

JACO

**Journal of the Academy of
Chiropractic Orthopedists**

2012



Volume 9

Issue 4

December, 2012



JACO

Journal of the Academy of Chiropractic Orthopedists

**The Open Access, Peer-Reviewed and Indexed
Publication of the Academy of Chiropractic Orthopedists**

December 2012 – Volume 9, Issue 4

Editorial Board

Editor-In-Chief

Bruce Gundersen, DC, FACO

Editor

Stanley N. Bacso, DC, FACO, FCCO(C)

Associate Editors

James Demetrious, DC, FACO

David Swensen, DC, FACO

Current Events Editor

James R. Brandt, DC, MPS, FACO

Editorial Advisory Board

James R. Brandt, DC, MPS, FACO

Ronald C Evans, DC, FACO

James Demetrious, DC, FACO

Reed Phillips, DC, PhD

Robert Morrow, MD

Editorial Review Board

Scott D. Banks, DC, MS

Thomas F. Bergmann, DC

Gary Carver, DC, FACO

Jeffrey R. Cates, DC, FACO

Rick Corbett, DC, DACBR, FCCO(C)

Anthony Vincent D'Antoni, MS, DC, PhD

Donald S. Corenman, MD, DC, FACO

James Demetrious, DC, FACO

Neil Erickson, DC, DABCO

Jaroslav P. Grod, DC, FCCS(C)

Tony Hamm, DC, FACO

A. Michael Henrie, DO

Dale Huntington, DC, FACO

Keith Kamrath DC, FACO

Charmaine Korporaal, M.Tech: Chiropractic,
CCFC, CCSP, ICSSD

Ralph Kruse, DC, FACO

Timothy J. Mick, DC, DACBR, FICC

Joyce Miller, DC, FACO

Raymond S Nanko, DC, MD, DAAPM, FACO

Joni Owen, DC, FACO

Deanna O'Dwyer, DC, FACO

Gregory C. Priest, DC, FACO

J Chris Romney, DC, FACO

David Swensen, DC, FACO

Larry L. Swank, DC, FACO

John M Ventura, DC, FACO

Michelle A Wessely BSc, DC, DACBR

Michael Wiles, DC, MEd, FCCS(C)

Steve Yeomans, DC, FACO

Journal of the Academy of Chiropractic Orthopedists

December 2012 – Volume 9, Issue 4

Image and Art Gallery

- ❖ Earth from Space - courtesy NASA. JACO 2012, 9(4): 1

Independent Research - Case Study

- ❖ Gundersen, B: **Cervical Disc Disease with Radiculopathy Recommended Surgery, Responds to Conservative Measures.** JACO 2012, 9(4): 3-5.

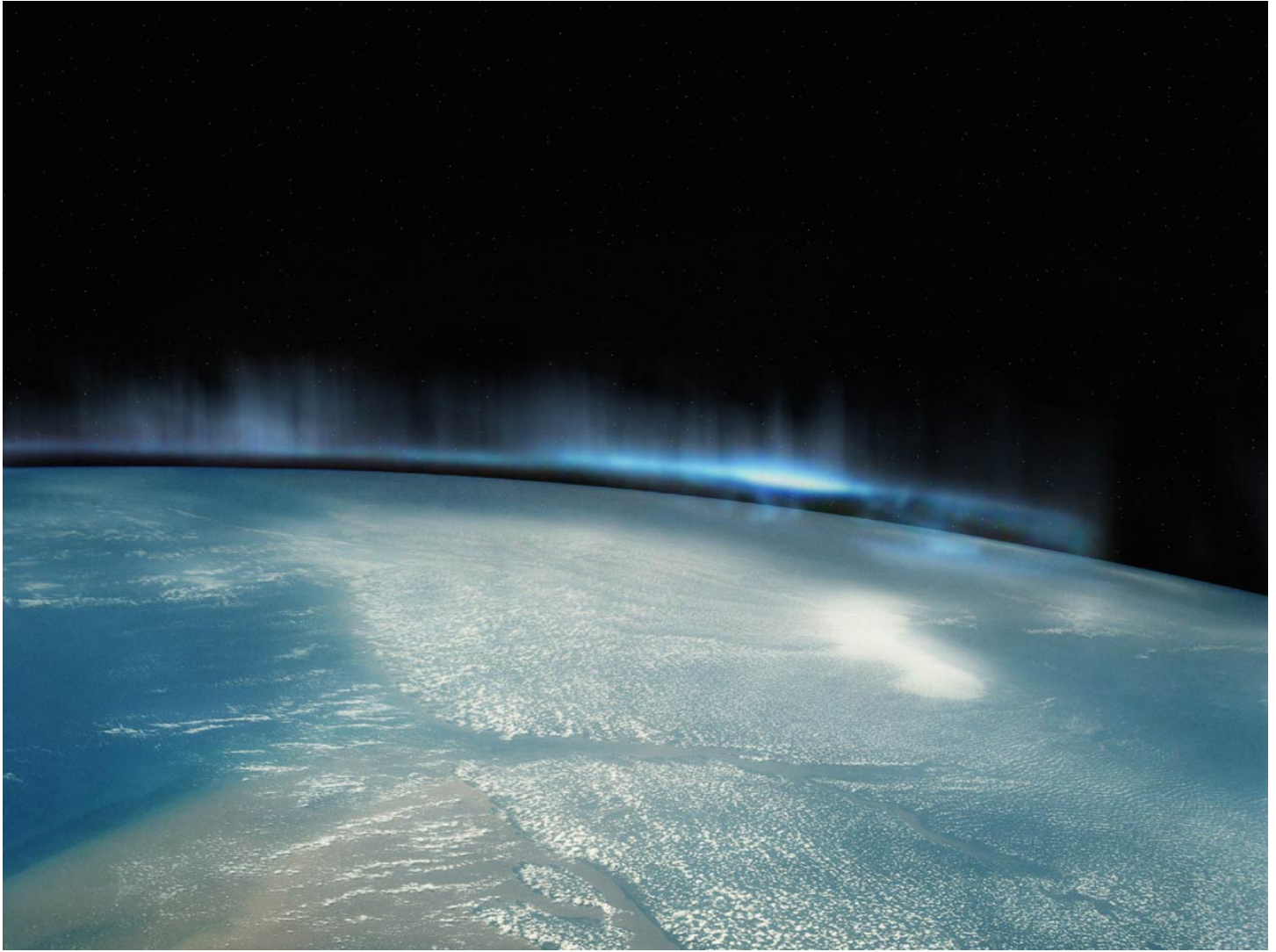
Abstracts and Literature Review – Low Back Pain / Radiculopathy

- ❖ Gu, R, et al: **Differential Diagnosis of Cervical Radiculopathy and Superior Pulmonary Sulcus Tumor.** *Reviewed by Corbett, R.* JACO 2012, 9(4): 7-9.
- ❖ Tubbs, RS, et al: **Ligaments of the Craniocervical Junction - A Review.** *Reviewed by Kamrath, K.* JACO 2012, 9(4): 11-16.
- ❖ Miyauchi, A, et al: **Morphological Features and Clinical Significance of Epidural Membrane in the Cervical Spine.** *Reviewed by Cates, J.* JACO 2012, 9(4): 18-21.

Announcements

- ❖ ACCO – Clinical Update 2013. JACO 2012, 9(4): 22.

Earth from Space



- The northern hemisphere of Earth (image courtesy of NASA)
- Highly charged electrons from the solar wind interact with elements in the earth's atmosphere (Aurora Borealis).



Cox[®] Technic Seminars

share

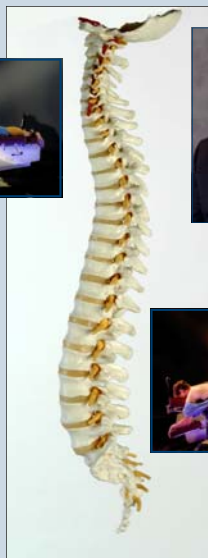
evidence-based protocols and outcomes for spinal pain treatment

Cervical Spine—Thoracic Spine — Lumbar Spine

Research Outcomes

- Federally Funded HRSA Projects
 - Better for Radiculopathy Relief
 - Better for Chronic Moderate/Severe LBP
 - Better for Chronic Mild LBP
 - Better for Recurrent Mild LBP
 - Fewer Doctor Visits 1 year later
 - IVD Pressure Drop to **-39 to -192 mm Hg**
 - **28% increase in intervertebral foramen**
 - Better for LBP relief 1 year later

“...taking the Cox courses over this year has really revived my enthusiasm for the profession and the practice, and opened me up to the power of what we can do. **Having the EVIDENCE and the PROTOCOL for back and neck pain has made a huge difference for me.**” -- Keith Olding, DC



Designed by Dr. James Cox, founder of Cox[®] Technic Flexion-Distraction and Decompression, Cox[®] Certification Courses offer **evidence-based application and support** to chiropractic physicians who invite the tough cases — **the disc herniation and stenosis cases** — as enthusiastically as other more common spine pain patients.

Hands-on practice at Part I is introductory and at Part II is more intense and available...**with an objective transducer to measure your pressure application.**

Cervical Spine Cox[®] Technic is introduced at Part I and built on with more hands-on at Part II.

Dr. Cox makes Clinical Practice Reality come to life at Part III which is open to everyone to see **how Cox[®] Technic affects patients and clinical practice!**

www.coxtechnic.com/doctors/education

1-800-441-5571



February 25-26, 2012

Tempe AZ @ Tempe Mission Palms Resort
Part III with Dr. James Cox

March 24-25, 2012

Orlando FL @ Grand Hyatt Orlando
Part I with Dr. George Joachim

April 21-22, 2012

Toronto @ Hilton Garden Inn at Airport
Part III with Dr. James Cox

May 5-6, 2012

Portland ME @ Hilton Garden Inn
Part III with Dr. James Cox

June 22-23, 2012

Netherlands
Part I with Dr. George Joachim

July 21-22, 2012

Minneapolis MN @ Hyatt Place MSP
Part I with Dr. Ralph Kruse

September 15-16, 2012

Charlotte NC @ Hyatt Place Charlotte
Part III with Dr. James Cox

October 6-7, 2012

Philadelphia PA @ Embassy Suites PHL
Part I with Dr. George Joachim

November 16-18, 2012

Lombard IL @ NUHS
Part II with Drs. Cox, Gudavalli,
Bifulco and Kruse

Independent Research - Case Study

Cervical Disc Disease with Radiculopathy Recommended Surgery, Responds to Conservative Measures.

By Bruce Gundersen, DC, FACO

Introduction

Cervical Disc Disease often presents with a variety of symptoms which may or may not be directly related a specific disc level or adjacent discs. This disorder is differentiated from many similar syndromes and conditions including: thoracic outlet, brachial plexopathies, cervical spondylosis, fibromyalgia, Parsonage Turner's syndrome, osteoarthritis, osteoporosis, Paget's Disease, multiple sclerosis, or psoriatic arthritis. Signs and symptoms may be blurred during the acute phase and advanced imaging may be the best diagnostic tool as the condition evolves. Prognosis and outcome expectations become difficult due to the poor predictive nature of the neurologic findings. Risk of treatment versus non-treatment must be considered against the acute status of the patient given the natural course of the disorder. It is clear that most studies find little etiology with neck pain and severity or advancement of neurologic signs, and do not necessarily correlate with worsened prognosis as do higher severity of pain and multiple episodic occurrences.

Case Report

This 54-year-old man presented with neck, arm, forearm, hand and upper back pain, numbness and tingling of the left arm, forearm and hand. Onset reported was "sleeping stupid the night before." The history of automobile trauma of 39 years previously was the solitary notable item discovered. No other physician had yet been consulted, and self-care had been implemented over the past 30 days consisting of: heat, contrived positional antalgia,

over-the-counter medications and yoga/meditation. These had not produced any remission or abatement of the symptoms.

Physical examination revealed Bakody's sign present on observation, mensuration of the arm and forearm showed -1cm of the left arm, muscle testing showed grade 4 of the left shoulder elevators, and left internal/external rotators on the left. Grip strength was checked in one position using the hand dynamometer showing left strength reduced by 10% in this right hand dominate, well-strengthened male. Sensory testing was unremarkable using a pin and camel hair brush. Deep tendon reflexes of the upper extremity were 2+ bilaterally. No other tests were provocative. The Revised Neck Oswestry tool intake score was 54, subjectively placing him in the "severe disability" category. Cervical disc disease was the working diagnosis and advanced imaging was indicated and ordered as well as a neurosurgical consultation.

The consultation was performed several days later, resulting in a diagnosis of cervical disc disease with resultant left radiculopathy. At this time, the surgeon recommended surgery at once. The patient opted against that. The relevant images reviewed were in Figure1 and Figure 2:



Figure 1



Figure 2

Figure 1 - T2 weighted image shows disc disease at C5-6.

Figure 2 - Confirmed in transverse image.

The patient was scheduled for computerized intermittent axial distraction for eight minutes at 25 lbs., followed by anti-gravity recumbent positioning, electrical stimulation (12 minutes) to patient tolerance. This protocol was performed three times per day for 6 days and then reduced in frequency and increased in dosage thereafter. After three weeks, the outcomes tool was repeated and scored at 34. Treatment sessions were reduced to three sessions per week, progressively decrease to two sessions and then one. After nine months, the patient had no subjective complaints. He rated his return of strength in the left arm at 50% and has had monthly treatment sessions, which he chose as a preventative and proactive measure.

Discussion

The physical examination findings were not consistent (i.e., muscle grading and grip strength)

with the C5-6 level of lesion shown on the imaging. Some “pre-fixed and post-fixed” findings were noted, although they were also not entirely consistent with the final diagnosis.

What can be learned from this experience? One thing is that the clinical resolution of any symptom pattern may not be entirely congruent with the diagnosis. Also, imaging and even surgical consultation should be considered as tools or findings and not as a diagnosis. Additionally, patients may present in clinical practice with inconsistent findings or a presentation that may not precisely match the diagnostic criteria as expected. Additionally, axial distraction is not segmentally specific and might have actually relieved symptoms that were present but not necessarily related to the imaging findings. Finally, as discussed below, the natural course of disc disease might have mimicked this particular case following the acute phase, and the follow-up treatment may have been erroneous when viewed retrospectively.

As seen in the epidemiology studies to follow, this condition may occur often in middle-aged men. It may also respond without surgery or without any intervention:

Epidemiology of cervical radiculopathy from a study done at the Mayo Clinic, 1994 showed that ages ranged from 13 to 91 years. The mean age $\pm$ SD was 47.6 $\pm$ 13.1 years for males and 48.2 $\pm$ 13.8 years for females. A history of physical exertion or trauma preceding the onset of symptoms occurred in only 14.8% of cases. A past history of lumbar radiculopathy was present in 41%. The median duration of symptoms prior to diagnosis was 15 days. A monoradiculopathy involving C7 nerve root was the most frequent, followed by C6. A confirmed disc protrusion was responsible for cervical radiculopathy in 21.9% of patients; 68.4% were related to spondylosis, disc or both. During the median duration of follow-up of 4.9 years,

recurrence of the condition occurred in 31.7%, and 26% underwent surgery for cervical radiculopathy. A combination of radicular pain and sensory deficit, and objective muscle weakness were predictors of a decision to operate. At last follow-up 90% of our population-based patients were asymptomatic or only mildly incapacitated due to cervical radiculopathy. The average annual age-adjusted incidence rates per 100,000 population for cervical radiculopathy in Rochester were 83.2 for the total, 107.3 for males and 63.5 for females. The age-specific annual incidence rate per 100,000 population reached a peak of 202.9 for the age group 50-54 years.¹

In another study, prevalence (cases per 1000 population) was 3.5 in the total population; it increased to a peak at age 50-59 years, and decreased thereafter. The age-specific prevalence was consistently higher in women.²

Signs and Symptoms of cervical radiculopathy may include any of these: loss of or reduction of deep tendon reflex, loss of strength, loss of muscle girth, sensory loss or change and pain that spreads into the arm, neck, chest and/or shoulders. Other symptoms may include lack of coordination, especially in the hands.

Conclusion

This patient was able to avoid surgery with conservative care. Compliance was rated by the patient at 100% and remission of symptoms was rated at 95% after 3 months. There were 3 days lost time from work and the cost of care was under \$2500 of which \$1400 was the MRI and the neurological consult.

References:

1. Radhakrishnan K, Litchy WJ, O'Fallon WM, Kurland LT. Epidemiology of cervical radiculopathy: A population-based study from Rochester, Minnesota, 1976 through 1990. Department of Neurology, Mayo Clinic, Rochester, MN.
2. Salemi G, Savettieri G, Meneghini F, Di Benedetto ME, Ragonese P, Morgante L, Reggio A, Patti F, Grigoletto F, Di Perri R. Prevalence of cervical spondylotic radiculopathy: A door-to-door survey in a Sicilian municipality. *Acta Neurol Scand.* 1996; 93(2-3):184-8.

[The Relationship Between A Chiropractor And Their Favorite Table KNOWS NO BOUNDS]

"A Versatile [Chiropractic] Table Could Save Your Career."

TAKE 5 MINUTES TO SEE WHY THIS CHIROPRACTOR
CHOOSES LLOYD TABLES



Dr. Tui Hitchcock,
Tallahassee, FL

"A good table should give you all the flexibility you need. For your comfort and safety. And for your patients' as well.

I've been in practice long enough to see my young patients start having children. I needed a table that was versatile [innovative] enough to handle a full term pregnant woman. And save my own back at the same time.

I can put my patients into a comfortable position for evaluation. Then I lower the table and adjust where it's safe for me. No more stooping and bending. After 4 days a week for 20 plus years, it can make a difference.

And your patients notice too.

I've had patients go to other chiropractors. They always come back and say, 'They don't have tables like yours.' Patients like the comfort. And I like how durable the tables are.

Save yourself from the pain of dealing with a lesser table. Buy quality, and you'll never regret it. I've more than made my money back on my investment.

More than two decades later, I'm still in full-time practice and relying on Lloyd's."

Reproducible • Innovative • Durable
Experience Lloyd Chiropractic Tables

Call 1-800-553-7297



LLOYD
TABLE COMPANY

www.lloydtable.com
1-800-553-7297

Abstracts & Literature Review

Differential Diagnosis of Cervical Radiculopathy and Superior Pulmonary Sulcus Tumor

GU Rui, KANG Ming-yang, GAO Zhong-li, ZHAO Jian-wu, and WANG Jin-cheng

Chinese Medical Journal 2012; 125(15): 2755-2757

JACO Editorial Reviewer: Richard P. Corbett, DC, FCCR Canada (Inc), FCCO(C)

Published:
Journal of the Academy of Chiropractic Orthopedists
December 2012, Volume 9, Issue 4

The original article copyright belongs to the original publisher. This review is available from: <http://www.dcothoacademy.com>
© 2012 Corbett and the Academy of Chiropractic Orthopedists. This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Authors' Abstract

Study Design: Retrospective analysis of ten cases of superior pulmonary sulcus tumor (Pancoast tumor).

Objective: Investigate the differential diagnostic methods of cervical radiculopathy and superior pulmonary sulcus tumor among patients with complaints of neck pain and radiating shoulder and arm pain.

Summary of Background Data: The superior pulmonary sulcus tumor may cause symptoms of pain or radiating pain in the neck and upper extremities, motor weakness, atrophy of the intrinsic (hand) muscles, and sensory disturbance in certain cervical nerve root dermatomes which mimic the symptoms of cervical radiculopathy. The result would be tragic if the superior pulmonary sulcus tumor was misdiagnosed as degenerative cervical spine disease.

Methods: 7132 patients with main complaints of neck pain and radiating shoulder and arm pain visited the outpatient department of spinal disorders, in the China-Japan Union Hospital of Jilin University in

Changchun, China. 10 cases (0.14%) were subsequently diagnosed with superior pulmonary sulcus tumor.

Results: Compared with patients with cervical radiculopathy, patients with superior pulmonary sulcus tumor had: History: a shorter mean history; Complaints: fewer complaints of neck pain or limited range of motion (ROM); Physical Findings: in all 10 cases: almost normal cervical spine ROM, and negative Spurling's neck compression test; Imaging: AP cervical: lack of pulmonary air at the lung apex in all cases, and rib encroachment in 1 case.

Conclusion: Superior pulmonary sulcus tumor can be differentiated from cervical radiculopathy by normal range of motion in the cervical spine, negative Spurling's neck compression test and the radiographic finding of lack of air at the pulmonary apex of the affected lung.

Background

The superior pulmonary sulcus tumor is a malignant tumor of the superior pulmonary sulcus of the lung apex. It has a relatively low incidence (5% of all pulmonary tumors), but a much poorer prognosis. It

may mimic the symptoms of cervical radiculopathy caused by degenerative cervical spine disease, causing symptoms such as pain or radiating pain in the neck and upper extremities, muscle weakness, atrophy of the intrinsic muscles, and sensory changes in cervical nerve root dermatomes.

This study investigates what features of the superior pulmonary sulcus tumor differentiate them from a cervical radiculopathy among patients with complaints of neck and radiating shoulder and arm pain, by reviewing 10 such cases.

Methods

Some 7132 patients visited the outpatient department of spinal disorders in the China-Japan Union Hospital of Jilin University in Changchun, China, from March 1998 through March 2005, with main complaints of neck pain and radiating shoulder and arm pain. Ten cases (0.14%) were subsequently diagnosed with superior pulmonary sulcus tumors that were later confirmed via needle biopsy. Findings of these 10 patients (clinical, physical, and imaging) were reviewed and compared with those patients with cervical radiculopathy.

Results

Four patients had plain film AP, lateral and oblique views performed in other hospitals before attending the authors' facility, where they had been diagnosed as degenerative cervical disease or cervical radiculopathy. Two of these patients underwent conservative treatment (collar fixation, band traction, and NSAID's), but they were refractory to treatment. Of note: The cervical spine range of motion was normal in 9 of the 10 patients. For all 10 patients:

- Pain was localized in the scapular or interscapular region
- There was no tenderness in the cervical spine region, and
- Spurling's neck compression test was negative.

Other findings: Night pain in 6 out of 10 subjects, weight loss in 4 out of 10, with cough and fever in 2

out of 10. Male: Female ratio was 6:4. Average age 67.1 years. Pain and tenderness points were equivocal. Brachial plexus traction test was positive. Sensory disturbance was common in the posterior and medial arm and ulnar hand, with diminished strength on elbow extension and grip.

Plain film findings: There was cervical alordosis in four cases. Mild degenerative changes were found in seven cases. In all 10 cases, AP cervical radiographs showed absence of air at the pulmonary apex. In only one case was encroachment of the first rib found on the affected side. All patients went on to have chest radiography, and in all 10 cases the PA view showed unilateral apical opacity. One case showed wide spread tumorous shadows in the ipsilateral lung. MRI performed on two patients, clearly showed encroachment on vertebral bodies and brachial plexus, on the coronal images. Transthoracic aspiration needle biopsy confirmed epidermoid carcinoma in five cases, adenocarcinoma in four cases, and small-cell lung cancer in one case.

Conclusions

Cervical radiculopathy is one of the most common diseases seen in the cervical spine disorder clinic. The symptoms of cervical radiculopathy may be mimicked by the superior pulmonary sulcus tumor. A combination of medical history, physical examinations, and radiographic studies could improve the detection rate of superior pulmonary sulcus tumor in patients whose main complaints were radiating shoulder and arm pain. Clues that may lead to the diagnosis of superior pulmonary sulcus tumor in patients whose diagnosis would otherwise be cervical radiculopathy are: In contrast to typical cervical radiculopathy, superior pulmonary sulcus tumors have:

- A shorter mean history of the disease
- Almost normal cervical spine range of motion
- Pain localized in the scapular or interscapular region
- No tenderness in the cervical spine region, and
- Negative Spurling's sign in all patients.

The current study confirmed Villas' (et al) opinion in their retrospective study of 10 patients, that a lack of air at the lung apex on the affected side may indicate a superior pulmonary sulcus tumor.

The authors of the current study recommend chest radiography should be performed if asymmetries of the superior margins of the pulmonary opacity are observed on a cervical spine AP radiograph. Following confirmation of diagnosis of superior pulmonary sulcus tumor on chest x-ray, CT and MRI would be appropriate, with needle biopsy for confirmation.

Clinical Relevance

Cervical radiculopathy is seen frequently in chiropractic clinics. Chiropractors should have a high index of suspicion when faced with a patient whose diagnosis would otherwise be cervical radiculopathy when the patient has the following: a shorter mean history of the disease, almost normal cervical spine range of motion and a negative Spurling's sign.

JACO Editorial Summary:

- The article was written by authors from the Department of Orthopedics, China-Japan Union Hospital of Jilin University, Changchun, Jilin 130033, China.
- The purpose of the study was to investigate the differential diagnostic methods of cervical radiculopathy and superior pulmonary sulcus tumor among patients with complaints of neck pain and radiating shoulder and arm pain.
- The main differentials are as follows. In contrast to typical cervical radiculopathy, superior pulmonary sulcus tumors have:
 - A shorter mean history of the disease
 - Almost normal cervical spine range of motion
 - Pain localized in the scapular or interscapular region
 - No tenderness in the cervical spine region, and

- Negative Spurling's sign in all patients.

Summary

The results of this investigation should assist clinicians in making the diagnosis of superior pulmonary sulcus tumor(s) in patients whose diagnosis would otherwise be cervical radiculopathy.

References and Additional Readings

1. Arcasoy SM, Jett JR. Superior pulmonary sulcus tumors and Pancoast's syndrome. *N Engl J Med* 1997; 337: 1370-1376.
2. Khosravi Shahi P. Pancoast's syndrome (superior pulmonary sulcus tumor): review of the literature. *An Med Int* 2005; 22: 194-196.
3. Owen TD, Ameen A. Cervical radiculopathy: pancoast tumour? *Br J Clin Pract* 1993; 47: 225-226.
4. Kraut MJ, Vallieres E, Thomas CR. Pancoast (superior sulcus) neoplasms. *Curr Probl Cancer* 2003; 27: 81-104.
5. Vargo MM, Flood KM. Pancoast tumor presenting as cervical radiculopathy. *Arch Phys Med Rehabil* 1990; 71: 606-609.
6. Kokubun S, Sato T, Ishii Y, Tanaka Y. Cervical myelopathy in the Japanese. *Clin Orthop* 1996; 323: 129-138.
7. Komaki R, Roth JA, Walsh GL, Putnam JB, Vaporciyan A, Lee JS, et al. Outcome predictors for 143 patients with superior sulcus tumors treated by multidisciplinary approach at the University of Texas M. D. Anderson Cancer Center. *Int J Radiat Oncol Biol Phys* 2000; 48: 347-354.
8. Tanaka Y, Kokubun S, Sato T. Cervical radiculopathy and its unsolved problems. *Curr Orthop* 1998; 12: 1-6.
9. Spurling RG, Scoville WB. Lateral rupture of the cervical intervertebral discs. A common cause of shoulder and arm pain. *Surg Gynecol Obstet* 1944; 78: 350-358.
10. Villas C, et al. Cervicobrachialgia and pancoast tumor: value of standard anteroposterior cervical radiographs in early diagnosis. *Orthopedics* 2004; 27: 1092-1095.

CHIROPRACTIC FOCUSED ■ LEADER IN MALPRACTICE ■ EXPERT DEFENSE



NCMIC

We Take Care of Our Own®

NCMIC Stands Out Among the Rest

[Click here](#) to learn more
about NCMIC offerings.

Malpractice Insurance Plan is offered through NCMIC Insurance Company.
Policy terms may vary by state law.

www.ncmic.com/3120

Abstracts & Literature Review

Ligaments of the Craniocervical Junction - A Review

R. Shane Tubbs, M.S., P.A.-C., Ph.D., Justin D. Hallock, M.D.,
Virginia Radcciff, M.D., Robert P. Naftel, M.D., Martin Mortazavi, M.D.,
Mohammadali M. Shoja, M.D., Marios Loukas, M.D., Ph.D.,
and Aaron A. Cohen-Gadol, M.D., M.Sc.

J Neurosurg Spine 2011; 14: 697–709

JACO Editorial Reviewer: Keith R. Kamrath, DC, FACO

Published:
Journal of the Academy of Chiropractic Orthopedists
December 2012, Volume 9, Issue 4

The original article copyright belongs to the original publisher. This review is available from: <http://www.dorthoacademy.com>
© 2012 Kamrath and the Academy of Chiropractic Orthopedists. This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Author's Abstract

The specialized ligaments of the craniocervical junction must allow for stability yet functional movement. Because injury to these important structures usually results in death or morbidity, the neurosurgeon should possess a thorough understanding of the anatomy and function of these ligaments. To the authors' knowledge, a comprehensive review of these structures is not available in the medical literature. The aim of the current study was to distill the available literature on each of these structures into one offering. (DOI: 10.3171/2011.1.SPINE10612)

Background

The craniocervical junction is an anatomically complex and important area of the human structure. The close proximity of vital neurovascular pathways makes this region clinically relevant. Injury to the craniocervical junction can produce a wide range of symptoms including localized pain, headaches, and proprioceptive disorders. Many of

the ligamentous structures in this region are the key to understanding appropriate diagnosis and treatment. However, a comprehensive review of these structures was not available prior to this review of existing research.

Methods

The study included a comprehensive review of the literature of the anatomy and biomechanics of the craniocervical junction. The authors included adult and pediatric observations utilizing cadaveric dissection, surgical reports, and radiographic imaging. The craniocervical ligaments were described in terms of their location, course, size, elasticity, and biomechanical significance.

Results

The craniocervical junction consists of two major joints: the atlantooccipital joint and the atlantoaxial joint. The majority of cervical mobility occurs at this region. The atlantooccipital joint is primarily responsible for flexion and extension while the atlantoaxial joint is primarily responsible for

cervical rotation. It is essential that these joints move in a specifically coordinated manner for proper biomechanics to occur. Rotation of the axis beyond 30-35 degrees can occlude the vertebral artery. The most important ligaments of the craniocervical junction are the transverse and alar ligaments. The transverse ligament is one of the most important ligaments in the body and is the largest, thickest, and strongest craniocervical ligament. The transverse ligament is the main stabilizing ligament of the atlantoaxial joint where about 47 degrees of rotation occur in the neck. This ligament is relatively inelastic and prone to rupture with greater than 3-5 mm of displacement.

The alar ligament, in addition to the transverse ligament, is the only ligament that is strong enough to oppose anterior displacement of the atlas on the axis. Its primary function is to limit axial rotation and lateral flexion on the contralateral side.

Damage to the alar ligament increases axial rotation which can damage or occlude the vertebral artery. The alar ligament is frequently injured in a motor vehicle collision. The transverse occipital ligament is a small ligament located posterior and superior to the alar ligaments and odontoid process. The presence of this ligament varies from 8.3-77.8% of specimens. It has similar functions to the alar ligament when present. The accessory atlantoaxial ligament inserts medially into the dorsal aspect of the axis and travels superolaterally to the transverse ligament on the lateral mass of the atlas. This ligament may supply blood flow to the odontoid process.

There are no existing studies of the accessory atlantoaxial ligament, but it is thought to function similarly to the alar ligament. The lateral atlantooccipital ligament courses lateral to the anterior atlantooccipital membrane, attaching to the anterolateral aspect of the transverse process of the atlas and onto the jugular process of the occipital bone. No studies have been conducted on the

lateral atlantooccipital ligament, but it may play a role in limiting lateral flexion of the head. The baskow ligament is a horizontal band attaching into the anteromedial portion of the occipital condyles. This ligament has been poorly studied, but it appears to restrict extension of the atlantooccipital joint. The apical ligament courses from the tip of the odontoid process to the basion. Present in only 80% of cadavers, some authors suggest that the apical ligament is rudimentary notochord tissue.

The tectorial membrane forms the posterior border of the supraodontoid space and consists of 2-3 distinct layers of tissue. Nerves and vessels travel between these layers as well as a bursa being present over the odontoid process. No clear agreement exists as to the function of the tectorial membrane. The posterior atlantooccipital membrane attaches the posterior arch of the atlas to the posterior rim of the foramen magnum. Little study has been devoted to the atlantooccipital membrane, but the vertebral arteries pierce this membrane and dura to enter the posterior fossa suggesting some clinical significance. The anterior atlantooccipital membrane attaches the anterior aspect of the atlas to the anterior rim of the foramen magnum. This soft tissue structure, along with the posterior atlantooccipital membrane, helps to maintain stability of the craniocervical joint.

The nuchal ligament is an extension of the supraspinous ligament and runs from the C7 spinous process to the inion of the occiput. This ligament restricts hyperflexion and appears to have a high concentration of proprioceptive fibers that “may play a role in maintaining proper alignment of the cervical spine.” The majority of the craniocervical ligaments are thought to be modified intervertebral discs.

The amount of elastic tissue varies from ligament to ligament. The transverse and alar ligaments contain very little elastic fibers. Ligaments that are under

constant pressure contain large amounts of fibrocartilage such as glycosaminoglycans which can trap water to act as a cushion. Fibrocartilage tends to act as a target for autoimmune disorders such as rheumatoid arthritis. Disorders such as RA, Down's Syndrome, calcium pyrophosphate dehydrate crystal deposition and "whiplash" commonly affect the ligaments of the craniocervical junction. RA tends to affect primarily the transverse ligament creating instability in the atlantoaxial joint. Approximately 9-30% of Down's syndrome children have atlantoaxial instability.

The predental space on radiograph was 8mm for a Down's Syndrome patient compared to 3mm for normal. A predental space greater than 3 mm for adult and 5 mm for children suggest transverse ligament pathology. Overhang of C1 on C2 lateral mass greater than 6.9 mm indicates a probable tear of the transverse ligament. CPPD may affect the transverse ligament and produce symptoms of myelopathy. Because the posterior atlantooccipital membrane interdigitates with the dura mater, mechanical forces may be transferred to the dura causing cervicogenic headaches. The transverse and alar ligaments are most likely to be injured in a whiplash-type injury, mainly due to their lack of elastic tissue. Plain film radiographs can provide useful information in evaluating the craniocervical ligaments, but the authors recommend MR as the imaging technique of choice. Alar ligaments can contain high amounts of epidural fat that may result in a high signal intensity on MR with no lesion present.

Conclusions

The ligaments of the craniocervical junction provide essential structural stability for this region.

Clinical Relevance

Chiropractors frequently see patients with motor vehicle or other injuries to the craniocervical junction. Neck pain, headaches, and proprioceptive symptoms are common for patients presenting for chiropractic treatment. It is important for chiropractors to understand the craniocervical anatomy and biomechanics to effectively diagnose and treat these conditions. Knowing when and, perhaps more importantly, when not to apply manual adjusting techniques to an injured craniocervical region is essential.

JACO Editorial Summary

- This article was written by authors from Children's Hospital – Birmingham, AL, the University of Tennessee, College of Medicine – Memphis, TN, Clarian Neuroscience, Campbell Brain and Spine Department of Neurological Surgery, Indiana University, Indianapolis, IN, and the Department of Anatomical Sciences, St. George's University, Grenada.
- The purpose of this study is to conduct a comprehensive review of the literature of the anatomy and biomechanics of the craniocervical junction.
- Rotation of the axis beyond 30-35 degrees can occlude the vertebral artery.
- The nuchal ligament restricts hyperflexion and appears to have a high concentration of proprioceptive fibers that "may play a role in maintaining proper alignment of the cervical spine."
- The transverse and alar ligaments contain very little elastic fibers.
- Ligaments that are under constant pressure contain large amounts of fibrocartilage such as glycosaminoglycans which can trap water to act as a cushion.
- Fibrocartilage tends to act as a target for autoimmune disorders such as rheumatoid arthritis.
- Approximately 9-30% of Down's Syndrome children have atlantoaxial instability.

- The predental space on radiograph was 8mm for a Down's Syndrome patient compared to 3mm for normal.
- A predental space greater than 3 mm for adult and 5 mm for children suggest transverse ligament pathology.
- Overhang of C1 on C2 lateral mass greater than 6.9 mm indicates a probable tear of the transverse ligament.
- CPPD may affect the transverse ligament and produce symptoms of myelopathy.
- Because the posterior atlantooccipital membrane interdigitates with the dura mater, mechanical forces may be transferred to the dura causing cervicogenic headaches.
- The transverse and alar ligaments are most likely to be injured in a whiplash-type injury, mainly due to their lack of elastic tissue.
- Plain film radiographs can provide useful information in evaluating the craniocervical ligaments, but the authors recommend MR as the imaging technique of choice for most ligaments.
- Alar ligaments can contain high amounts of epidural fat that may result in a high signal intensity on MR with no lesion present.

Summary

The results of this review should renew an interest and concern for chiropractors, especially those employing dynamic cervical techniques, for the importance of the craniocervical anatomy, neurology, and biomechanics.

References and Additional Readings

1. Adams VI: Neck injuries: III. Ligamentous injuries of the craniocervical articulation without occipito-atlantal or atlantoaxial facet dislocation. A pathologic study of 21 traffic fatalities. *J Forensic Sci* 38:1097–1104, 1993.
2. Akar Z, Kafadar AM, Tanriover N, Dashti RS, Islak C, Kocer N, et al: Rotational compression of the vertebral artery at the point of dural penetration. Case report. *J Neurosurg* 93 (2 Suppl): 300–303, 2000.
3. Benjamin M, Ralphs JR: Fibrocartilage in tendons and ligaments - an adaptation to compressive load. *J Anat* 193:481–494, 1998.
4. Bloom AI, Neeman Z, Floman Y, Gomori J, Bar-Ziv J: Occipital condyle fracture and ligament injury: imaging by CT. *Pediatr Radiol* 26:786–790, 1996.
5. Bogduk N: Anatomy of the spine, in White AH (ed): *Spine Care: Operative Treatment*. St. Louis: Mosby-Yearbook, 1995, Vol 2, p 821.
6. Boszczyk AA, Boszczyk BM, Putz R, Benjamin M, Milz S: Expression of a wide range of fibrocartilage molecules at the entheses of the alar ligaments—possible antigenic targets for rheumatoid arthritis? *J Rheumatol* 30:1420–1425, 2003.
7. Brash JC, Jamieson EB: *Cunningham's Manual of Practical Anatomy*, ed 10. New York: Oxford University Press, Vol 3, 1940.
8. Cattrysse E, Barbero M, Kool P, Gagey O, Clarys JP, Van Roy P: 3D morphometry of the transverse and alar ligaments in the occipito-atlanto-axial complex: an in vitro analysis. *Clin Anat* 20:892–898, 2007.
9. Clemente CD: *Anatomy: A Regional Atlas of the Human Body*, ed 4. Philadelphia: Lippincott Williams & Wilkins, 1997.
10. Derrick LJ, Chesworth BM: Post-motor vehicle accident alar ligament laxity. *J Orthop Sports Phys Ther* 16:6–11, 1992.
11. Dickman CA, Mamourian A, Sonntag VK, Drayer BP: Magnetic resonance imaging of the transverse atlantal ligament for the evaluation of atlantoaxial instability. *J Neurosurg* 75: 221–227, 1991.
12. Driscoll DR: Anatomical and biomechanical characteristics of upper cervical ligamentous structures: a review. *J Manipulative Physiol Ther* 10:107–110, 1987.
13. Dullerud R, Gjertsen O, Server A: Magnetic resonance imaging of ligaments and membranes in the craniocervical junction in whiplash-associated injury and in healthy control subjects. *Acta Radiol* 51:207–212, 2010.

14. Dvorak J, Hayek J, Zehnder R: CT-functional diagnostics of the rotatory instability of the upper cervical spine. Part 2. An evaluation on healthy adults and patients with suspected instability. *Spine* 12:726–731, 1987.
15. Dvorak J, Schneider E, Saldinger P, Rahn B: Biomechanics of the craniocervical region: the alar and transverse ligaments. *J Orthop Res* 6:452–461, 1988.
16. Ebraheim NA, Lu J, Yang H: The effect of translation of the C1-C2 on the spinal canal. *Clin Orthop Relat Res* 351:222–229, 1998.
17. Edwards RJ, Britz GW, Johnston FG: Fatal instability following “odontoid sparing” transoral decompression of a periodontoid pseudotumour. *J Neurol Neurosurg Psychiatry* 73:756–758, 2002.
18. el-Khoury GY, Kathol MH, Daniel WW: Imaging of acute injuries of the cervical spine: value of plain radiography, CT, and MR imaging. *AJR Am J Roentgenol* 164:43–50, 1995. R. S. Tubbs et al. 708 *J Neurosurg: Spine / Volume 14 / June 2011*.
19. Engelman ED, Schnitzlein HN, Hilbelink DR, Murtagh FR, Silbiger ML: Imaging anatomy of the cranio-vertebral junction (occipito-atlanto-axial joint). *Clin Anat* 2:241–252, 1989.
20. Farley FA, Gebarški SS, Garton HL: Tectorial membrane injuries in children. *J Spinal Disord Tech* 18:136–138, 2005.
21. Fielding JW, Cochran GB, Lawsing JF III, Hohl M: Tears of the transverse ligament of the atlas. A clinical and biomechanical study. *J Bone Joint Surg Am* 56:1683–1691, 1974.
22. Fielding JW, Hawkins RJ, Ratzan SA: Spine fusion for atlanto-axial instability. *J Bone Joint Surg Am* 58:400–407, 1976.
23. Ganguly DN, Roy KK: A study on the cranio-vertebral joint in the man. *Anat Anz* 114:433–452, 1964.
24. Ghanayem AJ, Zdeblick T, Dvorak J: Functional anatomy of joints, ligaments, and discs, in Clark CR (ed): *The Cervical Spine*, ed 3. Philadelphia: Lippincott Williams & Wilkins, 1997, p 46.
25. Grabb BC, Frye TA, Hedlund GL, Vaid YN, Grabb PA, Royal SA: MRI diagnosis of suspected atlanto-occipital dissociation in childhood. *Pediatr Radiol* 29:275–281, 1999.
26. Grant J: *A Method of Anatomy, Descriptive and Deductive*, ed 2. Baltimore: Williams and Wilkins, 1940.
27. Hack GD, Koritzer RT, Robinson WL, Hallgren RC, Greenman PE: Anatomic relation between the rectus capitis posterior minor muscle and the dura mater. *Spine* 20:2484–2486, 1995.
28. Haffajee MR, Thompson C, Govender S: The supraodontoid space or “apical cave” at the craniocervical junction: a microdissection study. *Clin Anat* 21:405–415, 2008.
29. Harris MB, Duval MJ, Davis JA Jr, Bernini PM: Anatomical and roentgenographic features of atlantooccipital instability. *J Spinal Disord* 6:5–10, 1993.
30. Hecker P: Appareil ligamenteux occipito-atloïdo-axoïdien: étude d’anatomie comparée. *Arch Anat Histol Embryol* 1: 417–433, 1922.
31. Inamasu J, Kim DH, Klugh A: Posterior instrumentation surgery for craniocervical junction instabilities: an update. *Neurol Med Chir (Tokyo)* 45:439–447, 2005.
32. Kaale BR, Krakenes J, Albrektsen G, Wester K: Active range of motion as an indicator for ligament and membrane lesions in the upper cervical spine after a whiplash trauma. *J Neurotrauma* 24:713–721, 2007.
33. Kim HJ, Jun BY, Kim WH, Cho YK, Lim MK, Suh CH: MR imaging of the alar ligament: morphologic changes during axial rotation of the head in asymptomatic young adults. *Skeletal Radiol* 31:637–642, 2002.
34. Krakenes J, Kaale BR, Nordli H, Moen G, Rorvik J, Gilhus NE: MR analysis of the transverse ligament in the late stage of whiplash injury. *Acta Radiol* 44:637–644, 2003.
35. Krakenes J, Kaale BR, Rorvik J, Gilhus NE: MRI assessment of normal ligamentous structures in the craniovertebral junction. *Neuroradiology* 43:1089–1097, 2001.
36. Krauss WE, Bledsoe JM, Clarke MJ, Nottmeier EW, Pichelmann MA: Rheumatoid arthritis of the craniovertebral

- junction. *Neurosurgery* 66 (3 Suppl):83–95, 2010.
37. Lang J: Craniocervical region, osteology, and articulations. *Neuro-Orthopedics* 1:67–92, 1986
38. Lang J: Skull Base and Related Structures. Stuttgart: Schattauer, 1995.
38. Maak TG, Tominaga Y, Panjabi MM, Ivancic PC: Alar, transverse, and apical ligament strain due to head-turned rear impact. *Spine* 31:632–638, 2006.
39. Marbacher S, Lukes A, Vajtai I, Ozdoba C: Surgical approach for synovial cyst of the atlantoaxial joint: a case report and review of the literature. *Spine* 34:E528–E533, 2009.
40. Martin MD, Bruner HJ, Maiman DJ: Anatomic and biomechanical considerations of the craniovertebral junction. *Neurosurgery* 66 (3 Suppl): 2–6, 2010.
41. Menezes AH: Craniocervical developmental anatomy and its implications. *Childs Nerv Syst* 24:1109–1122, 2008.
42. Menezes AH, Ryken TC: Craniovertebral abnormalities in Down's syndrome. *Pediatr Neurosurg* 18:24–33, 1992.
43. Milz S, Schlüter T, Putz R, Moriggl B, Ralphs JR, Benjamin M: Fibrocartilage in the transverse ligament of the human atlas. *Spine* 26:1765–1771, 2001.
44. Moguel GD, Kinsella LJ: Reversal of sympathetic failure due to cervical myelopathy in a patient with Down's syndrome. *Clin Auton Res* 13:224–226, 2003.
45. Myran R, Kvistad KA, Nygaard OP, Andresen H, Folvik M, Zwart J: Magnetic resonance imaging assessment of the alar ligaments in whiplash injuries: a case-control study. *Spine* 33: 2012–2016, 2008.
46. Nash L, Nicholson H, Lee AS, Johnson GM, Zhang M: Configuration of the connective tissue in the posterior atlantooccipital interspace: a sheet plastination and confocal microscopy study. *Spine* 30:1359–1366, 2005.
47. Nassos JT, Ghanayem AJ, Sasso RC, Tzermiadianos MN, Voronov LI, Havey RM, et al: Biomechanical evaluation of segmental occipitoatlantoaxial stabilization techniques. *Spine* 34:2740–2744, 2009.
48. Neumann D: Axial skeleton: osteology and arthrology, in *Kinesiology of the Musculoskeletal System: Foundations for Physical Rehabilitation*. St. Louis: Mosby, 2002, pp 251–310.
49. Oda T, Panjabi MM, Crisco JJ III, Bueff HU, Grob D, Dvorak J: Role of tectorial membrane in the stability of the upper cervical spine. *Clin Biomech (Bristol, Avon)* 7:201–207, 1992.
50. O'Rahilly R, Müller F, Meyer DB: The human vertebral column at the end of the embryonic period proper. 2. The occipitocervical region. *J Anat* 136:181–195, 1983.
51. Panjabi M, Dvorak J, Crisco J III, Oda T, Hilibrand A, Grob D: Flexion, extension, and lateral bending of the upper cervical spine in response to alar ligament transections. *J Spinal Disord* 4:157–167, 1991.
52. Rhoton AL Jr: The posterior cranial fossa: microsurgical anatomy and surgical approaches. *Neurosurgery* 47 (Suppl):S5–S298, 2000.
53. Saifuddin A, Green R, White J: Magnetic resonance imaging of the cervical ligaments in the absence of trauma. *Spine* 28: 1686–1692, 2003.

Announcing
our **Master of
Health Sciences**
in Clinical Chiropractic
Orthopedics



- Sports and Physical Rehabilitation track
- Occupational Health track
- Geriatrics and Pediatrics track

**Now accepting
applications for classes
beginning January 2013.**



Northwestern
Health Sciences University

College of Graduate Health Sciences
www.nwhealth.edu/graduate
admit@nwhealth.edu
800-888-4777 x409



***Your Web site is important.
And so is your time.***

Let ResidentTECH manage
your site, so you can manage
your business.

Contact us for your **FREE**
Web site evaluation!
Toll Free: **866.993.2228**
www.residenttech.com

To order the newly designed

Academy of Chiropractic Orthopedists'

Patient Education Brochure, purchase is now available at:

<http://www.dcorthoacademy.com/store-pamphlet.php>



Abstracts & Literature Review

Morphological Features and Clinical Significance of Epidural Membrane in the Cervical Spine

Akira Miyauchi, MD, Tadayoshi Sumida, MD, Hideki Manabe, MD, Yukio Mikami, MD, PhD,
Mayumi Kaneko, MD, PhD, Yoshio Sumen, MD, PhD, and Mitsuo Ochi, MD, PhD

SPINE Volume 37, Number 19, pp E1182–E1188
2012, Lippincott Williams & Wilkins

JACO Editorial Reviewer: Jeffrey R. Cates, DC, MS, FACO, DABCC

Published:
Journal of the Academy of Chiropractic Orthopedists
December 2012, Volume 9, Issue 4

The original article copyright belongs to the original publisher. This review is available from: <http://www.dcorthoacademy.com>
© 2012 Cates and the Academy of Chiropractic Orthopedists. This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Authors' Abstract:

Study Design: A prospective clinical study.

Objective: To elucidate the histomorphological features and clinical significance of the epidural membrane (EM) in the cervical spine based on operative and histological findings.

Summary of Background Data: The anatomical features of the EM have been mostly discussed on the basis of cadaver studies in the whole spine. However, the histomorphological features and clinical significance of the EM in the cervical spine based on operative findings have never been reported.

Methods: Eighty-seven patients with cervical spondylotic myelopathy who had undergone an expansive open-door laminoplasty under microscopy were evaluated with a more than 2-year follow-up period. The most damaged spinal segment was determined in each patient from the preoperative neurological and image findings along with the remaining symptoms at follow-up. The morphological features of the

EM were observed and recorded in each patient during decompression. For histology, specimens of common and remarkable types of the EM obtained from 16 patients were examined.

Results: The age at surgery averaged 64.5 years; there were 58 men and 29 women. With regard to the most damaged spinal segment, there were 14 cases at the C3–C4 level, 37 at the C4–C5 level, 32 at the C5–C6 level, and 4 at the C6–C7 level. The EM was an adipo-fibro-vascular tissue with various histomorphologies, blending with the periradicular sheath. Some EMs showed notable findings: obstructing dural tube expansion (13 cases, 14.9%), compressing a nerve root or disturbing its mobility (4 cases, 4.6%), and the combined type (1 case, 1.1%). All of them were located at approximately the most damaged spinal segment. In addition, some EMs had interesting histological features, such as harboring many small arteries, calcified debris, and metaplastic bone fragments.

Conclusion: The EM can develop into remarkable structures with spondylosis and aging in patients with cervical spondylotic myelopathy, affecting surgical outcomes as

well as successful decompression procedures. A sound understanding of the histomorphological features of the EM is required to obtain satisfactory surgical outcomes in the limited field afforded by minimally invasive surgery.

Key words: Cervical spine, epidural membrane, histology, myelopathy, minimally invasive surgery.

Background

This prospective study reviews the histology, morphology, and gross anatomical changes seen in patient with cervical spondylotic myelopathy in an operative setting. The purpose of this study was to further the understanding of the features and role of the epidural membrane in cervical spondylotic myelopathy.

Methods

Eighty-seven patients were included in this study. Observation and documentation of the subjects pre-surgical condition was accomplished with CT, MRI, and the Japanese Orthopedic Association (JAO) scoring system. In vivo evaluation of the epidural membrane was performed during surgery and pathological epidural membranes (p-EM) were assessed as type 1 or type 2; Type 1 p-EM being a band like or membranous constriction adhering to the dura, whereas the type 2 compressed the nerve root and/or restricted its mobility. Post surgical histological evaluation of removed tissues was also performed.

Results

Post surgical JOA scores improved with the mean recovery rate being 47.4 +/- 25.9%. Morphological features noted in the study included fibrous tissue on the central portion of the dura with increased vascularization in the lateral portion. Additionally, there were adhesions to the ligamentum flavum and dura. There was also a fibrous root pouch noted. Type 1 p-EM were found in 14.9% of cases and type 2 p-EM in 4.6% combined types were seen in 1.1%. Histological evaluation of tissues recovered during surgery show loose fibrous tissue with

scattered calcified debris, vascular anomalies including pseudoangioma-like changes and immature stromal cells.

Conclusions

The complexity and diversity of symptoms and findings seen with cervical spondylotic myelopathy make it difficult to diagnose and treat. This study shows that the EM attaches to both the ligamentum flavum and dura, and, is highly vascularized laterally. These data are of particular interest to those performing surgical procedures.

Clinical Relevance

Cervical spondylotic myelopathy can be difficult to diagnosis. It can be painless, progressive and debilitating. While CSM is not an absolute contraindication to chiropractic management or care, the practitioner that chooses to do so should have a firm grasp of the diagnostic and management challenges these cases can present. This paper provides the reader with advance insight and understanding of the role of the epidural membrane in these cases.

JACO Editorial Summary:

- The article was written by authors from the departments of orthopedic surgery and pathology, Hiroshima City, Asa Hospital, Hiroshima, Japan; the department of orthopedic surgery, Onomichi General Hospital, Onomichi, Japan; and the department of orthopedic surgery, Graduate School of Biomedical Sciences, Hiroshima University, Hiroshima, Japan.
- The purpose of this study was to further the understanding of the features and role of the epidural membrane in cervical spondylotic myelopathy.
- This study reviews the histology, morphology, and gross anatomical changes seen in patient with cervical spondylotic myelopathy in an operative setting
- Surgical intervention improved patients with CSM mean recovery rate 47% (JOA score).
- Morphological features noted in the study included fibrous tissue on the central portion

of the dura with increased vascularization in the lateral portion. Additionally, there were adhesions to the ligamentum flavum and dura.

- Histological evaluation of tissues recovered during surgery show loose fibrous tissue with scattered calcified debris, vascular anomalies including pseudoangioma-like changes and immature stromal cells.

Summary

This study adds to the basic understanding of the cervical spondylotic myelopathy and the role that the epidural membrane can play in its development.

References

1. Frykholm R. Cervical epidural Structures, periradicular and epidural sheath . *Acta Chir Scand* 1951 ; 102: 10–20.
2. SSunderland S . Meningeal-neural relations in the intervertebral foramen. *J Neurosurg* 1974; 40: 756–63.
3. Hayashi K, Yabuki T, Kurokawa T, et al. The anterior and the posterior longitudinal ligament of the lower cervical spine. *J Anat* 1977; 124: 633–6.
4. Kikuchi S. Anatomical and experimental studies of nerve root infiltration. *J Jpn Orthop Assoc* 1982; 56: 605–14.
5. Williams RW . Microcervical foraminotomy. *Spine* 1983; 8: 708–16.
6. Zeidman SM, Ducker TB. Posterior cervical laminoforaminotomy for radiculopathy. *Neurosurgery* 1993; 33: 356–62.
7. Nakagawa H, Mikawa Y, Watanabe R. Elastin in the human posterior longitudinal ligament and spinal dura. *Spine* 1994; 19: 2164–9.
8. Kubo Y, Waga S, Kojima T, et al. Microsurgical anatomy of the lower cervical spine and cord. *Neurosurgery* 1994; 34: 895–902.
9. Baba I, Sumida T, Ishida A, et al. Risk factors and prevention for C5 nerve root palsy after expansive open door laminoplasty for cervical spondylotic myelopathy and OPLL with microsurgical foraminotomy by operating microscope [in Japanese]. *Rinsho Sseikei Geka* 1995; 30: 499–505.
10. Tanaka N, Fujimoto Y, An HS, et al. The anatomical relation among the nerve roots, intervertebral foramina, and intervertebral discs of the cervical spine. *Spine* 2000; 25: 286–91.
11. Baba I. ‘Open door’ laminoplasty and microcervical foraminotomy. In: Baba I , ed. *Color Atlas of Microsurgery of the Spine & Spinal Cord*. Hiroshima, Japan: Hiroshima University; 2007: 15–33.
12. Shinomiya K, Dawson J, Spengler DM, et al. An analysis of the posterior epidural ligament role on the cervical spinal cord. *Spine* 1996; 21: 2081–8.
13. Chen CJ, Hsu HL, Tseng YC, et al. Hirayama flexion myelopathy: neutral-position MR imaging findings-important of loss of attachment. *Radiology* 2004; 231: 39–44.
14. Shiraishi T, Fukuda K, Yato Y, et al. Results of skip laminectomy: minimum 2-year follow-up study compared with open-door laminoplasty. *Spine* 2003; 28: 2667–72.
15. Yabuki S , Kikuchi S . Endoscopic partial laminectomy for cervical myelopathy. *J Neurosurg Spine* 2005; 2: 170–4.
16. Yukawa Y, Kato F, Ito K, et al. Laminoplasty and skip laminectomy for cervical compressive myelopathy. *Spine* 2007; 32: 1980–85.
17. Hirabayashi K, Miyakawa J, Satomi K, et al. Operative results and postoperative progression of ossification among patients with ossification of cervical posterior longitudinal ligament. *Spine* 1981; 6: 354–64.
18. Imagama S , Matsuyama Y , Yukawa Y , et al. C5 palsy after cervical laminoplasty: a multicentre study . *J Bone Joint Surg Br* 2010; 92: 393–400.
19. Glotzbecker MP , Bono CM , Wood KB , et al. Postoperative spinal epidural hematoma. *Spine* 2010; 35: 413–20.
20. Pospiech J , Panjonk F , Stolke D . Epidural scar tissue formation after spinal surgery: an experimental study. *Eur Spine* 1995; 4: 213–9.
21. Matsumoto M, Ishikawa M, Ishii K, et al. Usefulness of neurological examination for diagnosis of the affected level in patients

- with cervical compressive myelopathy: prospective comparative study with radiological evaluation. *J Neurosurg Spine* 2005; 2: 535–9.
22. Seichi A , Takeshita K , Kawaguchi H , et al. Neurologic level diagnosis of cervical stenotic myelopathy. *Spine* 2006; 31: 1338–43.
23. Ibrahim RE , Sciotto CG , Weidner N . Pseudoangiomatous hyperplasia of mammary stroma. Some observations regarding its clinicopathologic spectrum. *Cancer* 1989; 63: 1154–60.

Announcements

The American College of Chiropractic Orthopedists Presents:

Clinical Update 2013

April 25, 26 & 27th, 2013

The Tropicana, Las Vegas, Nevada
(ACCO Special Room Rates Apply Until: 03/24/2013)

For more information go to:

www.accoweb.org



ACCO
THE AMERICAN COLLEGE OF CHIROPRACTIC ORTHOPEDISTS

THE ACCO IS AN INTERNATIONAL ORGANIZATION DEDICATED TO THE ADVANCEMENT OF
THE PRACTICE OF NON-SURGICAL ORTHOPEDICS.