of the vagus nerve. It can be clearly concluded from our anatomical data that, when proposing to dissect a right vagus nerve for instance, it should be found in a posterior situation in about 2/3 of the cases, requiring greater surgical dissection range when compared to an anterior position. In addition, the symmetry comparing vagus nerve position on both sides is observed in less than 1/3 of the cases.

The data presented here certainly shed light on the anatomical issue of neural monitoring in thyroidectomy. It is now up to the surgeons to choose whether or not to perform monitoring during thyroidectomy, seeking the best relationship between risk and benefit.

**CONCLUSION**
The vagus nerve in the carotid sheath is between the common carotid artery and internal jugular vein, being posterior to the common carotid artery more often on the right side, and anterior on the left. Individual characteristics do not influence this position. Vagus nerve symmetry in the left and right carotid sheaths is seen in a minority of cases.
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