Degeneration of the Cervical Spine Influences the Risk of Sustaining Dens Fractures.

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Disclosures: M. Betsch: None. S. Blizzard: None. J.U. Yoo: None.

Introduction: Dens fractures have a bimodal age distribution, affecting primarily young active males, mostly as a result of motor vehicle accidents, and elderly patients as a result of ground level falls. In the elderly, dens fractures are the most common cervical spine fracture. The mechanism for these injuries is generally cervical spine hyperextension or hyperflexion resulting in a tensile failure of the dens. Older patients are at greater risk of falling than younger patients, since older people suffer from reduced visual activity, decreased reaction time, and blunted reflexes. The fracture risk in the elderly is further increased by the biochemical bone attrition associated with senile osteopenia, the most common cause of primary osteoporosis. In 2005 Lakshmanan et al. 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 [1]. With age the incidence of osteoarthritis (OA) of the cervical spine increases, possibly restricting motion at any particular cervical spine joint, which may adversely affect the movement and distribution of force across the segment of the spine after a trauma, increasing the likelihood of fracture. Despite the high prevalence of dens fractures and their increasing consequence to overall health of the aging population, there is a paucity of research identifying anatomic risk factors, such as degenerative disease. In this study, we propose that degeneration of the cervical spine may increase dens fracture risk.

Methods: We performed a retrospective cohort study of adult trauma patients age 55 and older, admitted to our level one trauma center between 1/1/2008 and 12/31/2011. Institutional Review Board approval was obtained and no informed consent was necessary. Per our institution’s protocol, all trauma patients received a cervical spine CT scan for cervical spine clearance. Of the 1,794 patients who met the inclusion criteria, scans were obtained for all 51 patients presenting with a dens fracture and for a random sample of 741 without a dens fracture who served as a control group. OA of the cervical spine_both disk spaces (Fig. 1) and facet joints (Fig. 2) of the C1 to T1 joints_was quantified using a modified version of a scoring system first described by Lakshmanan et al [1]. For analysis, patients with grades 2 and 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 representative joint. For our analysis, we divided the population into two groups comparing patients with and without dens fracture. Differences between groups were assessed using Chi-Square analysis. To rule out confounding effects of age and gender between the groups we performed a sub-group analysis.

Results: Patient age ranged from 55 years to 103 years. The mean age of patients with a dens fracture was 77.9 ± 9.7. The mean age for patients in the control group was and 70.7 ± 12.0. 51 patients with a dens fracture were identified (prevalence of 3.2%). Of those 51 patients, 39 (68.4%) sustained a dens fracture due to a ground level fall, 10 (17.5%) due to a motor vehicle accident, 2 (3.5%) due to falls from greater than standing height, and 6 patients (10.5%) due to other reasons. We found that patients with OA of the atlanto-dens interval (3.9%) were two times more likely to sustain a dens fracture (p<0.05)
than patients without OA (7.8%). For all other cervical disc spaces, we did not find significant differences between the groups. Interestingly, for the facet joints from C2 to C6 we did find a significant increase (p<0.001 - p=0.024) in the dens fracture risk between patients with and without OA (Fig.3). For the C5/C6 facet joints, we found the lowest increase in the relative dens fracture risk of 1.8 (4.8% patients without OA vs. 8.8% with OA), and for the C3/C4 facet joints we determined the highest increase in the relative dens fracture risk of 4.5 (2.4% without OA vs. 10.8% with OA).

**Discussion:** Despite the increasing incidence and detrimental health consequences to the aging population, there are only a few studies describing risk factors beyond osteoporosis, age, female sex, senility, and balance for sustaining a dens fracture. In 2014 Shinseki et al. found a nearly eightfold increase in the likelihood to sustain a dens fracture in patients with intraosseous dens cysts, and a nearly fivefold increase in dens fracture risk in patients with retro-dens synovitis [2]. The authors state that such degenerative changes may weaken the odontoid, consequently predisposing elderly trauma patients to dens fracture. Spondylotic changes of the cervical spine are associated with ageing, and seem to be closely related to wear and tear due to repeated movements and axial loading of the neck during one’s lifetime [15]. This study demonstrates that in patients 55 and older, OA of the facet joints between C2 and C6 and in the atlanto-dens interval is associated with a significant increase in dens fracture prevalence. OA of the atlanto-dens interval leads to a reduction in the atlantoaxial rotation, which can be further limited by severe degeneration of the facet joints below. As a consequence, a relative low-energy trauma can induce a forced atlantoaxial rotation, resulting in a dens fracture. Better understanding of the relation between the dens fracture and OA of the cervical spine may lead to more effective prevention or treatment of these fractures.

**Significance:** Our study shows that osteoarthritis of the atlanto-dens interval and the cervical facet joints may lead to a significant increase in dens fracture risk. Furthermore, given the results of our study demonstrating the association between OA and dens fracture in the elderly, cervical spine radiographs of elderly patients (particularly after a trauma) should be carefully assessed for these degenerative changes.

**References**

Fig. 1 Osteoarthritis of the facet joint was graded according to a scoring system by Lakshmanan et al. For the purposes of our analysis, patients with grade 2 to 3 (fig 1b and 1c above) degeneration were considered to have OA of the respective joint. Patients with grade 1 (1a) degeneration were considered to have no OA.

Fig. 2 For grading OA of the cervical spine disc levels and the atlantodens interval we used the same scoring system as described for the facet joints.
Fig 3. We found a significant difference in OA prevalence between fracture and non-fracture patients at the C2/3 through C5/6 facet joint levels.