Comparison of Occipito-atlanto-axial Parameters on CT in Pediatric Trauma Patients

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Introduction

Spinal cord injury without radiographic abnormality is a prevalent issue within the pediatric population. Children under the age of 10 are prone to sustaining injury at C1 to C4 because their biomechanical fulcrum exists between C2 and C3. The incidence of spinal cord injury in pediatric population has been estimated to be 4.6 per million per year or 1-2 % of all pediatric trauma cases. There may be subtle findings on computed tomography (CT) that may be able to identify occult cervical spine injury in pediatric trauma patients, which would be evident on magnetic resonance imaging (MRI).

Objective

This study aims to measure various dimensions of the atlantoaxial and atlantooccipital joints in the pediatric cervical spine in patients with normal spines to detect subtle irregularities on CT scans to warrant further work up with an MRI in trauma patients. Additionally, having an accurate diagnosis will help guide the appropriate type and duration of treatment, which can range from conservative treatment with immobilization to surgery.

Materials and Methods

This is a retrospective study of patients under the age of 10 years (0-12mo n=19, 13-23mo n=20, 24-35mo n=25, 36-59mo n=44, 60-83mo n=42, 84-131mo n=50) who received a cervical CT: 200 patients without presenting history of trauma and 29 patients with a presenting history of trauma that also received subsequent MRI (the reference standard). The lateral atlanto-dens interval (LADI), atlantooccipital interval (AOI), atlantoaxial interval (AAI), and delta lateral atlanto-dens interval (ΔLADI) were measured. The values of the normal 200 patients were compared to the 29 traumatic patients using Wilcoxon rank sum test and logistic regression

CT Measurements

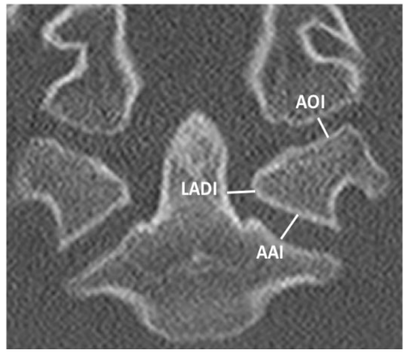

Figure 1: *Coronal CT cervical spine demonstrating LADI, AOI, AAI*

LADI: *M*easured perpendicularly on the coronal plane from the cortex of the C1 lateral mass to the cortex of the dens process at the level of the dental center

AAI: Center of the atlantoaxial joint space was identified . Then the joint space was measured perpendicularly from one cortex to another in coronal and sagittal planes bilaterally

AOI: Center of the joint space between the occipital condyle and the lateral mass was identified in coronal and sagittal planes and measured from both cortices in coronal and sagittal dimensions.

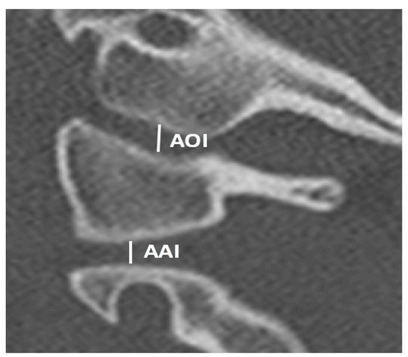

Figure 2*: Sagittal CT cervical spine demonstrating measurements of AOI and AAI*

Results

	Group I Mean (mm) [95% CI]	Group II Mean (mm) [95% CI]	P-value
	(n=200)	(n=29)	
LADI	5.3 [5.2, 5.5]	4.6 [4.3, 5.0]	**<0.001**
AAI	3.0 [2.9, 3.1]	3.3 [3.0, 3.6]	0.18
AOI	2.7 [2.6, 2.8]	2.5 [2.3, 2.7]	0.067
Δ LADI	1.1 [0.94, 1.22]	1.5 [1.0, 2.0]	0.075

The Wilcoxon Rank Sum was used to compare between groups.

Table 1: Comparison of the mean LADI, AAI, AOI, and ΔLADI between normal and trauma patients

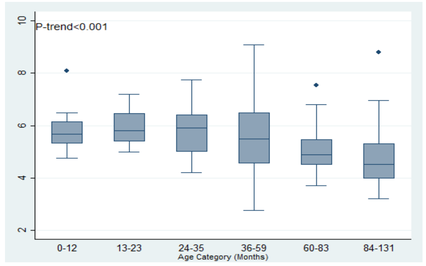

Figure 3: Scatter plot of LADI measurements (mm) in each age (with variation and outliers) category demonstrating a downward trend with age.

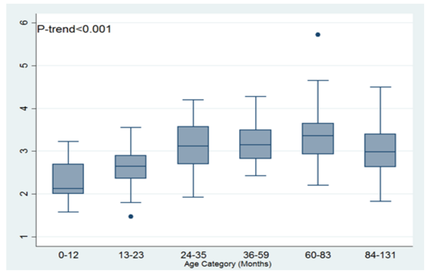

Figure 4: Scatter plot of AAI measurements in each age category demonstrating the upward trend with age

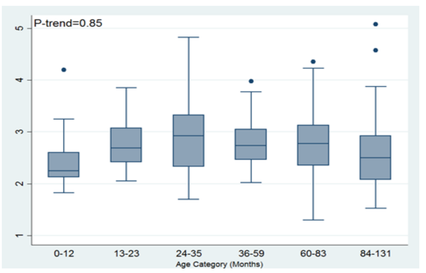

Figure 5: Scatter plot of AOI measurements in each age category demonstrating no change with age

Discussion and Conclusions

ΔLADI 95% CI was found to be 0.94-1.22 mm. The asymmetry is secondary to head tilt during exam and lack of a cervical spine collar to center the spine, which can lead to pseudo-asymmetry on coronal plane as slices are obtained through a slightly anterior lateral mass which would appear closer to the dens process than the contralateral side.

The AAI 95% CI was calculated to be 2.9-3.1 mm and an upward trend with age until age 36 months, after which they remain relatively stable (Figure 3). The AAI widening from birth to 36 months is most likely due to varying levels of ossification, and the AAI stability thereafter can be explained by normal bone maturation with age.

The normal overall value for AOI 95% CI was calculated to be 2.6-2.8 mm. Figure 4 demonstrates an upward trend through 36 months, again most likely demonstrating varying degrees of ossification explained by normal bone maturation with age.

There was a statistically significant difference between the Group I (nontrauma) mean LADI of 5.3 mm and the Group II (trauma) mean LADI of 4.6 mm with a p-value of <0.001 (Table 2). The values for AAI, AOI, and ΔLADI demonstrated no statistically significant difference between the two groups. The lack of difference for most of the parameters between Groups I and II demonstrates that it is not necessary to perform MRI on all trauma patients.

Simply having a trauma does not signify cervical spine or spinal cord injury; therefore, to assess the need for MRI in these patients, certain threshold values for normal cervical spine measurements on CT should be utilized

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