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A Ptolemaic mummy reveals evidence of invasive dentistry in ancient Egypt

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Abstract

Over the last decades, it has been confirmed that computerized tomography (CT) is a valuable tool for studying mummies. In joint efforts put forth by the Mummy Research Project of the Hellenic Institute of Egyptology, the National Archaeological Museum, and the Athens Medical Center, a mummy was transported to the Radiology Department of the Athens Medical Center for study. Thus, a complete CT scanning was performed of this Ptolemaic mummy (AIG 3343: Sekhem, male, 150–30 BCE), belonging to the Egyptian Collection of the National Archaeological Museum of Athens. The most significant finding is an interproximal carious cavity packed with protective material. This is the second case of dental packing in the literature among ancient Egyptian mummies studied to date. Its remarkable resemblance to the previously published study may indicate a common dental intervention performed by ancient Egyptians. Despite the well-known early medical traditions of ancient Egypt, spanning from the Old Kingdom to the Ptolemaic and Roman Periods, little evidence remains of their practices in dentistry. Our finding represents a rare perspective on the origins of what remains today a major allied health field discipline.

KEYWORDS

ancient dentistry, dietary habits, Egyptian mummies, fillings, invasive dentistry, operative dentistry, Panopolis, teeth

1 | INTRODUCTION

Worn teeth, caries, periodontal disease, and cavities/abscesses tormented ancient Egyptians (Zweifel, Büni, & Rühli, 2009). Among them, excessive tooth wear was the most common pathological condition in their dentition (Forshaw, 2009a). Ancient Egyptians were famous for their medical knowledge and specialization. Because of the excellence in medicine and the high prevalence of dental disorders, it could be logical for ancient Egyptians to have developed operative dental treatment. Regrettably, even though thousands of mummies have been examined, no substantial evidence has come to light. There are only a few cases where surgical treatment of a dental abscess is reported to have occurred along with three cases of potential prosthetic work and a small number of teeth removals (Forshaw, 2009b).

Research on human mummies has always been fascinating for scientists and laypeople alike. In the past, many ancient Egyptian mummies underwent destructive

procedures in laboratories such as unwrapping and autopsies with debatable scientific results, a practice that is today ethically unacceptable (Jackowski, Bollinger, & Thali, 2008).

Modern Palaeopathology uses noninvasive techniques to investigate mummies. Radiography, as a noninvasive method, was used to investigate the contents of wrapped mummies shortly after its invention by Roentgen in 1895. A royal mummy (Tuthmosis IV) was the first one studied by Dr. Khayat with Radiography in 1903 (Chan, Elias, Hysell, & Hallowell, 2008; Smith, 2000). The disadvantage of this method is that although skeletal structures can be adequately demonstrated, a more in-depth survey of wrappings, contents, and embalmment procedures is not feasible (Jackowski et al., 2008).

Computerized tomography (CT) has been applied to the study of mummies since the late 1970s. The first study with CT was published in 1979 (Chan et al., 2008; Harwood-Nash, 1979). In the following decades, its excellence in the investigation of mummies has been confirmed, and CT is considered the best method for this purpose, as it allows a nondestructive insight and assures the preservation of the investigated mummies for further study and exposition in the future. The first CT examination of mummy dentition occurred in the mid-1990s when scanning resolutions had improved enough (Cox, 2015). The rapid technological improvement with multi-detector CT has allowed researchers to acquire whole-body scans with high-resolution images. Multiplanar and excellent 3D reconstructions are now feasible. The amount and quality of imaging information have tremendously increased (Jackowski et al., 2008).

Considering the lack of physical evidence supporting the existence of interventional dentistry in ancient Egypt, we present a detailed dental study for the mummy AIG. 3343, with the rare finding of a carious cavity filled with what we believe was a protective material.

2 | MATERIALS AND METHODS

The mummy AIG-3343—based on the hieroglyphic inscriptions—belongs to Sekhem, an adult male ethnic Egyptian, son of Ta-Khor (Maravelia, 2005; Maravelia, Bontozoglou, Kalogerakou, Couvaris, & Geroulanos, 2019), dating from the mid-Ptolemaic Period to the early Roman Period (150–30 BCE) with provenance from Akhmim (Panopolis; more precisely from the necropolis of El-Hawawish). It was bought by Ioannes Demetriou, a wealthy nobleman from Alexandria, probably from the antiquities' market, through the intervention of Gaston Maspero. Subsequently, in 1884, the mummy was donated by him to the National Archaeological Museum of Athens together with nine other mummies.

Akhmim is an area in Upper Egypt 470 km south of Cairo on the east bank of the Nile River opposite modern Sohag, which is on the west bank. It is referred to as the capital of the ninth Nome of Upper Egypt. The ancient Greeks referred to the city with the name Khemmis or Panopolis, which derived from the ancient Egyptian god Min, who, in the Hellenistic Period, was identified with Pan. The city's antiquity is illustrated by the extensive necropolises dating from the sixth Dynasty (2345–2181 BCE) until the Ptolemaic Period. Rock-cut tombs were discovered there. The El-Hawawish area is located in the northeast of Khemmis, and it was the necropolis of Akhmim during the Old Kingdom. It is believed that the sarcophagi of the National Archaeological Museum of Athens originate from these tombs.

The coffin of this mummy has been studied by Maravelia (2005). This wooden anthropoid coffin is in poor condition. The head is decorated with Egyptian wig, and the face is painted with yellow ochre, matching the color of the skin. The rest of the coffin is not decorated. A vertical band with a hieroglyphic inscription—now almost wholly obscured—extends from the chest to the feet.

The mummy, including dentition, has never been radiographically investigated. In the context of the joint Mummy Research Project of the National Archaeological Museum, the Hellenic Institute of Egyptology, and the Athens Medical Center (AMC), this mummy was transported to the Radiology Department of the Athens Medical Center to be meticulously studied. It was examined using a 64-slice CT scanner (Somatom Sensation 64; Siemens Healthineers, Erlangen, Germany). A whole-body scan was performed at 120 kV and 250 mA. The slice thickness was 0.6 mm. The raw data were reconstructed using smooth body and high-resolution bone algorithms. Additionally, a specific dental scan was acquired with a slice thickness of 0.75 mm and a reconstruction increment of 0.5 mm. Multiplanar and 3D reconstructions were created using the Siemens Leonardo and Siemens Multimodality Workstations (Siemens Healthineers).

3 | RESULTS

Based on the features of the skull, we confirmed the epigraphic evidence that the mummy AIG. 3343 belongs to an adult male. His age is estimated to be between 20 and 30 years old, based on the fact that all epiphysis of long bones (McKern & Stewart, 1957), as well as the sternal epiphysis of the clavicle and the epiphysis of the iliac crest (Owings Webb & Suchey, 1985), appear united. There are no substantial degenerative changes in the

spine and large joints (Lundy, 1998). The height of the mummified body is 1.47 m; thus, the stature of the man when he was alive is estimated around 1.51–1.52 m (a rather typical medium height for ancient Egyptians), using femoral bones maximum lengths and the femoral linear regression formula for white males (Trotter & Gleser, 1952). The cause of death by our thorough examination could not be determined.

The overall dental condition is poor (Figure 1). There are signs of tooth wear in almost all teeth. It varies from a slight loss of enamel at the occlusal surfaces to an extensive loss of tooth tissue, as is the case in the right maxillary first premolar, where almost complete loss of crown and pulpal exposure is demonstrated. There is evidence of severe periodontal disease in many teeth with extensive bone loss around the roots of the maxillary lateral incisors, the proximal root of the left mandibular first molar, the roots of the right mandibular first molar, and the roots of the right mandibular lateral incisor and ipsilateral mandibular canine. Well-marginated lucency compatible with abscess/periapical cyst is seen around the roots of the right maxillary first premolar.

The most significant finding (Figure 2) in our study is the presence of a large interproximal carious cavity between the right mandibular second premolar and first molar filled with a hypodense material. The cavity is measuring 8.5 mm mesiodistally, 6 mm buccolingually, and 6 mm supero-inferiorly. The density of the material is low (average: −380 HU), possibly linen, which has a similar density. The opening of the carious cavity is smaller, measuring 6.5 mm mesiodistally and 5 mm buccolingually. Additional findings concerning the above teeth are severe bone loss surrounding the roots of the first molar and a periapical cyst around the root of the second premolar.

A similarly large interproximal carious cavity was noted. It involved the left mandibular second and third molars with concurrent signs of periodontitis and small cysts around the roots of the third molar. There is no material inserted into this carious cavity as a filling. The right and left maxillary first molars were lost, most likely antemortem, as there are no open alveoli at their positions, and there are no displaced teeth in the oral cavity, sinuses, pharynx, or larynx (Seiler & Rühli, 2015).

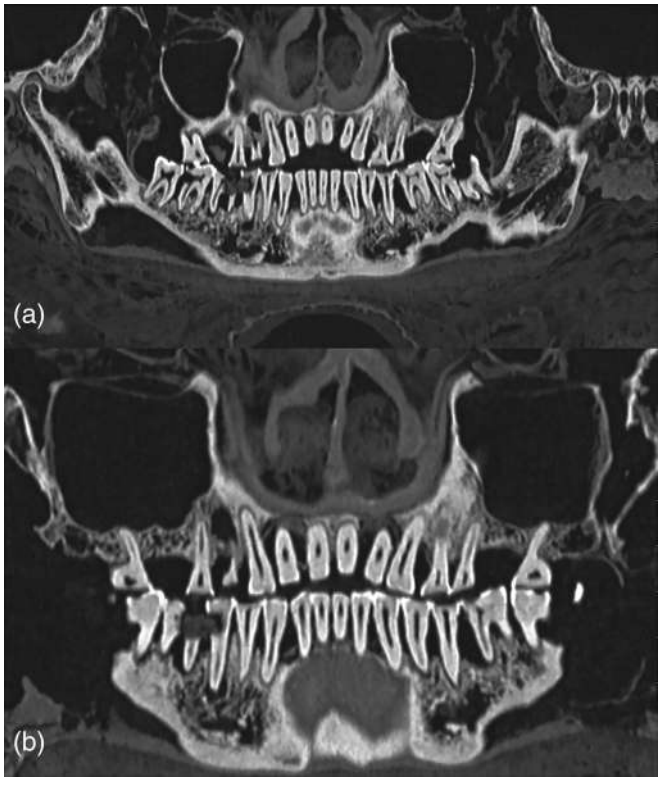

FIGURE 1 Curved multiplanar reconstructions of the mandible (a) and maxilla (b) showing tooth wearing, periodontitis, and periapical lucencies

4 | DISCUSSION

The ancient Egyptians experienced severe dental disorders such as worn teeth, abscesses/periapical cysts, periodontal disease, and caries. Some of them were painful, and others could result in sepsis and even death (Zweifel et al., 2009). The most common dental disorder was profound tooth wear caused by heavy attrition/abrasion. The overwhelming majority of Egyptians, both noble and peasants, experienced heavy tooth wear (Forshaw, 2009a; Soames & Southam, 1998). A study of 4,800 ancient teeth showed that almost 90% had signs of tooth wear (Leek, 1966). Tooth wear ranged from slight enamel loss to extensive loss of tooth tissue, which would occasionally result in resorption of the entire crown. It often caused pulpal exposure, necrosis of the pulp, apical periodontitis with subsequent multiple abscesses/osteomyelitis, and periapical cysts. The high level of attrition/abrasion is attributed to rough, stringy food with high fiber content together with contamination of bread (one of the primary and most popular foods of ancient Egyptians) with inorganic particles (Leek, 1972a, 1972b). Some of them (quartz, feldspar, mica, and others) were in the sand, which came from the desert (Forshaw, 2009a), while others originated from the use of flint-tooth harvesting equipment and soft sandstone tools in the process of grain grinding (Miller, 2008).

Ancient Egyptians were famous for their medical knowledge and specialization. Herodotus, the famous Historian, who visited Egypt around 440 BCE, illustrated the extent of medical specialty in ancient Egypt. From the translation of the hieroglyphic inscriptions found in

FIGURE 2 Axial slice (a) and oblique sagittal (b) reconstruction of the right side. A large interproximal carious cavity filled with hypodense material is clearly seen between the right second premolar and the first molar

tombs and monuments, 150 persons are recognized as medical professionals. Only nine of them are considered dentists. Hesy-Re, who lived in *c.* 2660 BCE (during the Old Kingdom) was the earliest in ancient Egypt and the whole world, who was identified as a dentist and physician and had the title "Overseer of Dentists" and "Overseer of Physicians." It is doubtful whether these honorary titles imply that these persons performed specific operative treatments, or their titles were associated with an official position or certain rituals. The terrible condition of the ancient Egyptians' teeth does not support the idea that they performed any dental operative procedures (Forshaw, 2009b).

Possible surgical treatment of dental abscess was described by Hooton in 1917 after having studied visually and radiographically an ancient Egyptian mandible, found by Reisner at Giza, dating around 2500 BCE (Hooton, 1917). Hooton based his opinion on two small penetrating holes apparent above and behind the right mental foramen, and he claimed that drillings were intentionally made as a part of an operative procedure to drain the pus of an abscess of the lower right first molar. However, a few years later, Wingate Todd (1921) argued that the anterior of the holes was a large accessory mental foramen, and the posterior hole, located between the roots of the first molar, was simply the opening of the draining sinus of the abscess. He concluded that there was no convincing evidence supporting the idea of surgical drainage in this case. When studying a similar case, Leek (1967a, 1967b) stated that circular holes as these are part of the pathological sequence of a chronic alveolar abscess and represent openings through the alveolar bone created by pus generated from an infected periapical lesion.

Two of the known prosthetic appliances, the Giza bridge (2500 BCE) and the el-Quata bridge (2500 BCE), were discovered not connected to the skull. The first was found by Junker at Giza in 1914 around the debris of a skeleton and consisted of two teeth (left second and third molar of the mandible) joined together by a gold wire. Initially, Junker reported that the two teeth were joined postmortem, in the mummification procedure. Later, he accepted the theory of Euler (Junker, 1929), who claimed that although the appliance was found outside the mandible, the wire was twisted around the teeth when the patient was alive to hold the one tooth, whose roots were pathologically absorbed, in place. Later, Leek (1967a, 1972c) examined the appliance and found that because of the profound wear of the tooth, it was almost impossible to identify the position of the tooth in the dentition or to confirm that the teeth came from the same mandible (Blomstedt, 2013). Furthermore, the wire of 0.35 mm was too thin to stabilize the teeth, and according to Leek, it was impossible to implement a knot with so many twists around the junction of the loops when the patient was alive because there was not enough space. The el-Quata bridge found in 1952 (a four-unit bridge), and it was studied in detail by Hoffman-Axthelm (1979). He reported

that the appliance was too weak to withstand the great forces of mastication during the lifetime. He concluded that this bridge was added to the mummified body during the mummification process (Blomstedt, 2013; Forshaw, 2009b; Hoffman-Axthelm, 1979). The third prosthetic work, the Tura el-Asmant bridge, also known as the bridge of Helwan (Blomstedt, 2013), dated to the Ptolemaic Period, and it seems to represent a true prosthetic appliance. It was a single-unit bridge that replaced the right maxillary central incisor, which most likely had been accidentally lost (Blustein, Stern, & Kottek, 1987; Forshaw, 2009b). However, because no other similar devices have been found so far, it is possible that either the procedure had been brought from another country or the bridge belonged to a foreign traveler (Forshaw, 2009b; Monier & Monier, 2001).

There is a vague consensus in the literature, whether extractions were conducted in ancient Egypt. Although the investigation of human remains caused some researchers to claim that extractions had been operated, it still sounds strange why many teeth severely damaged by periodontitis, which could have been easily extracted with simple procedures without the need for any specific equipment, have been left in place (Forshaw, 2009b; Miller, 2008).

Five of the 12 known medical papyri described pharmaceutical treatments and alternative therapies for 18 dental diseases with no reference to any operative dentistry. Their use was limited to the gingival and mucosal tissues. These treatments did not manage to arrest or delay the pathological process, and their results were limited to short-term alleviation (Forshaw, 2009b).

The most important finding (Figure 3) of our study of this mummy from ancient Panopolis is a large interproximal carious cavity between the right mandibular second premolar and first molar filled with low-density material. The distinct shape and low density of the material differed significantly from the embalming resin present in different parts of the skull. The dimensions of the mass of the material are greater than the opening of the cavity—a fact that reinforces the possibility that it has deliberately been inserted into the cavity. Its shape is different from the shape of the tooth, and there were other cavities that were not filled with the same material. We would expect the opposite if the material had been placed within the cavity postmortem to restore the dentition. The interproximal cavity is certainly intravital, as evidenced by the additional findings concerning the same teeth, such as severe bone loss around the roots of the first molar and the periapical osteolytic lesion surrounding the roots of the second premolar (Seiler & Rühli, 2015). For these reasons, we believe that the material was inserted into the cavity antemortem as a kind of treatment and not during the mummification for the afterlife.

We can assume that this tooth cavity was very painful and highly tormented for the mummified man during his life. It was also very severe, as in the era before antibiotic periapical infections generated from tooth wear and carious cavity could easily extend to the floor of the mouth and into the sinuses and cause severe risks for the health

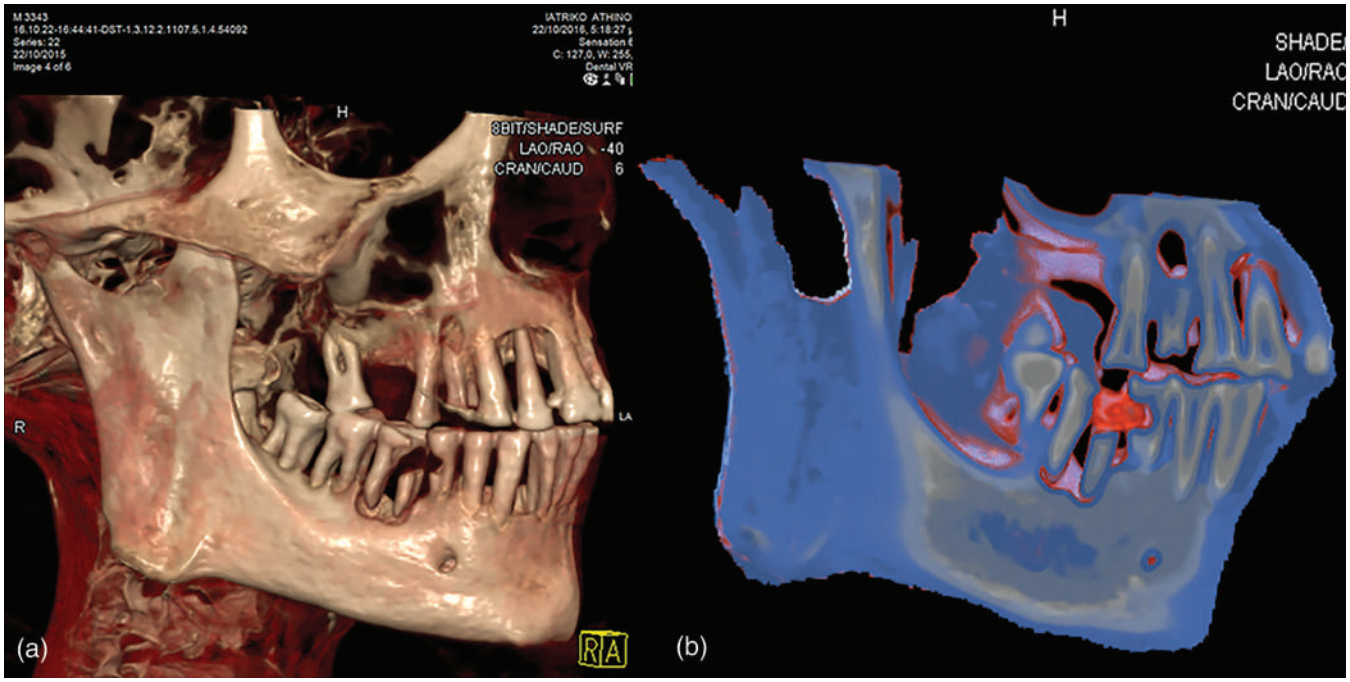

FIGURE 3 3D Reconstructions of the right side showing the large cavity and the inserted material (with red color in b)

and often the life of the individual (Bali, Sharma, Gaba, Kaur, & Ghanghas, 2015; Langsjoen, 1998; Leek, 1967a). The intensity and severity of the symptoms probably forced this man to seek for this specific and "advanced" treatment, most likely from a very famous dentist. From this rather sophisticated dental treatment, we could assume that this person (Sekhem), whose mummy was examined, may belong to the medium or relative upper layers of the ancient Egyptian society, although not the highest-ones since the poorly decorated coffin is not so elaborate and there is a lack of titles in the inscription, as Maravelia has shown (2005). We must point out, though, that the embalmment of this mummy is the best of the five mummies scanned until now, that the bandages were kept in excellent condition and that transnasal excerebration was performed.

The filling material, most likely linen, seems inadequate to reestablish the strength and function of the tooth. As a result, it cannot be considered as an example of true surgical dentistry. Rather, it represents a kind of more interventional conservative treatment that aimed to protect the carious cavity from food and safeguard the pulp/nerve from the painful contact with food or other objects. It could also serve as a means of application for a local remedy.

Our case of filling material inserted into a carious cavity is only the second case in the literature among Egyptian mummies studied to date. The first one was published in 2012 by Wade et al., who studied a Ptolemaic male mummy from Thebes (RM 2718; 350–60 BCE) kept at McGill University's Museum in Montreal (Wade, Hurnanen, Lawson, Tampieri, & Nelson, 2012). They recognized a quite similar large interproximal cavity between the left maxillary first and second molars, which was filled with low-density material (average: −350 HU), possibly linen. The study concluded that the filling material represents a kind of antemortem therapeutic effort. There is a striking similarity between our case and the one by Wade et al., which may indicate a common therapeutic procedure. Specifically, the packing material has almost the same appearance as the material of that case, as it has the same low homogenous density, its shape is similar and different from the shape of the tooth, and although its diameter exceeds the diameter of the opening of the carious lesion, it remains loose within the cavity. Additionally, as in that case, all the dental cavities noted in our case were not filled with packing material.

5 | CONCLUSIONS

Ancient Egyptians suffered from significant dental disorders. Despite their medical excellence and the knowledge from the ancient texts that the profession of dentist existed in ancient Egypt, there is not enough evidence that invasive dentistry was performed.

In our noninvasive H-R dental study, we described a rare finding, only the second case in the literature, to the best of our knowledge, which strengthens the theory of dental intervention in Ancient Egypt. We may assume that a more detailed examination of Egyptian mummies with modern scanners will probably reveal additional similar interesting findings concerning dentition, as well as other spectacular findings related to the whole body of the mummies.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

AUTHOR CONTRIBUTIONS

Ioannis Pantazis: Conceptualization; data curation; formal analysis; investigation; methodology; validation; visualization; writing-original draft; writing-review and editing. **Eleni Tourna:** Formal analysis; funding acquisition; investigation; methodology; resources; supervision; writing-original draft; writing-review and editing. **Alicia Maravelia:** Formal analysis; funding acquisition; investigation; methodology; supervision; writing-original draft; writing-review and editing. **Kiriakos Kalampoukas:** Conceptualization; formal analysis; investigation; methodology; validation; writing-original draft; writing-review and editing. **Georgios Michailidis:** Conceptualization; formal analysis; investigation; methodology; validation; visualization; writing-original draft; writing-review and editing. **Kleanthi Kalogerakou:** Investigation; visualization; writing-original draft; writing-review and editing. **Stavroula Kyriazi:** Conceptualization; formal analysis; investigation; methodology; validation; writing-original draft; writing-review and editing. **Constantinos Couvaris:** Formal analysis; investigation; validation; writing-original draft; writing-review and editing. **Stefanos Geroulanos:** Investigation; supervision; writing-original draft; writing-review and editing. **Nikos Bontozoglou:** Conceptualization; formal analysis; funding acquisition; investigation; methodology; resources; supervision; visualization; writing-original draft; writing-review and editing.

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