American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Chronic Neck Pain**

Variant 1: **Patient of any age, without or with a history of previous trauma, first study**.

Radiologic Procedure	Rating	Comments	RRL*
X-ray cervical spine	9	AP, lateral, open mouth, both obliques.	☢☢
X-ray myelography cervical spine	2		☢☢☢
CT cervical spine without contrast	2		☢☢☢
Myelography and post myelography CT cervical spine	2		☢☢☢☢
MRI cervical spine without contrast	2		O
Tc-99m bone scan neck	2		☢☢☢
Facet injection/arthrography cervical spine selective nerve root block	2		☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 2: **Patient of any age, history of previous malignancy, first study.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray cervical spine	9	AP, lateral, open mouth, both obliques.	☢☢
CT cervical spine without contrast	2		☢☢☢
MRI cervical spine without contrast	2		O
Tc-99m bone scan neck	2		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 3: **Patient of any age, history of previous neck surgery, first study.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray cervical spine	9	AP, lateral, open mouth, both obliques.	☢☢
CT cervical spine without contrast	2		☢☢☢
MRI cervical spine without contrast	2		O
Tc-99m bone scan neck	2		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Clinical Condition: **Chronic Neck Pain**

Variant 4: **Radiographs normal. No neurologic findings.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray myelography cervical spine	2		☢ ☢ ☢
CT cervical spine without contrast	2		☢ ☢ ☢
Myelography and post myelography CT cervical spine	2		☢ ☢ ☢ ☢
MRI cervical spine without contrast	2		O
Tc-99m bone scan neck	2		☢ ☢ ☢
Facet injection/arthrography cervical spine selective nerve root block	2		☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 5: **Radiographs normal. Neurologic signs or symptoms present.**

Radiologic Procedure	Rating	Comments	RRL*
MRI cervical spine without contrast	9		O
Myelography and post myelography CT cervical spine	5	If MRI contraindicated.	☢ ☢ ☢ ☢
X-ray myelography cervical spine	2		☢ ☢ ☢
CT cervical spine without contrast	2		☢ ☢ ☢
Tc-99m bone scan neck	2		☢ ☢ ☢
Facet injection/arthrography cervical spine selective nerve root block	2		☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 6: **Radiographs show spondylosis. No neurologic findings.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray myelography cervical spine	2		☢ ☢ ☢
CT cervical spine without contrast	2		☢ ☢ ☢
Myelography and post myelography CT cervical spine	2		☢ ☢ ☢ ☢
MRI cervical spine without contrast	2		O
Tc-99m bone scan neck	2		☢ ☢ ☢
Facet injection/arthrography cervical spine selective nerve root block	2		☢ ☢
X-ray discography cervical spine	1		☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Clinical Condition: **Chronic Neck Pain**

Variant 7: **Radiographs show spondylosis. Neurologic signs or symptoms present.**

Radiologic Procedure	Rating	Comments	RRL*
MRI cervical spine without contrast	9		O
Myelography and post myelography CT cervical spine	5	If MRI contraindicated.	☢☢☢☢
X-ray myelography cervical spine	2		☢☢☢
CT cervical spine without contrast	2		☢☢☢
Tc-99m bone scan neck	2		☢☢☢
Facet injection/arthrography cervical spine selective nerve root block	2		☢☢
X-ray discography cervical spine	1		☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 8: **Radiographs show old trauma. No neurologic findings.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray myelography cervical spine	2		☢☢☢
CT cervical spine without contrast	2		☢☢☢
Myelography and post myelography CT cervical spine	2		☢☢☢☢
MRI cervical spine without contrast	2		O
Tc-99m bone scan neck	2		☢☢☢
Facet injection/arthrography cervical spine selective nerve root block	2		☢☢
X-ray discography cervical spine	1		☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Clinical Condition: **Chronic Neck Pain**

Variant 9: **Radiographs show old trauma. Neurologic signs or symptoms present.**

Radiologic Procedure	Rating	Comments	RRL*
MRI cervical spine without contrast	9		O
Myelography and post myelography CT cervical spine	5	If MRI contraindicated.	☢☢☢☢
X-ray myelography cervical spine	2		☢☢☢
CT cervical spine without contrast	2		☢☢☢
Tc-99m bone scan neck	2		☢☢☢
Facet injection/arthrography cervical spine selective nerve root block	2		☢☢
X-ray discography cervical spine	1		☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 10: **Radiographs show bone or disc margin destruction.**

Radiologic Procedure	Rating	Comments	RRL*
MRI cervical spine without contrast	9		O
CT cervical spine with contrast	5	CT with contrast should be performed if MRI is unavailable or cannot be performed for any suspected disc space infection.	☢☢☢
X-ray myelography cervical spine	2		☢☢☢
CT cervical spine without contrast	2		☢☢☢
Myelography and post myelography CT cervical spine	2		☢☢☢☢
Tc-99m bone scan neck	2		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Expert Panel on Musculoskeletal Imaging: Richard H. Daffner, MD[1]; Barbara N. Weissman, MD[2]; Peter D. Angevine, MD, MPH[3]; Erin Arnold, MD[4]; Laura Bancroft, MD[5]; D. Lee Bennett, MD, MA[6]; Judy S. Blebea, MD[7]; Michael A. Bruno, MD[8]; Ian Blair Fries, MD[9]; Langston Holly, MD[10]; Jon A. Jacobson, MD[11]; Jonathan S. Luchs, MD[12]; William B. Morrison, MD[13]; Charles S. Resnik, MD[14]; Catherine C. Roberts, MD[15]; Mark E. Schweitzer, MD[16]; Leanne L. Seeger, MD[17]; David W. Stoller, MD[18]; Mihra S. Taljanovic, MD[19]; James N. Wise, MD.[20]

Summary of Literature Review

Background

The patient with chronic neck pain presents both diagnostic and therapeutic dilemmas for the clinician [1-4] because of considerable controversy in the literature over its etiology, as well as the role of imaging in its evaluation. Regarding etiology, the literature focuses on two general categories: post-traumatic and degenerative. Post-traumatic etiologies include the so-called "whiplash" syndrome, defined as any injury to the cervical vertebrae and adjacent soft tissues as a result of sudden jerking. This classically includes extension-flexion mechanisms sustained in rear-end motor vehicle collisions (MVC) as well as abrupt lateral flexion mechanisms. In addition, research in Canada and Scandinavia has identified a constellation of signs and symptoms termed whiplash-associated disorders (WAD) [5-7]. Table 1 shows the classification of WAD according to the Quebec Task Force [6,7].

Table 1. Quebec Task Force Classification of Whiplash-Associated Disorders (WAD) [6,7]

Grade	Clinical Presentation
0	No neck complaints. No physical signs.
1	Neck complaint of pain, stiffness, or tenderness only. No physical signs.
2	Neck complaint and musculoskeletal signs (↓ range of motion and/or tenderness).
3	Neck complaint and neurological signs (↓ or absent deep tendon reflexes, weakness and sensory deficits.
4	Neck complaint and fracture or dislocation.

Degenerative conditions include spondylosis, degenerative disc disease, and acute disc herniation. Degeneration may also be secondary to previous injury. In addition, there are many anecdotal reports in the literature about other etiologies of chronic neck pain that include carotid or vertebral artery dissection, arteriovenous malformations, and tumors.

Overview of Imaging Modalities

There was little in the older literature on the use of imaging modalities in the evaluation of patients with chronic neck pain. Most of the studies cite the use of radiographs, particularly to diagnose spondylosis, degenerative disc disease, or post-traumatic malalignment [6]. From a radiologic standpoint, a diagnosis of spondylosis may be made if any one of three findings is present: 1) osteophytes, 2) disc space narrowing, or 3) facet disease. Other imaging options available include facet injections [1,8,9] and provocative tests using discography [10-15]. The most recent literature focuses on the utility of magnetic resonance imaging (MRI), particularly in patients with WAD [5,7,16-19].

For this review, 27 papers are included in the bibliography. Three of these papers evaluated the largest groups of patients with chronic neck pain: Mäkelä et al (7,270 patients) [4]; the Quebec Task Force led by Spitzer et al (3,014 patients) [6]; and van der Donk et al (5,440 patients) [9]. The Quebec study focused entirely on whiplash. The other two studies discussed the etiology of neck pain in relation to other contributing factors.

Mäkelä et al [4] studied a representative sample of Finnish adults and, found the chronic neck syndrome occurring in 10% of men and 14% of women. Contributing features of symptoms included previous history of trauma and mental and physical stress at work.

The study by van der Donk et al [9] confirmed observations made by other investigators on smaller patient populations that disc disease is more likely to cause neck pain in men but not in women. In patients with spondylosis, they found that the presence of pain is related more closely to personality traits, neuroticism, and

[1]Principal Author and Panel Chair, Allegheny General Hospital, Pittsburgh, Pennsylvania.
[2]Panel Vice-chair, Brigham & Women's Hospital, Boston, Massachusetts.
[3]Columbia University Medical Center, New York, New York, American Association of Neurological Surgeons/Congress of Neurological Surgeons.
[4]Illinois Bone and Joint Institute, Morton Grove, Illinois, American College of Rheumatology.
[5]Florida Hospital, Orlando, Florida.
[6]University of Iowa Health Center, Iowa City, Iowa.
[7]Cleveland Clinic, Cleveland, Ohio.
[8]Penn State Milton S. Hershey Medical Center, Hershey, Pennsylvania.
[9]Bone, Spine and Hand Surgery, Chartered, Brick, New Jersey, American Academy of Orthopaedic Surgeons.
[10]University of California-Los Angeles Medical Center, Los Angeles, California, American Association of Neurological Surgeons/Congress of Neurological Surgeons.
[11]University of Michigan Medical Center, Ann Arbor, Michigan.
[12]Winthrop University Hospital, Mineola, New York.
[13]Thomas Jefferson University Hospital, Philadelphia, Pennsylvania.
[14]University of Maryland School of Medicine, Baltimore, Maryland.
[15]Mayo Clinic, Phoenix, Arizona.
[16]University of Ottawa, Ottawa, Ontario, Canada.
[17]David Geffen School of Medicine, University of California Los Angeles, Los Angeles, California.
[18]California Pacific Medical Center, San Francisco, California.
[19]University of Arizona Health Sciences Center, Tucson, Arizona.
[20]University of Kentucky, Lexington, Kentucky.

Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

the presence of previous injury.

The Quebec Task Force on whiplash [6] evaluated its members' experience with the disorder. It used consensus methods similar to those followed by the ACR committees on Appropriateness Criteria®. They developed a flow sheet defining WAD and made recommendations for diagnosis and management.

The literature review showed that there were *no* reliable radiologic or laboratory data to confirm or refute a diagnosis of whiplash [20,21]. Furthermore, there was little correlation between the presence of cervical spondylosis or degenerative disc disease and the severity or duration of patient symptoms. Although additional factors are associated with chronic neck pain, our study group considered only the imaging parameters. Personality traits and secondary gain (particularly in patients with post-traumatic neck pain) were prominent findings. While spondylosis and disc disease increase with age and are frequently asymptomatic, whiplash can accelerate these processes and lead to symptoms [22]. For these reasons, no variant specifically addressed whiplash per se. The variants cover the scenarios of chronic neck pain without considering the etiology (trauma, arthritis, or neoplasm).

Discography and Facet Joint Injections

Nearly a decade ago there was an increased emphasis on the use of provocative diagnostic discography and facet joint injections [9-15]. These studies purportedly were indicated for those patients who have multilevel facet or disc disease, in which the offending disc or facet joint cannot be identified. Facet injection, with or without arthrography, may help identify the location of pain source. Of particular note, however, is that extensive research by Carragee and associates [10-12] (with lumbar discography) has demonstrated that pain intensity during disc injection is most influenced by the emotional and psychological profiles of the patient as well as the influence of any ongoing compensation claims. They concluded that discography could not be used to reliably confirm the location of a pain source. Most recently, however, the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and its Associated Disorders concluded that there was no evidence to support using cervical provocative discography or anesthetic facet or nerve blocks [23].

Magnetic Resonance Imaging

More recently, investigators have reported the use of MRI for evaluating patients with chronic neck pain [5,7,16-19,24-26]. The earlier studies [16,17] suggested that MRI is the single best method for detecting and distinguishing between the various clinical diagnostic possibilities that may cause neck pain. Furthermore, cervical MRI examinations frequently include the upper thoracic spine, where degenerative changes have been shown to be associated with cervical symptoms [25]. However, more recent studies show that there is still no consensus on the usefulness of MRI in evaluating the ligaments and membranes of the craniocervical junction (CCJ) in patients with WAD [7,18,19,22,24,25,27]. Krakenes and Kaale [19] clearly felt that MRI could show structural changes in ligaments and membranes and concluded that there was correlation between clinical impairment and morphologic findings. On the other hand, Kongsted et al [24] found trauma-related MRI findings to be rare in WAD (7 of 178 patients). Myran et al [25] studied three groups of patients. The first had MVC-related WAD; the second had chronic neck pain with no traumatic history; the third group consisted of controls without neck pain and no traumatic history. They found no significant differences in the MRI findings of signal changes of the craniocervical ligament and concluded that signal changes previously attributed to trauma were not sustainable. Ichihare et al [22] in a long-term study of 133 patients found that MRI demonstrated progressive degenerative changes not associated with clinical symptoms. In addition, they concluded that there was no statistically significant association between the MRI findings and changes in clinical symptoms. Finally, Caragee [27] in a commentary on the Myran paper concluded that signal changes in alar ligaments are not reliable enough to indicated that ligament damage has occurred. He reiterated the conclusions of the Task Force on Neck Pain, of which he is a member, that "The validity of high-intensity signal MRI findings in the upper cervical spine ligaments as representing acute whiplash injury had not been demonstrated" [23].

There are, however, other abnormalities that MRI is useful for demonstrating in addition to ligamentous changes at the CCJ. These include disc herniations, canal encroachment by osteophytes or syndesmophytes, tumor, infection, fractures, and post-traumatic ligament ruptures of the lower cervical column. Although MRI is not perfect for finding all the causes of chronic neck pain, particularly at the CCJ, it is still considered the gold standard for making most diagnoses.

Is there a role for cervical computed tomography (CT) in patients with chronic neck pain? The literature has not addressed this issue, other than the pronouncement by Nordin's group. The Task Force on Neck Pain felt that cervical CT scans had better validity than radiographs in assessing high-risk and/or multi-injured blunt trauma patients. There is consensus among the members of the Musculoskeletal Imaging Expert Panel that CT myelography is a viable alternative to MRI for patients with suspected cord involvement, when MRI cannot be performed [23].

Clinical Scenarios

Our review considered a number of clinical scenarios in which patients presented with chronic neck pain. These included situations in which we attempted to determine the optimal first study to be performed in patients of any age without or with a history of remote trauma and in patients of any age with a history of previous malignancy or previous remote surgery.

Finally, seven clinical scenarios were considered that included patients in whom radiographs were normal or

showed cervical spondylosis, evidence of old trauma or deformity, or bony or disc margin destruction. Scenarios included patients without and with neurologic signs and symptoms. Whiplash was not considered as a separate entity, since patients with WAD will fit into one of the seven categories listed.

Summary

These guidelines apply to imaging of patients with chronic neck pain regardless of the etiology (trauma, arthritis, neoplasm):

- Patients of any age with chronic neck pain without or with a history of remote trauma should initially undergo a 5-view radiographic examination (anteroposterior [AP], lateral, open mouth, both obliques).
- Patients with a history of previous malignancy should initially undergo a 5-view radiographic examination. Radionuclide bone scanning should not be the initial procedure of choice [6].
- Patients with a history of neck surgery in the remote past should initially undergo a 5-view radiographic examination.
- Patients with normal radiographs and no neurologic signs or symptoms need no further imaging.
- Patients with normal radiographs and neurologic signs or symptoms should undergo cervical MRI that includes the CCJ and the upper thoracic region [5,16,17]. If there is a contraindication to the MRI examination such as a cardiac pacemaker or severe claustrophobia, CT myelography with multiplanar reconstruction is recommended.
- Patients with WAD should undergo MRI looking for disc herniations, spur encroachment of the vertebral canal, or ligament abnormalities of the lower cervical region. The value of MRI of the CCJ in patients with WAD is controversial [7,18,19,22,24,25].
- Patients with chronic neck pain from whiplash should undergo imaging following the guidelines above.
- Patients with radiographic evidence of cervical spondylosis or of previous trauma *without* neurologic signs or symptoms need no further imaging.
- Patients with radiographic evidence of cervical spondylosis or of previous trauma and neurologic signs or symptoms should undergo MRI. If there is a contraindication to MRI, CT myelography is recommended.
- Patients with radiographic evidence of bone or disc margin destruction should undergo MRI. If an epidural abscess is suspected, the examination should be performed with intravenous contrast. CT is indicated only if MRI cannot be performed.
- Facet injection and arthrography are useful for patients with multilevel disease diagnosed by any imaging modality to identify the specific level(s) producing symptoms.
- Discography is not recommended [1,23].
- The use of additional imaging procedures should be determined in a case-by-case manner, and the evaluation of patients with chronic neck pain should follow this "tailor-made" approach.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢ ☢	0.1-1 mSv	0.03-0.3 mSv
☢ ☢ ☢	1-10 mSv	0.3-3 mSv
☢ ☢ ☢ ☢	10-30 mSv	3-10 mSv
☢ ☢ ☢ ☢ ☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Procedure Contrast Information
- Evidence Table

References

1. Aprill C, Bogduk N. The prevalence of cervical zygapophyseal joint pain. A first approximation. *Spine* 1992; 17(7):744-747.
2. Deans GT, Magalliard JN, Kerr M, Rutherford WH. Neck sprain--a major cause of disability following car accidents. *Injury* 1987; 18(1):10-12.
3. Gore DR, Sepic SB, Gardner GM, Murray MP. Neck pain: a long-term follow-up of 205 patients. *Spine* 1987; 12(1):1-5.

4. Makela M, Heliovaara M, Sievers K, Impivaara O, Knekt P, Aromaa A. Prevalence, determinants, and consequences of chronic neck pain in Finland. *Am J Epidemiol* 1991; 134(11):1356-1367.
5. Kaale BR, Krakenes J, Albrektsen G, Wester K. Whiplash-associated disorders impairment rating: neck disability index score according to severity of MRI findings of ligaments and membranes in the upper cervical spine. *J Neurotrauma* 2005; 22(4):466-475.
6. Spitzer WO, Skovron ML, Salmi LR, et al. Scientific monograph of the Quebec Task Force on Whiplash-Associated Disorders: redefining "whiplash" and its management. *Spine* 1995; 20(8 Suppl):1S-73S.
7. Vetti N, Krakenes J, Eide GE, Rorvik J, Gilhus NE, Espeland A. MRI of the alar and transverse ligaments in whiplash-associated disorders (WAD) grades 1-2: high-signal changes by age, gender, event and time since trauma. *Neuroradiology* 2009; 51(4):227-235.
8. Anderberg L, Annertz M, Brandt L, Saveland H. Selective diagnostic cervical nerve root block--correlation with clinical symptoms and MRI-pathology. *Acta Neurochir (Wien)* 2004; 146(6):559-565; discussion 565.
9. van der Donk J, Schouten JS, Passchier J, van Romunde LK, Valkenburg HA. The associations of neck pain with radiological abnormalities of the cervical spine and personality traits in a general population. *J Rheumatol* 1991; 18(12):1884-1889.
10. Carragee EJ, Alamin TF. Discography. a review. *Spine J* 2001; 1(5):364-372.
11. Carragee EJ, Chen Y, Tanner CM, Truong T, Lau E, Brito JL. Provocative discography in patients after limited lumbar discectomy: A controlled, randomized study of pain response in symptomatic and asymptomatic subjects. *Spine* 2000; 25(23):3065-3071.
12. Carragee EJ, Tanner CM, Yang B, Brito JL, Truong T. False-positive findings on lumbar discography. Reliability of subjective concordance assessment during provocative disc injection. *Spine* 1999; 24(23):2542-2547.
13. Grubb SA, Kelly CK. Cervical discography: clinical implications from 12 years of experience. *Spine* 2000; 25(11):1382-1389.
14. Ohnmeiss DD, Guyer RD, Mason SL. The relation between cervical discographic pain responses and radiographic images. *Clin J Pain* 2000; 16(1):1-5.
15. Ortiz AO, Johnson B. Discography. *Tech Vasc Interv Radiol* 2002; 5(4):207-216.
16. Boutin RD, Steinbach LS, Finnesey K. MR imaging of degenerative diseases in the cervical spine. *Magn Reson Imaging Clin N Am* 2000; 8(3):471-490.
17. Chen CJ, Hsu HL, Niu CC, et al. Cervical degenerative disease at flexion-extension MR imaging: prediction criteria. *Radiology* 2003; 227(1):136-142.
18. Johansson BH. Whiplash injuries can be visible by functional magnetic resonance imaging. *Pain Res Manag* 2006; 11(3):197-199.
19. Krakenes J, Kaale BR. Magnetic resonance imaging assessment of craniovertebral ligaments and membranes after whiplash trauma. *Spine (Phila Pa 1976)* 2006; 31(24):2820-2826.
20. Arana E, Marti-Bonmati L, Montijano R, Bautista D, Molla E, Costa S. Relationship between Northwick Park neck pain questionnaire and cervical spine MR imaging findings. *Eur Spine J* 2006; 15(8):1183-1188.
21. Leak AM, Cooper J, Dyer S, Williams KA, Turner-Stokes L, Frank AO. The Northwick Park Neck Pain Questionnaire, devised to measure neck pain and disability. *Br J Rheumatol* 1994; 33(5):469-474.
22. Ichihara D, Okada E, Chiba K, et al. Longitudinal magnetic resonance imaging study on whiplash injury patients: minimum 10-year follow-up. *J Orthop Sci* 2009; 14(5):602-610.
23. Nordin M, Carragee EJ, Hogg-Johnson S, et al. Assessment of neck pain and its associated disorders: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine (Phila Pa 1976)* 2008; 33(4 Suppl):S101-122.
24. Kongsted A, Sorensen JS, Andersen H, Keseler B, Jensen TS, Bendix T. Are early MRI findings correlated with long-lasting symptoms following whiplash injury? A prospective trial with 1-year follow-up. *Eur Spine J* 2008; 17(8):996-1005.
25. Myran R, Kvistad KA, Nygaard OP, Andresen H, Folvik M, Zwart JA. Magnetic resonance imaging assessment of the alar ligaments in whiplash injuries: a case-control study. *Spine (Phila Pa 1976)* 2008; 33(18):2012-2016.
26. Arana E, Marti-Bonmati L, Molla E, Costa S. Upper thoracic-spine disc degeneration in patients with cervical pain. *Skeletal Radiol* 2004; 33(1):29-33.
27. Carragee EJ. Continuing debate: validity and utility of magnetic resonance imaging of the upper cervical spine after whiplash exposure. *Spine J* 2009; 9(9):778-779.