



## **A TREPHINED LATE BRONZE AGE SKULL FROM PELOPONNESUS, GREECE**

**C. Mountrakis<sup>1</sup>, S. Georgaki<sup>2</sup> & S.K. Manolis<sup>1</sup>**

*<sup>1</sup>Department of Animal & Human Physiology, Faculty of Biology, National & Kapodistrian University of Athens, Panepistimiopolis 157 84, Athens, Greece.*

*E-mails: c.mountrakis@gmail.com; smanol@biol.uoa.gr*

*<sup>2</sup>Department of Radiology, General Hospital of Corinth, 211 00 Corinth, Greece*

*E-mail: tgeorgaki@hospkorinthos.gr*

**Received: 24/01/2010**

**Accepted: 08/06/2010**

*Corresponding author: smanol@biol.uoa.gr*

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### **ABSTRACT**

Cranial trepanation is one of the most ancient surgical operations. This kind of "operation" has been reported in prehistoric Greece with several specific case studies. In this paper, a significant case of trepanation, on a male skull, dated to the Late Bronze Age, is presented. Our interest was pointed firstly to the verification of the technique, secondly the description of the trepanation's shape and finally to the surgical procedure. A series of imaging techniques were implemented including X-ray diffraction and CT scan imaging. The observations of the skull support our statement as to the nature of the trepanation. This specimen represents one of the earlier confirmed cases of trepanation in Greece. We also discuss when and how this technique came to Greece.

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**KEYWORDS:** Trepanation, Trauma, Paleopathology, Aegean populations, Greece

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## INTRODUCTION

Cranial trepanation, or the surgical removal of a portion of the skull, is a phenomenon which has been widely studied, as specimens which exhibit trepanning offer researchers insight into aspects of the behaviour and health of past populations. The term “trepanation” derives from the Greek word “trypanon” which means “drill”.

The significance of this procedure is exemplified by its widespread and diachronic application. Trepanations have been well documented and rigorously studied in Europe (Baggieri and Di Giacomo 2003; Holck 2008, Mariani-Costantini, et al, 2000; Mays, 2006; Mckinley, 1992; Powers, 2005; Rubini, 2008), Asia (Han & Chen 2007), North (Richards, 1995) and South America (Andrushko & Verano, 2008; Nystrom, 2007), as the practice appears to have been widespread in some cultures, such as that of the Incan Empire, which has garnered a great deal of attention in the literature.

Furthermore, it is of interest to note that the practice of trepanation remained in use from the Neolithic (Mallegni & Valasina, 1996; Weber & Wahl, 2006) until well into the European Middle Ages (Mays, 2006; Holck 2008; Rubini, 2008; Mckinley 1992; Mays, 2006; Powers, 2005).

Specifically for the Aegean region, trepanation has been discussed, to a lesser degree comparative to other regions, and primarily by researchers in the field of the history of medicine (Grmek, 1989; Arnott, 1997; Panourgias et al., 2005; Missios, 2007).

Anthropological examinations of such cases exist but are limited in number. Five cases of trepanation have been documented by Charles (1958) at Argos. Two skulls are dated to the Late Bronze Age era and the rest three are dated to the Geometric period. It is worth mentioning that these skulls have small circular holes on them possibly made with a sharp drill.

From the study of the skeletal material found in the Middle Bronze Age graves at Asine, Lerna and Mycenae (Grave Circles A, B), L. J. Angel identified five cases of trepanation, mostly performed on the parietal and frontal regions of the cranium (and occasionally on the occipital) (Angel, 1971, 1973, 1982), by using the scraping technique.

Manolis et al (1995) presented the findings on a skull from Delphi (dated to the Middle Bronze Age period, approximately 1700-1750 BC) which displays on the right parietal bone (in the middle of the squamosal suture) a “tear-drop” shaped trepanation of medium size, made also by the scraping technique. The operation was performed whilst the patient was alive; and he survived, since at the edges of the aperture were observed traces of osseous regeneration.

More recently Agelarakis (2006) and Liston (2009) have reported two trepanations dated to 7<sup>th</sup> century B.C. (Abdera) and 8<sup>th</sup> Century B.C. (Kavousi, Crete) respectively. However, there is another skull with trepanation which was unearthed from the village of Terpsithea (near the Pineios river, Thessaly), but its age is unknown, and we are waiting for the results of the radiocarbon dating. This paper presents a case study of a Late Bronze Age skull from the Agia Triada cemetery in North-West Peloponnesus (Ilia), which exhibits a cranial lesion that is consistent with intentional trepanation. Furthermore, we explore the introduction and early character of this behaviour in the Greek peninsula.

## MATERIALS & METHODS

*The Archaeological site:* The Mycenaean era cemetery of Agia Triada is located in the mountainous north-eastern region of Ilia, bordering the Achaia prefecture in north-eastern Peloponnesus (Figure 1). The site is situated on a large expanse on the summit of a foothill which stands over the banks of the Peinios River. It spreads through two localities, Agiannis and the Paleoboukouvina caverns. The cemetery was discovered in 1988 and includes approximately 50 chamber tombs which are dated to the Late Helladic III A-C period (1400-1060 B.C.) The graves are carved out of the hard porous stone and consist of a walkway (dromos), façade, and chamber. Burial pits and secondary burials were found in the interior of the tombs.

In the Agiannis locality, which represents the largest subsite of the cemetery, the tombs were ordered in four rows. Three of these rows, which consisted of a total of 35 tombs, have a N-S orientation, while the fourth row, which

consists of 5 tombs, is characterized by an E-W orientation, with their walkways located on the eastern side.

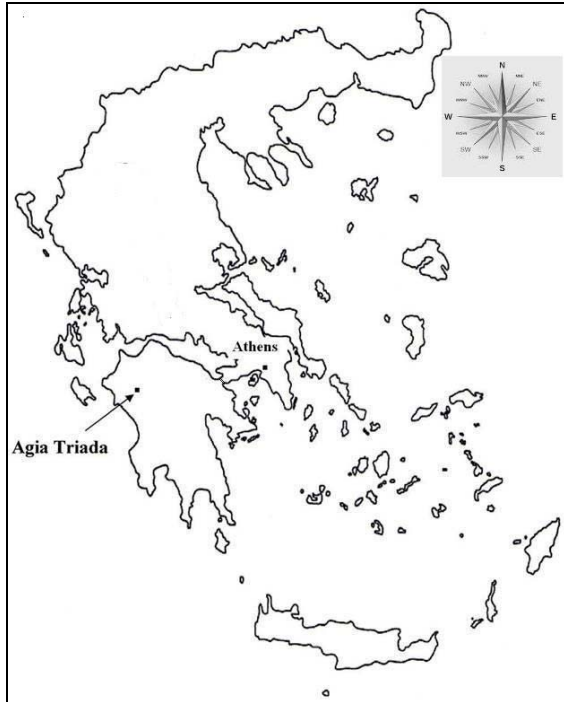


Figure 1. Map of Greece. The site of Agia Triada cemetery (Ilia) is indicated.

The tomb walkways have a mean length of 6-8 m. and a mean width of 1-2 m. The majority of these walkways exhibit a slight downhill incline toward the entrance with walls slope inward and converge overhead. In some of the walkways there are openings on the side walls or small pits in the ground which contained skeletal remains from burials secondary burials.

The minimum number of individuals exhumed from the cemetery is approximated currently at 350, as the study of the skeletal remains is underway. Each tomb contained from three to 28 individuals. There are significant differences in the varieties and significance of grave goods observed between the central and peripheral tombs, which may be a reflection of the social stratification of the settlement. These observations indicate the existence of a significant Mycenaean settlement in the area (Vikatou, 1999).

*Description of the skull:* The specimen under study is an incomplete skull (No of catalogue 2/154-26) dated to the Late Bronze Age, and was exhumed from Tomb 2. A MNI of 14 was calculated for this tomb, making it one of the larger aggregates, with the remains of all individuals

commingled, with most post-cranial remains in a poor state of preservation. It is therefore not possible to associate any postcranial remains with the trepanned incomplete skull. However it should be noted that the remains were assessed for pathologies and none of note were found among the individuals of this tomb. Of the 14 individuals, one was identified as a juvenile, while of the 13 adults, only 2 males and 4 female have been identified. (Table 1)

Table 1. The demographic analysis of the Grave 2

Sex	Age				Total
	Adult	Known Age	Sub-adult	Unknown	
Male	1	1 (<50yrs)	0	0	2
Female	4	0	0	0	4
Sub-adult	0	0	1	0	1
Unknown	0	1	0	6	7
					14

The skull in question is incomplete, as the splanchnocranium has not been preserved, while the calvaria is intact. The frontal bone includes the superior portions of the superciliary arches, while the temporal, parietal, and occipital bones are intact. Based on the robustness of the mastoid process and nuchal bun, the biological sex of the specimen has been determined as probably male, although it cannot be associated with post-cranial remains in order to verify this. While the specimen is obviously an adult, a more accurate age estimation is impossible, although there appears to be some suture fusion. This is because there are some areas of erosion on the ectocranial surface.



Figure 2. The skull of Agia Triada cemetery (Ilia) with the trepanation

The trepanation lesion is located on the antero-superior surface of the right parietal bordering the coronal suture, and its dimensions are 32.53mm (horizontal axis) x 25.37mm (vertical axis). The bone immediately surrounding the trepanation lesion is characterized by linear marking perpendicular to the lesion which is consistent with the scraping technique (Figure 3). Two post-mortem fractures extend posteriorly (A. 64.41mm, B. 16.20 mm, C. 16.20mm- and one anteriorly from the trauma. All of the fractures are complete, extending through the parietal bone cross-sectionally. A second, smaller lesion located medio-posteriorly to the trepanation was verified as postmortem damage.



**Figure 3.** Close up of the trepanation. The arrows indicate the width and the height of the lesion

*Imaging Method:* The antiquity of the specimen makes macroscopic examination of the intentionality of the lesion challenging (Quatrehomme & Iscan, 1997; Chege et al, 1996).

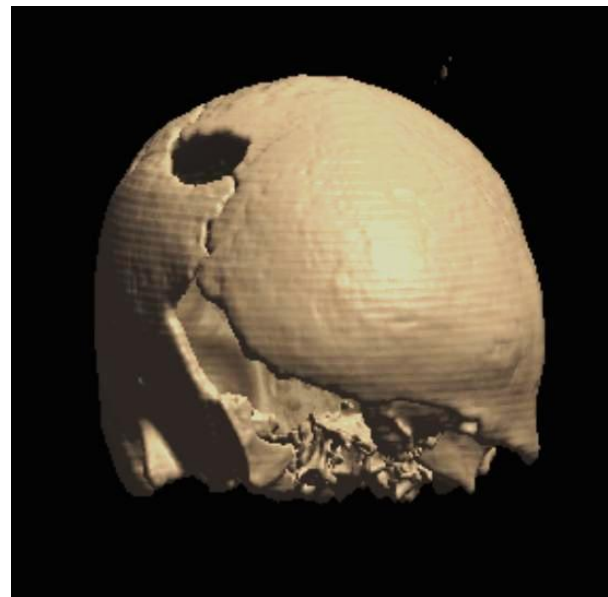
Therefore, to better display the full geometry of the trauma, and in order to fully assess its nature, a series of imaging techniques were implemented which included X-ray diffraction (Figure 4) and CT scan imaging (Figures 5 and 6).

Collaborating with the Department of Radiology in the General Hospital of Corinth a full virtual 3D model of the calvaria was created. The protocol developed to achieve this goal utilized Computed Tomography (CT) Scans from the skull. The calvaria was placed on a foam support base with the frontal bone of the cranium facing up. The slice thickness was set to 1mm. The axial 2D slices taken were then

elaborated in order to create coronal 2D images and a full 3D model. The Scanner used was a Single Slice Scanner CT AURA.



**Figure 4.** Photograph of the X-ray diffraction of the trepanned skull



**Figure 5.** 3-D reconstruction of the Agia Triada skull (1:2 ratio)

## RESULTS

The observation of the imaging analysis of the skull supports our statement as to the intentionality of the trepanation. Both x-ray and CT scan imaging analysis, as seen in figures 4 and 5, verify the characteristic bevelling and discontinuity of the bone in the area of the lesion, as well as osteogenic activity which is indicative of ante-mortem formation and the post-surgical survival of the individual. Bone regeneration is

evident along the entire surface of the surgical lesion. No diploe is exposed at the edges of the bone in the lesion aperture. Bone thickness was measured ranging from 1.16mm to 2.13mm on the edges of the lesion, while it increases to 5.30 mm to 6.20 mm when measured 1.00 cm superiorly and 1.00 cm inferiorly of the lesions edges, as the cranium is viewed laterally. This increase in bone thickness metrically confirms the bevelling. The radiating fracture lines that are observed anteriorly and posteriorly exhibit exposed diploe. The observed healing of the lesion and concurrent exposure of the diploe here indicate that the fractures are most likely post mortem. There are no indications on the calvaria of any further associated pathology that would assist in the formulation of an aetiology, although the specimen could not be compared with its corresponding postcranial remains. Linear markings observed on the superior surface, perpendicular to the lesion are indicative of the scraping method, one of several known methods implemented in the procedure (Andrushko & Verano, 2008). This method appears to have been the dominant technique of the region, as other examples of it have been observed in Mycenae, Lerna, and Acine (Arnott, 1996).

## DISCUSSION

We know little to nothing about the origins of trepanation in the Aegean. However, an examination of the presence of the technique in the wider area of Europe could prove helpful in understanding its presence in Greece.

The practice of trepanation appears in several Mesolithic sites and is clearly present in the Early Neolithic period in central Europe and the western Mediterranean. However trepanation is absent from samples of Mesolithic skeletons from the Iron Gates (Serbia) and of the first large series of Neolithic skeletons, those of Catal Hüyük in Turkey and of Cyprus, although it may have been known in the Zagros Mountains of Iraq, in the site of Shanidar Cave, in the 11th millennium BP (Agelarakis, 1993), which is the SW Asian Proto-Neolithic Period) and in Jericho from the 10th millennium B.C. (Crubézy et al., 2001). The practice of trepana-

tion in the Balkan Peninsula is supported by evidence dating to the Epipaleolithic (12<sup>th</sup> millennium B.C.) and Mesolithic (8<sup>th</sup> millennium B.C.) periods (Liu and Apuzzo, 2003; Apuzzo et al., 2007; Rose, 2003. Oakley et al., 1959). The cases which are most geographically proximal from these eras are observed in Italy (Mallegni & Valassina 1996), Germany (Weber & Wahl, 2006), Poland (Lorkiewicz et al., 2005) and Turkey (Güleç, 1995).

The evidence for this operation in the Aegean has come until now almost exclusively from Middle and Late Bronze Age cemeteries on the Greek mainland, (Central Greece and Peloponnesus) but this does not render trepanation unique to those periods, as these are the only Greek mainland cemeteries dating from these periods, that have been extensively studied so far. There is as of yet no evidence that this operation had been performed by the Minoans, therefore it is unlikely that this practice was introduced to the Greek mainland from Crete (Arnott, 1997). However, the trepanation from Kavousi, Crete published by Liston (2009), is much more recent (8<sup>th</sup> century B.C.) and after the population movements of the Mycenaeans and subsequent Dorians to Crete, who may have brought the technique to Crete.

A possibility worth exploring is that the antiquity of the technique is such that it predates the population movements of the Bronze Age. The evidence from the Near East (Mogliazza, 2009) is contemporaneous with that of Greece, and evidence of Neolithic and even Mesolithic examples, as well as cases in distant regions with little or no potential information flow (Andrushko, Verano 2008), may imply that this technique was established in earlier population groups, and was sustained in later generations as an ancestral practice.

If the practice of trepanation was instead introduced to the Aegean region, and was not an existing ancestral custom, then this necessitates the observation of Bronze Age archaeological data, which indicate population movements into the region, mostly during the transition from Early to Middle Bronze Age periods. However, the archaeological data indicate that no significant cultural changes are recorded in the end of the Early Bronze Age. Coastal set-

tlements persist, while new settlements are founded in inland localities, (closed agropastoral economies of inland communities) (Chasiakou A., pers com, 2009; Forsen, 1992, Manning, 1995).

Anthropological data imply that the earliest implementation of any technique of trepanation in the Aegean was during the Middle Bronze Age in the sites of Kirra, Lerna, Mycenae, and Asine (Manolis et al., 1994; Angel, 1971, 1973, 1981). It is possible that newly arrived populations (from the north or east) introduced the practice to the region, but this is difficult to verify.

There is also a lack of artefactual evidence, in the form of surgical instruments, associated with Bronze Age trepanation cases from the sites of Fokis, Argolis and Ilia (Pentazos V., pers. com, 1992; Angel, 1971, 1973, 1981, Vikatou, 1999), that would shed light on the details of the procedure's nature, while also providing valuable resources for the accurate description of the trepanations. This was possible in the case studies from Kavousi, Crete (Liston, 2009), and Abdera (Agelarakis, 2006) in which a series of surgical instruments are reported.

The practice of trepanation has been well documented in the Greco-roman world (Classical times to Roman period 6th century B.C. to 2nd century A.D.). The surgical method was part of the Hippocratic medical culture, as historic medical sources have provided a great deal of information. It is therefore clear that its uses were medical from this time period on, contrasting for example with the well known medico-religious Asclepian paradigm (which pre-dated and overlapped with Hippocratic medicine), where etiology and healing were given a mystical causation (Grmek, 1989). Anthropological examinations of trepanations by necessity focus on the patient. While the usage of trepanation can be defined by researchers in a paleopathological context, this does not necessarily help in formulating hypotheses from a biocultural perspective, of the perceptions of the implementers and the entire scope of potential patients (i.e. psychiatric or physical trauma)

as to the character of the technique. In this context, it would be useful to have more information regarding the practitioners of the technique, something that is beyond the scope of this study. This level of understanding requires inclusion of discourse of an archaeological/cultural nature, and while challenging, is necessary for a holistic understanding of this practice. It is in this context that the speculation persists as to the ritualism associated with earlier implementations of the technique. While it's purely medical nature becomes clear later with the emergence of the Hippocratic tradition in the 5<sup>th</sup> century BC, the same cannot be said with certainty for prehistory, including the Bronze Age and early Iron Age, as the religious/ritualistic contexts of its implementation, (characteristic of preceding populations, and other regions) may have overlapped with the medical (Andrushko & Verano, 2008; Han & Chen 2007; Grmek, 1989). In their examination of trepanation in Italy, Baggieri and Di Giacomo (2003) present an argument for the medical nature of the procedure in Italian prehistory, as supported by the presence of the Iron Age Etruscan medical culture. This trend is similar in Greece, where the occurrence of trepanations predates the well documented Greek medical culture. There is, however, very little in the way of artefactual evidence with which this behaviour could be attributed to a discrete medical or ritualistic tradition. Such artefactual findings could be significant, as potentially the presence of items with clear cultic associations could characterize the practice as ritual. This ambiguity may be insurmountable, as it may well be intrinsic to the practice, as part of an integrated medico-religious belief system. Indeed, the theoretical frontier that must be explored further is the transition of this technique from ritual to medical. The present case study is the first of a wider series of anthropological analyses that are intended to shed light onto the practice of surgical trepanation in Greece from a paleoepidemiological, paleopathological, and biocultural perspective.

## ACKNOWLEDGMENTS

The authors would like to thank the excavator Dr Olympia Vikatou, archaeologist, for her permission to study the human skeletal remains of the Agia Triada cemetery. We also thank Mrs Christiana Andreou for her help in taking CT scans and the elaboration for the 2D and 3D digital images, and Dr Constantine Eliopoulos for his help in taking the photographs of the skull and the X-ray diffraction.

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