# Factors Predicting Outcomes of Anterior Cervical Discectomy and Fusion in Cervical Spondylotic Myelopathy: A Prospective Study

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***Background:*** *Cervical spondylotic myelopathy (CSM) is a common condition in elderly. Anterior cervical discectomy and fusion (ACDF) becomes a standard procedure to address the ventral spinal cord compression from degenerated disc and osteophyte. However, the results after treatment are dubitable in many patients. There are many factors associated with the outcomes after surgery.*
***Objective:*** *To investigate the predictive factors for the outcomes of ACDF in patient with CSM.*
***Material and Method:*** *This prospective study was conducted between March 2011 and August 2013, all patients with clinical diagnosis of CSM who underwent ACDF by a neurosurgeon, were enrolled in the study. Recorded details included background factors, patient factors and operative factors. The Japanese Orthopaedic Association (JOA) score was used to evaluate preoperative and postoperative neurological status.*
***Results:*** *Fivety-four patients (35 males and 19 females) with mean age of 59 years old were included in the study. Mean duration of preoperative symptoms was 10.2 months. Regarding the JOA score, 45 patients (83.3%) had improvement, whereas 9 (16.7%) had no improvement. Regarding predictive factors, there was no statistically significant difference in age, gender, duration of symptom, underlying disease, smoking, number of ACDF level and type of bone graft between the groups with and without improvement of JOA score.*
***Conclusion:*** *There was no single factor could predict the operative outcomes. Nonetheless, male gender, patients without underlying disease and preoperative symptoms less than 1 year are the factors that are convincingly considered to be the favorable prognosticators.*

***Keywords:*** *Cervical spondylotic myelopathy, anterior cervical discectomy and fusion, predictor, outcome, Japanese Orthopedic Association score*

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Cervical spondylotic myelopathy (CSM) is widely seen in the setting of progressive chronic cervical spondylosis causing cord compression. The symptoms of myelopathy include motor and sensory disturbances which usually have insidious onset. There are many assessments employed in evaluation of this clinical syndrome. The Japanese Orthopaedic Association (JOA) score is one of the standard measures used to evaluate both preoperative and postoperative clinical status. Generally, there are two main surgical methods; anterior and posterior decompressing procedures. The anterior approach excels posterior approach in that it yields direct decompression and good axial pain relief[1,2]; however, it demands good surgical expertise.

Anterior cervical decompression and fusion (ACDF) has been widely accepted and become a standard procedure for relieve ventral cord compression. Nonetheless, the operative outcome is dubitable in several patients. There are many factors that may be associated with the outcome after the surgery[3-7]. The purpose of the present study is to investigate predictive factors for the outcomes of ACDF in patients with CSM, using The JOA score.

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## Material and Method

### *Patient population*

All consecutive 54 patients with a clinical

syndrome of CSM who underwent standard ACDF surgery from March 2011 to August 2013 at Siriraj Hospital by a neurosurgeon were enrolled in the present study. All of them had no previous neck surgery and history of trauma.

***Study design***

This study is a prospective descriptive analysis. SPSS 15.0 was used for analyzing the data with Chi-square and Fisher's exact test.

***Data recording***

Background factors included gender, age, underlying diseases and smoking. Patient factors included duration of preoperative symptoms, the JOA score in preoperative period and postoperative period at 6 to 12 months, postoperative complication and length of hospital stay. Operative factors included cervical level of ACDF, type of used bone graft, and intraoperative adverse event.

***Operative technique***

After informed consents were obtained, the patients were brought to the operating room. Anesthesiologists secured the airway via orotracheal access, using fiberoptic intubation in almost all cases. The patients were intubated awake under mild sedation with local lidocaine spray. In all cases, Gardner-Well tongs were applied with 5 to 10 pounds of traction weight. A small roll pillow was placed under the patient's neck to slightly extend the neck. The level of surgery was verified by intraoperative C-arm fluoroscopy. Standard anterior neck approach to the vertebral body was done. Under the high-magnification operative microscope, disc materials, vertebral end plates, anterior and posterior osteophytes, were removed by high-speed small-diameter drills and the Kerrison Rongeur. In all cases, the posterior longitudinal ligaments (PLL) were removed and the dura was clearly seen to assure the adequate decompression. After a bone graft was placed, titanium plate and screws were inserted and fixed. Povidone iodine and antibiotic solution were irrigated and a drain was placed. The platysma, subcutaneous tissue and skin were sutured in layers. Patients were instructed to wear the Philadelphia collar for 1 month after the surgery.

## Results

***Preoperative part***

Duration of symptoms before the surgery was 2 to 48 months with a mean duration of 10 months. Thirty patients had a wide variety of underlying diseases; diabetes mellitus (DM), hypertension and dyslipidemia. A history of smoking was recorded in 19 (35.2%) (Table 1).

***Operative part***

Fourteen patients (25.9%) underwent single level surgery while 40 (74.1%) had multiple-level ACDF. There were three types of bone graft used for fusion. Polyetheretherketone (PEEK) was most frequently utilized bone graft. The most common level of ACDF was C5-C6 follow by C4-C5 levels (Table 1). Dura tear with CSF leakage was observed in 1 patient. The treatment was fat packing with fibrin glue and postoperative lumbar drainage for 5 days. Posterior pharyngeal muscle injury was found in one patient. Primary repair was done. Several days later, barium swallowing study revealed normal finding.

***Postoperative part***

The mean hospital stay was 6 days. The

**Table 1.** Demographic characteristics

| Variables | Number of patient (%) |
|---|---|
| Total | 54 (100) |
| Gender | |
| Male | 35 (64.8) |
| Female | 19 (35.2) |
| Age (years) | |
| Mean $\pm$ SD (range) | 58.9$\pm$12 (30 to 81) |
| <60 years | 27 (50) |
| $\geq$60 years | 27 (50) |
| Duration of symptom (months) | |
| Mean $\pm$ SD (range) | 10.2$\pm$9.7 (2 to 48) |
| Underlying disease | 30 (55.6) |
| Diabetic mellitus | 14 (25.9) |
| Hypertension | 24 (44.4) |
| Dyslipidemia | 22 (40.7) |
| Smoking | 19 (35.3) |
| Level of ACDF surgery | |
| Single level | 14 (25.9) |
| Multiple level | 40 (74.1) |
| 2 levels | 13 (24.1) |
| 3 levels | 20 (37) |
| 4 levels | 7 (13) |
| Type of bone graft | |
| Autograft | 9 (16.7) |
| Allograft | 9 (16.7) |
| PEEK | 36 (66.7) |
| Length of hospital stay (days) | |
| Mean $\pm$ SD (range) | 6.1$\pm$2.4 (3 to 14) |

longest admission period was 14 days due to prolonged rehabilitation in a case who had severe neurological deficit before the surgery. Transient hoarseness and dysphagia were recorded in 12 patients (22.2%). In most cases, the symptoms were mild and resolved completely within 1 month after the surgery. Two patients took longer time for improvement. The first patient, who had posterior pharyngeal wall tear, suffered from these symptoms for several months. The authors believed that it was due to prolonged laryngeal nerve compression by a self-retaining retractor, which was placed in a long period of time during the repair. In the second patient who underwent 3-level ACDF, the symptoms improved in 10 months. No post operative surgical site hematoma or wound infection was recorded. Preoperative and postoperative JOA scores and surgical outcomes were demonstrated in Table 2. The correlation between factors and surgical outcomes was displayed in Table 3.

**Discussion**

CSM is one of the common degenerative diseases of human spine. The treatment can possibly be either anterior approach or posterior approach. The anterior approach is widely used due to its direct decompression and good outcomes. ACDF is one of the standard operations, which not only require good surgical skills but also multitude of factors. Many experts and researchers reported that good surgical outcomes were associated with young male patient with low disability level and no history of smoking[8-10].

In Thailand, there was one report in 1998 describing predictive factor and author's grading criteria for predicting surgical outcomes. The duration of the disease and age of patients were significant variables that were helpful for predicting outcomes. The author explained that osteophytic formation is not large in young age group. Furthermore, spinal cord compression was mainly caused by soft intervertebral discs, so anterior decompression could completely relieve spinal cord compression[8]. In the present study, the JOA score, the standard classification worldwide[11,12], was used to evaluate preoperative neurological status and postoperative outcomes and compare with potential predictive factors. Regarding patients' age, there was no significant difference of the JOA score between the patients younger and older than 60 years old. Good clinical improvement was found in both groups of patients because we totally removed all osteophytes and PLL. Therefore, the spinal cord could probably have more potential and time to recover right after the surgery. Regarding the duration of symptoms, the authors found that there was no statistical significant difference. Although there was a report showed that patients with preoperative symptoms less than 1 year would have good surgical outcome[11]. Our result can be explained by early awareness of the illness, so early check-up and investigation were sooner than in the previous study.

Nicotine is a toxin that inhibits bone-growing cells. Smoking has previously been demonstrated to be a risk factor not only for cervical and lumbar disc diseases, but also for pseudoarthrosis following ACDF. Hilibrand et al reported that smoking was an important factor influencing pain intensity and functional outcomes. In the present study, smoking was not a significant factor associated with poor outcome. Regarding gender, there was also no significant difference of surgical outcome between both genders, but the percentage of improvement of male patients was greater than their female counterparts.

ACDF has been reported to be effective and safe in decompression of ventral pathology[13]. The rate of fusion following single-level ACDF generally ranges from 80% to 95%. Applying this procedure greater than 3 levels can often result in complications,

**Table 2.** Preoperative and postoperative JOA score and surgical outcome

| **JOA score** | **Preoperative** | **Postoperative** |
|---|---|---|
| Mean ± SD (range) | 14.1±2.7 (6 to 17) | 15.9±1.6 (10 to 17) |
| **Surgical outcome** | **Number of patients (%)** | |
| Total | 54 (100) | |
| Improved JOA score | 45 (83.3) | |
| Not improved JOA score | 9 (16.7) | |
| Stable JOA score | 2 (3.7) | |
| Impaired JOA score | 7 (13) | |

**Table 3.** Correlation between factors and surgical outcomes

| Factor | Numbers of patients without improvement of JOA score (%) | Number of patients with improvement of JOA score | *p*-value |
|---|---|---|---|
| Age | | | |
| <60 years | 6 (22.2) | 21 (77.8) | 0.46 |
| ≥60 years | 3 (11.2) | 24 (88.9) | |
| Gender | | | |
| Male | 4 (11.4) | 31 (88.6) | 0.25 |
| Female | 5 (26.3) | 14 (73.7) | |
| Duration of symptom | | | |
| <12 months | 4 (12.9) | 27 (87.1) | 0.47 |
| ≥12 months | 5 (21.7) | 18 (78.3) | |
| Diabetic mellitus | | | |
| Absent | 8 (20.0) | 32 (80.0) | 0.41 |
| Present | 1 (7.1) | 13 (92.9) | |
| Hypertension | | | |
| Absent | 4 (13.3) | 26 (86.7) | 0.48 |
| Present | 5 (20.8) | 19 (79.2) | |
| Smoking | | | |
| Absent | 6 (17.1) | 29 (82.9) | 1.00 |
| Present | 3 (15.8) | 16 (84.2) | |
| Level of ACDF | | | |
| Single | 1 (7.1) | 12 (92.9) | 0.42 |
| Multiple | 8 (20.0) | 33 (80.0) | |
| 2 levels | 3 (23.1) | 10 (76.9) | 1.00 |
| 3 levels | 4 (20.0) | 16 (80.0) | |
| 4 levels | 1 (14.3) | 6 (85.7) | |
| Type of bone graft | | | |
| Allograft | 3 (33.3) | 6 (66.7) | 0.19 |
| Autograft | 2 (22.2) | 7 (77.8) | |
| PEEK | 4 (11.1) | 32 (88.9) | |
| Allograft vs. autograft | | | 1.00 |
| Allograft vs. PEEK | | | 0.13 |
| Autograft vs. PEEK | | | 0.58 |

including graft extrusion, subsidence, fracture and pseudoarthrosis. In our study, statistically significant difference in clinical improvement was not found between single-level and multiple-level ACDF. For the fusion rate, further investigation is needed.

According to the graft type, there were reports comparing between autograft and allograft in multiple level fixation[7,14-16]. No significant difference in terms of fusion rate and outcomes between both types of bone graft. Autograft may occasionally results in chronic pain at the harvest site, so some surgeons prefer to use allograft and PEEK instead. In our study, there was no difference in the outcomes between types of bone graft. Lastly, allograft is more cost effective than synthetic alternatives. Studying in bone fusion did not recorded in this study due to time limitation.

Dural tear has been reported to occur at a rate of 3.7% during anterior cervical spine surgery. Evidently, it is associated with ossification of the PLL and revision surgery. In this study, only one patient suffered from CSF leakage. The dural injury occurred because of a needle tube for collecting blood from the disc space to prepare a bone graft. It was repaired by packing with fat followed by fibrin glue application and lumbar drainage without further complication.

Temporary hoarseness and dysphagia occurred in 2% to 30% of patients immediately after operation while the rate of persistent vocal cord paralysis following anterior cervical surgery has been described as low as 0.33% to 2.5%[17-19]. We recorded

that our 12 patient (22%) developed transient hoarseness and dysphagia. The symptoms in 10 of 12 patients resolved completely within one month and the other two improved within one year. There has been an intensive debate over the most effective method of minimizing this risk. Apfelbaum et al proposed that deflation and reinflation of endotracheal tube during deep retractor placement decreased the risk of vocal cord paralysis from 6.4% to 1.69% ($p$ = 0.0002). This maneuver reduced pressure effect of pharyngeal tissue from endotracheal tube and retractors[18]. Finally, underlying conditions such as DM, hypertension and dyslipidemia are not known to be one of any significant factors. Nevertheless, these conditions are believed to be disturbing factors of bone and wound healing process.

**Conclusion**

CSM is a common degenerative disease of the spine. ACDF is widely adopted as one of the standard treatments due to the fact that this procedure culminates in a direct decompression to the spinal cord. To predict reliable postoperative outcomes, many factors including JOA score were taken into account. In this study, we tried to reach a plausible final conclusion regarding these factors, but there was no single factor that was statistically significant. Nonetheless, being male, absence of underlying disease and preoperative symptoms less than 1 year are the factors that are convincingly considered to be the good prognostic factors.

**What is already known from this topic?**

The favorable factors influencing outcomes following ACDF include young age, less duration of preoperative symptoms and absence of cigarette smoking. There was no significant difference in clinical outcomes between autograft and allograft. Multi-level ACDF may be associated with higher risk of complication.

**What this study adds?**

Although significant prognostic factor of clinical outcomes was not found, male patients without underlying disease who have preoperative symptoms less than one year, tend to have more favorable outcome following ACDF surgery. Multi-level ACDF does not increase risk of operative complication.

**Potential conflict of interest**

None.

**References**


1. Matz PG, Holly LT, Groff MW, Vresilovic EJ, Anderson PA, Heary RF, et al. Indications for anterior cervical decompression for the treatment of cervical degenerative radiculopathy. J Neurosurg Spine 2009; 11: 174-82.
2. Mummaneni PV, Kaiser MG, Matz PG, Anderson PA, Groff MW, Heary RF, et al. Cervical surgical techniques for the treatment of cervical spondylotic myelopathy. J Neurosurg Spine 2009; 11: 130-41.
3. Naderi S, Ozgen S, Pamir MN, Ozek MM, Erzen C. Cervical spondylotic myelopathy: surgical results and factors affecting prognosis. Neurosurgery 1998; 43: 43-9.
4. Peolsson A, Peolsson M. Predictive factors for long-term outcome of anterior cervical decompression and fusion: a multivariate data analysis. Eur Spine J 2008; 17: 406-14.
5. Anderson PA, Subach BR, Riew KD. Predictors of outcome after anterior cervical discectomy and fusion: a multivariate analysis. Spine (Phila Pa 1976) 2009; 34: 161-6.
6. Tracy JA, Bartleson JD. Cervical spondylotic myelopathy. Neurologist 2010; 16: 176-87.
7. Baskurt F, Kara B, Baskurt Z, Erbayraktar S. The assesment of pain and hand functions of patients with anterior cervical disc surgery. J Neurol Sci (Turk) 2011; 28: 337-46.
8. Unnanuntana A. Anterior decompression and fusion for cervical spondylotic myelopathy. J Med Assoc Thai 1998; 81: 272-7.
9. Peolsson A, Hedlund R, Vavruch L. Prediction of fusion and importance of radiological variables for the outcome of anterior cervical decompression and fusion. Eur Spine J 2004; 13: 229-34.
10. Gray MJ, Biyani A, Smith A. A retrospective analysis of patient perceived outcomes in patients 55 years and older undergoing anterior cervical discectomy and fusion. J Spinal Disord Tech 2010; 23: 157-61.
11. Hukuda S, Mochizuki T, Ogata M, Shichikawa K, Shimomura Y. Operations for cervical spondylotic myelopathy. A comparison of the results of anterior and posterior procedures. J Bone Joint Surg Br 1985; 67: 609-15.
12. Vitzthum HE, Dalitz K. Analysis of five specific scores for cervical spondylogenic myelopathy. Eur Spine J 2007; 16: 2096-103.
13. Galbraith JG, Butler JS, Dolan AM, O'Byrne JM. Operative outcomes for cervical myelopathy and radiculopathy. Adv Orthop 2012; 2012: 919153.

14. Samartzis D, Shen FH, Matthews DK, Yoon ST, Goldberg EJ, An HS. Comparison of allograft to autograft in multilevel anterior cervical discectomy and fusion with rigid plate fixation. Spine J 2003; 3: 451-9.
15. Silber JS, Anderson DG, Daffner SD, Brislin BT, Leland JM, Hilibrand AS, et al. Donor site morbidity after anterior iliac crest bone harvest for single-level anterior cervical discectomy and fusion. Spine (Phila Pa 1976) 2003; 28: 134-9.
16. Buttermann GR. Prospective nonrandomized comparison of an allograft with bone morphogenic protein versus an iliac-crest autograft in anterior cervical discectomy and fusion. Spine J 2008; 8: 426-35.
17. Hilibrand AS, Carlson GD, Palumbo MA, Jones PK, Bohlman HH. Radiculopathy and myelopathy at segments adjacent to the site of a previous anterior cervical arthrodesis. J Bone Joint Surg Am 1999; 81: 519-28.
18. Apfelbaum RI, Kriskovich MD, Haller JR. On the incidence, cause, and prevention of recurrent laryngeal nerve palsies during anterior cervical spine surgery. Spine (Phila Pa 1976) 2000; 25: 2906-12.
19. Audu P, Artz G, Scheid S, Harrop J, Albert T, Vaccaro A, et al. Recurrent laryngeal nerve palsy after anterior cervical spine surgery: the impact of endotracheal tube cuff deflation, reinflation, and pressure adjustment. Anesthesiology 2006; 105: 898-901.

## ปัจจัยทำนายผลการผ่าตัดหมอนรองกระดูกสันหลังร่วมกับการเชื่อมกระดูกสันหลังระดับคอทางด้านหน้าในโรคกระดูกสันหลังระดับคอเสื่อมกดทับไขสันหลัง: การศึกษาไปข้างหน้า

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**ภูมิหลัง:** โรคกระดูกสันหลังระดับคอเสื่อมกดทับไขสันหลังเป็นภาวะที่พบบ่อยในผู้สูงอายุ การผ่าตัดหมอนรองกระดูกสันหลังร่วมกับการเชื่อมกระดูกสันหลังระดับคอทางด้านหน้ากลายเป็นการผ่าตัดมาตรฐานสำหรับรักษาการกดทับไขสันหลังทางด้านหน้า โดยหมอนรองกระดูกสันหลังที่เสื่อมสภาพและกระดูกงอก อย่างไรก็ตามผลการรักษายังคงไม่แน่นอนในผู้ป่วยหลายราย มีปัจจัยหลายอย่างที่เกี่ยวข้องกับผลการรักษาหลังการผ่าตัด

**วัตถุประสงค์:** เพื่อศึกษาปัจจัยทำนายผลการผ่าตัดหมอนรองกระดูกสันหลังร่วมกับการเชื่อมกระดูกสันหลังระดับคอทางด้านหน้าในผู้ป่วยโรคกระดูกสันหลังระดับคอเสื่อมกดทับไขสันหลัง

**วัสดุและวิธีการ:** การศึกษาแบบไปข้างหน้านี้ทำในช่วงเวลาระหว่างเดือนมีนาคม พ.ศ. 2554 ถึงเดือนสิงหาคม พ.ศ. 2556 ผู้ป่วยที่เข้าร่วมการวิจัยคือผู้ป่วยทุกรายได้รับการวินิจฉัยเป็นโรคกระดูกสันหลังระดับคอเสื่อมกดทับไขสันหลัง ซึ่งได้รับการผ่าตัดหมอนรองกระดูกสันหลังร่วมกับการเชื่อมกระดูกสันหลังระดับคอทางด้านหน้าโดยประสาทศัลยแพทย์ 1 คน รายละเอียดข้อมูลที่เก็บในการวิจัย ได้แก่ ปัจจัยเกี่ยวกับภูมิหลังของผู้ป่วย ปัจจัยเกี่ยวกับผู้ป่วยและปัจจัยเกี่ยวกับการผ่าตัดมีการใช้คะแนน Japanese Orthopedic Association (JOA) ในการประเมินภาวะของระบบประสาทก่อนและหลังผ่าตัด

**ผลการศึกษา:** ผู้ป่วยที่เข้าร่วมการวิจัยมีทั้งสิ้น 54 ราย (ชาย 35 ราย หญิง 19 ราย) มีอายุเฉลี่ย 59 ปี ระยะเวลาเฉลี่ยของอาการก่อนผ่าตัดเท่ากับ 10.2 เดือน ผู้ป่วย 45 ราย (ร้อยละ 83.3) มีการดีขึ้นของคะแนน JOA ในขณะที่ผู้ป่วย 9 ราย (ร้อยละ 16.7) ไม่มีการดีขึ้นของคะแนน JOA ในด้านปัจจัยทำนายผลการรักษาพบว่าไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติของอายุ เพศ ระยะเวลาของอาการ โรคประจำตัว การสูบบุหรี่ จำนวนระดับที่ผ่าตัด และชนิดของกระดูกปลูกระหว่างกลุ่มที่มีการดีขึ้นของคะแนน JOA และกลุ่มที่ไม่มีการดีขึ้นของคะแนน JOA

**สรุป:** ไม่มีปัจจัยใดปัจจัยหนึ่งที่สามารถใช้ทำนายผลการรักษาหลังการผ่าตัด อย่างไรก็ตามเพศชาย ผู้ป่วยที่ไม่มีโรคประจำตัวและระยะเวลาที่มีอาการก่อนผ่าตัดน้อยกว่า 1 ปี เป็นปัจจัยที่เชื่อว่าน่าจะเป็นปัจจัยที่บ่งชี้ผลการรักษาที่ดีหลังการผ่าตัด