

Incidence and age and gender profiles of hyperplasia in individual cervical vertebrae

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Abstract

Objective: To analyze the incidence and age and gender profiles of hyperplasia in individual cervical vertebrae.

Methods: In this retrospective study, computed tomography three-dimensional reconstruction images of cervical vertebrae from patients with neck discomfort were analyzed for the presence of hyperplasia and compared with age and gender data.

Results: Scans from a total of 580 patients (352 males, 228 females) were analyzed. The highest incidence of hyperplasia was seen in C2 (25%), followed by C1 (23%), C6 (16%), C5 (15%), C7 (9%), C4 (8%) and C3 (4%). Patients with C2 hyperplasia were the youngest and those with C1 hyperplasia were the second youngest, while patients with C7 hyperplasia were the oldest. Of those with C2, C1 and C7 hyperplasia, males were significantly younger than females, whereas of those with C3, C4, C5 and C6 hyperplasia, females were significantly younger than males.

Conclusions: Hyperplasia of the cervical spine shows different age and gender profiles among the seven vertebrae. These findings may be helpful for the early recognition of cervical hyperplasia and highlight the importance of protecting the atlanto-axial joint in daily life.

Keywords

Cervical vertebrae, hyperplasia, age, gender

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Introduction

Hyperplasia of the cervical vertebrae is a common condition in middle aged and elderly people.¹ However, with changes such as increased time spent working at a desk or driving, resulting in long periods of inactivity with a poor posture, the morbidity of this disease is increasing year on year,

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with patients becoming progressively younger.^{2,3} Cervical hyperplasia has commonly been reported in cervical vertebrae C4, C5, C6 and C7,⁴ but such reports are often based on conventional X-ray plain films, which do not show the upper cervical spine (C1 and C2) clearly.⁵ The use of computed tomography (CT), together with multiplanar reconstruction, provides a clear image of all seven cervical vertebrae without any blind areas. The present study aimed to investigate differences associated with age and gender in the incidence of hyperplasia in individual cervical vertebrae as seen on CT multiplanar reconstruction images.

Patients and methods

Patients

Data from consecutive patients presenting with neck discomfort who had undergone 64-section spiral CT of the cervical spine between January 2010 and December 2012 at the Department of Radiology, Taian City Central Hospital, Shandong Province, China, were retrieved retrospectively. Patients with a history of trauma of the cervical spine, infective or inflammatory conditions of the spine, cervical tumours, dysplasia, metabolic disease or surgical procedures of the cervical spine were excluded from the study.

The study protocol was approved by the Ethics Committee of the Taian City Central Hospital, Shandong Province, China. The requirement for patient consent was waived due to the retrospective nature of the study.

Image analysis

All patients had undergone a 64-section spiral CT scan of the cervical spine in a supine position with the head advanced using a SOMATOM Sensation 64 CT scanner (Siemens, Erlangen, Germany). The scanning parameters used were a tube current of 300 mA, a tube voltage of 120 kV, a scan slice of 3.0 mm, a scan interval of

3.0 mm, a sharp kernel (B60s) and a field of view of 155×155 mm. After routine scanning, three-dimensional reconstruction was performed using a slice thickness of 0.75 mm and an increment of 0.7 mm.

Cervical hyperplasia was defined as the presence of one or more of the following features on the CT scan: lip-like or lace-like appearance of the anterior, posterior, superior or inferior edge of the vertebral body, lace-like appearance, osteophytes or a bone bridge formed by fusion of two adjacent osteophytes.⁶ CT scans were analyzed independently by two experienced radiologists (Q.K. and S.L.) who were blinded to each other's assessment and to the patient's information. Any discrepancy was resolved by discussion.

Statistical analyses

Data was presented as the number of patients or as the mean \pm SD. Associations between age and gender and the presence of hyperplasia in different cervical vertebrae were analyzed using one-way analysis of variance and the χ^2 -test. A *P*-value < 0.05 was considered to be statistically significant. All statistical analyses were performed using SPSS software version 17 (SPSS Inc., Chicago, IL, USA).

Results

A total of 580 patients were included in the study; of these, 352 were male and 228 were female. They ranged in age from 13 to 70 years, with a mean age of 38.5 years.

A total of 1356 hyperplastic vertebrae were seen on computed tomography (Figure 1). The distribution of hyperplasia in the individual cervical vertebrae is given in Table 1. Hyperplasia occurred with the highest frequency in C2 (25%), followed by C1 (23%), C6 (16%), C5 (15%), C7 (9%), C4 (8%) and C3 (4%). Hyperplasia was significantly more likely to occur in C1 and

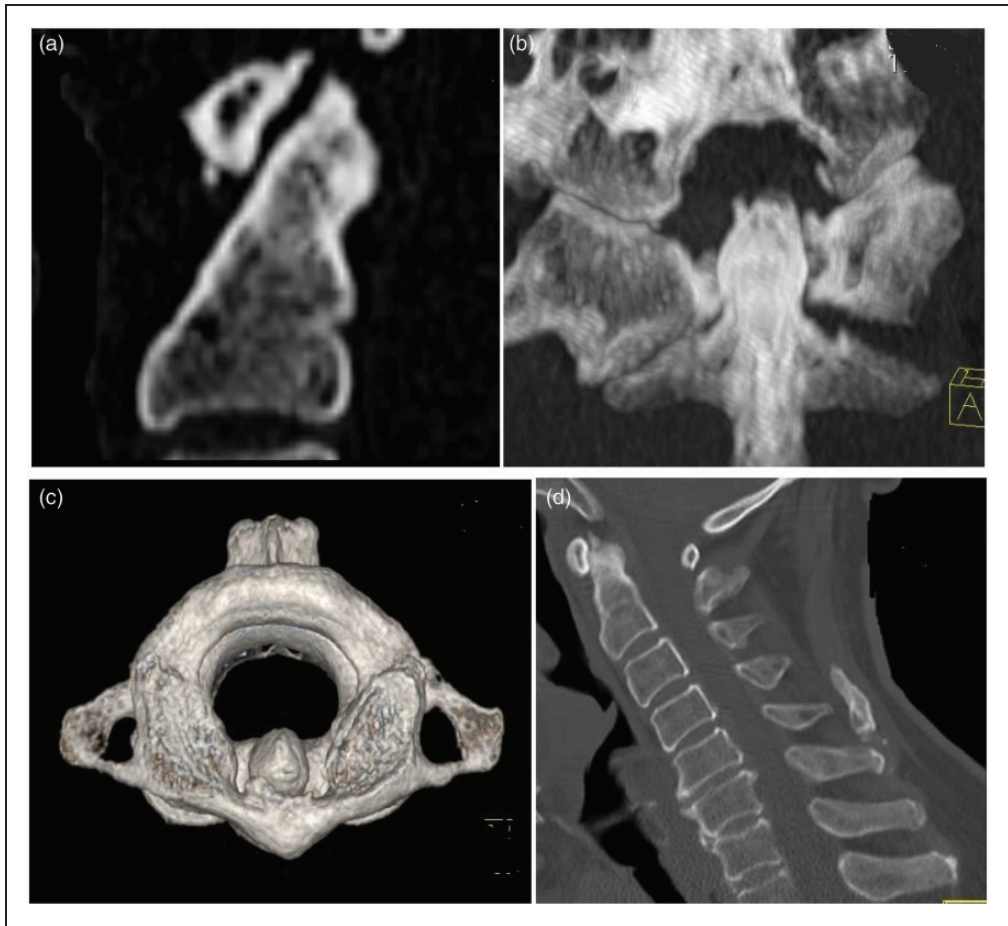


Figure 1. Computed tomography multiplanar reconstruction images of the cervical spine. (a) Sagittal maximum intensity projection image in a 66-year-old male showing lip-like hyperplasia at the superior border of the atlanto-axial joint. (b) Coronal maximum intensity projection image in a 66-year-old male showing hyperplasia of the atlanto-axial joint at the superior border of the dentate process of the axis and the lateral mass of the atlas. (c) Transverse volume rendering image in a 55-year-old female showing hyperplasia on the posterior edge of the anterior arch of the atlas. (d) Cervical sagittal multiplanar reconstruction image in a 66-year-old female showing hyperplasia of C1, C2, C5 and C6.

C2 than in the other cervical vertebrae ($P < 0.05$). The incidence of hyperplasia was higher in females than in males in C1, C2, C5, C6 and C7 ($P < 0.05$).

The mean \pm SD ages of patients with hyperplasia according to the cervical vertebra affected are given in Table 2 and Figure 2. There was a significant difference ($P < 0.05$) in the age of patients according to the cervical

vertebra affected, with patients with C2 hyperplasia being the youngest, followed by patients with C1 hyperplasia, while patients with C7 hyperplasia were the oldest (Table 2). In patients with C2, C1 or C7 hyperplasia, male patients were significantly younger than female patients, while in patients with C3, C4, C5 or C6 hyperplasia, female patients were significantly younger than male patients.

Discussion

Hyperplasia of the upper cervical spine vertebrae and of the posterior edge of vertebrae in the lower cervical spine are difficult to detect using plain film X-rays.^{5,7,8} In contrast, CT multiplanar reconstruction is able to show the detailed structure of the vertebral bodies^{5,9–13} and was therefore used in the present study to document hyperplasia of the cervical vertebrae.

Previous studies have reported that hyperplasia of C1 and C2 (the atlas and axis) is seen mostly in patients with cervical spine

symptoms aged 40–57 years, with C2 being the last of the cervical vertebrae to develop hyperplasia.^{2,6,14,15} In the present study, hyperplasia of C1 and C2 was seen at a mean \pm SD age of 47.97 ± 13.23 years and 44.12 ± 19.98 years, respectively, which is consistent with previous studies, and occurred at a younger age in male compared with female patients. In addition, hyperplasia occurred with the highest frequency in C2, followed by C1, C6, C5, C7, C4 and C3, which is in contrast to previously published reports. However, in most of the previously reported studies, conventional plain film X-rays were used, in which the upper cervical spine overlaps with maxillofacial structures. As a result, such films only show the distance between the odontoid process of the axis and the lateral mass of the atlas, with mild bone hyperplasia being poorly demonstrated.^{5,7,8} In the present study CT multiplanar three-dimensional reconstruction was used, which is the gold standard for the detection of osteoarthritis of C1 and C2.¹⁰ In addition, few studies have focused on the C1/C2 region, although these joints make a significant contribution to the mobility of the spine.^{16–18}

The present study revealed that C2 is the earliest and the most frequently affected vertebra in cervical hyperplasia, followed by C1.

Table 1. Gender distribution of hyperplasia in individual cervical vertebrae as seen on computed tomography.

Vertebra	Male (n = 352)	Female (n = 228)	All patients (n = 580)
C1	170 (48)	136 (60)	306 (53)
C2	179 (51)	161 (71)	340 (59)
C3	42 (12)	14 (6)	56 (10)
C4	70 (20)	45 (20)	115 (20)
C5	117 (33)	88 (39)	205 (35)
C6	121 (34)	93 (41)	214 (42)
C7	70 (20)	50 (22)	120 (21)

Data presented as number of patients (%).

Table 2. Age of patients with hyperplasia in individual cervical vertebrae as seen on computed tomography according to gender.

Vertebra	Male (n = 352)	Female (n = 228)	Statistical significance ^a		All patients (n = 580)
			P-value	F-value	
C1	46.52 \pm 13.78	49.78 \pm 12.31	< 0.001	23.08	47.97 \pm 13.23
C2	43.54 \pm 20.54	46.00 \pm 19.24	< 0.001	15.97	44.12 \pm 19.98
C3	50.40 \pm 17.67	49.50 \pm 18.11	< 0.001	64.23	50.18 \pm 17.61
C4	51.24 \pm 15.01	51.00 \pm 13.56	< 0.001	76.38	51.15 \pm 14.40
C5	52.34 \pm 12.47	52.08 \pm 11.41	< 0.001	82.54	52.23 \pm 12.00
C6	52.82 \pm 11.81	52.31 \pm 11.06	< 0.001	84.52	52.6 \pm 11.46
C7	56.70 \pm 11.20	56.84 \pm 11.18	< 0.001	82.61	56.76 \pm 15.82

Data are presented as mean \pm SD.

^aUsing one-way analysis of variance.

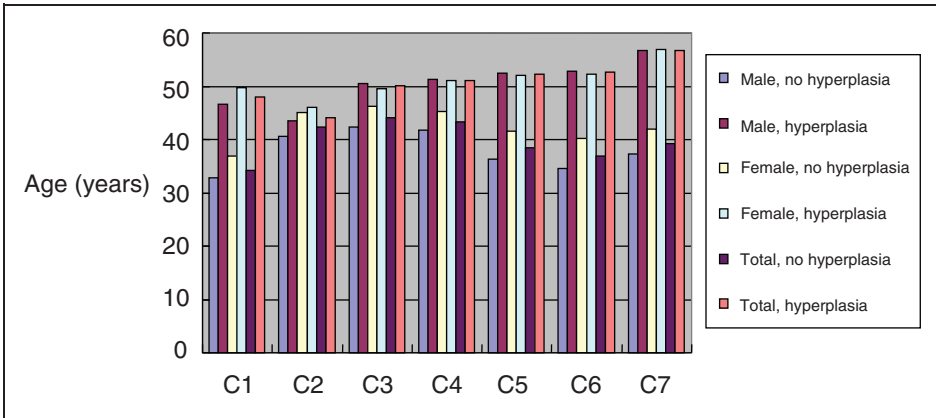


Figure 2. Relationships between mean age, gender and hyperplasia of individual cervical vertebrae.

This may be explained by the anatomical relationships of the cervical vertebrae and their movements. The cervical spine moves more than 600 times each hour,² with considerable impact on the atlas and axis. C1 and C2 are highly specialized vertebrae that provide considerable mobility for the skull and cervical spine in terms of rotation, flexion and extension.¹⁹ A greater degree of rotation is possible at the atlanto-axial joint than between the other cervical vertebrae. Rotation occurs around the odontoid process, with a range of movement of about 45°. As a whole, the neck can rotate up to 90°, half of which occurs at the atlanto-axial joint,^{20,21} with the other half being due to rotation of the other cervical vertebrae. Once the head and upper cervical vertebrae have rotated by 20–30°, the lower cervical vertebrae then rotate in order to complete the entire 90° rotation. The atlas and axis are therefore involved early in cervical movements and are responsible for a large part of the activity range of the neck.

The present study also found that C7 was the last vertebrae to show hyperplasia. This may be due to the fact that C7 mobility is less than that of the other cervical vertebrae.

In the present study, hyperplasia in C1, C2 and C7 occurred at a younger age in

males than in females, whereas hyperplasia in C3, C4, C5 and C6 occurred at a younger age in females than in males. In addition, the incidence of hyperplasia was higher in females than in males in C1, C2, C5, C6 and C7. The reasons for these differences are not clear and warrant further study.

One major weakness of the present study is its retrospective design, with the possibility of selection bias. In addition, the study focused on bone hyperplasia and did not consider changes to the intervertebral discs or early cystic degenerative changes in the odontoid process,³ and the hyperplasia was not graded. The study also did not analyze other factors that may affect bone hyperplasia, such as occupation and hormone levels. Lastly, the study did not investigate the relationship between hyperplasia seen on CT images and clinical symptoms.

In conclusion, the present study showed the pattern of development of cervical vertebra hyperplasia, with associated differences in age and gender. C2 was the most frequently affected vertebra, with a female predominance. These findings may be helpful for the early recognition of cervical hyperplasia and highlight the importance of protecting the atlanto-axial joint in daily life.

Declaration of conflicting interests

The authors declare that there is no conflict of interest.

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