Research Article

The Distribution and Location of Osteophytes in Vertebral Column

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Background : Several clinical conditions result from degenerative process of the spine with osteophytes developed in various levels as an evidence of the process.

Methods : A study was carried out on 230 skeletons, 156 male and 74 female, age ranged between 30 - 98 years to determine the distribution and location of osteophytes.

Results : The results showed that most osteophytes were distributed on C3 to C6, T10 and L5. Most osteophytes were located on the superior surface (62%) and inferior surface (54%) of the body in the lumbar region, on the inferior (18.5%) and superior (15%) articular facets of the cervical region and on the inner surface of the laminae (34.5%) in the thoracic region. The location of osteophytes on C3 to C6, T10 and L5 especially on the posterior and posterolateral aspects of the body, medial side of the articular facets and inner surface of the lamina could possibly compromise the width of the spinal canal or intervertebral foramen, thereby affecting the spinal cord and or spinal nerve roots causing neurological deficits. Varying severity of bony encroachment of the foramen transversarium of some cervical vertebrae from osteophytes, some to the extent of near obliteration, could have constricted or obliterated the vertebral arteries passing through them and deprived the brain of a source of its blood supply.

Conclusion: The distribution and location of osteophytes in 230 Thai was reported with clinical implications. **Bull Chiang Mai Assoc Med Sci 2001; 34: 79-88.**

Key words: Osteophyte, spinal stenosis

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บทคัดย่อ: การกระจายตัวและตำแหน่งของกระดูกงอกในกระดูกสันหลัง

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ความเป็นมา : ภาวะทางคลินิกมิใช่น้อย เป็นผลสืบเนื่องมาจากความเสื่อมของกระดูกสันหลังในระดับต่างๆ เช่นที่คอ อก และเอว หลักฐานที่ยืนยันความเสื่อมซึ่งพบได้คือ Osteophytes ในตำแหน่งต่างๆ

วิธีการ : ศึกษาโครงกระดูก จำนวน 230 โครงร่าง ชาย 156 โครงร่าง หญิง 74 โครงร่าง อายุระหว่าง 30-98 ปี เพื่อศึกษาการกระจายตัวและ ตำแหน่งของกระดูกงอก

ผลการศึกษา : มีกระดูกงอกเกิดมากที่ กระดูกสันหลังระดับ C3-C6, T10 และ L5 ตำแหน่งที่พบมากที่สุดใน Vertebral body ที่ Superior surface 62% และ Inferior surface 54% ในกระดูกสันหลังระดับเอว ที่ตำแหน่ง Inferior 18.5% และ Superior articular facet 15% ในกระดูกสันหลังระดับคอและพบที่บริเวณ Inner surface ของ Lamina 34.5% ในกระดูกสันหลังระดับอก

ตำแหน่งของกระดูกงอก ที่ C3-C6, T10 และ L5 โดยเฉพาะอย่างยิ่งด้าน Posterior และ Posterolateral ของ Vertebral body ด้าน Medial ของ Articular facet และ Inner surface ของ Lamina อาจมีผลต่อความกว้างของ Spinal canal และ Intervertebral foramen ซึ่งทำให้เกิดอันตรายต่อ Spinal cord และ Spinal nerve root เป็นสาเหตุของการเกิดอาการทางระบบประสาทของผู้ป่วย

พบกระดูกงอกที่รุกล้ำเข้าไปในรู Foramen transversarium ของกระดูกสันหลังส่วนคอในความรุนแรงที่แตกต่างกัน บางรายถึงขั้นทำให้รูแทบตีบตัน ซึ่งน่าจะทำให้หลอดเลือดแดง Vertebral ที่ลอดผ่านรูเหล่านี้ตีบแคบหรือตีบตันไป เป็นผลให้สมองขาดเลือดจากแหล่งเลือดส่วนหนึ่งดังกล่าวได้

สรุป : ได้รายงานการกระจายตัวและตำแ หน่งของกระดูกงอกในกระดูกคนไทย 230 รายพร้อมกับความเกี่ยวพันทางคลินิก **วารสารเทคนิคการแพทย์ เชียงใหม่ 2544; 34: 79-88.**

คำหัส: กระดูกงอก ช่องกระดูกสันหลังตีบแคบ

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Introduction

Vertebral osteophytes are a characteristic of intervertebral disc degeneration.[1] The aging process results in degenerative changes when osteophytes occur at cervical region in advanced stages which can cause compression of the spinal cord or spinal nerve root.[2] Sometimes very severe narrowing of the cervical canal, mostly by osteophytes growing from the posterior edge of the vertebrae, can cause cervical myelopathy.[3] Symptoms often develop insidiously and are characterized by neck stiffness, arm pain, numbness in the hand and weakness of the hands and legs. The differential diagnosis includes any conditions that can result in myelopathy and/or radiculomyelopathy. The diagnosis is confirmed by Magnetic resonance imaging (MRI) that show narrowing of the spinal canal caused by osteophytes.[1, 4] Osteophytes originating from lumbar vertebral bodies in the area of the intervertebral discs may be a source of nociceptive low back pain.[5]

Asymptomatic osteophytes of the anterior margins of the cervical vertebrae may occur in 20-30% of the population. However, there have been quite a few reported cases of anterior osteophytes induced dysphagia.[6, 7, 8, 9, 10] The literature also reported an unusual case of renal colic occurring in a 44 year old male whose intravenous urography showed right ureteral extrinsic compression by osteophytes of the L3 vertebra. After failure of medical treatment, the patient was operated with resection of the osteophyte and the post operative course was unevenful with reduction of pain.[11]

Degenerative changes in discs are always accompanied by osteophyte formation on the margins of the vertebral bodies and remodeling changes in the apophyseal joints, leading to the clinical condition of degenerative spondylosis. Twelve Studies concerning the distribution and localization of vertebral osteophytes in Thai are scarce. The purpose of this study was to determine the distribution and location of osteophytes in vertebral bodies, articular facets and laminae in cervical, thoracic and lumbar vertebrae, to obtain basic data as a foundation for further clinical application.

Materials and Methods

230 vertebral columns from Department of Anatomy, Faculty of Medicine, Chiangmai University, with 156 male and 74 female, age 30-98 years were studied. Records were made of distribution and localization of osteophytes at the superior and inferior surfaces of bodies, superior and inferior articular facets, and laminae in each vertebral level from C1 to L5. The localization of the osteophytes on the surfaces of the bodies were classified as anterior, posterior and lateral, those on the superior and inferior articular facets were classified as medial and lateral and those on the laminae were on the inner surface area. Osteophytes on the medial side of articular

facets are those protruding toward the intervertebral foramen, spinal canal or foramen transversarium whereas those on the lateral side away from them. The facet for Dens is designated "superior surface" of the body of C1 (Table 1)

Table 1 The distribution of osteophytes in cervical region (230 columns)

Level	Superior surface of the body		Inferior surface of the body		Superior facet		Inferior facet	
	Column	%	Column	%	Column	%	Column	%
C1	120	52	0	0	4	1.7	5	2.2
C2	0	0	51	22	5	2.2	44	1.9
C3	61	26.5	109	47.4	42	18.3	61	26.5
C4	121	52.6	120	52.2	68	29.6	67	29
C5	151	65.7	163	70.9	66	28.7	39	17
C6	168	73	132	57.4	40	17.4	25	10.9
C7	119	51.7	30	13	16	7	57	24.8

Results

The distribution of osteophytes in vertebral columns is as shown in Table 2. Of the region with greater distribution of osteophyts, the lumbar region had the greatest distribution on the body, the thoracic on the laminae and the cervical on the articular facets. The osteophytes were located on 45.9% of the superior and 43.8% on the inferior surfaces of the bodies in cervical region (Fig. 1). They were located on 62% of the superior and 54% of the inferior surfaces of the bodies in lumbar region (Fig. 2). In the cervical region osteophytes were found 15% on the superior articular facet and 18.5% on the inferior articular facets (Fig. 3). Osteophytes were also observed on 34.5% on the inner surface of the lamina in thoracic region (Fig. 4).

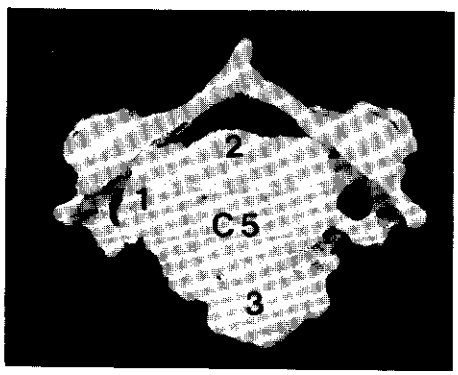

Figure 1: Locations of osteophytes on C5 : lateral (1), posterior (2) and anterior (3).

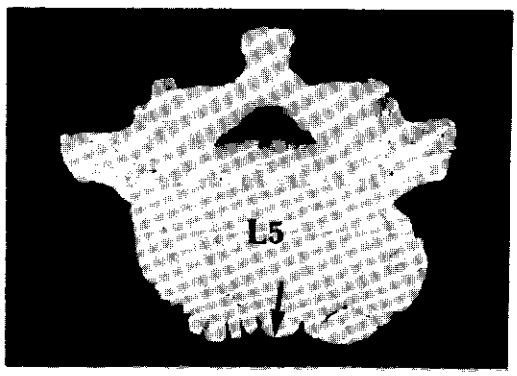

Figure 2: Anterior osteophytes on L5 (arrow).

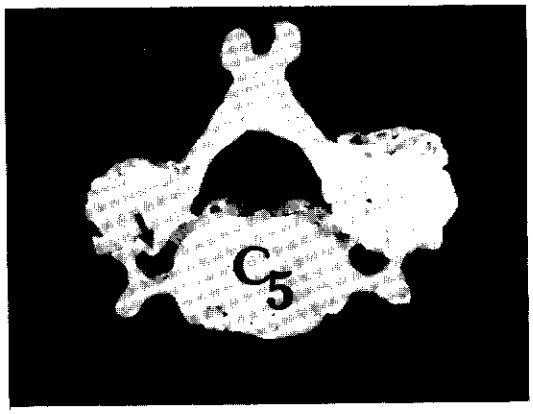

Figure 3: Facet osteophytes encroaching foramen transversarium on C5 (arrow).

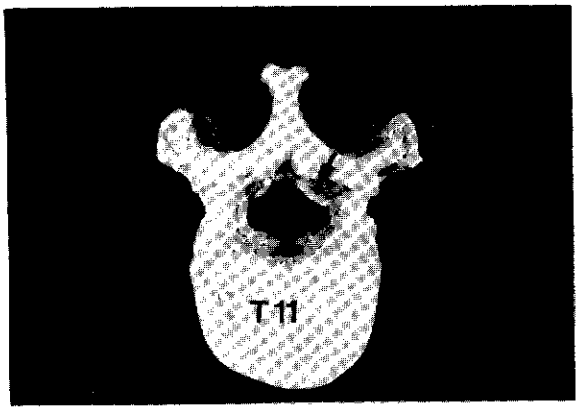

Figure 4: Osteophytes on inner surface of laminae (arrow) on T11.

The distribution of osteophytes in the cervical region is as shown in Table 2. The facet for Dens is designated "superior surface" of the body of C1. Most osteophytes were located on the superior surface of the body of C6 vertebra at 73%, next was on the inferior surface of C5 at 70.9%, with the superior and inferior articular facets at C4 level ranked third and fourth, respectively. No osteophyte was observed on the laminae of cervical vertebrae.

Table 2 Distribution of osteophytes in vertebral columns

Region	Superior surface on the body (%)	Inferior surface of the body (%)	Superior facet (%)	Inferior facet (%)	Lamina (%)
Cervical	45.9	43.8	15	18.5	0
Thoracic	28.3	31.3	7.3	6.5	34.5
Lumbar	62	54	8.2	5.9	9.7

The distribution of osteophytes in the thoracic region is as shown in Table 3 . It was found that osteophytes on the superior surface of the body clustered around T10 and T11 vertebrae for 97 columns (42%) each, and on the inferior surface around T8 and T9 vertebrae for 92 columns (40%) each. It was further observed that osteophytes clustered on the superior facet of T1 vertebra numbered 48 columns (20.7%), on the inferior facet of T3 vertebra 27 columns (11.7%) and on the lamina of T10 vertebra 153 columns (66.5%).

Table 3 The distribution of osteophytes in the thoracic region (230 columns)

Level	Superior surface of the body		Inferior surface of the body		Superior facet		Inferior facet		Lamina	
	Column	%	Column	%	Column	%	Column	%	Column	%
T1	64	27.8	58	25	48	20.7	14	6	3	1.3
T2	34	14.8	50	21.7	10	4.3	20	8.7	28	12.2
T3	47	20.4	62	27	22	9.6	27	11.7	47	20.4
T4	56	24.3	74	32	21	9.1	22	9.6	67	29.1
T5	46	20	53	23	14	6	15	6.5	83	36
T6	48	20.9	67	29	15	6.5	11	4.8	92	40
T7	61	26.5	78	34	10	4.3	9	3.9	103	44.8
T8	72	31.3	92	40	12	5.2	8	3.5	113	49
T9	90	39	92	40	8	3.5	13	5.7	131	57
T10	97	42	89	38.7	15	6.5	20	8.7	153	66.5
T11	97	42	71	30.9	13	5.7	12	5.2	141	61.3
T12	70	30.4	78	33.9	14	6	9	3.9	83	36

The osteophytes presented at lumbar region are as show in Table 4. The osteophytes in the lumbar region were distributed mostly around L4 and L5, with 74.8% on the superior surface of L4 and L5, 67.8% on the inferior surface of L5, 11.3% on superior facet of L5 and 11.7% on inferior facet of L5, while L1 contained most numerous osteophytes (20.4%) on its laminae .

Table 4 The distribution of osteophytes in lumbar region (230 columns)

Level	Superior surface of the body		Inferior surface of the body		Superior facet		Inferior facet		Lamina	
	Column	%	Column	%	Column	%	Column	%	Column	%
T1	85	37	101	43.9	14	6	3	1.3	47	20.4
T2	120	52	120	52	16	6.7	6	2.6	29	12.6
T3	164	71.3	114	49.6	14	6	10	4.3	9	3.9
T4	172	74.8	131	56.7	25	10.9	22	9.6	4	1.7
T5	172	74.8	156	67.8	26	11.3	27	11.7	0	0

The maximum frequency of osteophytes localization in vertebral body are summarized in Table 5 and those in articular facets in Table 6.

Table 5 The maximum frequency of localization of osteophytes in vertebral body.

	Superior surface of body			Inferior surface of body		
Location	Level	Column	(%)	Level	Column	(%)
Anterior	L3	152	66	L2	95	41
Lateral	C4	42	18	L5	60	26
Posterolateral	C6	16	7	C3	10	4
Anterolateral	C5	50	22	L4	14	6
Anterior and posterior	C4	3	1	C4	17	7
Posterior	C5	2	0.9	C3	11	5
Anterior, posterior and lateral	C6	86	37	C5	78	34

Table 6 The maximum frequency of localization of osteophyte in articular facet.

	Superior articular facet			Inferior articular facet		
Location	Level	Column	(%)	Level	Column	(%)
Medial	C4	11	5	T10	6	3
Lateral	T1	23	10	C4	43	19
Medial and lateral	C5	46	20	C4	21	9

The foramen transversaria on the transverse processes of cervical vertebrae were found encroached upon by osteophyes from the lateral side of the body and/or the medial side of the articular facets. These were observed clustering around C5 and C6 bodies and C5 facet (Table 5). Some foramen transversaria were nearly obliterated.

Discussion

In this study, osteophytes aggregated mostly on the superior and the inferior surfaces of the vertebral bodies in the lumbar region. The distribution at the superior and the inferior articular facets were present largely in the cervical region and on the laminae in the thoracic region. In the cervical region, on the

superior surface of the body, most osteophytes accumulated at C6 vertebra and on the inferior surface at C5 vertebra, and on the superior and inferior articular facets mostly at C4 vertebra (Table 1). In the thoracic region most osteophytes were on the laminae of T10 vertebra (Table 3). And in the lumbar region most osteophytes were found on the surface of the bodies of L4 and L5 vertebrae as well as on their articular facets (Table 4.)

The greater localization of osteophytes in various locations on C3-C6 and L5 vertebrae especially on the lateral aspect of the inferior surface of the bodies (Table 5) might be explained by the greater mobility and more weight transferred upon them. The articular facets of C4 and C5 had osteophytes in several directions, medial and medial-lateral. The possibility of osteophytes originating from the posterior and posterolateral aspects of the vertebral body as well as those originating from the medial side of the articular facets causing stenosis of spinal canal and intervertebral foramen resulting in neurological involvement can be postulated.

There were many osteophytes at the articular facets especially at C4 and C5 vertebra. These might result from weight bearing which was transferred to the articular facets. Furthermore, movement of these levels might also play some role for osteophytes formation as there were many osteophytes at facet for Dens in C1, supporting movement at this area. The previous reported vertical direction of trabecular pattern in superior and inferior articular facet in C3 to C6 level indicated weight bearing transfer of these level.[13] The thoracic region osteophytes were located on the inner surface of the laminae mostly at T10. These were on the medial side and could cause stenosis of the thoracic spinal canal with resultant injury to spinal cord[14].

The distribution of anterior osteophytes in the present study agree more with Nalthan's[15] result than with O'Neill's[1], but no significant difference is observed with either (Table 7).

Table 7 The vertebral body with maximum anterior osteophytes from various studies.

Author	Cervical	Thoracic	Lumbar
O'Neill TW. *et al*, 1999	L3	T9, T10	L3
Nathan H. *et al*, 1962	C6 superior surface of the body C5 inferior surface of the body	T10 inferior surface of the body T10 superior surface of the body	L4, L5 superior surface of the body L3 inferior surface of the body
Present study, 2001	C6 superior surface of the body C5 inferior surface of the body	T10, T11 superior surface of the body T10 inferior surface of the body	L3, L4, L5 superior surface of the body L2, L3, L4 inferior surface of the body

Anterior vertebral osteophytes were reported to cause clinical problems such as dysphagia from cervical osteophytes,[6, 7, 8, 9,10] abdominal pain from L4 osteophytes[16] and right ureteral extrinsic compression by osteophyte of the L3 vertebra.[11] In the present study, there were many osteophytes protruding from the anterior aspect of the vertebral body of the cervical spine especially at C5, C6 vertebrae (Table 5) where pharynx is at its narrowest part.[17] However, this study was carried out on dry skeleton with unknown history regarding whether there had been any symptoms.

In the cervical vertebrae, asymptomatic lateral osteophytes encroaching upon the foramen transversaria might constrict or obliterate the vertebral artery traversing through them, thereby depriving the brain of a souce of its blood supply. The medial facetal osteophytes could also do this by themselves or in combination with the lateral osteophytes.

In conclusion, numerous vertebral osteophytes in Thai, the same as in Caucasian and African, were localized on lateral and posterior aspects of the body, the medial side of the articular facets and the inner surface of the laminae. These might cause spinal canal or intervertebral foramen stenosis, resulting in neurological conditions with neck pain, back pain, arm pain, paraesthesia and/or muscle weakness of extremities, entailing human suffering.

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