Degeneration of the atlanto-axial joints

A histological study of 9 cases

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Submitted 01-01-13. Accepted 01-07-09

ABSTRACT – Degeneration of the lateral atlanto-axial joints (AAJ) has been described as a potential cause of severe neck pain. However, hardly any data are available on its incidence, especially in comparison to the lower cervical spine. In this histological study, we examined the AAJs in 9 specimens from elderly patients, graded the findings and compared them to those in the facet joints of the lower cervical spine. Most histological changes in the AAJs were mild, but the changes in the lower cervical spine were severer. Previous mechanical studies have described the AAJ as a very mobile joint with large neutral zones, which may explain the mild degree of osteoarthrosis found in these specimens.

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Several joints provide stability and yet considerable mobility of the head in relation to the spine. 4 separate joints are present between C1 and C2, of which 2 are located on either side of the odontoid, and 2 are intervertebral synovial joints—i.e. the lateral atlanto-axial joints (AAJ). Although they have been regarded as facet joints (Halla and Hardin 1987), they are unique in several ways. The axial joint surface is convex, articulating with a flat surface on the atlas. This incongruency results in a sizable joint space anteriorly and posteriorly of 3–5 mm each (Dvorak and Grob 1999). The wide and loose joint capsule provides ample mobility, particularly axial rotation (Panjabi et al. 1988). Control and stability of the joints therefore depend on a complex system of ligaments.

Degeneration of the AAJ has been described as a distinctive clinical syndrome and a potential cause of severe neck pain (Ehni and Benner 1984, Star et al. 1992). However, hardly any data are available on the incidence of degeneration and no histological examination of the degenerative findings, particularly in relation to the lower cervical spine, has been reported.

In this study, we examined the AAJs of 9 specimens from elderly patients, graded the histological findings and compared the results to those in the facet joints of the lower cervical spine.

Material and methods

The study included cervical spines from 9 subjects over the age of 50. The medical records of subjects contained no mention of pain in the cervical spine or previous surgery. To ensure that the musculature and ligaments were kept intact, the cervical spines were removed en bloc, sealed in double thickness polythene bags and frozen at –20 ºC.

After removing the C1–C2 motion segments from the lower cervical spine, the lateral atlanto-axial joints were divided into 2 intact blocks with a bandsaw into 3 parasagittal slices of about 5 mm thick. The blocks were fixed for 48 hours in a solution of 4% formalin and 3% dextran and then immersed in a solution containing 15% EDTA and 0.5% paraformaldehyde until they were completely decalcified, as shown on radiographs. All slices were processed in paraffin wax using standard methods, and tissue sections of 5 µm thickness were stained with hematoxylin and eosin for histological examination. The sections were classified with the grading system used in previous studies for histological changes in facet joints of the lumbar spine (Gries et al. 2000). Each joint was assigned 4 subscale scores, 1 each reflecting the

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Data on all specimens showing the grades of degeneration of the right and left atlanto-axial joints, and the average grades of the subaxial facet joints

Patient	Age	Atlanto-axial joint Right	Atlanto-axial joint Left	Facet joints lower spine
1	72	2	2	2.8
2	76	3	–	3.8
3	85	4	4	3.5
4	67	2	2	2.6
5	58	1	2	2.7
6	63	1	1	2.7
7	66	2	2	2.5
8	71	2	1	3.5
9	86	2	2	3.5
Average	72	2.1	2.0	3.1

characteristics of the cartilage, osteochondral junction, subchondral bone, and the margins. The subscale scores reflect the most severe features of the specimen on that particular scale. An overall or composite grade for each specimen was then calculated by taking the mean of the four subscale scores. The same classification was used for the histological grading of changes in the facet joints of the lower cervical spine in the same specimens (Läubli et al. 1999). Grading of the AAJ was then compared to the average grading of the entire lower cervical spine.

Results

17 atlanto-axial joints from the 9 specimens could be evaluated, 1 having been damaged during preparation. Most of the histological changes were mild, in only 1 case was the degeneration maximally rated "4" (Table). We found no relation between the severity of the changes and the age of the patients. Changes were similar in the 2 joints from the same specimen, no unilateral difference being noted. The most frequent single histological finding of joint degeneration was tangential superficial cartilage flaking (7 cases). Meniscus-like synovial folds were seen in all joints (Figure 1).

Apart from 1 case, changes in the lower cervical spine were more severe. The difference in gradings of the AAJs and lower facet joints was statistically significant (Table, paired t-test, $p = 0.003$).

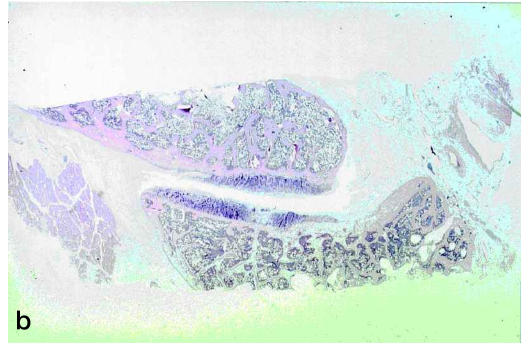
Discussion

Degenerative osteoarthrosis of the cervical spine may involve all levels, including the upper cervical region. Atlanto-axial arthrosis was shown radiologically in 4% of patients with degenerative arthrosis of the spine (Halla and Hardin 1987). Posttraumatic changes also seem to play an important role (Ehrat et al. 1996). Patients can present with occipitocervical pain, frequently diagnosed as "occipital neuralgia", headaches, and limited rotation towards the affected side (Ehni and Benner 1984). An experimental increase in pressure in the AAJ by injections causes consistent patterns of pain (Dreyfuss et al. 1994). The diagnosis is further confirmed on "open-mouth" radiographs showing loss of the normal joint space, subchondral sclerosis and the formation of osteophytes.

Figure 1. (a) Typical example of a macroscopic view of a midsagittal section of an atlanto-axial joint. Note convexity of joint surfaces and synovial folds on either side of the joint.

(b) Histological section of the same specimen showing minor degenerative changes.

Figure 2. (a) Macroscopic view of a midsagittal section of a C4–5 facet joint of the same specimen. Roughening and thinning of the cartilage surfaces are visible.



(b) The histological section shows advanced degeneration of the cartilage with thinning, roughening and fissuring.

Despite its clinical importance, we know of no histological study of C1–2 osteoarthrosis, particularly with a comparison of the changes in the subaxial spine. Harata et al. (1981) described 31 clinical cases of atlanto-axial osteoarthrosis. Histological findings were obtained in 1, and they were "similar to those commonly observed in other joints affected by osteoarthrosis"—i.e., thinning and fibrillation of articular cartilage with subchondral sclerosis.

We compared the histological changes in the AAJ to facet joints from the lower cervical spine of the same specimen. Both are true synovial joints and the same classification system was used (Läubli et al. 1999, Gries et al. 2000). It was interesting to note that degeneration was significantly less severe in the upper cervical spine. The joint surfaces of the AAJ are incongruous, resulting in a limited direct contact of the joint surfaces. Additional synovial folds compensate for this incongruency similar to seen in menisci in the knee (Chang et al. 1992, Schonstrom et al. 1993), which we found in all our joints. A loose joint capsule allows movements around three axes. Panjabi et al. (1988) reported about 20° range of motion for flexion/extension and 15° for left/right lateral bending, respectively. The greatest mobility, however, was found for axial rotation with more than 75°. The neutral zone for axial rotation was large with 75% of the mobility. The AAJ therefore may be classified as a generally loose joint, moved by very weak forces. This may be one of the reasons why degenerative changes are less marked than in the lower cervical spine. Moreover, the center of rotation is much closer to the joint in the upper cervical spine than in the lower region, which results in smaller movements acting on the joint (Dvorak et al. 1991).

Our findings have their clinical correlation in the fact that the mobility of the entire cervical spine decreases with age, but the rotation in the upper cervical spine increases (Castro et al. 2000).

No funds have been received in support of this study.

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