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BONE CHANGES OF THE SKULL COMPATIBLE WITH CALVARIAL HYPEROSTOSIS SYNDROME IN AN 11-MONTH-OLD MIXED-BREED DOG: CASE REPORT

MODIFICĂRI OSOASE ALE CRANIULUI COMPATIBILE CU SINDROMUL DE HIPEROSTOZĂ AL BOLȚII CRANIENE LA UN CÂINE METIS ÎN VÂRSTĂ DE 11 LUNI: STUDIU DE CAZ

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ABSTRACT | REZUMAT

Calvarial hyperostosis syndrome (CHS) is a rare developmental bone disorder of uncertain aetiology that affects dogs under 1 year of age. This disorder is characterized by an excessive proliferation of new bone with asymmetric distribution,involving the bones of the cranial vault, such as the frontal, parietal, and possibly occipital bones. In this case report, an 11-month-old male mixed-breed dog with a firm and painful deformity located in the right frontal region is presented. A physical examination revealed no other changes. An X-ray exam of the skull revealed periosteal proliferation along the dorsal aspect of the calvaria, causing thickening and increased opacity of the frontal bone. Computed tomography (CT) of the skull revealed focal and expanding thickening of the right frontal bone but without involvement of the mandible. The clinical and imaging findings identified in a young patient, as well as the distribution of bone changes, are compatible with CHS.

Keywords: calvarial hyperostosis syndrome, CT scan, dog, periosteal reaction, X-ray exam

Sindromul de hiperostoză al bolții craniene (CHS) este o tulburare de dezvoltare osoasă rară, cu etiologie incertă, ce afectează câinii cu vârsta sub 1 an. Această tulburare se caracterizează printr-o proliferare excesivă de os nou cu distribuție asimetrică, implicând oasele bolții craniene, cum ar fi oasele frontal, parietal și, posibil, occipital. În acest studiu de caz, este prezentat un câine mascul, cu vârsta de 11 luni, din rasă mixtă, care prezenta o deformare fermă și nedureroasă, localizată în regiunea frontală dreapta. Examenul fizic nu a evidențiat alte modificări. Examenul radiografic al craniului a evidențiat o proliferare periostală de-a lungul părții dorsale a bolții craniene, determinând îngroșarea și creșterea opacității osului frontal. Tomografia computerizată a craniului (CT) a evidențiat îngroșarea focală și expansibilă a osului frontal drept, însă fără implicarea mandibulei. Aspectele clinice și imagistice identificate la un pacient tânăr, precum și distribuția modificărilor osoase sunt compatibile cu CHS.

Cuvinte cheie: sindromul de hiperostoză a bolții craniene, scanare CT, câine, reacție periostală, examen radiografic

Calvarial hyperostosis syndrome (CHS) or idiopathic calvarial hyperostosis (ICH) in dogs is a progressive, non-neoplastic bone disorder affecting the bones of the skull vault (Latin: *calvaria*) (1, 6). This condition is characterized by the production of new bone in excess, which leads to the thickening of the flat bones of the skull (the frontal and parietal bones, and sometimes even the occipital), without the involvement of the mandible (10). Until now, the aetiology of the disease is not fully known, considered to be the result of the intervention of several triggering factors, including infectious, nutritional, and metabolic processes (10), but also genetic factors (6). This bone disorder was originally described in Bullmastiff dogs, affecting young males and females, between 5 and 10 months of age (8, 10). Later, similar signs of the disease were also described in patients who belonged to other dog breeds (2, 3, 7, 11, 12, 13). When the condition first begins, the swelling of the skull hurts, but as the patient achieves skeletal maturity, it tends to take on a more severe, self-limiting nature (10, 13). In addition, some patients may have fever, convulsions, hydrocephalus, and lymphadenopathy (10), but also lameness following the damage to the long bones of the limbs (8). Exophthalmos may be the consequence of excess bone production in the frontal bone (7). The objective of this report was to present the clinical and imaging findings consistent with CHS in a young native mixed-breed patient.

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MATERIALS AND METHODS

An approximately 11-month-old male mixed-breed dog presented to the referring veterinarian with a

head deformity in the right fronto-parietal region. The history showed that the animal was adopted from an animal shelter 9 months ago and showed no signs of disease. At the time of adoption, the animal was dewormed and properly vaccinated. About 6 weeks ago, the owner noticed the appearance of deformation in the frontal area of the skull, which gradually increased. There was no previous accident that could have caused the deformity to appear. Later, the owner noticed that the animal became depressed, preferring secluded places, but without expressing any other signs of disease. Thus, the decision was made to present the animal to the veterinary clinic.

The physical examination did not reveal the presence of other changes, except for the deformity noted by the owner, located at the level of the right frontal sinus and extending caudally on the dorsal side of the head, appearing as a firm, fixed, and painless deformity on palpation. Laboratory results (CBC and serum biochemical profile) were within reference limits, except for mild neutrophilia [13.81 (reference range 3.00-12.00 x 10^9/L)], mild eosinophilia [1.12 (reference range 0.00-0.80 x 10^9/ L] and mild hyperglycaemia [124 (reference range 60-110 mg/dL)].

The radiographic evaluation of the skull was made from a lateral view (Examion Laurus-Rad machine, Germany). On the radiographic image, the presence of a periosteal proliferation along the surface of the skull was observed, which causes the obvious thickening and increased opacity of the frontal and parietal bones. This new bone production presents as a mildly inhomogeneous opacity, with a smooth surface in the rostral part and a slightly irregular surface in the aboral part (Fig. 1). No signs of adjacent cortical lysis were observed, suggesting the presence of a non-aggressive bone lesion. Afterward, the animal was sent for a CT evaluation (General Electric Revolution machine, USA). The patient received premedication before general anaesthesia with butorphanol (Butomidor, 10 mg/ml, Richter Pharma, Austria) in a dose of 0.2 mg/kg IV, and medetomidine in a dose of 2 mg/kg (Dorbene Vet 1 mg/kg, Syva, Spain). Anaesthetic induction was performed with propofol (Propofol-Lipuro 10 mg/ml, B. Braun Melsungen AG, Germany) 4 mg/kg, and general anaesthesia was maintained, after intubation, with isoflurane (Isoflutek 1000 mg/g, Alivira, Spain) and 100% oxygen, with patient monitoring throughout the procedure (4). Transverse cranial helical CT series were obtained from the level of the nose to the occipito-atloid joint. The obtained images were reformatted with a bone tissue algorithm, obtaining multiplanar reconstructions (sagittal, transverse, and dorsal) and 3D volumetric renderings. The CT image obtained in the sagittal plane revealed the presence of a new bone production, with a heterogeneous appearance, which determined the marked thickening of the frontal bone, with a slight extension towards the parietal bone (Fig. 2). The CT image obtained in the transverse plane allowed the localization of the change predominantly on the right side of the head, highlighting the heterogeneous and thickened appearance of the frontal bone, which presents a mild irregular outline, a change suggestive of new bone formation (Fig. 3). The expansion of the right frontal bone over the median towards the left side of the head was also observed (Fig. 4), as well as a mild thickening of the left frontal bone, in the mediodorsal plane. Although there was a slight depression of the frontal bone at the level of the right sinus, no extension of new bone production within the sinus or cranial cavity or involvement of the temporal bone was identified. Also, no damage to the mandibular bone was observed.

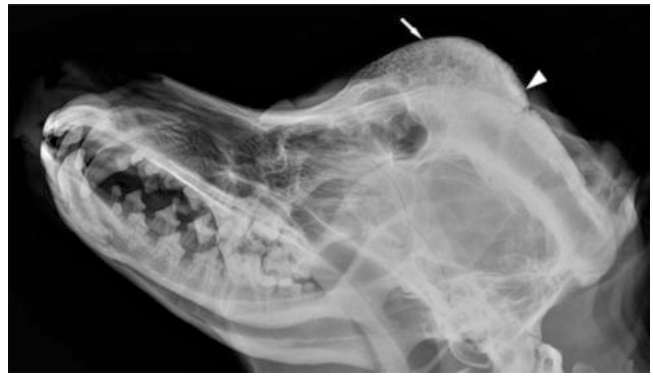

Fig. 1. Right lateral view of the skull of an 11-month-old male with periosteal reaction and thickening of the frontal and parietal bones, showing a smooth surface in the rostral and aboral parts (arrow) and irregular in the middle third (arrowhead)

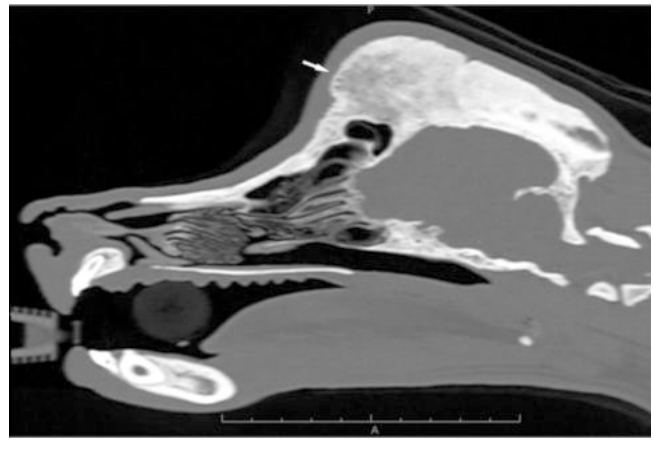

Fig. 2. CT image of the skull in the sagittal plane with bone algorithm showing the formation of new bone on the dorsal part of the calvaria that produced the excessive thickening of the frontal bone (arrow)

The differential diagnosis included CHS, a chronic periosteal reaction secondary to trauma, a chronic in-

flammatory reaction, or a neoplastic process.

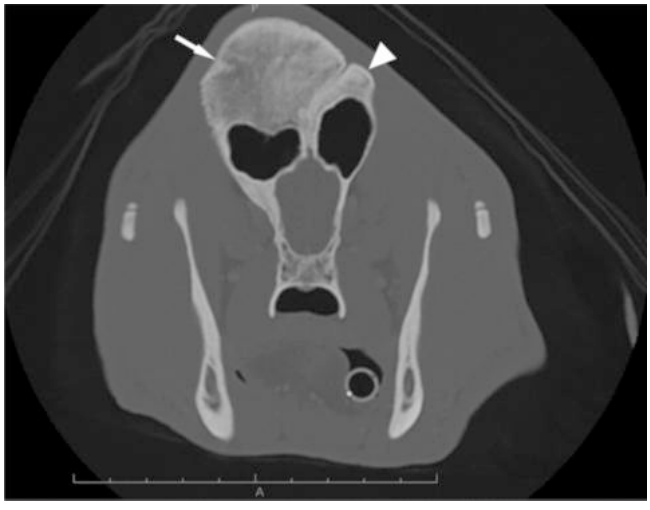

Fig. 3. CT image of the skull in the transverse plane with bone algorithm highlighting the thickening and deformation of the right frontal bone (arrow), which exceeds the median of the head, extending to the left side, and causing thickening of the wall of the frontal sinus in the mediodorsal plane (arrowhead)

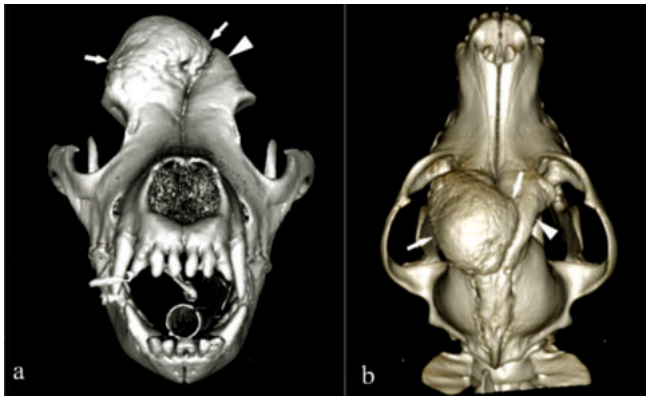

Fig. 4. Three-dimensional CT image of the skull.
a) frontal view showing the deformation of the right frontal bone (arrows) as well as a slight deformation of the left frontal bone (arrowhead);
b) dorsal view showing the extension of new bone production in the frontal region

The synthetic analysis of the clinical signs, identification data, and the patient's history, corroborated with the specific imaging aspects and in correlation with the data from the literature, allowed the assessment that the bone changes highlighted in the patient included in the present study are compatible with CHS. The owner was informed of the bone changes identified in his dog as well as the presumptive diagnosis. Although a biopsy and histopathological examination were recommended to establish a definite diagnosis, the owner refused. Considering the stable condition of the patient and the fact that no medical or surgical treatment was necessary, the animal was handed over to the owner and allowed to go home, following its evolution. Two months after evaluation, the owner reported that the patient was in a stable condition with no other changes in the fronto-parietal region. The dog was subsequently lost to follow-up.

RESULTS AND DISCUSSION

Hyperostosis is the excessive proliferation, localized or diffuse, of bone tissue, and in dogs, it can affect different segments of the skeleton, such as the spine (diffuse idiopathic skeletal hyperostosis), limb bones (hypertrophic osteopathy and hypertrophic osteodystrophy) or skull bones (osteopathy craniomandibular, hyperostotic syndrome of the cranial vault). CHS is a rare disorder of bone development in dogs, involving the flat bones of the calvaria and usually showing an asymmetric distribution. Until now, in veterinary literature, a small number of cases have been described (10). The Bullmastiff breed was most commonly affected, initially suggesting a breed predisposition (8, 10). However, similar bone changes were later described in individuals belonging to other breeds, such as Pit Bull Terriers (3, 13), English Springer Spaniels (7), Weimaraners (3), and Boxers (11), including a patient of mixed race (12). The case we describe in this report is a domestic dog of mixed breed, which demonstrates the possibility of this condition occurring in a larger number of breeds than initially considered, generally large and medium-sized ones being affected. It was initially thought to be a disease affecting only males (10), but later it was shown that females can also develop the disease (1, 3, 7, 8, 12).

It is considered to be juvenile osteopathy (6), so far being described only in young patients, aged between 4 (2, 3, 7) and 10 months (10). Similar to those described in the literature, the case presented here was that of young patient, approximately 11 months old, whose skeletal maturity had not yet been reached. To our knowledge, this is the first case of CHS in a dog described in our country.

Usually, the clinical signs of this condition are discrete, being dominated by the development of a bony protuberance, initially painful, located at the level of the frontal bone and with a tendency to extend to the parietal and even occipital bones (1, 8, 10). In some situations, other signs, such as decreased appetite, malaise, fever, eosinophilia, and lymphadenopathy (8, 10), as well as convulsions, hydrocephalus (10), or blepharospasm and exophthalmos (7), have been simultaneously identified. The imaging changes are characterized by exuberant periosteal proliferation, with often asymmetric distribution, which leads to the thickening of the broad bones of the cranial vault, na-

mely the frontal, parietal, and occipital, changes that were also identified in the case described in this report.

CHS is considered to have clinical and histopathological similarities with craniomandibular osteopathy (CMO) in dogs, but also with infantile cortical hyperostosis (ICH) in humans (10, 14). All these bone disorders affect the young and are self-limiting, but multiple clinical aspects differentiate them, suggesting that each osteopathy is a distinct condition (7, 8, 10). In the case of the three conditions, the anatomical location of the bone changes is of major importance in their differentiation (3, 5, 7, 10).

CMO is a proliferative, non-neoplastic osteopathy found in growing dogs less than 1 year of age (14) belonging to several dog breeds such as the Labrador Retriever, Doberman Pinscher, Great Dane, Boxer, English Bulldog, West Highland White Terrier, Bullmastiff, Pit Bull Terrier, Airedale Terrier, Scottish Terrier, Cairn Terrier, and German Wirehaired Pointer (6, 9).

This osteopathy is characterized by painful deformation of the mandible and temporomandibular joint, accompanied by discomfort when opening the mouth, prehension dysphagia, hypersalivation and intermittent episodes of fever. Imaging is expressed by an irregular, excessive periosteal reaction, with bilateral symmetrical distribution, predominantly affecting the mandible, but with extension to the temporomandibular joint, the tympanic bulla, and the occipital bone (14, 15), unlike CHS, in which the excessive production of new bone shows an asymmetric distribution, involving the dorsal aspect of the calvaria (respectively the frontal and parietal bones), without affecting the mandible (9, 15). A case was described in the literature in which bone changes compatible with both conditions were identified (13). Thus, new bone proliferation was found with bilateral distribution, both at the level of the mandibular rami, but without affecting the temporomandibular joints or tympanic bullae, as well as the thickening and increased opacity of the frontal and parietal bones, recommending the use of the term "juvenile canine cranial hyperostosis idiopathic" in the case of the presence of the respective syndrome in young dogs (13).

In human medicine, there is a condition with clinical and histopathological findings similar to CHS (10, 14), called ICH. This osteopathy, also known as "Caffey disease", is characterized by the formation of new periosteal and subperiosteal bone, with a bilateral and symmetrical distribution, predominantly involving the mandible (14), but reports are indicating the involvement of the appendicular skeleton (scapula, clavicles, ribs, and long bones) (5), which differentiates it from CHS.

The aetiology and pathogenesis of CHS are still unknown. Previous studies have suggested the possible involvement of infectious, nutritional, metabolic, and genetic factors in the onset of the disease (1, 10), excluding traumatic, neoplastic, or degenerative aetiologies (2). In our opinion, further in-depth studies are necessary to elucidate the causes underlying the appearance of this proliferative osteopathy in dogs, as well as a better understanding of its pathogenesis.

The imaging technique, represented by an X-ray examination and a CT scan, is the most effective way to evaluate bone tissue. In the present report, both of the previously mentioned methods were used to evaluate the bones of the skull. The presence of this hypertrophic osteopathy can be suspected based on radiographic and/or CT findings of the skull, although confirmation is based on histopathological examination (7, 8, 10). In the present report, it was not possible to evaluate the histopathology, but the presence of bone changes (hypertrophic type, with asymmetric distribution, involving the frontal bone, but without affecting the mandible) corroborated with the patient's vulnerability due to age, in the absence of previous mechano-traumatic injuries (according to anamnestic data and the patient's history) and in correlation with the literature data, allowed the diagnosis of CHS to be established in the evaluated patient.

The condition is usually self-limiting, with most cases showing regression of the lesion once the patient completes growth without recurrences (1, 7, 10), although sometimes skull asymmetry may persist for a long time (2). No specific treatment is necessary, but in the initial phase of the disease, when pain is detected, it is recommended to institute analgesic treatment (3, 7, 10).

CONCLUSIONS

This report presented clinical and imaging findings consistent with CHS in a young mixed-breed dog, demonstrating that this osteopathy is widespread, affecting both purebreds and mixed-breeds alike, but with different frequencies. Therefore, CHS should be included in the differential diagnosis whenever a young dog presents with asymmetric periosteal proliferation involving the broad bones of the cranial vault.

REFERENCES

1. *Fischetti A.J., Lara-Garcia A., Gross S.,* (2006), What Is Your Diagnosis. JAVMA, 229:211-212
2. *de Heer N., Maltha J., van Garderen E.,* (2015), Calvarial hyperostosis syndrome in a young Wemaraner dog. Vlaams Diergen Tijds, 84:154-157
3. *Haktanir D., Eravci Yalin E., Devecioğlu Y., Demirutku A., Gürel A.*, (2018), Calvarial Hyperostosis Syndrome in an American Pit Bull Terrier. Acta Vet Eurasia, 44: 49-52
4. *Jeff K.O.*, (2013), Small Animal Anesthesia and Pain Management: a color handbook, 1st ed., (Ed.) Manson Publishing/The Veterinary Press, London, UK

5. *Kutty N., Thomas D., George L., John T.B.,* (2010), Caffey disease of infantile cortical hyperostosis: a case report. Oman Med J, 25:134-136
6. *Letko A., Leuthard F., Jagannathan V., Corlazzoli D., Matiasek K., Schweizer D., Hytönen M.K., Lohi H., Leeb T., Drögemüller C.*, (2020), Whole genome sequencing indicates heterogeneity of hyperostotic disorders in dogs. Genes (Basel), 11(2):163
7. *Mathes R.L., Holmes S.P., Coleman K.D., Radlinsky M.A.G., Moore P.A.*, (2012), Calvarial hyperostosis presenting as unilateral exophthalmos in a female English Springer Spaniel. Vet Ophthalmol, 15:263-270
8. *McConnell J.F., Hayes A., Platt S.R., Smith K.C.*, (2006), Calvarial hyperostosis syndrome in two bullmastiffs. Vet Radiol Ultrasound, 47:72-77
9. *Padgett G.A., Mostosky U.V., Prieur D.J.*, (1986), Animal model: the mode of inheritance of craniomandibular osteopathy in West Highland White Terrier dogs. Am J Med Genet, 13:9-13
10. *Pastor K.F., Boulay J.P., Schelling S.H., Carpenter J.L.*, (2000), Idiopathic hyperostosis of the calvaria in five young bullmastiffs. J Am Anim Hosp Assoc, 36: 439-445
11. *Simó M., Marti J.M., Cairó J.,* (2017), Hiperostosis craneal idiopática en un Boxer. Clin Vet Peq Anim, 37: 247-249
12. *Slovak J.E., Gilmour L.J., Miles K.G.,* (2015), What is your diagnosis ? JAVMA, 246:1187-1189
13. *Thompson D.J., Rogers W., Owen M.C., Thompson K.G.,* (2011), Idiopathic canine juvenile cranial hyperostosis in a Pit Bull Terrier. N Z Vet J, 59:201-205
14. *Thornburg L.P.*, (1979), Infantile cortical hyperostosis (Caffey-Silverman syndrome). Animal model: craniomandibular osteopathy in the canine. Am J Pathol, 95:575-578
15. *Tudor N.*, (2022), Craniomandibular osteopathy in dog - clinical and radiographic aspects. Practica Veterinară, 37, Available at: https://www.medichub.ro/reviste-de-specialitate/practica-veterinara-ro/osteopatia-cranio-mandibulara-la-caine-aspecte-clinice-si-radiografice-id-7008-cmsid-69 (Accessed: 22 September 2022).