Supplemental Digital Material

Search Terms/strategies

Key Question 1:

Search (spondylotic[TIAB] OR MYELOPATHY[TIAB] OR “OSSIFICATION OF THE POSTERIOR LONGITUDINAL LIGAMENT”[TIAB] OR OPLL[TIAB]) AND (cervical[TIAB]) AND (MRI[TI] OR MAGNETIC RESONANCE IMAGING[TI] OR "Magnetic Resonance Imaging"[Mesh]) Filters: Comparative Study; Randomized Controlled Trial; Clinical Trial

Key Questions 2 and 3:

Search (spondylotic[TIAB] OR MYELOPATHY[TIAB] OR “OSSIFICATION OF THE POSTERIOR LONGITUDINAL LIGAMENT”[TIAB] OR OPLL[TIAB]) AND (cervical[TIAB]) AND (MRI[TIAB] OR MAGNETIC RESONANCE IMAGING[TIAB] OR "Magnetic Resonance Imaging"[Mesh] OR “SIGNAL INTENSITY[TIAB] OR T2[TIAB]) AND (incidence[MeSH:noexp] OR mortality[MeSH Terms] OR follow up studies[MeSH:noexp] OR prognos\*[Text Word] OR predict\*[Text Word] OR course\*[Text Word]) NOT (HIRAYAMA[TIAB] OR CASE REPORT OR "Review" [Publication Type] OR "Case Reports" [Publication Type])

Risk of Bias of included studies

Table S1. Methodological quality (risk of bias) of prognostic studies assessing MRI factors associated with outcome following surgical treatment.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Methodological principle** | **Chen** **(2001)** | **Chibbaro****(2006)** | **Kim****(2008)** | **Okada** **(1993)** | **Nakashima****(2012)** | **Park** **(2006)** | **Setzer (2009)** | **Shin****(2010)** | **Suda****(2003)** |
| Study design |  |  |  |  |  |  |  |  |  |
| Prospective cohort\* study |  |  |  |  | **🗸** |  | **🗸** |  |  |
| Retrospective cohort\* study | **🗸** | **🗸** | **🗸** | **🗸** |  | **🗸** |  | **🗸** | **🗸** |
| Case-control study |  |  |  |  |  |  |  |  |  |
| Case-series  |  |  |  |  |  |  |  |  |  |
| For cohort study: Patients at similar point in the course of their disease or treatment for cohort study | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** |
| Patients followed long enough for outcomes to occur | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** |
| Complete follow-up of > 80%† |  | **🗸** |  |  |  |  |  |  |  |
| Accounting for other prognostic factors‡ | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** |
| **Evidence class** | **III** | **II** | **III** | **III** | **II** | **III** | **II** | **III** | **III** |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Methodological principle** | **Suri****(2003)** | **Uchida****(2005)** | **Vedantam****(2011)** | **Wada****(1999)** | **Wang****(2010)** | **Yamazaki****(2003)** | **Zhang** **(2011)** | **Zhang****(2010)** |
| Study design |  |  |  |  |  |  |  |  |
| Prospective cohort\* study |  |  |  |  |  |  |  |  |
| Retrospective cohort\* study | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** |
| Case-control study |  |  |  |  |  |  |  |  |
| Case-series  |  |  |  |  |  |  |  |  |
| For cohort study: Patients at similar point in the course of their disease or treatment for cohort study | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** |
| Patients followed long enough for outcomes to occur | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** |
| Complete follow-up of > 80%† |  |  |  |  |  |  |  |  |
| Accounting for other prognostic factors‡ | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** | **🗸** |
| **Evidence class** | **III** | **III** | **III** | **III** | **III** | **III** | **III** | **III** |

\*Cohort studies follow individuals with the exposure of interest over time and monitor for occurrence of the outcome of interest.

†Applies to cohort studies only.

‡Authors must consider other factors that might influence patient outcomes.

Table S2. Methodological quality (risk of bias) of prognostic studies assessing MRI factors associated with outcome following nonsurgical treatment.

|  |  |  |  |
| --- | --- | --- | --- |
| **Methodological principle** | **Oshima****(2012)** | **Shimomura****(2007)** | **Yoshimatsu****(2001)** |
| Study design |  |  |  |
| Prospective cohort\* study |  | **🗸** |  |
| Retrospective cohort\* study | **🗸** |  | **🗸** |
| Case-control study |  |  |  |
| Case-series  |  |  |  |
| For cohort study: Patients at similar point in the course of their disease or treatment for cohort study | **🗸** |  | **🗸** |
| Patients followed long enough for outcomes to occur | **🗸** | **🗸** | **🗸** |
| Complete follow-up of > 80%† | **🗸** | **🗸** |  |
| Accounting for other prognostic factors‡ | **🗸** | **🗸** |  |
| **Evidence class** | **II** | **II** | **III** |

\*Cohort studies follow individuals with the exposure of interest over time and monitor for occurrence of the outcome of interest.

†Applies to cohort studies only.

‡Authors must consider other factors that might influence patient outcomes.

**Table S3. Excluded articles and reasons for exclusion.**

|  |  |  |
| --- | --- | --- |
| **Author** | **year** | **Reason for exclusion** |
| **NONOPERATIVE STUDIES** |  |
| Bednarik | 2004 | Presymptomatic CSM |
| Bednarik | 2008 | Presymptomatic CSM |
| Bednarik | 1999 | No MRI |
| Barnes | 1984 | No MRI |
| Nakamura | 1998 | No MRI |
| Kadanka  | 2000 | Not prognostic |
| Kadanka | 2002 | Not prognostic |
| Kadanka | 2005 | Univariate |
| Kadanka | 2011 | Not prognostic |
| Matsumoto | 2000 | Univariate |
| Matsumoto | 2001 | Univariate |
| Sumi | 2012 | Univariate |
| **SURGICAL STUDIES** |  |  |
| Ahn JS | 2010 | no multivariate analyses |
| Alafifi T  | 2007 | no multivariate analyses |
| Avadhani A | 2010 | no multivariate analyses |
| Bucciero A | 1993 | no multivariate analyses |
| Chatley A | 2009 | no multivariate analyses |
| Chiewvit P | 2011 | no multivariate analyses |
| Chung | 2002 | no multivariate analyses |
| Fernandez de Rota | 2007 | no multivariate using MRI as exposure |
| Giammona G | 1993 | no multivariate analyses |
| Huang | 2003 | no multivariate analyses |
| Kasai | 2001 | no multivariate analyses |
| Kohno K | 1997 | no multivariate analyses |
| Mastronardi L | 2007 | no multivariate analyses |
| Matsuyama Y | 2004 | no multivariate analyses |
| Mihara | 2007 | no multivariate analyses |
| Mizuno J | 2003 | no multivariate analyses |
| Morio Y | 2001 | Comparison groups, n <5 |
| Morio Y | 1994 | no multivariate analyses |
| Naderi S | 1998 | no multivariate analyses |
| Nakamura M | 1998 | no multivariate analyses |
| Nakamura M | 2012 | no multivariate analyses |
| Papadopoulos CA | 2004 | no multivariate analyses |
| Satomi K | 2001 | no multivariate analyses |
| Seichi A | 2011 | no multivariate analyses |
| Shen HX | 2009 | no multivariate analyses |
| Singh A | 2001 | no multivariate analyses |
| Takahashi M | 1989 | no multivariate analyses |
| Uchida  | 2012 | no multivariate analyses |
| Yagi M | 2010 | no multivariate analyses |
| Yukawa Y | 2007 | no multivariate analyses |
| Zhang YZ | 2009 | same as Zhang 2010 |

**References for excluded articles**

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**2.** Alafifi T, Kern R, Fehlings M. Clinical and MRI predictors of outcome after surgical intervention for cervical spondylotic myelopathy. *J Neuroimaging.* Oct 2007;17(4):315-322.

**3.** Avadhani A, Rajasekaran S, Shetty AP. Comparison of prognostic value of different MRI classifications of signal intensity change in cervical spondylotic myelopathy. *Spine J.* Jun 2010;10(6):475-485.

**4.** Bucciero A, Vizioli L, Carangelo B, Tedeschi G. MR signal enhancement in cervical spondylotic myelopathy. Correlation with surgical results in 35 cases. *J Neurosurg Sci.* Dec 1993;37(4):217-222.

**5.** Chatley A, Kumar R, Jain VK, Behari S, Sahu RN. Effect of spinal cord signal intensity changes on clinical outcome after surgery for cervical spondylotic myelopathy. *J Neurosurg Spine.* Nov 2009;11(5):562-567.

**6.** Chiewvit P, Tritrakarn SO, Phawjinda A, Chotivichit A. Predictive value of magnetic resonance imaging in cervical spondylotic myelopathy in prognostic surgical outcome. *J Med Assoc Thai.* Mar 2011;94(3):346-354.

**7.** Chung SS, Lee CS, Chung KH. Factors affecting the surgical results of expansive laminoplasty for cervical spondylotic myelopathy. *Int Orthop.* 2002;26(6):334-338.

**8.** Fernandez de Rota JJ, Meschian S, Fernandez de Rota A, Urbano V, Baron M. Cervical spondylotic myelopathy due to chronic compression: the role of signal intensity changes in magnetic resonance images. *J Neurosurg Spine.* Jan 2007;6(1):17-22.

**9.** Giammona G, Giuffrida S, Greco S, Grassi C, Le Pira F. Magnetic resonance imaging in cervical spinal cord compression. *Arq Neuropsiquiatr.* Sep 1993;51(3):407-408.

**10.** Huang RC, Girardi FP, Poynton AR, Cammisa Jr FP. Treatment of multilevel cervical spondylotic myeloradiculopathy with posterior decompression and fusion with lateral mass plate fixation and local bone graft. *J Spinal Disord Tech.* Apr 2003;16(2):123-129.

**11.** Kasai Y, Uchida A. New evaluation method using preoperative magnetic resonance imaging for cervical spondylotic myelopathy. *Arch Orthop Trauma Surg.* Oct 2001;121(9):508-510.

**12.** Kohno K, Kumon Y, Oka Y, Matsui S, Ohue S, Sakaki S. Evaluation of prognostic factors following expansive laminoplasty for cervical spinal stenotic myelopathy. *Surg Neurol.* Sep 1997;48(3):237-245.

**13.** Mastronardi L, Elsawaf A, Roperto R, et al. Prognostic relevance of the postoperative evolution of intramedullary spinal cord changes in signal intensity on magnetic resonance imaging after anterior decompression for cervical spondylotic myelopathy. *J Neurosurg Spine.* Dec 2007;7(6):615-622.

**14.** Matsuyama Y, Kawakami N, Yanase M, et al. Cervical myelopathy due to OPLL: clinical evaluation by MRI and intraoperative spinal sonography. *J Spinal Disord Tech.* Oct 2004;17(5):401-404.

**15.** Mihara H, Kondo S, Takeguchi H, Kohno M, Hachiya M. Spinal cord morphology and dynamics during cervical laminoplasty: evaluation with intraoperative sonography. *Spine (Phila Pa 1976).* Oct 1 2007;32(21):2306-2309.

**16.** Mizuno J, Nakagawa H, Inoue T, Hashizume Y. Clinicopathological study of "snake-eye appearance" in compressive myelopathy of the cervical spinal cord. *J Neurosurg.* Sep 2003;99(2 Suppl):162-168.

**17.** Morio Y, Teshima R, Nagashima H, Nawata K, Yamasaki D, Nanjo Y. Correlation between operative outcomes of cervical compression myelopathy and mri of the spinal cord. *Spine (Phila Pa 1976).* Jun 1 2001;26(11):1238-1245.

**18.** Morio Y, Yamamoto K, Kuranobu K, Murata M, Tuda K. Does increased signal intensity of the spinal cord on MR images due to cervical myelopathy predict prognosis? *Arch Orthop Trauma Surg.* 1994;113(5):254-259.

**19.** Naderi S, Ozgen S, Pamir MN, Ozek MM, Erzen C. Cervical spondylotic myelopathy: surgical results and factors affecting prognosis. *Neurosurgery.* Jul 1998;43(1):43-49; discussion 49-50.

**20.** Nakamura M, Fujimura Y. Magnetic resonance imaging of the spinal cord in cervical ossification of the posterior longitudinal ligament. Can it predict surgical outcome? *Spine (Phila Pa 1976).* Jan 1 1998;23(1):38-40.

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**23.** Satomi K, Ogawa J, Ishii Y, Hirabayashi K. Short-term complications and long-term results of expansive open-door laminoplasty for cervical stenotic myelopathy. *Spine J.* Jan-Feb 2001;1(1):26-30.

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**31.** Zhang YZ, Wang LF, Shen Y, Ding WY, Xu JX, He J. The effects of MRI signal intensity changes and clinical manifestations on prognosis after surgical intervention for cervical spondylotic myelopathy. *Orthop Surg.* May 2009;1(2):101-106.

**Table S4. Detailed tables for prognostic studies of outcome following nonsurgical care.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Author (year) Study Design** | **Study Objective** | **Sample and Characteristics** | **Non-MRI factors assessed** | **MRI factor assessed** | **Outcome Measures** | **Follow-up** | **Effect and Summary of Results** |
| Oshima et al. (2012)Retrospective cohort | To investigate natural course and prognostic factors in patients with mild forms of CSM, focusing on intramedullary ISI on T-2 weighted MRI. | N = 45Male: 60% Mean age (range): 58.9 years (35–76)Diagnosis:Mild CSM (n = 45)Conservative treatment:None (observation) | * Age
* Alignment (C2-7) (˚)
* Developmental canal stenosis (yes: no)
* Duration of disease
* Local slip (yes: no)
* Pre-op JOA
* ROM (C2-7) (˚)
* Segmental lordotic angle (˚)
* Segmental ROM (˚)
* Sex
 | T2WI:* Spinal cord diameter (%)\*
 | * Conversion to surgery based on deterioration of motor JOA score†
 | Mean 78 months (range, 24-208) | **Correlation of MRI factor with conversion to surgery***Spinal Cord Diameter (<50%)** HR = 2.24 (95% CI, 0.83-6.06; *P* = .11)
 |
| Shimomura et al. (2007)Prospective cohort | To investigate the outcomes and prognostic factors for CSM after nonsurgical treatment. | N = 70Male: 70%Mean age: 55.1 years Diagnosis:Mild CSM (n = 70)Conservative treatment: 2 week hospitalization, in-bed Good Samaritan traction for 8 hours a day with or without anti-inflammatory drugs | * Age
* Developmental or dynamic cnal factors of cervical spine (DVF or DNF)
* Follow-up period (months)
* Pre-op JOA
* Sex
 | T2WI:* Presence or absence of preoperative high signal intensity within the spinal cord
* Extent of spinal cord compression at the max compression segment (circumferential and partial)‡
 | * Deterioration based on JOA score
 | Mean 35.6 months (± 25.2) | **Correlation of MRI factor with deterioration***Presence of high signal intensity area** OR = 1.32 (95% CI, 0.16-10.8; *P* = .80)

*Circumferential spinal cord compression* * OR = 26.6 (95% CI, 1.68-421.5; *P* = .02)
 |
| Yoshimatsu et al. (2001)Retrospective cohort | To investigate symptomatic changes after conservative treatment in patients based on a clear understanding of the effects and limitations of conservative treatment. | N = 69Male: 51%Mean age (range): 67 (42-87) yearsDiagnosis:Mild CSM (n = 69)Rigorous conservative treatment: Continuous traction by the Good-Samaritan method 3-4 hours daily, immobilized cervical spine by a cervical orthosis in combination with drug therapy and exercise therapy, carried out for 1-3 months | * Age
* Antero-posterior diameter of the spinal canal
* Disease duration
* Past therapeutic history
* Pre-op JOA
* Presence of conservative treatment
* Presence of rigorous conservative treatment
 | T2WI:* Presence of ISI
* Number of intervertebral discs compressing the spinal cord§
 | * Exacerbation or improvement of symptoms based on JOA
 | Mean 29 months (range, 1-76) | **Correlation of MRI factor with exacerbation***Presence of ISI** OR = 1.52 (*P* = .52)

*Number of intervertebral discs compressing the spinal cord** OR = 1.41 (*P* = .42)

**Correlation of MRI factor with improvement***Presence of ISI** OR = 0.53 (*P* = .42)

*Number of intervertebral discs compressing the spinal cord** OR = 1.09 (*P* = .87)
 |

CSM = cervical spondylotic myelopathy; HR = hazard ratio; ISI = increased signal intensity; JOA = Japanese Orthopaedic Association; MRI = magnetic resonance imaging; ROM = range of motion.

\*The extent of spinal cord compression was defined by the ratio of the spinal cord diameter of the narrowest part to that of the C1 level using sagittal images on T2-weighted MRI (< 50% versus ≥ 50%)

†Motor JOA score: Upper extremity motor function: 0-cannot eat with a spoon; 1-can eat with a spoon but not with chopsticks; 2-can eat with chopsticks but to a limited degree; 3-can eat with chopsticks but awkward; 4-no disability; Lower extremity: 0-cannot walk; 1-needs cane or aid on flat ground; 2-needs cane or aid only on stairs; 3-can walk without cane or aid but slowly; 4-no disability.

‡Partial spinal cord compression: ventral surface of spinal cord is compressed by a combination of osteophytes and disc bulging. Still dorsal subarachnoid space for spinal cord can be seen; Circumferential spinal cord compression: circumferential surface of spinal cord is compressed and deformed by a combination of osteophytes, disc bulging, and ligamentum flavum infolding. Dorsal subarachnoid space for spinal cord cannot be seen.

§Mean number of discs compressing the spinal cord: Improvement = 2.40 ± 0.74; Exacerbation = 2.33 ± 0.75; No change = 1.89 ± 0.78

**Table S5. Detailed tables for prognostic studies of outcome following surgery.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Author (year)****Study design** | **Study Objective(s)** | **Sample and Characteristics** | **Non-MRI factors assessed** | **MRI factor assessed** | **Outcome Measures** | **Follow-up** | **Effect and Summary of Results\*** |
| Chen et al. (2001)Retrospective cohort | To determine whether intramedullary signal intensity on T2-weighted MRI is an important predictor of outcome  | N = 64Male: 65.6%Mean age (range): 56.67 (27-86) yearsMean duration of symptoms: NRDiagnosis: * CSM

Decompression surgery:* Type NR

Signal intensity (SI) grade†*Grade 0 (n = 20)*Male: 60.0%Mean age: 61.5 years*Grade 1 (n = 23)*Male: 65.2%Mean age: 54.1 years*Grade (n = 21)*Male: 71.4%Mean age: 55.0 yearsCervical curvature*Grade 0* Normal: 35% (7/20)Abnormal: 65% (13/20)*Grade 1*Normal: 30% (7/23)Abnormal: 70% (16/23)*Grade 2*Normal: 24% (5/21) Abnormal: 76% (16/21)Cord compression ratio (mean)*Grade* *0*: 44.0 ± 10.1*Grade 1*: 27.6 ± 11.7*Grade 2*: 26.1 ± 9.2 | * Sex
* Pre-op JOA score
* Age
 | * Pattern of intramedullary high SI.
* Cervical curvature
* Cord compression ratio
 | * Recovery ratio percentage of 21 point JOA score
 | 6 months (% f/u NR) | **SI grade and JOA recovery ratio percentage:** * SI grade 0: 58.0 ± 25.3
* SI grade 1: 68.2 ± 20.8
* SI grade 2: 29.7 ± 22.4

*grade 1 vs. 0*: regression coefficient = 5.63; P = .490*grade 2 vs. 0:* regression coefficient = –33.30; *P* < .001*grade 2 vs. 1: P* < .001 (no regression coefficient)**Cervical curvature and recovery rate (%) of JOA score:**Regression coefficient = –0.77; *P* = .901**Cord compression ratio and recovery rate (%) of JOA score:**Regression coefficient = –0.21; *P* = .422 |
| Chibbaro et al. (2006)Retrospectivecohort | To evaluate the prognostic value of several clinical and imaging variables in patients undergoing anterior cervical corpectomy. | N = 70Male: 67.1%Mean age (range): 57 (29-76) yearsMean duration of symptoms (range): 13.4 (4-120) monthsDiagnosis: * CSM

Decompression surgery:* Anterior cervical corpectomy
 | * Age
* Duration of symptoms
* Number of levels decompressed
 | * T1 and T2 weighted SI changes
 | * 17 point mJOA
 | Mean 42 months (range, 12-83) (90.9% f/u; n = 70/77) | **Preoperative MRI signal change and postoperative mJOA score:*** Low SI change on T1W sequences = lower postoperative mJOA score (P < .05)
* High SI on MRI T2W sequences = higher postoperative mJOA score (*P* < .01)
 |
| Kim et al. (2008)Retrospective cohort | To assess the effect of diabetes mellitus and smoking on the outcome of surgery for cervical myelopathy on the outcome of cervical laminoplasty, while also investigating the interaction between the various prognostic factors. | N = 87Male: 57%Mean age (range): 62.3 years (42–76)Mean duration of symptoms (range): 10 months (4–36)Diagnosis: * CSM, OPLL [with diabetes mellitus (n = 31) and control group (n = 56)]

Decompression surgery:* Expansive open door laminoplasty: n = 87
 | * Age
* Presence of diabetes
* Presence of diabetes and older age (interaction)
* Presence of diabetes and smoking (interaction)
* Duration of symptoms
* Preoperative JOA score
 | * Signal change (increased signal on T2 with a decreased signal on T1)

  | * Recovery rate of JOA score‡
 |  2 years (%f/u NR) | **Risk of Poor Outcome (< 50% in JOA recovery rate) in multivariate analysis:**aOR = 3.53 (95% CI, 1.67–5.95); *P* = .01“Signal changes on MRI proved to be a significant risk factor for a poor outcome” |
| Morio et al. (2001)Retrospective cohort | To reinvestigate the characteristics of MRI findings in cervical compression myelopathy that reflect the clinical symptoms and prognosis, and to identify radiographic and clinical factors that correlate with the prognosis. | N = 73Male: NRMean age (range): 64 years (43–81)Mean duration of symptoms (group with MRI signal changes decreased postop): 14.9 ± 16.6 monthsMean duration of symptoms (group with MRI signal changes unchanged): 32.5 ± 27.8 months Diagnosis:* CSM (including 9 patients with soft disc herniations with developmental canal stenosis) (n = 42)
* OPLL (n = 31)

Decompression surgery:* Cervical expansive laminoplasty (n = 73)
* French door or modified French door and laminectomy (n = NR)
 | * Age
* Duration of symptoms
* Severity of myelopathy (preoperative JOA score)
* Transverse area of spinal cord at site responsible for cervical myelopathy
 | * Preoperative SI changes (on T1-weighted sequences/T2-weighted sequences: **N/N** = normal SI on T1 /normal SI on T2; **N/Hi** = normal SI on T1/Hi SI on T2; **Lo/Hi** = low SI on T1/Hi SI on T2)
 | * Recovery rate of JOA score‡
* JOA score
 | 3.4 years (range 0.5 – 10 years) (% f/u NR) | **Preop MRI Signal Change in multivariate analysis:****JOA recovery rate**Adjusted R2 = 0.297; *P* = .0002 **Postop JOA score**Adjusted R2 = 0.703; *P* < .0001“Low-signal intensity changes on T1-weighted sequences indicate a poor prognosis. High-signal intensity changes on T2-weighted images include a broad spectrum of compressive myelomalacic pathologies and reflect a broad spectrum of spinal cord recuperative potentials.” |
| Nakashima (2012)Prospectivecohort | To investigate the relationship between preop step test results and postop neurological recovery (particularly for lower limb function), and ascertain the crucial determinants of surgical outcomes using statistical analyses. | N = 101Male: 60.4%Mean age (±SD): 63.6 ± 11.8 yearsMean duration of symptoms (±SD): 2.6 ± 3.6 yearsDiagnosis:* CSM: n = 87
* OPLL: n = 14

Decompression surgery:* Double door laminoplasty (Kurokawa’s method)
 | * Preop step test ≥ 14.5
* Age
* Sex
* Duration of symptoms
* Preop JOA score
* C2-C7 angle on lateral radiographs
* C7 plumb line on whole spinal lateral radiographs
 | * SI change on T2-weighted images in sagittal and axial planes
 | * Effective clinical results in JOA score (> 50% JOA recovery rate)
* “Effective” clinical results on JOACMEQ-L (either condition met: 1) the postop score was higher than the preop score by ≥ 20 points or, 2) the preop score was less than 90, and the postop score reached 90 points or more)
 | > 1 year (range NR) (78.9% f/u; n = 101/128) | **JOA recovery rate > 50%***P* = ns on univariate analysis so variable was not included in multivariate analysis**Effective clinical results on JOACMEQ-L,** *multivariate analysis*HR = 0.39 (0.13-1.18); *P* = .98 |
| Okada et al. (1993)Retrospective cohort | To determine whether spinal cord plasticity and intramedullary signal intensity are predictive of surgical outcome. | N = 74Male: 70.3% Mean age (range): 58.9 years (35–83)Mean duration of symptoms: NRDiagnosis:OPLL (n = 23)CSM (n = 34)CDH (n = 17)Decompression surgery:Anterior (n = 20)Posterior (n = 54) | * Age
* Duration of symptoms
* Preoperative JOA
 | * Transverse area
* SI Ratio
* Compression ratio
 | * Recovery rate of JOA score‡
 | NR (% f/u NR) | **Correlation of MRI factor with recovery rate (%) of JOA score (univariate analysis)***Preoperative transverse area** OPLL: r = 0.678 (*P* < .01)
* CSM: r = 0.586 (P < .01)
* CDH: NS

*Signal intensity ratio** OPLL: r = 0.537 (*P* < .01)
* CSM: r = 0.426 (*P* < .01)
* CDH: NS

Compression ratio* NS for all diagnoses

“The increased intramedullary T2-weighted MRI signal at the site of maximal cord compression significantly influenced the rate of recovery” |
| Park et al. (2006)Retrospective cohort | To determine any clinical or imaging factors that are predictive of surgical outcome and to formulate a multiple regression equation incorporating all of these factors. | N = 80Male: 62.5%Mean age (range): 62.1 (36-86) yearsMean duration of symptoms (± SD): 19.1 ± 21.1 monthsDiagnosis:* CSM (n = 61)
* OPLL (n = 11)
* CDH (n = 8)

Decompression surgery:* Various methods

High intensity signal changes on T2-WI\*\**Group A (n = 41)*Mean age: 64.4 ± 10.9Mean duration of symptoms: 18.2 ± 22.6 months*Group B (n = 32)*Mean age: 58.0 ± 10.5Mean duration of symptoms: 18.1 ± 17.1 months*Group C (n = 7)*Mean age: 67.3 ± 9.6Mean duration of symptoms: 28.3 ± 29.1  | * Age
* Duration of symptoms
* Pre-op severity
* Surgical method
* Type of disease
 | * Number of compressed segments§
* Presence of intramedullary high intensity segments on T2WI
* Number of intramedullary high intensity segments on T2WI (Group vs. Group B vs. Group C)
 | * Recovery rate of NCSS
 | 3 months (% f/u NR) | **Correlation of MRI factor with recovery rate (%) of NCSS:*** Presence of high intensity segments on T2WI (*P* = .031)
* Number of compressed segments (NS, *P* = .791)

**High intensity segments on T2-WI and recovery rate (%) of NCSS score:** * Group A: 58.2 ± 32.1
* Group B: 40.5 ± 31.0
* Group C: 32.7 ± 37.0

*P* = .018 (A, B and C)*P* = .012 (A and B)*P* = .096 (A and C)“In multivariate analysis, number of high intensity segments on T2WI was found to correlated with recovery rate; R=-0.289, *P* < .01” |
| Setzer (2009)Prospective cohort | To evaluate the association of APOE polymorphism and the outcome of CSM patients after an ACDF and anterior cervical corpectomy | N = 60Male: 66.7%Mean age (range): 61.5 (26–86) yearsMean duration of symptoms (± SD): 22.0 ± 30.5 months Diagnosis:* CSM

Decompression surgery:* ACDF (n = 41)

Corpectomy (n = 19) | * Age
* Symptom duration
* Preop mJOA score
* APOE ε4 carrier status
 | * Diameter of the most effected segment of the spinal cord
* Number of affected segments
* SI on T2-weighted images
 | * mJOA
 | Mean 18.8 ± 4.6 months | **No improvement in mJOA**All MRI factors assessed were *P* = ns in the multivariate analysis |
| Shin (2010)Retrospective cohort | To determine any radiological or clinical factors that are predictive of outcome following ACDF for the treatment of CSM. | N = 70Male: 64.3%Mean age (range): 51.1 (26–69) yearsMean duration of symptoms (range): 9.9 weeks (1–60)Diagnosis:* CSM

Decompression surgery:* Anterior cervical discectomy and fusion (ACDF) at one (n = 43) or two (n = 27) levels

Signal intensity (SI) grade†*Grade 0 (n = 20)*Mean age: 49.3 ± 8.8 yearsMean duration of symptoms: 5.8 ± 8.8 weeks *Grade 1 (n = 25)*Mean age: 53.7 ± 9.2Mean duration of symptoms: 10.4 ± 12.9 weeks *Grade 2 (n = 25)*Mean age: 50.0 ± 10.3Mean duration of symptoms: 12.6 ± 9.5 weeksCompression ratio (%)*Grade 0*: 35.6 ± 7.5*Grade 1*: 32.7 ± 6.7*Grade 2*: 31.9 ± 10.4 | * Age
* Symptom duration
* Cervical curvature
* Cervical stenosis
* Preoperative JOA
* Postoperative JOA
 | * Grade of SI on T2-weighted images
* Length of SI change on T2-weighted images
* Compression ratio of spinal cord
 | * Recovery rate of JOA score‡
 | Mean 32.7 months (range, 10.4-50.5) (f/u NR) | **SI grade and recovery rate (%) of JOA score (regression analysis):** “In regression analysis, SI grade was found to be prognostic of neurological outcome” *P* = .027*Univariate analysis*:* SI grade 0: 81.5 ± 17.0
* SI grade 1: 70.1 ± 17.3
* SI grade 2: 60.7 ± 20.9

*P* = .002 for comparisons between SI grades* *SI grade 1 vs. 0: NR*
* *SI grade 2 vs. 0: NR*

**Length of SI change and recovery rate (%) of JOA score (regression analysis):**NS (*P* = .096) **Cord compression ratio and recovery rate (%) of JOA score (regression analysis):** NS (*P* = .595) “The SI grade on the preoperative T2WI was negatively related to neurological outcome. Hence, the severity of SI change…emerged as a significant prognostic factor in post-operative CSM.” |
| Suda (2003)Retrospective cohort | To investigate the influence of preoperative cervical alignment on postoperative neurologic recovery, and to determine the crucial determinants of postoperative clinical results using statistical measures. | N = 114Male: 79%Mean age: 60 years (range 30–81 years)Mean duration of symptoms: NRDiagnosis:* CSM with non-traumatic cervical lesions (n = 154)

Decompression surgery:* Bilateral open-door laminoplasty (n = 154)
 | * Age
* Sex
* Preoperative JOA score
* Local kyphosis angle
* Number of enlarged laminae
* Overall cervical alignment (C2-C7 angle)
 | * Signal change on T1- and T2-weighted imaging in both sagittal and axial planes
 | * Recovery rate of JOA score‡
 | 5 years (range 2–13 years) (74% f/u; n = 114/154) | **Risk of Poor Outcome (< 50% in JOA recovery rate) in multivariate analysis**OR = 4.10 (95% CI, 1.51-11.12); *P* < .01“Signal intensity change in the spinal cord on MRI also was another factor associated with poor surgical outcomes. The patients with signal intensity changes showed poor neurological recovery, even after sufficient decompression surgery.” |
| Suri et al. (2003)Retrospective cohort | To assess the prognostic value of various clinical and MRI factors  | N = 146Male: 79.5%Mean age (range): 47.1 (17-76) yearsMean duration of symptoms (range): 11.7 (1.5-120) monthsDiagnosis:* CSM

Decompression surgery:* Anterior cervical discectomy, corpectomy, laminectomy, or laminoplasty
 | * Age
* Duration of symptoms
* Surgical approach
 | * Number of prolapsed intervertebral discs (PIVDs)
* Intramedullary signal changes (ISCs) on T1WI and T2WI
 | * Motor Improvement
* Nurick grade
 | 3 and 6 months (Postop MRI was obtained in 44 of 121 (36.4%) patients with ISCs on preop MRI) | **Motor improvement** *aOR (95% CI)*Number of PIVDs * 1 vs. ≥ 3 levels: 2.12 (0.7, 10.4)
* 2 vs. ≥ 3 levels: 0.72 (0.22, 1.32)

*P* = NSSignal changes * None vs. T1 + T2: 5.1 (1.87, 25.1)

*P* ≤ .001* T2 vs. T1 + T2: 2.9 (1.4, 9.19)

*P* ≤ .05**Nurick grade** *aOR (95% CI)*Number of PIVDs * 1 vs. ≥ 3 levels: 2.91 (0.7, 10.4)
* 2 vs. ≥ 3 levels: 2.61 (0.4, 8.9)

*P* < .001Signal changes * None vs. T1 + T2: NR, P > .05
* T2 vs. T1 + T2: 3.23 (1.2, 16.0)

*P* <.05 |
| Uchida (2005)Retrospective cohort | To report the results of multivariate analysis and multiple regression analysis of neurological outcome in 135 patients who underwent cervical decompressive surgery. | N = 135Male: 62%Mean age (range): 43.8 years (27–73) Duration of symptoms: < 1 year to ≥ 3 yearsDiagnosis:* CSM (n = 77)
* OPLL (n = 58)

Decompression surgery:* En bloc C3–C7 open door laminoplasty (n = 92)
* Robinson’s anterior fusion (n = 15)
* Subtotal spondylectomy at 1–2 vertebrae with interbody fusion (n = 28)
 | * Age at surgery
* Preoperative JOA score
* Type of OPLL
* Type of myelopathy
* Spinal cord evoked potentials type
* Spinal canal narrowing (preop CT)
* Postoperative expansion rate of spinal canal
* Radiological abnormality
 | * Level of compression
* Spinal cord alignment after laminoplasty
* Rate of flattening of the cord
* Increased transverse area of the cord
* SI on MRI
 | * JOA score
 | 8.3 years (range 1.0 – 12.8 years) (% f/u NR) | CSM (multivariate analysis)*Anterior surgery (n = 32)***Level of compression** * ≥ 3 disc levels involved: *P* = .008

**Rate of flattening of the cord*** ≥ 70%: *P* = ns
* < 50%: *P* = .038

**Increased transverse area of the cord*** < 40%: *P* = .038
* 40%-59%: *P* = .023
* ≥ 60%: *P* = .009

*Laminoplasty (n = 45)***Level of compression** * ≥ 3 disc levels involved: *P* = .029

**Rate of flattening of the cord*** ≥ 70%: *P* = .049
* < 50%: *P* = .012

**Increased transverse area of the cord*** < 40%: *P* = .008
* 40%-59%: *P* = .006
* ≥ 60%: *P* = .007

OPLL (multivariate analysis)*Anterior surgery (n = 11)***Level of compression** * 2 levels involved: *P* = .039
* ≥ 3 disc levels involved: N/A

**Rate of flattening of the cord*** ≥ 50%: *P* = .046
* < 30%: *P* ≥ .05

**Increased transverse area of the cord*** < 40%–59%: *P* = .013

*Laminoplasty (n = 47)***Level of compression** * 2 levels involved: *P* = .008
* ≥ 3 disc levels involved: *P* = .003

**Rate of flattening of the cord*** ≥ 50%: *P* = .029
* < 30%: *P* = .043

**Increased transverse area of the cord*** < 40%–59%: *P* = .0009

**Spinal cord alignment and intensity signal** were *P* = ns for all groups.Multivariate analysis indicated that the outcome for patients with CSM was positively influenced, in order ofimportance, by increased transverse area of the cord ≥60%, presence of single-level anterior fusion, a high preoperative neurological score, normal epidural SCEPs, and clinical features of brachialgia and cord type; in patients with OPLL: presence of mixed or localized OPLL, normal epidural SCEPs, high preoperative neurological score, a single-vertebra spondylectomy with anterior fusion, laminoplasty, widening of the transverse area of the cord ≥40%, and an expansion rate of the spinal canal after laminoplasty ≥40%. |
| Vedantam et al. (2011)Retrospective cohort | To evaluate whether the type of increased signal intensity (ISI) is a predictor of surgical outcome.  | N = 197Male: 93.9%Mean age (± SD): 48.8 ± 0.6 yearsMean duration of symptoms (range): 8 months (1-180)Diagnosis* CSM, with OPLL identified in 67 patients

Decompression surgery* Central corpectomy at 1-level (n = 99), 2-levels (n = 92), and 3-levels (n = 6)

Signal intensity (SI) grade†*Grade 0 (n = 30)*Mean age (±SD): 49.3 ± 1.8 yearsMedian duration of symptoms: 8.5 months *Grade 1 (n = 104)*Mean age (±SD): 48.6 ± 0.8 yearsMedian duration of symptoms: 6.0 months *Grade 2 (n = 63)*Mean age (±SD): 3.3 ± 0.1 yearsMedian duration of symptoms: 8.0 months  | * Age
* Duration of symptoms
* Pre-op Nurick
 | * SI grade on T2WI

(**Type 1**: dull or light with unclear margins**Type 2**: brilliant or intense and clearly defined)* Hypointensity on T1WI
 | * Nurick grade change ≥1
* Cure: Nurick f/u grade of 0 or 1
 | Mean 35.2±1.9 months (% f/u NR) | **Nurick grade change ≥1** *aOR (95% CI)*Signal intensity grade* Type 2 vs. 0/1: 0.8 (0.3, 1.7) *P* = .59
* Type 1 vs. 0: 0.7 (3, 1.5) *P* = .41

Hypointensity * NR

**Cure** *aOR (95% CI)*Signal intensity grade* Type 2 vs. 0/1: 0.48 (0.2, 0.9) *P* = .04
* Type 1 vs. 0: 1.4 ( 0.7-2.7) *P* = .23

Hypointensity * Present vs. absent: 0.1 (0.01, 0.9) *P* = .04
 |
| Wada (1999)Retrospective cohort | To investigate whether MRI can predict the surgical outcome in patientswith CSM | N = 50Male: 72%Mean age (±SD): 61.0 ± 10.9 years (range, 45–81)Mean duration of symptoms (±SD): 9.1 ± 8.5 months (range, 1–36)Diagnosis:* CSM

Decompression surgery:* Open-door laminoplasty
 | * Age
* Duration of symptoms
* Severity of myelopathy
* AP canal diameter at max compression on plain radiographs
* Transverse area of spinal cord at max compression on CT myelography
* Number of blocks on myelogram
 | * SI changes on T2-weighted images in sagittal and axial views
 | * Recovery rate of JOA score‡
 | Mean 35.1 months (range 24.4–48.3) (67% f/u) | **Segments of high intensity and JOA recovery rate (%)**Correlation coefficient = –.294; *P* = ns (not included in multivariate analysis) |
| Wang (2010)Retrospective cohort | To investigate the clinical significance of both the signal intensity ratio obtainedfrom MR imaging and clinical manifestations on the prognosis of patients with cervical OPLL. | N = 58Male: 71%Mean age (range): 59.6 years (47–77)Mean duration of symptoms: NRDiagnosis:* OPLL

Decompression surgery:* Expansive open-door laminoplasty

Groups based on SI ratio* Low (< 1.396), n = 23;

Mean age: 55.8 ± 8.9 years* Intermediate (≥ 1.396 and < 1.689), n = 20;

Mean age: 61.2 ± 7.7 years* High (≥ 1.689), n = 15;

Mean age: 63.4 ± 8.9 years | * Age
* Duration of disease
* Preoperative JOA score
* Babinski sign
* Ankle clonus
 | * Change in SI ratio (low, intermediate, high) on T2-weighted images
 | * Recovery rate of JOA score‡
* JOA score
 | 14.6 months (range 12–18 months) (57% f/u; n = 58/102) | **JOA recovery rate (median [IQR]) (univariate analysis):*** Low : 0.75 (0.26)
* Intermediate: 0.56 (0.42)
* High: 0.20 (0.15)

*P* = .002 for *Low vs. Intermediate**P* < .001 for *Low vs. High**P* < .001 for *Intermediate vs. High***Postop JOA score** **(median [IQR]) (univariate analysis):*** Low : 15.0 (2.0)
* Intermediate: 13.0 (4.0)
* High: 9.0 (2.0)

*P* = .001 for *Low vs. Intermediate**P* < .001 for *Low vs. High**P* < .001 for *Intermediate vs. High*“Patients with low signal intensity ratios that changed on T2-weighted imaging experienced a good surgical outcome.” |
| Yamazaki et al. (2003)Retrospective cohort | To determine clinical and imaging predictors of surgical outcome | N = 64Male: 51.6%Mean age (± SD): 64.6 ±12.0 yearsMean duration of symptoms (± SD): 25.6 ± 30.6 monthsGroups based on age*Eldery (≥65 years, n = 35)*Mean age (±SD): 73.9 ± 4.4 yearsMean duration of symptoms (±SD): 20.7 ± 19.2 months*Younger (<65 years, n = 29)*Mean age (±SD): 53.4 ± 7.8 years Mean duration of symptoms (±SD): 33.6 ± 39.8 months | * Age
* Duration of symptoms
* Pre-op JOA score
* Canal diameter
* Transverse area
 | * SI changes on T2WI
 | * Recovery ratio of JOA score‡

Excellent: ≥50% (n=44)Fair: <50% (n=20) | Mean 40 months (% f/u NR) | **Recovery rate of JOA score:**Age <64 years:*Signal intensity** Excellent recovery: 6/21 (28.6%)
* Fair recovery: 2/8 (25.0%)

*P* = .84865+ years:*Signal intensity** Excellent recovery: 4/23 (17.4%)
* Fair recovery: 6/12 (50.0%)

*P* = .051 |
| Zhang (2011)Retrospective cohort |  To elucidate whether preoperative increased signal intensity can reflect symptom severity and predictsurgical outcomes in patients with CSM on the basis of a T2-weighted to T1-weighted MRI ratio (T2:T1 ratio).  | N = 52Male: 57.7%Mean age (range): 56.3 years (45–67)Mean duration of symptoms (range): 16.1 months (3–34)Diagnosis: * CSM caused by degenerative disc disease at 1 level (n = 23) or multiple levels (n = 29)

Decompression surgery: * Anterior (n = 31)
* Posterior (n = 16)
* Combined anterior and posterior (n = 5)

Groups based on increased signal intensity (ISI) ratio*With ISI (n = 36)*Mean age: 57.9 ± 6.3 yearsDuration of symptoms: 18.7 ± 7.5 monthsWithout ISI (n = 16)Mean age: 52.8 ± 6.7 yearsDuration of symptoms: 10.4 ± 5.1 months | * Age
* Duration of disease
 | * Increased signal intensity (ISI) ratio
 | * Recovery rate of JOA score‡
* JOA score
 | Mean 23 months (range, 15–30) (%f/u NR) | **JOA recovery rate (%) (univariate analysis)*** Without ISI: 54.3 ± 13.2
* With ISI: 27.3 ± 12.8
* Intermediate ISI††: 32.6 ± 14.4
* High ISI††: 21.9 ± 8.3

*P* < .05 for *None vs. Intermediate**P* < .05 for *None vs. High**P* < .05for *Intermediate vs. High***Postoperative JOA score (univariate analysis)*** Without ISI: 14.3 ± 0.9
* With ISI: 11.6 ± 1.7
* Intermediate ISI††: 12.3 ± 1.6
* High ISI††: 10.8 ± 1.5

*P* < .05 for *None vs. Intermediate**P* < .05 for *None vs. High**P* < .05for *Intermediate vs. High*“For patients with CSM, an increased T2:T1 ratio is associated with a decrease in both the preoperative JOA score and the recovery rate after surgery. The T2:T1 ratio can be used to help predict surgical outcomes.” |
| Zhang (2010)Retrospective cohort | To quantifysignal intensity (SI) ratio and to determine whetherMR T2 image SI ratio and clinical manifestation can contribute to assessment of the prognosis of the disease. | N = 73Male: 67.1%Mean age (range) : 53.3 years (34–77)Mean duration of symptoms: NRDiagnosis:* CSM

Decompression surgery: * Anterior, posterior, or posterior-anterior united decompression

Groups based on increased signal intensity (ISI) ratio*Low (< 1.32), n = 18*Mean age: 47.4 ± 6.2 years*Intermediate (≥ 1.32 and < 1.68), n = 32*Mean age: 53.8 ± 10.9 years*High (≥ 1.68), n = 23*Mean age: 58.4 ± 10.5 years | * Age
* Duration of disease
* Babinski sign
 | * SI ratio
 | * Recovery rate of JOA score‡
* JOA score
 | Min. 12 months (44.5% f/u; n = 73/164) | **JOA recovery rate (%) (univariate analysis)*** Low: 0.77 ± 0.12
* Intermediate: 0.51 ± 0.22
* High: 0.35 ± 0.23

*P* < .05 for *Low vs. Intermediate**P* < .05 for *Low vs. High**P* < .05 for *Intermediate vs. High***Postoperative JOA score (median [quartile range]) (univariate analysis)*** Low: 16.0 (2.0)
* Intermediate: 13.0 (4.0)
* High: 10.0 (3.0)

*P* < .001 for *Low vs. Intermediate**P* < .001 for *Low vs. High**P* = .005 for *Intermediate vs. High*“Patients with low SI ratio who were not too old and had a shorter duration of disease experienced a good surgical outcome. However, with the increase ofSI ratio and the occurrence of pyramidal sign, a poor prognosis after surgery will show. SI ratio and clinical manifestation can be a predictor of surgical outcome.” |

ACDF = anterior cervical discectomy and fusion; APOE = apolipoprotein E; CDH = cervical disc herniation; CSM = cervical spondylotic myelopathy; ISI = increase signal intensity; JOA = Japanese Orthopaedic Association; NR = not reported; NS = not significant; OPLL = ossification of the posterior longitudinal ligament; SD = standard deviation; SI = signal intensity.

\*When available, p-values from the multivariate regression analysis were used; when unavailable, univariate p-values were reported.

†Grade 0 = no intramedullary high SI on T2-weighted MRI; Grade 1 = predominantly faint and indistinct border; Grade 2 = predominantly intense and well-defined border

‡The recovery rate of the JOA score is calculated by subtracting the preoperative JOA score from the postoperative JOA score and dividing that number by the difference between the preoperative JOA score and the full score (17 points); the resulting score is multiplied by 100 to get the recovery rate.

§A compressed segment was determined by CT myelography or MRI.

\*\*Group A = normal T1WI/normal T2WI; Group B = normal T1WI/high SI T2WI; Group C = low SIT1WI/high SI T2WI

††Of patients with ISI, the T2:T1 ratios ranged from 1.18 to 2.77. These patients were further subdivided by the median T2:T1 ratio (1.77) into two groups of 18 patients each: “Intermediate” ISI = 1.18-1.74; “High” ISI = 1.79-2.77.