

Identification of the Correct Cervical Level by Palpation of Spinous Processes

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BACKGROUND: The ability to identify the correct vertebral level through examination is an important skill for clinicians who are performing nerve blocks without fluoroscopy. The conventional palpation method, which identifies the most prominent cervical spinous process as the seventh cervical (C7) spinous process is unreliable in many cases. We compared the accuracy of 2 different palpation methods used for identifying C7.

METHODS: Ninety-six patients scheduled for cervical spine procedures under fluoroscopy guidance were randomized into either the control group or the flexion-extension group. The control group was examined with the conventional method, and the flexion-extension group was examined through assisted flexion and extension of the patient's cervical spine and identifying the lowest freely moving spinous process as C6 and the following stationary cervical spinous process as C7. A single anesthesiologist attempted to identify the C7 spinous process by using either the conventional method or the flexion-extension method and marked the presumed C7 spinous process with a radiopaque indicator. The actual vertebral level was then confirmed by fluoroscopy. The accuracy of the 2 different palpation techniques was compared, and the influence of patients' age, gender, and body mass index (BMI) was also examined.

RESULTS: The C7 spinous process was correctly identified in 77.1% of patients in the flexion-extension group, compared with 37.5% in the control group ($P < 0.001$). The C6 spinous process was identified as the most prominent cervical spinous process instead of C7 in 47.9% of patients in the control group, showing that errors are more common in the cephalad direction with the conventional method. The accuracy of the flexion-extension method was significantly higher than the conventional method regardless of the patient's age, gender, and BMI. Particularly, this difference in accuracy was seen not only in patients with a BMI $< 25 \text{ kg/m}^2$, but also in those with a BMI $\geq 25 \text{ kg/m}^2$ (BMI $< 25 \text{ kg/m}^2$, $P = 0.006$ vs BMI $\geq 25 \text{ kg/m}^2$, $P = 0.008$).

CONCLUSIONS: The flexion-extension method is more accurate than the conventional method when identifying cervical vertebral level. (Anesth Analg 2011;112:1232–5)

The ability to identify the correct vertebral level through examination is an important skill for clinicians who are performing nerve blocks without fluoroscopy. Various methods of identifying the correct vertebral level by palpation have been described for the lumbar, thoracic, and cervical regions, but none has been reported to show satisfactory reliability.^{1–3} The most frequently used palpation method in the cervical region is palpating the most prominent spinous process (vertebra prominens) as the seventh cervical (C7) spinous process with the patient in the anatomic position. This method has limitations in that the sixth cervical (C6) or the first thoracic (T1) spinous process may be comparably or more prominent than C7 in 30% to 40% of the population.^{4,5} Another

palpation method well known to orthopedists and manual therapists is identifying C6 and C7 by flexing and extending the patient's neck.^{6–8} Because the C6 spinous process is noteworthy for being the lowest freely moving spinous process during flexion and extension of the cervical spine, the C7 spinous process will remain stationary whereas the C6 spinous process moves in and out during flexion and extension. This study compared the clinical accuracy of these 2 different palpation methods in identifying the position of C7.

METHODS

The study protocol was approved by the research ethics committee of Severance Hospital. After obtaining informed written consent, adult patients scheduled for cervical spine procedures under fluoroscopic guidance at our pain clinic were recruited for this study. Exclusion criteria included patients with previous cervical spine surgery, severe spinal anatomic abnormalities, and pregnant women. Enrolled study subjects were randomly assigned to either the control or flexion-extension group.

In the control group, patients were seated with the upper body in the anatomic position, and a fellowship trainee attempted to identify C7 by palpating the most prominent spinous process of the cervical spine. In the flexion-extension group, the most prominent 2 cervical spinous processes would be palpated by investigator's

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Table 1. Demographic Data

	Control group (n = 48)	Flexion-extension group (n = 48)
Age (y)		
Range	23–65	26–76
Mean (SD)	50 (10)	47 (14)
Height (cm)		
Range	146–181	147–187
Mean (SD)	161 (9)	164 (9)
Weight (kg)		
Range	44–87	38–90
Mean (SD)	60 (10)	61 (11)
BMI (kg/m ²)		
Range	18.2–30.8	15.8–31.2
Mean (SD)	23.2 (3.0)	22.7 (3.3)
Gender, n (%)		
Female	35 (73)	31 (65)
Male	13 (27)	17 (35)
BMI category, n (%)		
<25 kg/m ²	32 (67)	35 (73)
25–29.9 kg/m ²	14 (29)	12 (25)
≥30 kg/m ²	2 (4)	1 (2)

BMI = body mass index.

There were no significant differences between groups.

index and middle finger with the seated patient's cervical spine in flexion. Then, through an assisted movement of the cervical spine into extension, if the upper palpated cervical spinous process moved anteriorly while the lower spinous process remained stationary, the lower cervical spinous process would be labeled C7. If both of the palpated spinous processes remained stationary, the upper cervical spinous process would be thought to be C7, and the palpation process would be repeated by moving 1 level cephalad at a time to confirm the level of C7. The spinous process thought to be the C7 spinous process was marked with a radiopaque indicator and was immediately confirmed in the lateral view with fluoroscopy.

The accuracy of each palpation technique was calculated as the proportion of patients in which the palpated vertebral level corresponded to the radiographic vertebral level. The proportions of accurate assessments across techniques were then compared using the Fisher exact test. The impact of patient factors (age, gender, and body mass index [BMI]) on the accuracy of palpation was also evaluated by multivariate logistic regression analysis. All analyses were performed with SPSS for Windows version 18.0 (SPSS, Inc., Chicago, IL). $P < 0.05$ was considered to be significant.

RESULTS

Ninety-six patients were enrolled in this study; 48 patients each were randomized to the control group and the flexion-extension group. Patient characteristics, including age, gender, and BMI were not different between the 2 groups (Table 1). The spinous process of C7 was correctly identified in only 37.5% of patients when palpating the most prominent vertebra as C7. The C6 spinous process was identified as the most prominent cervical spinous process instead of C7 in 47.9% of patients in the control group, showing that errors are more common in the cephalad direction with the conventional method. The flexion-extension palpation method had an accuracy of 77.1%,

Table 2. Comparison of Control to Flexion-Extension for C7 Identification

Identified vertebral level	Control group (n = 48)	Flexion-extension group (n = 48)
Cervical/thoracic vertebra		
C5	1 (2.1)	—
C6	23 (47.9)	5 (10.4)
C7	18 (37.5)	37 (77.1)
T1	6 (12.5)	5 (10.4)
T2	—	1 (2.1)
Level		
Correct (C7)	18 (37.5)*	37 (77.1)*
Incorrect (all others)	30 (62.5)	11 (22.9)

Data are n (%).

C7 = seventh cervical spinous process.

*Flexion-extension versus control, $P < 0.001$.

Table 3. Impact of BMI on Accuracy of C7 Identification

	BMI <25 kg/m ²		BMI ≥25 kg/m ²	
	Control group (n = 32)	Flexion-extension group (n = 35)	Control group (n = 16)	Flexion-extension group (n = 13)
Accurate C7 palpation				
No	19 (59.4)	9 (25.7)	11 (68.7)	2 (15.4)
Yes	13 (40.6)	26 (74.3)*	5 (31.3)	11 (84.6)*

Data are n (%).

BMI = body mass index; C7 = seventh cervical spinous process.

*BMI <25 kg/m², $P = 0.006$ versus BMI ≥25 kg/m², $P = 0.008$.

which was significantly higher than the control group ($P < 0.001$) (Table 2).

Age, gender, and BMI did not affect the accuracy of either method in locating C7. In this study, the accuracy of the flexion-extension method was significantly higher than the conventional method not only in patients with a BMI <25 kg/m², but also in those with a BMI ≥25 kg/m² (BMI <25 kg/m², $P = 0.006$ vs BMI ≥25 kg/m², $P = 0.008$) (Table 3).

DISCUSSION

In this study, we compared the accuracy of 2 different palpation methods used for identifying C7. Compared with the conventional method in which the most prominent cervical spinous process is identified as C7, the flexion-extension method was found to be more accurate in locating C7.

There have been studies that compared the accuracy of thoracic level identification when using C7 as a reference point versus other landmarks,^{1,2} and also on the interexaminer reliability of different cervical spinous process palpation methods.⁹ To our knowledge, there have been no studies that directly compared the accuracy of the conventional method and flexion-extension method used for palpating the C7 spinous process.

The widely used method to identify cervical vertebral levels is to palpate the most prominent cervical spinous process as C7, but the accuracy of this method is not known to be satisfactory. Holmaas et al.² reported that the C7-T1 interspace was correctly identified in only 14 of 44 cases (33.8%) when using this method. In another study, Robinson et al.⁹ examined intertester reliability and validity of 2

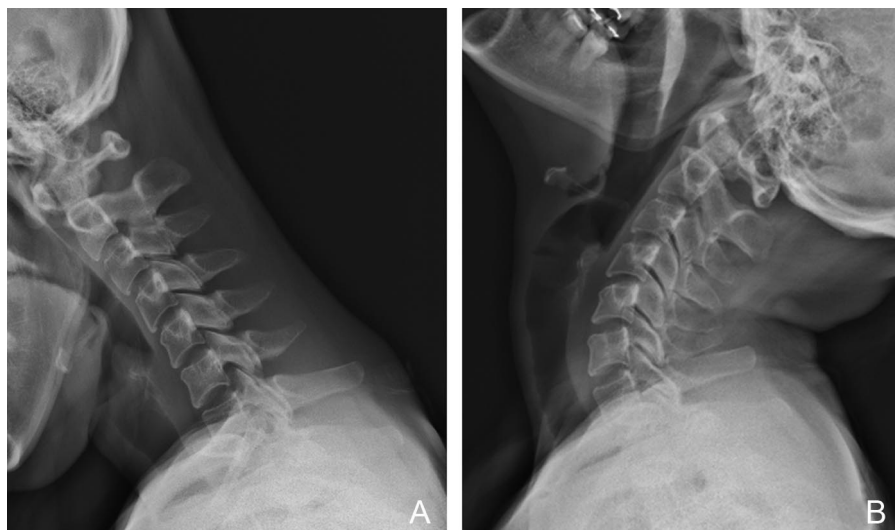


Figure 1. Lateral view radiograph of the cervical spine in (A) flexion and (B) extension. The separating and gathering of spinous processes during flexion and extension only occur in the cervical spine and cannot be observed at the cervicothoracic junction.

therapists in identifying the C7 spinous process with the flexion-extension method; C7 was correctly identified in 10 participants (55%) and 13 participants (72%), respectively. In the present study, C7 was correctly identified in 37.5% of patients in the control group, whereas the flexion-extension group showed an accuracy of 77.1%. These findings are consistent with the above-mentioned previous studies.

Biomechanics of the cervicothoracic junction is unique because of the transition from the mobile cervical to rigid thoracic spine. During extension, the anterior disk space of the lower cervical spine grows wider whereas the posterior length shortens and the separated spinous processes move closer together.¹⁰ The separating and gathering of spinous processes during flexion and extension only occur in the cervical spine and cannot be observed at the cervicothoracic junction (Fig. 1). The approximation of spinous processes during extension seems to render the palpation of the C6 spinous process difficult whereas the spinous processes of C7 and T1 remain relatively palpable.

The C7 spinous process is frequently used as a reference point when palpating lower cervical and thoracic vertebral levels for epidural injections, catheter insertions, and paravertebral blockades. Teoh et al.¹ compared the vertebra prominens (C7) and the tip of the scapula as landmarks for locating the seventh thoracic (T7) spinous process and found the vertebra prominens to be a more accurate landmark. They reported an accuracy of 29% when using the vertebra prominens compared with 10% when using the scapular landmark. However, Holmaas et al.² reported that using C7 as a reference point for identifying thoracic intervertebral spaces had an accuracy of only 12.2% and that there was poor association between correct identification of the reference point and correct identification of a given thoracic interspace. Further studies may be needed to evaluate the accuracy of thoracic spine palpation when the flexion-extension method is used to determine the cervical counting reference point.

BMI has been reported to adversely affect the accuracy of palpation methods in the cervical, thoracic, and lumbar regions.^{1,2,11} An excessive amount of subcutaneous fat in

obese patients worsens the accuracy of palpation methods relying on surface anatomy. Also, an increase in body weight and body surface area has been shown to increase the probability of a major deposit of fat in the posterior cervical region, especially between C6-7 and T1-2, referred to as the "hump pad."¹² This fatty tissue renders cervicothoracic region palpation even more difficult in obese patients, thus leading to inaccurate vertebral level palpation. However, BMI did not seem to affect the accuracy of the flexion-extension method in this study. The accuracy of the flexion-extension group was significantly higher than the control group regardless of BMI. This is in contrast to previous studies^{1,2,11} in which increases in BMI decreased the accuracy of palpation methods. One limitation of this study is that the BMI of the majority of patients ($n = 67$, 70%) was within the normal range or underweight, 26 patients (27%) were "overweight" (BMI of 25.0–29.9 kg/m²), and only 3 patients (3%) were classified as "obese" according to the BMI classification of the World Health Organization. This may have resulted in a higher accuracy of palpation in both methods of this study. Therefore, although it can be said that the flexion-extension method has a relatively higher accuracy in normal to overweight patients, its significance in obese patients remains unstudied.

The fact that the examiner was not blinded to the results of fluoroscopy may have introduced a source of bias as well as a learning effect. Interobserver variability may have been reduced by having a single observer conducting all of the examinations, but this may also have induced a learning effect. Another possible source of error may have occurred because of the female predominance of the study subjects. Gender difference of the proportion of the population in which other cervical or thoracic spinous processes are longer than the C7 spinous process has not yet been studied.

In conclusion, the flexion-extension method is more accurate than the conventional method when identifying cervical vertebral level, and its accuracy does not seem to be affected by the patient's BMI. This simple maneuver will

be useful when determining the lower cervical and upper thoracic vertebral levels for various procedures, such as epidural injections and paravertebral blockades. ■■

DISCLOSURES

Name: Seokyoung Shin, MD

Contribution: This author helped design the study, conduct the study, analyze the data, and write the manuscript.

Attestation: Seokyoung Shin has seen the original study data, reviewed the analysis of the data, approved the final manuscript, and is the author responsible for archiving the study files

Name: Kyung Bong Yoon, MD, PhD

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Attestation: Kyung Bong Yoon has seen the original study data, reviewed the analysis of the data, and approved the final manuscript.

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Contribution: This author helped design the study and conduct the study.

Attestation: Duck-Mi Yoon has seen the original study data, reviewed the analysis of the data, and approved the final manuscript.

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