

# Age-Related Divergence of Upper and Lower Cervical Lordosis: A Radiographic Analysis

Michael Li, Sri Guttikonda, Ula N Isleem, Samuel Kang-Wook Cho

**INTRODUCTION:** Cervical spinal deformity can be a serious condition characterized by abnormal cervical alignment, more commonly affecting older adults. Understanding age-related changes in cervical lordosis may enhance our understanding of how cervical curvature influences global spinal alignment and inform personalized treatment strategies. We introduce a model of age-related cervical sagittal imbalance, hypothesizing that age is associated with increased upper cervical (C2–C4) lordosis and decreased lower cervical (C5–C7) lordosis.

**METHODS:**

We retrospectively reviewed standing lateral radiographs from 449 patients obtained in 2023 at a single institution. Fourteen cervical and global sagittal parameters were measured using ImageJ, including C2–C4 and C5–C7 Cobb angles, pelvic tilt (PT), sagittal vertical axis (SVA), and thoracic kyphosis. Patients were stratified by decade of age and geriatric status ( $\geq 65$  vs  $< 65$  years). The primary outcome was the difference between C2–C4 and C5–C7 lordosis. A positive difference indicated relative hyperlordosis of the upper cervical spine, whereas a negative difference reflected preserved lower cervical curvature. Secondary outcomes included associations with global alignment. Group comparisons, Pearson correlations, and multivariable regression analyses were conducted to evaluate relationships between segmental cervical lordosis and global alignment.

**RESULTS:**

We observed significant differences between C2–C4 and C5–C7 Cobb angles across age groups. Geriatric patients ( $n = 145$ ) had a significantly greater difference between C2–C4 and C5–C7 lordosis (mean =  $+5.12^\circ \pm 8.26^\circ$ ) compared to non-geriatric patients ( $n = 289$ , mean =  $-1.32^\circ \pm 6.04^\circ$ ,  $p < 0.001$ ). When stratified by decade of age, the C2–C4 and C5–C7 difference correlated strongly with age ( $r = 0.925$ ,  $p < 0.001$ ). Segmental lordosis values were significantly associated with global sagittal parameters. C2–C4 lordosis was positively associated with PT ( $r = 0.177$ ,  $p < 0.001$ ), SVA ( $r = 0.145$ ,  $p < 0.01$ ), and C2–C7 SVA ( $r = 0.260$ ,  $p < 0.001$ ). In multivariable regression, PT ( $\beta = 0.102$ ,  $p < 0.01$ ) and SVA ( $\beta = 0.012$ ,  $p < 0.05$ ) were independent predictors of increased upper cervical lordosis.

**DISCUSSION AND CONCLUSION:**

Our findings suggest an age-related pattern of cervical spinal changes in which increasing age is associated with increased lordosis in the upper cervical spine (C2–C4) and decreased lordosis in the lower cervical spine (C5–C7). These changes may contribute to broader cervical and global spinal deformities and have implications for surgical planning and age-specific alignment targets.

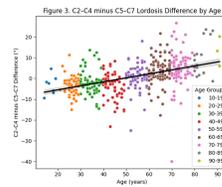
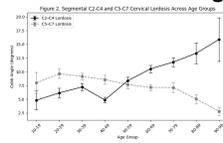
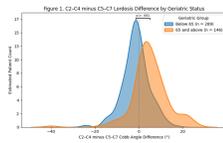
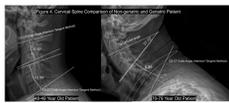


Table 1. Average Cervical Cobb Angle Differences and Ratios Across 10-Year Age Groups

Age Group (n)	10-19 (n=21)	20-29 (n=46)	30-39 (n=51)	40-49 (n=71)	50-59 (n=81)	60-69 (n=121)	70-79 (n=101)
Average C2-C4 and C5-C7 Cobb Angle Difference	1.06°	-1.48°	-1.94°	-3.70°	3.37°	4.84°	8.30°
Average C2-C4 and C5-C7 Cobb Angle Ratio	0.54	0.81	0.98	0.99	1.76	2.21	2.80