

EXPERIMENTAL ASSESSMENT OF IMAGING MEASUREMENTS TO DIAGNOSE ATLANTOAXIAL INSTABILITY ON COMPUTED TOMOGRAPHY IMAGES

D. Flueckiger¹, B. Vidondo², F. Forterre³, B. Planchamp³, J. Guevar³, C. Precht¹

¹ Clinical Radiology, Department of Clinical Veterinary Medicine, University of Bern, Switzerland

² Veterinary Public Health Institute, Department of Clinical Research and Veterinary Public Health, Vetsuisse Faculty, University of Bern

³ Division of Small Animal Surgery, Department of Clinical Veterinary Medicine, Vetsuisse Faculty, University of Bern

INTRODUCTION: ATLANTOAXIAL INSTABILITY (AAI)

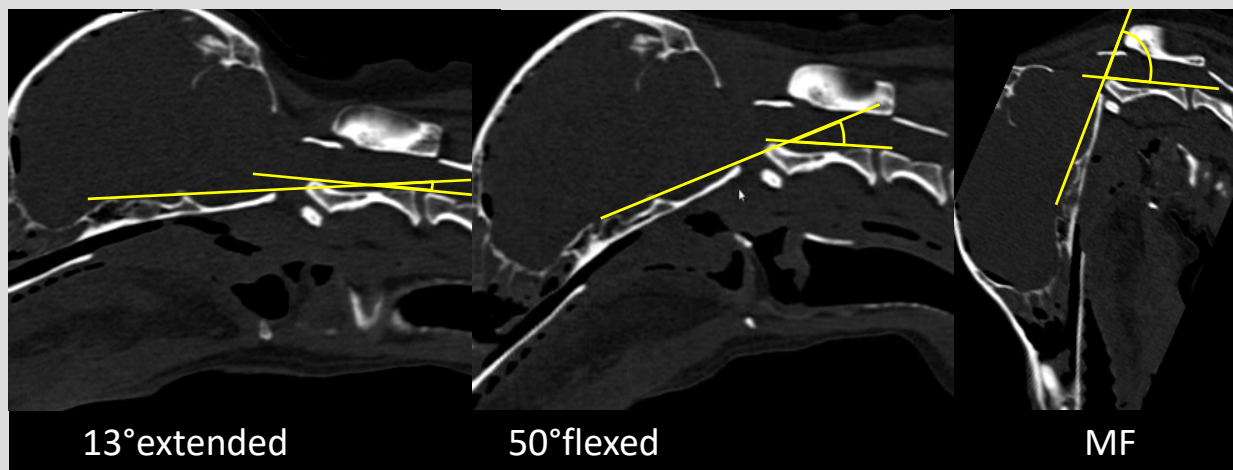
- Congenital (young small/toy breed dogs) or traumatic joint anomaly → increased mobility → dorsal subluxation of dens → compression of spinal cord
- Imaging diagnosis: Cutoff values for radiography and advanced imaging (CT, MRI) have been proposed and head-neck positions (HNP) have been shown to have a significant influence on measurements^{1,2,3,4}. However, standardized HNP (sHNP) have not been systematically assessed in affected animals.

STUDY AIM

- Experimentally assess the diagnostic value of CT imaging measurements in three sHNP in dog cadavers before and after transection of atlantoaxial (AA) ligaments (Lig. apicale, Lig. transversum and Ligg. alares).

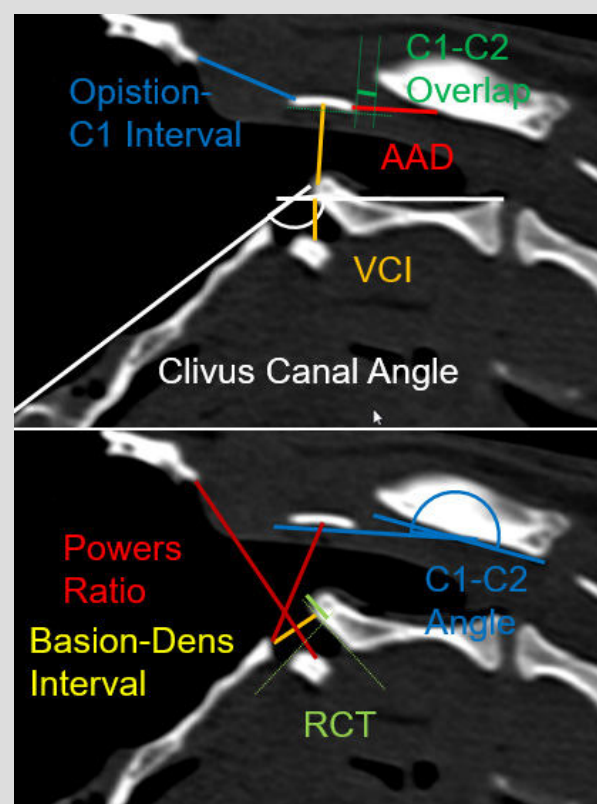
MATERIAL & METHODS

- Experimental study with eight canine cadavers (6 females and 2 males): 2 Miniature Pinscher, 2 Shih Tzu, 2 crossbreed dogs, 1 Pomeranian, 1 Chihuahua.
- Integrity of AA ligaments assessed with MRI and visually.
- High-resolution CT scans with intact ligaments in sHNP:
 - ❖ 13° extended
 - ❖ 50° flexed, resembling a natural head-neck position
 - ❖ maximally flexed (MF)

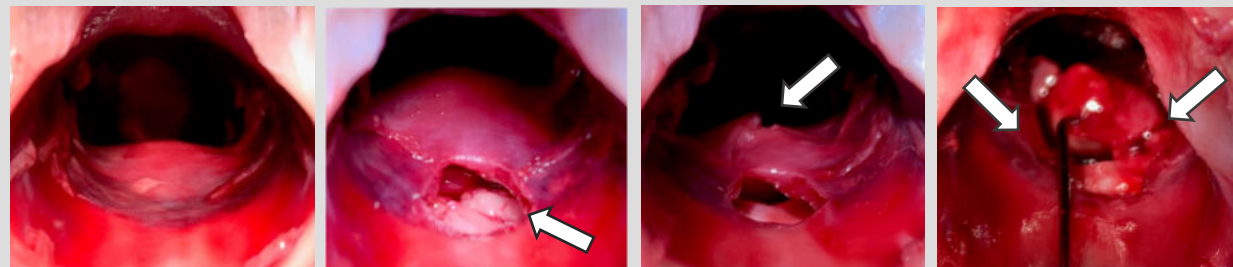


- CT Measurements by board-certified veterinary radiologist (CP):

- ❖ Clivus Canal Angle
- ❖ C1-C2 Angle
- ❖ C1-C2 Overlap
- ❖ Atlantoaxial distance (AAD)
- ❖ Basion-Dens Interval
- ❖ Opistion-C1 Interval
- ❖ Ventral Compression Index (VCI)
- ❖ Ratio of cranial translation (RCT)
- ❖ Powers Ratio



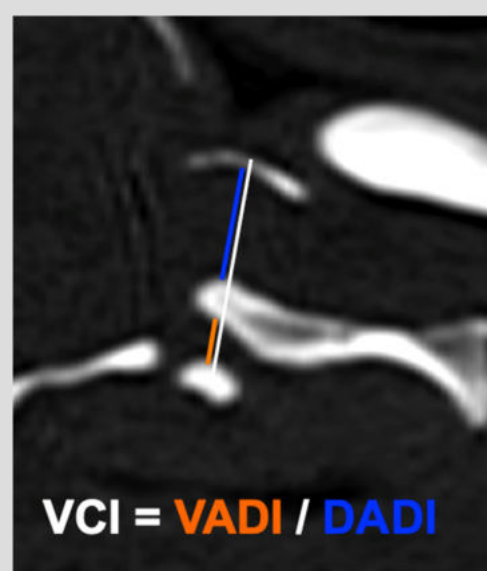
- Dissection of ligaments with ophthalmic knife and scalpel No. 10.



- Repetition of CT after ligaments have been transected.
- Repeated measures ANOVA and ROC cutoff analysis.

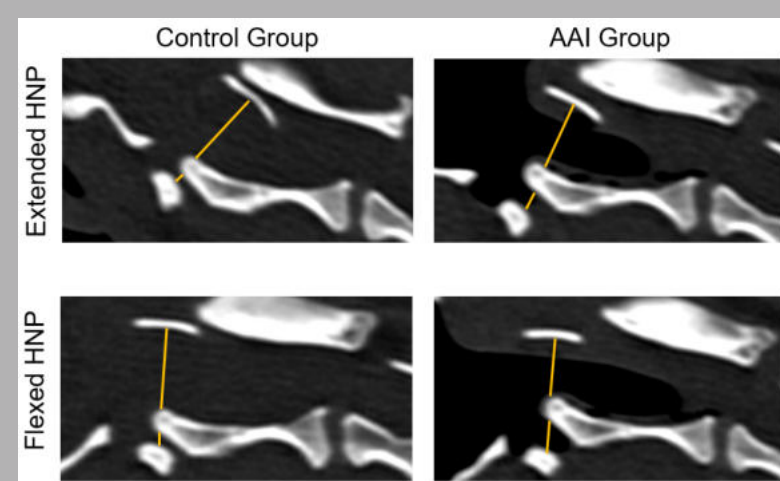
DISCUSSION

- Experimental setup allowed assessment of the influence of sHNP on proposed measurements in individual animals both with the ligaments intact and after transection.
- VCI:
 - Most sensitive and specific in flexed HNP, less sensitive in extended HNP → in agreement with previous studies^{1,2}.
 - Previous study¹ reported a lower cutoff value with higher sensitivity and specificity, which may be explained by a very homogeneous control-group with a small standard deviation (SD). Our study population showed a higher SD, which might mirror the natural range of motion of small breed dogs.
- Head-neck position:
 - Extended HNP → higher risk to miss an AAI case than in flexed HNP → in agreement with previous studies on CT, MRI and radiography^{1,2}.



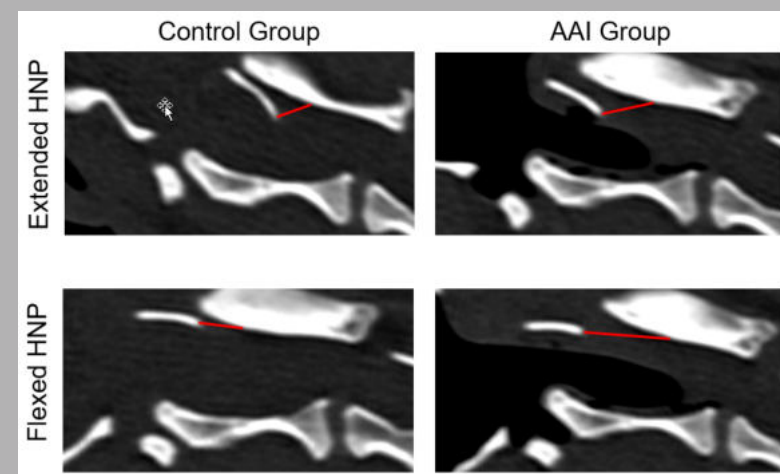
RESULTS

- Cutoffs with high sensitivity and specificity for the VCI, AAD and Basion-Dens Interval:



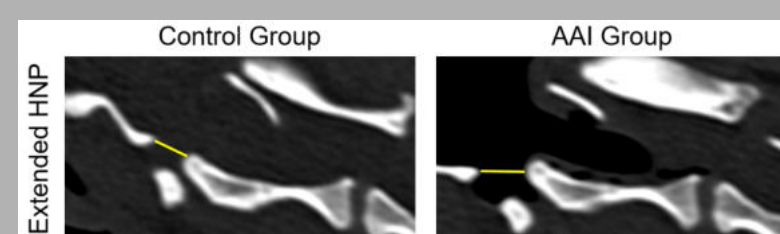
VCI

- Extended HNP:
 - ❖ Cutoff ≥ 0.33
 - ❖ Sens. 87.5%
 - ❖ Spec. 87.5%
- Flexed HNP:
 - ❖ Cutoff ≥ 0.42
 - ❖ Sens. 100%
 - ❖ Spec. 87.5%



AAD

- Extended HNP:
 - ❖ Cutoff ≥ 4.8 mm
 - ❖ Sens. 75%
 - ❖ Spec. 75%
- Flexed HNP:
 - ❖ Cutoff ≥ 5.9 mm
 - ❖ Sens. 75%
 - ❖ Spec. 75%



Basion-Dens Interval

- Extended HNP:
 - ❖ Cutoff ≥ 7.7 mm
 - ❖ Sens. 75%
 - ❖ Spec. 87.5%
- Flexed HNP:
 - ❖ No reasonable cutoff

- In MF HNP cutoff values for VCI, Basion-Dens Interval and RCT can be established, are however obsolete in clinical patients due to high grade of dislocation and resulting severe spinal canal stenosis.
- Other measurements did not yield reasonable cutoff values in sHNP.

- ❖ **VCI is the most sensitive and specific measurement in extended and flexed HNP.**

LIMITATIONS

- Small sample size, focus limited to Lig. apicale, Lig. transversum and Ligg. alares.

CONCLUSION

- Cutoff values enable objective diagnosis of AAI in small breed dogs in CT.
- VCI is most sensitive and specific measurement:
 - ≥ 0.33 in extended HNP
 - ≥ 0.42 in flexed HNP
- Standardized physiologically flexed HNP (approx. 50°) confirmed as a reliable position for the diagnosis of AAI in dogs without bony alterations.

REFERENCES

- 1 Planchamp B, Forterre F, Vidondo B, Hernandez-Guerra AM, Plessas IN, Schmidt MJ, Waschk MA, Precht C. Determination of cutoff values on computed tomography and magnetic resonance images for the diagnosis of atlantoaxial instability in small-breed dogs. *Vet Surg.* 2022 May;51(4):620-630.
- 2 Cummings, Kelly R., et al. "Objective measurements of the atlantoaxial joint on radiographs performed without flexion can increase the confidence of diagnosis of atlantoaxial instability in toy breed dogs." *Veterinary Radiology & Ultrasound* 59.6 (2018): 667-676.
- 3 White, Dana A., et al. "Flexed radiographic angles for determination of atlantoaxial instability in dogs." *Veterinary Surgery* 48.8 (2019): 1406-1415.
- 4 Upchurch, J. J., et al. "Influence of head positioning on the assessment of Chiari-like malformation in Cavalier King Charles spaniels." *Veterinary Record* 169.11 (2011): 277-277.