

## REVIEW ARTICLE

### Cranial trepanation in *The Egyptian*<sup>☆</sup>

S. Collado-Vázquez<sup>a,\*</sup>, J.M. Carrillo<sup>b</sup>

<sup>a</sup> Departamento de Fisioterapia, Terapia Ocupacional, Rehabilitación y Medicina Física, Facultad de Ciencias de la Salud de la Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain

<sup>b</sup> Departamento de Personalidad, Evaluación y Psicología Clínica, Facultad de Psicología de la Universidad Complutense de Madrid, Madrid, Spain

Received 17 December 2010; accepted 19 May 2011

Available online 24 July 2014

#### KEYWORDS

Ancient Egypt;  
Surgery;  
History of neurology;  
Medicine and literature;  
Egyptian medicine;  
Trepanation

#### Abstract

**Introduction:** Medicine and literature have been linked from ancient times; proof of this shown by the many doctors who have made contributions to literature and the many writers who have described medical activities and illnesses in their works. An example is *The Egyptian*, the book by Mika Waltari that provides a masterly narration of the protagonist's medical activity and describes the trepanation technique.

**Development:** The present work begins with the analysis of trepanations since prehistory and illustrates the practice of the trepanation in *The Egyptian*. The book mentions trepanation frequently and illustrates how to practice it and which instruments are required to perform it. Trepanation is one of the oldest surgical interventions carried out as treatment for cranial trauma and neurological diseases, but it also had the magical and religious purpose of expelling the evil spirits which caused the mental illness, epilepsy, or migraine symptoms.

**Conclusions:** Trepanation is a surgical practice that has been carried out since prehistory to treat post-traumatic epilepsy, migraine, and psychiatric illness. *The Egyptian* is a book that illustrates the trepan, the trepanation technique, and the required set of instruments in full detail.

© 2010 Sociedad Española de Neurología. Published by Elsevier España, S.L.U. All rights reserved.

#### PALABRAS CLAVE

Antiguo Egipto;  
Cirugía;  
Historia de la neurología;  
Medicina y literatura;  
Medicina egipcia;  
Trepanación

#### La trepanación craneal en Sinuhé, el Egipcio

#### Resumen

**Introducción:** La Medicina y la Literatura han estado unidas desde antiguo, prueba de ello es que muchos médicos se han dedicado a la Literatura y muchos escritores han plasmado en sus obras la actividad médica y la enfermedad. Un ejemplo es la obra *Sinuhé, el egipcio* de Mika Waltari, que narra magistralmente la actividad médica del protagonista y describe la técnica de trepanación.

<sup>☆</sup> Please cite this article as: Collado-Vázquez S, Carrillo JM. La trepanación craneal en Sinuhé, el Egipcio. Neurología. 2014;29:433–440.

\* Corresponding author.

E-mail address: [susana.collado@urjc.es](mailto:susana.collado@urjc.es) (S. Collado-Vázquez).

**Desarrollo:** El presente trabajo comienza con el análisis de las trepanaciones desde la Prehistoria y se ilustra la práctica de la trepanación en *Sinuhé, el egipcio*. En esta obra se hace referencia en múltiples ocasiones a la trepanación y se detalla la forma de practicarla y el instrumental necesario. La trepanación es una de las intervenciones quirúrgicas más antiguas llevada a cabo con fines terapéuticos en traumatismos craneales y patologías neurológicas, pero también con una finalidad mágico-religiosa, para expulsar los espíritus malignos causantes de enfermedades mentales o de los síntomas de epilepsias y migrañas.

**Conclusiones:** La trepanación es una práctica quirúrgica realizada desde la Prehistoria en traumatismos craneales, epilepsias, cefaleas y enfermedades psiquiátricas. En la novela *Sinuhé, el egipcio* se describe con detalle la figura del trepanador, la técnica de trepanación y el instrumental necesario.

© 2010 Sociedad Española de Neurología. Publicado por Elsevier España, S.L.U. Todos los derechos reservados.

## Introduction

Since ancient times, medicine has been defined as both a science and an art, and as a sphere within which science, culture, and the humanities are not clearly delimited.<sup>1</sup> Many doctors have also been writers, including Anton Chekhov, Gregorio Marañón, Pedro Laín Entralgo, and Juan Antonio Vallejo Nágera. In turn, many writers have described medicine, illness, pain, and death in such works as *Don Quixote* by Cervantes, *The Death of Ivan Ilych* by Tolstoy, *The Citadel* by Cronin, *Rest Home* by Camilo José Cela, and *The Plague* by Albert Camus.<sup>2–5</sup>

*The Egyptian*, penned by Finnish author Mika Waltari, is a powerful tale of the protagonist's medical career, his learning process, and the evolution from magical beliefs to a more scientific form of medicine. This book refers to trepanning and indicates how the procedure was performed and what instruments were used.<sup>6</sup> Trepanning is a surgical procedure that has been practised since prehistoric times for head trauma, post-traumatic epilepsy, migraine, and a host of neurological disorders. However, these operations also held magical significance in ancient times.<sup>7–9</sup>

The purpose of this article is to examine Waltari's literary description of trepanation while offering a historical overview of this practice.

## Procedure

### Cranial trepanation

Palaeopathology studies have shed light on a surgical procedure that has been practised by numerous cultures since time immemorial: trepanation. This practice consists of removal of cranial bone slabs using an instrument called a trephine, from the Greek word for 'drill'.<sup>7,10</sup> Trepanning gives rise to many questions, such as the purpose of the procedure, whether it had precise indications, if it was part of a ritual, what were the most common complications, and the survival rate.<sup>11–13</sup>

Trepanning seems to have been prescribed as a treatment measure for headache, mental illness, epilepsy, and most of all, head trauma. In the latter case, the procedure was

used to relieve pressure on the brain caused by fracture, to remove bone shards, or to drain haematomas.<sup>11,14,15</sup>

The procedures and instruments varied according to the culture and the moment in history. In general, however, the practitioner would detach the scalp, perforate the cranium, and clean the wound before covering it with a plate of precious metal and then applying a bandage. Instruments employed included trephines, knives, tumis (T-shaped knives), saws, chisels, burins, hammers, sharp stones, and forceps. The operation lasted between 30 and 60 minutes in adults and about 10 minutes in children.<sup>7</sup>

### Prehistory

Trepanned skulls from the Neolithic and Mesolithic periods, some as much as 10 000 years old, have been found in Japan, the Iberian peninsula, Germany, Ukraine, the Czech Republic, Hungary, France, Syria, Chile, Mexico, Peru, and Bolivia. Many of these skulls exhibit new bone formation along the edges of the orifice, indicating that the subjects survived the intervention (Fig. 1).<sup>10,16–19</sup>

It is believed that between 80% and 90% of the subjects may have survived and that many deaths were due to postoperative infection and not the operation itself. These figures vary greatly depending on the historical moment, geographical location, and the technique employed.<sup>19–21</sup>

In his study of more than 600 skulls, Verano calculates a survival rate of about 78%, although he is not able to distinguish between short-term and long-term survival.<sup>22</sup>

According to Laín Entralgo, the purpose of trepanation would have been twofold: firstly, to surgically remove real or suspected accumulated material from the cranial cavity, and secondly, to magically release harmful presences that might have entered the body as the result of a curse.<sup>23</sup> Other authors support this assessment.<sup>24,25</sup>

According to Reverte Coma, when primitive man removed a depressed bone fragment from the skull, smoothed the edges of the skull fracture, and removed necrotic tissue, his actions were rational. After repeating these actions many times, ancient practitioners would have become experts with numerous cases of successful trepanation using different methods, including grinding and drilling. These techniques were used as therapy for head trauma,



Figure 1 Prehistoric skull with a burr hole.

headaches, mental illness, and epilepsy, but although their use implied a certain degree of rationality in ancient cultures, the process was also a magical act aiming to cure an illness caused by an evil spirit that had to be released.<sup>25</sup>

As many as 5 to 7 trepanations were performed on some skulls, which exhibit burr hole sizes ranging from 1 to 10 cm. In some cases, we find signs that the patient survived.<sup>7,22</sup> Skulls have also been found showing incomplete trepanation; this was probably due to death of the patient during the procedure, which was then halted.<sup>22</sup> Trepanned skulls most frequently belong to adult males, the group most likely to suffer head trauma, but others have been found from women and children under 12, and in some cases as young as 2 or 3 years.<sup>22</sup>

### Ancient Egypt

Babylonian and Egyptian inscriptions recommend trepanning in certain cases. In other cases, pronouncing invocations to expel the demons causing the disease would have been sufficient.<sup>11,14,15</sup> This provides an idea of how closely medical practice was linked to magical and religious concepts at the time.<sup>22,26,27</sup>

Some authors state that trepanation was not frequently performed in ancient Egypt. Similarly, the Edwin Smith Papyrus (700 BCE), a copy of a much older papyrus describing surgical techniques, does not mention this type of procedure. Elliot Smith, a professor in Cairo, studied some 15 000 Egyptian skulls and found no traces of trepanation.<sup>6,26,28–31</sup>

Scholars have found a few trepanned skulls from Ancient Egypt, but their numbers are low compared to other cultures. For example, the Czech anthropologist Hrdlicka discovered an Egyptian skull with trepanation marks and reported his find to Egyptologist James Breasted. The Qasr Al-Eini Museum of medicine, a dependency of Cairo University, conserves three trepanned skulls from the time of the

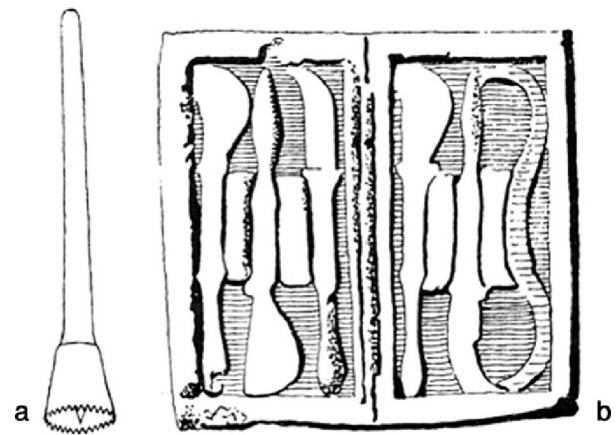


Figure 2 Instruments used by Greek doctors in trepanation procedures. (A) Simple trephine with central spike and (B) Scalpel kit.

pharaohs that show signs that the patients survived. Radiographic and tomographic studies of a pre-Ptolemaic mummy with a trepanned skull showed clear signs of osteoblastic bone reaction along the edges of the orifice, indicating that the patient survived. Likewise, the grand tomb of Maya and Merit in Saqqara also contained a skull with a burr hole in the occipital area and signs compatible with patient survival. This operation was probably carried out to drain a subdural haematoma.<sup>8,26</sup>

### Greece and Rome

Practitioners in ancient Greece and Rome used trepanning to treat convulsions, especially those resulting from trauma.<sup>31</sup>

Hippocrates of Kos (460–370 BCE) was a pioneer in treating cranial lesions as we see in *On Injuries of the Head*. Here, he proposed a classification system for cranial fractures and indicated the cases in which trepanation might be indicated; at a later point, he improved that technique (Fig. 2).<sup>8,28</sup>

In the 1st century, Celsus (25 BCE–50 CE) described trepanations and instruments such as *terebras* and trephines.<sup>32</sup>

Along with other Greco-Roman authors, Galen (129–200 CE) described this practice and recommended it for cranial fractures to relieve pressure and decrease pain. It was more controversial, however, as treatment for epilepsy, headache, or paralysis.<sup>12</sup> Aretaeus of Cappadocia (120–200 CE) recommended trepanning in epilepsy cases when conservative treatment had failed. In contrast, Caelius Aurelianus (400 CE) criticised the practice of trepanning as harmful in some cases.<sup>12,33</sup>

Few trepanned skulls from Imperial Rome have been discovered, and this may have several explanations. It is possible that surgery was only used on rare occasions when conservative treatment had failed. Another explanation is that cremating corpses was a common practice in Rome, and therefore few skeletons from that period remain.<sup>12</sup>

### Middle ages

During the Mediaeval period, trepanation was performed as therapy for head trauma and epilepsy (Fig. 3) as well as



Figure 3 The extraction of the stone of madness.

for superstitious reasons as a means of ousting evil spirits. Paintings depict these procedures, such as *Cutting the Stone* by Hieronymus Bosch (Fig. 4). It was believed that madness was caused by the formation of stones below the cranial surface, and healers would make incisions in the head to extract them. After the operation, the healer would show bystanders a stone that he had palmed, claiming that it had come from the patient's head.

### Early modern period

During the Renaissance, craniotomy continued to be used to treat post-traumatic epilepsy by removing fragments of fractured bone without removing damaged brain tissue.<sup>31</sup>

Andreas Vesalius (1514–1564) performed several trepanations; his patients included Don Carlos, Prince of Asturias and Henri IV of France. In the latter procedure, he was assisted by French surgeon Ambroise Paré (1510–1592).<sup>31,35</sup>

Andrés Alcázar (1500–1584) perfected the trepanation technique, designed tools for the procedure, and wrote one of his century's best studies on the use of the technique: *Chirurgiae libri sex*, published in 1575.

In 1600, William Harvey recommended trepanation as treatment for migraines<sup>36</sup> and Finger mentions that Duretus, also in 1600, cured an epileptic child by removing a broken bone that exerted pressure on the brain.<sup>31</sup>

### Contemporary period

Trepanations continued to be performed, and researchers perfected both techniques and tools. For example, in 1828, Dr Benjamin Dudley of Kentucky developed a trepanation technique for treating traumatic epilepsy.<sup>31</sup> At the time, trepanning was performed in cases of epilepsy, head trauma, brain cysts, and brain tumours.<sup>37</sup>

### Early palaeopathology studies of trepanation

Rivet states that the first early trepanned skull was found by Montfaucon in Cocherel in 1685; the first detailed case of a trepanned skull was presented by Jean-Denis Barbié du Bocage in 1816. A body of knowledge about trepanning began to accumulate in 1839 when Morton published *Crania Americana*. The book included an image of a trepanned skull from Peru which Lehmann-Nitsche later examined.<sup>38,39</sup> Interest in this practice grew when anthropologist Ephraim George Squier returned from Peru with a prehistoric trepanned skull. The skull was studied and presented to the Anthropological Society of Paris 2 years later by Paul Broca, who affirmed that the patient had survived for at least several weeks after the operation. Subsequent discoveries of other trepanned skulls awakened the interest of doctors, historians, and anthropologists.<sup>12</sup>

### Sinuhe the Egyptian

Mika Waltari (1908–1979) wrote his novel *The Egyptian* in 1945, after having spent 10 years studying Egyptian culture. The author demonstrated his craftsmanship and talent for blending the documented history of ancient Egypt with popular stories and legends. For example, he draws from *The Story of Sinuhe*,<sup>40</sup> the tale of a government official in the age of Senusret I (1956–1911 BCE in the Twelfth dynasty of the Middle Kingdom). So as not to be implicated in a conspiracy he accidentally discovered, and which would prove fatal to Amenemhat I, he fled to Palestine, where he remained until his old age. In addition to using the same name for his protagonist, Waltari draws on other parallels, such as telling his story in first person, including the tale of the flight of Sinuhe, and describing the conspiracies in which he found himself embroiled. According to Waltari's version, these conspiracies were due to religious reforms introduced by Akhenaten, the tenth pharaoh of the Eighteenth dynasty, who ruled from 1353 to 1336 BCE. Waltari's novel includes several references to the ancient Egyptian story, for example, when the mother chooses the name of her adopted son based on legendary history, and when she related the adventures of Sinuhe to her son. *The Story of Sinuhe*, dating from the 14th century BCE, is known thanks to two of the Berlin papyri, 10499 (B) and 3022 (R) discovered in 1863 by the Egyptologist Chabas. We also observe similarities to certain passages of the Old Testament, specifically, the story of Moses. Like that Biblical figure, Sinuhe was abandoned in the Nile in a basket, and his flight may be compared to Moses' exodus in search of the Promised Land.

Another story from which the Finnish author probably drew material was the saga of Tabubu. This story written in the time of the Ptolemaic dynasty tells of the nightmares

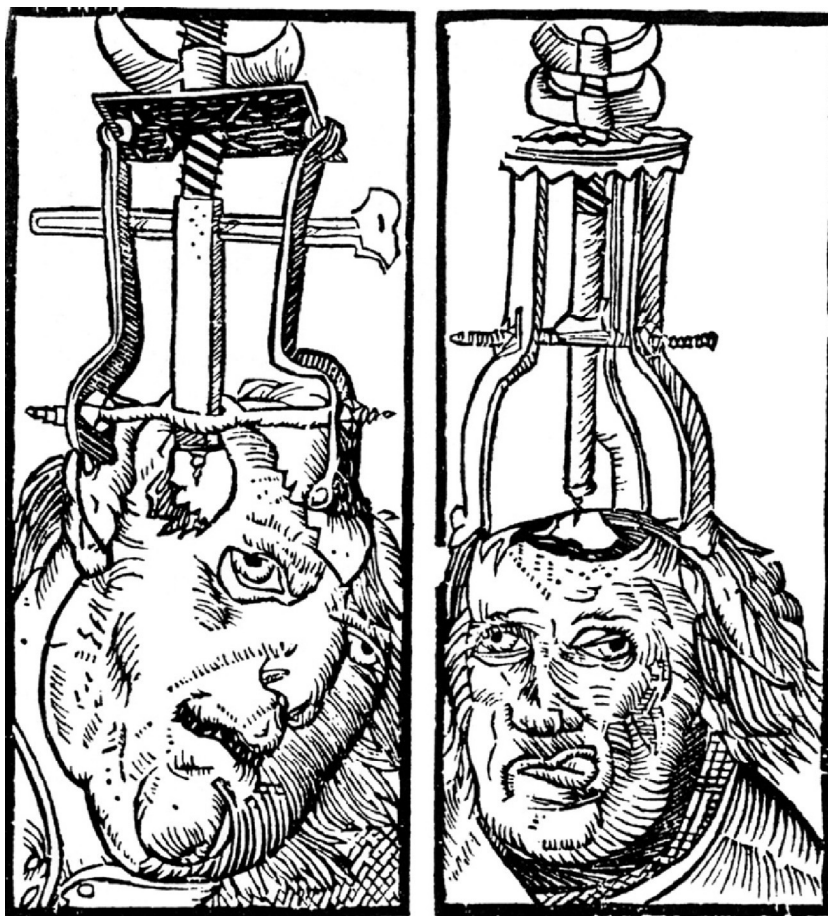


Figure 4 Mediaeval trepanation.

with which Tabubu, priestess of the cat-goddess Bastet, tormented the son of Ramesses II. In *The Egyptian*, Tabubu became the devious Nefernefer, the wicked woman who seizes all of Sinuhe's worldly goods.

The author also draws from *The Satire of the Trades*, also called *The Instruction of Dua-Kheti* (2400 BCE), as we gather from a dialogue between the protagonist and the scribe Horemheb on the importance of the scribe's profession.

In the late 19th century, 380 clay tablets were found in Tell el-Amarna; foreign governors of Canaan, Mittani, Assyria, and Babylon had written them to Amenhotep III and IV, and these pharaohs appear in Waltari's novel. Considering the author's interest in Akhenaten, it is very likely that he would have analysed the Amarna letters for background information.

In 1941, a few years before Waltari published his novel, Egyptian writer and Nobel Prize winner Naguib Mahfuz (1911–2006), wrote *Awdat Sinuhi* (*The Story of Sinuhe*). This novella is directly based on ancient texts, but it also takes the liberty of including love stories that do not appear in the originals, and Mika Waltari would do the same in his version.

*The Egyptian* was Waltari's first historical novel and his most successful book. It is structured in 15 chapters narrated in first person by Sinuhe, the royal doctor who has been exiled since the death of Amenhotep IV (Fig. 5). Throughout the story, Sinuhe's concept of medicine evolves from a magical and religious view to a more rational and empirical

view thanks to his experience and powers of observation.<sup>6</sup> The setting is Ancient Egypt, during the reign of Amenhotep IV who changed his name to Akhenaten and created a religious schism by introducing worship of Aten as a sole deity.<sup>6</sup> Waltari had already developed an interest in this pharaoh, as shown by his play that premiered in Helsinki in 1938.

His original novel, *Sinuhe egyptiäinen*, was published in Finnish in 1945. It would go on to be translated into different languages and published in many countries. In Spain, editor José Janés published the novel, translated by Manuel Bosch Barrett, in 1950. This translation was used in all subsequent editions of the book released by Plaza y Janés (1963, 1966, 1971, 1981, 1995), GP (1959), Círculo de Lectores (1965, 1991), RBA editores (1993), Debolsillo (2000, 2009), and other publishers. We use the same translation for our analysis of trepanation in the Spanish version of *The Egyptian*.

### Trepanation in *The Egyptian*

*The Egyptian* is a work of historical fiction and its author made no claims of scientific, historical, or medical accuracy. As mentioned before, Waltari researched this topic extensively, and by intertwining history, legend, and his own imagination, he presented a plausible recreation of life in ancient Egypt with some artistic license. For example, he



Figure 5 Engraving depicting pharaoh Amenhotep IV.

refers frequently to trepanation, when it seems that trepanning was only rarely practised in Egypt. It is likely that the author would have read a Greco-Roman or mediaeval text on trepanation, given that the technique and instruments were correctly and minutely described. Similarly, during his research sessions, he may have read palaeopathology studies on this neurosurgical procedure that so fascinated him. Since the practice had been carried out in so many populations and cultures since prehistory, he decided to include it in his tale of ancient Egypt, even though the Egyptians almost never employed the technique and no studies point to ritual trepanation in dying pharaohs as described by the author.

On several occasions, *The Egyptian* mentions the figure of the trepanner and provides vivid descriptions of the trepanning process, the reasons why it was performed, and the instruments used.

Sinuhe's father Senmut tells his children about his friend Ptahor, the royal trepanner, who he says has saved many lives. Later in the story, Sinuhe, now a trepanner himself, tells a patient that only 1% of those undergoing the procedure will survive. This figure does not match his father's assertions that Ptahor has used trepanning to save many lives. Furthermore, in the trepanations described in the book, the surviving patients considerably exceed that tiny percentage. Likewise, the literature we consulted indicates that many trepanned skulls show signs of survival after the

operation, and it is believed that some 80% to 90% of the patients may have survived.

Speaking of his friend Ptahor, Senmut says, "he releases evil spirits that drive men to madness".<sup>41</sup> This sentence supports the magical and religious concept of illness that was attributed to malignant forces. Sinuhe witnesses several interventions and he will perform others himself. The multiple mentions of trepanation are surprising given that the practice was uncommon in Egypt; however, it is possible that the number of operations described in the novel represent only a small percentage of the total patients attended. On the other hand, on one occasion, when Sinuhe is studying in the House of Life, he states that he rarely sees the royal trepanner since trepanation is seldom performed.<sup>41</sup>

The novel describes the following instruments: trephines or bores, flint knives, saws, forceps, and an ebony-handled hammer. It stresses the cleansing process that takes place before surgery, during which the surgeon washes himself and the instruments are purified and passed under a flame. This process may have been completed for reasons of hygiene and asepsis, or as a ritual. The book also describes patients being given a drug mixed with narcotics to send them to sleep and alleviate the pain.<sup>41</sup>

The first of the patients treated by Ptahor is an old man with a low probability of surviving the procedure. The practitioner completes the trepanation merely to practice his technique. The second patient is a strong young slave who was struck in the head with a stone during a brawl. He can neither speak nor move his limbs. In both cases, the trepanner's technique is carefully described.

"My task was to shave the heads of both patients with the keenest of razors. Then the heads were cleaned and washed once more, the scalps massaged with a numbing salve, and Ptahor was ready for his work. First he made an incision in the scalp of the old man and pushed the edges back regardless of the copious flow of blood. Then with swift movements he bored a hole in the bared skull with a large tubular bore and lifted out the circle of bone."<sup>41</sup> After finding that there was nothing wrong with the patient's head, he replaced the extracted piece of bone, sutured the wound, and bandaged his head. The old man died some time later. The outcome of the procedure was very different in the case of the healthy young slave. He was given drugs and bound firmly, and his head was placed in a special vice so that he could not move it during the operation. The trepanner incised the scalp and stopped the profuse flow of blood, which he had not bothered to do in the case of the dying old man because he was not expected to survive and was only used as a practice case.

"The veins at the edges of the incision were cauterized and the blood stopped by special medicaments. . . . When Ptahor had cleansed the outside of the skull, he pointed out to us the place where the bone had been crushed in. By means of bore, saw, and forceps he removed a piece of skull as large as the palm of one's hand and then he showed us how clotted blood had gathered among the white convolutions of the brain. With infinite care he removed the blood bit by bit and freed a bone splinter that had been forced into the brain substance. . . . Next Ptahor closed the opening with a plate of silver that had been prepared meanwhile to correspond in shape to the piece of bone that had been removed and fixed it firmly in position with tiny clips."<sup>41</sup>

After completing the operation, he asked his helpers to wake the patient, who was nearly unconscious; they untied him, trickled wine down his throat, and gave him strong drugs to inhale in order to wake him. Soon he was sitting up and cursing, even though he had been unable to speak and move shortly before. Ptahor explained to Sinuhe that the splintered bit of bone and the pooled blood had caused the patient's symptoms, which disappeared after both had been removed. He predicted that the patient would recover if he were able to survive the first 3 days, and that in a mere 2 weeks he would be able to settle the score with the man who had broken his skull.

Sinuhe would go on to perform several trepanations; during one intervention, the patient did not lose consciousness and reported that he felt better as soon as the doctor removed the bone fragment, which ended his terrible headache and the disturbing and continuous noises in his ears. He also operated on another 2 patients who survived, and he performed the intervention 3 times in the House of Life once he had become the royal trepanner. The first patient was in poor condition and died. The second patient was a man who had fallen from a roof 2 years before and sustained no apparent injury. However, he had experienced seizures ever since his accident, especially when he had been drinking alcohol: "He...merely shouted in a furious voice, kicked, and bit his tongue, and could not contain his water."<sup>41</sup> When the doctor had opened his skull, he found quantities of old blood in many locations, and despite his efforts to cleanse it, the patient died 3 days later. The third patient was described as "a young boy [whose] head was beaten in... I...removed the splinters of bone from his brain and covered the hole with a plate of purified silver. He recovered and was still alive when I left Thebes 2 weeks later, although he found difficulty in moving his arms and could feel nothing when the hands and the soles of his feet were tickled with a feather. I believed that in time he would be completely cured."<sup>34</sup>

Some of the trepanations described in *The Egyptian* only served as a means of practising the technique; in addition, ritual trepanning was performed on the pharaoh. The reason for the operation is not given in some cases, but the rest were performed to treat head trauma with or without skull fracture, and post-traumatic epilepsy in one case.

Although Sinuhe informs a patient that the probability of surviving trepanation was very low at about 1%, when he thinks back on his life and his profession he recalls his success in these interventions: "...at this time I tended many sick people. Of the patients whose skulls I opened only three died so that my reputation as a skull surgeon stood high."<sup>41</sup>

## Conclusions

Trepanning is a surgical practice that has been used since prehistoric times to treat head trauma, epilepsy, headaches, and mental illness.

In his novel *The Egyptian*, Mika Waltari displays an accurate knowledge of techniques used in trepanation. His understanding is largely based on his extensive research, although the sources he used as his references probably reflected practices from areas other than Egypt;

palaeopathology studies indicate that trepanning was rarely practised in that area.

Mika Waltari's novel provides a good example of the historical, scientific, literary, and humanist value contained in some books that link medicine to literature.

## Conflicts of interest

The authors have no conflicts of interest to declare.

## References

1. Barbado Hernández FJ. Medicina y Literatura en la formación del médico residente de Medicina interna. *An Med Interna*. 2007;24(4):195–200.
2. López-Muñoz F, Álamo C, García-García P. Locos y dementes en la literatura cervantina: a propósito de las fuentes médicas de Cervantes en materia neuropsiquiátrica. *Rev Neurol*. 2008;46:489–501.
3. Baños JE. El valor de la Literatura en la formación de los estudiantes de Medicina. *Educ Med*. 2003;6(2):1–9.
4. Ramírez-Leyva E. Medicina y Literatura en el siglo XIX. *Laborat Acta*. 2005;17(4):129–32.
5. Iniesta I. Neurología y Literatura. *Neurología*. 2010;25(8):507–14.
6. González-Arrieta ML. Medicina y Literatura, un eslabón indisoluble. Enfoque literario sobre las aportaciones de la cultura egipcia a la Medicina. *Gac Méd Mex*. 2004;140:225–8.
7. Carod-Artal FJ, Vázquez-Cabrera CB. Paleopatología neurológica en las culturas precolombinas de la costa y el altiplano andino (II). Historia de las trepanaciones craneales. *Rev Neurol*. 2004;38(9):886–94.
8. Kshetry VR, Mindea SA, Batjer HH. The management of cranial injuries in antiquity and beyond. *Neurosurg Focus*. 2007;23(1):1–8.
9. Sanan A, Haines S. Repairing holes in the head: a history of cranioplasty. *Neurosurgery*. 1997;40:588–603.
10. Martínez F, Decuadro-Sáenz G. Claudio Galeno y los ventrículos cerebrales. Parte I, Los antecedentes. *Rev Neurocir*. 2008;19:58–65.
11. Cruz-Campos G. Concepción y evolución histórica de la epilepsia en el Perú precolombino y del Virreinato. *Rev Neurol*. 1998;27(159):862–6.
12. Tullo E. Trepanation and Roman medicine: a comparison of osteoarchaeological remains, material cultura and written texts. *J R Coll Physicians Edinb*. 2010;40:165–71.
13. Martin G. Why trepan? Contributions from medical history and the South Pacific. In: Arnott R, Finger S, Smith CUM, editors. *Trepanation. History, discovery, theory*. Lisse, The Netherlands: Swets & Zeitlinger; 2003. p. 323–45.
14. Lainez Andrés JM. La clasificación de las cefaleas de la International Headache Society. *Luces y sombras*. *Neurología*. 2004;19(7):339–43.
15. Carod-Artal FJ, Vázquez Cabrera CB. Paleopatología neurológica en las culturas precolombinas de la costa y el altiplano andino(I). Deformaciones craneales intencionales. *Rev Neurol*. 2004;38(8):791–7.
16. Campillo D. La trepanación prehistórica. Barcelona: Bellaterra; 2007.
17. Campillo D. Neurosurgical pathology in prehistory. *Acta Neurochir (Wien)*. 1984;70:275–90.
18. Mogliazza S. An example of cranial trepanation dating to the Middle Bronze Age from Ebla, Syria. *J Anthropol Sci*. 2009;87:187–92.

19. Lillie MC. Cranial surgery dates back to Mesolithic. *Nature*. 1998;391:854.
20. Alt KW, Jeunesse C, Buitrago-Tellez CH, Wachter R, Boes E, Pichler SL. Evidence for stone age cranial surgery. *Nature*. 1997;387:360.
21. Andrushko VA, Verano JW. Prehistoric trepanation in the Cuzco region of Peru: a view into an Ancient Andean practice. *Am J Phys Anthropol*. 2008;137:4–13.
22. Verano JW. Trepanation in Prehistoric South America: geographic and temporal trends over 2000 years. In: Arnott R, Finger S, Smith CUM, editors. *Trepanation. History, discovery, theory*. Lisse, The Netherlands: Swets & Zeitlinger; 2003.
23. Laín Entralgo P. *Historia de la medicina*. Barcelona: Salvat; 1985.
24. Lerma Agudelo C. Arte, humanismo y cirugía: una visión holística. *Rev Colomb Cir*. 2009;24:207–22.
25. Reverte Coma JM. *Los huesos hablan. Antropología forense histórica*. Madrid: Tarabilla; 2001.
26. Martín-Araguz A, Bustamante-Martínez C, Emam-Mansour MT, Moreno-Martínez JM. Neurociencia en el Egipto faraónico y en la escuela de Alejandría. *Rev Neurol*. 2002;34(12):1183–94.
27. Natahn B, Evans G. The treatment of head injury during the Renaissance. *J Accid Emerg Med*. 1998;15:119–20.
28. Cruz-Benítez L, Ramírez-Amezcuca FJ. Estrategias de diagnóstico y tratamiento para el manejo del traumatismo craneoencefálico en adultos. *Trauma*. 2007;10(2):46–57.
29. García Albea E. La neurología en los papiros médicos faraónicos. *Rev Neurol*. 1999;28(4):430–3.
30. Krivoy A, Krivoy J, Krivoy M. Aspectos neuroquirúrgicos parciales del Papiro de Edwin Smith. *Gac Méd Caracas*. 2002;110(3):386–91.
31. Finger S, Clower WT. Victor Horsley on trephining in pre-historic times. *Neurosurgery*. 2001;48(4):911–8.
32. Gómez-González J, Briceño-Iragorry L. Trepanaciones históricas y prehistóricas en Venezuela. *Gac Méd Caracas*. 2007;115(4):292–6.
33. García Albea E. Areteo de Capadocia (siglo II dC) y las primeras descripciones neurológicas. *Rev Neurol*. 2009;48:322–7.
34. Cano de la Cuerda R, Collado-Vázquez S. Deficiencia, discapacidad, neurología y arte. *Rev Neurol*. 2010;51:108–16.
35. Izquierdo Rojo JM, Barbera Alacren J. *Lecciones de neurocirugía*. Oviedo: Universidad de Oviedo; 1992.
36. Edmeas J. The treatment of hedeache: a historical perspective. In: Gallagher RM, editor. *Therapy for headache*. New York: Marcel Dekker; 1990. p. 1–8.
37. Chico-Ponce de León F. Historia de la cirugía de cráneo, de los tumores cerebrales y de la epilepsia en México. *Neurocirugía*. 2009;20:388–99.
38. Rivet L. *Pathologie et chirurgie préhistoriques*. Presse Médicale. 1945;53:402.
39. Vera Torres J. Antonio Lorena Rozas (1849–1932). *Acta Med Per*. 2007;24(3):237–41.
40. Serrano A, Gassó J, Castellanos C. *La historia de Sinuhè i altres contes*. Lleida: Pagès; 2006.
41. Waltari M. *Sinuhé, el egipcio*. Barcelona: Plaza & Janés; 2010 [The Egyptian. New York: G. P. Putnam's Sons, 1949].