Altered Cervical Intervertebral Motion in Chronic Neck Pain: Evidence from Biplane Videoradiography

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INTRODUCTION: Chronic neck pain (NP) is a prevalent musculoskeletal condition, yet current examination techniques provide limited insight into vertebral-level motion abnormalities. Biplane videoradiography enables precise measurement of cervical intervertebral kinematics. This study examined vertebral-level motion in individuals with chronic NP compared to controls across all cardinal planes.

METHODS: Twenty-three participants (13 NP, 10 controls | CTRL: 7F, 3M. NP: 10F, 3M) completed three trials each of flexion–extension, lateral bending, and axial rotation in a seated biplane videoradiography system integrated with optical motion capture. Vertebral kinematics (C4–C7) were derived from CT-based models using semi-automated shape-matching. Outcomes included total range of motion (tROM), percent contribution to global head-to-torso motion (%ROM), and trial-to-trial variability. Nonparametric bootstrapping established 90% confidence intervals. All procedures were approved by the University of Minnesota IRB with informed consent obtained.

RESULTS: Compared to controls, NP participants showed significantly reduced axial rotation tROM and %ROM at C5–C6, with greater %ROM at head-to-C4. They also exhibited greater %ROM at C4–C5 during flexion–extension. Variability across trials was significantly greater for NP at head-to-C4 during flexion–extension %ROM. No group differences were observed in lateral bending. Across groups, C6–C7 contributed least to axial rotation, while global head-to-torso motion exceeded individual intervertebral contributions.

DISCUSSION: This is the first study to quantify cervical intervertebral kinematics in chronic NP across all cardinal planes using biplane videoradiography. Findings indicate localized motion deficits at C5–C6 during axial rotation and redistribution of motion at C4–C5 and head-to-C4, supporting altered biomechanical patterns in chronic NP.

SIGNIFICANCE/CLINICAL RELEVANCE: These findings highlight the potential of intervertebral kinematic analysis to advance understanding of cervical motion impairments in chronic NP and support the development of individualized comparisons to normative datasets to guide diagnosis and treatment.

REFERENCES: 1. Safiri S, et al. BMJ. 2020;368:m791. 2. Hogg-Johnson S, et al. Eur Spine J. 2008;17(Suppl 1):39–51. 3. Anderst WJ, et al. Spine. 2011;36(6):E393–400.

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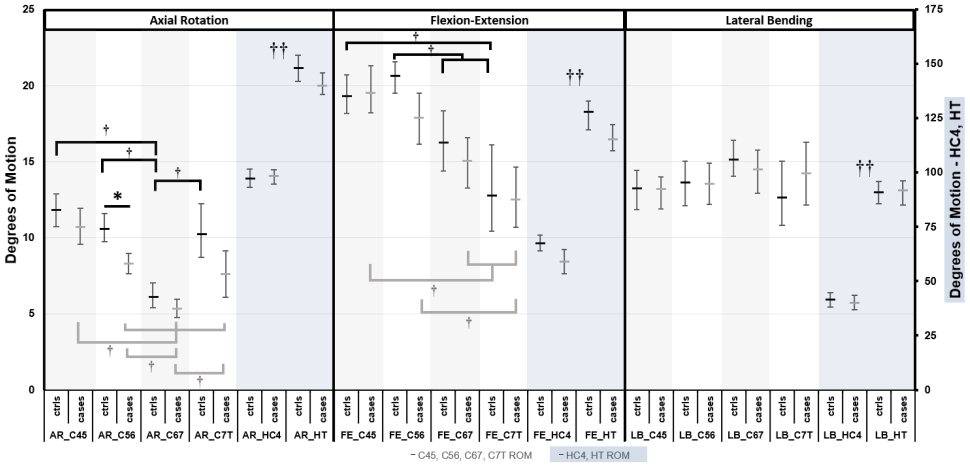

Figure 1. Total ROM Average
Mean and 90% CIs from nonparametric bootstrapping for total ROM (axial rotation, flexion–extension, lateral bending) across C4–5, C5–6, C6–7, C7–T1, HC4, and HT. HC4 and HT are on the secondary axis (light blue). *p<0.05 between cases and controls; † within-group differences; ‡ HT significantly greater than HC4 and both significantly greater than C4–7.

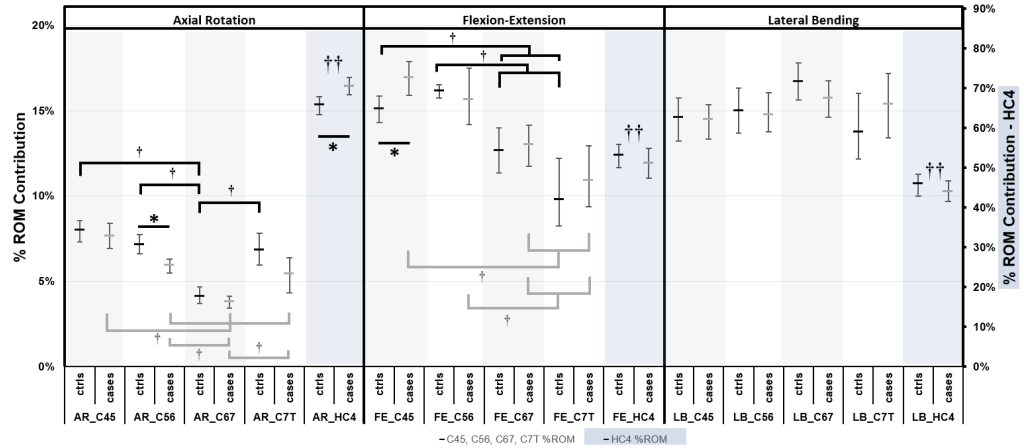

Figure 2. Percent ROM Contribution Average
Mean and 90% CIs from nonparametric bootstrapping for percent HT ROM contribution across C4–5, C5–6, C6–7, C7–T1, and HC4. HC4 is on the secondary axis (light blue). *p<0.05 between cases and controls; † within-group differences; ‡ HC4 significantly greater than C4–7.