

Clinical Study

Prevalence of degenerative changes of the atlanto-axial joints

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Abstract

BACKGROUND CONTEXT: Degeneration of the atlantodens and atlanto-axial joints is associated with cervical spine pain and may also be associated with an increased risk of dens fracture. However, there is paucity of literature describing the prevalence of specific degenerative changes in the atlantodens and atlanto-axial facet joints.

PURPOSE: To document age-related degenerative changes of the cervical spine in a large cohort of patients.

STUDY DESIGN/SETTING: This is a retrospective cohort study.

PATIENT SAMPLE: Adult trauma patients were admitted to our Level 1 trauma center.

OUTCOME MEASURES: Osteoarthritis of the atlantodens and atlanto-axial facet joints of the cervical spine and the presence of intraosseous cyst and calcific synovitis, as determined by computed tomography (CT) scans.

METHODS: We conducted a retrospective study of 1,543 adult trauma patients who received a cervical spine CT scan. The anterior atlantodens joint interval was measured. The presence or absence of intraosseous cysts and calcific synovitis was recorded. Degeneration of the atlantodens and atlanto-axial facet joints at age intervals was quantified.

RESULTS: The atlantodens interval narrowed linearly with age ($R^2=0.992$, $p<.001$). The prevalence of intraosseous cysts increased exponentially with age from 4.2% to 37.4%, and calcific synovitis increased from 0% to 11.1%. Intraosseous cyst formation generally began in the second and third decades of life and synovitis in the fifth and sixth decades of life. Facet joints also demonstrated age-related changes; however, the rate of degenerative changes was lower than in the atlantodens joint.

CONCLUSIONS: To our knowledge, this is the first study that documents specific changes of both atlantodens and atlanto-axial facet joints as a function of age in a large cohort of 1,543 patients. These changes increased exponentially with age and may contribute to pain and limitation in motion. In light of our findings and recent studies demonstrating the association between degeneration and dens fracture in elderly, cervical spine radiographs of elderly patients should be carefully assessed for these changes. © 2015 Elsevier Inc. All rights reserved.

Keywords:

Osteoarthritis; Cervical spine; Dens fracture; Risk factors; Intraosseous cyst; Calcific synovitis

Introduction

The atlantodens and atlanto-axial facet joints are anatomically unique and functionally important diarthrodial joints of human spine [1]. The dens rotates within a ring space created by the anterior arch of the atlas and the transverse ligament, and this movement must be accompanied by sliding motion of the facet joints [2]. This unique segment contributes between 40% and 70% to the total cervical spine rotation [2,3]. To date, the actual prevalence of radiographic arthritis and severity of arthritis is not known.

Recently, arthritis of the atlanto-axial joints has been reported as a risk factor for dens fracture [4,5]. Dens fractures have a bimodal age distribution, affecting primarily young

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Fig. 1. Degeneration of the facet joint computed tomography representations of all grades of degenerative changes of the left and right facet joints (C3–C6), shown in the coronal plane: Grade 1 (Left) shows normal joint space without osteophyte formation. Grade 2 (Middle) shows obliterated joint space with osteophyte formation. Grade 3 (Right) shows ankylosis of the joint.

active males mostly as a result of motor vehicle accidents and elderly patients as a result of ground-level falls [6–9]. Dens fractures are the most common cervical spine fracture in the elderly, accounting for 9% to 18% of all cervical spine fractures [10–12]. The mechanism for these injuries is generally cervical spine hyperextension or hyperflexion resulting in a tensile failure of the dens [10,11,13]. In 2005, Lakshmanan et al. [2] reported in a small series of patients that there was a possible relationship between upper cervical spine degeneration and the incidence of Type II dens fractures. Recently, our group demonstrated that atlantodens degeneration with presence of intraosseous dens cysts and retrodens calcific synovitis significantly increased the risk of sustaining a dens fracture in the elderly.

The purpose of this study was to describe the prevalence of the degenerative changes of the atlantodens joint and atlanto-axial facet joints as a function of age using computed tomography (CT) scans of the cervical spine.

Materials and methods

This study was performed with the institutional review board approval. We performed a retrospective study of adult trauma patients at least 18 years of age, who were admitted to our Level 1 trauma center between January 1, 2008 and 31 December, 2011. As part of our institution's routine protocol, all trauma patients received a cervical spine CT scan for cervical spine clearance. Of the 8,631 patients who met the inclusion criteria, 1,543 (18%) were selected at random using a random number generator for analysis as our study cohort. This number was determined by an a priori power analysis with the parameters set at $\beta=0.1$ and $\alpha=0.05$. Data were collected on the

degenerative changes of the atlanto-axial joints of each individual. The subjects were subdivided into eight age groups according to the decade of age.

All cervical spine images were taken with a CT scanner (Philips Brilliance 64, Cleveland, OH, USA). A collimation of 0.9 to 1.5 mm and an increment of 0.2 to 0.4 mm were selected, and multiplanar reconstruction images were routinely obtained in arbitrary imaging planes. Degenerative changes were qualitatively assessed using sagittal and coronal views of the upper cervical spine. The interval of the anterior atlantodens joint space was measured in the midsection of the odontoid process on sagittal views (Fig. 1). To determine the interrater reliability of the anterior atlantodens joint space measurements, two authors (MB and SRB) independently analyzed a total of 50 randomly selected CT scans. For these measurements, we found an excellent statistically significant correlation ($R^2=0.71$, $p<.001$) between the two raters. Intraosseous cyst formation was identified as a clear lytic defect found within the odontoid process. Calcific synovitis was defined by a calcified soft-tissue mass posterior to the odontoid process and transverse ligament. Degeneration of the anterior atlantodens and facet joint was quantified at the C1–C2 level using a modified version of a scoring system described by Lakshmanan et al. [2] (Table 1 and Fig. 2). All findings of osteoarthritis were considered not only in the axial and midsagittal images but also from any direction using multiplanar reconstruction images. For further analysis, patients with Grade 2 or 3 degeneration were considered to have osteoarthritis and assigned an osteoarthritis score. Patients with Grade 1 degeneration were considered to have no osteoarthritis of the respective joint.

Data analysis

Data were analyzed using SPSS 20.0 (SPSS, Inc., Chicago, IL, USA). Normality of the data was evaluated using the Shapiro-Wilk test. For the atlantodens joint interval, we used an unifactorial analysis of variance (modified Bonferroni method) to evaluate differences among age groups. The prevalence of cyst and calcific synovitis in our patient cohort was compared across age groups and sex using chi-square tests. The relationships among atlantodens interval, cyst, calcific

Table 1

Grading the severity of degenerative changes in the anterior atlantodens and lateral atlanto-axial joints

- | |
|---|
| 1—None-mild: normal or narrowed joint space with or without minor osteophyte formation. |
| 2—Moderate: obliterated joint space with or without osteophyte formation. |
| 3—Severe: ankylosis of the joint with excrescences either in the joint or transverse ligament calcification, or both. |

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