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THE HIPPOCRATIC MEDICAL TREATMENT OF *FRACTURA MANDIBULAE* TRACED IN A BYZANTINE WARRIOR OF THE 14TH CENTURY

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ABSTRACT

This article addresses a rare palaeopathological case of *fractura mandibulae* involving a Byzantine warrior of the late 14th century. The medical treatment and aspects of the healing regimen, providing glimpses of the human condition during the most tumultuous last 100 years of the Empire as experienced at the provincial fort of *Polystylon* (ancient *Abdera*) at the shores of the Aegean Sea in Western Thrace, also reflected on the continued implementation of an intervention approach that had been recommended ca. 1,800 years earlier by the Hippocratic corpus.

KEYWORDS: Thrace, Polystylon, mantible, worrior, Byzantine

1. INTRODUCTION

During the mid-1380s, at the sacking of the *Polystylon* fort in Western Thrace, the Byzantine warrior had been decapitated at the hands of the Ottoman conquerors. His head, also bashed with a ghastly-sized compressed-comminuted fracture at the upper facial third region, had been caringly interred in a cist grave of a 4.5/5.5 year old individual. Earth and few large ceramic fragments, as with the majority of the graves of the 14th century cemetery of *Polystylon* (initially published sectionally, embedded into a larger archaeo-anthropological report, Agelarakis, 2017), had concealed through the passage of time the remains of the two individuals. The cranial structure of the decapitated warrior was recovered in slight stratigraphic superposition at a right lateral position to the cranium of the young individual; the grave was recovered in 1991, during excavations conducted under the auspices of the 12th Hellenic Ephorate of Byzantines Antiquities (Agelarakis, and Agelarakis, 2015) (Fig. 1).

Figure 1. The cist grave context revealing the decapitated remains of the warrior and its intra-contextual association with the skeleton of the youth.

Along with the horrific traumata, caused by blunt force impact, at the cranial *facies anterioris*, and *basilaris*, assessed to have been afforded by the strike of different types of weapons, the Byzantine warrior disclosed a rarefied manifestation of a healed mandibular left-unilateral parasymphyseal fracture (for concise reviews on the diagnostics, prevalence, and treatments of mandibular fractures cf. Ellis et al., 1985; Koshy et al., 2010; Erdmann et al., 2008).

2. RESULTS & DISCUSSION

The traumatism had fractured the dento-alveolar and basal region of the mandible causing a comminuted-complex and vertically unfavorable cleft along with a basal triangle. The basal triangle comprised elements of the left oblique line, the mental tubercle with the *loci* of origin of m. depressor *labii inferioris* and medial fibers of m. depressor *anguli oris*, medial *loci* of insertion of m. *platysma*, as well as the shattered digastric fossa (Fig. 2). Competitive explanatory hypotheses on the causative agent of the fracture ranged from a forceful fall injury while horse-riding, a trauma sustained in battle by a spearhead thrust while mounted, by a forceful strike of other sharp hand-held weapon at close-encounter battle engagement, or by a ballistic in nature projectile-inclusive of a missile (Pilcher, 1996; Stefanopoulos et al., 2014) propelled by black powder (Coupland, 2011; Stefanopoulos et al., 2015; Demetriades et al., 1998); a jousting trauma was considered as unlikely contemplating the milieu of cascading warfare events during the period.

Upon palaeopathological examination, it was clearly established that the mandibular fracture had been treated medically by means of a closed reduction. The surgeon-physician, possibly helped by an aid, having manually placed the two major *corpus* fragments of the mandible in their approximate anatomic position *ante*, in partially securing the realignment of the dentate jaw fragments and considering the prospect of restoring functional occlusion, implanted dental inter-wiring or threading, using as apposed anchors the remaining, stable in their alveolar sockets, mandibular teeth of the two fragments.

During circumspect study of the mandibular left and right molars preserved *in situ*, it became apparent that their surfaces, with the exception of the occlusal ones, were involving faint, yet discernible under low magnification, intermittent shallow imprints in the shape of ca. 0.8 to 1.34 mm in width bands. These bands were noticeable on both mesio-distal interdental (included the distal surfaces of the third molars) and bucco-lingual surfaces of the molars. They were marking the lower borders of the distal thirds of the crowns, from above the margins of the cemento-enamel junctions through to the most superior proximal third *termini* of their root components. On the domain of root segments involved, more prominent were the detectable traces at the bulging points of

their mesio-distal / bucco-lingual contours, and particularly at the bucco-lingual ends of the mesio-distal, interdental, surfaces. Overall, those traceable markings were canvassed by a subjacent degree of slight supragingival calculus accumulation which had otherwise deposited on the supero-inferior borderlines of the bands. Noticeably, the mesio-buccal middle and distal thirds of the enamel crown component of the first right mandibular molar ($R.M_1$) revealed in addition a sharply bordered horizontal (transversal to the long axis of the tooth) depression, of mechanical nature, creating a well-defined imprint that was reaching into the dentino-enamel junction of the tooth. This is suggested to reveal a preserved trace of a purposeful objective by the physician during the intervention. It reflected on the significant degree of medical attention paid, to both safely secure the dental inter-wiring where rendered necessary, by surgical modification of the dental crown component, yet aiming to also minimize the potential of further irritation to the masticatory and buccal mucosa-particularly in the application of bandages that would have pressed on the buccal subunit of the cheeks. While it was not possible to run trace element analyses on said dental surfaces, in seeking to identify residual gold metal-threading signatures, it was possible nevertheless to determine through inspectional evaluations the lack of silver alloy grayish discolorations, unless such were absorbed within the slight calculus accumulations. Similarly, there were no traces observed of a patina which could possibly reflect on copper wiring stains, and/or of cupric acid (greenish oxidation stains should the metal wiring used had been of bronze) discoloration.

Figure 2. A left ventro-lateral view of the mandible with a focus on the healed fracture and molars in situ

Though the trauma dressing with bandage applications, which would have wrapped orofacial to postero-lateral head and neck *loci* and fastened on the vault of the head (a few relative images are available in figure 5 of p. 1010, and figure 6 of page 1012 in Gahho & Ariyan 1984) could not be detected skeletally- as they would not have caused traceable ectocranial vault imprints, they would most probably have been implemented as part of the treatment regimen; inherent to the retention of compresses to the chin and for the essential protective support and immobilization of mandibular fragments. The bandaging it is suggested would have materialized given that it was integral to the handling of mandibular fractures, subsequent to the realignment and interdental threading of the dentate jaw fragments preferably by gold wire; as recommended in the pattern of medical directions, advice, and precautions provided to physicians since the 5th century BC by the Hippocratic corpus (Goold 1999). Further, the Hippocratic method was prescribing recommendations and was forewarning of particular concerns on the post-operative medical attention and the patient's judicious ability to adhere to the treatment regimen during the recovery process; conditions, which it portended could influence the outcome of the healing process.

In retrospect of more than six hundred years, based on the severity and complexity of the warrior's mandibular parasymphyseal comminuted fracture, treated with closed reduction, outcome assessments of the healing process were disclosing a considerable callus formation between the healed mandibular components. Following the osteosynthesis process, an overriding misalignment of the mandibular parts had taken place with a post-left lateral incisor ($L.I_2$) to a pre-left second premolar ($L.PM_2$) bone defect (Fig. 3).

Figure 3. A left supero-lateral mandibular view of the healed mandibular components, the condition of the retained alveols, and the occlusal wear patterns of the molars.

Ventrally, it involved the mandibular domains of the mental fossa, the oblique line, and mental tubercle. Inferiorly, it affected the digastric fossa, inferolingually the submandibular fossa, and lingually the mental spines of the genial tubercles. Essentially, there was a derangement of the fused mandibular fragments, most discernibly revealed at the epicenter of the amalgamated components with a mesio-posterior ectopism of the left mandibular *corpus* element and a significant lingual callus formation entailing the postero-lingual migration of m. *genioglossus*, m. *styloglossus* (due to the repositioning of m. *genioglossus*' origin on the mental spine and the contiguous repositioning of the postero-lateral domains of the tongue), and of the suprahyoid muscle group attachments (Fig. 4). The latter, along with any untoward sequelae of the fractured mandible (in the case under investigation, it appears that there should not have been any consequent effects by a delay in receiving medical help), would have functioned during the early stages of secondary bone healing (before bony healing) in antagonism with the muscles of mastication hindering proper ossification alignment of the bicortical mandibular bone fragments, and the remedy of the ruptured neurovascular bundles[1].

Partially due to an embedded hematoma, soft tissue remnants and detached bone fragments which could not have been extracted under the closed reduction treatment (although on the positive side closed reduction does not challenge surgically the vascular network) and possibly even due to the patient's inability to strictly adhere to the firm course of prescribed immobility in *fractura mandibulae*, as also cautioned in the Hippocratic treatise. (Goold 1999, 259, and 265) could be the combined reasons for the slight mandibular malunion rather than the surgeon's inability to carefully inspect and line up with manual adjustments the comminuted fragments; as endorsed since the Hippocratic corpus (Goold 1999, 259). In fact, had there not been follow up adjustment treatments of the aligned jaw fragments by the physician, the fractured jaw component identified as the base triangle would not have been set to fuse as close to the contour of the mandibular oblique line and mental protuberance (presenting indirectly ample evidence, that locus specific properly placed bandaging was implemented during the healing process).

[1] Following the fracture and during the healing process there had been acutely intensified, antagonistic, directional dynamics between: a) the muscles of mastication (m. temporalis, m. masseter, and mm. mesial and lateral pterygoids), basically lifting the left mandibular fragment upwards (action: elevator muscles--the lateral pterygoid also acts as a mandibular protrusion muscle) with trajectory emphasis at the *gonion*, and b) the suprahyoid muscles (m. digastric, m. geniohyoid, m. stylohyoid [as it assists in the lowering of the mandible], and m. mylohyoid) which would pull the right mandibular fragment mainly downwards (action: depressor-retractor muscles) with emphasis at the anterior mandibular region of the *pogonion*. Similarly, to the latter, the base triangle fragment would have been pulled downwards.

Figure 4. A dorso-lingual view of the mandible with a focus on the callus formation and outcome of the dorso-ectopic loci of attachments on Ms. genioglossus, geniohyoideus, digastricus, and mylohyoideus.

It could be easily surmised, however, that the Byzantine warrior had been saved from a life-threatening wound by the imminent surgical intervention and requisite follow up medical attention of an experienced physician for the duration of the rather lengthy healing process, (which also involved the immobility of the masticatory apparatus, possibly through maxillo-mandibular fixation, whereby certain amenities must have been accessible for the assistance by a support group[2]). Such a healing regimen could not have been easily attainable while for example the Byzantine warrior would continue to participate in naval operations or in the field during active military campaigns; particularly under the tumultuous circumstances of the period and warfare against the invading Ottoman forces, conditions that branded his adult life experiences.

Evidence on the high quality of care and of the erudite level of therapeutic methods applied during the medical care and relative support through the healing process is derived not only by the absence of any dento-cranial manifestations that would indicate the presence of palaeopathological manifestations which could have been caused by secondary infectious changes (for comparative purposes to current protocols and methods cf. Petersen et al., 2008; Hospenthal et al., 2011), but also by the alignment of the healed mandibular fragments that resulted in a rather favorable grade of functional occlusion in masticatory processes, between maxillo-mandibular incisal and occlusal dental surfaces[3], aided by a high degree of continued attention on matters of oral hygiene (considered as most important since the recommendations of the Hippocratic corpus, cf. Ailianos 1977-78).

Accordingly, dental wear patterns between functioning maxillo-mandibular counterparts that were preserved *in situ* presented smooth, nearly horizontally homogenous, occlusal surfaces, reflecting on the very good quality of dietary intake preparation; indicative of a dental age at death assessment (based on dental wear patterns adjusted for the population sample of Polystylon), within the terminal Middle Adulthood to early Late Adulthood, within the range of 35

[2] For example not only to minimally care and feed the patient for four to six weeks, but to also follow up the wounded area and to provide for the adjustments necessary regarding functional occlusion till recovery within the range of eight to eleven months (for the latter under modern medical conditions, personal communications, since 1992, with my late doctoral advisors Drs. Irwin D. Mandel, Director of Clinical Research, and Sidney L. Harowitz, Acting Dean, School of Dental and Oral Surgery, Presbyterian Hospital, Columbia University).

[3] Despite a slight mesial displacement of the right mandibular condyle with an ipsilateral articular extension within the right temporo-mandibular fossa, and concomitant osteoarthropathic effects with a focus on the left temporo-mandibular joint counterparts; the latter as a results of years of functional modification through masticatory processes.

to 40 years. Meanwhile, a set of maxillary teeth preserved *in situ*, the left canine ($L.C^1$) and first premolar ($L.PM^1$), having lost the capacity to functional occlusion with their mandibular counterparts (since the mandibular fracture), had retained a level *ante* of wear on their incisal and occlusal enamel surfaces. There was only a slight cusp tip flattening on the canine with traces of an incipient islet of dentin and of a more moderate buccal cusp flattering on the premolar with a better-defined islet of dentin. Such wear patterns of the two teeth, dysfunctional in masticatory processes since the trauma impact, provided for a dental age assessment of ca. 25 to 28 years, suggesting that the mandibular fracture could have been sustained approximately ten years before the incidence of his execution (the evidentiary data retrieved from dental anthropological evaluations were corroborated by palaeopathological assessments on the histologic and morphological nature of the mandibular callus formation indicative that the mandibular healing had taken place long term before death).

On matters of trauma induced dental loss and deficient neurovascular plexus functions at the inferior alveolar *loci*, it may be argued that the warrior would have experienced audible changes in certain aspects of speech resonance (minimally due to the posterolingual repositioning of muscle groups and oral mucosa tissues within the oral cavity that aid in speech production), along with paraesthesia and sensory loss, due to damage of the inferior alveolar nerve (particularly the left mental nerve, but also of vascularization damage specifically of the inferior labial artery and vein and their respective mental branches) minimally within the region of the lower lip and chin area.

Moreover, although unable to skeletally trace additional intraoral soft tissue defects that would have been caused by the injury, the external scarring at the left lower mid-facial, upper and lower lip and chin regions and the mesial mandibular subunit, concomitant to traces of injury at the left infraorbital component and left lateral locus of the zygomatic subunit, could have been somewhat concealed by the growth of a beard with moustache. Notwithstanding serious life-threatening conditions that could have prompted the potential for enervation it appears that the *Polystylite* warrior, following the healing process, was duly engaged at a commanding position in the defense of the fort until its fall to the Ottomans. His cranial remains, discovered six centuries later in the grave of a youth at the center of the fort's cemetery site, uniquely manifest an account of unyielding actions against the assailants as well as the chronicle of his horrific suffering and decapitation, as a *kephalé* of the fort, persecuted at the hands of the invaders; indicative that the fort did not surrender, but that it must have been taken by force.

CONCLUSION

However limited the unearthed dento-cranial record of the Byzantine veteran may be it nevertheless yielded a rare ensemble of archaeo-historical information, offering a testimonial on the defense of the fort under siege, the heroic resistance to the invaders, and the inhumane consequences suffered at the hands of the conquerors. It also disclosed a rarely preserved case of palaeopathology, relevant to a grievous trauma impact and of valuable methodological aspects of medico-surgical intervention, of the healing regimen and even of a tangible record of its outcomes. Consequently, it unveiled distinctive marks of the warrior's life experiences, permanently ingrained in his cranial remains, as it also contributed valuable tesserae toward the domain of medical history on matters of medical practice. It elucidated an unbroken nexus to elements and principles in the treatment regimen of *fractura mandibulae* as prescribed in the Hippocratic treatise, implemented after the passage of ca. 1,800 years during the torment of the final warred phase of the Byzantine Empire.

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