

ANTHROPOLOGY

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EARLY IRON AGE SURGICAL TECHNOLOGIES: ANTE-MORTEM TREPANATION AMONG THE EARLY NOMADS OF GORNY ALTAI*

Results of a science-based analysis of ante-mortem trepanation carried out by Scythian Age surgeons of Gorny Altai (4th–3rd centuries BC) are presented. Inductively coupled plasma-mass spectrometry, energy dispersive X-ray fluorescent analysis using synchrotron radiation, and magnetic resonance tomography were supplemented by micro-wear experiments. All trepanations were performed by scraping and included two stages. The bone tissue around the holes reveals high concentrations of copper and tin but no traces of iron or arsenic, suggesting that surgical instruments were made of tin bronze. A knife, experimentally manufactured of copper, tin, and zinc alloy and shaped like knives used by Southern Siberian nomads, was successfully used to perform trepanation on a cadaver.

Keywords: Trepanation, Pazyryk culture, Scythian Age, experimental micro-wear analysis, mass spectrometry, X-ray fluorescence.

Introduction

Successful high-risk operations performed by ancient surgeons long before the turn of the Christian Era and documented by skeletal remains are very impressive

and prompt researchers to examine this practice in detail. This particularly concerns ante-mortem trepanations, which resulted in the exposure of intracranial soft tissues such as vessels, dura mater, and sometimes the brain*.

*Supported by the Russian Foundation for Basic Research (Project No. 13-06-00153a).

*Ante-mortem trepanations include those which do not affect the inner cortical table. They are known as symbolic

Prehistoric trepanations first came to light in 1865, when Ephraim George Squier, a United States diplomat in Peru and an amateur archaeologist and ethnologist, brought to the New York Academy of Medicine a cranium from an Inca burial in the Cuzco region of Peru. The specimen had an opening, 15 × 17 mm in size, on the right part of the frontal bone, limited by four rectilinear incisions made with a burin-like tool (Fernando, Finger, 2003). The views of the Academy members as to the success of the operation were divided. The cranium was sent to the famous French surgeon, anatomist, and anthropologist Paul Broca, who concluded that the operation had been performed *ante mortem*, and that the sharp edges around the hole and signs of inflammation showed that death occurred one or two weeks later.

In the mid-1800s, less than 10 % of patients normally survived trepanation even in the best European hospitals. This was due to a very high risk of infection and to the fact that only patients with grave cranial injuries were operated on (Gross, 1999). Even at the present time, progress in medicine notwithstanding, trepanation cannot be regarded as safe and requires considerable skill. The risk it entails is about the same as in brain contusion (Prakticheskaya neirokhirurgiya..., 2002). Apart from the difficulty of the surgery itself, efficient anesthetics are needed, profuse bleeding from soft tissues and bone must be curtailed, and the development of infection in the wound must be prevented.

In the 20th century, hundreds of trepanned crania were discovered and examined, spanning the period from the Epipaleolithic to the 18th century. As a result, five principal techniques of craniotomy were described (Lisowski, 1967; Saul F.P., Saul J.M., 1997).

1. Making a rectangular hole by straight cuts. This technique is exemplified by the Peruvian skull. The tool was made of flint or obsidian.

2. Scraping. Paul Broca reproduced this technique using a piece of glass. It took him 50 minutes to scrape a hole in the cranium of a cadaver (Finger, Clower, 2003).

3. Cutting a circular groove and lifting off the disc of bone. This method was widely used in Kenya until recently (Gross, 1999).

trepanations (Bartucz, 1950) and have been practiced since the Upper Paleolithic (Mednikova et al., 2012) with apparently magic purposes (Mednikova, 2001, 2003, 2004). Symbolic trepanations are related to the tradition of scarification and tattooing, which were part of the rites of passage (Mednikova, 2004: 142). Rather than touching upon symbolic trepanations, we address true craniotomies.

4. Using a trephine (crown-saw). This method, described by Hippocrates, was elaborated by Roman surgeons and is still used (Fabbri et al., 2012).

5. Drilling a circle of closely spaced holes and then cutting or chiseling the isthmuses of bone between them. This method was recommended by the Romans, adopted by the Arabs, and became common in the Middle Ages. Its variant is still used today despite the availability of high-speed electric and pneumatic drills which have generally replaced the manually pulled Gigli saws.

It was found that the safest among the ancient techniques was scraping (Kirkur, 2003). The analysis of healing in a large collection of trepanned crania from Anatolia demonstrated that scraping yielded better results than sawing or drilling (Erdal Y.S., Erdal Ö.D., 2011).

Each technique varies depending on the material of which the tool was made, on the idiosyncrasies of “medical schools”, and on the skills mastered by a specific surgeon. Even in modern medicine the surgeon’s training and his practice are highly individual because surgery has always been an art rather than a craft.

Our in-depth study addresses the techniques of three *ante-mortem* trepanations on crania from early nomadic (Scythian Age) burials in Gorny Altai (4th–3rd centuries BC). The results were partly published in our previous article (Chikisheva et al., 2014), where we assessed the cultural and historical context of the trepanations, their adequacy from the standpoint of modern neurosurgery and radiology; also, we used written sources such as medical treatises outlining neurosurgical theories adopted in major medical centers of the past*.

Materials and methods

The trepanation technique was studied in three crania: those of a male aged 50–60 from Bikeh III burial mound 3, excavated by V.D. Kubarev (2001); a female

*Only theories were evaluated, since their efficiency is by far not always reflected by skeletal remains. A hypothesis explaining the disagreement between the detailed descriptions of recommended trepanations and their low frequency has been proposed by Nerlich et al. (2003), who examined trepanations in crania from Egyptian cemeteries spanning the period from 3000–500 BC. The authors hypothesized that Egyptian physicians, who realized the unordinary nature and complexity of trepanation as well as the risk it entailed, deemed it worth theoretical description rather than actual implementation.

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