Should Cervical Disc Arthroplasty Be Done on Patients with Increased Intramedullary Signal Intensity on Magnetic Resonance Imaging?

Hsuan-Kan Chang[1,2], Wen-Cheng Huang[1,2], Jau-Ching Wu[1-3], Peng-Yuan Chang[1,2], Tsung-Hsi Tu[1,2], Li-Yu Fay[1,2], Ching-Lan Wu[2,4], Huang-Chou Chang[5], Henrich Cheng[1-3]

■ OBJECTIVE: **Several trials from the U.S. Food and Drug Administration have demonstrated the success of cervical disc arthroplasty (CDA) in patients with degenerative disc disease causing radiculopathy, myelopathy, or both. For patients who had increased intramedullary signal intensity (IISI) on magnetic resonance image (MRI), however, the effectiveness and safety of CDA was unclear. This study aimed to evaluate the outcomes of CDA for patients with IISI on preoperative MRI.**

■ METHODS: **Consecutive patients who received 1-level CDA for symptomatic degenerative disc disease were reviewed retrospectively. Patients with IISI on preoperative T2-weighted MRI were compared to those without IISI (non-IISI). Clinical outcome parameters including visual analog scale, Neck Disability Index, Japanese Orthopedic Association (JOA), and Nurick scores were analyzed. Radiographic studies included dynamic lateral radiography and MRI.**

■ RESULTS: **A total of 91 patients were analyzed (22 in the IISI group and 69 in the non-IISI group). The mean follow-up was 30.0 months. The demographic data were mostly similar between the 2 groups. All clinical outcomes, including visual analog scale, Neck Disability Index, JOA, and Nurick scores in the IISI group demonstrated significant improvement after operation. The IISI group had similar clinical outcomes to the non-IISI group, except that the JOA scores were generally worse. Follow-up MRI demonstrated significant regression of the length of IISI ($P = 0.009$). Both groups had preserved motion after CDA.**

■ CONCLUSIONS: **Both clinical and radiological outcomes improved (the average length of IISI in the cervical spinal cord became shorter) after CDA. Therefore, CDA is a safe and effective option for patients even when there is IISI on the preoperative T2-weighted MRI.**

INTRODUCTION

For more than half century, anterior cervical discectomy and fusion (ACDF) has been the standard surgical management for patients with disc disease causing myelopathy who require anterior discectomy. In recent decades, the efficacy and safety of using cervical disc arthroplasty (CDA) in 1- or 2-level symptomatic degenerative disc disease (DDD) and spondylosis has been well demonstrated by several prospective, randomized and controlled studies from the U.S. Food and Drug Administration (FDA).[1-10] The inclusion criteria of patients in these trials were DDD or spondylosis causing intractable radiculopathy, myelopathy, or both[5,6,8]; however, the actual outcomes of CDA in cervical myelopathy have been scantly addressed in the literature.

Increased intramedullary signal intensity (IISI) on T2-weighted magnetic resonance imaging (MRI) has been correlated with

Key words
- Cervical disc arthroplasty (CDA)
- Increased intramedullary signal intensity (IISI)
- Myelopathy

Abbreviations and Acronyms
ACDF: Anterior cervical discectomy and fusion
CDA: Cervical disc arthroplasty
CSM: Cervical spondylotic myelopathy
DDD: Degenerative disc disease
FDA: U.S. Food and Drug Administration
IISI: Increased intramedullary signal intensity
JOA: Japanese Orthopedic Association
MRI: Magnetic resonance imaging
NDI: Neck Disability Index
OPLL: Ossification of posterior longitudinal ligament
VAS: Visual analogue scale

From the [1]Department of Neurosurgery, Neurological Institute, Taipei Veterans General Hospital, Taipei; [2]School of Medicine and [3]Institute of Pharmacology, National Yang-Ming University, Taipei; [4]Department of Radiology, Taipei Veterans General Hospital, Taipei; and [5]Department of Surgery, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan

To whom correspondence should be addressed: Jau-Ching Wu, M.D., Ph.D. [E-mail: jauching@gmail.com]

Citation: World Neurosurg. (2016) 89:489-496.
http://dx.doi.org/10.1016/j.wneu.2016.02.029

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

poor neurologic outcomes and functional recovery in patients with cervical spondylotic myelopathy.[11-13] Surgical procedures of stabilization and decompression via anterior, posterior, or both approaches have been discussed widely as options for the treatment of cervical spondylotic myelopathy. Various kinds of grafting materials and instrumentations for stabilization have been reported to yield favorable neurologic outcomes with the achievement of arthrodesis after decompression.

It is intuitive to anticipate neurologic improvement after decompressive procedures, including discectomy, corpectomy, laminectomy, or laminoplasty, because of a relief of pressure on the neural tissue afterwards. It is uncertain, however, whether the neurologic improvement is maintained if the effect of fixation (immobilization) is replaced by devices aiming at preservation of motion (e.g., CDA). Furthermore, there are scant data of postoperative MRIs among patients with cervical myelopathy managed with CDA. The present study therefore aimed to analyze the clinical and radiologic outcomes of CDA in patients with IISI on preoperative T2-weighted MRIs. A comparison of the IISI between the pre- and postoperative T2-weighted MRIs of these myelopathic patients also was conducted.

METHODS

Inclusion and Exclusion Criteria of Patients

Consecutive patients (age >18 years) who received 1-level CDA for symptomatic DDD and spondylosis of the subaxial cervical spine (C3–C7) during the period 2007–2011 were included in the present study. All their radiologic and clinical evaluations were reviewed retrospectively for the study.

The indication of 1-level CDA in the current series was medically intractable radiculopathy, myelopathy, or both, caused by DDD or sponylosis.[3,5,6,9,10] All patients had received medication and physical therapy for more than 3 months but had failed to achieve relief of symptoms before CDA.

The exclusion criteria were as follows: 1) traumatic spinal cord injury or fracture; 2) evident segmental instability (i.e., more than 3.5-mm translation or 20° angular motion) at the indexed level; 3) segmental arthrodesis without mobility (i.e., less than 2° range of motion on lateral flexion and extension radiography); 4) severely incompetent facet joints at the index level on preoperative computed tomography scans; 5) adjacent segment disease after previous cervical fusion; 6) ossification of posterior longitudinal ligament (OPLL); 7) kyphotic deformity; 8) presence or history of discitis; 9) long-term steroid user; 10) osteoporosis; or 11) previous cervical spine surgery. Patients who had malignancy, metabolic bone disease, spondyloarthropathy such as rheumatoid arthritis, infection, or severe systemic disease such as stroke also were excluded.

On the basis of the preoperative MRI, patients were divided into 2 groups, the IISI group (i.e., patients with "increased intramedullary signal intensity" on the T2-weighted MRI) and the non-IISI group (i.e., those who had no change in signal intensity on the T2-weighted MRI). Both groups of patients were evaluated under similar study protocols, and the study was approved by the institutional review board. All the radiologic and clinical evaluations were analyzed and compared.

Radiologic and Clinical Evaluations

Standard anteroposterior, lateral, and dynamic (flexion and extension) lateral radiographs were taken preoperatively, within 5 days postoperatively, and at postoperative 3, 6, 12, and 24 months' follow-up time points. The range of motion at the index level was determined by measurement of the preoperative and postoperative 24-month dynamic lateral radiographs via the Cobb method, similar to that adopted in previous FDA–investigational device exemption trials.[6] The digitalized images were interpreted using the PACS system software SmartIris (Taiwan Electronic Data Processing Co., Taipei, Taiwan) on a medical-use screen by independent radiologists and neurosurgeons. All radiologic examinations initially were interpreted and measured by the first author (H.K.C.). The images and data were then double-checked and confirmed by 2 senior authors (C.L.W. and J.C.W.).

Every patient's pre- and postoperative MRIs were evaluated. Noncontrast-enhanced cervical spine MRIs before operation and 24 months after operation were compared. The mid-sagittal images of T2-weighted MRIs were used to assess the intramedullary signal intensity. The hyperintensity in the cervical spinal cord was measured in millimeters along its longest axis, and the craniocaudal length of the spinal cord with increased signal intensity of each patient was compared (Figure 1).[14]

Standardized clinical outcome measurements, including visual analogue scale (VAS) of neck and arm pain, Neck Disability Index (NDI) scores, and Japanese Orthopedic Association (JOA) scores, were collected before the operation and at each time-point for postoperative follow-up. The Nurick scores were used to grade the severity of myelopathy in patients with IISI on the T2-weighted MRIs (i.e., the IISI group). Clinical data were collected by 2 special nurse assistants under the physicians' supervision during clinic visits.

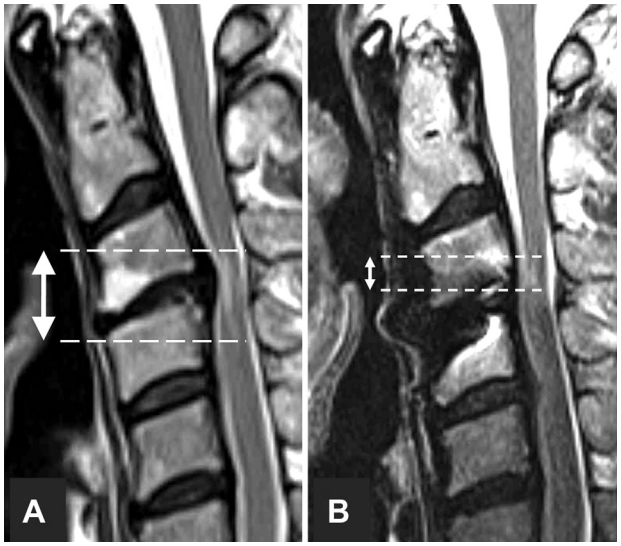

Figure 1. Demonstration of measurement of the craniocaudal length of increased intramedullary signal intensity on sagittal T2-weighted magnetic resonance imaging. (**A**) Preoperatively; (**B**) postoperatively.