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Morphometric Analysis of C1-C2 Cervical Spine to Assess the Ergonomic Changes Among 18 – 24 Year Age Group Using Cbct – Pilot Study.

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KEYWORDS

Cone Beam Computed Tomography, Cervical vertebrae, Altanto-Axial Joint, ergonomics, Adolescents

ABSTRACT:

Context:

An analysis of the atlas and axis anatomy using Cone Beam Computed Tomography(CBCT) might aid in understanding the atlantoaxial relationship.

Aim: Using Cone Beam Computed Tomography (CBCT) to measure the atlantoaxial interval, this study aimed to analyze the morphometric changes in C1 and C2 in participants aged 18 to 24 years, retrospective study.

Methods and Materials: There were 15 male and 15 female participants in the study. Using CS Imaging Software, CBCT scans of the subjects were obtained using a CS 9600 CBCT machine with exposure parameters of 120kVP and 2–6 mA. The Lateral Atlantodental Interval (LADI) was measured in mm scale at the sagittal view, and the scans were examined in orthogonal slices to check for any disease.

Results: There was no discernible age difference between the male and female groups. Males (P=0.932) had a mean LADI that was statistically significantly higher than females(P=0.038). The Mean LADI did not differ statistically significantly among the study individuals of different ages (P=0.743).

Conclusions: The results of our study show that there is a larger LADI in the 18–24 age range, particularly in men. Therefore, CBCT evaluation of LADI may be used as a screening method for early detection of atlantoaxial dislocations, particularly in children and adolescents who are more sensitive.

1. Introduction

Most extraoral imaging modalities in maxillofacial radiology partially cover the cervical spine. Two-dimensional radiography's limitations include structure overlap, leading to unclear visualization of the cervical spine. Cone Beam Computed Tomography (CBCT) offers a better definition for studying cervical spine structures[1]. Recent research has focused on craniocervical relationships to assess atlanto-occipital dislocations and cervical vertebrae degenerative changes[2].

The atlas and axis, though relatively minor units of the vertebral column, are crucial for craniovertebral movements. Congenital abnormalities and trauma are major reasons for altering the atlantoaxial segment's arrangement[3]. Chronic postural changes, especially the forward head posture in children and adolescents using computers and smartphones, can lead to cervical instability, spinal degeneration, and neck musculoskeletal disorders[4,5,6]. CBCT can aid in understanding these relationships and identifying atlantoaxial segment disorders early. This study evaluates morphometric changes in C1 and C2 among 18-24-year-olds using CBCT, aiming to provide insights into early detection and prevention strategies for cervical spine disorders in young adults.

2. Materials and Methods

The Present study was undertaken after obtaining consent from the institutional ethical review board(institutional ethical clearance number:KIDS/IEC/2023/I/007-A), Helenski Declaration(2013) was followed and only full volumes(16×17) data was taken in the system. The present study included subjects within the age group of

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18-24 years with no history of any systemic illness. Subjects with previously diagnosed head, neck and spinal disorders and those with other underlying systemic illness were excluded from the study. A total of thirty subjects were selected for the study and radiographic CBCT examination of the study subjects were carried out with a Carestream (France) CS9600 device under standard patient positioning protocols. All the Scans were acquired in an exposure parameter of 120kVP and 2-6 mA using a variable field of view and the CBCT images of DICOM format were studied using CS Imaging Software. The Scans were studied in Orthogonal slicings for the presence of any pathology and the measurements of Lateral Atlantodental Interval (LADI) was measured in mm scale at sagittal view.

3. Statistical Analysis

The data obtained from the study was tabulated and subjected to statistical analysis using SPSS Version 26. The data was expressed as means and standard deviations. Comparison of the age and LADI between the study groups was carried out using independent t test. Comparison of LADI among various age groups was carried out using One way ANOVA. P value less than 0.05 was considered to be statistically significant.

4. Results

The study included a total of 15 males and 15 females. The mean age of the males was 21.47 ± 2.17 and among the females was 21.40 ± 2.10. There was no statistically significant difference in the age between the male and female group. (P=0.932). The overall mean Lateral Atlantodental Interval (LADI) among the studied subjects was 3.42 ± 0.40. The mean LADI among males was 3.57±0.37 and females was 3.27±0.38. The mean LADI was higher in males than the females with a statistically significant difference. (P=0.038) (Figure 1) The mean LADI among subjects aged 18 years was 3.64 ± 0.61, 19 years was 3.40 ± 0.14, 20 years was 3.10 ±0.42, 21 years was 3.35 ± 0.34, 22 years was 3.28 ± 0.11, 23 years was 3.41 ± 0.05, 24 years was 3.52 ± 0.27. There was no statistically significant difference noted in the mean LADI among various ages of the study subjects. (P=0.743) (Figure 2)

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5. Discussion

The atlas and axis are the most cephalic cervical vertebrae occupying the C1 and C2 positions respectively. The ring-shaped morphology of the atlas lacks vertebral body and is in direct relation with the skull, accommodating the spinal cord at the exit from the foramen magnum. The axis is considered as a major weight-bearing vertebra of the upper cervical segment, as the load from the occipital condyles is transferred to the C1 lateral masses at their articulation, and subsequently to the C2 lateral masses[7,8].

The atlantoaxial joint is a biaxial, pivotal joint formed by the articulation of the dens/odontoid process of the axis with the atlas, the joint along with transverse ligaments contributes to the cervical stability and mobilization[9,10]. Computed Tomography is the widely utilized radiographic modality for the study of the atlantoaxial joint anatomy. Assessment of shape and type of the atlas and axis, contraposition between superior and inferior articular facets of lateral atlantoaxial joints, dimension of the atlantodental interval, Power ratio, width and position of facets, etc. are some of the methods followed to study the joint anatomy[11].

The Atlantodental Interval (ADI), which measures the distance between the posteroinferior border of the anterior arch of the atlas and the anterior edge of the odontoid process of the second cervical vertebra, is used to diagnose atlantoaxial segment instability [11,12].

Mihalache et al. compared the use of Multi-Slice Computed Tomography (MSCT) and Cone Beam Computed Tomography (CBCT) for the morphological assessment of C1 and C2. Their study reported CBCT to be a valuable alternative to CT for studying the bony architecture of the cervical vertebrae, with the added benefit of comparatively reduced radiation exposure[13].

In the present study, CBCT was used to assess the Atlantoaxial joint, and the Lateral Atlantodental Interval (LADI) was assessed among the study subjects. A total of thirty subjects with equal distribution of both genders as 15 males and 15 females. The mean age of the male group was 21.47 ± 2.17 years and the female group was 21.40 ± 2.10 years. There was no significant difference in the age of the study subjects, to avoid gender and age-based bias in the study.

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Based on the observations of Hinck et al.[14], an atlantodental interval of less than 3 mm in males and less than 2.5 mm in females was considered to be normal. According to the reports of Yang et al.[11], atlantodental interval greater than 3 mm is considered to be more prone to atlantoaxial dislocations. However, in the present study, the overall mean LADI of the population studied was 3.42±0.40 mm, indicating the vulnerability of 18–24-year adolescents for atlantodental dislocations. The increase in the LADI could be attributed to a wide variety of predisposing causes in the age group studied, which may include hypermobility and instability due to postural abnormalities resulting in ligamentous laxity. Cesur et al.[15] in their study among 14 to 20 years old subjects of the Turkish population have reported LADI values to be higher in the 14-20 years age group. However, the values of LADI observed by Cesur et al.[15] were comparatively higher than those observed in our present study. Various factors such as age, gender, ethnicity, habitual posture, trauma, and degenerative changes have been implicated in influence of the atlantodental Interval, as reported by literature evidence [12,16].

A study by Hadidi et al. [17] among adolescent university students has reported a relation between the postural changes of neck and neck pain associated with the adolescent age group with increased usage of smartphones. Therefore, increased LADI could be directly related to the habitual characteristics and postural change of the head common to the adolescent age group.

In the present study, the LADI was found to be higher in males (3.57±0.37 mm) than in females (3.27±0.38 mm). Our findings are in accordance with the findings of Cesur et al. [15] and Chen et al.[16] who reported significantly higher LADI in Males. Stemper BD et al.[19] have reported significant gender-based differences in the spinal geometry.

Though we observed higher values of LADI in the age group of 18-24 years, there was no significant difference noted within the age group. Atlantoaxial dislocations are frequently reported in children and adolescents. The presentation of atlantoaxial dislocations may vary from asymptomatic or chronic neck pain to severe neurological impairment and fatality, depending on the traumatic or non-traumatic etiology. Therefore, it is necessary for early identification of the condition by appropriate clinical and radiographic assessment [20].

The present study is bound for inherent limitations such as a smaller sample size and lack of clinical correlation, inclusion of more parameters. Further prospective case-control studies with considerably larger sample size and relevant clinical abnormalities of the head and neck have to be carried out to explore the importance of LADI measurements. In future, measurements taken from anterior, posterior, and lateral ADI can be included.

6. Conclusion

The present study was an attempt to evaluate the changes in LADI among the adolescent age group. The results obtained from the study indicate the higher LADI in the age group of 18-24 years, especially among males. Therefore, assessment of LADI from CBCT scan may be used as a screening tool in the vulnerable population adolescents, for early identification of Atlantoaxial dislocations, so as to prevent the associated morbidity. This study paves the way to do a prospective study for work-related musculoskeletal disorders (WMSD). Since studies based on the correlation of work-related musculoskeletal disorders with radiographs are very sparse.

Figure 1: Graphical representation of comparison of LADI among males and females.

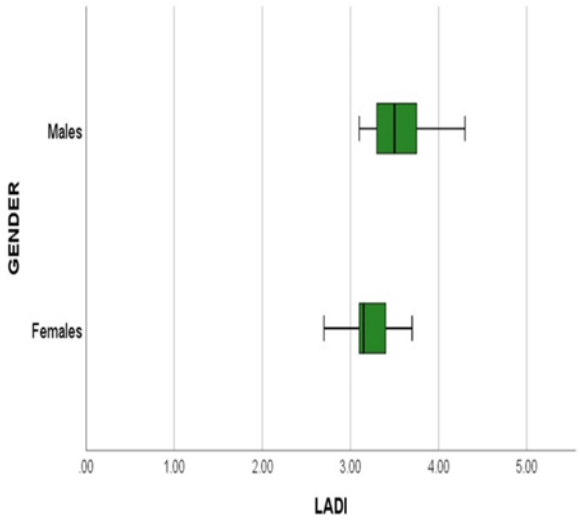

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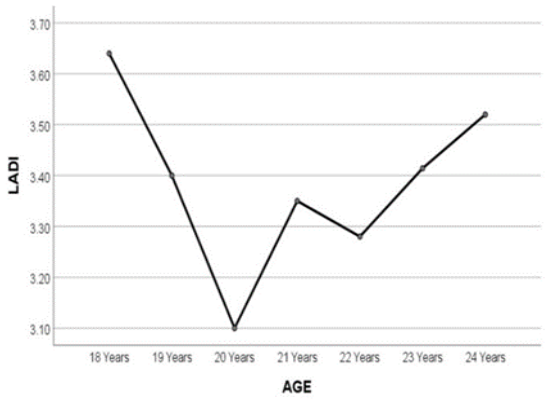
Figure 2: Graphical plot of mean LADI of various age groups.



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