Neurosurgical Forum
LETTERS TO THE EDITOR

Segmental mobility and heterotopic ossification after cervical arthroplasty

TO THE EDITOR: We read with great interest the recent article by Chang et al.¹ (Chang HK, Chang CC, Tu TH, et al: Can segmental mobility be increased by cervical arthroplasty? *Neurosurg Focus* 42(2):E3, February 2017) in which they analyzed the radiographic and clinical outcomes of cervical disc arthroplasty (CDA) using the Prestige LP prosthesis. They retrospectively reviewed 50 consecutive patients who had undergone 1-level CDA for the treatment of cervical degenerative disc disease and spondylosis. They reported, for the first time, the changes in segmental mobility (Δ ROM) from preoperatively to postoperatively and their influence on outcomes. They concluded that patients with increased segmental mobility (Δ ROM $> 0^\circ$) had significantly less heterotopic ossification (HO) and similarly improved clinical outcomes as compared to those in patients with decreased segmental mobility (Δ ROM $< 0^\circ$). However, in our opinion, given their results, we cannot conclude whether the decreased segmental mobility influenced the formation of HO or the formation of HO caused the decrease in segmental mobility.

In their study, they reported that once Δ ROM were determined postoperatively, patients were then divided into 2 groups: the group with increased segmental mobility (Δ ROM $> 0^\circ$) and the group with decreased or unchanged segmental mobility (Δ ROM $< 0^\circ$). Their results demonstrated that the postoperative reduction in segmental mobility (ROM) was significantly correlated ($p = 0.012$) with the formation of HO. However, the results of Δ ROM were calculated using the differences between ROM at the final follow-up (> 24 months) and preoperation instead of the differences between ROM when patients were divided into groups and preoperation. Thus, given the results, we can only conclude that decreased segmental mobility is correlated to HO, but we cannot determine whether the decreased segmental mobility influenced the formation of HO or the other way around. McAfee et al.² introduced the classification of HO in 2003. According to that classification, Grades 3 and 4 HO can cause the decrease in segmental mobility. Furthermore, what was the average postoperative time that the patients were divided into different groups? The index segment may have already had

HO, which could be the main reason for the decrease in segmental ROM.

In conclusion, we applaud and congratulate Chang et al.'s remarkable work. They reported for the first time the correlation between changes in segmental mobility (Δ ROM) and HO. However, we cannot determine whether the decreased segmental mobility influences the formation of HO or the HO causes the decrease in segmental mobility. This debate needs further study in the future.

Junfeng Zeng, MD

Hao Liu, MD, PhD

Yi Yang, MD

West China Hospital, Sichuan University, Chengdu, Sichuan,
People's Republic of China

References

1. Chang HK, Chang CC, Tu TH, Wu JC, Huang WC, Fay LY, et al: Can segmental mobility be increased by cervical arthroplasty? *Neurosurg Focus* 42(2):E3, 2017
2. McAfee PC, Cunningham BW, Devine J, Williams E, Yui-Yahiro J: Classification of heterotopic ossification (HO) in artificial disk replacement. *J Spinal Disord Tech* 16:384–389, 2003

Disclosures

The authors report no conflict of interest.

Response

We read with interest Dr. Zeng and colleagues' comments on our article. In our paper, we concluded that segmental mobility (as reflected by the mean ROM) and overall cervical alignment (that is, the mean sagittal vertical axis [SVA] and C2–7 Cobb angle) had no significant impact on the clinical outcomes of 1-level CDA, and that patients with increased segmental mobility (Δ ROM $> 0^\circ$) had significantly less HO and similarly improved clinical outcomes compared to those in patients with decreased segmental mobility (Δ ROM $< 0^\circ$).

The actual cause of HO formation following CDA remained elusive. Suggested etiologies of HO included pre-existing cervical spondylosis, multilevel disc disease, and suboptimal installation of the device.^{1,3,9,10,12,14} Our series, as with many published FDA trials,^{2,4–6,11} demonstrated that most of the CDAs successfully preserved segmental mobility from immediate postoperation up to 2–5 years

thereafter, whether or not there was HO formation. Although the HO seemed not to affect the clinical success of CDA in the study period in many studies,^{1,8,9,12–14} most spine surgeons would attempt to avoid its formation. Our study at the very least provides evidence that spine surgeons who perform CDA should aim for the avoidance of decreased segmental mobility ($\Delta\text{ROM} < 0^\circ$) and, if possible, try their best to increase ROM ($\Delta\text{ROM} > 0^\circ$) after a single-level CDA. However, an increased ROM ($\Delta\text{ROM} > 0^\circ$) might not always be achievable in CDA because there could be limitations, such as inadequate resection of bilateral uncovertebral joints, an improperly installed device, and pre-existing ankylosis.^{7,10} It can never be over-emphasized that the success of CDA depends on choosing the right patients for surgery and performing the surgery correctly.

Hsuan-Kan Chang, MD^{1,2}

Jau-Ching Wu, MD, PhD^{1,2}

Chih-Chang Chang, MD^{1,2}

Tsung-Hsi Tu, MD^{1,2}

Wen-Cheng Huang, MD, PhD^{1,2}

Li-Yu Fay, MD^{1–3}

Peng-Yuan Chang, MD^{1,2}

Ching-Lan Wu, MD^{2,4}

Henrich Cheng, MD, PhD^{1–3}

¹Neurological Institute, Taipei Veterans General Hospital, Taipei, Taiwan

²School of Medicine, National Yang-Ming University, Taipei, Taiwan

³Institute of Pharmacology, National Yang-Ming University, Taipei, Taiwan

⁴Taipei Veterans General Hospital, Taipei, Taiwan

References

1. Chang PY, Chang HK, Wu JC, Huang WC, Fay LY, Tu TH, et al: Differences between C3–4 and other subaxial levels of cervical disc arthroplasty: more heterotopic ossification at the 5-year follow-up. **J Neurosurg Spine** 24:752–759, 2016
2. Coric D, Kim PK, Clemente JD, Boltes MO, Nussbaum M, James S: Prospective randomized study of cervical arthroplasty and anterior cervical discectomy and fusion with long-term follow-up: results in 74 patients from a single site. **J Neurosurg Spine** 18:36–42, 2013
3. Fay LY, Huang WC, Wu JC, Chang HK, Tsai TY, Ko CC, et al: Arthroplasty for cervical spondylotic myelopathy: similar results to patients with only radiculopathy at 3 years' follow-up. **J Neurosurg Spine** 21:400–410, 2014
4. Heller JG, Sasso RC, Papadopoulos SM, Anderson PA, Fessler RG, Hacker RJ, et al: Comparison of BRYAN cervical disc arthroplasty with anterior cervical decompression and fusion: clinical and radiographic results of a randomized, controlled, clinical trial. **Spine (Phila Pa 1976)** 34:101–107, 2009
5. Mummaneni PV, Amin BY, Wu JC, Brodt ED, Dettori JR, Sasso RC: Cervical artificial disc replacement versus fusion in the cervical spine: a systematic review comparing long-term follow-up results from two FDA trials. **Evid Based Spine Care J** 3:59–66, 2012
6. Sasso WR, Smucker JD, Sasso MP, Sasso RC: Long-term clinical outcomes of cervical disc arthroplasty: a prospective, randomized, controlled trial. **Spine (Phila Pa 1976)** 42:209–216, 2017
7. Tu TH, Chang CC, Wu JC, Fay LY, Huang WC, Cheng H: Resection of uncovertebral joints and posterior longitudinal ligament for cervical disc arthroplasty. **Neurosurg Focus** 42 (Suppl 1):V2, 2017
8. Tu TH, Wu JC, Huang WC, Chang HK, Ko CC, Fay LY, et al: Postoperative nonsteroidal antiinflammatory drugs and the prevention of heterotopic ossification after cervical arthroplasty: analysis using CT and a minimum 2-year follow-up. **J Neurosurg Spine** 22:447–453, 2015
9. Tu TH, Wu JC, Huang WC, Guo WY, Wu CL, Shih YH, et al: Heterotopic ossification after cervical total disc replacement: determination by CT and effects on clinical outcomes. **J Neurosurg Spine** 14:457–465, 2011
10. Tu TH, Wu JC, Huang WC, Wu CL, Ko CC, Cheng H: The effects of carpentry on heterotopic ossification and mobility in cervical arthroplasty: determination by computed tomography with a minimum 2-year follow-up: clinical article. **J Neurosurg Spine** 16:601–609, 2012
11. Upadhyaya CD, Wu JC, Trost G, Haid RW, Traynelis VC, Tay B, et al: Analysis of the three United States Food and Drug Administration investigational device exemption cervical arthroplasty trials. **J Neurosurg Spine** 16:216–228, 2012
12. Wu JC, Huang WC, Tsai HW, Ko CC, Fay LY, Tu TH, et al: Differences between 1- and 2-level cervical arthroplasty: more heterotopic ossification in 2-level disc replacement: clinical article. **J Neurosurg Spine** 16:594–600, 2012
13. Wu JC, Huang WC, Tsai TY, Fay LY, Ko CC, Tu TH, et al: Multilevel arthroplasty for cervical spondylosis: more heterotopic ossification at 3 years of follow-up. **Spine (Phila Pa 1976)** 37:E1251–E1259, 2012
14. Wu JC, Huang WC, Tu TH, Tsai HW, Ko CC, Wu CL, et al: Differences between soft-disc herniation and spondylosis in cervical arthroplasty: CT-documented heterotopic ossification with minimum 2 years of follow-up. **J Neurosurg Spine** 16:163–171, 2012

INCLUDE WHEN CITING

DOI: 10.3171/2017.5.FOCUS17276.

©AANS, 2017