

## Anatomical measurement for localization of the true vocal cord in Thais.

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**Problem** : *Appropriate placement of the thyroplasty window and prosthesis is essential for the best outcome of vocal fold medialization. Nowadays, the technique of medialization thyroplasty needs to be performed in a "blind" fashion. The previous studies of this subject were performed in Caucasian peoples but, as we know, there are anatomical differences between Thai or other Asians and Caucasians.*

**Objective** : *Study thai anatomy for localization of the true vocal cord. This study used reference points on the anterior surface of the thyroid cartilage to locate the point of anterior commissure and use the angle of the true vocal cord and thyroid cartilage to determine the direction of the true vocal fold.*

**Setting** : *Department of Anatomy, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.*

**Research design** : *Descriptive study*

**Materials & methods** : *Thirty-three embalmed cadavers were used in this study.*

**Results** : *The anterior commissure in Thai larynges is located a little above the midpoint of the thyroid cartilage. In women, the level of the true vocal cord was found to be 4/10 from the lower border of the thyroid cartilage and in men it was 1/3 from the same reference point. The difference is statistically significant. The angle between the true vocal fold and the anterior edge of the thyroid cartilage is about 60-70 degrees.*

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**Conclusion** : *In Thai people, we found that the anterior commissure is located a little above the midpoint of the thyroid cartilage. The angle between the true vocal fold and the anterior edge of the thyroid cartilage is about 60-70 degrees.*

**Key words** : *Medialization thyroplasty, Localization of true vocal cord.*

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- ปัญหา** : การกำหนดตำแหน่งและขนาดของช่องทางต่างที่จะเจาะบนกระดูกอ่อน  
ธัยรอยด์และวัสดุที่จะใช้เสริมสายเสียงแท้ที่เหมาะสมนับเป็นสิ่งสำคัญ  
สำหรับการผ่าตัดแก้ไขภาวะสายเสียงอัมพาต ในปัจจุบันการผ่าตัดยังไม่  
สามารถแน่ใจว่าจะทำได้ตรงตำแหน่งที่ต้องการเสมอไป การศึกษาที่ผ่าน  
มานั้นกระทำในชาวยุโรปแต่อย่างที่เราทราบกันโดยทั่วไปว่า สรีรร่างกาย  
ของชาวเอเชียรวมถึงคนไทยด้วย ย่อมมีความแตกต่างจากชาวยุโรป
- วัตถุประสงค์** : การตรวจวัดระยะต่าง ๆ เพื่อกำหนดตำแหน่งของสายเสียงแท้จากภาย  
นอกกล่องเสียง โดยใช้จุดอ้างอิงบนด้านนอกของกระดูกอ่อนธัยรอยด์  
เพื่อกำหนดตำแหน่งของขอบหน้าของสายเสียงแท้ และมุมระหว่างสาย  
เสียงแท้กับขอบหน้าของกระดูกอ่อนธัยรอยด์
- สถานที่ทำการศึกษา** : ภาควิชากายวิภาคศาสตร์ คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
- วัสดุและวิธีการ** : ศึกษาในร่างกายของผู้บริจาคร่างกายเพื่อการศึกษาหลังเสียชีวิต 33 คน
- ผลการศึกษา** : ตำแหน่งขอบหน้าของสายเสียงแท้ในคนไทยจะอยู่สูงกว่าตำแหน่งกึ่ง  
กลางของกระดูกอ่อนธัยรอยด์เล็กน้อย ในผู้หญิงอยู่ที่ตำแหน่ง 4/10  
เหนือขอบล่างของกระดูกอ่อนธัยรอยด์ ในผู้ชายอยู่ที่ 1/3 จากตำแหน่ง  
อ้างอิงเดียวกัน มุมระหว่างสายเสียงแท้กับขอบหน้าของกระดูกอ่อน  
ธัยรอยด์มีค่าประมาณ 60-70 องศา
- สรุป** : การศึกษาครั้งนี้พบว่าในคนไทยตำแหน่งขอบหน้าของสายเสียงแท้จะอยู่  
สูงกว่าตำแหน่งกึ่งกลางของกระดูกอ่อนธัยรอยด์เล็กน้อย มุมระหว่าง  
สายเสียงแท้กับขอบหน้าของกระดูกอ่อนธัยรอยด์มีค่าประมาณ 60-70  
องศา

Medialization thyroplasty (Isshiki type 1) <sup>(1-3)</sup> is one method for voice rehabilitation in cases of unilateral vocal fold paralysis. This technique has less limitations when compared with other techniques because medialization thyroplasty is flexible in adjustment of vocal fold augmentation. Although there is coexisting arytenoid fixation, <sup>(1,2)</sup> we can do this type of surgery. In addition to these advantages, by removing the prosthesis we can reverse the operation with no harm to the laryngeal structures. For these reasons, medialization thyroplasty is the most popular technique for treatment of unilateral vocal fold paralysis.

To arrive at a favorable outcome from this operation, there are several factors of concern: localization of the true vocal cord from the external laryngeal landmark; prosthesis size, shape and stability, skill of the surgeon, etc. Localization of the true vocal cord (anterior commissure to vocal process of arytenoid cartilage) has been studied and published on by many authors. <sup>(4,5-8)</sup> The exact location of the true vocal cord is necessary for placement of the thyroplasty window and insertion of the prosthesis into the larynx. If the position of the augmented prosthesis is too high (ventricle or false vocal cord level), the true vocal cord will not approximate and there will be a gap between both true cords. The voice will be hoarse and the patient may have problems of diplophonia from false cord vibration, and there will be an increased possibility of extrusion of the prosthesis through the thin mucosa of the ventricle. If the position of augmentation is too low (subglottic level), medialization will be inadequate.

In the study of Meiteles et al <sup>(6)</sup> (1992), they found that the vocal fold level is at the midpoint of

the height of the thyroid cartilage (point of anterior commissure) and the point between the upper 2/3 and lower 1/3 of the posterior edge of the thyroid ala (point of vocal process of arytenoid). Harvey M. Tucker <sup>(9)</sup> recommended that the vocal fold level is the midpoint between the thyroid notch and the lower border of the thyroid cartilage in the mid-sagittal plane and that the fold of the true vocal cord is backward parallel with the lower edge of the thyroid cartilage. Carrau & Myers <sup>(4)</sup> (1995) placed needles through the thyroid cartilage into the larynx and used these needles as the reference points. This method may be the most reliable technique to locate the position of the true vocal cord, however this technique is invasive and it may cause an injury to the laryngeal structures such as hematoma. However, no complications were reported in that paper.

We present here an alternative method to assist the surgeon in identifying the position of the vocal fold and in designing a thyroplasty window with adequate size and ideal positioning. We use reference points on the anterior surface of the thyroid cartilage to locate the point of the anterior commissure and use the angle of the true vocal cord and thyroid cartilage to determine the direction of the true vocal fold.

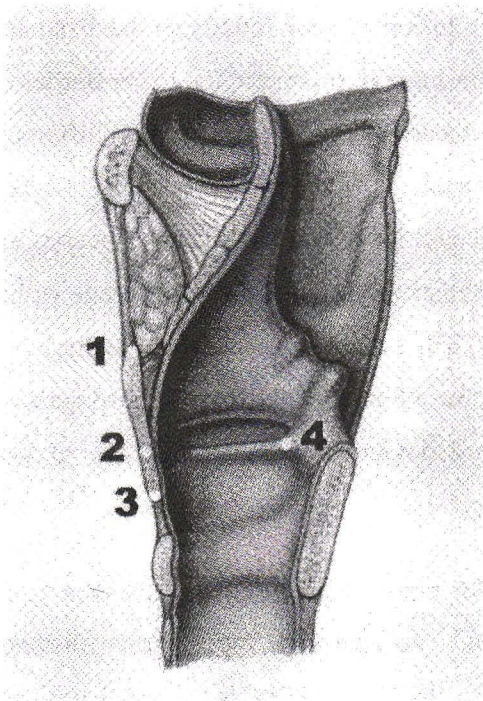
## Materials and methods

Thirty-three embalmed Thai cadavers were used in this study. Of the 33 cadavers, 23 were men and 10 were women. At death, their ages ranged between 29 and 94 years. They were acquired at the Department of Anatomy, Faculty of Medicine, Chulalongkorn University. None had any signs of disease in the laryngeal area, and their laryngeal structures appeared normal. The larynges

were incised vertically in the midline (laryngofissure), and then we choose the better site of the hemilarynx to study.

In the study we used transparency film (7 x 10 cm<sup>2</sup>) placed on the hemilarynx and marked with the following reference points:

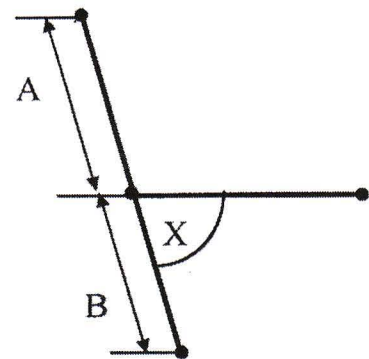
1. Thyroid notch
2. Anterior commissure
3. Inferior border of thyroid cartilage at midline
4. Vocal process of arytenoid



**Figure 1.** Medial view of hemilarynx showing the reference points: 1. thyroid notch, 2. anterior commissure, 3. inferior border of thyroid cartilage at midline, 4. vocal process of arytenoid

From the reference points, a straight line is drawn connecting the point of the thyroid notch and the point of the inferior border of the thyroid cartilage through the point of the anterior commissure. Then another straight line is drawn connecting the point of the anterior commissure and the point of vocal process.

- A = The distance from the thyroid notch to the anterior commissure  
B = The distance from the anterior commissure to the lower border of the thyroid cartilage  
X = The angle between the vocal fold and the anterior edge of the thyroid cartilage



**Figure 2.** Diagram showing: the distance from the thyroid notch to the anterior commissure (A), the distance from the anterior commissure to the lower border of the thyroid cartilage (B), the angle between the vocal fold and the anterior edge of the thyroid cartilage (X)

In addition to the absolute value of the reference distances, we calculated the relative distance for localization of the anterior commissure:  $A / (A+B)$ . From all data, we calculated mean, standard deviation, range, etc and used the T-test to analyze the data as follows:

## Results

In this study of 33 embalmed cadavers, 23 were men (70%) and 10 were women (30%). They had died at ages ranging between 29 and 94 years (mean = 66 years). They were acquired at the Department of Anatomy, Faculty of Medicine, Chulalongkorn University. Causes of death were heart diseases<sup>(11)</sup>, lung diseases<sup>(6)</sup>, liver diseases<sup>(2)</sup>, cerebrovascular diseases<sup>(2)</sup>, kidney diseases<sup>(1)</sup>, cancer of other sites except laryngeal cancer<sup>(5)</sup> and unknown causes of death<sup>(7)</sup>. None had any signs of diseases in the laryngeal area, and their laryngeal structures appeared normal. The larynges were incised vertically in the midline (laryngofissure), and then we choose only the best site of the hemilarynx to study. Nine were the left larynx (27%) and 24 were the right larynx (73%).

From the above table, we found that the absolute distance values were widely different, had a wide range, and a high standard deviation. We calculated the relative distance for localization of the anterior commissure:  $A / (A+B) = 4/10$  of the distance from the thyroid notch to the lower border

of the thyroid cartilage with low standard deviation (SD = 0.06). However the angle between the vocal fold and the anterior edge of the thyroid cartilage (X) was in the range of 47-79 degrees despite a high standard deviation (SD = 8.23). Therefore, using this value directly should take into consideration the individual variations.

In a comparative study between the men and women, we found that the values in the men were higher than in the women. When we analyzed the data, we found that the distance from the thyroid notch to the anterior commissure was not significantly different between men and women ( $p = 0.292$ ). In contrast, we found that the distance from the anterior commissure to the lower border of the thyroid cartilage was significantly different between men and women ( $p = 0.002$ ). But the relative distance for localization of the anterior commissure was statistically significantly different with:  $A / (A+B) = 1/3$  of the distance from the thyroid notch to the lower border of the thyroid cartilage with low standard deviation in men and  $4/10$  in women. (Table 1.)

**Table 1.** The distance from the thyroid notch to the anterior commissure (A), the distance from the anterior commissure to the lower border of thyroid cartilage (B), the relative distance for localization of the anterior commissure:  $A / (A+B)$ , the angle between the vocal fold and the anterior edge of the thyroid cartilage (X) and the statistic values (Minimum, Maximum, Mean and Standard deviation).

| DISTANCE,<br>ANGLE | MINIMUM | MAXIMUM | MEAN  | STANDARD<br>DEVIATION |
|--------------------|---------|---------|-------|-----------------------|
| A (mm.)            | 5.00    | 9.00    | 6.85  | 1.06                  |
| B (mm.)            | 7.00    | 15.50   | 11.35 | 2.33                  |
| A + B (mm.)        | 13.00   | 24.00   | 18.20 | 2.67                  |
| A / (A + B)        | 0.29    | 0.53    | 0.38  | 0.06                  |
| ANGLE              | 47.00   | 79.00   | 63.94 | 8.23                  |

The mean angle between the vocal fold and the anterior edge of the thyroid cartilage was 60 degrees in men and 70 degrees in women. The

differences between men and women are statistically significant but with a high standard deviation. (Table 2.)

**Table 2.** The distance from the thyroid notch to the anterior commissure (A), the distance from the anterior commissure to the lower border of thyroid cartilage (B), the relative distance for localization of the anterior commissure:  $A / (A+B)$ , the angle between the vocal fold and the anterior edge of the thyroid cartilage (X) and the statistic values (Range, Mean and Standard deviation) comparing men and women.

|           | MALE      |      |      | FEMALE    |      |      | P-VALUE |
|-----------|-----------|------|------|-----------|------|------|---------|
|           | RANGE     | MEAN | SD   | RANGE     | MEAN | SD   |         |
| ANGLE     | 47.0-76.0 | 61.5 | 7.63 | 60-79     | 69.5 | 7.01 | 0.008   |
| A (mm.)   | 5.5-9.0   | 6.9  | 1.06 | 5.0-8.5   | 6.5  | 1.03 | 0.292   |
| B (mm.)   | 8.0-15.0  | 12.1 | 1.83 | 7.0-15.5  | 9.5  | 2.44 | 0.002   |
| A+B (mm.) | 15.0-24.0 | 19.1 | 2.19 | 13.0-22.5 | 16.1 | 2.58 | 0.002   |
| A / (A+B) | 0.3-0.5   | 0.37 | 0.05 | 0.3-0.5   | 0.41 | 0.07 | 0.004   |

### Discussion

All previous studies on laryngeal morphometry<sup>(4-8)</sup> have been performed in foreign countries. Most studies recommend the midpoint of the height of the laryngeal cartilage (between thyroid notch and lower border of thyroid cartilage). However there had not been any study in Thai or other Asian peoples. This study uses reference points that were different from other studies. From our study we found that the vocal fold was above the midpoint of the laryngeal cartilage as recommended in other studies. Estimations by T-test, allow us to conclude that in Thai women the level of true vocal cord is 4/10 from the lower border of the thyroid cartilage and in Thai men it is 1/3 from the same reference point. This difference is statistically significant.

Determining the direction of the true vocal fold backward from the landmark of the anterior

commissure, has never been reported in other papers. If the direction of the true vocal fold is known by using the reference points on the anterior edge of thyroid cartilage, the value can be used in clinical work. The position of the patient can be adjusted on the operating table to make the level of the anterior edge of the thyroid cartilage parallel with the horizontal plane. The direction of the true vocal fold can then be estimated by using 60 degrees in males and 70 degrees in females. However, in this study, the values of the angle are high standard deviation. Therefore, clinical application should be considered carefully by using this with other clues. Anatomic study of the external laryngeal framework with surgical implications by Meiteles, et al<sup>(6)</sup> (1992) found that the vocal fold level is the midpoint of the height of the thyroid cartilage (point of anterior commissure) and the point between the upper 2/3 and the lower 1/3 of

the back edge of the thyroid ala (point of vocal process of arytenoid).

### Conclusion

Adequate placement of the thyroplasty window and prosthesis is essential for optimal medialization of the vocal fold. Nowadays, the technique needs to be performed in a blind fashion. Misplacement, including caudal or cephalic misplacement, results in inadequate medialization, extrusion of prosthesis, diplophonia or other adverse complications.<sup>(9)</sup> The previous anatomical studies<sup>(7)</sup> were performed in Caucasian peoples, but we know that there are anatomical differences between Thai or other Asian peoples and Caucasians. In Thai people, we found that the anterior commissure is located a little above the midpoint of the thyroid cartilage. The angle between the true vocal fold and the anterior edge of the thyroid cartilage is about 60-70 degrees. Other reliable methods are needed to determine the mapping of the true vocal cord. These need to be rapid, economical, and not invasive for the best outcome of medialization thyroplasty.

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