Emergency care – in vain

By Caroline Ahlström Arcini and Niklas Marklund

Introduction

As far back as the Stone Age, people opened holes in the skull – so-called trephinations – to try to help their loved ones suffering from headaches or convulsions, or to free mentally ill people who were thought to be afflicted by evil spirits (Arnott *et al*. 2003). Several skeletons around the world exhibit holes in the skull with rounded edges, indicating that the person survived a surgical procedure. Already in the 19th century the French anthropologist Paul Broca concluded that the hole he found in an ancient skull from Peru was the product of a prehistoric surgical procedure on a living patient who survived the surgery (Broca 1867). Since then, many osteologists have reported on what came to be known as trepanations in material from different periods (Aufderheide 1985; Aufderheide & Rodríguez-Martín 1998; Brothwell 1994; Crubézy *et al*. 2001). However, 20 years ago more detailed studies were carried out and some of these so-called trepanations were re-assessed (Arnott *et al*. 2003). In some cases, the hole in the skull was reinterpreted to be caused by a tumor and several were initially found to be caused by trauma to the skull. The trauma appeared to be treated by removing pieces of the broken skull bone. So, in that sense an operation was undertaken, but not by opening an undamaged part of the skull.

Violence has been present throughout our history and in some periods it has been more common than in others, at least that is what we can infer from the skeletal material available. There are no statistics on how many of those who suffered cranial injuries survived, but some with extensive damage surprisingly show signs of healing, indicating survival for some time post-injury. Determining how much time has elapsed after an injury is, with a few exceptions, impossible to make a statement based on archaeological material. Studies of living individuals show that after surgery to the skull, there is no evidence of healing after a few days but after simple, linear fractures the healing is typically complete after 6–8 weeks. In more complex skull fractures, healing can take much longer. In cases where the skull cap had been removed and the opening is large, the hole still remains almost the same size as in the beginning, persisting for many years and only the edges have been remodeled and made rounder (Verano 2003).

It is probably not merely the size of the injury, nor how much of the skull bone that has been damaged that is most important in terms of whether a skilled man or woman corresponding to later times barber surgeons could save the person's life or not. What also has been important is where on the skull the injury occurred, how deep the injury was, and to what extent the brain was affected. Moreover, injuries to the skull carries high risks of infection and extensive bleeding from the scalp, skull bone and underlying brain. What was also of major importance was whether the person was conscious or not, or whether there were injuries to other organ systems.

However, any medical professional, or even layman in the field, who observes a large hole in a skull of a skeleton dated to the prehistoric period or Middle Ages often asks the question: How could that person survive such an injury in an era without neuroimaging, surgery, anesthetics and antibiotics? One such astonishing case has been found in Denmark at Vibygårds Mose, south of Roskilde in Zealand, during peat-digging (Bennike 1985) (fig. 1). The skeleton was not completely preserved but the skull, pelvic and limb bones were present. The osteological analysis made by Bennike indicate that it was of a man that died at the age of 35–50 years. The skeleton has been ^{14}C-dated to 3580±90 years, i.e. neolithic time.

Fig. 1. Skull from Vibygårds Mose, Denmark. Photo: Pia Bennike.

On the left side of the back of the head a large triangular opening is visible. The sides of the opening measure 95 mm and the edges of the hole show smooth rounded edges indicating that the individual's wound had healed. It cannot be determined with accuracy how long the individual has lived with the injury, but it is almost certainly several years as the edges of the injury have been remodeled and made rounder. When the edges heal, the three layers that normally make up the skull do not form, but only the two compact layers. Bennike believed that the treatment in the form of removal of damaged skull fragments was performed by someone knowledgeable and that it was preceded by extensive head trauma. Based on the extent and location of the damage her conclusion is that it was due to major trauma to the head, injuring the skull bone. The injury may have been caused by an axe striking the head obliquely from behind. This may have caused a fracture in the skull bone to the left of the cut. It was suggested by Bennike that the wound and removal of the bones may have damaged the posterior neck muscles. From the skull, the depth of injury cannot be ascertained. However, had it injured the large underlying venous sinus (the left transverse sinus) the injury would not have been survivable. Injury to the underlying brain could have caused e.g. visual filed impairment due to damage to the visual areas of the occipital lobe and may have caused balance disturbance due to injury to the cerebellum.

Experience from archaeological investigations shows that in cases where an injury is fatal, the pieces that have been chopped off are always found directly adjacent to the skull, unless the grave has been disturbed, like in this case from medieval Åhus (fig. 2a–b). In those cases where the person has survived, there are two scenarios: either the damaged skull bones have been removed and the edges have healed and are

Fig. 2. a) Skull from Dominican Convent in Åhus, Scania, Sweden. viewed from above, with the injured bone flap in its original position. b) The same skull seen from the side showing the large opening. Photo: Staffan Hyll.

Fig. 3a–b. Skull from Black friar convent, Skänninge, Östergötland, Sweden. The image shows a large depressed skull fracture on the back of the head, resulting in several cracks in the skull. The injury has healed. Photo: Per Lagerås.

rounded, like in the man from Vibygårds Mose. The second approach is not to remove the broken skull fragments but to let them heal together with the skull (fig. 3a–b).

Material

In 2019, a puzzling case was uncovered during an excavation of a Viking Age boat grave in Old Uppsala. The excavation was performed by the Archeologists in Uppsala and osteologist Caroline Ahlström Arcini carried out the excavation of the skeleton. To lift the skull, the surrounding soil was carefully removed. On the left side of the skull there was no sign of damage, but when the skull was lifted and turned so the right side was exposed, it became clear that a sword tangentially had cut a big hole in the posterior part of the right parietal bone (fig. 4a–b). The cut was sharp, tangential and based on the appearance of the skull edges it is likely that the cut had come from above and behind the man and hit him along the skull.

However, something was peculiar: the bone pieces of the skull expected to be found next to the gaping hole were missing. This was highly unusual. The soil was carefully searched. Absence of the skull pieces could only mean one thing: the man had survived for some time.

Some people trained in that day's medical treatments must have helped him after the incident. If the cut had been directly fatal, the severed piece of skull would have remained next to the skull. Most commonly, the cuts are so clean that the severed pieces fit exactly.

The buried man turned out to be a male aged approximately 40 years old and 180,4 cm tall. The osteological analysis shows no other wounds on the skeleton, neither unhealed nor healed ones indicating that the man had not been previously injured in battle, at least not sustaining skeletal injuries.

The rest of the skeleton was excavated, and the bones were lifted. Once all the skeletal remains had been removed, the excavation of the boat's contents continued, revealing different types of artefacts and bones from sacrificed animals. At the bottom of the boat a fragmented ceramic vessel was found. It was placed approximately 80 cm from the feet of the buried man. Next to the fragmented vessel, the archaeologist found various pieces of bones. Bones, which had been collected in a bag or wrapped in a piece of cloth/leather. As the bones were presumed to be from animals, no further note was taken of them. It was not until the skeletons were examined by the osteologist that it was discovered that five of the pieces was identified as human skull bone of different sizes. Immediately the osteologist recalled the shape of the large gaping hole in the man's skull and suspected that the pieces found were the missing ones. When removing the skull from its box, the newly found pieces of bone were found to fit perfectly when placed over the large hole (fig. 4c–d). This implies that he had received medical treatment for his wounds.

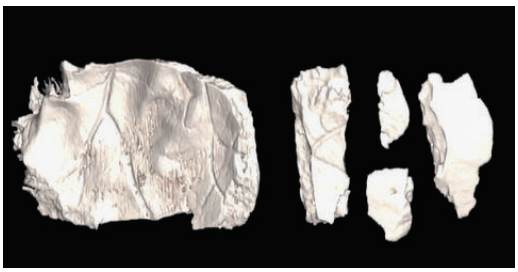

Fig. 4. Skull from a boat grave, Old Uppsala, Sweden. a) The image shows the large gaping hole in the skull and the resulting sharp edges. b) The black and white image is a CT image of the skull. c) CT scan of the bone that was removed from the same skull. d) the bone pieces that have been put back on the hole to show how well they fit. Photo: Caroline Ahlström Arcini and Marie-Louise Aurumskjöld.

Upon investigation of the skull and discovered skull bone pieces using photon-counting computed tomography (CT) at the Department of radiology, Skåne University Hospital and Lund University, Sweden, there was no evidence of bone necrosis or osteoclastic activity (Abel et al. 2023). This finding indicate that survival was rather short, some days rather than weeks, in view of the limited signs of bone healing.

Result and discussion

It can be noted that acts of violence involving injuries to the cranium can exhibit different outcomes. For example, in some cases, the outcome was immediately fatal, in others the individual survived. There is not much to say about those who did not survive, but the fact that help from others was needed to survive, the healing process and the problems that the survivors may have suffered are of interest. In this context, the man from the boat grave in Uppsala is particularly interesting. The finding of the collected missing pieces of bone from the skull in the boat grave far from the original location at the head gives a clear indication that pieces were removed as a part of treatment in an attempt to save the man's life. In short, this means that he had indeed survived for a limited period of time. As it is archaeological material, we cannot say with certainty how long he survived. No traces of new bone formation (osteoclastic activity) have been observed which means that he did not survive more than a week, presumably even shorter (Barbian & Sledzik 2008). This is also reasonable in view of the findings of the removed bone fragments, which were included in the grave with the intention that he should be as whole as possible for the journey to Valhall, the kingdom that, according to mythology, gathered all the fallen warriors. Keeping these pieces of bone, some of

Fig. 5. Male skull from a cemetery at Vreta, Östergötland, Sweden, showing a healed skull wound. Photo: Per Lagerås.

them very small, together for a long time would perhaps be less likely.

It is most likely those closest to the man, in the same social position, who established that he was alive. We cannot tell whether he was conscious or not after the blow, but he might very well have been. Based on contemporary finds where people with battle wounds have survived, they must have been familiar with treating such a wound. One such case originates from a man buried in the boat next to this man but also at a burial site in Vreta (Arcini et al. 2022). The individual in Vreta survived a large blow to the back of the head (fig. 5).

Regarding the treatment of the man from the boat grave in Old Uppsala, the circumstances of the finding of the missing skull bones placed in the grave with him but apart from the skull clearly indicates that the skull bones were carefully removed from the open wound. Arguably, the sharp cut would have produced a large wound in the scalp, exposing the underlying loose skull fragment that could be removed by the treating individual. Those who took care of him most likely had the experience that he had a good chance of survival. They had probably previously encountered unconscious individuals and may have observed them awaken after pieces of bone, and potentially even underlying hematomas pressing on the brain, were removed.

During the Viking age medical instruments made of iron were present, for example scalpels and tweezers (Bergquist 2013). However, as we have seen on the skull from the Stone Age Vibygårds Mose, it was not decisive since people managed to survive extensive skull injuries even when instruments were made of stone.

So, what can the injury tell us about how it would have affected the man if he survived? Based on the size of the injury, there must have

been a large wound in the scalp causing much pain and bleeding from the edges of the wound. With the force required to produce such extensive injury to the skull, injury to the underlying brain is likely. Injury to the parietooccipital lobes can cause a range of symptoms including disorientation and visual field deficits, and he may have developed seizures. While the injury seems posterior to the primary motor and sensory areas, some motor impairment is possible. In addition, if the cut caused a brain hemorrhage the level of consciousness was likely affected.

Regarding the recovered bone pieces that were removed, it could be said that the wound was cleaned and the bone pieces removed, and that the scalp edges were probably attached. Since he did not survive, the pieces of bone have followed him into the grave but not near his head. There is no description of any similar case in the osteological literature to the best of our knowledge.

Another more general question is whether this individual's position in society had an impact on the ability to receive medical aid? Probably, but the knowledge of how to take care of injuries before medicine became institutionalized, has certainly also been known among common people.

References

Abel, F., Schubert, T. & Winklhofer, S., 2023. Advanced Neuroimaging With Photon-Counting Detector CT. *Investigative Radiology* 58(7):472–481.

Arcini Ahlström, C., Mills, R., Konsmar, A. & Hedvall, R., 2022. Folk från kungens gårdar. *Fornvännen* 117:140–145.

Arnott, R., Finger, S. & Smith, C. (eds.), 2003. *Trepanation: History, discovery, theory*. Lisse.

Aufderheide, A. C., 1985. The enigma of ancient cranial trepanation. *Minnesota medicine* 68(2):119–122.

Barbian L. T., Sledzik, P. S., 2008. Healing following cranial trauma. *Journal of Forensic Science*. 53(2):263–268.

Bennike, P., 1985. *Palaeopathology of Danish skeletons: A comparative study of demography, disease and injury*. Copenhagen.

Bergqvist, J., 2013. *Läkare och läkande: Läkekonstens professionalisering i Sverige under medeltid och renässans*. Lund.

Broca, P., 1867. Cas singulier de trépanation chez les Incas. *Bulletins De La Société D'anthropologie De Paris* 2(2):403–408.

Brothwell D. R., 1994. Ancient trephining: Multifocal evolution or trans-world diffusion. *Journal of Paleopathology* 6(3):129–138.

Crubézya, É., Bruzekb, J., Guilainec, J., Cunhad, E., Rougéa, D. & Jelineke, J., 2001. The antiquity of cranial surgery in Europe and in the Mediterranean basin. *Comptes Rendus de l'Académie des Sciences* 332:417–423.

Verano, J. W., 2003. Trepanation in prehistoric South America: Geographic and temporal trends over 2,000 years. Arnott, R., Finger, S. & Smith, C. (eds.). *Trepanation: History, discovery, theory*. Lisse.

Caroline Ahlström Arcini

The Archaeologists, National Historical Museums
Odlarevägen 5
SE-226 60 Lund, Sweden
caroline.ahlstrom.arcini@arkeologerna.com

Niklas Marklund

Department of Neurosurgery,
Skåne University Hospital
and Department of Clinical Sciences Lund,
Neurosurgery
Lund University
Box 117
SE-221 00 Lund, Sweden
niklas.marklund@med.lu.se