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Axis Fracture Repair with Locking Plate in Dog

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ABSTRACT

Background: Cervical fractures in dogs occur most commonly in the cranial region, mostly requiring surgery. Various types of implants are being used while fixation using plate is poorly described in the literature. The plate and screw types are a limiting factor since they can lead to loss of stability due to loosening of the screws. The use of locking plates has been advocated, which does not allow movement between the screw-plate-bone, providing extreme stability and rigidity to the system. This study describes the use of locking bone plate to stabilize axis fracture in a dog and the results obtained with this technique.

Case: A 9-month-old male Poodle presented due to a history of trauma to the cervical spine caused by a fall of an object. Upon physical examination, the patient was alert and physiological parameters within the normal reference limits. However, neurological examination showed tetraplegia, hyperreflexia, preserved nociception and much cervical pain. There were no changes in the cranial nerves test. Cranial cervical lesion was initially suspected and the patient was rigidly fixed on a flat surface. The radiographic examination showed a fracture of the second cervical vertebra (axis) with anatomical axis deviation, and the patient was referred for surgery. After anesthesia, the dog was positioned dorsal decubitus and rigidly fixed on the operating table with the thoracic limbs pulled caudally. The surgical approach of the cranial cervical spine started through the ventral access until complete visualization of the fracture line and the caudal portion of the axis body. After perfect apposition and alignment of the bone fragments, rigid stabilization was performed using locking plate and screws. The patient had a favorable neurological recovery, and five days after the surgery, no change was observed in locomotion and postural reactions, besides the absence of neck pain.

Discussion: The implant used in this study was small and displayed a good fit along the body axis. The locked system allowed the bolt head to lock in the hole of the plate, forming a bone-screw-plate unit that prevents its failure. In our case, the tip of the caudal screws protruded approximately two millimeters within the spinal canal, without any apparent effect on the outcome. In a previous study, in which plates were used for ventral fixation and stabilization of the atlantoaxial joint, the screws also protruded into the vertebral canal without causing any problems, presumably because the cervical vertebral canal is wider than the diameter of the spinal cord at this location. Failure rate of up to 44% has been reported for all the processes of atlantoaxial ventral fixation if the surgery is deemed successful when resolution of neurological signs occurs, and there is no need for further surgery. According to this, the present case can be considered successful taking into account the clinical outcome after surgery, the rapid reduction of pain, return to ambulation and the absence of neurological deficits. We conclude that the locking plate was a viable alternative to other fixation techniques for fractures involving the second cervical vertebra in small animals since it allowed relative stability of the fracture and an excellent neurological recovery of the patient.

Keywords: nervous system, spinal cord, vertebral fracture, cervical stabilization.
INTRODUCTION

The fracture and/or cervical dislocation occur most commonly in the cranial cervical region, with approximately 80% occurring in the axis [2]. Patients with cranial cervical fracture, mostly require surgery, which aims at realignment and spinal stabilization [2]. Several implant types have been used, but the osteosynthesis using plate has not been commonly described for the surgical treatment of atlantoaxial conditions. Possibly plate type, shape and size, as well as the type of screws have been limiting factors [3].

The loss of stability due to screws and conventional plates failure applied ventrally to vertebrae has been common cause of implant review [9]. Therefore, the use of locked plates instead of conventional plates has been advocated [1]. The locking plate system is rigid and does not permit movement between the components of the device (plate-bone-screw), providing extreme stability and rigidity to the system. The screw heads and plate holes have nuts that block the assembly, thus dispensing the need for perfect modeling of the plate to the bone axis to be fixed [3,4].

In the literature reviewed, there are no reports on the use of locking plate specifically to treat second cervical vertebra fractures in dogs. This report describes the use of locking plate in the fixation of axis fracture and the result of using this technique in a dog.

CASE

A 9-month-old male non-castrated Poodle presented due to a history of trauma in the cervical region. The owner reported that while playing with a hair dryer wire, the dog pulled the wire, and the hair dryer fell on his neck from about 1.5 meters height. Physical examination showed that the animal physiological parameters were within the normal reference range. Upon neurological examination, the patient was alert, presented no change in the cranial nerves, tetraplegia, hyperreflexia, proprioceptive deficits and nociception preserved in all four limbs, and a lot of neck pain. The patient was rigidly fixed on a flat surface and cervical radiographs in latero-lateral (LL) projection were performed. The radiographs showed a fracture with anatomical axis deviation at the level of the second cervical vertebra (axis) (Figure 1). The results of the electrocardiogram, blood count and biochemical profile were within physiological limits for the species and the patient was referred for surgical stabilization.

The patient was premedicated with acepromazine\(^1\) (0.05 mg/kg) and morphine\(^2\) (0.5 mg/kg). After 15 min, anesthesia was induced with midazolam\(^3\) (0.3 mg/kg) and propofol\(^4\) (3 mg/kg) and maintained with isoflurane\(^5\) and oxygen (250 mL fixed + 30 mL/kg) in a semi-closed system. We performed prophylactic therapy with cefazolin\(^6\) (22 mg/kg) 30 min before starting the procedure, which remained for 24 h after surgery.

The patient was positioned dorsal decubitus and rigidly fixed on the operating table with the thoracic limbs pulled caudally. The ventral cervical region was aseptically prepared for surgery. The surgical approach started with a ventral midline incision that extended cranially from the larynx to the level of the third cervical vertebra. The skin and superficial fascia were sectioned to visualize the sternothyroid muscles. Immediately thereafter, the trachea and esophagus were isolated to the left, preserving the sternothyroid muscle, thyroid artery and carotid sheath. The deep fascia was dissected and the tendon of the long neck muscles was disinserted from the ventral apophysis of the atlas until complete visualization of the fracture line and the caudal portion of the axis body.

In order to reduce the fracture, a screw\(^7\) 1.5 mm in diameter was inserted into the caudal part of the axis body, serving as support, an orthopedic wire was wrapped around its head and pulled towards the caudoventral direction lifting the axis body ventrally, maintaining the proper spinal alignment while the definitive fixation implant was inserted (Figure 2).

After perfect alignment and apposition between bone fragments, the rigid stabilization was performed using the locking plate\(^8\) and orthopedic screws. The locking plate with 1.5 mm diameter and six holes was modeled slightly and the fixing started. Two holes in the cranial and three others in the caudal portion of the axis vertebral body were drilled using a 1.0-mm diameter drill. All holes were performed while using drill guide for locking plate. The length of the drill that pierced the vertebral body was controlled by measuring the thickness of each point of the vertebral body on the radiographs previously performed, always considering the space between the plate and the bone. The length of the drill was controlled in previous moments of each perforation measuring the excess drill that passed in the drill guide. Four 1.5 mm locking screws were inserted, of which two in the cranial and...
two in the caudal portion of the fracture. On the spot where the plate was molded, the hole lost the ability to lock, and a 2-mm non-locked bicortical screw was inserted. After fixation of the fracture, the bolt initially inserted to assist on its reduction was removed together with the steel wires. The tissues were sutured routinely. The dog remained with the cervical collar for five days after the surgery.

The patient remained hospitalized for two days taking morphine (0.2 mg/kg/SC/LR), meloxicam (0.1 mg/kg/SC/SID), diazepam (0.5 mg/kg/SC/TID), and cefazolin (30 mg/kg/IV). Dipyrone (25 mg/kg/TID) and tramadol hydrochloride (3 mg/kg/TID), were prescribed orally for seven days.

The patient had a favorable neurological recovery, and five days after the surgery, the new assessment and neurological examination performed showed normal movement and postural reactions, and absence of neck pain. The cervical collar was removed and the suture stitches were removed 10 days after surgery. Revaluations performed 30 and 60 days after surgery showed no changes in the status.

DISCUSSION

As in the atlantoaxial joint, the greater degree of movement in axis fractures is within the sagittal plane, with only minimal lateral movement in the transverse plane [5]. The plate, therefore, has to counteract the bending forces in the ventral aspect of the vertebra [3].

In the cervical spine, the locking plate was used only to treat the cervical spondylomyelopathy and atlantoaxial subluxation [3,9].

The implant used in this study was small, displaying a good fit along the body axis. This blocking system allowed the screw head to lock in the plate hole, forming a plate-bone-screw unit that prevents screw failure [4,7]. The plate was discreetly pre-modeled to allow a better fit in the bone axis; however, due to the biomechanical properties of the locking plate the modeling is not necessary in order to allow fracture stability [3].

The poor positioning of the implant within the medullary canal, loosening, migration and failure of fixation are known complications [3,6]. In this case, the end of one of the caudal screws protruded approximately two millimeters within the spinal canal, without any apparent effect on the clinical outcome of the patient. In a previous study using the fixation plates for treatment of ventral atlantoaxial instability, the screws protruded into the vertebral canal without causing any problems, presumably because the cervical vertebral canal is wide compared to the diameter of the spinal cord at this location [3,8].
Anatomical reduction was achieved, in this case, without difficulty by inserting a bone cortical screw in the caudal portion of the axis body, which served as support for the orthopedic wires that were wrapped around its head and pulled toward the caudo-ventral direction raising the fractured caudal segment of the axis body ventrally, maintaining proper spinal alignment while the locking plate was inserted, protecting the spinal cord from repeated concussions [6].

Given that this type of surgery is considered successful when there is resolution of neurological signs and no need for additional surgery, a failure rate up to 44% for all atlantoaxial ventral fixing processes has been reported [6]. According to this, the present case can be considered successful taking into account the clinical outcome after surgery, the rapid reduction of pain, early return to ambulation and the absence of neurological deficits.

It is concluded that the locking plate is a viable alternative to treat fractures involving the second cervical vertebra in small animals since it allowed relative stability of the fracture and an excellent recovery from the neurological standpoint of the patient in the postoperative period.

SOURCES AND MANUFACTURERS

1 Acepran®, Vetnil, São Paulo, SP, Brazil.
2 Dimorf®, Cristália, São Paulo, SP, Brazil.
3 Dormine®, Cristália, São Paulo, SP, Brazil.
4 Propovan®, Cristália, São Paulo, SP, Brazil.
5 Isoflorane®, Cristália, São Paulo, SP, Brazil.
6 Cellozina®, Rio Química Indústria Farmacêutica Ltda, São José do Rio Preto, SP, Brazil.
7 Parafuso cortical®, Cão Médica, Campinas, SP, Brazil.
8 Placa bloqueada®, Cão Médica, Campinas, SP, Brazil.
9 Meloxican®, Ourofino, Cravinhos, SP, Brazil.
10 Diazepam®, Teuto, Anápolis, GO, Brazil.

Declaration of interest. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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