Evaluation biomécanique cadavérique de trois implants pour stabilisation atlanto-axiale

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Biomechanical Evaluation of the Stabilizing Function of Three Atlantoaxial Implants Under Shear Loading: A Canine Cadaveric Study

Benoit Riedinger[1], Alexander Bürki[2], Christina Stahl[1], Judith Howard[1], and Franck Forterre[1]

[1]Department of Clinical Veterinary Medicine, Vetsuisse Faculty, University of Berne, Berne, Switzerland and [2]Institute for Surgical Technology and Biomechanics, University of Berne, Berne, Switzerland

Corresponding Author
Franck Forterre
Division of Small Animal Surgery
Department of Clinical Veterinary Medicine
Vetsuisse Faculty
University of Berne
Länggassstrasse 128, CH 3012
Berne, Switzerland
franck.forterre@vetsuisse.unibe.ch

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Objective: To compare the biomechanical properties of a ventral transarticular lag screw fixation technique, a new dorsal atlantoaxial instability (AAI) clamp, and a new ventral AAI hook plate under sagittal shear loading after transection of the ligaments of the atlantoaxial joint.
Study Design: Cadaveric biomechanical study.
Animals: Canine cadavers (n = 10).
Materials and Methods: The occipitoatlantoaxial region of Beagles euthanatized for reasons unrelated to the study was prepared leaving only ligamentous structures and the joint capsules between the first 2 cervical vertebrae (C1 and C2). The atlanto-occipital joints were stabilized with 2 transarticular diverging positive threaded K-wires. The occipital bone and the caudal end of C2 were embedded in polymethylmethacrylate and loaded in shear to a force of 50 Newtons. The range of motion (ROM) and neutral zone (NZ) of the atlantoaxial joint were determined after 3 loading cycles with atlantoaxial ligaments intact, after ligament transection, and after fixation with each implant. The testing order of implants was randomly assigned. The implants tested last were subjected to failure testing.
Results: All stabilization procedures decreased the ROM and NZ of the atlantoaxial joint compared to transected ligament specimens. Only stabilization with transarticular lag screws and ventral plates produced a significant reduction of ROM compare to intact specimens.
Conclusion: Fixation with transarticular lag screws and a ventral hook plate was biomechanically similar and provided more rigidity compared to dorsal clamp fixation. Further load cycling to failure tests and clinical studies are required before making clinical recommendations.

Etude biomécanique prospective comparant les propriétés mécaniques de trois systèmes de fixation atlanto-axiale, une fixation par vis-transarticulaires, une fixation par un nouveau modèle de clamp dorsal s'inspirant du connecteur de Kishigami (fig 2), et une fixation avec une nouvelle plaque ventrale à crochets (fig 3).

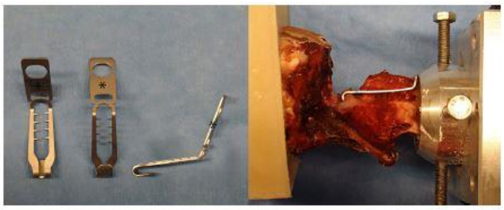

Figure 2 Photographs of the dorsal atlantoaxial instability (AAI) clamp and after fixation on a specimen. *Corresponds to the application component of the clamp that is snapped off after placement.

Figure 3 Photographs of the ventral atlantoaxial instability (AAI) hook plate and hook plate after fixation on a specimen.

M et M : ex vivo / 10 cadavres de Beagle / Structures *Occiput-C1-C2* isolées, avec capsules articulaires et structures ligamentaires préservés. Les articulations occiput-atlas ont été bloquées avec deux broches filetées divergentes (de 1,8 mm) et l'occiput et la partie caudale de C2 ont été scellées dans du PMMA puis soumises à un chargement en cisaillement jusqu'à 50 N (déplacement vertical de C2 par rapport à C1 fixé rigidement à l'occiput scellé). L'amplitude des mouvements (ROM) et la zone neutre (ZN) de C1-C2 ont été déterminées au cours de trois cycles de mise en charge, la première avec les ligaments intacts, la seconde après section du ligament atlanto-axial dorsal, et la troisième après mise en place des implants. Les implants testés en dernier ont été soumis à un chargement jusqu'à rupture.

<u>Résultats :</u> Des courbes effort/déplacement ont été générées. La ROM représente l'amplitude de mouvement total entre -50 et + 50 N, la ZN représente la même amplitude entre -5 et +5 N. Toutes les méthodes de stabilisation, dorsale ou ventrales, ont diminué le ROM et ZN des articulations C1-C2 comparativement aux articulations avec ligament sectionné et sans implant. Seuls les stabilisations ventrales (lag screws ou plaques) ont réduit significativement le ROM par rapport aux articulations C1-C2 intactes.

Les fixations par vis trans-articulaires et par plaque ventrale ont produit des résultats assez similaires en terme de stabilité, et une rigidité supérieure à la fixation par clamp dorsal.

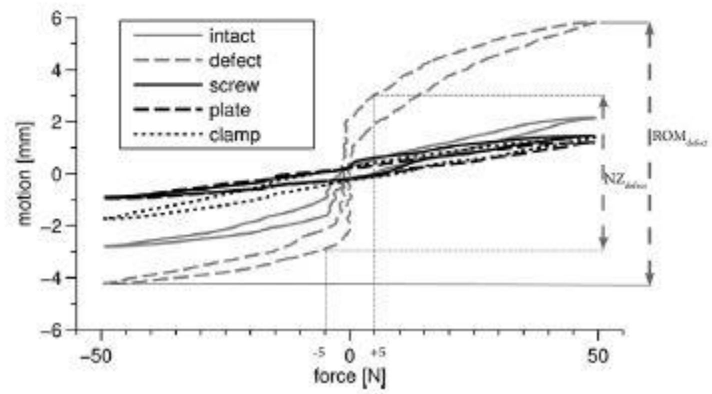

Figure 1 Overview of force–displacement behavior of the atlantoaxial (AA) joint with intact ligaments, after transection of ligaments, and after fixation with each implant. Positive displacement represents motion in dorsal direction. Extracted range of motion (ROM) and neutral zone (NZ) for defect specimen are shown.

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