Praca oryginalna *Original paper*

Morphological analysis and morphometry of the foramen magnum of the american staffordshire terrier breed newborns

ALEKSANDER CHRÓSZCZ, MACIEJ JANECZEK, MONIKA WOJNAR, NORBERT POSPIESZNY

Department of Veterinary Anatomy and Histology, Agricultural University of Wrocław, ul. Kożuchowska 1/3, 51-631 Wrocław, Poland

Chrószcz A., Janeczek M., Wojnar M., Pospieszny N.

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Summary

The aim of the investigations was the description of foramen magnum morphology. Fourteen skulls of American Staffordshire terrier pups were examined. The morphology of the foramen magnum was described, its height and width were measured, and the index of the foramen magnum (width/height × 100) was calculated. The height of the skull, maximum width and maximum height of the occipital condyle were also measured. In all the examined skulls the shape of the foramen magnum was regular and ellipsoidal. The average height of the foramen magnum was 5.7 mm, the average width – 6.05 mm. The value of the foramen magnum index was 106.82. The average skull height was 22 mm. The average maximum height of the occipital condyle was 5.33 mm and its average maximum width was 2.85 mm. There were no differences between females and males in all parameters. The shape of the foramen magnum was regular. The occipital condyli were symmetrical.

Keywords: foramen magnum, skull, dog, craniometry

Irregularities in the shape of the foramen magnum and the occipital bone constitue a crucial problem in the veterinary medicine as well as in human medicine. There were plenty of clinical symptoms described, regarding the irregularly formed foramen magnum and occipital bone. Authors described, among many others, convulsions, ataxias, prolapse of the brain to the medullary canal and occipital dysplasia (1, 2, 5, 8, 11, 16, 20, 22, 25). The causes of the occipital foramen's irregularities are unknown (26). The direct relationship between the occipital bone's irregularities and the Chiari's syndrome in humans was proven (13, 15, 17, 18). The irregularities of the foramen magnum particularily often appear in brachycephalic dogs (eg. Shihtzu or Pekinese), but can also be encountered in dolichocephalic and mesocephalic breeds (6, 21, 26, 27). It is occurred, the skull of american staffordshire terrier is mesocephalic type (10). The aim of study was the description of foramen magnum morphology in american staffordshire terrier pupps.

The examinations were carried out on dogs of american staffordshire terrier breed. This breed was introduced in Poland in 1989 (12, 14). Since then we have observed a dynamic growth of this breed population (9).

Material and methods

The examinations were carried out on fourteen skulls of american staffordshire terrier pups (7 females and 7 males). The pups were of four litters and different parents whose parentage was documented. The pups were one day old. Their heads were macerated and then anatomicaly preparated with the aid of a magnifying glass. The height and width of the foramen magnum were measured and its index was calculated (width/height × 100) (fig. 3). The heigth of the skull was measured (fig. 4). The maximum width and maximum hight of the condyli occipitalis was measured (fig. 3). Each measurment was repeated three times. The measurments were carried out with the aid of an electronic slide calliper Sylvac 110-DL with 0.1 mm accuracy.

Results and discussion

An foramen magnum, in all skulls examined, was always located between an occipital squama (*squama occipitalis*), lateral parts (*partes laterales*) and an occipital basis (*basis ossis occipitalis*). The shape of the foramen magnum was, in all skulls examined, regular and ellipsoidal (fig. 1, 2). Lateral parts were symmetrical. Particular parts of the occipital bone were not grown together but connected with membrane. The membrane surrounded the foramen magnum from all

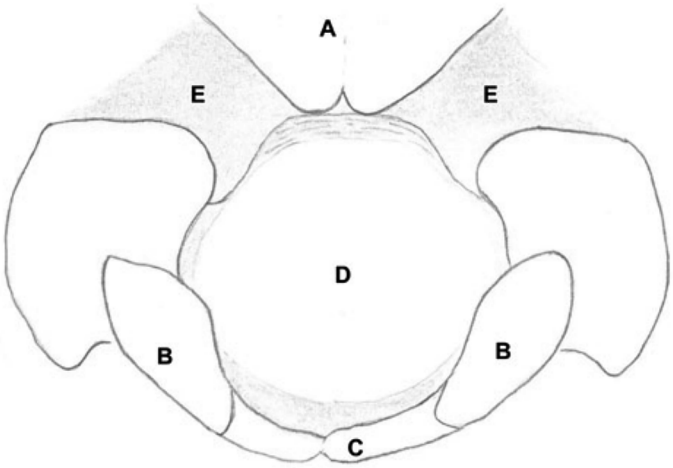

Fig. 1. The foramen magnum; A – squamous part (supraoccipital), B – lateral part (exoccipital), C – basiliar part (basioccipital), D – foramen magnum, E – synchondrosis

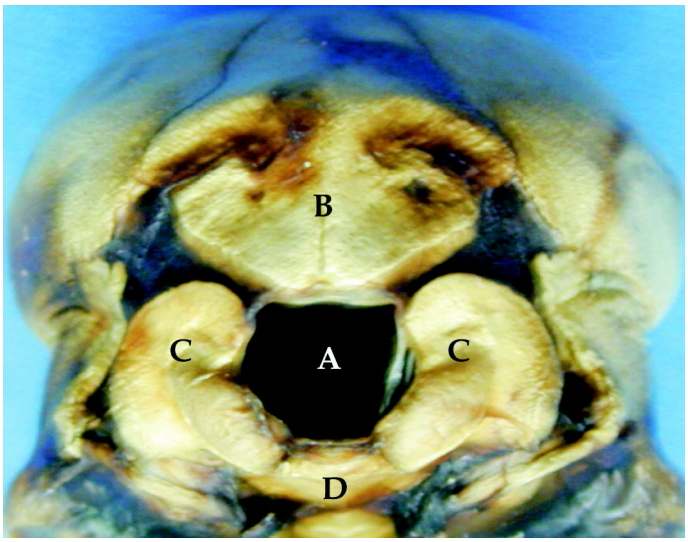

Fig. 2. The foramen magnum and occipital bone; A – foramen magnum, B – squamous part (supraoccipital), C – lateral part (exoccipital), C – basiliar part (basioccipital)

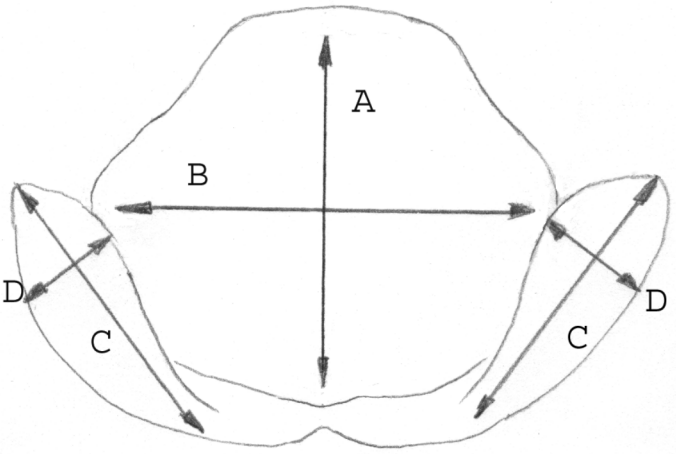

Fig. 3. Morphometric points of foramen magnum and occipital condyles; A – height of foramen magnum, B – width of foramen magnum, C – maximum height of the occipital condyle, D – maximum width of the occipital condyle

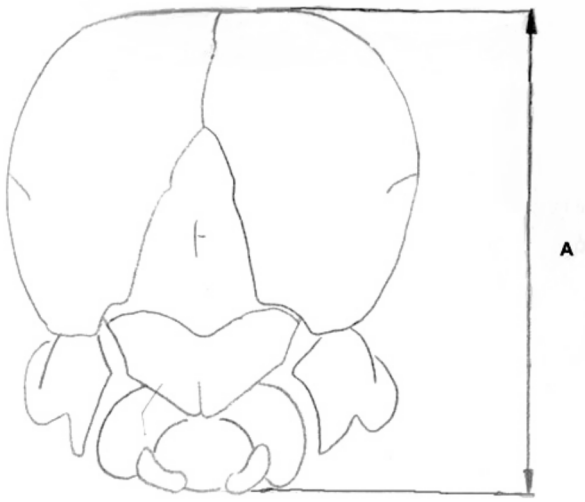

Fig. 4. Skull of the american staffordshire terrier newborn; A – height of the skull

sides. The results of the craniometric measurments are presented in tab. 1. Usually the width of the foramen magnum was bigger than its heigth. In the case of males only one skull had the foramen magnum higher than wider – while in the case of females, two. The average heigth of the foramen magnum was 5.7 mm and the average width – 6.05 mm. Discrepancies between the heigth and the width of the foramen magnum between males and females are not statistically important. The average value of the foramen magnum index in males and females is 106.82 mm. and the differance of the index value between males and females is also statistically not important (tab. 1). The average skull heigth was 22 mm. The heigth of the foramen magnum was 29.9% of the skull heigth. None of the skulls examined displayed any dorsal notches or any additional foramen in the occipital squama.

Tab. 1. Measurements of the skull ($\bar{x} \pm Sd$)

Parameters	Male n = 7	Female n = 7	Male and female n = 14
Height of the foramen magnum (mm)	5,86 ± 0,42	5,52 ± 0,62	5,70 ± 0,52
Width of the foramen magnum (mm)	6,26 ± 0,91	5,81 ± 0,60	6,05 ± 0,75
Hight of the skull (mm)	22,1 ± 0,35	21,5 ± 0,50	22,0 ± 0,85
Index of the foramen magnum	106,73	107,63	106,82
Maximum height of the occipital condyle (mm)	5,30 ± 0,20	5,35 ± 0,20	5,33 ± 0,35
Maximum width of the occipital condyle (mm)	2,83 ± 0,30	2,90 ± 0,30	2,85 ± 0,40

The measurments of occipital condyli proved their symmetry (tab. 1).

An foramen magnum of the german shepherd is always quoted as a model example of a regularly formed one (26). Our examinations were carried out on one day old pups, whose foramen magnum formation process, as well as their skulls, were not finished.

However, it was possible at this stage to determine the formation irregularities or at least to spot the elements pointing at the possibility of their future occurrence. Simoens et al. (23) stated that the shape of an foramen magnum does not undergo any changes with age. The foramen magnum index in puppies in comparison to grown up dogs does not show any significant and statistically important changes (26).

Irregularly formed foramen magnum is a very crucial clinical problem. Underdevelopment of the foramen magnum and its irregular shape are one of the reasons for the Chiari's syndrome occurrences in humans (13, 15, 17, 18). In veterinary medicine a dorsal notch is most possible to occure as well as an additional foramen in the occipital squama.

Watson et al. (26), in his researches carried out on 36 skulls of beagle breed, pomeranian and chichuahua, observed the presence of a dorsal notch in 33 cases. Similarly Simoens et al. (23) while examining the skulls of pekingese (also pups) observed a dorsal notch in all cases. Despite the fact that the presence of this formation does not have to be accompanied by clinical symptoms it is, however, and increases the possibility of such symptoms to occure (20, 26, 27). Simoens at all (24) confirm, that the foramen notch in some breeds is an normal morphological extension. Watson et al (26) stated that dorsal notch should be regarded as a variation, not an anomaly. Investigating the shape and the size of the foramen magnum one should take into account the breed conditioning. Thus, in the case of pekingese, the dorsal notch is not bigger in young dogs than in older ones while, in the case of beagles, one can observe the occurrence of a bigger dorsal notch in young dogs (23). Watson et al. (26) stated that a dorsal notch can be more often observed in dogs of beagle breed with brachycephalic type of the skull rather than in dogs of the same breed but with dolichocephalic type of skulls. Onar et al (19) thinks that, in german shepherd, the appearance of an extension or dorsal notch in the foramen magnum is not a results of morphologic situation but a pathological abnormality. The reasons for that are unknown. Despite the fact that the influence of the endocrine system on the shape of the skull was proven, its effects on the formation of the foramen magnum were not observed (3, 4). It is believed that occurrence of the dorsal notch may have something to do with a disproportionately big, in relation to the skull capacity neurocranium, brain in dogs of brachycephalic type of a breed. In such a case an excessive pressure against occipital bone could lead to disturbances in the process of bone formation resulting in a dorsal notch (7). In none of the skulls examined such a formation was observed.

Conclusions

In all skulls examined the shape of the occipital foramen was regular. No differences between males and females in the shape, heigth, width and the occipital foramen index were observed. A small number of skulls examined did not allow a unequivocal determination whether the dogs of this breed are free from the developmental pathology of the bone and occipital foramen. The examinations conducted may show that such morphological variations, if occurring at all in this breed, may rather be marginal.

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Adres autora: lek. wet. Aleksander Chrószcz, Kożuchowska 1/3, 51-631 Wrocław, Poland; e-mail: bjorn@onet.pl