PERFORATIONS IN ARCHAEOLOGICAL NEOLITHIC CATTLE SKULLS: A NEW METHODOLOGICAL APPROXIMATION FOR THEIR STUDY AND EXPLANATION

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Abstract. We describe and discuss in this paper new data obtained from the study of the perforations in four cattle skulls recovered in the early Neolithic site of "la Draga" (north-east Iberian Peninsula), dated around 5300-5100 cal BC. All the perforations are located in the posterior region of the skulls, behind the frontal and nuchal eminences, and consist of rounded holes, elliptical in shape and of various sizes. The observed frequency of occurrence is also variable, with only one cattle skull showing multiple perforations. The rounded margins are indicative of the condition being present during the life of the animal. A detailed examination of these specimens was carried out using computed tomography (CT). This technique provides particularly good bone tissue detail, generating cross-sectional images and three-dimensional reconstructions. The CT study allowed the assessment of normal anatomy and bone tissue status around the previously identified perforations to suggest the presumptive diagnosis. We discuss also the available archaeological evidence and the hypothetical explanations concerning the possible causes of the phenomenon (genetic or congenital origin, parasites, tumours, infections, external physical influences due to yokes use during ploughing) according to the status of the animals (wild and domestic), evaluating their possibilities and limitations in order to exclude or test each hypothesis, and advance our understanding in this research subject.
Key words: Neolithic, la Draga, Archaeozoology, cattle skulls, cranial perforation, computed tomography.

NEOLITO LAIKOTARPIO GALVIJŲ KAUKOLĖSE RASTOS ANGOS: NAUJAS METODOLOGINIS POŽIŪRIS Į TYRIMĄ IR INTERPRETACIJA

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Santrauka. Šiame straipsnyje pateikiami keturių galvijų kaukolių angų aprašymai ir jų analizė. Naminių galvijų kaukolės rastos ankstyvojo neolito laikotarpio "la Draga" gyvenvietėje (5300–5100 pr. Kr., Iberijos pusiasalio Šiaurės Rytai). Visos angos išsidėsčiusios užpakalinėje kaukolių srityje, už kaktikaulio ir sprando pakylų, ir yra ovalios formos bei įvairaus dydžio. Angų dažnumas įvairus, išskyrus vieną kaukolę, kurioje rastos daugybinės angos. Suapvalinti angų kraštai rodo, kad jos susiformavo gyviems galvijams. Detali kaukolių analizė atlikta naudojant kompiuterinę tomografiją (KT). Ši metodika leidžia labai detaliai įvertinti kaulinio audinio detales, nes leidžia sukurti skerspjūvių vaizdus bei atlikti trimatę rekonstrukciją. KT tyrimas leido įvertinti normalią anatomiją bei kaulinio audinio būklę apie nustatytas angas ir pateikti galimą diagnozę. Straipsnyje taip pat aptariamas turimas archeologinis kontekstas bei galimos angų atsiradimo priežastys (genetinės ar įgimtos kilmės, parazitai, navikai, infekcijos ar išorinių veiksnių, tokių kaip kinkymas į jungą įtaka) pagal gyvūnų statusą (laukiniai ar naminiai), bandoma įvertinti pateiktų hipotezių pagrįstumą ir pagerinti mūsų suvokimą apie šį tyrimo objektą.
Raktažodžiai: neolito laikotarpio galvijai, la Draga, archeozoologija, galvijų kaukolės, kaukolių angos, kompiuterinė tomografija.

Introduction. Archaeozoological analysis of the faunal remains recovered from the Draga site (north-east Iberian Peninsula) (5300-5100 cal BC) has made it possible to state that bovine husbandry played an important role in the general frame of the production strategies implemented by the communities that occupied this settlement. With a relative abundance of 31 % on the basis of the number of classified remains and 73 % on the basis of biomass quantity, the bovids were certainly the principal source of meat. Only 30 % of animals were slaughtered at an adult age and, in few occasions, were they aged over nine years. The individual's distribution by age and sex demonstrates the significant dominance of males slaughtered between 15 and 24 months, a pattern that conforms

well to the theoretical exploitation model of this animal for meat production and consumption. Nevertheless, while this general trend, we can observe the presence of specimens slaughtered before one year and the complementary presence of adult and old animals (more than six years). With the aim of demonstrating the possible draught exploitation of cattle, an exhaustive analysis of the material was carried out to identify the presence or absence of pathological deformations on the skeletal remains caused by a recurrent overstrain of the animal.

In the Draga site the association, in a limited space, of four cattle skulls with plough implements as yokes and helms of reduced dimensions is highly significant in this sense. Three of the skulls present perforations in the occipital part. These perforations, three in one skull (1998-1) and one in the other two (2003-45, 2001-2), are regular with an oval configuration (Figure 1). Four skulls (2005-25) do not present perforations but present strong depressions in the occipital bone and enlarged foramina. The dimensions of the perforations are variable, ranging between 2, 27 cm. and 1 cm. in length and between 0,3 and 1,5 cm. in breadth. With regard to the animals characteristics, both individuals with one perforation are of juvenile age (2003-45, 2001-2) whereas the remaining two are of adult age (98-1, 2005-25). With the purpose of classifying the remains by sex, in this work we use the information and biometrical data published by Sykes & Symmons (2007). The results of the dispersion graph (Figure 2) carried out from the Basal Circumference (BC) and Minimum Basal Diameter (BB) measurements of the horn cores shows three *Bos* specimens distributed perfectly between the females (2003-45, 1998-1 and 2001-2) whereas the fourth specimen (2005-45) correspond to a male. Nevertheless, we can not discard definitively the presence of an ox. Having in mind the horn-core classification according to the cattle type horn-core size categories proposed by Sykes & Symmons (2007) (in base to the length of their outer curve –OC) the three first ones correspond to short horn (OC = 182,174 and 195 respectively) and the last one to the medium horn category (OC=320). Concerning the morphology, and following the same author's classification, with the exception of the last one, that presents a type 2 curvature (light curve); the other three correspond to the curved type. None of the female horn-cores presents torsion (no twist) and the horn-core of the male specimen has a light twist. Another interesting aspect is that at the Draga site the simultaneous presence of *Bos taurus* and *Bos primigenius* remains has been documented, the latter in low numbers. The comparative analysis carried out from the measurements of the four skulls with published biometrical data for *Bos primigenius* horn-cores, shows that the smaller specimens (98-1,2003-45, 2001-2) are distributed perfectly in the variability range of the domestic females, whereas the male specimen (2005-25) is placed in the lowest range of the wild males. We cannot reject the possibility that it corresponds to a wild animal or an animal in an initial domestication stage, therefore.

Figure 1. **Draga's *Bos* skulls with perforations in the occipital part**

The presence of perforations in the nuchal and occipital parts of the bovine cranium is a pathology documented in numerous archaeological contexts of different chronologies. A revision to the existing publications on the topic (Brothwell *et al.*, 1996; Manaseryan *et al.*, 1999; Baxter, 2002) demonstrates that it has affected a significant quantity of animals. We cannot establish until now any correlation between the presence of cranium perforations and the age and sex of the animals. There are different reasons proposed to explain the origin of this pathology. At first, the presence of holes was linked to the utilization of head yokes (Brothwell *et al.*, 1996). The explanation given by these authors contemplates as causal factor the repeated pressure of the yokes on the cranium nuchal area that resulted in bone remodelling. The recent recovery of a *Bison bonasus* (Manaseryan *et al*., 1999) and a possible *Bos primigenius* female cranium (Baxter, 2002) with this type of deformation has extended the debate about this question, revealing the potential congenital origin of the perforations. Other causes attributed to this deformation (Brothwell *et al.*, 1996) have referred to parasites, tumours or infections. However, in none of the cases have they been refuted or confirmed in a definitive way. With the aim to have a more detailed knowledge about the cause or causes of the perforations identified in the Draga bovine remains, an exhaustive examination of

these remains by means of computerised tomography was undertaken. In addition to the bucraniums, a maxilla bovine remain with a marked protuberance was also analyzed. Computed tomography (CT) is gradually becoming more widely available and has advantages for the investigation of a variety of lesions affecting most parts of the body of humans and animals. CT scans have properties similar to those of conventional radiographs because both are produced via the absorption of x-rays by tissues of different density, but the cross-sectional depiction of anatomy in CT images eliminates the superimposition of body parts, which significantly limits conventional radiography. Moreover, CT can detect differences in tissue density that are too small to be visible on conventional radiographs and allowed more information to be gathered about a suspected abnormality observed directly or via radiography. CT provides particularly good bony tissue detail. Although CT images are acquired in the transverse plane, the data can be reprocessed after acquisition to produce three-dimensional (3D) reconstructions.

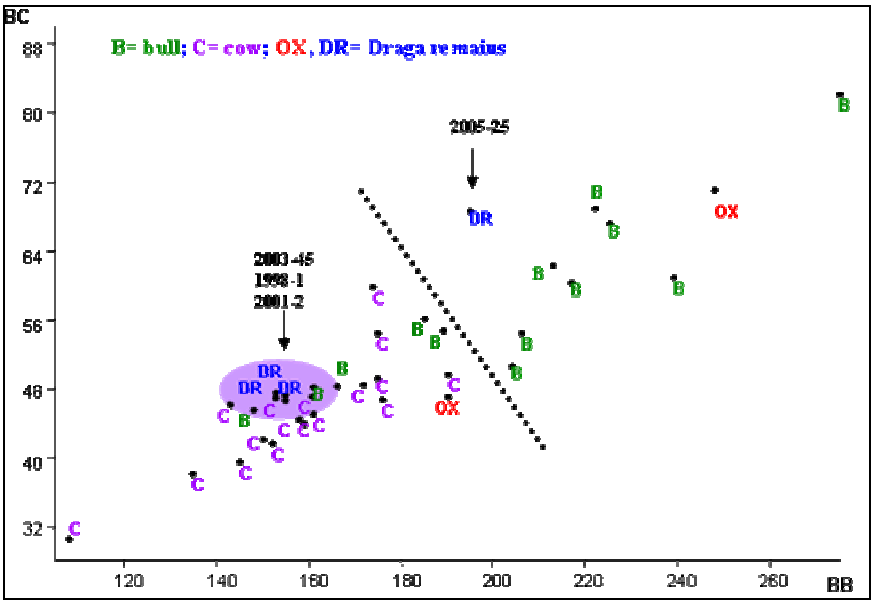

Figure 2. **Dispersion graph of Basal Circumference (BC) and Minimum Basal Diameter (BB) measurements**

Material and Methods. The CT scan was performed using a second-generation CT scanner[1] with technique settings of 120 kV, 315 mAs and 2.1 sec. Contiguous slices were obtained 2-3 mm apart (scan increment) and the slice width was 5.0 mm.

Results-Discussion. Three different types of bony lesions could be identified. Perforations were detected in three cattle skulls, but a maxilla protuberance and two bony depressions in other skulls could also be observed. CT images provided good detail of these previously identified alterations in all cases.

Bony perforations showed similar features after the CT study. Despite the obvious bony discontinuity, no differences in the diameter between the bone surrounding the holes and adjacent regions of apparently normal skull could be detected. The surrounding bone exhibit normal radiographic osseous features, including hyperdense appearance, and no additional lesions were identified. Absence of the classical pathological signs, such as bone lysis, bone proliferation, sclerosis, degenerative changes or density alterations, around these discontinuities rule out primary or secondary bone diseases (e.g. neoplasm, infectious/parasitic osteomyelitis or nutritional processes) as the aetiology of these skull perforations. However, the completely normal appearance of the bone tissue that surrounded these discontinuities, including absence of any surface irregularities, guided us to consider the possibility that they were present during the life of the animal. We suggest the possibility that normal bone growth pattern during the animal's life had been able to create a smooth bone surface around the defects. Otherwise, the surface would not be so smooth and well defined. Interestingly, some of the perforations shared a similar pattern of conic and sharp appearance identified on the transverse CT images in one or both margins of the discontinuity (Figures 3, 4). One hypothesis for this particular finding could be that these perforations were performed in the same way or, at least, they shared similar aetiologies, as iatrogenic mechanical trauma or other external trauma.

Additional images were obtained after three-dimensional reconstructions of the transverse plane images from all the cattle skulls. In human and veterinary medicine, three-dimensional reconstructions are particularly useful to detect fractures, particularly in cranial trauma patients. In our samples, we did not detect any other lesion than the previously reported but, although no obvious advantages could be obtained from these three-dimensional images, they allowed us to investigate and re-evaluate the skulls and the findings without more manipulation.

[1] Elscint 2400 elite.

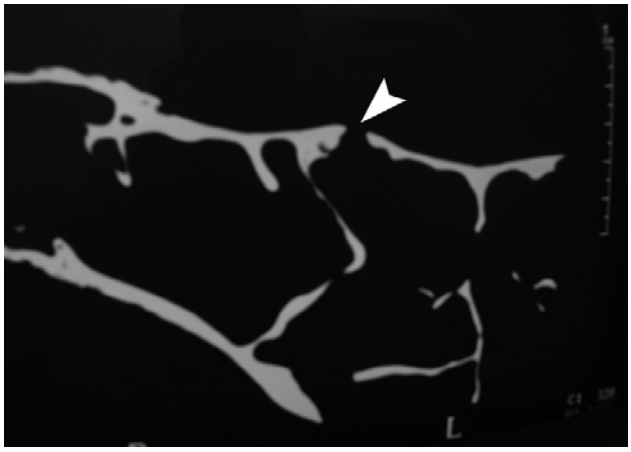

Figure 3. **Transverse CT image of the skull 1998-1. Bone window. The perforation showed sharp, conic appearance** (arrowhead)

We also evaluated two skull depressions in different samples. No bone discontinuity or pathologic lesion could be detected after performing CT transverse or three-dimensional reconstructions. Our impression is that both share similar physiological appearance.

The maxilla protuberance was also evaluated via CT (transverse and 3D). This lesion showed normal hyperdense bony features showing continuity with the maxilla without any sign of previous bone disease. We considered the possibility that it constituted a physiologic bony protuberance, but other diagnostics could not be rule-out.

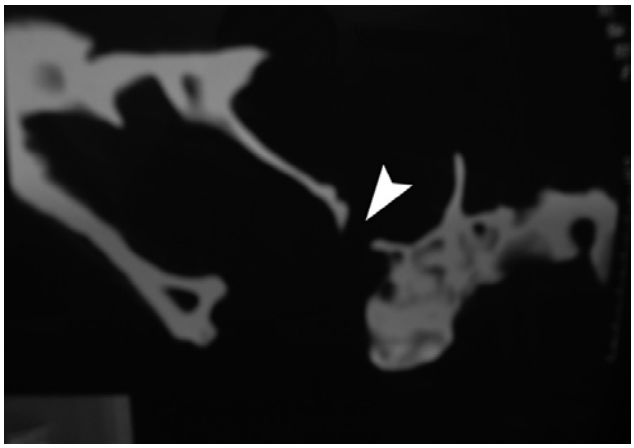

Figure 4. **Transverse CT image of the skull 1998-1. Bone window. Another bony perforation with similar sharp, conic appearance** (arrowhead)

Conclusion. The Draga cattle crania constitute one of the most ancient prehistoric samples in which it has been possible to document the presence of perforations. Although other Neolithic contexts, such as Letchworth (Hertfordshire, UK) (Baxter, 2002) and Spiennes (Belgium) (Brothwell, *et al.*, 1996), have produced bovine cranium remains with this lesion, the majority of studied and published remains come from historical contexts (Roman and medieval) (Brothwell, *et al.*, 1996). The degree of preservation of archaeozoological remains and the historically-attested use and exploitation of cattle can notably influence the quantification of this aspect. The detailed examination of the remains by means of computed tomography has allowed some of the potential causes of this phenomenon like neoplasms, infectious/parasitic osteomyelitis or nutritional processes to be discarded. In this sense, the documentation of homogeneous dynamics in the conformation of the holes, indicative of a common origin, is significant. Although the obtained results contemplate external trauma as a causal factor, the high relative presence of perforations in the Draga bovine crania corresponding to animals of different sex, age and biological domestication stage seems to exclude, *a priori*, that the systematic use of head yokes was the cause. Nevertheless, having in mind the characteristics of the archaeological record at this site, which includes the spatially significant association of bovine skulls and the implements related to the exploitation of animal energy, and the analysis of distal extremities, which show the use of some cattle for this purpose, the traction hypothesis cannot be completely excluded.

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