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Case report

Difficulties in distinguishing between an atlas fracture and a congenital posterior atlas arch defect in postmortem analysis

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ABSTRACT

We found one atlas from a sample of 148 skeletons (0.67%) that presented different anatomical variations which made it difficult to determine whether the vertebra had an atlas fracture, an unusual Type B posterior atlas arch defect, or a combination of both. We carried out a stereomicroscopy, radiographic, and computerized tomography scan study that revealed that the dry atlas we found presented a very uncommon congenital Type B posterior atlas arch defect, simulating a fracture. In short, the present paper has revealed that differentiating Type B posterior atlas arch defects from fractures in post-mortem dry vertebrae is more difficult than expected. Thus we believe that it can be easier than expected to mistake Type B posterior arch defects for fractures and *vice versa* in postmortem studies.

1. Introduction

Posterior atlas arch defects have been classified in five types [1] depending on the extent of absence of the posterior arch and the presence or absence of the posterior tubercle: Type A, failure of midline fusion of the two hemiarches with a small gap; Type B, unilateral cleft ranging from a small defect to the complete absence of one hemiarch; Type C, bilateral clefts of the lateral aspects with preservation of the most dorsal part of the arch; Type D, absence of the posterior arch with a persistent posterior tubercle; Type E, absence of the entire arch including the tubercle.

When found, congenital posterior atlas arch defects are usually presented as posterior midline fusion defects with a remaining small gap (Type A defect). This is the commonest Type A defect which is present in about 4% of the population and accounts for more than 90% of all posterior arch aplasias [1]. In contrast, Type B posterior defects have been reported to occur in only 0.69% of the population [2].

In vivo atlas fractures can be mistaken for posterior atlas arch defects [2,3]. On the other hand, visual examination of human skeletons provides us with a unique opportunity to discover and describe posterior atlas arch defects [4]. In addition, theoretically, it should not be difficult to distinguish between an atlas fracture and a posterior arch defect in the postmortem study of dry atlases; this is not, however, as easy as might be expected in a dry cadaveric vertebra.

2. Case report

We carried out a study to detect posterior atlas arch defects in dry vertebrae. We used the dry vertebrae collection obtained from the body donor program of our Department. The study was approved by the institutional review board at our University. We reviewed 148 dry cadaveric cervical columns from Caucasian cadavers aged between 61 and 86 years at time of death.

We found a skeleton (a female aged 71 years at death; cause of death, myocardial infarction; year of death 2011) from a sample of 148 (0.67%) with an atlas that presented different anatomical variations which made it difficult to determine whether the vertebra had an atlas fracture, an unusual Type B posterior atlas arch defect, or a combination of both. The medical history of the subject revealed that she was diagnosed with osteoarthritis (OA) and osteoporosis. No information about cervical spine trauma or fractures was recorded in the medical history of the subject.

Macroscopic vision of the atlas revealed a linear defect at the base of the left posterior arch which seemed to be part of a complex

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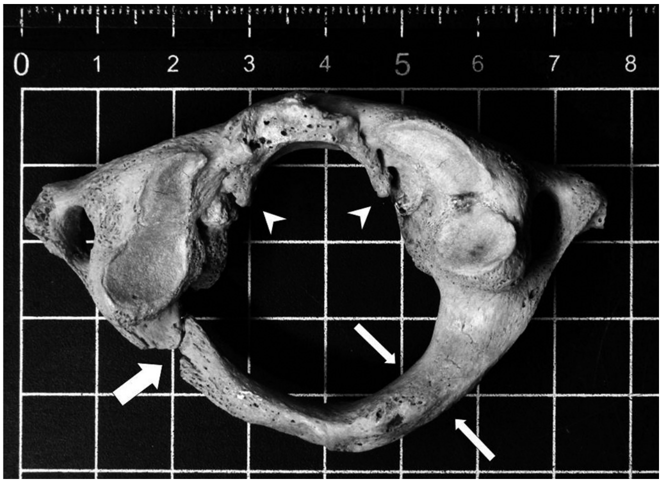

Fig. 1. Superior view of the atlas. The thick arrow shows a linear defect at the base of the left posterior arch which seems to be part of a complex fracture pattern. The thin arrow shows that the right posterior hemiarch was thicker than the left and joined normally to the massa lateralis atlantis. Arrowheads show that the vertebra presented a marked irregularity of the tubercles in the attachment of the transverse ligament.

fracture pattern (Figs. 1 and 2). The posterior arch of the atlas was clearly asymmetric. The right posterior hemiarch was thicker than the left and joined normally to the massa lateralis atlantis , unlike the left posterior atlas hemiarch. The posterior tubercle was not directly behind the anterior tubercle. The vertebra also presented a marked irregularity of the tubercles in the attachment of the transverse ligament.

The 20x stereomicroscopy study (stereomicroscope BMS SL-40, Breukhoven b.v, Netherlands) revealed marked differences between the superior and inferior views of the region of interest which made us doubt between a congenital posterior atlas arch defect, a pre-mortem fracture, or a post-mortem osseous loss during handling of the specimen (Figs. 3 and 4).

Plain radiographs displayed regular and smooth defect edges without sclerosis (Fig. 5). No callus formation or residual cortical deformity was present, so fracture healing was not suspected. However, radiodense tissue appeared to join the two ends.

We also carried out a computerized tomography (CT) scan using the GE LightSpeed VCT 64 Slice CT system (General Electric,

Fig. 2. Inferior view of the atlas. The thick arrow shows the linear defect at the left posterior arch which seems to be part of a complex fracture pattern with osseous loss. The thin arrow shows that the posterior tubercle was not directly behind the anterior tubercle. Arrowheads show a thicker right posterior hemiarch.

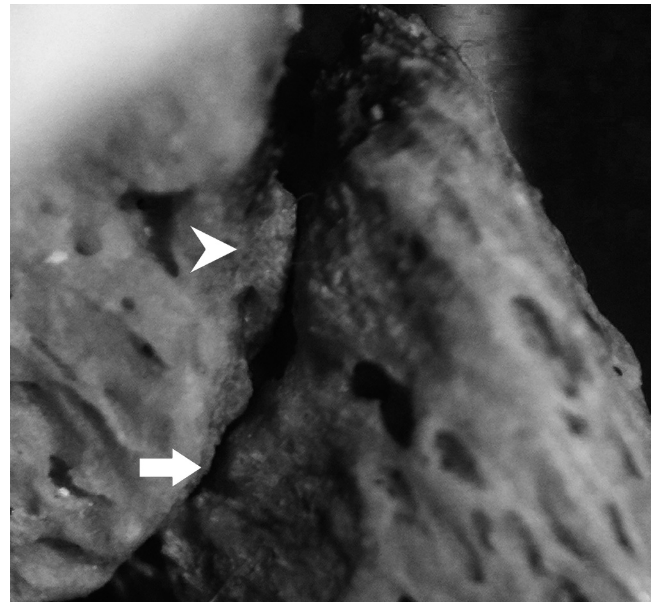

Fig. 3. 20× stereomicroscopy top view. The thick arrow shows the linear defect with no fracture callus and no osteogenic reaction. Nevertheless, the arrowhead shows a region that seems to have had an osteogenic reaction. This top view suggests that the anatomical variation found would have been caused by a pre-mortem injury or it could be a congenital posterior atlas arch defect.

Milwaukee, WI, USA) that provides a transaxial slice thickness of 0.5 mm and bone kernel reconstruction. For optimal imaging, the vertebra was placed in a plastic container and fixed using modeling clay, thereby reproducing an anatomical position.

The CT image showed a linear image of a break in the left posterior atlas hemiarch (Fig. 6). It showed a fine straight line of low radiological density; there was no increase in density at the ends, nor was there any periosteum thickening due to fracture callus. This suggests a diagnosis of a Type B posterior atlas arch defect, not a fracture. If it had been a fracture, the line would have

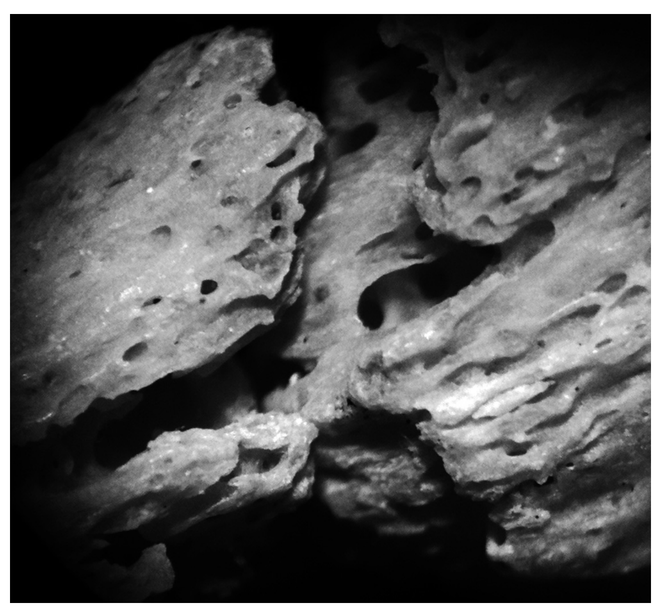

Fig. 4. 20× stereomicroscopy bottom view of the region of interest that shows osseous loss with no signs of an osteogenic reaction. This bottom view seems to suggest that the anatomical variation found would have been caused by a pre-mortem/perimortem injury or during post-mortem handling of the specimen.