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Mini Review

Cranial Trepanation Surgery Four Thousand Years Ago in Catalonia

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Summary

Some groups that arrived in Catalonia four millennia ago from Central Europe, metal prospectors in the area of Solsona (Catalonia), present a high frequency of cranial trepanation, associated with brachycrania. In the set of 146 crania of the Bronze Age in Catalonia, Fisher's exact test showed that the group of brachycranials of Solsona is statistically associated with cranial trepanation. Some cases of the surgical technique used in cranial trepanations are described.

Keywords: Cranial Surgery; Trepanation; Bronze Age; Catalonia.

Introduction

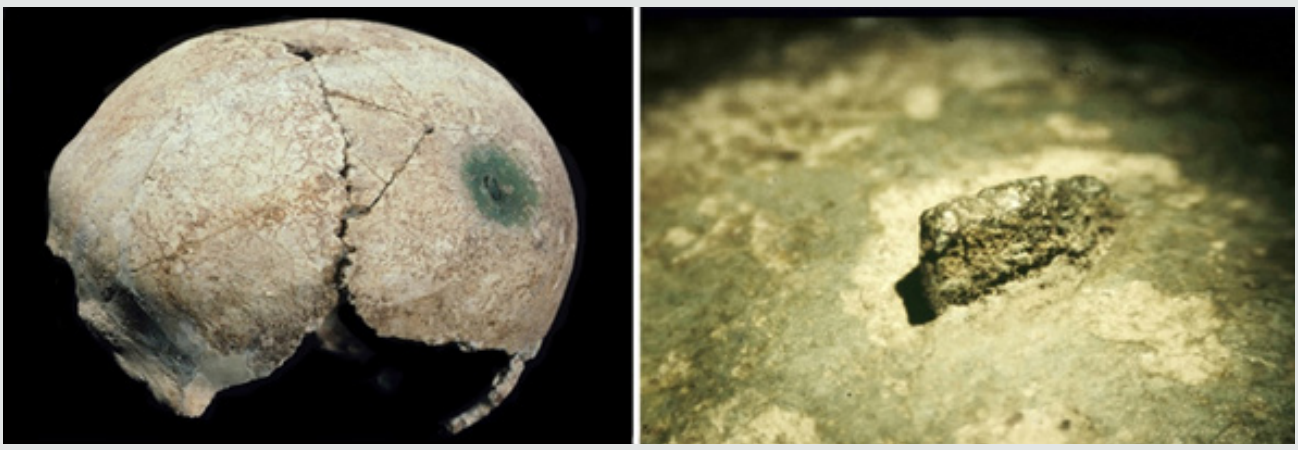

Figure 1: Skull 6 from the Bronze Age dolmen El Collet de Su (Solsona, Catalonia) Museum of Archeology of Catalonia. Left: Note the copper arrowhead stuck in the parietal and a greenish area produced by the humidity of the burial. Right: Approach to the arrowhead, which must have been broken in an attempt to extract it, leaving a portion included in the parietal.

Megalithism was a cultural phenomenon characterized by mass burials made with large blocks of stone in the Western Mediterranean and Atlantic Europe, from the late Neolithic to the Bronze Age. Burials appear in dolmens (simple chamber tombs) and in sepulchral caves from the Bronze Age, from the 2nd millennium BC. The major advances made in recovering and sequencing the DNA of ancient bones, has brought the biodynamics of populations of the European Bronze Age back into the spotlight [1-7]. Paleogenomics has provided a reasonable reconstruction of certain human migrations, the dissemination of domestication processes, farming and diseases, and even the kinship of prehistoric family clans. There was also intensive prospecting for metals such as gold, copper and tin [8]. Groups of these prospectors reached Catalonia from northern Italy and northern France via the Rhone valley [9-10]. Some megalithic burials are associated with brachycephalic and copper mines (Figure 1), such as in the Solsona area, near the Catalan Pyrenees (Figure 2). This article is a review of some cases of cranial trepanation associated with small migrations, most likely from minorities of metal prospectors in the Bronze Age, their association with the exploitation of copper and the surgical technique used in cranial trepanations.

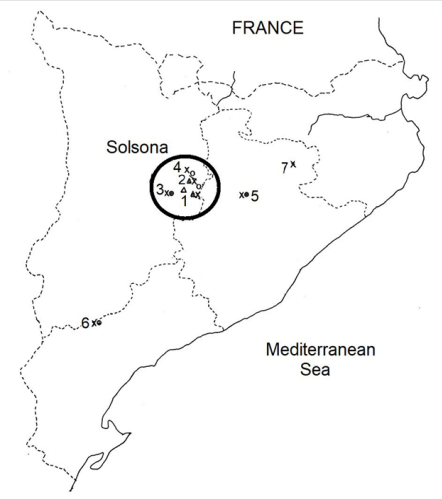

Figure 2: Archaeological sites of Catalonia from the Bronze Age. The Solsona area (circle) registers a high frequency of brachycraniums and cranial trepanations, although this coincidence also appears in nearby geographical areas. 1) El Collet de Su, 2) Clarà, 3) Aigües Vives, 4) El Vilar de Simosa, 5) Torre d'en Cornet, 6) Cova de l'Heura, 7) Roda de Ter.

Cranial Trepanation in The Catalan Bronze Age

An osteological study of the human remains of the Catalan Bronze Age showed that a minority group of foreigners of Central European origin settled mainly in Solsona (Figure 2) and in particular in three settlements that were very close to each other: the megaliths of El Collet, Clarà and the burial cave of Aigües Vives. The immigrants, who differed from the local population for being brachycranial (very wide and short head) and for their association with copper mining and the practice of cranial trepanation, mixed with the local population and reused the megalithic tombs and burial caves [11-12]. It is now known that brachycephalisation, or globular crania, is an evolutionary trend that started in the Mesolithic period [13]. This process took place in a number of populations around the world and has a strong genetic basis [13]. In the context of the European Bronze Age, brachycephaly is a useful population marker since the short and wide heads differ from the long and narrow heads of the previous populations, among which the former end up being diluted [8].

Three crania were later discovered near the Solsona area at the settlement of 'Bauma del Ossos de la Torre d'en Cornet' (Sallent) (Figure 2) [14]. Cranium 1 (Figures 3 left & 4) shows the mark of a scalp practiced on the head to reach the bone, which maybe because of a lesion in the periosteum followed of a tuberous hyperosthosis. The incision does not differ from those practiced by current neurosurgeons (Figures 3 left & 4). It appears to be a wide trepanation in the right parietal, with signs of evident scarring, although the area of periorificial abrasion is minimal due to the curvature of the bone. The medial part is surrounded by an arched parasagittal line, formed by moderate erosion and a bone protrusion (Figure 4). The line confirms the idea that the incision on the scalp was arch shaped, obtaining a flap on the lower base. This is the only case where there is objective proof of a pre-operative incision, although this does not permit us to suppose that similar practices took place in other trepanations.

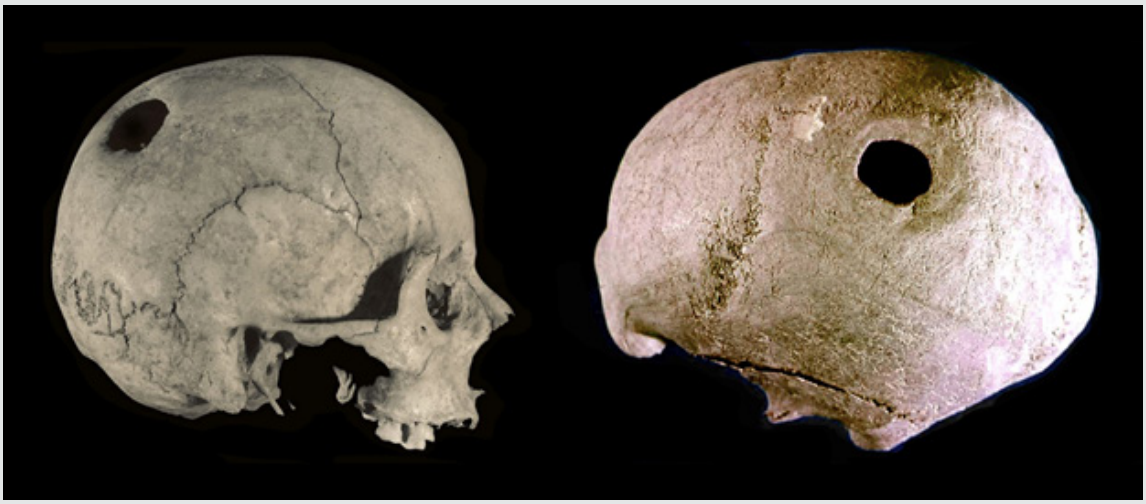

Figure 3: Trepanned skulls from the Bronze Age using the abrasion technique from Catalonia. Left: side view of skull 1 Bauma from Ossos de la Torre d'en Cornet (Sallent, Catalonia). Manresa County Museum. Right: Trepanned skull from Roda de Ter (see Figure 2).

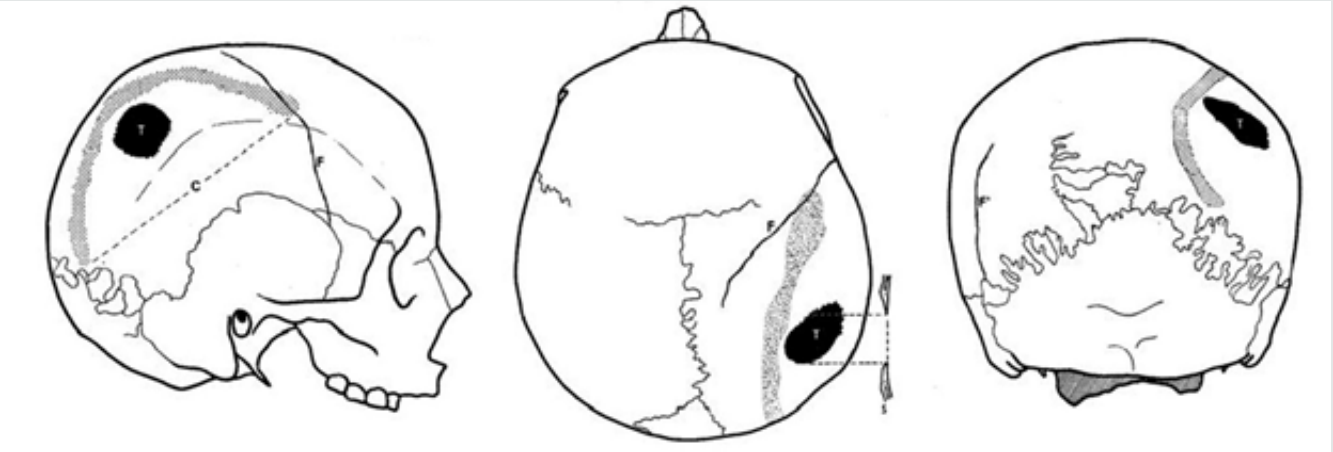

Figure 4: Orthogonal graphs of Bronze Age skull 1 from Bauma dels Ossos de la Torre d'en Cornet (Sallent, Catalonia). Manresa County Museum. Pointed arch: tuberous hyperostosis resulting from the incision to lift the scalp. T: trepanation by abrasion. C: Chord. F and F': postmortem fissures.

It is a typical intentional trepanation in which abrasive techniques are used, and where there was a long period of post-operative survival, given that the scarring is complete. The following factors support this notion: a) the diploic cavities are totally covered with a fine lamina of compact bone; b) there is a grooved reaction; c) a hyperostotic reaction can also be seen behind and in front of the orifice; d) the radiographic image shows that the diploic cavities diminish in size the closer they are to the perforation. Abrasion was almost certainly used since all the characteristics of the technique can be seen here. However, the surrounding ring of progressive thinning of the bone is made up of a thin fringe of only 10 mm (Figure 4, centre), which is not commonly seen in this technique, since it tends to be much wider. The intense brachycephaly of this cranium creates a very curved parietal area, which explains this peculiar feature. The same explanation can be used for the trepanation another cranium found close to Roda de Ter (Figure 2 & 3 right).

Statistical Test

It is possible to establish if the practice of trepanation is related to the group of short and wide heads in the Solsona area in the Bronze Age (Figure 2), in the set of 146 Catalan Bronze

Age crania [11]. Given that the χ 2 test is not advisable due to the very low frequencies between the trepanned subjects (Table 1), the P values were computed using Fisher's Exact Test [15]. This test considers all possible cell combinations that would result in the marginal frequencies and computes the probability of a 2x2 contingency table using hyper-geometric distribution. The result is statistically significant, P value = 0.0038, or, expressed in a different manner, a probability of between 262 that the Catalan Bronze Age brachycephalics of Solsona included in this frame are not related to trepanation. This test did not use the trepanned cranium of Cova de l'Heura (Figure 2) since the total number of non-trepanned crania is unknown. However, if we include it, the above conclusions remain unchanged: P value = 0.006505, or a probability of between 153. Obviously, the link between brachy craniums and trepanation is a cultural coincidence.

Table 1: Fisher's exact test for a 2 x 2 table. Bronze Age skulls from Catalonia.

	Brachycranium	Not Brachycranium	Total
trepanned	5	4	9
not trepanned	17	120	137
total	22	124	146

Trepanation and Pain

Trepanation is no more painful than any other perforating or cutting wound in any other part of the body, since no pain is felt in the bone, meninges or brain. The scalp bleeds profusely, with the exception of the temporal and facial arteries, the bleeding can be stopped with effective compression or a horizontal tourniquet above the ears, by cauterising or applying powdered substances. The utensils used were usually sharp stones such as flint or obsidian. Complications were many and varied in type and severity, such as haemorrhaging, neurological lesions, infections and bone necrosis. In 4000 BCE, the Sumerians used the poppy (*Papaver somniferum*). Its fame comes from its high contents in alkaloids obtained from the sap that exudes from cuts made to the bud, which is used to make opium and other derivatives. This is the first historical reference made to the use of opium. Frequent use was made in Babylonian medicine of opium, mandrake, cannabis (*Cannabis sativa*), beer and wine. The civilisations of ancient Egypt (1000-1500 B.C.) began to use plant narcotics, such as poppy, cannabis, and mandrake (*Mandragora autumnalis*), a species of phanerogam that belongs to the Solanaceae family and was extensively used in Europe for medicinal purposes. The Hearst Papyrus mentions that these plants were cultivated in India and Persia. The Ebers Papyrus (1550 BC) describes in great detail the use of opium as a treatment for headaches. Some Babylonian cylinders and Mesopotamian bas-reliefs show the heads of *Papaver somniferum*, both for anaesthetic and recreational ends. Hippocrates used a soporific sponge with a mixture of opium, mandrake and henbane (of the Belladona family). Alcohol, marihuana and extreme cold have also traditionally been used in surgery.

Disclosure statement

The author reports no conflict of interest.

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