Morphological Studies of Ossification of the Posterior Longitudinal Ligament by Computed Tomography

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Research Cord No.: 503.1

Key Words: *Spinal cord injury, OPLL, CT, Posterior longitudinal ligament*

CT による後縦靱帯骨化症のX線形態学的検討

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（昭和56年5月12日受付）

（昭和56年7月23日最終原稿受付特別掲載）

後縦靱帯骨化症は，ほぼ日本人に固有の疾患とされる．これは，本来が骨化物であるため，脊柱管の内部に位置するにもかかわらず，一般のX線検査でも観察が可能であった．しかし，脊椎管内の軟組織の性状については不明であった．

本報告では，CT で可能となった横断像観察から第1に骨化物については辺縁，内部構造あるいは偏在性と，神経症状との関係を調べた．第2に，骨化物以外の後縦靱帯の変化—肥厚や硬膜外腔の空間占有病変，硬膜硬化（石灰化），椎体後縁骨棘あるいは黄靱帯骨化と神経症状との関係，第3に脊髄病変（低吸収域）の有無を調べた．

対象とした後縦靱帯骨化症は85例である．神経症状を確認した64人についての骨化物の検討では，辺縁が asymmetrical なものは radiculopathy が多かった．位置が偏在しているものでも，radiculopathy が多かった．骨化物の内容が不均一なものでは，myelopathy と radiculomyelopathy が多かった．

脊髄の変化については，神経症状のない症例では変形はなかった．形態が扁平なものでは radiculopathy が多かった．atrophic なものでは radiculomyelopathy が多かった．

脊髄内に，低吸収域を示したものでは myelopathy が一位であった．

椎骨およびその周辺の靱帯についての病的変化

を spondylotic なものと hyperostotic なものとに分けた.

Myelopathy は周辺変化が spondylotic なものに多かった. radiculomyelopathy は hyperostotic な周辺の場合に多かった.

以上は, 後縦靱帯骨化症の病態について以前から推測されてきた事項とほぼ一致するものである.

Abstract

We used computed tomography to assess thickening of the posterior longitudinal ligament, the space occupying lesions within the spinal canal and pathological changes in the spinal cord. Such pathological disarrangements cannot be adequately imaged using routine radiological procedures. In 85 patients with ossification of the posterior longitudinal ligament, there were 64 in whom the neurological signs were confirmed and radiculopathy was more frequent among those with asymmetrical ossification at the margin. This pathology was also more evident among those with a eccentric position. Myelopathy and radiculomyelopathy were frequent occurrences among those with non-uniform contents of ossification.

In patients with no subjective or objective symptoms there was no evidence of deformation of the spinal cord. A flat cord was often associated with a radiculopathy while an atrophic cord was often linked to radiculomyelopathy. Myelopathy was a common occurrence in those patients with a low dencity area within the spinal cord.

These findings are in good parallel with heretofore existing assumptions regarding mechanisms related to development of neurological signs if ossification of the posterior longitudinal ligament.

Introduction

The incidence of ossification of the posterior longitudinal ligament (OPLL) is high in Japanese[1]. This entity involves an ossification within the spinal canal and often routine X-rays are adequate for a diagnosis. The so-obtained lateral views can be classified into serial, segmental and mixed types, depending on the extension of the OPLL in the longitudinal direction within the spinal canal. When the ossification involves one vertebral body, the classifications are papillary, hook or staple types. The involvement of two vertebral bodies means the bridge type. A cross section of the ossification by transverse axial tomography (Takahashi Tomography) shows round, key and wave-shaped forms. This procedure is concerned with area or location of the ossification in the vertebral foramen.

Patients with OPLL develop symptoms in the spinal cord or nerve root. If the lateral X-ray view shows the ratio between the diameter of ossification and the spinal canal diameter in its antero-posterior direction to be more than 40%, neurological signs may be present[3].

If the margin of the ossification is obscure and there is a high absorption of X-ray, the prognosis is usually poor. Some ossifications have a two-staged growth or structure of "osteocortex and medulla".

Spondylotic or hyperostotic change of the vertebral body induces space occupying lesion within the spinal canal or narrows the canal, and an oppression on the neurological system will ensue[6]. OPLL is also associated with thickening of the ligament, apart from the ossification. Congestion of the plexus of the vertebral vein or the thick ligament may be seen on CT as an extradural mass lesion. Thickening or ossification of the dura mater may also be evident. A cross section of spinal cord can be classified into large, normal sized, flat or atrophic. A softening lesion or cystic degeneration may sometimes occur in the spinal cord.

The purposes of our present work was to examine the margin, content and location of ossification itself in relation with neurological signs, to assess the a) thickening of the Posterior Longitudinal Ligament (PLL) excluding ossification, b) space occupying lesion of the external space of the dura mater, c) hardening (calci-

fication) of the dura mater, d) posterior spur of the vertebra and ligamentum flavum ossification in relation with neurological signs, e) also to determine the possibility of spinal lesion (low density area)[2].

Materials and Methods

The CT scanner used was an EMI CT5005. A window level of 100 and a window width of 400 were considered appropriate to the actually determined values, as a result of investigations of the human dry bone[5]. Window level 15 and window width 75 were used to observe the soft tissue components. The thickness of a slice was about 13 mm (Fig. 1).

The study included 85 patients with OPLL. The male-female ratio was 65% to 35%. Ages ranged from 34 to 74 years with a mean of 56 years (Table 1). OPLL was detected at the level of the cervival spine in 86%, at the thoracic spine in 17%, and at the multiple in 15%. Neurological signs were confirmed in 64 of the 85 patients.

Results and Discussion

Table 2 shows specific sites of OPLL in the cervival spine. Measured dimensions, classified features and locations are illustrated in Fig. 2.

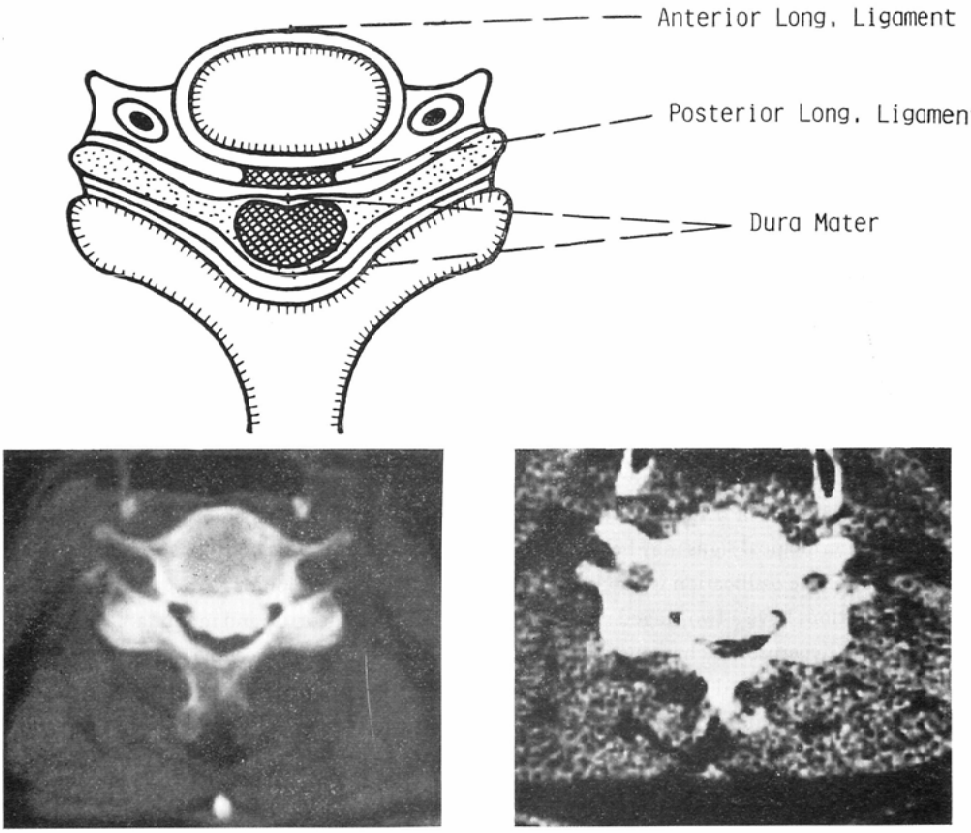

Fig. 1　The top figure shows the anatomical position of PLL in a section of the human cervical vertebra. (From ref. 4)
The lower left shows a highly advanced OPLL and the X-ray absorption is higher than in the vertebral medullary portion.
The lower right shows the soft component within the spinal canal. An atrophic spinal cord is evident.

Table 1. OPLL, age distribution

≦40	4 (5%)	
41~50	24 (28%)	88%
51~60	29 (34%)	
61~70	22 (26%)	
71≦	6 (7%)	

Table 2. OPLL, site in cervical spine

C_1	11 (3%)	
C_2	41 (12%)	
C_3	55 (16%)	
C_4	65 (19%)	56%
C_5	62 (18%)	
C_6	66 (19%)	
C_7	40 (12%)	

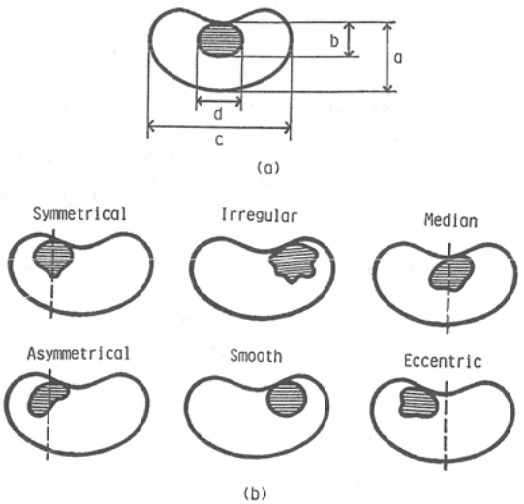

Fig. 2 (a) Measured dimensions
a: A-P diameter of spinal canal
b: A-P diameter of OPLL
c: L-R diameter of spinal canal
d: L-R diameter of OPLL
(b) Classified patterns and locations

Measurement of ossification indicated that the L-R diameter ranged from 2-20 mm with a mean of 11 mm, as shown in Table 3. The ratio between the A-P diameter and spinal canal diameter of OPLL ranged from 13~80% with a mean of 41%. Further, the area narrowing rate was fixed by $\frac{b \times d}{a \times c} \times 100\,(\%)$. The area narrowing rate ranged from 1~60% with a mean of 23%, as shown in Table 3.

Table 3. Size of OPLL

	Range	Average
Size of lesion	(mm)	(mm)
A-P diameter	2~9	5
L-R diameter	2~20	11
Longitudinal length	13~195	60
Narrowing rate	(%)	(%)
b/a	13~80	41
d/c	8~100	52
Area	1~60	23

Table 4. Accompanied vertebral abnormality (%)

Neurological sign [total]	Vertebral body		
	Spondylotic	Hyperostotic	Not changed
Myeolpathy [13]	8 (62)	5 (39)	0 (0)
Radiculomyelopathy [32]	13 (41)	17 (53)	2 (6)
Radiculopathy [16]	7 (44)	7 (44)	2 (13)
None [3]	0 (0)	1 (33)	2 (67)

Table 5. Radiological pattern (%) of the OPLL

	Neurological sign [total]			
	Myelopathy [13]	Radiculomyelo-pathy [32]	Radiculopathy [16]	None [3]
Ossification				
Margin asymmetrical	5 (39)	13 (41)	8 (50)	1 (33)
irregular	7 (54)	17 (53)	9 (56)	1 (33)
Location eccentric	4 (31)	9 (28)	6 (38)	0 (0)
Content inhomogeneous	10 (77)	24 (75)	11 (69)	2 (67)
Spinal cord				
Not deformed	1 (8)	0 (0)	1 (6)	2 (67)
Flat	8 (62)	17 (53)	13 (81)	1 (33)
Atrophic	4 (31)	15 (47)	2 (13)	0 (0)
Low density area	2 (15)	3 (9)	1 (6)	0 (0)
Inside spinal canal				
Thickened PLL	5 (39)	11 (34)	7 (44)	0 (0)
(Extra) dural change	2 (15)	16 (50)	5 (31)	1 (33)

Myelopathy was frequent in the accompanying spondylotic change of the vertebra and radiculo-myelopathy was seen in cases of hyperostotic change, as shown in Table 4.

The results in relation to neurological signs are summarized in Table 5.

Conclusions

OPLL predominated in;

(1) Men

(2) Ages 41-70 years

(3) Cervical spine and C4-C6
(4) Solitary lesion
(5) Accompaning vertebral abnormality (80%).

Neurological signs were affected by;

(6) Morphology of OPLL
(7) Lesion in the extradural space, dura or cord.
(8) The area of narrowing did not relate directly to the incidence of neurological signs. Because even at a ratio below 30%, the incidence of neurological signs was 7%.

Acknowledgment

We thank Miss Mariko Ohara for editing the manuscript.

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