Cervical Muscle Activity During Loaded Arm Lifts in Patients 10 Years Postsurgery for Cervical Disc Disease

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Abstract

Objective: The purpose of this study was to compare the mechanical activity of the neck muscles during loaded arm lifting tasks in individuals with long-standing disability after anterior cervical decompression and fusion (ACDF) with that of healthy controls.

Methods: Ten individuals (mean age, 60 years; SD, 7.1) who underwent ACDF (10-13 years previously) for cervical disc disease and 10 healthy age- and sex-matched controls participated in the study. Ultrasonography was used to investigate the degree of deformation and deformation rate of ventral and dorsal neck muscles at the C4 segmental level during a single (1 × arm flexion to 120°) and repeated (10 × arm flexion to 90°) loaded arm elevation condition.

Results: The ACDF group showed greater deformation and deformation rate of the longus capitis ($P = .02$) and deformation rate of the sternocleidomastoid ($P = .04$) during the 120° arm lift. For repeated 90° arm lift, there was a significant group effect with higher deformation rate values observed in the longus capitis ($P = .005$-$.01$) and multifidus ($P = .03$) muscles in the ACDF group. Muscle behavior did not change the repeated arm lifts (no group × time interactions) for either the ventral or the dorsal muscles.

Conclusions: For study participants, greater muscle mechanical activity levels were observed in the ventral and multifidus muscles of patients with persistent symptoms after ACDF. These differences may indicate altered motor strategy in this patient group when performing the upper limb task and may need to be considered when prescribing exercise for postsurgical rehabilitation. (J Manipulative Physiol Ther 2013;36:292-299)

Key Indexing Terms: *Neck Muscles; Neck Pain; Surgical Procedure; Motor Skills; Ultrasonography*

Individuals who have previously undergone anterior cervical decompression and fusion (ACDF) surgery for cervical disc disease often experience persistent mechanical neck pain and disability.[1-5] A known feature of persistent neck pain disorders is altered muscle activity within the dorsal and ventral neck muscle layers irrespective of origin (traumatic or nontraumatic).[6-10] This is considered detrimental to the health of the cervical vertebral column that relies heavily on muscles for its optimal physical support.[11] As such, altered muscle activity,[12,13] and the proposed consequential changes in loading to the spine, may contribute to the persistence of neck pain and disability in some individuals.[14] However, compared to other conditions,[12,13] the activity of cervical muscles in individuals after ACDF has not been widely studied.[15]

On the basis of available evidence, it is reasonable to expect that individuals following ACDF may exhibit altered muscle activity. In addition, these individuals may have further physical insult to cervical structures during the surgical procedure that may affect the capacity of muscles

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Paper submitted December 17, 2012; in revised form March 8, 2013; accepted April 4, 2013.
0161-4754/$36.00

http://dx.doi.org/10.1016/j.jmpt.2013.05.014

to support the cervical spine. Certainly, studies have shown deficits in strength and endurance of neck muscle in cervical postsurgical patients.[1,5,16] Although these studies show a gross loss of capacity of the muscles to generate and sustain cervical muscle force after ACDF, they do not shed light on motor strategies by which this patient group physically supports their neck under load. This information would be valuable from an exercise prescription perspective, as incorporating exercise to train the differential activity of neck muscles has proven beneficial in other neck pain conditions.[17,18]

The purpose of the study was to compare the differential activity of the dorsal and ventral neck muscles layers during loaded lifting tasks in individuals with long-standing disability after ACDF with that of healthy controls. The findings of this study may inform clinical decision making when prescribing exercise for individuals with persistent neck symptoms after ACDF surgery.

Methods

Participants

Ten volunteers (7 women and 3 men; mean [SD] age, 60 [7.1] years) with a history of persisting pain and disability 10 to 13 years after ACDF surgery for cervical disc disease participated in this cross-sectional study. They reported a mean pain intensity of 36 mm (24.9 mm) (on a 100-mm visual analogue scale [VAS])[19] and scored an average of 31% (8.9%) on the Neck Disability Index.[20] All participants followed a standardized pathway of care after surgery. Participants used a Philadelphia collar for 6 weeks and received routine physical therapy at the Spine Clinic including basic ergonomics, light shoulder movements, and exercises to improve active range of neck motion after removal of the collar. After this period, any intervention was on a pragmatic basis in primary care.

Ultrasound measurements recorded from the ACDF surgical group were compared to those recorded from 10 healthy controls matched for sex and age (mean [SD] age, 60 [6.5] years). Participants were excluded from the control group if they reported a history of neck or shoulder pain or injury, scored 10 mm or greater on a VAS (mean [SD] VAS, 0.08 [0.29] mm) when asked to rate their general level of neck discomfort,[21] and reported previous trauma to the neck or head, significant pain in the thorax or lower back, or any neurological or inflammatory conditions.

This study received approval from the Regional Medical Research Ethics Committee at the Faculty of Health Sciences at Linköping University in Sweden and was conducted in accordance with the declaration of Helsinki. All participants received verbal and written information about the study and signed a consent form.

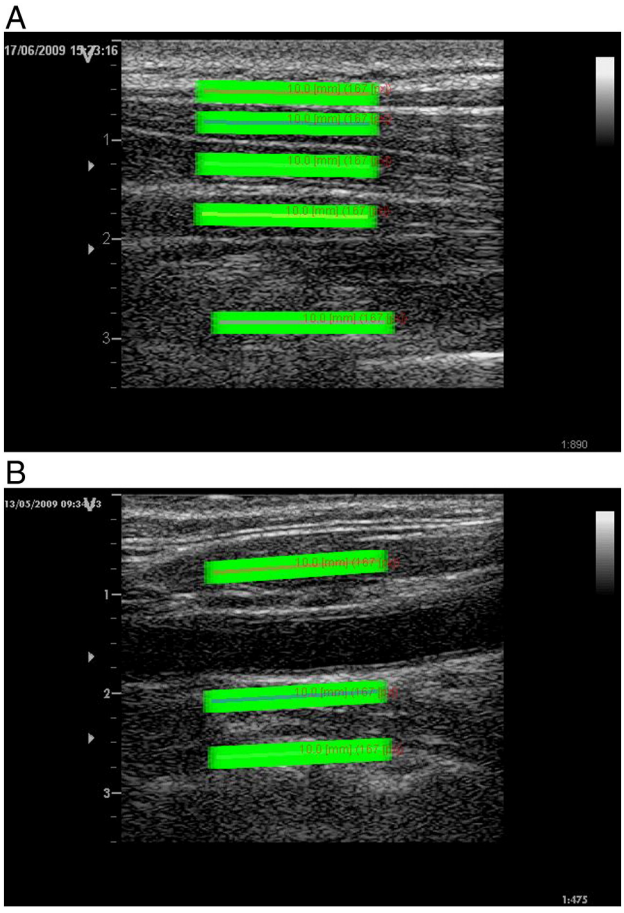

Fig 1. *A, Longitudinal ultrasound image of dorsal neck muscles with ROIs from superficial to the deep: trapezius, splenius, semispinalis capitis, semispinalis cervicis, and multifidus. B, Longitudinal ultrasound image of ventral neck muscles with ROIs from superficial to the deep: sternocleidomastoid, longus capitis, and longus colli. (Color version of figure is available online.)*

Ultrasound Measurements

Ultrasound measurements of the cervical muscles were recorded with a 14.0-MHz linear transducer (38-mm footprint) and an Ultrasound Vivid 9 dimension (GE Healthcare, Horten, Norway) unit using a high frame rate (78 frames/s) operated in B-mode with a two-dimensional ultrasound imaging system. Ultrasound images of cervical muscle activity were recorded during experimental lifting conditions, which were later analyzed as image sequences ("videos") using postprocess speckle tracking analysis. Recordings were made for both the dorsal (upper trapezius, splenius, semispinalis capitis and cervicis, and cervical multifidus) (Fig 1A) and ventral (sternocleidomastoid, longus capitis, and longus colli) (Fig 1B) neck muscles. All recordings were made at the C4 vertebral level identified by palpation of the C4 spinous process for the dorsal muscles and by the carotid artery bifurcation[22] for the ventral muscles. The transducer was first positioned in a