Table 2. Multivariate-adjusted odds ratios for the new onset of low back pain with work disability

Factors	Adjusted OR[a]	95%CI
Previous episodes of low back pain		
No	1.00	
Yes	3.25	1.53-6.91
Lifting		
Not frequent	1.00	
Frequent	3.77	1.16-12.3
Monotonous work		
Not monotonous	1.00	
Monotonous	2.21	0.99-4.94
Interpersonal stress at work		
No stress	1.00	
Stress	2.42	1.08-5.43

OR: Odds ratio, CI: Confidence interval

[a] Adjusted for previous episodes of low back pain, lifting, monotonous work, interpersonal stress at work, age and gender.

特集 リウマチ性疾患の痛みをやさしく教えます

運動器疾患における神経障害性疼痛

竹下克志
TAKESHITA Katsushi
東京大学大学院医学系研究科整形外科学

Key Words ▶▶▶▶ ■神経障害性疼痛 ■中枢性感作 ■変形性関節症 ■後縦靱帯骨化症 ■プレガバリン

神経障害性疼痛は国際疼痛学会で「体性感覚系に対する損傷や疾患の直接的結果として生じている疼痛」と定義され，痛覚過敏やアロディニアを特徴とする非ステロイド性抗炎症薬抵抗性の痛みである．神経根症など脊椎疾患の多くにみられ，四肢運動器の障害においても生じている可能性がある．

はじめに―神経障害性疼痛とは？―

現在，痛みは①侵害受容性疼痛，②神経障害性疼痛，③心因性疼痛（または機能性疼痛）に分類される．①の侵害受容性疼痛は，痛み情報が皮膚などの侵害受容器から脊髄後角を経て外側視床路を通る上向路を中心とした，生体へのさまざまな有害な外的侵襲に対する生理的反応である．また，③の心因性疼痛は身体表現性疼痛とほぼ同義で，身体の障害から予測される痛みをはるかに超える痛みがあり，心理的要因が原因の過半であると診断された場合に用いられる．

神経障害性疼痛は知覚神経の障害による痛みであり，痛覚過敏や通常は痛くない程度の刺激を痛みと感じるアロディニア，神経障害で妥当と思われる部位への電撃痛や刺すような痛み，焼けるような痛みなどを特徴とする．末梢から脊髄後角そして脳に至る感覚神経系のさまざまなレベルで生じると想定されており，国際疼痛学会（International Association for the Study of Pain：IASP）において「体性感覚系に対する損傷や疾患の直接的結果として生じている疼痛」[1]と定義されている．診断ではIASPから診断アルゴリズム[2]が提唱され，スクリーニングとして神経障害性疼痛用調査票が各国で作成されている．われわれはpainDETECT[3]を用いている．ただ，臨床上は侵害受容性疼痛と神経障害性疼痛が併発している場合が多い．また痛み刺激は内側脊髄視床路を通り前帯状回や扁桃体に至る痛みの情動系も賦活化するため，抑うつや不安といった情動障害が起こりやすい．すなわち，上記3種類の痛みはほとんどの臨床例でオーバーラップして表出されていることを認識する必要がある．治療の観点からは各種薬剤の効果が異なることが重要であり，侵害受容性疼痛では非ステロイド性抗炎症薬（non-steroidal anti-inflammatory drugs：NSAIDs）が比較的有効であるが，神経障害性疼痛ではNSAIDsの効果はきわめて限定的であり，抗けいれん薬や抗うつ薬が有効である．

神経障害性疼痛用調査票を用いた疫学調査では一般人の7～8％[4]に神経障害性疼痛がある．また，運動器疾患を担当する整形外科の慢性疼痛外来患者の39～43％[5]に

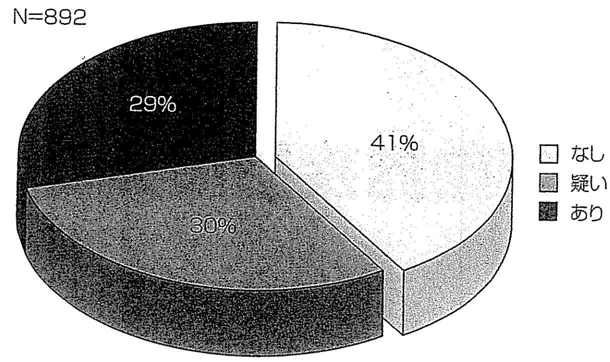
みられるとされる．外傷や腫瘍性疾患などでも神経障害性疼痛の関与はあると思われるが，本稿では脊椎と四肢変性疾患について触れる．

1．脊椎変性疾患における神経障害性疼痛

脊椎症において神経障害は以前から脊椎疾患の主たる課題である．ただし運動障害すなわち麻痺に大部分の関心が注がれてきた点は否めない．欧州の腰痛患者に対する調査では25〜30％に神経障害性疼痛の関与があると報告されている[9]．われわれが厚生労働省研究班でおこなった2010年の頸椎後縦靱帯骨化症に対する調査では神経障害性疼痛のある患者が29.8％を占め，疑いを含むと6割にみられた（図❶）．また2011年におこなった腰部脊柱管狭窄症に対する調査では神経障害性疼痛のある患者が13.8％，疑いを含むと5割にみられた．

神経障害性疼痛の代表としては腰椎椎間板ヘルニアにみられる腰部神経根症（根性坐骨神経痛）や変形性頸椎症に伴う頸部神経根症がある．いずれも強烈な痛みを起こしうる病態であり，即効的な疼痛緩和には大量ステロイドの短期内服やブロック治療が望ましい．より有害事象の少ない治療として2010年から使用可能となったプレガバリンがよい．ただし，めまいやふらつきが一時的に出現することが多いため，処方開始時からすぐに有効量を投与することはむずかしい．運動障害が高度あるいは進行する例や，上記保存治療で痛みを緩和できない場合には圧迫部位の解除すなわち除圧手術が必要である．プレガバリンはきわめて有効な場合があり，手術が回避できた例がしばしばある．

また，手術で圧迫を解除しても神経障害性疼痛が治癒しない場合も少なくない．われわれが2007年におこなった調査では脊椎手術を受けた患者においても2割程度の患者は日常生活に支障をきたすような痛みが残存していた[10]．また腰部脊柱管狭窄症後の足底部のしびれが残りやすいことが知られており，治療満足度にも影響する[11]．腰椎椎間板ヘルニアの術後にプレガバリンを投与すると残存する痛みが緩和され治療成績が向上した報告があり[12]，手術治療をおこなう患者でも神経障害性疼痛を意識して治療に臨む必要がある．



図❶　後縦靱帯骨化症の神経障害性疼痛

2．変形性関節症における神経障害性疼痛

四肢の変形性関節症（osteoarthritis：OA）における痛みの主体は何であろうか？変性は関節軟骨の変性，磨耗からはじまるとされているが，神経終末がないため正常軟骨に痛みが生じることはない．軟骨変性から軟骨下骨の障害，それに引きつづいて生じる骨棘形成や滑膜炎が原因とされる侵害受容性疼痛と考えられており，病期によっては炎症性疼痛が主体となる．しかし近年，侵害受容性疼痛と炎症性疼痛のみではなく，神経障害性疼痛の関与があることがしだいに明らかになってきた．関節組織が障害を受けると，マクロファージやリンパ球などから各種nerve growth factorやサイトカインが放出され，神経終末の刺激に対する閾値を低下させる．こうした，いわゆる末梢性感作が脊髄後角にある痛み伝播を増幅させ修飾させると中枢性感作が生じ[6]，さらに痛みに病的に敏感な状態，すなわち神経障害性疼痛となる．高齢者の膝OAに対する調査票の研究では28％に神経障害性疼痛の要素があったとされる[7]．また，Caチャネル$\alpha_2\delta$サブユニットをブロックするプレガバリンは三環系抗うつ薬とならんで神経障害性疼痛の第一選択薬であるが，人工膝関節手術の術後投与によって痛みが緩和され治療成績が向上したことがランダム比較試験で示されている[8]．このように神経障害性疼痛は四肢関節変性疾患においても重要な病態であると認識されはじめている．

おわりに

神経障害性疼痛の代表的な疾患は線維筋痛症や複合性

局所疼痛症候群，脊髄障害性疼痛症候群であるが，運動器疾患に広くみられる病態である可能性が高くなっている．今後，運動器疾患の診療においては神経障害性疼痛を念頭に置いてあたる必要があるだろう．

文 献

1) Loeser JD *et al*：The Kyoto protocol of IASP Basic Pain Terminology. *Pain* **137**：473-477, 2008
2) Treede RD *et al*：Neuropathic pain：redefinition and a grading system for clinical and research purposes. *Neurology* **70**：1630-1635, 2008
3) 住谷昌彦ほか：痛みのマネジメント―痛みの分類と神経障害性疼痛の定義・診断・治療について―，エルゼビア・ジャパン社，Excerpta Medica 2010，pp. 1-28
4) Bouhassira D *et al*：Prevalence of chronic pain with neuropathic characteristics in the general population. *Pain* **136**：380-387, 2008
5) Jespersen A *et al*：Is neuropathic pain underdiagnosed in musculoskeletal pain conditions? The Danish PainDETECTive study. *Curr Med Res Opin* **26**：2041-2045, 2010
6) Im HJ *et al*：Alteration of sensory neurons and spinal response to an experimental osteoarthritis pain model. *Arthritis Rheum* **62**：2995-3005, 2010
7) Hochman JR *et al*：Neuropathic pain symptoms in a community knee OA cohort. *Osteoarthritis Cartilage* **19**：647-654, 2011
8) Buvanendran A *et al*：Perioperative oral pregabalin reduces chronic pain after total knee arthroplasty：a prospective, randomized, controlled trial. *Anesth Analg* **110**：199-207, 2010
9) Freynhagen R *et al*：The evaluation of neuropathic components in low back pain. *Curr Pain Headache Rep* **13**：185-190, 2009
10) 藤原奈佳子ほか：後縦靱帯骨化症の痛みとしびれの実態と痛みに影響する要因．厚生労働省特定疾患対策研究平成19年度研究報告書　脊柱靱帯骨化症に関する調査研究，2008，pp. 17-38
11) Hara N *et al*：Predictors of residual symptoms in lower extremities after decompression surgery on lumbar spinal stenosis. *Eur Spine J* **19**：1849-1854, 2010
12) Burke SM *et al*：Perioperative pregabalin improves pain and functional outcomes 3 months after lumbar discectomy. *Anesth Analg* **110**：1180-1185, 2010

Spine

SPINE Volume 36, Number 23, pp E1519–E1524
©2011, Lippincott Williams & Wilkins

DEFORMITY

Is a Right Pedicle Screw Always Away From the Aorta in Scoliosis?

Katsushi Takeshita, MD,* Toru Maruyama, MD,† Shurei Sugita, MD,* Yasushi Oshima, MD,* Jiro Morii, MD,* Hirotaka Chikuda, MD,* Takashi Ono, MD,* and Kozo Nakamura, MD*

Study Design. Retrospective analysis.

Objective. We evaluated the aorta safety in placement of a right pedicle screw in scoliotic patients.

Summary of Background Data. Past reports emphasized the aorta risk in placing pedicle screws on the concave left side in right thoracic scoliosis. However, risk on the right side has drawn limited interest.

Methods. Thirty-four scoliotic patients with an average age of 18.0 years were evaluated. The Cobb angle averaged 59.0° ± 14.0°. From computed tomographic data, we evaluated the aorta location relative to the spine at each level from T4 to L4 and simulated placement of a right pedicle screw with a direction different from the ideal trajectory. Sensitivity analysis was performed independently by variable direction errors and screw length: the maximum error of trajectory was set to 5° in the medial direction and to 5°, 10°, or 20° in the lateral direction, and a screw length was set at 40, 45 or 50 mm. We defined "aorta-at-risk" when a patient has some level where a simulated pedicle screw involves the aorta, and compared the curve characteristics (the apical vertebral translation, the Cobb angle and the Nash-Moe grade) between the aorta-at-risk cases and the aorta-no-risk cases.

Results. In left thoracic or lumbar curves, the aorta often resided in front of right pedicles at the periapical level. In a scenario of a simulated pedicle screw with a maximum error of 20° in the lateral direction and a screw length of 50 mm, the aorta was at risk in 7 (33%) of 21 left lumbar curves. Curve characteristics of the aorta-at-risk cases at L1 were a larger apical vertebral translation ($P = 0.003$), a larger Cobb angle ($P = 0.006$), and a larger Nash-Moe grade ($P = 0.017$) compared with those of the aorta-no-risk cases.

Conclusion. Surgeons need to pay attention to the position of the aorta in placing a pedicle screw on the right at the periapical level of a left curve either in thoracic or lumbar spine.

Key words: scoliosis, aorta, pedicle, screw. **Spine 2011;36: E1519–E1524**

From the *Department of Orthopaedic Surgery, the University of Tokyo, Tokyo, Japan; †Department of Orthopaedic Surgery, the Saitama Medical Center, Saitama, Japan.

Acknowledgment date: April 7, 2010. First revision date: September 6, 2010. Second revision date: December 22, 2010. Acceptance date: January 8, 2011.

The manuscript submitted does not contain information about medical device(s)/drug(s).

No funds were received in support of this work. No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

Correspondence and reprint requests to Katsushi Takeshita, MD, Department of Orthopaedic Surgery, Faculty of Medicine, The University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, Tokyo 113-8655, Japan; E-mail: Takeshita-ort@h.u-tokyo.ac.jp

DOI: 10.1097/BRS.0b013e31820f8e6b

One of the disadvantages of a pedicle screw is the possibility of aorta involvement. The aorta is located on the left side of the thoracic spine and stays in front of the lumbar spine in normal subjects,[1] and past reports emphasized the aorta risk in placing a screw on the concave side, which is usually left in right thoracic scoliosis.[2,3] On the contrary, risk on the right side in scoliosis has drawn limited interest. The purpose of this study was to evaluate the safety of the aorta in placement of a right pedicle screw in scoliosis surgery.

MATERIALS AND METHODS

A total of 34 patients with scoliosis were evaluated after excluding congenital scoliosis and soft-tissue related disease such as Marfan syndrome. The average age at a computed tomographic examination was 18.0 years (range = 10–30), and there were 4 males and 30 females. Scoliosis was idiopathic in 30 patients, Chiari-syrinx in 2, multiple epiphyseal dysplasia in 1, and Noonan syndrome in 1. There were 29 thoracic curves and 24 lumbar curves, and the Cobb angle averaged 59.0° ± 14.0° (28° to 100°; Table 1).

Computed tomography (CT) was taken for surgical planning with a thickness of 1.25 mm, and data were transferred to a personal computer for analysis (ExaView LITE: Ziosoft, Tokyo, Japan). In the thoracic spine, we selected the middle of the base of the right superior facet where a pedicle screw is placed as the point of origin of the coordinate system (Figure 1A). A line connecting both of the middle points of bases of the superior facets was defined as the X-axis. In the lumbar spine, we drew a line between both the medial edges of superior facets as the X-axis (Figure 1B). The Y-axis was drawn perpendicular to the X-axis starting from the dorsal edge of the right superior facet. In thoracic and lumbar spine, the angle formed by the Y-axis and a line connecting the origin and the center of the aorta was defined as the right pedicle-aorta angle, and length of a line connecting the origin and the edge of the aorta as the right pedicle-aorta distance. From the repeatability test in our

TABLE 1. Properties of Scoliosis

ID	Diagnosis	Age (yr)	Sex	Th Side	Th Cobb (degrees)	Th Apx	L Side	L Cobb (degrees)	L Apx
8	idio	17	F	R	53	T9	n.d.	n.d.	n.d.
11	idio	19	F	R	63	T10	n.d.	n.d.	n.d.
12	idio	19	F	R	83	T9	n.d.	n.d.	n.d.
13	idio	20	F	R	51	T7	L	28	L1/2
14	idio	16	F	n.d.	n.d.	n.d.	R	50	L1
15	idio	19	F	R	57	T8	L	49	L2
19	idio	29	F	n.d.	n.d.	n.d.	L	71	L1
21	idio	12	F	R	87	T9/T10	n.d.	n.d.	n.d.
23	idio	17	F	R	57	T8	L	62	L2
24	Chiari	15	F	R	62	T4/T5	L	88	L1/2
26	idio	16	F	R	54	T7/T8	L	54	L2
27	idio	16	F	R	52	T8/T9	L	42	L2
28	idio	20	F	R	54	T7	L	37	L2
29	idio	18	M	R	50	T8/T9	L	31	L2
30	idio	18	F	R	58	T9	n.d.	n.d.	n.d.
32	idio	13	F	R	58	T8/T9	L	40	L2
33	idio	11	F	L	79	T5	R	100	L1
34	Chiari	12	M	R	52	T8/T9	L	65	L4
35	idio	29	F	R	54	T8	L	67	L2
37	idio	15	F	R	68	T9	n.d.	n.d.	n.d.
39	idio	19	F	R	57	T10	n.d.	n.d.	n.d.
40	idio	23	F	R	63	T9/T10	n.d.	n.d.	n.d.
41	idio	10	F	R	61	T10	L	35	L3
44	Noonan	23	F	R	78	T9	n.d.	n.d.	n.d.
46	idio	13	M	R	83	T9/T10	L	63	L2/3
48	MED	16	M	R	62	T9	L	42	L2/3
49	idio	21	F	n.d.	n.d.	n.d.	L	56	L1
50	idio	19	F	L	63	T5	R	64	T12
51	idio	17	F	R	66	T7	L	67	L1
53	idio	30	F	n.d.	n.d.	n.d.	L	55	L2
54	idio	13	F	R	57	T8	L	55	L2
56	idio	29	F	R	50	T7	L	55	L3
57	idio	16	F	R	58	T9	n.d.	n.d.	n.d.
58	idio	13	F	n.d.	n.d.	n.d.	L	60	L3

Dx indicates diagnosis of scoliosis; idio, idiopathic; L side, convex side of a lumbar curve; L Cobb, Cobb angle of a lumbar curve; L Apx, apex level of a lumbar curve; MED, multiple epiphyseal dysplasia; n.d., not deformed; T side, convex side of a thoracic curve; T Cobb, Cobb angle of a thoracic curve; T Apx, apex level of a thoracic curve.

previous study,[4] interclass correlation coefficients were 0.922 to 0.957 in the intraobserver measurement and 0.896 to 0.929 (0.864–0.961) in the interobserver measurement.

We evaluated the location of the aorta relative to the spine at each level from T4 to L4 and simulated placement of a right pedicle screw with a direction different from the ideal

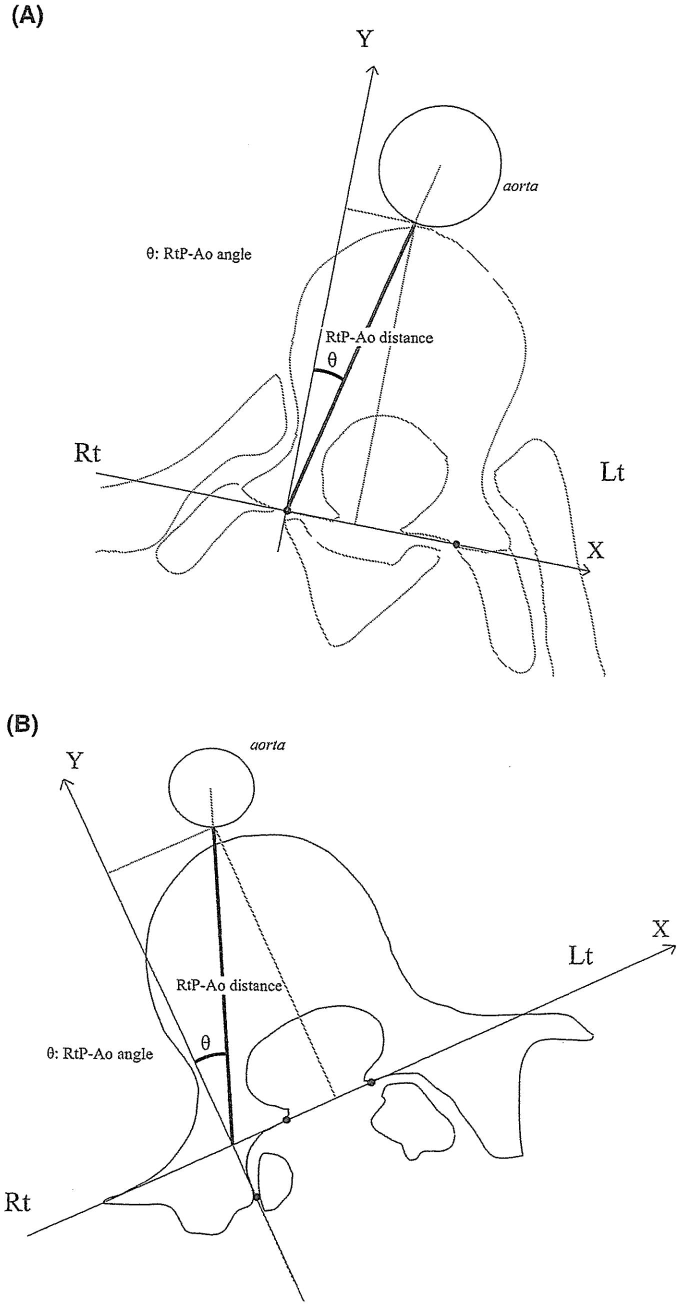


Figure 1. Measurement of two aorta parameters: right pedicle-aorta distance (Rt P-Ao distance) and right pedicle-aorta angle (Rt P-Ao angle). A, Schematic drawing in a thoracic curve. The origin was set at the middle point of the base of a right superior facet, and the X-axis was determined by connecting the middle point of the base of a left superior facet and the origin. B, Schematic drawing in a lumbar curve. The X-axis was determined first by connecting both the medial edges of the superior facets; the Y-axis was drawn perpendicular to the X-axis from the dorsal edge of a left superior facet, and the origin was determined.

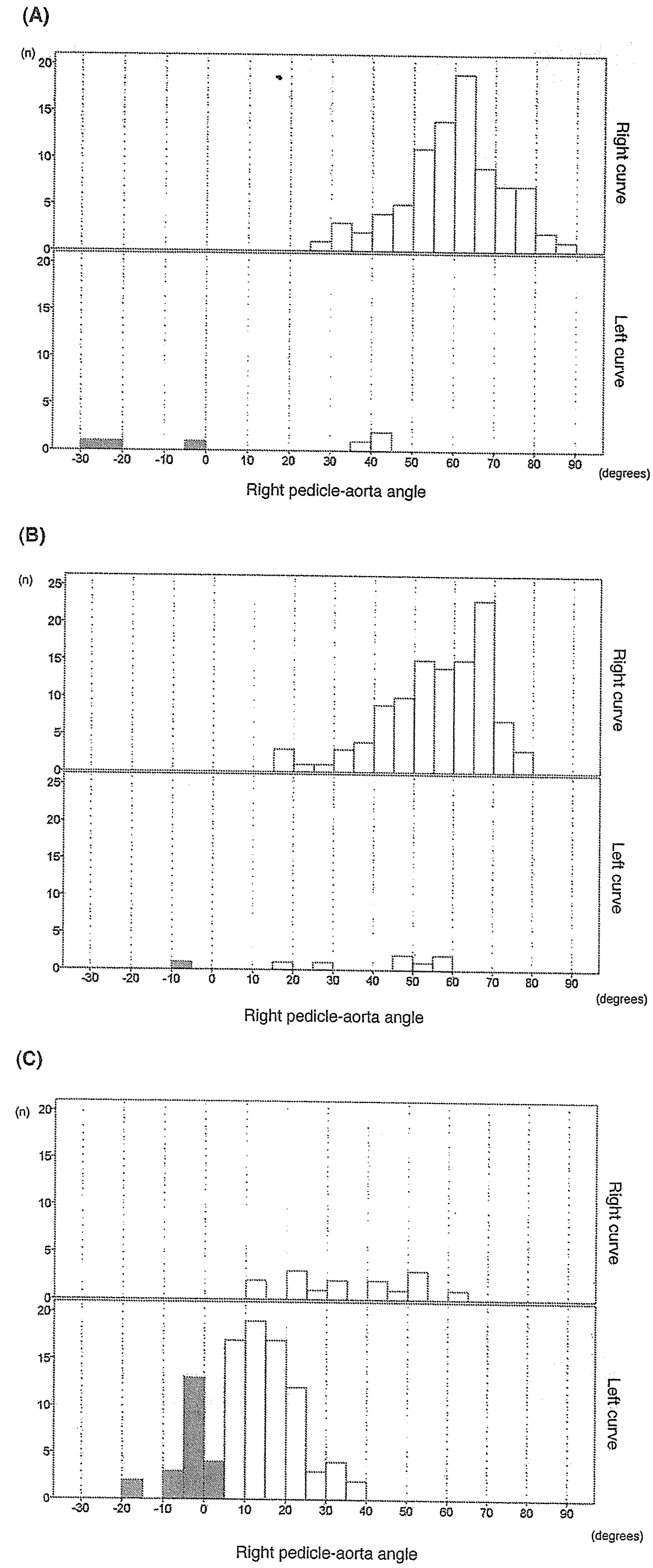


Figure 2. Distribution of right pedicle-aorta angles at 385-spine level. Bar is shaded if a right pedicle-aorta angle was below 5°. A, Histogram at T4 to T7. Upper: right curves, lower: left curves. B, Histogram at T8 to T11. Upper: right curves, lower: left curves. C, Histogram at T12 to L4. Upper: right curves, lower: left curves.

trajectory. Sensitivity analysis was performed by variable direction errors and a screw length independently. We defined "aorta-at-risk" when a patient has some level where the simulated pedicle screw involves the aorta. As preliminary analysis had shown that the aorta-at-risk level was observed mostly in the lumbar spine, the maximum error of trajectory was set to

TABLE 2. Distribution of the Aorta-At-Risk Cases With Left Lumbar Curves in Simulated Scenarios

Angle (degree)	Length (mm)	Level	T4 to T11	T12	L1	L2	L3	L4
		Total	147	21	21	21	20	13
5	40	%	0	0	0	0	0	0
		No	0	0	0	0	0	0
5	45	%	0	0	14	5	0	0
		No	0	0	3	1	0	0
5	50	%	0	5	24	29	10	0
		No	0	1	5	6	2	0
10	40	%	0	0	0	0	0	0
		No	0	0	0	0	0	0
10	45	%	0	0	14	10	0	0
		No	0	0	3	2	0	0
10	50	%	0	5	29	33	10	0
		No	0	1	6	7	2	0
20	40	%	0	5	5	0	0	0
		No	0	1	1	0	0	0
20	45	%	0	5	19	10	0	0
		No	0	1	4	2	0	0
20	50	%	0	10	33	33	10	0
		No	0	2	7	7	2	0

The maximum error of medial trajectory of a pedicle screw was 5° in all scenarios.

Angle indicates the maximum error of lateral trajectory of a pedicle screw; Length, simulated screw length; No, number of the aorta-at-risk cases.

5° in the medial direction and to 5°, 10°, or 20° in the lateral direction, and the length of the screw was set at 40, 45 or 50 mm. We compared the curves between the aorta-at-risk cases and the aorta-no-risk cases. Analyzed curve characteristics were the apical vertebral translation (AVT), the Cobb angle and the Nash-Moe grade.

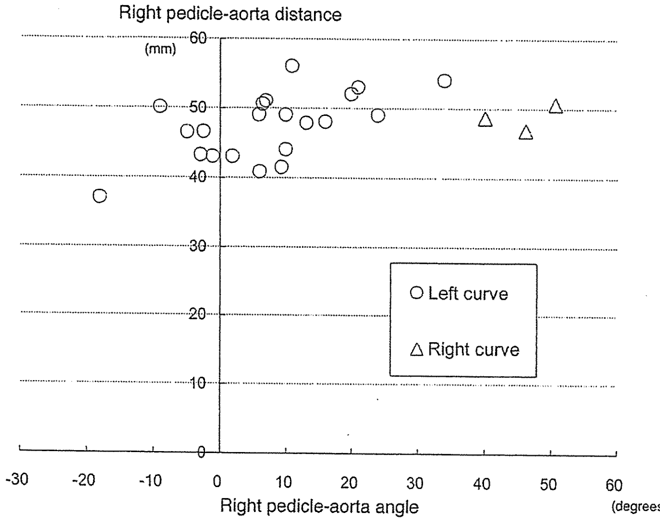


Figure 3. Scatter graph of the aorta location at 1st lumbar level. A circle denotes a case with a left lumbar curve and a triangle denotes a case with a right lumbar curve.

RESULTS

A total of 385 spines were evaluated to locate the aorta position relative to the spine. The aorta often resided in front of a right pedicle at periapical level in left curves (Figure 2). The number of levels where the right pedicle-aorta angle was below 5° was 1 of 2 left thoracic curves and 7 (33%) of 21 left lumbar curves (Table 2). On the contrary, there was no level where the right pedicle-aorta angle was below 5° in 27 right thoracic curves and in three right lumbar curves.

Distribution of the aorta-at-risk cases in nine simulated scenarios indicated that a simulated pedicle screw with a length of 50 mm at L1 or L2 posed potential risk (24%–44%) irrespective of trajectory errors among patients with left lumbar curves (Table 3). Curve characteristics of the aorta-at-risk cases at L1 (Figure 3) were a larger AVT ($P = 0.003$), a larger Cobb angle ($P = 0.006$), and larger Nash-Moe grade ($P = 0.017$) compared with those of the aorta-no-risk cases. AVT, the Cobb angle and Nash-Moe grade were highly correlated with each other: correlative coefficient was 0.814 ($P = 0.000$) between AVT and the Cobb angle, 0.737 ($P = 0.000$) between AVT and Nash-Moe grade, and 0.602 ($P = 0.004$) between the Cobb angle and Nash-Moe grade.

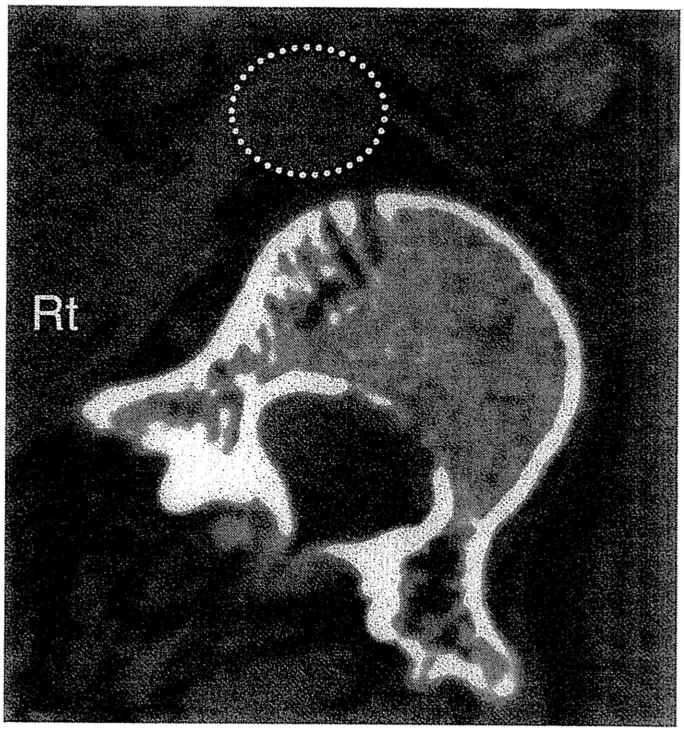
TABLE 3. Past Reports of Aortic Abutment by Thoracic Pedicle Screws Analyzed by Computed Tomography in Patients With Scoliosis

First Author	No. of patients	Follow-up Period (months)	No. of Pedicle Screws	No. of Screw with Aorta Abutment	Left /Right
Liljenqvist[6]	32	na	110	1 (0.9%)	1/0
Smorgick[7]	25	na	112	2 (1.8%)	2/0
Sarlak[8]	19	35.9	185	7 (3.8%)	na*
Total	76		1442	13 (2.5%)	3/0

na indicates not available.

**Reported with convex/concave. One screw of 7 screws was at the convex side.*

(A)



(B)

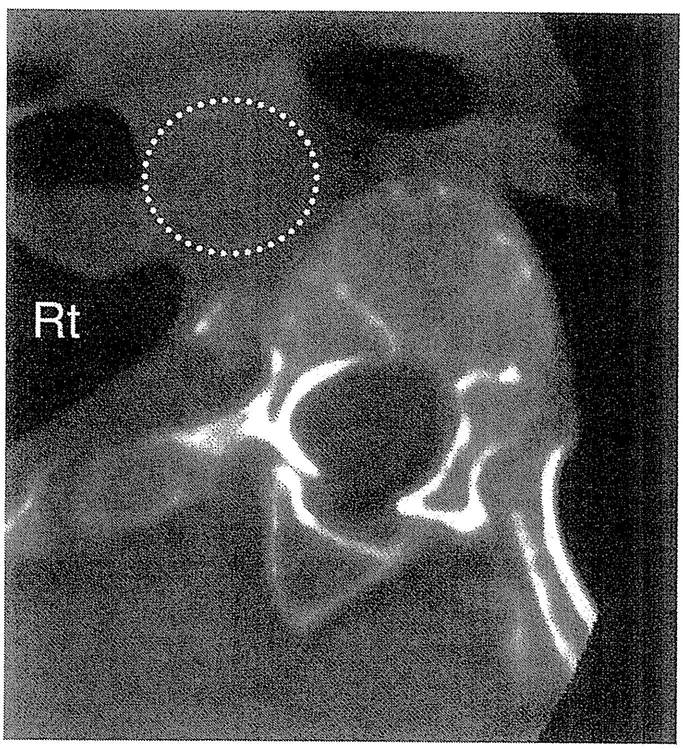


Figure 4. Representative cases in which the aorta resided laterally to the right of the spine. Dotted line circles the aorta. **A,** A 1st lumbar level in a left 88° lumbar curve. **B,** A 6th thoracic level in a left 100° thoracic curve.

DISCUSSION

We investigated lumbar curves in addition to thoracic curves, and found that the aorta moved to the right side of the vertebral body in a left curve, and the safety of the aorta from a long pedicle screw decreased either in the thoracic spine or in the lumbar spine. In a case with a large left curve, the aorta shifted to the right lateral side of the vertebral body, and a lateral deviation from an ideal trajectory could result in aorta indentation even by a pedicle screw of a moderate length (Figure 4).

Many spine surgeons prefer to use pedicle screws in thoracic or lumbar spine because of its easiness of placement inside the bony structure and its sound capability in correction and stabilization. However, Kakkos and Shepard[5] reviewed the delayed aorta injury by pedicle screws in five patients including three deformity cases. They stated, "The true incidence of this complication is probably under-reported" in their conclusion. We found three past studies,[6–8] which analyzed thoracic curves exclusively by computed-tomography postoperatively (Table 3), and the aorta involvement in 6 (2.5%) of the 1442 screws is substantial. Though the true risk of aortic abutment is unknown, a screw will stay just next to the aorta in such a young generation and it is impractical to monitor such patients closely for over tens of years. In fact, 6 of 76 patients of the past three reports had reoperation.

The aorta resides on the left side of the normal thoracic spine,[1] and past reports dealt with a thoracic pedicle screw on the concave side which is usually the left side of the thoracic curve.[2,3,7] In scoliosis, a three-dimensional spinal deformity changes the spatial relationship between the aorta and the spine depending on the severity of scoliosis, and the aorta might resides on the right side of a vertebral body. Only one past report by Milbrandt and Sucato[9] discussed the aorta risk on the right side. They analyzed left thoracic scoliosis and stated "the aorta was in a high-risk position for a (right) posterior screw that exit the lateral border of the pedicle or body in the largest curve of our series." Our present study confirmed the aorta risk by a right pedicle screw in left thoracic or lumbar scoliosis. We believe a deliberate planning by multiplanar reconstructed images of multidetector-CT is most crucial to prevent an annoying situation. Moreover, we prefer to use a computer-navigation system by preoperative CT for safe placement of pedicle screws.

Judging from high correlations between curve characteristics and the aorta risk in the present study, surgeons need to pay attention to the position of the aorta in placing a pedicle screw on the right in a left curve either in a thoracic or lumbar spine.

Key Points:

- The aorta is often located in front of right pedicles at the periapical level in left thoracic or lumbar curves.
- Curve characteristics of the aorta-at-risk cases were a larger apical vertebral translation, a larger Cobb angle, and a larger Nash-Moe grade.
- Surgeons need to pay attention to the position of the aorta in placing a pedicle screw on the right at the periapical level of a left curve either in thoracic or lumbar spine.

References

1. Moore KL. The thoracic and abdominal aorta. In: Moore KL, ed. *Clinically Oriented Anatomy*. 6th ed. Baltimore, MD: Williams & Wilkins; 2010:167–313.
2. Sucato DJ, Duchene C. The position of the aorta relative to the spine: a comparison of patients with and without idiopathic scoliosis. *J Bone Joint Surg Am* 2003;85-A:1461–9.
3. Takeshita K, Maruyama T, Ono T, et al. New parameters to represent the position of the aorta relative to the spine for pedicle screw placement. *Eur Spine J* 2010;19:815–20.
4. Takeshita K, Maruyama T, Chikuda H, et al. Diameter, length, and direction of pedicle screws for scoliotic spine—analysis by multiplanar reconstruction of computed tomography. *Spine* 2009;34:798–803.
5. Kakkos SK, Shepard AD. Delayed presentation of aortic injury by pedicle screws: report of two cases and review of the literature. *J Vasc Surg* 2008;47:1074–82.
6. Liljenqvist UR, Halm HF, Link TM. Pedicle screw instrumentation of the thoracic spine in idiopathic scoliosis. *Spine* 1997;22:2239–45.
7. Smorgick Y, Millgram MA, Anekstein Y, et al. Accuracy and safety of thoracic pedicle screw placement in spinal deformities. *J Spinal Disord Tech* 2005;18:522–6.
8. Sarlak AY, Tosun B, Atmaca H, et al. Evaluation of thoracic pedicle screw placement in adolescent idiopathic scoliosis. *Eur Spine J* 2009;18:1892–7.
9. Milbrandt TA, Sucato DJ. The position of the aorta relative to the spine in patients with left thoracic scoliosis: a comparison with normal patients. *Spine* 2007;32:E348–53.

Spine

SPINE Volume 36, Number 18, pp 1453–1458
©2011, Lippincott Williams & Wilkins

CERVICAL SPINE

Acute Cervical Spinal Cord Injury Complicated by Preexisting Ossification of the Posterior Longitudinal Ligament

A Multicenter Study

Hirotaka Chikuda, MD, PhD,* Atsushi Seichi, MD, PhD,† Katsushi Takeshita, MD, PhD,* Shunji Matsunaga, MD, PhD,‡ Masahiko Watanabe, MD, PhD,§ Yukihiro Nakagawa, MD, PhD,¶ Kazuya Oshima, MD, PhD,|| Yutaka Sasao, MD, PhD,** Yasuaki Tokuhashi, MD, PhD,†† Shinnosuke Nakahara, MD,‡‡ Kenji Endo, MD, PhD,§§ Kenzo Uchida, MD, PhD,¶¶ Masahiko Takahata, MD,|||| Toru Yokoyama, MD,*** Kei Yamada, MD, PhD,††† Yutaka Nohara, MD,‡‡‡ Shiro Imagama, MD,§§§ Hideo Hosoe, MD,¶¶¶ Hiroshi Ohtsu, MS,|||||| Hiroshi Kawaguchi, MD, PhD,* Yoshiaki Toyama, MD, PhD,**** and Kozo Nakamura, MD, PhD,*

Study Design. Retrospective multicenter study.

Objective. To review the clinical characteristics of traumatic cervical spinal cord injury (SCI) associated with ossification of the posterior longitudinal ligament (OPLL).

Summary of Background Data. Despite its potentially devastating consequences, there is a lack of information about acute cervical SCI complicated by OPLL.

Methods. This study included consecutive patients with acute traumatic cervical SCI (Frankel A, B, and C) who were admitted within 48 hours of injury to 34 spine institutions across Japan. For analysis of neurologic outcome, patients who had completed at least a 6-month follow-up were included. Neurologic improvement was defined as at least one grade conversion in Frankel grade.

Results. A total of 453 patients were identified (367 men, 86 women; mean age, 59 years). OPLL was found in 106 (23%) patients (87 men, 19 women; mean age, 66 years). Most of the patients with OPLL (94 of 106) were without bone injury, presenting with incomplete SCI. The prevalence of OPLL reached 34% in SCI without bone injury. The cause of SCI was predominantly falls (74%). Only 25% of the patients were aware of OPLL. Half of the OPLL patients reported gait disturbance before injury. Forty-eight (52%) OPLL patients without bone injury underwent surgery (median, 13.5 days after injury), mostly laminoplasty. Overall, no significant difference was noted in neurologic improvement between surgery group and conservative group. However, further stratification showed that surgery was associated with greater neurologic recovery in patients who had gait disturbance before injury ($P = 0.04$).

Conclusion. Prevalence of OPLL among cervical SCI was alarmingly high, especially in those without bone injury. Most of cervical SCI associated with OPLL were incomplete, without bone injury, and caused predominantly by low-energy trauma. The majority of the patients were unaware of OPLL. Surgery produced better neurologic recovery in patients who had gait disturbance before injury.

From the *Department of Orthopaedic Surgery, Faculty of Medicine, the University of Tokyo, Tokyo, Japan; †Department of Orthopaedics, Jichi Medical University, Tochigi, Japan; ‡Department of Orthopaedic Surgery, Imakiire General Hospital, Kagoshima, Japan; §Department of Orthopaedic Surgery Surgical Science Tokai University School of Medicine, Kanagawa, Japan; ¶Department of Orthopaedic Surgery, Wakayama Medical University, Wakayama, Japan; ||Department of Orthopaedic Surgery, Osaka University Graduate School of Medicine, Osaka, Japan; **Department of Orthopeadic Surgery, St. Marianna School of Medicine, Kanagawa, Japan; ††Department of Orthopaedic Surgery, Nihon University School of Medicine, Tokyo, Japan; ‡‡Department of Orthopaedic Surgery, National Okayama Medical Center, Okayama, Japan; §§Department of Orthopedic Surgery, Tokyo Medical University, Tokyo, Japan; ¶¶Department of Orthopaedics and Rehabilitation Medicine, Fukui University Faculty of Medical Sciences, Fukui, Japan; ||||Department of Orthopaedic Surgery, Graduate School of Medicine, Hokkaido University, Hokkaido, Japan; ***Department of Orthopaedics Surgery, Hirosaki University Graduate School of Medicine, Aomori, Japan; †††Department of Orthopaedic Surgery, Kurume University, Fukuoka, Japan; ‡‡‡Department of Orthopaedic Surgery, Dokkyo Medical University, Tochigi Japan;, §§§Department of Orthopaedic Surgery, Nagoya University Graduate School of Medicine, Aichi, Japan; ¶¶¶Department of Orthopaedic Surgery, Gifu University School of Medicine, Gifu, Japan; ||||||Department of Clinical Trial Data Management, Graduate School of Medicine, the University of Tokyo, Tokyo, Japan; and ****Departments of Orthopaedic Surgery, School of Medicine, Keio University, Tokyo, Japan.

Acknowledgment date: March 30, 2010. Revision date: July 19, 2010. Acceptance date: July 20, 2010.

The manuscript submitted does not contain information about medical device(s)/drug(s).

No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

This study was performed with the aid of the Investigation Committee on the Ossification of the Spinal Ligaments of the Japanese Ministry of Health, Labor and Welfare.

Address correspondence and reprint requests to Hirotaka Chikuda, MD, PhD, Department of Orthopaedic Surgery, Faculty of Medicine, the University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8655, Japan; E-mail: chikuda-tky@umin.ac.jp

DOI: 10.1097/BRS.0b013e3181f49718

Key words: canal stenosis, myelopathy, ossification of the posterior longitudinal ligament, patient awareness, spinal cord injury, surgery, trauma, treatment. **Spine 2011;36:1453–1458**

Ossification of the posterior longitudinal ligament (OPLL) affects about 2% of Japanese[1,2] and is a major cause of cervical canal stenosis in Japan. Although individuals with OPLL often remain asymptomatic, chronic cord compression may lead to myelopathy, especially in those with severe canal compromise.

OPLL is also known to predispose these individuals to severe neurologic deterioration after trauma. Despite its potentially devastating consequences, there is a lack of information about acute cervical spinal cord injury (SCI) complicated by OPLL. Except for a few case series, reports on this subgroup of SCI patients remain largely anecdotal.[3,4] The prevalence of OPLL among patients with acute cervical SCI has not been determined, and the clinical characteristics of SCI patients with OPLL remain unclear as well. In particular, little attention has been paid to a patient's status before injury such as his or her awareness of OPLL. In addition, optimum treatment of SCI complicated by OPLL remains controversial; a dilemma reflected by the wide variations in current treatment options, ranging from emergency surgery to conservative treatment. Although surgical decompression is widely believed to have a beneficial role for those with persistent cord compression, there is no comparative study supporting this hypothesis.

Here, we conducted a retrospective multicenter study to determine the prevalence of OPLL among cervical SCI and clarify the clinical characteristics of SCI patients with OPLL, and further evaluated the efficacy of surgical treatment.

MATERIALS AND METHODS

This multicenter study was conducted by a Research Group for Ossification of the Spinal Ligament sponsored by the Japanese Ministry of Health, Labor and Welfare. This study included all consecutive patients with acute traumatic cervical SCI (Frankel A, B, and C) who were admitted within 48 hours of injury from January 2000 to June 2006. Thirty-four institutions to which the members of the research group belong joined this study. Severity of SCI was assessed by Frankel grade classification.[5] Presence of OPLL was confirmed using plain radiographs or computed tomography (CT). On the basis of the criteria established by the Japanese Ministry of Public Health and Welfare, OPLL was classified into the following types: continuous, segmental, localized, and mixed.[6] The maximum percentage of spinal canal stenosis was evaluated using plain radiographs as previously reported.[7]

To assess patients' medical status at admission and complications after the injury, we consulted medical charts and nursing summaries. Complications that occurred within 1 month after injury were included in this study. The charts were also evaluated for patient status before injury including awareness of OPLL and preexisting gait disturbance. For analysis of neurologic recovery, patients who had completed a 6-month follow-up were included.

Neurologic improvement was defined as one grade or greater improvement in Frankel grade. The ratio of patients who achieved neurologic improvement was calculated. Patients were stratified by whether they had gait disturbance before injury.

Continuous variables were compared using Student t test or Dunnett test, and categorical data were analyzed using the χ^2 test. Fisher exact test was used when appropriate. All statistics were calculated using SPSS, version 13.0 (SPSS Inc, Chicago, IL). Values were considered statistically significant for P less than 0.05.

RESULTS

A total of 453 patients were initially identified (Table 1), including 367 men and 86 women with a mean age of 59 years. OPLL was found in 106 patients (87 men, 19 women; mean age: 66 years), accounting for 23% of all patients. Peak incidence of SCI in patients with OPLL occurred between 70 and 75 years of age, and about 80% of OPLL-associated SCI patients (85 of 106) were classified as incomplete. Of the 453 patients, 274 (60%) were without bone injury, such as fracture or dislocation, and nearly 90% of the patients with OPLL (94 of 106) were also without bone injury. The prevalence of OPLL was 34% among this subgroup of patients.

Clinical characteristics of SCI patients with OPLL were further examined (Table 2). The primary cause of SCI in OPLL patients was predominantly falls, followed by motor vehicle accidents. Influence of alcohol use was reported in 19 patients (18%). Of note, among patients who were aware of OPLL, only one was under the influence of alcohol at the time of injury. Concurrent fractures at other sites or visceral organ injuries were relatively rare in this subgroup of SCI patients. Only 25% of patients were aware of OPLL before their injury, and even fewer patients (17%) were regularly visiting a physician

TABLE 1. Characteristics of Enrolled Patients

	SCI With OPLL	SCI Without OPLL	Total
No. (% of total) of patients	106 (23%)	347	453
Sex (men/women)	87/19	280/67	367/86
Mean age at injury (yrs, mean ± SD)	66.2 ± 11.5*	57.0 ± 18.6	59.2 ± 17.6
Frankel grade at admission			
A	21	125	146
B	29	76	105
C	56	146	202
SCI without fracture or dislocation (%)	94 (34%)	180	274

**Between-group difference was significant (P < 0.01).*

SCI indicates spinal cord injury; OPLL, ossification of the posterior longitudinal ligament; SD, standard deviation.

TABLE 2. Clinical Characteristics of SCI Patients With OPLL

	SCI Patients With OPLL (n = 106)
Cause of SCI	
Falling (% of total)	78 (74%)
Falling on one's rear	9
Falling on a flat surface	42
Falling down stairs	16
Falling from a height	11
Motor vehicle accident	19
Sports-related	3
Not specified	6
Alcohol involvement (% of total)	19 (18%)
Concurrent fracture at other site	4
Concurrent visceral organ injury	2
Awareness of OPLL before injury (% of total)	26 (25%)
Regular doctor visit for OPLL (% of total)	18 (17%)
Gait disturbance before injury (% of total)	47 (44%)

SCI indicates spinal cord injury; OPLL, ossification of the posterior longitudinal ligament.

TABLE 3. Characteristics and Complications* of OPLL Patients Without Bone Injury

	Surgery Group (n = 48)	Conservative Group (n = 46)
Age (yrs; mean [SD])	64 (10)	68 (13)
Sex (men/women)	38/10	40/6
Severity of SCI (no. of patients [%])		
Complete	8 (17)	8 (17)
Incomplete	40 (83)	38 (83)
Maximum canal stenosis (%; mean [SD])	46 (13)	46 (14)
Corticosteroid (no. of patients [%])	29 (60)	39 (85)†
Complications		
Tracheotomy	7 (15)	6 (13)
Pneumonia	9 (19)	11 (24)
Sepsis	2 (7)	3 (7)
Gastrointestinal bleeding	3 (6)	2 (4)
Urinary tract infection	8 (17)	13 (28)
Wound infection	3 (6)	2 (4)

**Complications occurring within 1 month of injury were included.*

†significantly higher in conservative group ($P < 0.01$); continuous variables were compared using Student t test; categorical data were analyzed using Fischer exact test.

for OPLL at the time of injury. Approximately half of patients (44%) reported preexisting gait disturbance of varying degrees.

On radiographic evaluation, ossification type was found to be continuous in 46 patients, mixed in 38, segmental in 12, localized in 5, and unclassified in 5. Mean maximum percentage of spinal canal stenosis was 46 ± 13% (mean ± SD; range: 19%–85%). No significant difference was noted in maximal canal compromise between Frankel grade groups at admission (Dunnett test).

We also evaluated the use of corticosteroids for treatment of SCI. Of the 106 SCI patients with OPLL, 76 (72%) received intravenous administration of corticosteroids. The Second National Acute Spinal Cord Injury Study protocol[8] was applied in 57 patients, whereas intermittent administration of a lower dosage was performed in the remaining 19. Complications associated with intravenous corticosteroid administration were reported in 10 patients, including gastrointestinal bleeding or ulcer in 6, pulmonary complications in 2, and wound infection and exacerbation of diabetes mellitus in 1 each.

We then examined the efficacy and safety of surgical treatment, focusing on patients without bone injury (Table 3). Of the 94 patients in this category, 48 (52%) underwent surgery (median: 13.5 days after injury) whereas the remaining 46 received some form of nonoperative treatment. Clinical characteristics of the two groups were comparable with regard to age, sex, maximum canal stenosis, and severity of SCI. Most of the surgery group patients (43 of 48) received laminoplasty. The conservative group was more likely to receive intravenous corticosteroids ($P < 0.01$). No significant difference was noted in documented complications between the surgery and conservative groups.

Neurologic improvement was then examined in patients who had completed at least 6 months of follow-up (Table 4). Overall, 72 of the 106 patients with OPLL underwent follow-up at 6 months postinjury. Of the 94 OPLL patients presented with SCI without bone injury, 64 (68%) were followed up for at least 6 months after injury (mean: 25 months; range: 6–27 months). Of these 64 patients, 41 showed neurologic recovery at follow-up, as defined by one grade or greater improvement in Frankel grade. No significant difference was noted in neurologic improvement between the surgery and conservative groups (surgery group: 71%, conservative group: 52%; $P = 0.13$).

We then stratified patients according to presence or absence of gait disturbance before injury (Table 5). In this preplanned analysis, surgery was associated with better neurologic recovery in those who had gait disturbance before injury (surgery group: 82%, conservative group: 44%; $P = 0.04$).

DISCUSSION

Our study had three major findings. First, we found an alarmingly high prevalence of OPLL among cervical SCI, particularly in those without bone injury. Second, we also identified

TABLE 4. Neurological Outcome of OPLL Patients Without Bone Injury*

Surgery (n = 41)						Conservative (n = 23)					
	Grade at follow-up						Grade at follow-up				
	A	B	C	D	E		A	B	C	D	E
Grade at admission						Grade at admission					
A	3	2	2			A	3			1	
B		3	5	4	1	B			1	2	
C		1	5	11	4	C		2	6	8	

Frankel grade was used as outcome measure.

**Patients who had completed at least 6 mo of follow-up were included.*

the clinical characteristics of these patients: most of cervical SCI associated with OPLL were incomplete, without bone injury, and caused primarily by low-energy trauma. The vast majority of patients were elderly and unaware of OPLL. Last, we also found that surgery was associated with greater neurologic recovery than conservative treatment in patients who had gait disturbance before injury.

In this study, we focused on patients who had lost ambulatory ability immediately after injury (Frankel A, B, and C). From a practical point of view, traumatic SCI is intellectually indistinguishable from aggravation of preexisting myelopathy in individuals with OPLL, particularly when presented with mild symptoms. Our sample of more than 100 patients with OPLL represents the largest study of its subject matter ever reported.

OPLL was found to be highly prevalent in patients with acute traumatic cervical SCI: in particular, OPLL was found in 34% of cervical SCI patients without bone injury. Our findings underscore the important role of OPLL in occurrence of acute traumatic cervical SCI. In line with our present finding, Koyanagi *et al*[9] also previously reported that OPLL was highly prevalent (38%) in SCI patients without bone injury. The prevalence of OPLL among cervical SCI patients appears to be increasing because prevalence values reported in earlier studies have historically been less than 10%.[3,10]

TABLE 5. Neurological Outcome of Patients Stratified by Presence of Gait Disturbance Before Injury*

Patients who had gait disturbance before injury (n = 31)

Surgery (n = 19)					Conservative (n = 12)				
	Grade at follow-up					Grade at follow-up			
	A	B	C	D/E		A	B	C	D
Grade at admission					Grade at admission				
A	3	1	1		A	2			1
B		3	1	2	B				2
C		1	1	6	C		2	2	3

Patients without gait disturbance before injury (n = 31)

Surgery (n = 22)					Conservative (n = 9)				
	Grade at follow-up					Grade at follow-up			
	A	B	C	D		A	B	C	D
Grade at admission					Grade at admission				
A		1	1		A	1			
B			4	3	B			1	
C			4	9	C			4	3

Frankel grade was used as outcome measure.

**Patients who had completed at least 6 mo of follow-up were included.*

We also sought to clarify the clinical characteristics of SCI patients with OPLL. The majority of such patients were elderly with the peak incidence in those occurring between 70 and 75 years of age. Most of these patients were without bone injury and presented with incomplete SCI. Concomitant injuries were relatively rare, and the primary cause of SCI was minor trauma, such as a fall (74%). Patients suffered severe neurologic deficit after experiencing even subtle trauma such as falling from a standing height or falling onto one's rear, underscoring the fact that individuals with OPLL are extremely vulnerable to trauma.

Despite its potential role in preventing SCI, patient awareness of OPLL has not been fully investigated. We found that the vast majority of SCI patients with OPLL were unaware of OPLL before injury. An earlier study has suggested that once patients are made aware of OPLL and its potential risk, they are expected to more carefully avoid high-risk behaviors such as walking on a slippery slope or drinking too much alcohol.[7] Indeed, in this study, SCI associated with alcohol ingestion was significantly decreased when patients had been made aware of OPLL. This finding underscores the importance of patient awareness and indicates the effectiveness of patient education in reducing cervical SCI in those with OPLL.

The efficacy of decompressive surgery in treating cervical SCI remains controversial,[11,12] particularly in patients without bone injury. Some authors recommend surgery for patients with preexisting canal stenosis, as persistent cord compression may hinder neurologic improvement.[13–15] In contrast, other researchers have reported no additional benefit with surgery in comparison to conservative treatment.[16,17]

In this study, we evaluated the safety and efficacy of surgical treatment in patients with OPLL. Most of the surgeries we conducted here were classified as "late surgery," with a median interval of 2 weeks from injury to surgery. The surgery and conservative groups were comparable with regard to age, maximum canal compromise, and initial severity of neurologic injury (Table 3), and both groups had similar rates of complications. Overall, no significant difference was noted between the groups in neurologic recovery as defined by improvement in Frankel grade (surgery group: 71%, conservative group: 52%). However, further stratification showed that surgery was associated with better neurologic recovery in those who had gait disturbance before injury (surgery group: 82%, conservative group: 44%).

The reason why surgery benefitted patients with preexisting gait disturbance is not clear. In most patients, presence of gait disturbance indicated that the patient had already developed myelopathy. Contrary to our initial hypothesis, however, our results indicated that this subgroup of patients experienced improved neurologic recovery after decompressive surgery.

Two distinct factors must be considered in understanding the pathomechanism of SCI in patients with OPLL: direct injury by traumatic force, which is believed to be irreversible; and preexisting cord compromise because of long-standing compression. The relative contribution of these two factors may vary among patients. Decompressive surgery may have little or no benefit on primary cord injury caused by traumatic force, but may in turn benefit cord compromise brought on by persistent compression. Presumably, the contribution of traumatic force, an irreversible factor, may be smaller in patients with gait disturbance before injury than in those without gait disturbance. Patients with preexisting cord compromise may be particularly vulnerable and may easily become paraplegic on suffering minor trauma. In this study, we assumed that the variable contribution of these two factors accounts for the seemingly perplexing results obtained here. Further research in this field may provide valuable information for predicting neurologic recovery after decompressive surgery in SCI patients with preexisting canal stenosis.

Several limitations to our study warrant mention. First, the follow-up period was relatively short. Although significant improvement in motor function is known to be achieved within 6 months after injury, longer term follow-up studies may yield additional information.[14] Our follow-up rate was 68% at 6 months postinjury. This could have influenced the validity of our conclusion, although we found no apparent bias in the patients who were lost to follow-up within 6 months. Reasons for the dropout are not specified and can vary. This study was carried out at academic tertiary referral centers serving a relatively large area. SCI patients admitted to these medical centers are subsequently transferred to local hospitals near their residence after the acute phase. Presumably, some patients, especially who remained nonambulatory, required a great deal of assistance for transport. These patients might have found it difficult to travel a long distance from their residence to the hospital. We can also speculate that some patients, especially elderly patients, might have been suffering from complications after injury or comorbidities. These medically fragile patients might have been in poor or deteriorated health status and unable to show up at prescheduled checkup. The conclusions of this study need to be verified by future prospective studies. Second, Frankel grade was used as an outcome measure. Frankel grade has been widely used to rank severity of SCI in the literature despite its low discriminative ability. We therefore may have underestimated the neurologic recovery of the patients. Other validated outcome measures with high-discriminative ability may provide more detailed information. In addition, the indications and timing of surgery were not standardized between institutions, and thus selection bias cannot be entirely discounted. Despite these limitations, however, we feel that our study contains valuable information of clinical importance, providing a basis for future research.

CONCLUSION

In conclusion, our results underscore the importance of OPLL in the occurrence of acute traumatic cervical SCI in Japan, particularly in patients without bone injury. Our data indicate that patient awareness of OPLL may aid in preventing cervical SCI. Furthermore, our results suggest the efficacy of surgical decompression in patients with preexisting gait disturbance. These findings may aid in implementing an action plan aimed at prevention and better treatment of cervical SCI complicated by OPLL.

➢ Key Points

- ❑ OPLL was highly prevalent in patients with acute SCI, particularly in those without bone injury.
- ❑ Most of cervical SCI associated with OPLL were incomplete, without bone injury, and caused primarily by low-energy trauma. Majority of these patients was elderly and unaware of OPLL before injury.
- ❑ Decompression surgery was associated with better neurologic recovery compared with conservative treatment in patients who had gait disturbance before injury.

References

1. Iwasaki M, Yonenobu K. Ossification of the posterior longitudinal ligament. In: Herkowitz H, Garfin S, Eismont F, et al. eds. *Rothman-Simeone The Spine*. 5th ed. Philadelphia, PA: Saunders; 2006: 896–912.
2. Matsunaga S, Sakou T. OPLL: disease entity, incidence, literature search, and prognosis. In: Yonenobu K, Nakamura K, Toyama Y, eds. *OPLL Ossification of the Posterior Longitudinal Ligament*. 2nd ed. Tokyo, Japan: Springer, 2006:11–17.
3. Endo S, Shimamura T, Nakae H, et al. Cervical spinal cord injury associated with ossification of the posterior longitudinal ligament. *Arch Orthop Trauma Surg* 1994;113:218–21.
4. Koyanagi I, Iwasaki Y, Hida K, et al. Acute cervical cord injury associated with ossification of the posterior longitudinal ligament. *Neurosurgery* 2003;53:887–91; discussion 91–2.
5. Frankel HL, Hancock DO, Hyslop G, et al. The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. I. *Paraplegia* 1969;7:179–92.
6. Tsuyama N. Ossification of the posterior longitudinal ligament of the spine. *Clin Orthop Relat Res* 1984:71–84.
7. Matsunaga S, Sakou T, Hayashi K, et al. Trauma-induced myelopathy in patients with ossification of the posterior longitudinal ligament. *J Neurosurg* 2002;97:172–5.
8. Bracken MB, Shepard MJ, Collins WF, et al. A randomized, controlled trial of methylprednisolone or naloxone in the treatment of acute spinal-cord injury. Results of the Second National Acute Spinal Cord Injury Study. *N Engl J Med* 1990;322:1405–11.
9. Koyanagi I, Iwasaki Y, Hida K, et al. Acute cervical cord injury without fracture or dislocation of the spinal column. *J Neurosurg* 2000;93:15–20.
10. Mihara K, Torigoe Y, Konishi H. Cervical spinal cord injury associated with ossification of the posterior longitudinal ligament [in Japanese]. *Orthop Traumatol* 1991;40:763–5.
11. Fehlings MG, Sekhon LH, Tator C. The role and timing of decompression in acute spinal cord injury: what do we know? What should we do? *Spine (Phila Pa 1976)* 2001;26:S101–10.
12. Fehlings MG, Skaf G. A review of the pathophysiology of cervical spondylotic myelopathy with insights for potential novel mechanisms drawn from traumatic spinal cord injury. *Spine (Phila Pa 1976)* 1998;23:2730–7.
13. Bose B, Northrup BE, Osterholm JL, et al. Reanalysis of central cervical cord injury management. *Neurosurgery* 1984;15:367–72.
14. Chen L, Yang H, Yang T, et al. Effectiveness of surgical treatment for traumatic central cord syndrome. *J Neurosurg Spine* 2009;10:3–8.
15. Guest J, Eleraky MA, Apostolides PJ, et al. Traumatic central cord syndrome: results of surgical management. *J Neurosurg* 2002;97:25–32.
16. McKinley W, Meade MA, Kirshblum S, et al. Outcomes of early surgical management versus late or no surgical intervention after acute spinal cord injury. *Arch Phys Med Rehabil* 2004;85:1818–25.
17. Pollard ME, Apple DF. Factors associated with improved neurologic outcomes in patients with incomplete tetraplegia. *Spine (Phila Pa 1976)* 2003;28:33–9.

日本における慢性疼痛の実態

－Pain Associated Cross-sectional Epidemiological (PACE) survey 2009. JP－

原　著
Original Article

松平　浩[1)]
竹下克志[2)]　久野木順一[3)]
山崎隆志[4)]　原　慶宏[2)]
山田浩司[1,2)]　髙木安雄[5)]

1)関東労災病院勤労者筋・骨格系疾患研究センター
2)東京大学医学部附属病院整形外科・脊椎外科
3)日本赤十字社医療センター脊椎整形外科
4)武蔵野赤十字病院整形外科
5)慶應義塾大学大学院健康マネジメント研究科

要　旨
2009年1月に，慢性疼痛の病態に関して全国大規模調査を行った．解析対象は20,044名で，NRS 5以上かつ継続期間3カ月以上と定義した慢性疼痛の有病率は22.9％であった．特に40歳台の女性で高く，痛み部位は，腰，肩，膝の順に上位を占めた．直近1年の民間療法も含む医療機関受診者は55.9％であり，整形外科への受診が多かった．病院・診療所受診者における治療満足度では，45.2％が満足していなかった．理由としては，「症状が取れなかったから」，「痛みについて理解してもらえなかったから」，「納得のいく説明が得られなかったから」の順に多かった．慢性疼痛保有者は少なくないにもかかわらず，患者の期待に医療者が十分応えられていない実態が示唆された．

（ペインクリニック 32：1345-1356，2011）
キーワード：慢性疼痛，有病率，治療満足度

はじめに

西欧先進諸国において，慢性疼痛は，活動，コスト面とも最も不利益をもたらす要因とされてきた[1)]．つまり，慢性疼痛は生活の質（QOL）を低下させ，就労を困難にさせるなど，社会的な損失が大きいとされている．わが国においても厚生労働省が実施している国民生活基礎調査[2)]によると，頻度の高い自覚症状として腰痛，肩こり，関節痛，頭痛が上位を占め，受診頻度の高い上位5傷病には男女とも腰痛が含まれており，多くの国民が痛みを抱えながら生活していると考えられる．このような背景から，国策としても「慢性の痛み」に対する取り組みの必要性が生じ，2009年12月に厚生労働省健康局において「慢性の痛みに関する検討会」が発足し，2010年9月に今後の慢性の痛み対策についての提言が公表された[3)]．その中で，慢性の痛みに関する現状把握に着手し，今後の施策につながる基礎資料の作成の必要性が重要視されているが，まずは有病率および有訴者の実態と動向を知ることが不可欠であろう．海外では，疫学情報として最も基礎的な情報である一般集団（住民）の有病率に関する調査報告が集積さ

〈Original Article〉
Prevalence and characteristics of chronic pain in the general Japanese population
Ko Matsudaira, et al
Clinical Research Center for Occupational Musculoskeletal Disorders, Kanto Rosai Hospital

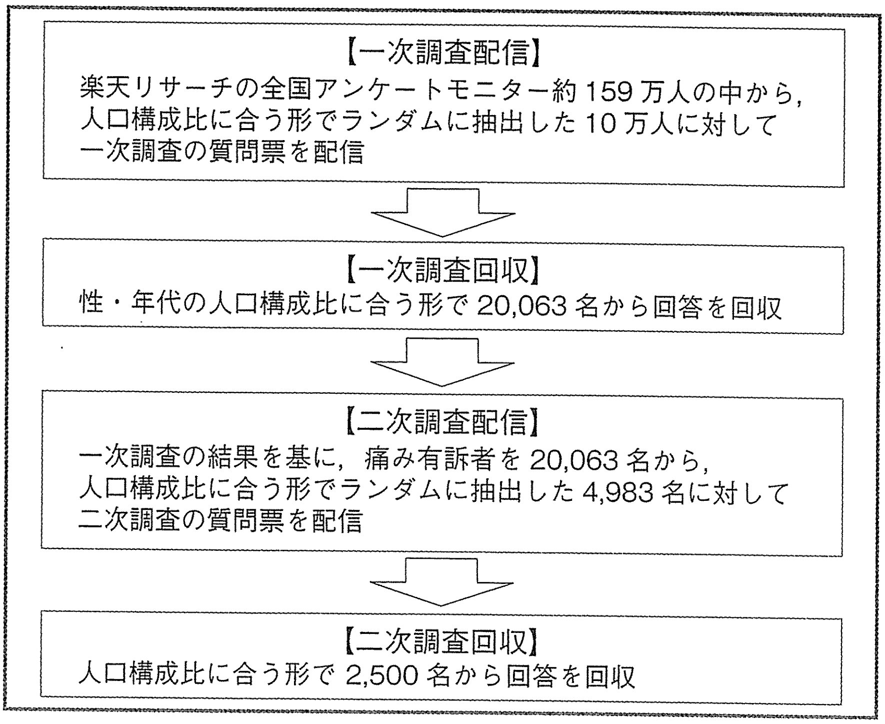


図１　調査概要（調査期間：2009 年 1 月 10 日〜18 日）

れてきたが[1,4]，わが国においてはほとんど行われてこなかった[5,6]．前述した国民生活基礎調査がある程度は実態を反映していることは間違いないであろうが，疼痛部位や慢性化等の定義化がされていないという限界がある．そこで今回，本邦における慢性疼痛の現状把握の第一歩として，有病率および有訴者の実態と動向を知ることを主目的に大規模調査を実施したので報告する．

Ⅰ．対象および方法

2009 年 1 月 10 日〜18 日に，インターネット上で質問票に回答する形式で調査を実施した．調査概要を図１に示したが，調査実施にあたってはインターネット調査会社（楽天リサーチ）に登録している全都道府県にわたるアンケートモニター約 159 万人（1,588,965 名）から，2007 年 10 月時点の性・年齢を日本全体の構成に近似させ，かつ 20 歳以上 80 歳未満であること条件とし，無作為に抽出した 10 万人に質問票を配信し，20,063 名の回答を得た（一次調査の回答率：20.1％）．

この一次調査では，日本人一般生活者の疼痛に関する有訴率を主に知ることを目的とし，人体図で定義した直近１カ月の痛みの部位（図２）とその痛みの程度（0〜10 の 11 段階，numerical rating scale：NRS），そして，最も痛みで困っている部位に関する痛み継続期間，痛みの原因（きっかけ），痛みによる社会的活動（仕事，家事，学業等）への影響度，加えて医療経済的評価の際の基盤となる効用値を算出できる健康関連 quality of life（QOL）指標の EQ-5 D[7] および性，年齢，就労状況等に関するデータを収集した．

次いで，一次調査の直後に二次調査を行った．二次調査では，一次調査の回答者から，過去１カ月に身体のいずれかに痛みがあった人の中から約５千人（4,983 名）を，これも一次調査と同様に性・年齢を日本全体の構成に近似させ，無作為に抽出し，配信し，2,500 名のデータを収集した（回答率 50.2％）（図１）．第二次調査の調査項目は，過去１年間で痛み（しびれを含む）治療目的で医療機関を受診したか，受診した場合の受診先と医師の診療を受けていた場合の治療満足度（満足，まあ満足，やや不満足，

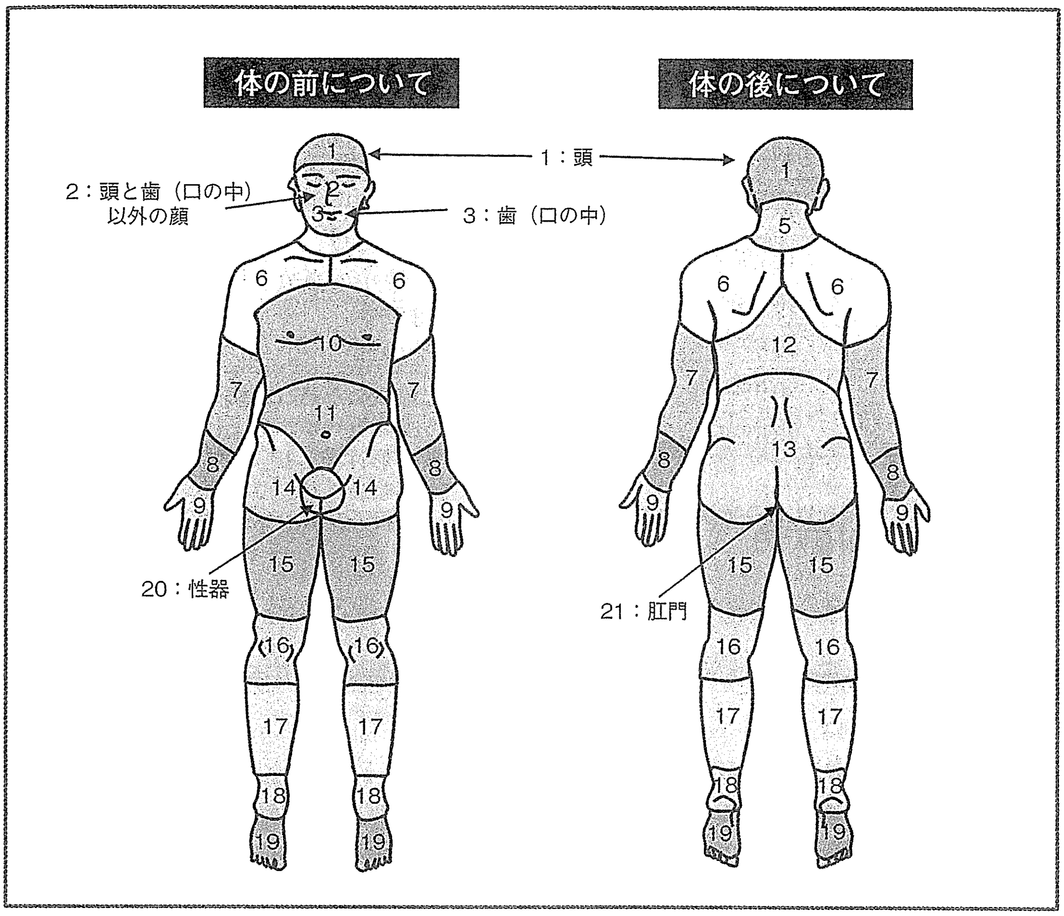


図２　人体図で定義した痛みの部位

不満足の４段階），治療満足度が低かった（やや不満足あるいは不満足）場合のその理由，また，１年後に自分が患っている痛みが仕事や日常生活を送る上で問題になっていると思うか，加えて包括的健康関連 QOL 尺度である SF-8[8] についても調査した．

１）サンプル収集の実際

対象となった回答者は，登録してある E-mail address に研究参加への協力依頼をし，二重登録ができないように管理した．Missing data 対策として，調査不備がある場合，入力が完了できないように設定した．参加者に対しては financial incentive として，net-shopping 等に利用できるポイント加算を行い，同一対象者が複数回は回答できないようにした．また，故意に同じ選択肢を回答する者や論理的でない回答をする登録者は調査対象から除外した．

２）測定項目の詳細

痛み部位は，人体図を用い，全 21 個所に区分した（**図２**）．具体的には，図における番号は以下を想定したものとして定義・区分した（１：頭部，２：頭・歯（口腔内）以外の顔，３：歯（口腔内），４：喉・前頸部，５：後頸部，６：肩部，７：肘部，８：手関節，９：手・手指，10：前胸部，11：腹部，12：背部，13：腰部，14：股関節部，15：大腿部，16：膝部，17：下腿部，18：足関節部，19：足・足趾，20：性器，21：肛門）．その保有者が最も多いと予想された腰痛（腰部）に関しては，腰痛の有病率（prevalence）調査の際に部位提示の世界標準[9]である肋骨下縁から下殿溝まで，つまり今回は臀部も含め腰の範囲とし，21（肛門痛）を除く 13 の痛みを腰痛と定義した．

痛みレベルの測定には，0～10 の 11 段階 NRS を用いが，その際，０を痛みがまったくない状態，10：想像できる最悪の痛み（これ以

表1　慢性疼痛保有率（有病率）

	全　体	男　性	女　性
有病率	22.9%	20.0%	25.7%
人数〔名〕	4,590/20,044	1,948/9,746	2,642/10,298

年齢別有病率	男　性	女　性
30 歳未満	10.7%	21.7%
30〜40 歳未満	16.2%	23.7%
40〜50 歳未満	20.6%	28.0%
50〜60 歳未満	20.9%	26.1%
60 歳以上	23.6%	26.7%

有病率：
〔NRS（0〜10 の 11 段階）で５以上の痛みが３カ月以上持続する痛みを持つ人数〕／〔対象人数〕

表2　痛みの原因（きっかけ）（n＝4,590）

特にきっかけはなかった	34.9%
日常生活での動作や姿勢	24.0%
事故ではないが仕事中の動作や姿勢	12.5%
病気のため*	9.6%
スポーツ中	5.7%
交通事故	3.4%
仕事中の事故（けが）	1.4%
通勤中	0.6%
その他	8.1%

*病気のため（内訳）
椎間板ヘルニア：16%，関節リウマチ：11%，変形性関節症：9%，がん：4%，うつ：3%，偏頭痛：3%，四十（五十）肩：2%，虫歯：2%，骨折：1%，その他：47%

上我慢できない痛み）と定義した．痛みによる社会生活への支障度は，von Korff の pain grade[10]を参考にし，① 痛み（しびれを含む）はあったが仕事（学業，家事等）に支障はなかった，② 痛み（しびれを含む）のため仕事（学業，家事等）に支障をきたしたこともあったが休職（学業，家事等を休む）はしなかった，③ 痛み（しびれを含む）のため休職（学業，家事等を休む）をしたことがある，の３段階とした．また，今回用いた健康関連 QOL 尺度についてであるが，一次調査で用いた EQ-5D は，効用値を算出できる尺度（選好に基づく尺度）の最も代表的なもので，243 通りの健康状態を弁別し，これに「意識不明」と「死」を加え，合計 245 の健康状態を評価できる尺度である．日本では 1997 年 11 月に，日本語版 EQ-5D が EuroQol Group の認定を受けた．EQ-5D の効用値は点数が低いほど健康関連 QOL が低いことを表し，死亡を 0，完全な健康を 1 として算出される．二次調査で使用した SF-8 は大規模調査に有用とされる包括的健康関連 QOL 尺度であり，SF-36 と同様の 8 下位尺度を各 1 問ずつ問うもの[8]で，NBS（norm-based scoring）によってスコア化され，日本人においては SF-36 よりも信頼度の高い 2 つのサマリースコア（身体的健康度および精神的健康度）を算出できる調査票である[11]．

3）慢性疼痛の定義

研究者で議論し，痛み区分 21 のいずれか 1 つ以上の痛みのうち最も困っている部位の NRS に関し，程度の弱い痛みは一般的に社会活動への影響が乏しいとの判断から，５以上[6]かつ継続期間が国際疼痛学会の基準に準じた３カ月以上[12]と定義することとした．

4）検討項目

一次調査における検討項目は，上記定義に従った，性・年代別の慢性疼痛有訴率，慢性痛として最も困っている部位の順位，原因（きっかけ），社会生活への支障度の分布に加え，慢性疼痛等の EQ-5D スコア（効用値）とした．効用値の算出法は the Japanese N3 model[13]を用いた．二次調査においては，一次調査で前述した慢性疼痛の定義に該当する人を抽出し，慢性疼痛による医療機関等への受診動向（機関や診療科の種類），病院・診療所を受診した場合の治療満足度と不満足であった場合の理由，受診動向および治療満足度別の SF-8 スコア，1 年後にも日常生活を送る上で痛みが問題になっていると思うか等を検討項目とした．

データマネジメントおよび解析は，第三者解析機関（みずほ情報総研）で行われ，統計ソフトは PASW Statistics 18 を用い，両側検定で $p<0.05$ を有意とした．なお，本調査は，慶應