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NOTE

Surgical stabilization of the atlanto-occipital overlap with atlanto-axial instability in a dog

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Abstract

The atlanto-occipital (AO) overlap in combination with atlanto-axial (AA) instability was found in a dog. We hypothesized that ventral fixation of the AA junction can stabilize the atlas and prevent AO overlap by reviewing our past cases with AA instability. A standard ventral fixation of the AA junction using stainless k-wires and polymethyl methacrylate (PMMA) was performed. The dog fully recovered, and no complication was noted. The results of the postoperative CT imaging supported our hypothesis. The ventral fixation of the AA junction is a feasible treatment option for similar cases, although craniocervical junction abnormalities (CJA) including AA instability are varied, and careful consideration is required for each case.

Key Words: Atlanto-axial instability, Atlanto-occipital overlap, dog

Atlanto-axial (AA) instability can cause neck pain or other neurological signs in small breed dogs. Cerda-Gonzalez reported that magnetic resonance (MR) imaging of the dogs with AA instability showed concurrent atlanto-occipital (AO) overlap[4]. This phenomenon is concurrently found in craniocervical malformations in humans[6,9], and some canine cases of Chiari-like malformations or Caudal occipital malformation syndrome are suspected to show this[3]. Recently, the term "craniocervical junction abnormalities (CJA)" has been used for malformations that occur around the occipital bone and upper cervical vertebra[5]. Because of this variation, the standardized treatment of CJA was not established, and to the best of our knowledge, there was no case report that attempted surgical correction of the AO overlap in combination with AA instability. In this study, we propose the possibility of ventral fixation treatment for these cases.

A one-year-old female Chihuahua with sudden and recurrent neck pain was presented to a private clinic and diagnosed with AA instability by MR and CT imaging (Fig. 1). The dog was referred to Veterinary Medical Center, the University of Tokyo for surgical correction.

At initial presentation, the dog shows neck pain without paresis nor ataxia. The neurologic status was G1 (no neurologic impairment)[2].

On MR images, occipital dysplasia was apparent, and the cranial border of the atlas was rostral to the level of the foramen magnum on

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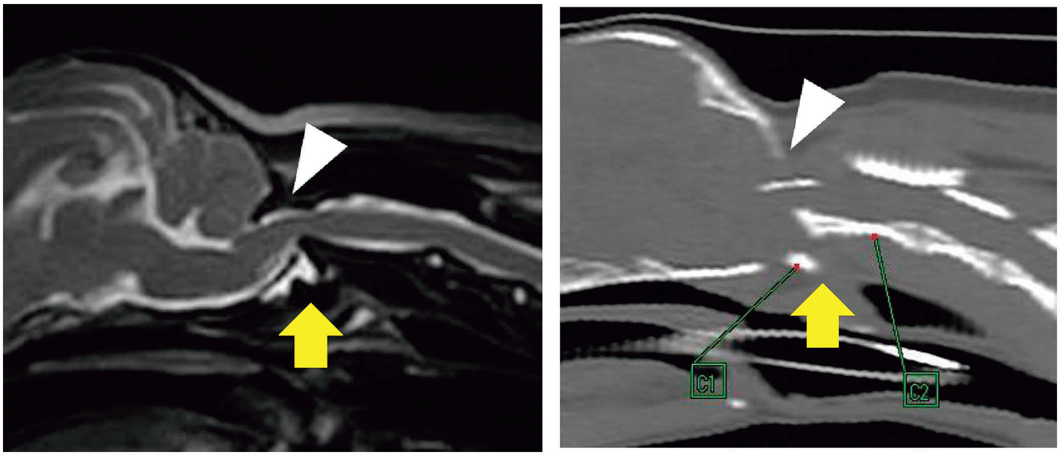

Fig. 1. Magnetic resonance (T2W sagittal image) and computed tomographic images showing AA instability (arrow) and AO overlap (arrowhead).

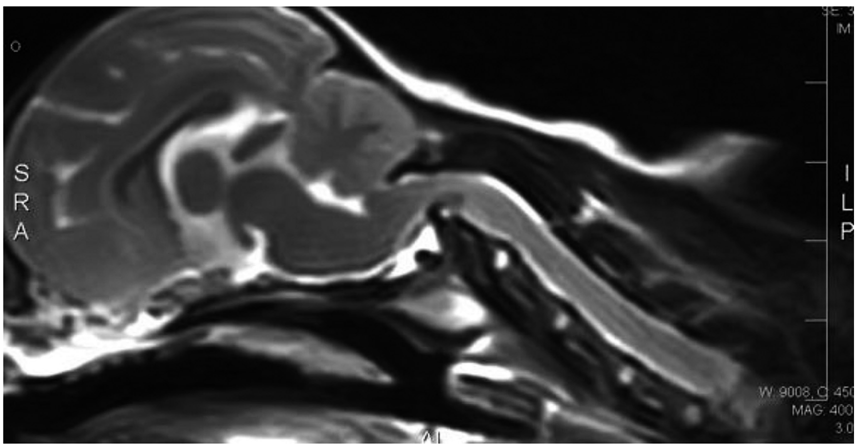

Fig. 2. Suspected case of AO overlap. Magnetic resonance T2W sagittal image.

mid-sagittal images in association with the AO overlap. AA instability was considered the responsible lesion. However it was not certain to fix the AA junction is safe and effective for this case without worsening AO overlap.

For the decision making, the AA instability cases were reviewed. For this retrospective investigation, cases which diagnosed by MR imaging and surgically treated in our hospital from April 2007 to Mach 2011 were included. There were three AO overlap cases out of the 15 cases (Fig. 2). These three cases were treated with ventral fixation of the AA junction and two fully recovered and no complications were noted. The other dog died of aspiration on the postoperative day 3 but the neurologic status of this dog stable after operation. Although the number of similar cases was small, the procedure was considered feasible to perform. We hypothesized that AA junction fixation stabilized the atlas and prevented the atlas from rotating and compressing the brain stem. After getting informed consent, ventral fixation of the AA junction was performed with non-threaded stainless Kirchner wires (0.028–0.35 inch, IMEX Veterinary Inc.) and polymethylmethacrylate (Surgical Simplex, Stryker Japan) as described below (Fig. 3).

Using a standard anesthetic protocol, the dog was maintained with isoflurane in oxygen. The dog was positioned in dorsal recumbency, with the neck extended slightly to prevent the atlas

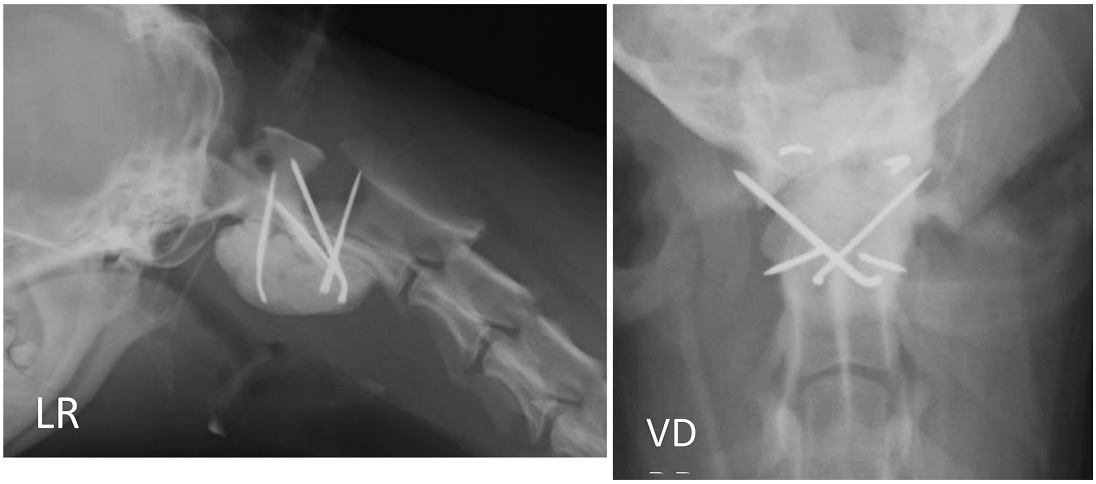

Fig. 3. Postoperative Radiograph. The AA junction was fixed with 6 wires and polymethylmethacrylate.

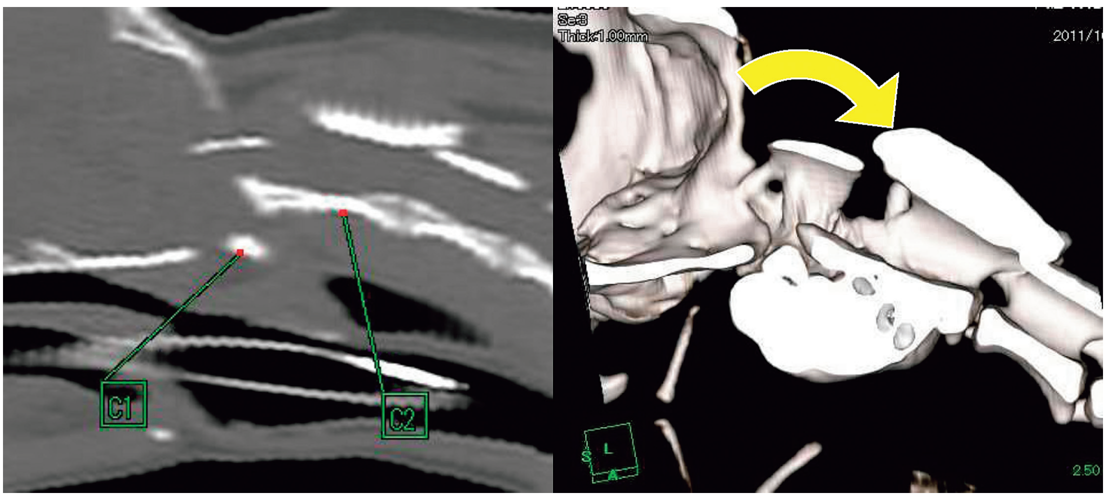

Fig. 4. Pre (A) and postoperative (B) CT images. The cranially rotated atlas was reduced parallel to the axis (arrow).

overlap and the forelimbs were pulled caudally. The position was maintained with vacuum beanbag and adhesive tape. A modified ventral approach to the AA junction was performed[12]. The ventral aspect of the AAJ capsule was sharply excised using an 11 blade and the articular cartilage was removed from the articular surface of the C1 and C2 using surgical burr. Reducing the subluxation of C2 with towel forceps, two transarticular wires were inserted from the cranioventral part of C2 directed towards the alar notch through the central part of the C1–C2 articulation. Then additional wires were inserted into C1 and C2. The pins were secured together with polymethylmethacrylate (PMMA)[11]. A ventral cervical brace using thermoplastic material was placed postoperatively.

The dog recovered normally except the intermittent neck pain persisting by the time of suture removal. Postoperative radiograph showed a pin inserted into C2 was too long and might cause muscular injury and neck pain. About one month later, the dog showed no neurological signs and CT images confirmed that the atlas was fixed parallel to the axis and the overlap was resolved (Fig. 4). One year later, the dog did not show any clinical signs.

The AO overlap is described as the rotation of the atlas in relation to the occipital condyles, causing compression and elevation of the caudal aspect of the brainstem and cranial aspect of the cervical spinal cord[4]. All 4 cases had occipital dysplasia and three had AA instability. There was no evidence of prior trauma, and occipital fractures and/or atlas rotation were not observed in these cases. Our case also had no prior trauma and occipital dysplasia, and AA instability were apparent.

Although they discussed AO overlap as the primary dynamic phenomena following occipital dysplasia and similar to primary basilar invagination (BI) in humans, another hypothesis based on the mechanical model and retrospective analysis was formulated: the over-rotation of the atlas is prevented by AA stability (Fig. 5). Accompanied by AA instability, atlas rotation or AO overlap can occur as a dynamic phenomenon due to the weight of the patient's head (Fig. 5). Therefore, the fixation of AA junction can stabilize the atlas and prevent rotation into the foramen magnum (Fig. 5).

The treatment reported for traumatic AO dislocation is manual reduction and foramen magnum decompression[8,10,13]. However, no reports detailed naturally occurring cases, and our case did not have history of trauma. In human medicine, Goel reported that BI without syringomyelia can be treated by distraction and fixation of the atlantoaxial junction[7]. Our surgical outcome and postoperative CT imaging suggest AO overlap with AA instability similar to human BI. Although the outcome of this dog support our hypothesis, the clinical importance of AO overlap in this case and safety for spinal cord around AO junction are not fully understood. Aikawa *et al.* also reported that AA instability can cause dorsal dynamic compression followed by hypertrophied dorsal atlantoaxial component, but they could not determined the efficiency of the treatment[1]. AA ventral fixation using stainless wires, pins and screws makes it difficult to evaluate the spinal condition after procedure. Recently, Kirchner wire or screws made of titanium become commercially

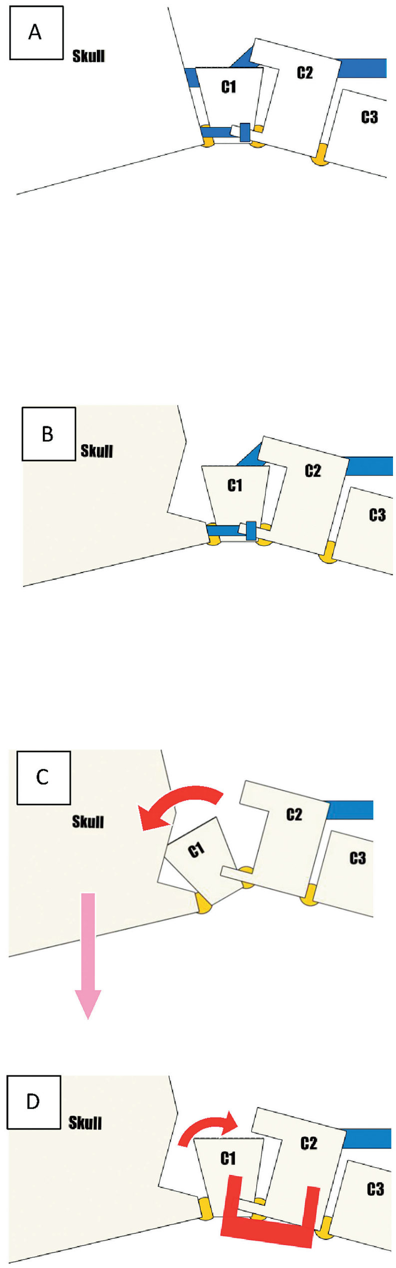

Fig. 5. Mechanical model of AO overlap and the treatment plan. Skull and cervical vertebra are characterized as white polygonal shapes (skull, C1, C2, C3). Blue bands represent ligaments around junctions. Yellow solid circle connecting the bones are rotational center. A) Normal Occipito-atlanto-axial junction model. B) The occipital dysplasia model. Over-rotation of the atlas is prevented by AA stability. C) AO overlap with AA instability model. When accompanied with AA instability, atlas rotation or AO overlap (red arrow) can easily occur as dynamic phenomena due to the weight of the patient's head (pink arrow). D) Operation model. AA junction fixation (red polygon) is able to stabilize the atlas to prevent rotation (red arrow) into the foramen magnum.

available. Postoperative MR imaging with these wires or screws may be useful for further evaluation of the surgical procedures against AO and AA disorders including AO overlap.

In the present report, the fixation of the AA junction is proposed to be feasible for the treatment of the patients with atlanto-occipital (AO) overlap in combination with atlanto-axial (AA) instability. However only one case was showed in this report and further clinical investigation with more cases is necessary to clarify the indication and effectiveness of this treatment.. Goel reported that BI with syringomyelia should be treated using foramen magnum decompression or in combination with AA fixation[6], and Gonzalez presented the case of AO overlap without AA instability[4]. Hence, CJA is varied, and specific consideration is needed for each case.

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