SPINE SECTION

Original Research Article

Depth by Ultrasound from Skin Surface to the C6 Transverse Process while Applying Pressure

Young Deog Cha, MD, PhD,* Mi Hyeon Lee, MD,* Yong Han Yoon, MD,† Jung Uk Han, MD, PhD,* Hyun Kyoung Lim, MD,* In Young Jung, MD,* and Jang Ho Song, MD, PhD*

*Anesthesiology and Pain Medicine and
†Thoracic and Cardiovascular Surgery, Inha University College of Medicine, Incheon, Korea

Reprint requests to: Jang Ho Song, MD, PhD, Anesthesiology and Pain Medicine, Inha University College of Medicine, 7-206, 3-GA, Sinheung Dong, Jung-Gu, Incheon 400-711, Korea. Tel: 82-32-890-3968; Fax: 82-32-881-2476; E-mail: jhs@inha.ac.kr.

Abstract

Background. A stellate ganglion block is commonly performed on the anterior tubercle of sixth cervical spine’s transverse process. When the procedure is performed, identifying the anatomical landmarks and confirming the depth of the needle insertion to the transverse process are essential for ensuring safety. The purpose of this study was to determine the depth of the needle insertion from the skin to the transverse process for a safe stellate ganglion block.

Methods. One hundred patients were enrolled for this study. The patients’ heights, weights, and neck circumferences were measured. In the supine position, the anterior tubercle of the transverse process were palpated and pressed with the examiner’s fingers. While spreading the fingers, an ultrasound probe was placed with the same strength as the fingers and the depth from the skin to the transverse process was measured.

Results. The mean depth from the skin to the transverse process in men was 9.5 ± 2.7 mm on the left side and 9.7 ± 2.5 mm on the right side, whereas in women, it was 8.0 ± 2.2 mm on the left side and 8.2 ± 2.0 mm on the right side. There was no significant difference between the right and left sides among or between the genders but men showed greater depths than women. Although both genders showed a correlation between body mass index and depth, only men showed a correlation between the neck circumference and depth.

Conclusions. In this study, the mean depth from the skin to the transverse process did not exceed 10 mm in both genders and the maximum depth was 16.6 mm.

Key Words. Cervical; Sympathetic Block; Ultrasound

Introduction

Stellate ganglion block is an intervention used for various pain conditions of the head, neck, and upper extremities involving the sympathetic nervous system [1]. It can be used in other conditions such as phantom pain, postherpetic neuralgia, cardiac arrhythmias, orofacial pain, and vascular headaches [2]. Over 30,000 stellate ganglion blocks are performed annually in South Korea alone. However, complications such as pneumothorax or vertebral artery puncture can occur when the block is performed using the conventional blind technique at the level of the seventh cervical vertebra (C7). Therefore, the block is normally performed on the anterior tubercle of the transverse process of the sixth cervical spine (C6) (Figure 1). Also known as Chassaignac’s tubercle, the anterior tubercle of C6 can be easily palpated in most patients [3].

The location of the stellate ganglion has been studied using computed tomography [4] and magnetic resonance imaging [5]. In a previous study, we described the relationship between Chassaignac’s tubercle and the neck crease, which is a surface landmark used for blocking the stellate ganglion. In approximately 70% of the general population, C6 lies beneath the skin crease just below the thyroid cartilage [6].

For the safe conduct of a blind stellate ganglion block, it is essential to perceive the depth of the anterior tubercle of the transverse process, for the needle can be inserted too deeply if it misses the tubercle. Incorrect placement of the needle may lead to an injury to the vertebral artery, esophagus, thyroid gland, or spinal nerve [7]. Yet, there have been no studies or reports attempting to establish...
the adequate depth of the needle insertion for an effective stellate ganglion block without complication or injury to the adjacent structures. With this in mind, the present study was undertaken to determine the depth of the transverse process of C6, so that guidelines could be established for the safe conduct of stellate ganglion blocks using the conventional blind technique.

Methods

This study was approved by the Institutional Review Board of this hospital, and all subjects provided written consents following a descriptive explanation of the purpose and method of this study. This study was performed from April to May 2010. One hundred patients were selected ranging in ages from 20 to 70 years of age. The patients were classified between 1 and 3 on the American Society of Anesthesiology physical status classification. Patients with neck deformities and disease history related to the neck were excluded. The patients’ heights and weights were recorded through questionnaires, and the body mass index (BMI) was calculated. The neck circumference was measured at the skin crease immediately below the thyroid cartilage.

The patients were placed in the supine position, and a pillow was set under their shoulders to extend the neck. Neck muscle relaxation was accomplished by asking the patients to open their mouths slightly. Actual blocks were not performed on the volunteers, but they were palpated as for an actual procedure. The sternocleidomastoid muscle was retracted, and the examiner pressed on the skin. With the force maintained, an ultrasound probe was placed where the needle would normally be inserted and the depth from the skin to the transverse process was measured. A probe resembling fingers in shape (Figure 2) and a SONOACE 6000 (50–60 Hz, Medison, Seoul, Korea) ultrasound machine were used. The depth was measured three times each on the right and left sides, and the data was recorded in millimeters (Figure 3). While one examiner
was pressing down on the probe, another examiner checked the depth on a monitor. The monitor was turned away from the examiner with the probe to blind him or her to the measurements.

The patients’ age, height, weight, BMI, and neck circumferences were recorded and reported as the mean ± standard deviation. Using the measured depth from skin to the transverse process, the mean, the standard deviation, and the range were calculated. A two-sample t-test was used to compare the depths between male and female subjects, whereas a paired t-test was used to compare the depths of the right and left sides within subjects. A Pearson correlation analysis was performed to determine the relationship between the depth of transverse process and each of neck circumference and BMI. A P value of <0.05 was considered to be statistically significant.

Results

Table 1 lists the demographics of the 100 patients (50 male and 50 female).

The depth from the skin to the anterior tubercle of the transverse process was greater in males, both on the right and on the left sides. Both males and females showed no difference in depth between the right and the left sides (Table 2).

Males showed positive correlations between their BMI and depth of the anterior tubercle (Figure 4) and between the neck circumference and depth (Figure 5).

**Table 1** Demographic data

<table>
<thead>
<tr>
<th></th>
<th>Male (N = 50)</th>
<th>Female (N = 50)</th>
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<tbody>
<tr>
<td>Years (yr)</td>
<td>37.0 ± 14.3</td>
<td>44.8 ± 18.7</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>173.1 ± 6.4</td>
<td>159.2 ± 6.3</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>72.8 ± 11.7</td>
<td>53.7 ± 7.3</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>24.3 ± 3.7</td>
<td>21.4 ± 3.1</td>
</tr>
<tr>
<td>Neck circumference (cm)</td>
<td>39.9 ± 3.3</td>
<td>33.9 ± 2.2</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation.

**Table 2** Measurements (mm) of the skin to transverse process bilaterally by ultrasound in the pressed state in male and female patients

<table>
<thead>
<tr>
<th></th>
<th>Male (N = 50)</th>
<th>Female (N = 50)</th>
<th>P value</th>
</tr>
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<tbody>
<tr>
<td>Left side</td>
<td>9.5 ± 2.7 (4.0, 15.9)</td>
<td>8.0 ± 2.2 (3.4, 9.1)</td>
<td>0.002*</td>
</tr>
<tr>
<td>Right side</td>
<td>9.7 ± 2.5 (4.0, 16.6)</td>
<td>8.2 ± 2.0 (4.1, 12.4)</td>
<td>0.002*</td>
</tr>
</tbody>
</table>

* P < 0.05.

Values are expressed as mean ± standard deviation (range).

The depth from the skin to the anterior tubercle of the transverse process was longer in men, both right and left. There was no difference between the right and left, in both males and females.

**Figure 4** There are positive correlations between BMI and depth of skin to transverse process in male. BMI vs right side depth: correlation coefficient (r) = 0.618. P = 0.00000173. BMI vs left side depth: correlation coefficient (r) = 0.625. P = 0.00000124. BMI = body mass index.

Females also showed a positive correlation between their BMI and depth (Figure 6); however, there was no correlation between neck circumference and depth (Figure 7).

Discussion

Some authors recommend fluoroscopy or ultrasound to secure accuracy and safety for stellate ganglion blocks [8,9], but in many large areas such devices are not available. Under those conditions, a blind technique becomes the method of choice.

The success rates of the blind technique vary between 16% and 100% [10,11], and life-threatening complications associated with the procedure have been reported [12]. Those complications are predicated by the anatomy of the stellate ganglion.
In 80% of the general population, the inferior cervical ganglion and first thoracic ganglion combine to form the stellate ganglion. The stellate ganglion is oval in shape, approximately 2.5 cm long, 1 cm wide, and 0.5 cm thick, and normally rests on the neck of the first rib, possibly extending to the vertebral body of C7 [5,13,14]. The cervical sympathetic trunk extends from the cephalic pole of the ganglion, and cross the longus colli muscle deep to the prevertebral fascia [15]. When a conventional blind technique is used, the needle first comes into contact with the C6 transverse process, and is then withdrawn 2–5 mm in order to avoid injection into the longus colli muscle, and thereby compromising the success of the block. Studies of the thickness of the longus colli muscle have been conducted to ensure more accurate positioning of the needle [16].

Complications can arise if the needle is inserted too medially. Here, the transverse process is narrower than at the anterior tubercle, and if the needle misses the bone, the vertebral artery can be entered. If the needle is inserted too laterally and too deeply, the spinal nerve can be pierced. With respect to the latter, a false sense of security can arise if the posterior tubercle is mistaken for the anterior tubercle. Yet, the posterior tubercle lies some 10 mm deeper than the anterior tubercle. For this appreciation of depth of insertion becomes crucial to the safe conduct of the procedure.

Figure 5 There are positive correlations between neck circumference and depth of skin to transverse process in male. Neck circumference vs right side depth: correlation coefficient (r) = 0.592, P = 0.00000327. Neck circumference vs left side depth: correlation coefficient (r) = 0.605, P = 0.00000603.

Figure 6 There are positive correlations between BMI and depth of skin to transverse process in female. BMI vs right side depth: correlation coefficient (r) = 0.43, P = 0.00859. BMI vs left side depth: correlation coefficient (r) = 0.368, P = 0.00184. BMI = body mass index.

Figure 7 There are no correlations between neck circumference and depth of skin to transverse process in female. Neck circumference vs right side depth: correlation coefficient (r) = 0.148, P = 0.304. Neck circumference vs left side depth: correlation coefficient (r) = 0.128, P = 0.377.
Cha et al.

The blind approach for a stellate ganglion block requires inserting the needle while the skin is depressed. In the present study, this depression was simulated using an ultrasound probe in order that direct measurements of depth could be taken. Consistency of depression was addressed by having the procedure performed by the same person who has over 20 years experience in performing stellate ganglion block.

Fluoroscopy was not used to confirm the level of the sixth cervical transverse process because the study simulated the conventional blind technique. Instead, the operator relied on a previous study [6] that showed that the C6 anterior tubercle is the most palpable structure deep to the skin crease of the neck in 70% of subjects.

A study using computed tomography [4] demonstrated variable depths between the skin and transverse process, ranging from 10 mm to 33 mm. In the present study, lesser values were found because the skin was depressed, as required for the blind technique. The mean depth from skin to transverse process in men was 9.5 ± 2.7 mm for the left side and 9.7 ± 2.5 mm for the right side, while in women, it was 8.0 ± 2.2 mm for the left side and 8.2 ± 2.0 mm for the right side. These mean values did not exceed 10 mm. In men, the range was 4–16.6 mm, and in women, it was 3.4–12.4 mm. These values imply an upper limit of 17 mm.

Both genders demonstrated a correlation between BMI and depth, but only men showed correlations with neck circumference and depth. Men with a larger neck tend to have more muscle. Consequently, even when the skin is pressed, the thickness of the muscle should correlate with the measured depth. On the other hand, women with a larger neck tend to have more fat than muscle. As fat can be compressed more than muscle, the neck circumference of women would not correlate with the measured depth. Consequently, men with obesity or thick necks are expected to require deeper needle insertion. As the present study was performed on an oriental population, these relationships might apply only to that population. Before results are generalized, they need to be checked in other populations.

Nevertheless, the results of the present study provide initial guidelines for the safe conduct of the blind technique for stellate ganglion blocks. Care should be taken when the anterior tubercle is not encountered within 10 mm of insertion of the needle. In that event, the needle should be moved in a cephalad or caudal direction in an attempt to find the anterior tubercle of the transverse process before proceeding to deeper depths. Failure to encounter the tubercle within 17 mm should give cause to reflect on the accuracy of placement of the needle.

Acknowledgments

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References


