Fukushima J. Med. Sci.,
Vol. 53, No. 1, 2007

[Case Report]

CERVICAL SPINOUS PROCESS BIFURCATION IS NOT USEFUL AS A LANDMARK IN POSTERIOR CERVICAL SPINE APPROACH

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(Received July 12, 2006, accepted December 26, 2006)

Abstract: *Background*: In the posterior cervical spine approach, the form of the cervical spinous process tip is one important landmark for level determination. However, it is still controversial whether the most caudal level of the bifurcated spinous process is C5 or C6 in previous reports.

Methods: The study samples consisted of 47 bleached bones and 3 fixed bodies for anatomical practice. According to the classification of Okuwa, patients who showed remarkable bifurcation of the spinous process tip were regarded to have "remarkable bifurcation", those who showed unclear indentation in the spinous process tip to have "slight bifurcation", and those who showed no bifurcation and no indentation to have "lack of bifurcation".

Results: The spinous process tips from C2 to C5 bifurcated in 26 out of 50 cervical spines (52%), and those from C2 to C6 in 20 (40%). There was no significant difference in the frequency of bifurcation of the spinous process tip between males and females.

Conclusion: The results of the present study indicate that it does not seem useful to use bifurcation of the cervical spinous processes for anatomical landmarks.

Key words: cervical spinous process, bifurcation, landmark

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INTRODUCTION

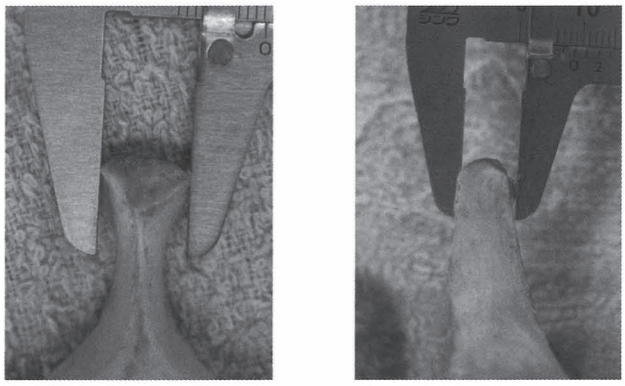
In the posterior cervical spine approach, the form of the cervical spinous process tip is thought to be one of important landmarks for level determination. However, in previous reports, some investigators regard the most caudal level of the bifurcated spinous process as C5[1,2], and others as C6[3-6]. In the present study, the form of the cervical spinous process tip was anatomically investigated.

MATERIALS AND METHODS

The study samples consisted of 47 bleached bones and 3 fixed bodies for anatomical practice (a total of 50 samples). The study samples were obtained from 36 Japanese males and 14 Japanese females. The age range was 20 to 82 years of age (average 62 years old). According to Okuwa's classification, the patients who showed remarkable bifurcation of the spinous process tip were regarded as having "remarkable bifurcation", those who showed unclear indentation in the spinous process tip as having "slight bifurcation", and those who showed no bifurcation and no indentation as having "lack of bifurcation"[7]. In the present study, "remarkable bifurcation" and "slight bifurcation" were classified as "presence of bifurcation", and "lack of bifurcation" as "absence of bifurcation" (Fig. 1). In addition, the size of width and the cranio caudal direction of the spinous process tip was measured at each level (Fig. 2), and its relations with gender, height and weight of sample donor were statistically analyzed using chi-square test, Mann-Whitney U test, and Spearman's rank correlation coefficient. Classification and measurement were performed 3 times each by 3 medically qualified spine disease specialists authorized by the Japan Spine Research Society. When the classification result differed depending on

a : remarkable bifurcation b : slight bifurcation c : absence of bifurcation

Fig. 1. Classification of the bifurcation of the spinous process tip
In the present study, "remarkable bifurcation" and "slight bifurcation" were classified as "presence of bifurcation", and "lack of bifurcation" as "absence of bifurcation".



a : Measurement methods of width of spinous process tip

b : Measurement medhods of size in the craniocaudal direction of the spinous process tip

Fig. 2. Measurement methods of the size of spinous process tip

the specialists, it was decided by majority. Inter-observer reliability was calculated using the intraclass correlation coefficient.

RESULTS

1) *Frequency of bifurcation of the spinous process tip*

The spinous process tips from C2 to C4 bifurcated in all 50 samples. The bifurcated spinous process tip was observed at C5 in 47 out of 50 samples (94%), at C6 in 21 samples (42%), and at C7 in one sample (2%) (Fig. 3). Reexamining those results in terms of bifurcation range, the 47 samples of spinous process tip at C5 included samples in which the spinous process tip was bifurcated up to C6 (range : C2-C6) and those up to C7 (C2-C7). Therefore, there were 26 samples with a bifurcated spinous process tip in the C2-C5 bifurcation range (52%) ; 47 samples at

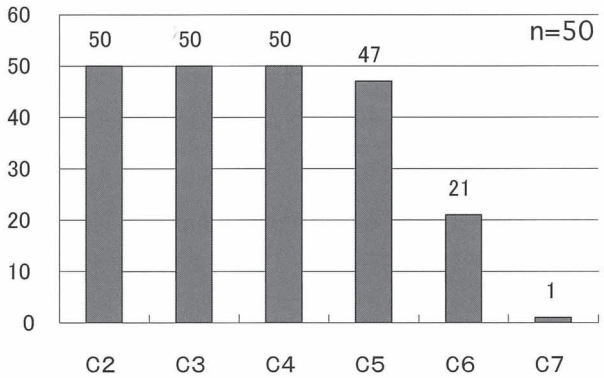


Fig. 3. The frequency of bifurcation of the spinous process tip by levels

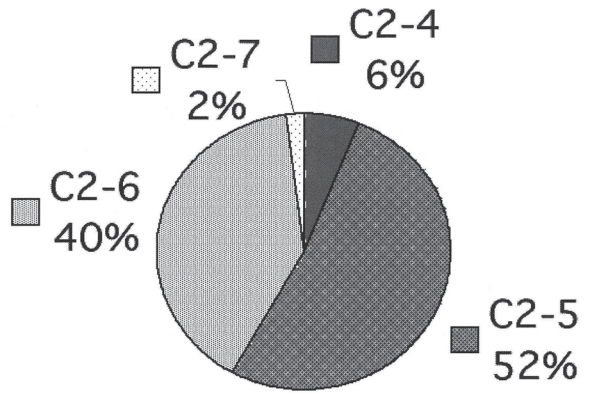


Fig. 4. The range of bifurcation of the spinous process tip

Table 1a. Difference in the frequency of bifurcation of the spinous process tip at C5 between males and females

	male	female
with bifurcation	33	14
without bifurcation	2	1
	$p=0.377$	

Table 1b. Difference in the frequency of bifurcation of the spinous process tip at C6 between males and females

	male	female
with bifurcation	15	6
wituout bifurcation	20	9
	$p=0.469$	

Table 2a. Presence of bifurcation with body weight (kg)

	C5	C6
with bifurcation	44.3±10.3	46.0±14.4
without bifurcation	36.0± 5.7	42.0± 8.6
	$p=0.144$	$p=0.572$

Table 2b. Precence of bifurcation with height (cm)

	C5	C6
witu bifurcation	153.1±7.1	151.7±14.3
wituout bifurcation	155.5±6.4	154.0± 3.9
	$p=0.621$	$p=0.533$

C5 minus 21 samples at C6. Likewise, there were 20 samples with a bifurcated spinous process tip in the C2-C6 range (40%); 21 samples at C6 minus one at C7 (Fig. 4).

There was no significant difference in the frequency of bifurcation of the spinous process tip at C5 and C6 between males and females (Tables 1a and 1b). In addition, there was no significant correlation of the presence of bifurcation at C5 and C6 with body weight, or with height (Tables 2a and 2b). In the classification of tip bifurcation, the intra-observer reliability was 0.88, and the inter-observer reliability was 0.74.

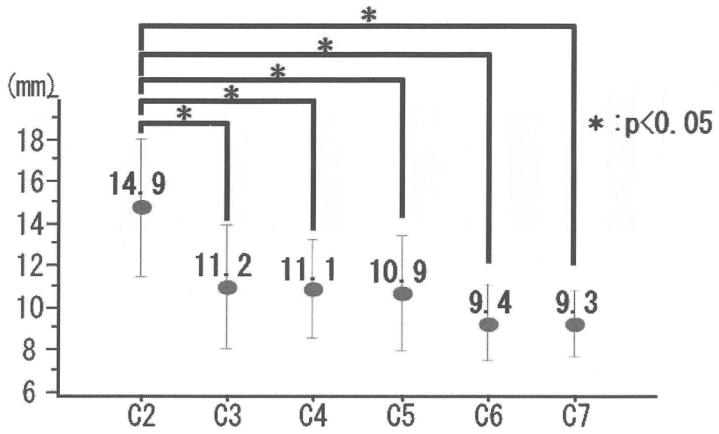


Fig. 5. The width of the spinous process tip

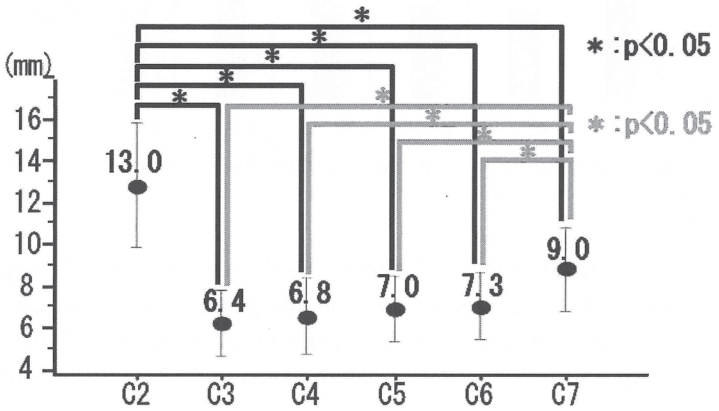


Fig. 6. The craniocaudal direction of the spinous process tip

2) Size of the spinous process tip

Width of the spinous process tip was the widest at C2, and became narrower at the lower levels (Fig. 5). C2 spinous process was significantly wider than processes at other levels ($p<0.05$). Size of the spinous process tip in the craniocaudal direction was the largest at C2, followed by C7. The size was smaller as the levels became upper from C7 to C3 (Fig. 6). Size of C2 spinous process in the craniocaudal direction was significantly larger than processes at other levels ($p<0.05$). Size of C7 spinous process in the craniocaudal direction was significantly larger than C3-C6 spnous processes ($p<0.05$).

There were no significant differences in width or size in the craniocaudal direction of the spinous process tips at any levels between males and females (Figs. 7a and 7b).

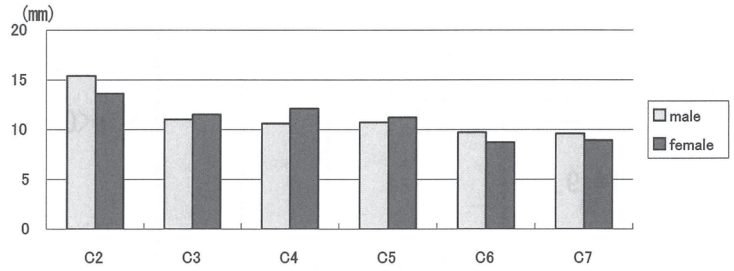


Fig. 7a. Differences in width of the spinous process tips between males and females

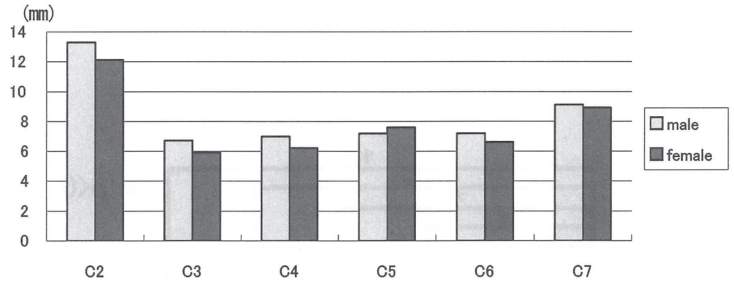


Fig. 7b. Differences size in the craniocaudal direction of the spinous process tips between males and females

There were no significant correlations of body weight or height with width or size in the craniocaudal direction of the spinous process tips from C2 to C7 ($p=$ 0.435-0.753). In measurements of width and size in the craniocaudal direction of the spinous process tip, the intra-observer reliability was 0.82, and the inter-observer reliability was 0.81.

DISCUSSION

As both inter-observer reliability and intra-observer reliability in this study are more than 0.8, these results are thought have high reliability.

The tip of cervical spinous process in human generally has depression in the median-sagittal direction, and dichotomously bifurcates. The reason why the process tip bifurcates in most cervical vertebras in human is revealed to be dependent on the development of both the interspinal and semispinalis cervicis muscles in human[8].

The length of the spinous processes from C3 to C6 are generally shorter than those at C2 and C7. This leads to decrease of collision of the spinous processes on dorsal flexion and increase of the range of motion. Our results showed that the size of spinous processes from C3 to C6 in the craniocaudal direction was significantly smaller than that of spinous processes at C2 and C7 (Fig. 6). The smaller size of

spinous processes in the craniocaudal direction has an advantage in increasing the range of dorsal flexion in the cervical vertebra. However, the small size of spinous processes in the craniocaudal direction results in the small area to attach posterior cervical muscles. Therefore, the spinous process might be bifurcated to increase the area to attach the muscles.

In the posterior cervical spine approach, the form of the cervical spinous process tip is thought to be one of important landmarks for level determination. However, in previous reports, some investigators regard the most caudal level of the bifurcated spinous process as C5[1,2], and others as C6[3-6].

In the present study, the most caudal level of the bifurcated spinous process was C5 in most study samples, but they accounted for only about half of the samples. There might be a problem associating with regarding the most caudal level of the bifurcated spinous process as a landmark for level determination of the cervical vertebra. It is known that there is an apparent difference in the size of the cervical transverse process or transverse foramen between Japanese males and females; it is significantly larger among men than women[9]. Yet, there was no significant difference in the frequency of bifurcation of the spinous process tip between males and females. In addition, there was no significant correlation of the presence of bifurcation with body weight, or with height.

When applying the posterior cervical spine approach, it might be necessary to confirm the level by preoperative plain x-ray, and, if necessary, by intraoperative x-ray fluoroscope.

REFERENCES

1. Hollinshead WH, Rosse C. Textbook of Anatomy, 4th ed. Harper and row publishers, Philadelphia, 285-307, 1985.
2. Yoshizawa E, Oiwa T. Comprehensive Textbook of Orthopaedic Operations vol. 8. *In*: Yamamuro T, Inoue S, eds. Kanehara and CO., LTD, Tokyo, 9-59, 1993.
3. Elaine NM. Human Anatomy and Physiology, 5th ed. Benjamin Cummings, San Fransisco, 198-247, 2001.
4. Harrison RJ. Bones. Cunningham's Textbook of Anatomy, 12th ed. *In*: Romanes GJ, ed. Oxford University Press, London, 75-209, 1981.
5. Louis R. Surgery of the Spine. Springer-Verlag, Berlin, 19-48, 1983.
6. Tsuji H. Spine. Surgical Exposures in Orthopaedics-The Anatomic Approach, 2nd Ed. Tokyo, 215-301, 1996.
7. Okuwa T. Ueber die Arteria Mediana des Japaners. Kanazawaidai Kaibokyoshitsu Gyoseki, **27**: 98-105, 1937.
8. Von Eggeling H. Die Gabelung der Hlswireldoren und ihre Ursachen. Anat. Anz. Centralblatt f. gesamt. Wiss. Anat. Bd, 55, 1922.
9. Kimura K, Konishi M, Hu SY. Shape and size of the transverse foramina in Japanese. Okajimas Folia Anat Jpn, **62**: 123-131, 1985.