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EARLY EVIDENCE OF CRANIAL SURGICAL INTERVENTION IN ABDERA, GREECE: A NEXUS TO *ON HEAD WOUNDS* OF THE HIPPOCRATIC CORPUS

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ABSTRACT

This paper presents the case study of a cranial surgical intervention involving head trauma at the right occipito-parietal region carried out during the second half of the 7th century B.C. the Archaic Period, on an adult female individual, a member of a larger group of colonists from Klazomenai, [one of the twelve cities of the Panionian League in Greek Asia Minor], who endeavored to found the city of Abdera (Herodotus: *Historia*) in Aegean Thrace.

The wound, suspected to have been caused by a sling shot, must have caused a compressed cranial fracture, endangering the dura mater and necessitating a surgical intervention resulting in a 14.78mm by 9.19mm cerebral opening by the method of scraping, as opposed to trepanation, for the removal of bone splinters and possibly of the lodged projectile, for the obliteration of fissure fractures, and for the subsequent therapy of the wound.

Of great importance to medical science is the opportunity afforded by the treated wound which provides a nexus predating the methodological and procedural approaches of the late 5th century B.C. recommended in the Hippocratic treatise *On Head Wounds* (*Hippocratic Corpus*: III), specifically as it refers to protocols of examining, diagnosing, and surgically treating and caring for head trauma – a rich legacy of medical knowledge and practice of ancient Greek Medicine.

KEY WORDS: Cranial surgical intervention, Abdera, Head wounds, Hippocratic Corpus

INTRODUCTION

Before the end of the 7th century B.C., a surgeon in the Greek city of Abdera on the northern-eastern coast of the Aegean faced a difficult case. Standing back from his patient, a young woman who lay on the table before him, the surgeon cautiously examined her serious head wound. Normal practice required that the healer ask how the injury occurred, but in this case it was clear from the broken flesh and hair matted with blood that a stone or lead missile hurled from a sling¹ had crashed into the back of her head. Stepping closer, the surgeon gently explored the wound first by hand and then with a probe. As he feared, the missile had landed at a sutural junction which was still unossified at her young age, and which was one of her weakest loci of the cranial structure.

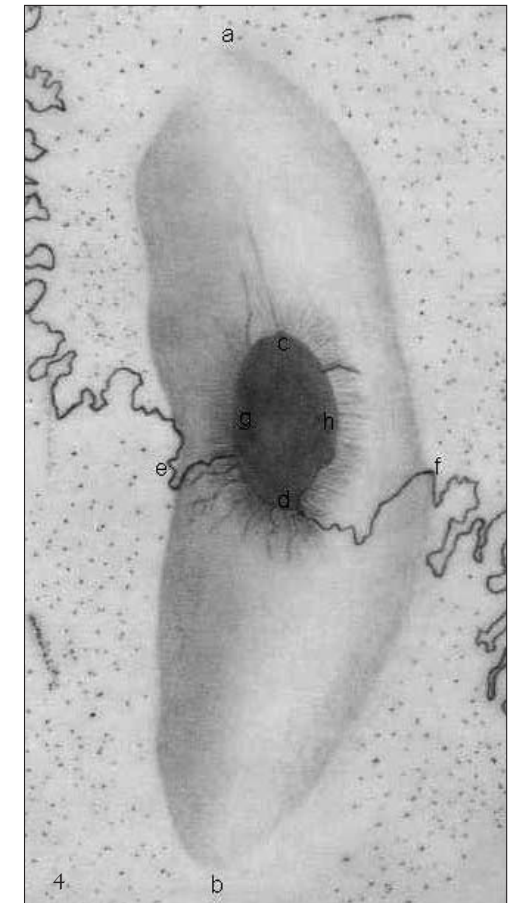
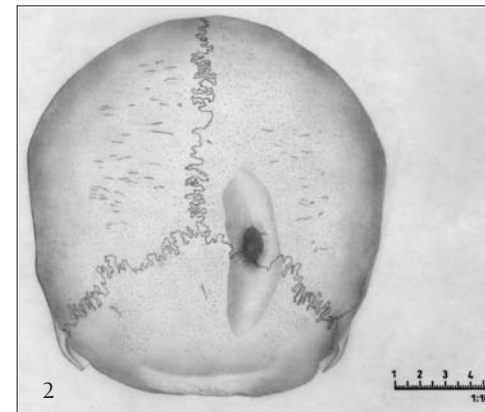
CASE STUDY FROM ABDERA

New evidence, on which this article is based, will further elucidate aspects of the history of the development of Greek medical practice. The patient² was among those sent north by Klazomenai, one of the Greek cities of the Panionian League, to establish a colony at Abdera around 654 B.C.³ She was successfully treated [a difficult operation performed by a master surgeon saved her] and lived for a considerable number of years (Agelarakis 2004a; 2006). Her remains, which were excavated at Abdera⁴ (Skarlatidou 1984; 1985; 1987; 1990; 2000) and which I have had the privilege to study in the context of a larger (Agelarakis 1989; 1997a; 1997b; 1998; 2000; 2001; 2004b) archaeo-anthropological project⁵, provide incontrovertible evidence that two centuries before Hippocrates⁶ drew breath, the surgical procedures and practices that we associate with the Hippocratic Corpus⁷ treatise *On Head Wounds*⁸ were already in use (Agelarakis 2004a; 2006). What is then

the evidence offered by this early surgical intervention, and how does it compare with the Hippocratic text? And what does it tell us about the development of surgery? Given that Hippocrates is the most famous physician of antiquity, considered as the founder of medical science, who was the medical practitioner that carried out successfully such a complex cranial surgery?

According to the historian Herodotus, the Clazomenaeans at Abdera were "driven out by the Thracians" (Herodotus, *Historia*) who perhaps conducted a war of attrition, contesting the colonists' access to land for agriculture and resources such as timber and/or opportunistically plundering and destroying their crops (c.f. endnote 1). Yet the archaeological record indicates that the Clazomenaeans settlers persisted for at least eight decades (Skarlatidou 2005), and excavations have revealed many traces of their colony, including its 4.0m fortification walls and cemeteries (Koukouli-Chrysanthaki 1997). In one of the Clazomenaeans burial grounds⁹ was the grave with the well-preserved skeleton of the woman who had survived the sling shot and subsequent surgery. From her bones, it was possible to determine that she had died of an unknown cause(s). Her cranial¹⁰, dental¹¹ and infracranial axial and appendicular¹² skeleton showed paleopathological changes of both traumatic-infectious and degenerative nature which were not debilitating, however, for she had been relatively healthy and quite physically active as revealed by her skeletal remains and skeletomuscular imprints¹³. Therefore, she was able to contribute to the workings of the community at Abdera.

The locus of surgical intervention (fig. 1, 2 and 3) presents a cerebral ovoid-shaped hiatus at the dorso-cranial *norma occipitalis*, measuring 14.78mm in length



Figs. 1-4 Cranial surgical interventions of the Clazomenaeans woman.

by 9.19mm in width, on a nearly superior-inferior direction and in effect parallel to the *sutura sagittalis*, surrounded by a larger nearly ellipsoid area of an ascendingly shallower surgical intervention through the smoothed diploic components tapering off at the ectocranial surface¹⁴ and measuring 66.36mm in length by 19.91mm in width and extending from the occipital bone over the lambdoid suture into the right parietal (fig. 4)¹⁵. That the surgeon took considerable time to carefully carry out the operation while using a rasp for the scraping of the bone within the walls of the wound is

clear not only from the morphology of the wound, but also from faintly discernible¹⁶ U-shaped scraping marks¹⁷, radiating outwards from the cerebral opening and situated in a tightly packed formation approximately 3.0mm wide outlining the border of the cerebral opening. The traces of these scrapings may not disappear entirely through reparative osteoblastic process, therefore remaining traceable for a considerable time after patient recuperation. Each of the U-shaped scraping traces measured a maximum width of ~0.8mm superiorly, between the lips of their individual outlines¹⁸, and a minimum of ~0.4mm inferiorly at their basal component. The recognition of the severity of the traumatic impact on the cranial bones, and the surgeon's remarkable care, commitment and attention to detail during the application of the medical procedure is further realized by the significantly [surgically] reduced thickness of the diploic components and endocranial compact table at, and peripheral to, the cerebral opening measuring approximately 1.0mm at locus "c" (fig. 4) and 0.5mm at locus "d", the latter being embedded into the synarthrotic *sutura dentate / limbosa* at the specific locus of the joint¹⁹.

When she was hit, the missile crushed the soft tissues of her scalp and caused a serious depressed bone fracture, possibly with the projectile embedded in it, accompanied by fissure fracture(s) endangering [with marginal sharp bone components] the dura mater, the two layered fibrous membrane enveloping the brain, the coarse and richly fibrillated outer surface of which closely adheres to the inner endocranial table, especially at the loci of the sutures. Surgery was needed to remove bone splinters and possibly the lodged missile in order to obliterate the danger of hidden fissure fracture(s), to evaluate the

condition of the dura mater if incised and/or exposed, and to apply "healing drugs", to deter the potential of morbid post-traumatic implications due to inflammatory processes and infectious conditions.

The surgeon, to judge by procedures recommended in the Hippocratic text *On Head Wounds*, first would have evaluated the injury without touching the patient, then would have touched the wound, and subsequently would have used a probe, if needed, to better diagnose the type, extent, and severity of the trauma. He also would have tried to gather information from the patient and/or witnesses about the circumstances of the injury and the patient's immediate physiological responses to the impact. Then, he would have proceeded in cutting and opening up the soft tissues surrounding the wound in length and width at the focal point of impact for better visual inspection and preparation for surgical intervention before dressing the wound with a paste of fine barley wheat boiled with vinegar²⁰. The next day, after removal of the lint dressing and barley paste he would have further cleaned and dried the soft tissues involved and would have carried out a final diagnosis of the nature and range of the bone injury²¹ possibly applying a treatment of black ink on the cleaned bone followed by an additional application of barley based paste which he would have lint dressed²² in order to locate on the following day the suspected, invisible, hair-line fissure fracture(s) that in the meanwhile would have been discolored by traces of absorbed ink, and also to examine and care for the condition of the dura mater if it was exposed and/or scratched²³.

On Head Wounds sets up a procedural protocol for the medical examination and treatment of the patient, as it describes variants of ectocranial morphologic expressions of human cranial sutural joints²⁴, diagnostic

procedures for identifying and treating a range of more than seven types of cranial injuries caused by different weapons and episodic circumstances²⁵, prognostics for carrying out a conservative or surgical procedure, mode of surgical procedures, time tables for carrying out surgical procedures, and the application of pharmaceutical and curative treatments. In most cases, a wound on the back of the head, where "bone suppuration takes longer where the bone is thicker and oozing puss will take longer to reach the brain" was less likely to be fatal than one in the front. But, as in the case of the woman from Abdera, "when a suture shows at the exposed bone area of the wound, of a wound anywhere on the head, the resistance of the bone to the traumatic impact is very weak should the weapon get wedged in the suture." Therefore, according to the Hippocratic text, the case was a serious one. It was made more so because of the nature of the weapon, a missile from a sling, because, "[o]f those weapons that strike the head and wound close to the cranial bone and the cranium itself, that one that will fall from a highest level rather than from a trajectory parallel to the ground, and being at the same time the hardest, bluntest and heaviest...will crack and compress the cranial bone."

Depending on the condition of compressed head fractures, *On Head Wounds* recommends, after careful diagnosis and preparatory procedures, surgical intervention using trepanation by drilling with rotating cylindrical saw bits to remove a disk of bone from the skull at the locus of impact. This would eliminate the danger of leaving untreated surface bone splinters and radiating fissure fractures. It would also permit the removal of bone components that crushed inward allowing the brain to swell from the contusion without pressing against loose bone

elements laden with sharp edges as it had been recognized that an untreated puncture of the dura mater would not have aided in the patient's recovery. But there was one cranial area where a scraping approach was strongly recommended instead of trepanation: "It is necessary, if the wound is at the sutures and the weapon penetrated and lodged in the bone, to pay attention to recognize the kind of injury sustained by the bone [b]ecause...he who received the weapon at the sutures will suffer a far greater impact at the cranial bone than the one who did not receive it at the sutures. And most of those require trepanation, but you must not trepan the sutures themselves...you are required to scrape the surface of the cranial bone with a rasp in depth and length, according to the position of the wounded, and then cross-wise to be able to see the hidden breakages and crushes...because scraping exposes the harm well even if those injuries, although they exist in the bone, were not otherwise revealed...and if you determine that the cranial wound requires an operation you must carry it out within three days...."

Faced with a compressed fracture with radiating fissure fracture(s) and fearing damage to the dura mater, [see differential diagnosis in endnote²⁶], the surgeon would have proceeded within the second or third day to scrape the bone in length, width, and depth, removing fragments and eliminating through scraping the fissure fracture(s) using a rasp(s)²⁷ and not trepanation. He then would have tended to the suppuration of any adjacent injured tissues, applying drug treatments while cleaning and drying all tissues involved. Such an approach, as recommended in *On Head Wounds*, would nurture the swift regeneration of new soft tissue which, proliferating over the crucial area of the wound and surgical intervention, would aid in the reparative, healing, process²⁸.

ON THE IMPLICATIONS OF THIS CASE STUDY FOR GREEK MEDICAL SCIENCE

While the reconstruction of the patient's treatment is in part conjecture, based on the Hippocratic text itself, the size and shape of the surgical intervention and use of the rasp and scraping especially over the locus of a suture, rather than trepanation, is certain from evidentiary data retrieved from the cranial bones themselves. Hence, the particular medical approach that reflects a conceptualized method and surgical procedure matches the course of action that was recommended two centuries later in *On Head Wounds* for this type of injury in the specific anatomic location of the head. Therefore, the *prima facie* evidence offered by this case study readily contributes new data in support of both the crucial issues of antiquity, and the presence of ancient elements to be identified in *On Head Wounds* of the Hippocratic Corpus, at least those that refer to the relative diachronic discussion since the era of Galen and thereafter²⁹. Further, the fact that such a surgical intervention predates by nearly two centuries a critical surgical procedural recommendation in the treatise *On Head Wounds*, may surpass, possibly for the first time in the realm of the Corpus Medicorum Graecorum³⁰, the concept of just identifying³¹ "primitive Hippocratic doctrine"³² elements in the Hippocratic texts aiming to provide deductive conclusions³³ including but not limited to issues of authenticity or pseudepigrafa³⁴ of Hippocratic Corpus components. Moreover to the issue of antiquity and *a fortiori* to the presence of an important component of ancient elements identified in *On Head Wounds*, as substantiated by this archaeo-anthropological discovery³⁵, tangential issues may need to be addressed concerning the specter of original "ownership" of medical

knowledge and praxis, and also of the mode of transfer and conveyance of that information [of truly empirical and anthropocentric nature in this particular case] over generational time, about two centuries later, through the treatise *On Head Wounds*. Consequently, starting with the latter issue this case study offers *prima facie* evidence reflective of "a unity of outlook among earlier physicians"³⁶, in the conceptualized medical method and approach as it pertains to surgical intervention on head trauma inflicted on suturaleal joints, the integrity of which transcended a period of approximately two hundred years as validated by the record available in *On Head Wounds*. Additionally, in reference to the issue of chronology and original "ownership" of medical knowledge and praxis, this case study presents incontrovertible evidence of a surgical method and procedure considerably older than the record in *On Head Wounds* from approximately the late 5th century BC. Whereas the latter provides a testimonial in support of a medical epistemological environment attained by Greek medical practitioners prior to the advent of the Ionian School of Natural Philosophers, [a significant argument not only about the antiquity but also about the kind of empirical methods versus philosophical concepts the foundation of medical science was based on]³⁷, it also pays tribute to the masterful skills of the learned medical practitioner³⁸ in Abdera, lending further support to the Hippocratic treatise *On Ancient Medicine* whose author argues that the field of medical art had already been established in an earlier era based on observation and empirical methodological procedures and approaches, rather than as a collateral derivative of philosophical concepts and/or doctrines.

EPILOGUE

Ancient Greek sources offer little aid in tracing the development of medicine before Hippocrates (Kouzis 1929; Jouanna 1999). It is not surprising that the medical historian G. Majno wrote (Majno 1975) that "the beginnings of Greek medicine, which should fill a library, are mostly blank pages." Greek medical writings predating the Hippocratic Corpus have not yet been discovered. Moreover, historical references record [excluding the Homeric poems] the names of few Greek physicians before Hippocrates. The earliest of them is recorded by historian Herodotus who notes³⁹ that [some time after 522 B.C.] the surgeon Democedes of Kroton [son of Kalliphon] successfully treated the Persian king Darius for a sprained ankle after Egyptian doctors had failed⁴⁰. Democedes had already practiced in Aegina, Athens, and Samos before treating Darius, but that is still a century after the physician of Abdera performed his masterful surgery.

Should one look to earlier times, Homer, describes in the *Iliad* over 140 combat injuries, many of which were inflicted by spear and arrowheads which sliced through flesh and bones. The wounds treated, the weapon extracted, the wounds bound, healing aided by the applications of herb ointments to reduce pain and restrain hemorrhaging – these offer clear indications that the contemporaries of Homer had the ability to fully comprehend, visualize and/or possibly recall, events of such injuries sustained in battle and the life-saving intervention of the physician, who was often implicated in surgical procedure. But in all the Greek army there were few trained physicians, for example Machaon and Podalirios⁴¹, both sons of the legendary hero-physician Asklepios⁴², son of the god Apollo and Koronis daughter of Phlegyas, the king of the legendary Lapiths⁴³. In the

battle, Machaon is wounded in the shoulder by Paris's arrowhead while Podalirios is on the battlefield fighting. Machaon is rushed by Nestor who takes him in his chariot back to camp for treatment "for deserving the lives of many men is the physician who knows how to extract arrowheads and with herbal ointments to cure the wounds" says Idomeneas in the *Iliad*⁴⁴. Further, Achilles' comrade Patroclus treats the injured Eurypylos using a method he learned from Achilles⁴⁵. Who taught both Asklepios and Achilles? According to Homer it was Cheiron the wisest of all centaurs⁴⁶ to whom Apollo entrusted the raising and mentoring of his new born son Asklepios⁴⁷.

The narrative of medical interventions of Homeric times, describing treatments and curative capabilities of the Early Iron Age seem rather simplistic when compared to the quantum leap of medical advancements of later Greek medical practice, such as the achievements of the physician at Abdera during the second half of the 7th century B.C. It is proposed that the roots of Greek medical advancements, as reflected in this case study, may be traced to the early migrations of Greeks to the East⁴⁸ and West, and their endeavors to claim territory to establish and sustain their colonies. Further, it appears that the sociopolitical⁴⁹ organizational changes that ensued with the incipient development of city states during the 9th century B.C. (Agelarakis 2005) and their subsequent emergence in the 8th century B.C. (34) favored a rapid evolution in medical practice⁵⁰, especially the treatment of acute trauma sustained in warfare of hoplitic nature toward the end of the 8th century B.C. (Zafeiropoulou and Agelarakis 2005).

While it could not be argued that the Greeks developed sophisticated medical practices entirely in isolation⁵¹, there is no strong evidence that they drew on an outside

source making the leap from healing in the context of the magical and the occult, the treatments of incipient surgical procedures with application of herbs, to performing the sophisticated head surgery exhibited on the female individual from Abdera which calls for the pretext of a vast accumulation of medical experience and praxis through empiricism and anthropocentrism. Although we may never know the exact

composition of the Clazomenaeon colonists who endeavored to found the city of Abdera, we do know that among them was a masterful surgeon, one of the earlier Greek medical practitioners and Hippocrates' predecessor, whose breath of medical knowledge, procedures and empiricism we may now examine further in *On Head Wounds* of the Hippocratic Corpus.

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¹ To date the relations between the native Thracians and the Clazomenaeon colonists have not yet been explored independently, by means of archaeo-anthropological research, of accounts available to us through the historical record. Hence, for the purposes of this article and as it pertains to the subject matter of such relations, I have drawn a course using as a compass the historic data of Herodotus, *Historia*: A:168, which rather underline difficulties in the relations between the natives and the colonists. Hence, hypothetically, the sling could have been hurled by one of the native Thracians intent on the colony's destruction. Nevertheless, it should be considered that archaeological research detects an uninterrupted sequence of Clazomenaeon activities in Abdera for at least eight decades, cf. Skarlatidou, E. (2000) "Apo to Archaiko Nekrotafeio ton Abdiron: Symboli stin Ereuna ton Klazomenion sta Abdira", Ph.D. Thesis, Dept. of History and Archaeology, Aristotelian University, Thessaloniki. Further, anthropological research with a focus on skeletal biology and paleopathology on the Clazomenaeon population sample recovered so far in Abdera indicates a distinct lack of skeletal trauma, especially among adult individuals, the specific nature of which could offer clues about the possibility of warfare, possibly reflecting an engagement environment characteristic of opportunistic skirmishes and attrition impact on yieldable resources carried out by the natives against the colonists, cf. Agelarakis, A. (2004) "The Clazomenaeon Colonization Endeavor at Abdera in Retrospect: Evidence from the Anthropological Record". *Klazomenai, Teos and*

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- ² This pertains to the dry skeletal remains of a female individual the biological sex assessment of which was based on skeletal anatomic morphological traits and metric indices of the cranium-infracranial skeletal structures. The age assessment was carried out based on morpho-anatomic criteria and skeletal indices, as well as developmental and acquired manifestations permanently recorded on the cranial, dental and postcranial remains. Hence, the degree of cranial sutural synostosis indicated an age of \sim 25 to <35 years, the dental record indicated an age of approximately 45 years, the nature and degree of degenerative axial and appendicular skeletal pathologies indicated an approximate age of >35 to 40/45 years, and the morpho-anatomic changes of the iliac auricular surface indicated an approximate age of 45 to 51 years.
- ³ Herodotus, (c. 484-420 BC), *Historia*, Book A: 168. Thucydides, (c. 460-455 BC), *Historia*, Book B: 97. Strabo of Amaseia, (c. 64/3 BC-AD 21), *Geography*, Book 7: *North and East Europe, North Balkans*. Diodorus Siculus, (c. 60-30 BC), *World History, Bibliotheca Historica*. Gaius Plinius Secundus, (23/24-79 AD), *Naturalis Historia*, Books 3-6. Diels H. (1906; and 1960-61) *Die Fragmente der Vorsokratiker*, 2nd ed., Berlin, Weidmann. Lazaridis, D. (1950) "Anaskafi en Abdirois", *Praktika Archaeologikis Etaireias*, 293-302; (1952), 260-278; (1954), 160-172; (1955), 160-164; (1956), 139-140; (1966), 59-66; (1971), 63-71. Koukouli-Chrysanthaki, H. (1985) "Abdera and the Thracians". *Thracia Pontica* III, 82-98. Skarlatidou, E. (1985) "The Archaic Cemetery of Abdera". *Thracia Pontica* III, 99-108. Koukouli-Chrysanthaki, H. (1982) "Anaskafikes ereunes sta archaia Abdira". *Praktika Archaeologikis Etaireias*, 1-17; (1983A), 1-12; (1984A), 1-11; (1987), 177-185. Bakirtzis, Ch. (1982) "Anaskafi Polystylou Abdiron". *Praktika Archaeologikis Etaireias*, 18-26; (1983A), 13-19. Skarlatidou, E. (1984) "Episkopisi tis istorias ton Abdiron me basi tis filologikes piges kai ta arxaiologika dedomena". *Thrakiki Epetirida*, vol. 5, 147-161. Bakirtzis, Ch. and Zikos, N. (1984) "Anaskafi Polystylou Abdiron". *Praktika Archaeologikis Etaireias*, 11-17. Skarlatidou, E. (1987) "Anaskafi sto archaio nekrotafeio ton Abdiron". *To Archaeologiko Ergo Sti Makedonia kai Thraki*, vol.1, 421-425, and 538 (summary). Koukouli-Chrysanthaki, H. (1987) "Anaskafes sta Archaia Abdira". *To Archaeologiko Ergo Sti Makedonia kai Thraki*, vol. 1, 407-410. Kranioti, L. (1987) "Tymbos apo ti Boreio-Dytiki nekropoli ton Abdiron". *To Archaeologiko Ergo Sti Makedonia kai Thraki*, vol. 1, 431-435. Samiou, X. (1988) "To elliniko nekrotafeio ton Abdiron". *To Archaeologiko Ergo Sti Makedonia kai Thraki*, vol. 2, 471-480. Skarlatidou, E. (1990) "Oikismoi kai egkatakataseis istorikon chronon mesa sta oria tis 'choras' ton Abdiron". *Mnimi D. Lazaridi: Recherches Franco-Helleniques*, vol. 1, 611-618. Kallintzi, K. (1990) "Anaskafi tafikou tymbou sta Abdira". *To Archaeologiko Ergo Sti Makedonia kai Thraki*, vol. 4, 561-568. Koukouli-Chrysanthaki, H. (1997) "I archaiki poli ton Abdiron. B: Arxaiologikes ereunes". *Praktika 2^{ou} Diethnous Symposiou Thrakikon Spoudon: Archaia Thraki*, vol. II, 715-734.
- ⁴ By Dr. Eudokia Skarlatidou of the Greek Archeological Service
- ⁵ For the theoretical and methodological procedures of skeletal biological and paleopathological analyses applied in this project, including this case study, cf. Agelarakis, A. (2004) "The Clazomenaeon Colonization Endeavor at Abdera in Retrospect: Evidence from the Anthropological Record". *Klazomenai, Teos and Abdera: Metropoleis and Colony, Proceedings of International Symposium*. (eds.) Moustaka, A. Skarlatidou, E. Tzannes, M.-C. and Ersoy, Y. Thessaloniki, 327-349.
- ⁶ Hippocrates the Asclepiad of Kos, the ancient Greek physician we know as the 'Father of Medicine' (born ca. 460 BC) was spoken of with respect by his contemporary, Socrates, and his later contemporaries Plato and Aristotle, as the established authority in medical method and practice of the time period in the Hellenic world, Plato, *Protagoras*: 311, and *Phaedrus*: 270; Aristotle, *Politics* VII:4:1326a.16.
- ⁷ Whereas it is debatable that the ancient medical treatises, numbering about 72 and collectively known as the Hippocratic Corpus, can be ascribed utterly to him the more one delves into the Corpus the clearer an understanding emerges that *On Head Wounds* has a standing of its own and must have been compiled by a great physician and teacher of medical practice, representing a wealth of accumulated medical knowledge, experience, and tradition. E. T. Withington notes "The writer, indeed, though he teaches with authority and confidence, confesses failures and welcomes improvements". Withington T. E., (1984) *Hippocrates*, Vol. III: vvii, The Loeb Classical Library, Cambridge Massachusetts.

- ⁸ Littré E. (1841-1844) *Oeuvres complètes d'Hippocrate*, Paris; Adams F. (1849) *Genuine Works of Hippocrates translated from the Greek*, London; Petrequin, E. J. (1877-1878) *Chirurgie d'Hippocrate*, Paris; Kühlewein H. (1898) *Die chirurgischen Schriften des Hippokrates*, Nordhausen; Withington T. E. (1984) *Hippocrates*, Vol. III, The Loeb Classical Library, Cambridge MA.; Lypourlis D. (2001) *Hippocrates: Surgery*, Athens.
- ⁹ At archaeological sector "K", while there are additional coeval burial grounds, such as those in sector "P"
- ¹⁰ Both parietals reveal ectocranial changes caused by inflammatory-infectious reactions [either primary, and/or secondary to the wound with granulous layers of depositional hyperporous subperiosteal bone, basal layers of which had converted into lamellar bone some time before death. The area of reaction is more apparent posteriorly to the bregmatic / vertex region, peaking at the parietal tuberosities and extending over the lambdoid region to the *planum occipitale* and *nuchale*. Hyperporosity was also observed at the sphenoid wings, and at both orbital roofs, however without any hyperostotic changes.
- ¹¹ a: Linear enamel hypoplasias as permanent markers of arrested and improved enameloblastic cell growth and matrix deposit, possibly reflective of early life constitutional stress occurring at 3.2 and 4.2 years respectively [causative agents could include but are not limited to childhood diseases, fevers, or even a seasonal environmental stressor, which in both occasions the individual was able to overcome]; b: Mild curve of Spee with homogeneous, moderate to advanced incisal edge and occlusal surfaces' wear due to functional masticatory modification showing flattened occlusal platforms lacking occlusal cusps with creases of tertiary reparative dentin; c: Maxillo-mandibular / labio-buccal enamel ring surfaces' micro fractures caused by the preparatory quality of dietary intake and/or combined with habitual conditions of the use of teeth in "third" hand functions; and d: Periodontal disease related changes: i) alveolar ridge hyperporosity; ii) periodontal windows at both maxillary first molars; iii) advanced alveolar bone reduction with flat alveolar *septae* exposing further originally anatomic dental root surfaces into the oral cavity causing excessive dental movement within the alveoli and enhancing the probability of infectious pathogeneity; and iv) moderate accumulations of supragingival calculus deposits. For the demographic and paleopathological profiles of the Clazomenaeon population at Abdera c.f. Agelarakis, A. (2004) "The Clazomenaeon Colonization Endeavor at Abdera in Retrospect: Evidence from the Anthropological Record". *Klazomenai, Teos and Abdera: Metropoleis and Colony, Proceedings of International Symposium*. (eds.) Moustaka, A. Skarlatidou, E. Tzannes, M.-C. and Ersoy, Y. Thessaloniki, 327-349.
- ¹² Infra-cranially, on the axial skeleton, there were spondyloarthropathic changes at several of the cervical and thoracic vertebrae in the form of osteophytic growth [such as lipping], and osteophytic reactions accompanied by traceable porosity at articular facets of the ribs. On the appendicular skeleton there were osteoarthropathic changes in the form of lipping and porosity affecting unilaterally, to a moderate degree, the left proximal humeral articular surface, and bilaterally, to a severe degree, the mesial areas of the proximal ulnar articular surfaces; the latter may be suggestive of changes caused by occupational or culturally mandated circumstances. Further, the right *os coxae* revealed enthesophytic growth at the area of the *fossa iliaca*.
- ¹³ There were no osteological data nor paleopathologic clues to suggest that she had been paralyzed or incapacitated to paresis, whereas it would be conjecture to presuppose that she was limping in bipedal locomotory mode as an immediate result or parergon of the cranial traumatism.
- ¹⁴ Showed a smooth and mildly sclerotic marginal border as a result of the healing process
- ¹⁵ Whereas the maximum length (a-b= 66.36mm) and maximum width (e-f= 19.91mm) readings represent linear measurements which lack the mensurational incorporation of the convex contour [removed by the surgical procedure] of the ectocranial table at that region, the esoteric readings of a-c= 23.54mm and b-d= 30.14mm represent respectively linear measurements of oblique surfaces [hypotenuses of two non isosceles 90 degree triangles that can be drawn] in relation to the maximum length "a-b" measurement [the long "legs" of both triangles being part of the "a-b" measurement]. Therefore, the sum of the composite linear measurements of {"a-c", c-d= 14.78mm, and "b-d"} at 68.46mm supersedes the "a-b= 66.36mm" metric value by 2.10mm. Similarly, the sum of the composite linear measurements of {e-g=5.04mm, g-h= 9.19mm, and h-f= 6.33mm} at 20.56mm supercedes the "e-f= 19.91mm" metric value

by 0.65mm.

¹⁶ Preferably using a light refraction approach

¹⁷ In slight excess of 85

¹⁸ As seen in a perspective that would simulate sagitto-coronal cuts pending on their location to those plains

¹⁹ Hence, compounding the fear and/or suspicion that an overlapped [therefore not visible unless scraped] component of the synarthrotic suture could have fragmented, and already could have had incised and/or imminently could have presented such a potential to damage the dura mater.

²⁰ Molecular microbiology trials on the possible antiseptic attributes of *Hordeum vulgare*-vinegar extracts have been carried out by Weeks, B., and A. Agelarakis with preliminary observations supporting a case for further research, cf. Agelarakis, A. (2004) and Weeks, B. "On the antiseptic and antifungal abilities of the Hippocratic *Hordeum vulgare* plaster applications", tabulated data in manuscript; Osawa, T., Katsuzaki, H., Hagiwara, Y., Hagiwara, H.; and T. Shibamoto (1992) "A Novel Antioxidant Isolated From Young Green Barley Leaves". *Journal of Agricultural and Food Chemistry*, vol. 40/7, 1135-1138.

²¹ Being able to identify better, through clearer visual inspection of the regional anatomic diagnostic landmarks of the sagittal and lambdoid sutures, the extent of the injury

²² Which according to *On Head Wounds* he would have moistened with olive oil to deter excessive adherence

²³ By drying out carefully any excessive secretions and by controlling any gathering of wetness, cf. *On Head Wounds*

²⁴ Significant observations in the variability of human cranial synarthrotic morphologies to be used as anatomic landmarks in medical-surgical treatment

²⁵ Accidental versus malevolent causalities and in the latter case stipulations on the form/shape, weight, speed, and trajectory of handheld weapons or projectiles, cf. *On Head Wounds*

²⁶ It is suggested that the wound sustained by the female individual had been caused by a heavy and compact globular [q.v. *On Head Wounds (HW)*: 11] sling projectile which resulted in crushed soft tissue and non-superficial cranial bone fracture, involving the weaker bone area of the lambdoid sutural joint (*HW*:3). Judging from the morphologic clues retrieved from the locus of surgical intervention and x-ray imaging of cranial surfaces and manifestations, it was assessed that the traumatic event had caused either a deeply penetrating depressed fracture compressing all superimposing tissues to the endocranial table [with the possibility of a wedged projectile into the diploic component], or a depressed fracture with less severe compression effects but accompanied by a fissure fracture(s) reaching the endocranial table; in either case, the endocranial table reveals a surgically manipulated cerebral opening equal to a 14.78mm by 9.19mm area of impact. The following represents the course of action which would have been taken by a practitioner following the recommendations *On Head Wounds*: **a**) In the case of a wound that would have involved a compressed fracture with wide bone fragmentation, adequate separation of bone fragments, lack of radiating fissure fracture(s) and unharmed dura mater he would have followed a conservative treatment by tending to the supuration of all damaged scalp tissues (*HW*:15) and necrosis (*HW*:16) of the severed bone fragments at the area of the wound, applying drug treatments while cleaning and drying the wound. Then, after the subsidence of the swelling he would have proceeded to remove any necrotic bone fragments, subsequently carefully overseeing the growth of new, healthy, scalp tissue, applying drug treatments and keeping the wound clean and dry (*HW*:17); **b**) In the case of a wound that would have involved a compressed fracture with radiating fissure fracture(s), and hence a suspicion of dura mater damage, the surgeon would have proceeded within the second or at the latest third day (*HW*:14) to scrape the bone in length, width and depth (*HW*:14) removing bone fragments and eliminating by method of bone scraping fissure fracture(s) using rasp(s)--and not trepanation (*HW*:12), then he would have tended to the suppuration of any adjacent injured tissues, applying drug treatments while cleaning and drying all tissues involved, followed up by the treatment for a healthy recovery of the patient (*HW*:15). In carrying out a differential diagnosis it is suggested that the surgeon had to follow the latter mode of surgical intervention considering the osteological evidentiary data retrieved from this case study.

²⁷ It is suggested that the surgical tools used were made of bronze.

²⁸ If a headdress, headband or other pertinent cover was recommended in order to both conceal the wound for purposes of aesthetics and/or as a safeguard from accidental puncture wound the sensitive area of the head no relative discernible traces were detected focally, in the specific region of the wound, neither in the larger cranial vault and lateral walls' surfaces; assessments were carried out at the macroscopic level, under low (45x) magnification, and through x-ray imaging.

²⁹ On the significance of the Hippocratic Corpus to medical science and on issues relevant to the authenticity of the treatises from the ilk of Paracelsus, Versalius and Harvey, to the contributions of F. Bacon, T. Sydenham, D. Le Clerc, H. Boerhaave, M. P. E. Littré, H. Diels, J. Ilberg, K. Deichgräber, M. Pohler, A. Roselli, J. Jouanna, C.F. Salazar, W. D. Smith, P.J. Van der Eijk, to mention a few.

³⁰ A domain which has seen a renewed interest after the W.H.S. Jones translation of the Egyptian papyrus *Anonymus Londinensis*, containing Menon's references to Hippocrates, cf. Jones, S.H.W. (1947) *The Medical Writings of Anonymus Londinensis*, (translation), Cambridge.

³¹ Primarily through medical historic research, philological and grammarian approaches to the Hippocratic Corpus

³² Cf. statements made in Oxford Classical Dictionary: Medicine:6

³³ Even if most often through *reductio ad absurdum*

³⁴ Cf. Diels, H. (1910) "Ueber einer neuer Versuch, die Echtheit einiger hippokratischen Schriften nachzuweisen," *Sitzungsbeichte der reussischen Akademie der Wissenschaften*, philosophisch-historische Klasse, 1140-1155; Wellmann, M. (1926) "Hippokrates des Thessalos Sohn," *Hermes*, vol. 61, 329-334, and (1929) "Hippokrates des Herakleides Sohn," *Hermes* vol. 64, 16-21; Ilberg, J. (1924) "Die Aerzteschule von Knidos," *Berichte über die Verhandlungen der sächsischen Akademie der Wissenschaften zu Leipzig*, Philologisch-historische Klasse, vol. 76, 3; Edelstein, L. (1939) "The Genuine Works of Hippocrates," *Bulletin of the History of Medicine*, vol. 7, 247-248, and (1967) in translation, in *Ancient Medicine: Selected Papers*, (eds.) Temkin, O., and C. L. Temkin, L.C. Baltimore, Maryland.

³⁵ Of qualitative nature, lacking the ability to offer statistical implications, yet significant given its antiquity, and the condition of preservation

³⁶ *A contrario* to all general statements made so far to the opposite, on this subject matter, a concise resume of which is available in Oxford Classical Dictionary (1970): Medicine:6.

³⁷ For it certainly predates it chronologically, lending support to arguments of the Hippocratic treatise *On Ancient Medicine* (Περὶ Ἀρχαίων Ἰητρικῆς) against those [possibly the Pythagorean Phylolaos and/or Empedokles] who claimed that the evolution of Greek medicine had been based on the development of philosophical substrates, and hence *a posteriori contra* to Edelstein, L. (1967) *Ancient Medicine: Selected Papers*, (eds.) Temkin, O., and Temkin, L.C., Baltimore, Maryland. For a comprehensive discussion on this essential matter cf. Schiefsky, J. M. (2005) *Hippocrates On Ancient Medicine: Studies in Ancient Medicine*, vol.28, Brill Press, Leiden,.

³⁸ This advocates for a proposal to seek out the origins of his education and medical training further in the past as implicated by the relative chronological *terminus ante quem* provided by this case study. *A propos* Herodotus indicates that Kroton [founded in the 7th c BC] was renown for its good physicians, *Historia*, 3:131

³⁹ *Historia*, 3: 125; 129-137

⁴⁰ Also successfully treated queen Attosa, Darius' wife, from a spreading breast abscess, cf. Herodotus, *Historia*, 3:133-134

⁴¹ Leaders of a contingency of 30 ships representing Tricca, Ithomi, and Oichalia of Thessaly, Homer, *Iliad* 2:729-733. Whereas the Oxford Classical Dictionary translates the name Podalirios (Ποδαλείριος) as 'Lily-foot', the etymology of his name may be explained as (ποδῶν αλεωρήν=βοήθειαν) which translates into "helping people to stand on their feet", a description of the function of a general medical practitioner, as he is in fact depicted in 5th century BC statues in the form of a younger person healing the feet of patients,

whereas Machaon (Μαχάων) etymologically explained by the nouns μάχαιρα (a short sword or dagger of the kind Patroklos used to extract an arrowhead from Eurypylos' thigh, q.v. Homer, *Iliad*: 11.844 and μάχη (battle), as well as the verb μάχομαι (I am fighting) is translated by the Oxford Classical Dictionary as "Warrior". Machaon is indeed a warrior but also a medical practitioner in the *Iliad*; the etymology of his name rather could be explained as relative to surgery and the use of surgical knives to extract penetrating objects [as the Thesalians were known for using the single edged slightly curved sword formidable for its cleaving/chopping and thrusting abilities in battle, q.v. *Euripides*, *Electra*:836-837] depicted accordingly in antiquity, as a young individual holding in the left hand botanical medical remedies [c.f. Theophrastus: *Enquiry into Plants* (*Περί Φυτῶν Ἱστορίας*)], and in the right hand the scalpel, hammer, and trepanning drill, the earliest surgeon in Greek iconography. The two Homeric physicians were revered as gods for their contribution to Medicine together with their father Asklepios throughout ancient Greece, cf. Pausanias, *Guide to Greece* (*Ελλάδος Περιηγήσεως*), *Korinthiaka*: 16.10; Diodoros, IV: 71.4; Svoronos, I. (1917) "Asklepiaka Mnemeia kai Kionolatρεία en Athenas", *ArchaiologikiEpetiris*, 86-87; Kranioti, L. (1990) "Archaia Epigrafi apo tin Strymi", *Mnimi D. Lazaridi: Recherches Franco-Helleniques*, vol. 1, 629-633.

⁴² "And my ancestor, Asclepius, ...the creator of our art, as our friends and poets here tell us, and I believe them; and not only medicine in every branch, but the arts of gymnastic and husbandry are under his dominion" [said by the physician Eryximachus in his speech on the human body and medicine, Plato, *Symposium*: 186, cf. Jowett, B. M. A. (1937), *The Dialogs of Plato*, New York].

⁴³ Pyndar, *Pythian Odes* (*Πυθιονίκαι*) 3: A.5-10, B. 24

⁴⁴ *Iliad*: 11:505-520

⁴⁵ *Iliad*: 11: 809-848

⁴⁶ *Iliad*: 11: 832

⁴⁷ Pyndar, *Olympian Odes* (*Ολυμπιονίκαι*) 3: B.40-46; Pausanias, *Guide to Greece* (*Ελλάδος Περιηγήσεως*): 2.26.6

⁴⁸ Specifically including the Mycenaean cultural elements and the wealth of their accumulated medical traditions

⁴⁹ Q.v. Hippocratic Corpus: *Physician* (*Περί Ἴασού*): 14.

⁵⁰ A *contrario* to L. Edelstein who had attempted to propose that there was no incipient science in Greek medical prognosis but rather the result of social changes and ensued pressures on physicians to professionalize their inconsistent methods, q.v. Edelstein, L. (1939) "The Genuine Works of Hippocrates," *Bulletin of the History of Medicine*, vol. 7, 247-248, and (1967), in translation, In *Ancient Medicine: Selected Papers*, (eds.) Temkin, O., and C. L. Temkin, Baltimore.

⁵¹ Scurllock, J. "Physician, exorcist, conjurer, magician: A tale of two healing professions." In Van Der Toorn, K., et al. (2000) (eds.) *Mesopotamian Magic Textual, Historical, and Interpretative Perspectives*, 69-79.