**Atlantoaxial subluxation or instability**

**B. Meij**

*Department of Clinical Sciences of Companion Animals*

*Faculty of Veterinary Medicine, Utrecht University*

*Yalelaan 108, 3508 TD, Utrecht, The Netherlands*

*Corresponding author: b.p.meij@uu.nl*

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**The atlantoaxial joint**

The atlantoaxial joint is the joint between the first and second cervical vertebrae in the neck, referred to as the atlas and axis, respectively. It differs from the joints between the other vertebrae in that there is no intervertebral disc present, so cervical disc herniation between C1 and C2 is not possible. Instead, the atlantoaxial junction is a true joint that is stabilized by ligaments just like a joint in a leg, and contains a synovial membrane and fluid. The design of this joint allows the dog’s head to move from side to side, in vertical and horizontal direction, but also allows axial rotation.

**What is the cause of atlantoaxial subluxation?**

Subluxation of the atlantoaxial joint occurs when the normal alignment of the first and second vertebrae in the neck is disrupted. This results in excessive movement of this joint (instability) which can cause neck pain and pressure on the nerves of the spinal cord which runs through the vertebral canal. Although an injury can result in damage to the ligaments or the vertebrae, it is more common that dogs are born with an abnormality of the second cervical vertebra (the axis) or of the ligaments, which makes the likelihood of subluxation developing greater, often as a consequence of minimal, (if any) trauma. Also the conformation of the breed (excessively large head in relation to body size) will contribute to the predisposition for atlantoaxial subluxation.

Although any dog could develop atlantoaxial subluxation due to trauma (for example, running into a patio door or car accident), it is most commonly seen in miniature toy breeds of dogs, such as Chihuahua, Yorkshire Terriers or Miniature Poodles. Very rarely it can occur in cats. Often in miniature toy breeds of dogs, a congenital abnormality underlies the problem, and for this reason the condition is most often seen in immature dogs (less than 1 year of age). Affected dogs may show signs of neck pain, such as yelping and crying or rigidity of the neck. More subtle signs may include in a low head carriage or difficulty lowering the head to eat or drink. Signs of spinal cord injury can vary in severity, from mild weakness or incoordination in all four limbs to inability to stand and walk. In the worst case scenario the dog may go down and develop tetraplegia.

**Diagnosis of atlantoaxial subluxation**

A detailed neurological examination is necessary to detect evidence of spinal cord injury and possible neck pain. Grading of neurological deficits is important before treatment is started, the grade will affect the prognosis. A dog with only cervical pain will have a better outcome than a dog that is tetraplegic. Investigations are then required to confirm atlantoaxial subluxation and distinguish it from many other neck problems. In miniature toy breeds, cervical disc herniations are also common and this is the main differential diagnosis for atlantoaxial subluxation. Other conditions that may be concurrent with atlantoaxial subluxation (and negatively affect the prognosis) are hydrocephalus, Chiari-like malformation (enlarged foramen magnum) with secondary cerebellar herniation, and cervical syringohydromyelia. Investigations usually require general anesthesia and this must be undertaken with extreme care, as manipulation of the neck can exacerbate any spinal cord injury.

Normal radiographs of the neck can be very useful for diagnosing atlantoaxial subluxation, but they provide only limited information about any underlying bone deformity and no information regarding the severity of any spinal cord injury. The most valuable radiographic views are the lateral views in neutral position and in flexion. When the neck is flexed survey radiographs may show a marked increase in the gap between the dorsal arch of C1 and the spinous process of C2 which is diagnostic for atlantoaxial subluxation. For surgical planning and treatment more advanced imaging techniques such as an MRI or CT scan are required. A CT scan with 3-dimensional reconstructions can confirm the diagnosis and provide more detailed information about any bone deformity, which in turn can help with the detailed planning required for a potential surgical procedure. CT examination may show absence or hypoplasia of the dens or in other cases fracture of the dens. MRI scanning uses high powered magnets and a computer to generate images of the spine. MRI can also confirm the diagnosis, help in assessing concurrent spinal cord injury, like syringohydromyelia, and it can rule out other brain or spinal cord abnormalities that may be present. In many situations a combination of radiographs, MRI and/or CT may be required.
Treatment of atlantoaxial subluxation

Conservative treatment
This involves strict cage rest, application of a neck brace and administration of NSAIDs. Maintaining a neck brace, often for several weeks, is very difficult and is poorly tolerated by many patients. A neck brace must be regarded as a temporary support in a phase with acute cervical pain but it will not solve the problem.

Surgery
The aim of surgery is to stabilize (fuse) the atlantoaxial joint in a normal position. This alleviates neck pain and enables the spinal cord to recover from injury. Surgery is a very intricate procedure due to the location of the problem and the small size of many of these patients. Atlantoaxial subluxation surgery should only be performed by experienced surgeons with advanced training. A number of surgical techniques can be used:

1. Ventral transarticular fixation with screws. Two screws are placed across the joint space. The joint space is first opened and using a sharp curette the cartilage is removed. The screws are angled away from the midline at approximately 30° towards the medial angle of the alar notch (Figure 1) and downward (dorsal) at approximately 20° from the horizontal.

2. Multiple ventral implants (screws and K-pins) and bone cement. This is the most reliable approach involving placing bone screws into the first and second cervical vertebrae (the atlas and axis) and connecting the screws together with special bone cement. The surgery is performed through an incision made on the ventral side of the neck.

3. Dorsal wire fixation. In this treatment the C1-C2 region is approached from the dorsal side. A loop of wire is passed under the dorsal arch of C1 and retrieved from the atlanto-occipital space. The wire ends are fixed to the dorsal spinous process of C2.

Surgery in a dog with atlantoaxial subluxation is considered as surgery with increased risk for complications and owners should be warned about this. The C1-C2 region is close to the medulla oblongata and brain stem which contains the respiratory center. One of the main complications of surgery are death due to cardiac or respiratory arrest. Implant failure is also seen due to the small size of the patients and minimal holding power for the implants because of the limited bone stock available in the C1-C2 junction.

Prognosis of atlanto-axial subluxation
With conservative treatment, although an improvement can be expected in many cases, pain and spinal cord injury often recur once the neck brace is removed or NSAIDs are stopped and activity is increased. As a consequence, surgical stabilization of the atlantoaxial joint is indicated in most patients.

The success rate with surgery is generally good provided the atlantoaxial joint is adequately realigned and screws and cement are placed in the bones in a safe manner. The prognosis tends to be better in dogs that show clinical signs whilst still young, can still walk prior to surgery and where signs have not been present for a long time.
**Figure 1 Left:** Lateral radiograph showing increased gap between the dorsal arch of C1 and the spinous process of C2, diagnostic for atlantoaxial subluxation. **Right:** Position of screws for the ventral transarticular fixation technique.