

THE INFLUENCE OF AGE, SEX, AND POSTURE ON THE MEASUREMENT OF ATLANTODENTAL INTERVAL IN A NORMAL POPULATION

Peter G. Osmotherly, MMedSci,^a Scott F. Farrell, B. Pty(Hons I),^b Shane D. Digby, B. Pty(Hons I),^b Lindsay J. Rowe, MAppSc(Chiro), MD,^{c,d} and Anthony J. Buxton, MEd^e

ABSTRACT

Objective: The atlantodental interval (ADI) is used in assessing atlantoaxial stability. This measurement may potentially be affected by several features encountered during patient examination. This study examined the influence of 3 features: age, sex, and posture, on the measurement of ADI in a normal population.

Methods: The ADI was measured sequentially on 269 lateral cervical radiographs of adults with no demonstrated bony injury. Images were stratified by age and sex with equal representation in each age group. A further 25 asymptomatic adults were assessed for posture using craniocervical angle measured from digital lateral photographs. The ADI was then measured from a lateral radiograph. The data were examined for correlation between age, craniocervical angle, and ADI using Spearman rank correlation. The ADI of age groups was compared by Kruskal-Wallis test. The relationship between ADI and sex was examined using Wilcoxon rank sum test. Interaction between age and sex was explored using an interaction term in regression analysis.

Results: The ADI decreased with age, median measurements reducing from 2.07 to 0.85 mm across age groups ($P < .01$). No significant relationship was demonstrated between ADI and sex. No significant interaction was demonstrated between age and sex. Measurements of craniocervical angle did not correlate with ADI ($\rho = 0.03$, $P = .90$).

Conclusion: The magnitude of ADI decreases with advancing age. Age should be considered a modifying factor when interpreting measurement of ADI, particularly in consideration of potential minor instabilities. Patient sex does not appear to influence ADI, either independently or in interaction with age. Craniocervical posture variation does not influence ADI in an asymptomatic adult population. (*J Manipulative Physiol Ther* 2013;36:226-231)

Key Indexing Terms: *Atlanto-Axial Joint; Diagnostic Imaging; Age Factors; Posture*

The atlantoaxial joint is the most mobile segment of the vertebral column and has the least inherent stability of any of the vertebral articulations.¹ With little osseous stability, maintenance of this region is ensured by the integrity of the craniocervical ligaments, particularly the transverse ligament of the atlas^{2,3} together with an efficient local neuromuscular system.⁴ Manual therapists

approach the upper cervical region with some caution due to the possibility of atlantoaxial instability.⁵ Transverse ligament integrity may be compromised in patients who have experienced trauma,⁶⁻¹⁰ infections of the pharynx or neck,^{11,12} rheumatoid arthritis, and seronegative spondyloarthropathies.¹³⁻¹⁶ Congenital anomalies may also effect stability of the articulation.¹⁷⁻¹⁹

^a Senior Lecturer in Physiotherapy, The University of Newcastle, School of Health Sciences, The University of Newcastle, Callaghan, Australia.

^b School of Health Sciences, The University of Newcastle, Callaghan, Australia.

^c Conjoint Associate Professor, Senior Staff Specialist Radiologist, Division of Radiology, Hunter New England Imaging, Hunter New England Local Health Network, Newcastle, Australia.

^d Conjoint Associate Professor, School of Medicine and Population Health, The University of Newcastle, Callaghan, Australia.

^e Senior Lecturer in Diagnostic Radiography, School of Health Sciences, The University of Newcastle, Callaghan, Australia.

Submit requests for reprints to: Peter G. Osmotherly, BSc, Grad Dip Pty, MMedSci, Senior Lecturer in Physiotherapy, School of Health Sciences, The University of Newcastle, Callaghan, NSW, 2308, Australia (e-mail: Peter.Osmotherly@newcastle.edu.au).

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The atlantodental interval (ADI), defined as the distance between the anterior border of the odontoid process and the posterior inferior border of the anterior arch of the atlas on a lateral radiographic view,²⁰ is often used to identify instability at the atlantoaxial segment.²¹ The normative values for the atlantodental interval for diagnosis of gross atlantoaxial displacement with the potential for spinal cord and lower brainstem compression are well established^{11,22–24}; however, there is less consideration given of relatively minor instabilities, which may be potential causes of cervical spine pain and dysfunction treated by manual therapists.^{3,25,26} The assessment of the atlantodental interval may potentially be affected by a number of factors routinely encountered in patient examination including age and degenerative change, sex, and habitual posture, and these may also influence published normative values.

The influence of age on this measurement has been previously examined with conflicting findings. Sharp and Purser²⁷ examined the midposition cervical lateral radiographs of a convenience sample of 1478 patients. Categorizing their results into 0.5-mm increments, these authors concluded that an ADI of up to 3 mm should be considered normal in people after the age of 44 years. These findings should be seen in the context that the sample included a number of patients with evidence of rheumatoid arthritis, a disease associated with developing atlantoaxial instability, comprising up to 17% of the individual age strata.

Karnjanasthiti et al²⁸ examined ADIs in 400 lateral cervical radiographs seemingly unscreened for preexisting pathology. These authors demonstrated a trend toward decreasing ADI with increasing age, although this trend was reversed in the 50- to 59-year age group. No consistent association was demonstrated with regard to sex in their sample. The influence of age on ADI is supported by the observations of Hinck and Hopkins²³ who described a sex-mediated age effect on measurement, suggesting that normative ADI values accounting for age and sex could be calculated using a linear function. In contrast, Frobin et al²⁹ assessed the ADI in 96 lateral radiographs and concluded that ADI measurements were neither dependent upon age or sex but a function of the depth of the vertebral body of the axis.

The consideration of upper cervical spine posture involves assessment of the excursion of the head relative to the line of gravity³⁰ and the position of the upper cervical segments in the sagittal plane. The protruded neck position is often of clinical interest because it is frequently associated with a forward head posture³¹ and functional sitting positions.³² Radiographic analysis of sagittal translation in the upper cervical segments has indicated that during protrusion, the atlantoaxial joints approach end of range extension, whereas during retraction, the atlantoaxial joints move toward end range flexion.³² This would infer that

the ADI is increased in retracted positions and reduced in protruded positions in individuals without instability of the upper cervical spine.

Examination of upper cervical spine segments in rheumatoid arthritis patients reveals some potentially important variance in considering the effect of sagittal position on ADI in cases where instability may be present. Using lateral radiographs to compare the upper cervical segments of healthy participants and rheumatoid arthritis patients, Karhu et al³³ noted that, in a neutral head position, the atlas was oriented in a more flexed position on the axis in the patient group due to a combination of superior migration of the posterior arch of the atlas and developing atlantoaxial subluxation. Measurement of the ADI in positions of protrusion and retraction of the upper cervical spine in a population diagnosed with rheumatoid arthritis reveals a variation in effect of position upon measurement. Although retraction was consistently associated with atlantoaxial joint flexion with an anterior translation of the atlas and a consequent increase in ADI, protrusion could result in either atlantoaxial extension with posterior translation leading to a reduced ADI or extension accompanied by an anterior translation of the atlas resulting in a paradoxical atlantoaxial subluxation and an increase in measured ADI.³⁴ Hence, both retracted and protruded positions offer the potential risk of atlantoaxial subluxation in individuals in the presence of instability.

The purpose of this study was to examine the influences of age, sex, and posture on the measurement of ADI in a normal population to improve understanding of the factors affecting natural variation of this measurement that is frequently used to assess atlantoaxial stability.

METHODS

Ethical approval for this work was granted by the Hunter New England Human Research Ethics Committee and The University of Newcastle Human Research Ethics Committee.

Participants

For the assessment of the influences of age and sex, functional radiographic studies for people between the ages of 18 and 91 years were obtained from existing patient files held by Hunter New England Area Health Service, Australia. All radiographs were taken as part of routine clinical management of these patients. As is standard clinical practice, all radiographs were taken with the patient in standing. Studies considered eligible for inclusion were reported by a radiologist to be free of pathology. Studies were excluded if there was any indication of fracture or bony injury, head or neck trauma, diagnosed ligamentous injury, congenital cervical disorders or conditions known to be associated with craniocervical ligament laxity, or a

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