Evidence of trepanations in a medieval population (13th–14th century) of northern Spain (Gormaz, Soria)

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Abstract The goal of this study is to describe briefly two trepanned cranial specimens from a Spanish medieval archaeological site. One of them belongs to a mature male in which a grooving trepanation technique was used. The other is a mature female skull in which a scraping procedure was performed. The historical context of the individuals is assessed, as well as characteristics from both trepanations and evidence of survival after the intervention. In the female skull, signs of osseous regeneration can be observed, which imply survival after the operation. No survival signs can be found in the male skull. Possible causes that could have motivated the intervention are also discussed.

Key words: Trepanation, grooving, scraping, mediaeval, Spain

Introduction

Trepanation is the removal of part of the calvarium by sharp instruments, and is considered one of the oldest examples of surgical procedures: there is evidence of trepanation from as far back as prehistory, and some primitive communities still perform this procedure (Aufderheide, 1985; Blos, 2003; Ellis, 2009). The carving of a hole in the skull vault exposes the inner cranium to the outside environment, and survival of this procedure depends on avoiding damage to the meninges, brain and blood vessels (Lisowski, 1967; Aufderheide et al., 1998).

Trepanations in time and space

Reported cases of trepanation have been found to belong to a very wide spectrum of ages, from prehistory to the present day (Jensen and Stone, 1997; Gross, 1999, 2003). The earliest evidence of this neurosurgical practice is a trepanned skull that dates back to 10000 BCE at the beginning of the Neolithic period (Gerszten et al., 1998; Piek et al., 1999; Kshettry et al., 2007), although some authors suggest that there were cases in Mesolithic times (Verano, 2003). These first trepanations are a 'primitive' form of surgery that can also be observed today among certain extant groups such as the Kisii from Kenya, or Polynesian islanders (Ackerknecht, 1947; Margetts, 1967; Alt et al., 1997; Verano and Andrushko, 2010). The earliest of which dated between 200 BCE and 400 AD and came from the burial site of Paracas (Verano, 2008; Redfern, 2010). However, the frequency of trepanations is higher in certain parts of the world, notably South America: Peru is recognized as a major source of ancient trepanned crania (Campillo, 1984; Verano and Finger, 2009; Verano and Andrushko, 2010), the earliest of which was dated to between 200 BCE and 400 AD and came from the burial site of Paracas (Verano, 2003). These first trepanations were a 'primitive' form of surgery that can also be observed today among certain extant groups such as the Kisii from Kenya, or Polynesian islanders (Ackerknecht, 1947; Margetts, 1967; Campillo, 1984; Sheehan et al., 2005; Qureshi and Olouch-Olunya, 2010). Although not the first reported example, the first case of cranial trepanation clearly identified, correctly interpreted and eventually generally accepted was the pre-Columbian Peruvian skull studied by the French surgeon and anthropologist Paul Pierre Broca (1867). This skull, which came from an Incan individual, presented a cranial opening that Broca described as a form of primitive surgical procedure. He also hypothesized that this procedure was not carried out postmortem, and even that the individual had survived for at least a few weeks after the surgery. These claims were originally controversial and not immediately accepted, though this case of ancient trepanation eventually became a milestone in the history of medicine (see Finger and Fernando, 2001, for a review).

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In Europe, although there are sporadic cases from the Mesolithic (c. 9000–5000 BCE), as for example the Portuguese skull of Concheiro da Moita do Sebastião (Crubézy et al., 2001), the oldest well-known cases indicate that the trepanation of skulls became usual in the Neolithic period (c. 4500–1800 BCE) or at the beginning of the Bronze Age (c. 1800–850 BCE), especially throughout the Mediterranean basin (Dastugue, 1973; Campillo, 1984; Herskovitz, 1987; Jackes et al., 1997; Bennike, 2003). The first trepanned European skull was found in 1685 by Bernard de Montfauchon in Cocherel, France (Finger, 1994; Clower and Finger, 2001). Since this discovery, more findings have been reported by anthropologists of nearly all European countries: Germany, France, Spain, Portugal, the Czech Republic, Scotland, Denmark, Austria, Poland, Italy, England, Russia and Sweden (Kshettry et al., 2007).

Regarding the Iberian peninsula, most trepanned skulls belong to the Chalcolithic Period (c. 2500–1700 BCE) and the majority of those come from the regions adjacent to the Mediterranean basin (82% of the published cases; 114/139). Among them, the Balearic Islands occupy a prominent place with the greater number of cases, while in Catalonia and Valencia several ancient examples have been also found (Campillo, 1977, 2007). Specifically in Spain, trepanations have been found in other regions such as Murcia, Andalucía, the Basque Country, Madrid, etc., even though all of these account for only 6% of total cases (8/127). Survival signs were found in 75% of published Spanish trepanned skulls (95/127; Campillo, 2007). There are no significant differences in terms of technique, cranial location, age and sex of the individuals between the characteristics of trepanations performed in the Iberian peninsula and those found in other European regions (Campillo, 1984; Roberts and McKinley, 2003).

It is worth noting that, in contrast with the rich history of trepanations in ancient times, medieval surgical trepanations are much less common and only a few cases are known for the whole of Europe (Holck, 2008). One of these cases comes from Spain, and was described in the skull of the Spanish Burgundy King Henry I of Castille, who died from an accidental blow to his head at the age of 13 (Vara-Lopez, 1949; Arco y Garay, 1954). Despite this scarcity of findings, trepanation is described as a procedure that was commonly performed in the Iberian peninsula and those found in other European regions (Campillo, 1984; Roberts and McKinley, 2003).

Trepanation procedures
To perform a trepanation, the first step is to remove the soft tissue at the surgical point, exposing the skull cap. After that, a piece of the calvarium has to be removed. Different techniques and surgical tools can be used, but damage to the underlying blood vessels, meninges and brain has to be carefully avoided (Han and Chen, 2007).

In reported cases, the burr holes are preferentially located on the left side parietal of the skull, which is the most convenient location for a right-handed practitioner (trepanner) and a common place for injuries caused by fighting with right-handed opponents. Although several varieties of trepanation technique can be distinguished, all of them can be grouped into three general procedures (Campillo, 1984; Außerheide et al., 1998): grooving, scraping and incising (boring and cutting). All of them have in common that the cortical hole in the outer table is bigger than the one in the inner table of the skull. Different trepanation procedures have been found in the same archaeological sites, which complicates the linking of these procedures to specific cultural environments or purposes (Campillo, 2007).

- **Grooving.** Grooving is the most frequently used trepanation technique in Europe and probably the easier to perform. It involves drilling the bone with a sharp and hard stone or a metallic element (groove), by half turns or full turns, repeatedly drawing and redrawing the groove while pressure is exerted. This creates a hole of troncoconical shape and circular outline (Campillo, 2007). Although a hard sharp stone is sufficient for this technique, there is evidence from Roman and medieval times that other devices such as drills or crown saws (modiolus) were also used (Kirkup, 2006).

- **Scraping.** Scraping is the oldest trepanning technique (Weber and Wahl, 2006) and the most successful regarding survival rates. It takes advantage of the cranial curvature, and consists in thrusting with a forward and backward movement on the bone surface, until the vault wears away and perforation is complete. Results appear as small ellipsoidal or round orifices, surrounded with ample eroded surfaces (Campillo, 2007). For this procedure a granulated or glassy multifaceted stone is enough, but more advanced instruments such as scrapers (raspatories) were also used when available (Kirkup, 2006).

- **Boring and cutting.** This method has been scarcely used in Europe, though is the most common technique found in South America (Verano, 2003). It uses a pointed tool to perform circular trepanations or a knife to perform rectilinear trepanations (by making perpendicular cuts in the skull). As a result, the hole, usually with serrated edges, may have different polygonal or circular shapes, although the most usual is a square or rectangle (Priorešchi, 1996; Campillo, 2007).

In Europe, a sex bias has been observed in trepanation techniques: the grooving technique is more common than the others in male individuals, while the scraping technique was the most used in female individuals (Campillo, 2007). Female cases of trepanation have been found even in very ancient times (see Priorešchi, 1996), but are uncommon, as this procedure seems to have been predominantly carried out on adult males (Piggott, 1940; Campillo, 1984; Jennert, 1991). Examples of trepanned children skulls are also very rare (Jordanov et al., 1988; Verano, 2003; Andrushko and Verano, 2008) and some authors have proposed that this probably reflects (i) the lower childhood frequency of the susceptible disorders that were treated by cranial surgery; (ii) an uneven conservancy of fragile skeletal remains; or (iii) a reluctance of ancient physicians to expose children to potentially life-threatening surgical techniques (Mariani-Costantini et al., 2000).

All these procedures were first carried out using stone...
tools and without any anaesthetic, but as neither the bone nor brain have pain receptors (Kandel et al., 2000; Hong et al., 2010), the practice itself should not have been particularly traumatic or painful after the scalp and soft tissue had been pierced. This is, in fact, the basis of ‘awake’ brain surgery, which is regularly used in hospitals worldwide (Whittle et al., 2005). In any case, it has been proposed that sleep could have been induced in people who would be trepanation subjects by making them ingest large amounts of wine (Keller, 1966; Nemes, 2002). Another anaesthetic method could have involved the use of extracts from plants, such as coca (Erythroxylum coca), which might have been used by ancient South American surgeons (Vogel, 1970). Findings such as ‘Otzi the Iceman’ give indirect support to this theory, as they show that people from the Chalcolithic had knowledge about the use of certain mushrooms as antibiotic medicine (Capasso, 1998). In Europe, during the Middle Ages, the anaesthetic properties of poppy (Papaver somniferum), which contains morphine as its main alkaloid) and nightshades (the family Solanaceae, which contain solanine) were also well known, and may have been used in these procedures (Priorscchi, 2003; Sabatowski et al., 2004). Furthermore, in southern Spain, evidence of the use of Papaver somniferum by Neolithic individuals has been found at the site of Cueva de los Murcielagos in the province of Granada (Merlin, 2003). The poppy capsules recovered from this site pre-date the findings of the Eastern Mediterranean by more than two millennia, and give a more complete picture of the extension of drug use in ancient societies (Chouvy, 2009).

Throughout the history of trepanation, percentages of mortality vary greatly (Priorscchi, 1996; Campillo, 2007). In medieval times, as in Roman times, mortality was very high, probably due to infections (Weber and Czarnetzki, 2001b). Risk of infection was caused by the trepans used to drill the cranium, which were made of metal and washed between interventions, turning them into potential carriers of bacteria. In former times, when trepanns were made of stone, survival was higher and the risk of infection lower. Three motives have been given to explain this fact: shorter duration of the intervention (Weber and Wahl, 2006), smaller size of lesions (Campillo, 1984; Weber and Czarnetzki, 2001a) and the choice of surgical tool—freshly knapped flint has been shown to serve as a sterile surgical instrument (Piek et al., 1999). Of course, the skill of the surgeon regarding the protection of the dura mater is also a major factor, because if the dura mater remains intact, lethal infections rarely occur (Weber and Wahl, 2006). This was not unknown by ancient practitioners, as is evidenced by the finding of dural separators (meningophyaxes) in Roman archeological sites (Kirkup, 2006). These instruments were used solely for protecting the dura mater during cranial surgery, avoiding the appearance of complications such as meningitis or brain abscesses (Tullo, 2010).

Regarding the healing of trepanations, some details are known about South American societies, in which plants were widely used throughout the pre-Columbian period to treat fractures and infections (Thieme-Sachse, 2000). Specifically, it is known that ancient Peruvian trepanners used the bark of the calabash tree (Crescentia cujete) and a poultice of leaves and saliva to cover the hole left by the surgery, which promoted scarring and prevented infections (Mignone et al., 2004). In Spain there are no precise details about these procedures, but there is a long-standing story of traditional healing being commonly practised, and while most of it was dedicated to respiratory diseases, plant-based treatments for injuries and fractures were also known (Raja et al., 1997).

The aim of the current study is to report and describe two cases of trepanations discovered in a medieval necropolis from northern Spain. As has been stated before, both this particular location and dating are unusual for a trepanation case. Another particular feature of our cases is that one of the trepanations was performed in a woman, while the other could have been carried out postmortem.

**Material and Methods**

**Historical reference and location of the necropolis**

The skeletal remains used in this study were recovered during the archaeological excavation campaign which took place in the year 2000 inside the surroundings of the San Miguel hermitage. San Miguel is located on the bank of the Duero River (Figure 1), and belongs to Gormaz, a village of the province of Soria (Spain). This particular region had much strategic importance during the war of the Reconquista, in which the Islamic government of Caliph Al-Hakam II built Gormaz Castle over the remains of a previous Roman or pre-Roman fortress (Layna, 2004) (Figure 2). The location of this fortress allowed it to command the river valley, the mountains and natural accesses to the plateau (Escorza, 2007). Thus, Gormaz Castle played a key role in the war, and was taken and retaken numerous times during its course, until it finally passed into Christian hands due to the efforts of Fernando I, King of Leon. When the war was nearly over, from the 15th century on, the castle became a military prison (Castellanos, 1999). All these facts, combined with the natural richness of the environment, resulted in human occupation

![Figure 1. Map of Spain showing the location of the San Miguel hermitage in the village of Gormaz (Soria, Spain), which is located at the Duero River bank.](image-url)
of the zone reaching its peak during the 10th century (Heras et al., 2008).

The San Miguel hermitage (Figure 3) is located at the foot of the hill in which the castle is located; its precise geographic coordinates are 42°29′31″N and 3°00′28″W (IGME, 1991). The origins of this hermitage are a pre-Romanesque church, which was later reconstructed in the Romanesque style. No data exist on the exact dates of construction or reconstruction of the temple, but it is known that the people exhumed in the porch of the sanctuary can be chronologically ascribed to the 13th–14th centuries and to the Gormaz Christian population settlement (Heras et al., 2008).

Description and dating of the remains

During the excavation campaigns carried out in San Miguel, numerous burials were found in the outskirts of the nave. All of them were near the walls, and most were clustered in the southern sector of the temple. This area holds the main entrances and the porch, construction of which was completed in the 12th century. Up to 36 different tombs, superimposed in two levels, were documented here. The lower level of the tombs is occupied with anthropomorphic structures carved directly in the rock and covered with limestone slabs. In the upper level the tombs were directly built from these slabs (Balado et al., 2008).

Even through the total number of tombs was 36, the total number of buried individuals in this area is much greater, evidence of widespread reuse of available space. A previous study by two of us (Caro and Lopez, 2003) identified 154 individuals in this sector. This exhaustive use can be explained noting the proximity of this sector to the sacred space of the church, which was usually coveted as a burial ground in medieval Christian societies (Schulenberg, 2005).

Existing evidence can help dating the period of use of the cemetery. First of all, all of the tombs were clearly built after the construction of the porch, as their location is adequate to the space left available by the construction works. In no case were the foundations affected or any tomb broken, and therefore the initiation of burials can be dated to no earlier than the first half of the 11th century.

The second piece of evidence comes from the numismatics of the coins which sometimes accompanied buried individuals. The presence of these coins could be due to an ancient custom commonly called ‘Charon’s Obol,’ which consisted of placing money on the body of a dead person so that his or her soul could pay for the journey to the afterlife (Grinsell, 1957). This custom was most probably derived from classical Greek and Roman religious practices, and as such it spread throughout Europe during the Roman Empire (Stevens, 1991). A total of 16 coins were found, most of them carried in the hands of individuals. 14 of these coins could be assigned to a certain time period due to their imagery, and they correspond to the reigns of Alfonso X (1252–1284), Ferdinand IV (1295–1312), Alfonso XI (1312–1350)
and Henry II (1369–1379). The chronology of these coins gives us an approximate dating for the burials that goes from the second half of the 13th century to the second half of the 14th century (Balado et al., 2008).

Figure 4 shows the trial excavation number 14 (which affects the entire portico of the chapel) and indicates the location where the two trepanned individuals were discovered. After the archaeological excavations and recovery of the remains, these were moved to the provincial museum of Soria for subsequent transport to the Laboratory of Physical Anthropology of the University of León.

**Analysis of the human remains**

Biological sex determination was based on methods which relied on classical morphological parameters of sexual dimorphism, such as morphological features of the pelvis, i.e. the subpubic concavity, the ventral arc and paeuicular sulcus presence, the thickness of the ischiopubic ramus and the greater sciatic notch shape of the pelvis bone (Ferembach et al., 1979; Buikstra and Ubelaker, 1994). In addition, the morphological cranial characteristics of the skull, such as the robusticity of the nuchal crest, the size of the mastoid process, the sharpness of the supraorbital margin, the prominence of glabella and the projection of the mental eminence, were also used (Buikstra and Ubelaker, 1994). The assessment of age-at-death was determined on the principal macroscopic changes of the pelvis with the following criteria: metamorphosis of the pubic symphysis (Lovejoy et al., 1985a, b; Meindl et al., 1985), changes of the auricular surface of the ilium (Brooks and Suchey, 1990; Buikstra and Ubelaker, 1994), and stages of tooth attrition (Lovejoy, 1985; Hillson, 1996).

**Results and Discussion**

Among the remains exhumed from the porch of the Church of San Miguel de Gormaz, we have described the presence of two particular examples of cranial medieval trepanation.

The first specimen belongs to a mature adult male aged between 50 and 55 years (SO/GZ/00/UE 1484 II), which unfortunately lacks his mandible and the entire postcranial skeleton, although the skull is complete except for a part of the right parietal (Figure 5, Figure 6). A complete trepanation is present almost in the center of the left parietal. The trepanation opening has a rounded conical shape hole with asymmetrical sloping edges. This is a clear example of the application of a grooving technique by continuous rotation of the tip of the trepan. The edges of the lesion are slightly angled and its dimensions on the intracranial surface are 10.2 mm × 11.1 mm, while on the ectocranial surface the lesion is 15.2 mm × 16 mm in size. The cut-out piece of the cranium (rondelle), probably cone-shaped, is not among the rest of the bones. This trepanation does not show any evidences of healing, the spongy diploë being open and visible in all sides of the perforation (Figure 7). In addition, there is absence of bone regrowth at the edges of the incision, indicating that the lesion did not undergo any scarring process.

Our first impression was to think that the person had died after the surgery. It remains unclear how long the individual survived after the operation and it is even uncertain if the individual stayed alive during the procedure. Possible marks of healing after the cutting are nearly absent, and in any case too blurry to investigate macroscopically. No evidence of an inflammatory reaction can be found either. Thus, the survival period may be considered to have been relatively short.
or death could even have happened during the surgical procedure. In our case, as is usual with archaeological specimens, it is not possible to distinguish between each of these situations and neither it is possible to be certain that the trepanation could not have been performed postmortem (Ubelaker and Adams, 1995; Ortner, 2003). Moreover, as no pathological signs to justify a trepanation can be found, this further suggests that the operation could have been conducted postmortem and thus a ritual intervention after death cannot be discarded. These kinds of ritual intervention are not uncommon, and sometimes had the purpose of obtaining rondelles or bone powder for use in healing potions or as magical amulets (Lisowski, 1967; Facchini et al., 2003). Finally, there are several fissures next to the trepanation, but as no vital reaction signs can be appreciated and their borders have an irregular shape, they are most probably postmortem (Aufderheide et al., 1998; Botella et al., 2000).

The second case is a trepanation which was performed on a female aged between 45 and 50 years (SO/GZ/00/T 54 VI), which already makes it an interesting example, since trepanations in women appear to be infrequent and therefore there are fewer examples cited in the literature. In fact, Campillo (2007) points out that only 10% of trepanned skulls coming from Spain have been identified as females (13/127). Unlike the previous male, in this case the female was represented by not only the skull, but also the mandible and most of the bones of the postcranial skeleton.

The cranium of this female is remarkably well preserved,
and shows an intentional perforation that, as in the previous case, also took place in the left parietal bone. The affected region here is the posterior quadrant, approximately 15 mm from the sagittal suture (Figure 8, Figure 9). The skull was trepanned using the scraping technique, and while this is clear enough in our case, it should be noted that these kind of trepanations could be problematic to diagnose, as they can be confused with other pathological conditions (Kaufman et al., 1997).

The border of the rounded hole has ectocranial dimensions of $35.8 \times 39.2$ mm and presents clear signs of regeneration. All the diploë is obliterated, indicating that, contrary to the male case, the subject survived the operation. On the exocranial surface a thin and smooth border of newly formed bone can be found around the margins of the burr hole, indicating a hyperostotic reaction at the line of the perforation. The newly formed bone extends more than 10 mm in all directions to the center of the hole (Figure 10). The apparently advanced scarring process suggests that the woman recovered from the surgery and lived for some time afterwards. Bone regeneration in the skull bones has for long been known to be much slower than in long bones (Schmitz and Hollinger, 1986). Furthermore, there are records of cases from before the routine use of bone-graft therapy in which incomplete closure was observed even 15 years after a trepanation (Brenizer, 1916). This suggests that the woman could have lived for a long time after the trepanation was performed, but the precise duration of survival cannot be inferred.

In this case, we can rule out a postmortem ritual as the cause of the trepanation, but, again, there is no evidence in the skeleton that can help us to elucidate a precise motive for the procedure. This is an important matter that usually remains unanswered in most archaeological trepanation cases (Tullo, 2010). In the first discussions about archaeological trepanations, Broca attributed them mainly to religious belief, proposing that trepanation could free the body of a sick person of the devils that were torturing him (Clower and Finger, 2001; Finger and Fernando, 2001). Horsley, who was a surgeon and a contemporary of Broca, considered that trepanations could be related to the treatment of convulsions caused by cranial traumas, as holes were not randomly distributed, but located on top of the primary motor cortex (Finger and Clower, 2001). Thus, the practice of trepanation would be a therapy for epilepsy, headaches and trauma, and not (though it cannot be excluded) a purely magico-religious
practice (Clower and Finger, 2001; Finger and Fernando, 2001). This is precisely the case in South America, particularly in Peru, where the majority of archaeological trepanations can be associated with cranial trauma (Prioreschi, 1996; Verano, 2003). Following this view, it has been proposed that in ancient times, prehistoric men may have decided to treat head lesions after observing that they could involve the development of mental disorders such as loss of consciousness, memory corruption, convulsions and even changes in behavior (Finger, 1994). Several authors also consider this as a plausible hypothesis (see Walker, 2001; Liu and Apuzzo, 2003; Andrushko and Verano, 2008), even though the absence of written testimonies from these times makes it impossible to determine the knowledge that these cultures had about the brain and its mental functions.

However, there are many cases, and ours is one example of them, in which the skull shows no obvious evidence of injury. Several possibilities have been suggested to explaining why trepanation was performed; these can be summarized as follows:

1. Therapeutic intention due to the neurosurgical needs of the patient. While the most frequent reason would have been the relief of intracranial pressure after a skull fracture, there are other intracranial and psychiatric disorders that could have been treated with a trepanation. These would not be always identifiable in skeletal material, and they range from cranial or brain tumours to headaches, vertigo, neuralgia, meningitis, convulsions and epilepsy (Asenjo, 1963; Campillo, 1984).

2. Customary or ritual reasons due to magico-religious beliefs (Aufderheide, 1985). In Europe, an example of these is found in the numerous cases of removal of a so-called ‘Stone of Madness’ (Harris, 2004, Holck, 2008), which was considered a valid treatment for mental illnesses. The attempt to confer mystical powers on trepanation has also been described in some cases (Carod-Artal and Vázquez-Cabrera, 2004; Campillo, 2007). While ritualistic procedures seem to be more common in certain cultural contexts such as Eastern Europe (Marczik et al., 2002), they have been sporadically found in other regions in the same archaeological contexts than supposed therapeutic trepanations (Facchini et al., 2003; Roberts and McKinley, 2003).

This latter possibility is interesting when combined with the circumstance that the coins found in this necropolis could also have had a ritual origin, as persistence of pagan beliefs and syncretism in medieval Christian societies has been known for a long time (Ariès, 1974; Edwards, 1988; Watkins, 2004). Furthermore, the custom of leaving coins as a ‘Charon’s Obol’ has been observed in Spanish necropoles even after the 16th century (Hopkinson et al., 2008). These facts raise questions about the survival of pagan ritual practices in a Christian society in which there was a great influence of the ecclesiastical hierarchy in everyday customs (see Lorenzo, 2008 for other examples). In any case, the ritual meaning of the intervention would be more probable in our male case, as available evidence cannot discount that his operation could have taken place after death.
Conclusions

In both cases mentioned above, the general aspect of the skull and the clear morphology of the two cranial openings allow us to classify these as ‘trepanations’ (Kaufman et al., 1997). First, none of the individuals present signs of previous skull injury or trauma that could have promoted these openings. Other circumstances such as nectrotic areas secondary to infectious processes, e.g. mycoses, syphilis or tuberculosis, present a more irregular form than the ones found here (Hackett, 1976; Campillo, 1977; Brothwell, 1981).

Congenital origins can be discarded for the same reason, and also because these lesions usually appear in characteristic locations (Kaufman et al., 1997). Diseases like metastatic carcinoma or other kinds of bone neoplasm (like a simple benign tumor) are also not plausible explanations because carcinomas present complex irregularity and multiplicity with varying size and ill-defined margins, while benign tumors present synostoses and only uncommonly produce holes in the skull (Campillo, 1977).

Also, holes produced by carcinomas are usually less than 5 mm in diameter and tend to be confined to the diploë (Taveras and Wood, 1964). Finally, taphonomical processes (intervention of animals, plants or chemical soil products) or damage due to the archaeological intervention can also be ruled out. Furthermore, the shape of the holes can be clearly explained by referring to common trepanation techniques and instruments. In addition, there are signs of scarring and postsurgical survival in the female individual.

Thus, as an intentional operation is the only valid explanation for the appearance of these holes, something would have had to motivate the procedure. However, this motive has not left any traces in the available bones or archaeological context, and therefore no conclusions can be drawn in this respect. Nevertheless, it can be said that if the male individual had suffered a fracture significant enough to motivate the trepanation, the small dimensions of the trepanation hole would have left at least a part of the fracture visible. The same cannot be said in the female case, in which the trepanation hole is big enough and does not permit us to discount this hypothesis. Alternative explanations such as pathologies that do not leave traces in the bone or even magical or ritual practices are also possibilities, but they cannot be corroborated with the existing evidence.

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