CT evaluation of HU bone density of the vertebrae in dogs with spine compression

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Abstract
Bone mineral density (BMD) is defined as the mineral concentration in bone. BMD is directly related to bone strength and is a useful predictor of osteoporotic fracture; it is therefore used to diagnose and monitor osteoporosis in humans. The purpose of this study was to evaluate if there are changes in the adjacent vertebral body (cranial and caudal) consistency in case of disk protrusion or IVDD. The result show changes of the HU of the vertebral body of the vertebrae situated cranial and caudal of the protrusion site, but there is no statistical correlation between the disk protrusion or IVDD and those changes.
Keywords*: IVDD, bode density, dog, CT*

Introduction

The canine intervertebral disc (IVD) is a versatile structure and is responsible for the stability and flexibility of the spine. IVD degeneration is a common phenomenon in dogs and is characterized by the degradation of the extracellular matrix, mainly proteoglycans and collagen. The medical definition of degeneration is: "tissue change into a less active or less functional form", and true degeneration is defined by the actual chemical change of the tissue itself (1).

Once the degenerative process has begun to trigger a cascade of events, these may eventually lead to a structural failure of IVD and the clinical signs of the disease. Common conditions related to IVD degeneration in dogs include: degenerative lumbosacral stenosis (DLSS), cervical spondylomyelopathy (CSM) and Hansen type 1 and 2 hernia. IVD hernia is the most common cause of neurological deficits in dogs with a lifetime prevalence estimated at 2%. However, IVD degeneration is not synonymous with IVD disease. While IVDs that lead to clinical signs will inevitably degenerate, degenerate IVDs are common findings in dogs (2).

The purpose of the paper is to determine if the disc protrusion in the dog induces changes in the bone density at the vertebral level, by performing measurements at the vertebra where the protusion occurs and by comparison with the neighboring vertebrae.

Material and methods

The study was conducted on 12 dogs, between the ages of 2 and 10 years, from the breed Bichon, Teckel and French Bulldog, in number of 5, 6 and 1 respectively; of these 6 were male and 6 females. The study was conducted at the Faculty of Veterinary Medicine in Cluj-Napoca, within the Radiology discipline for a period of one year.

The reason for the consultation being represented by different neurological symptoms, these being in correlation with the localization of the hernia, the degree of the protrusion, the time elapsed from the appearance of the symptoms and until the moment of the consultation, the temperament of the patient.

If the hernia was located at the thoracolumbar level, only the pelvic limbs were affected, that is to say paraplegia, and if the hernia was located at the cervical level, the thoracic limbs were also affected, in this case the term tetraplegia was used.

Anesthesia. For the correct examination, in the case of a radiological examination or a CT scan, the animal must be in a fixed position and undergo general anesthesia. The protocol used in anesthesia: intramuscular premedication with acepromazine in a concentration of 0.1 mg / kg, glycopyrrolate 0.01 mg / kg, butorphanol 0.1 mg / kg; intravenous thiamylal induction 10 mg / kg, intubation and maintenance with isoflurane in a circular narcosis system.

The examination was performed by computerized tomography. The CT images were obtained using a CT scanner (SOMATOM SCOPE, SIEMENS HEALTCARE, FMV CLUJ-NAPOCA). After anesthesia the patients are positioned on the CT table in the dorso-ventral position. The scanning conditions were as follows: 130 KVP and 130 mA, thickness of sections of 1mm, range of sections of 1mm. The 3D Net Medical program was used to visualize the vertebrae, respectively the disc herniation and to measure the bone density, in Hounsfield Units (HU), at this level. After examining the spine in the patients who had disc protrusion, we measured the bone density for 3 vertebrae in each patient: the vertebra where we observed the protrusion, the anterior vertebra, and the posterior vertebra respectively. Using different options from the program, we made several measurements on each vertebra, using the function "circle" by which we measured with approximation the diameter of the vertebral canal, the function "polygon" by which after drawing several lines we measured with approximation the diameter of the vertebral body, the volume, the maximum and minimum density at this level, respectively seven more points by which we measured the density in these areas, three of them being located in the middle of the vertebral body, on a vertical line starting from the middle of the medullary canal, two on the lateral parts of the vertebral body, and two on one side and the other of the medullary canal (Figure 1). In total we have measured the HU of 36 vertebras.

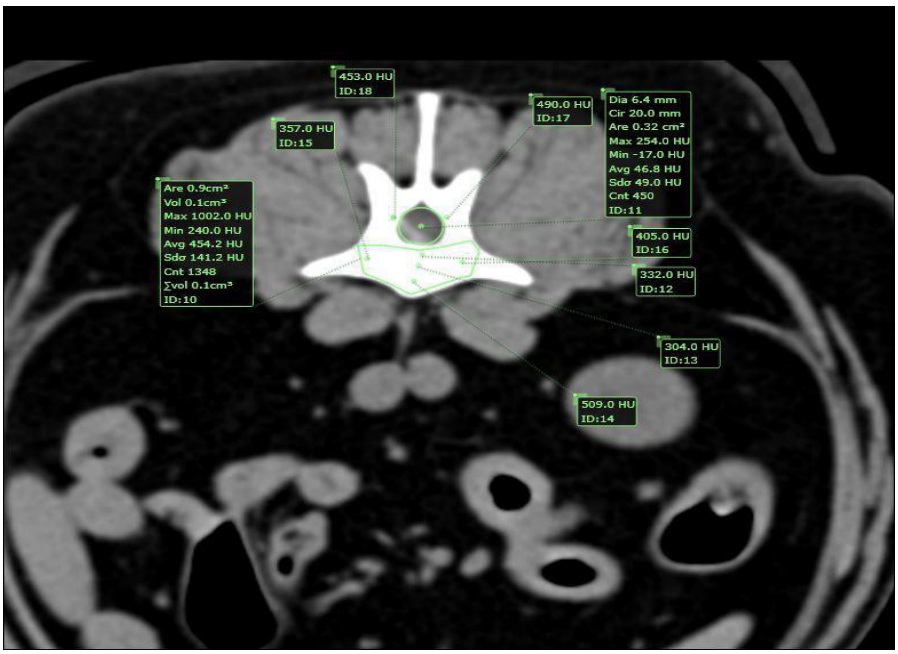

Fig. 1 Measuring the disk extrusion and the vertebral body density using Hounsfield Units

Results and discussion

Bone mineral density (BMD) is defined as the mineral concentration in bone. BMD is directly related to bone strength and is a useful predictor of osteoporotic fracture; it is therefore used to diagnose and monitor osteoporosis in humans. In human medicine, BMD is known to be affected by many factors, including age, sex, endocrine disease, gastrointestinal disease and certain medications. Osteoporosis or low BMD is a common condition that puts the patient at increased risk of pathological fracture; therefore, early diagnosis, prevention and monitoring of BMD are essential (2, 3).

Dual energy X-ray absorptiometry (DXA) is a standard, non-invasive and accurate method for measuring BMD and body composition in humans. Typically, central scans of DXA (lumbar vertebrae and proximal femur) are obtained, but DXA can be used to assess BMD throughout the body or at any specific location of the body. This method has several advantages, including cost-efficiency and fast scan time (3,4).

Quantitative computed tomography (QCT) is also used to measure BMD in humans and has a higher sensitivity than DXA, but a lower specificity for diagnosing osteoporosis. Although DXA is considered a standard BMD measurement technique, QCT is more sensitive than DXA for diagnosing osteoporosis and predicting the risk of pathological fracture, as trabecular BMD is lost faster than cortical BMD as the disease progresses. Decreased BMD in patients with metabolic or endocrine disorders is more evident in the trabecular bone than in the cortical bone, especially in the vertebrae. Measurement of trabecular BMD is essential for early detection of decreased bone mineral content, and QCT may be preferable compared to DXA (5,6).

Data obtained were recorded in a excel sheet and analyzed by using the paired two samples t-student test. Comparison of the media is performed to decide if there are significant differences between the studied environments, in our case whether the bone density changes or not in the vertebrae with protrusion compared to the neighboring ones.

We performed two analyzes, one between the caudal vertebra from the protrusion and the anterior vertebra and the other between the caudal vertebra from the protrusion and the posterior vertebra.

Most dogs with disc protrusion belonged to the Teckel and Bichon breeds, not observing a gender predisposition, the ratio being 50/50.

Depending on the area of the spine in which the protrusion occurred, 10 of the 12 cases concerned a vertebra in the lumbar region, and 2 cases in the thoracic region.

According to the topography of the disc, 3 of the protrusions were left ventro-lateral, 4 ventral and 5 ventro-lateral straight.

The diameter of the medullary canal narrowed between 5% and 50% in some cases due to protrusion.

The average of the 36 vertebrae measured at the vertebral body level was 515 HU (Hounsfield Unit) with a standard deviation of 91 HU, and the average of the same vertebrae, in which we measured 5 points at the vertebral body level and 2 points at the vertebral arch level, was 516 HU with a standard deviation of 74 HU.

Following the use of a t-test, in one of the 12 cases, a decrease in bone density was observed in comparison with the previous vertebra, but without statistical significance, the degeneration at this level could be the consequence of age, the dogs was 8 years, or due to metabolic deficiencies, genetics or other causes. The statistical significance was present for the t-student one tail sequence, a decrease in bone density being visible, base only on this case is hard to asses a correlation between disk protrusion and changes of the vertebral body HU values.

The HU values increase at the level of the vertebral canal where the protrusion occurs and the hyperattenuating disc material is present.

Following the measurements and analyzes, in some cases the HU values measured decrease at the level of the vertebrae where the disc protrusion occurs, without having statistical significance. Also, the increasing HU values of the vertebra where the lesion was identified were observed in 3 cases, without statistical significance. The decrease or increase in HU values cannot be correlated with the disc protrusion.

Conclusions

In conclusion, the disc protrusion itself does not cause a change in bone density at the level of the affected vertebrae. The lot in the study is to small and inhomogeneous, further study targeted on a specific breed and on a large number of individuals are required in order to establish a proper correlation between the disk protrusion of IVDD and changes in the bone density of the vertebral body.

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