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CAUSATION AND METHODS OF SKULL TREPANATION IN THE PAST FROM THE POINT OF VIEW OF THE LATEST FINDINGS FROM THE CZECH TERRITORY

ABSTRACT: Intentionally opened skulls are considered one of the most fascinating paleopathological findings. A summary of trepanned skulls found on the Czech territory (2002) includes 51 items. Since then the anthropological analysis of skeletal remains from both the earlier excavation and new archaeological sites has brought new data. This paper presents a diverse group of eight trepanned skulls. One skull dates from the La Tène period; another six from the Early Middle Ages or Middle Ages, while the date of the last one is unknown. Four of the trepanations can be considered as post-traumatic treatment, the other skulls show no pathological changes that could be the reason for such an operation. The scraping method prevails; two operations were performed by cutting, one by drilling with the use of a trepan. Only one operation was unfinished. Both operations performed by cutting were unhealed – in one case the opening touches the imprint of the middle meningeal artery on the inner side of the skull, which is usually considered a fatal complication.

KEYWORDS: Paleopathology – Trepanation – Trepanation methods – Cranial trauma – Intracranial hematoma – La Tène period – Middle Ages – Central Europe

INTRODUCTION

The evidence of intentional skull opening is considered one of the most attractive paleopathological findings. The first trepanned skull found among archaeological skeletal remains was recorded in 1868; the first record from the Czech territory comes from 1874 (Pudil 1874, Matiegka 1918a, Matiegka 1918b). A summary of the findings on the Czech territory was published eight years ago (Malyková 2002) and presents 51 findings of generally known trepanned skulls since the beginning of records whether they were published and/or registered in anthropological evaluations.

Since the above mentioned summary was published, some new findings have appeared due to anthropological analysis of skeletal remains from both earlier excavations

and from new archaeological sites. Most of them come from the Early Middle Ages or Middle Ages, only one comes from the La Tène period. The higher number of medieval trepanned skulls does not reflect the number of operations in a given period, but only the fact that the largest collection of examined skeletal remains is dated to that period.

Apart from the skull from Staré Mýto (Ústí nad Orlicí district), mentioned in an anthropological evaluation (Likovský 2001) in a survey of findings (Malyková 2002), and the skull from Malín (Kutná Hora district), mentioned in the conference proceedings (Velímský *et al.* 2007), these findings have not been published yet. These trepanations deserve special attention for several reasons: they vary in the method of operation; in the type of tools used; in the probable reason for and in complications of the operation.

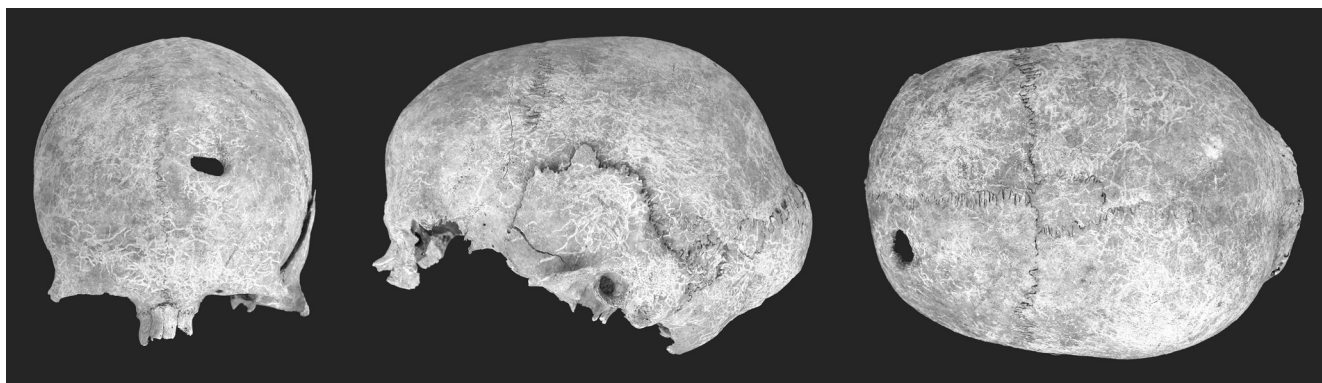


FIGURE 1. Tišice (Mělník district). The skull from grave No. 3054 (added number NM Praha P7A 40595) in three different views, with a trepanation in the left half of frontal bone and a concave occiput (bathrocephaly). Photo J. Likovský.

NEW FINDINGS SUMMARY

Tišice (Mělník district)

La Tène Period

During the excavations in the area of the village of Tišice in 2003, P. Foster unearthed graves dating back to different periods – a Chalcolithic cremation burial, a Hallstatt inhumation burial, two early La Tène graves and some Roman period graves.

The skull of a person from grave number 3054 (later inv. number NM Praha P7A40595) dates to the La Tène period and shows evidence of artificial intervention. The skeleton was placed in the grave in a stretched position, on its right side with the head bent towards the chest.

Description

From this skull, only the neurocranium with fragments of zygomatic bones are preserved. The postcranial skeleton is damaged. The neurocranium is of medium robust build with cranial sutures from synostosed stage. The frontal eminences are medium to strongly shaped, the glabella is moderately formed, the supraorbital ridges are moderately developed and the forehead is perpendicular. The mastoid processes are small, the orbits are low and angular and the nasal bridge is moderately broad and shallow. The body of the mandible is moderately high, with slightly prominent chin and medium to strongly abraded teeth. Metric characteristic of the skull is dolichocranic. The metopic suture persists, wormian bones are present in the bregma and lambdoid sutures and the occiput protrudes (bathrocephaly, *Figure 1*). The postcranial skeleton is medium robust with a mildly developed relief of muscle insertions and the epiphyses are fully fused. The sex-determining traits of the skull indicate a female; DNA analysis, on the other hand, indicates a male. Due to the poor state of preservation, the sex-determining traits of the pelvis are ambiguous. The subject's age at death was approximately 35–50 years (Stránská 2004).

In the left half of the frontal bone, there is an almost oval opening of 15×10 mm in size with a smooth edge. On the inner surface of the cranial bone, around the opening, there is no evidence of inflammation but a broken part of

a compact bone can be seen secondarily partially damaged and grown together (*Figure 2*).

In the skeleton of this individual, there are also two healed fractures of the upper part of diaphysis, one on the left forearm and other on the left tibia.

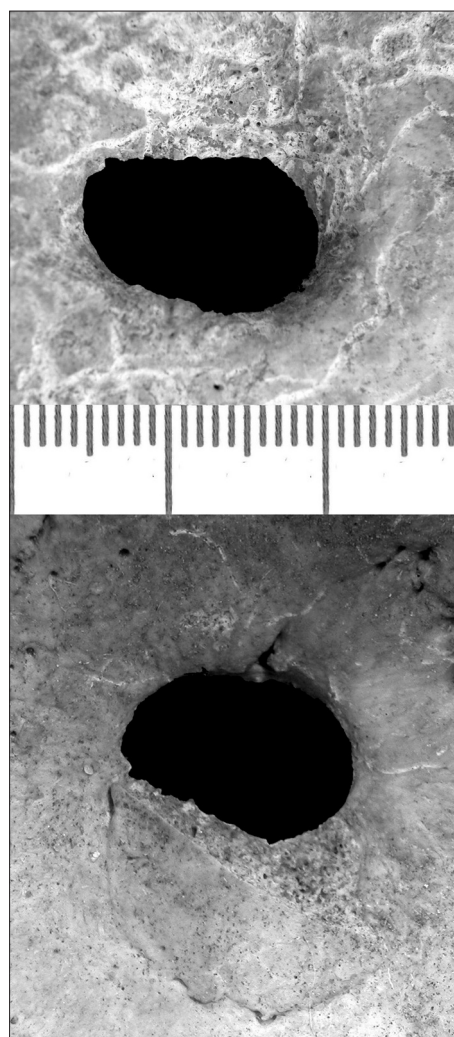


FIGURE 2. Tišice (Mělník district). The skull from grave No. 3054 (added number NM Praha P7A 40595) – detail of trepanation from outside (up) and from inside (down), with a partially healed broken part of the inner compact bone. Photo J. Likovský.

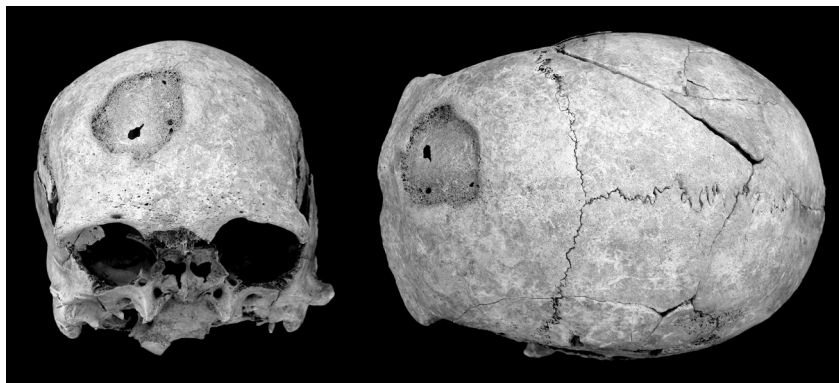


FIGURE 3. Klecany (Praha–Východ district). The skull from grave No. 20/2000 (added number NM Praha P7A 40657), with a visible artificial operation. Photo J. Likovský.

Klecany (Praha-východ district)

Early Middle Ages, 10th century A.D., "Klecany II" cemetery site

The excavation in a smaller early medieval cemetery for the social elite in Klecany (later called "Klecany II") was done by I. Krutina and N. Profantová in 2000. Forty graves were found. A skull with a large hole on the frontal bone (inv. number NM Praha P7A 40657) was found in the grave 20/2000.

Description

The skull and incomplete postcranial skeleton are preserved. The lower extremities are not preserved. The ovoid skull is of middle robust structure with mildly developed relief of muscle insertions and sutures in various stages of ossification. The glabella is distinct and the supraorbital ridges are moderately to strongly developed. The forehead is receding and the frontal eminences are not formed. The external occipital protuberance is strongly shaped, the occiput is arched and the mastoid processes are of medium size. The zygomatic bone is protruding (*Figure 3*). The body of the mandible is medium high with medium prominent chin and straight gonial angles. The frontal teeth are strongly abraded; the molars and the second premolars are abraded up to the roots. The postcranial skeleton is moderately robust and the epiphyses are fully fused. The sex-determining traits of the pelvis indicate a male. The subject's age at death was approximately 35–50 years (Stránská 2005b).

In the right part of the frontal bone, there is an oval hole reaching to the outer compact bone and the diploic bone; the inner compact bone is untouched (*Figure 4*). The edge is slightly damaged and the type of damage reflects the artificial origin of the hole. The size of the hole is 40×45 mm. There are no clear traces of healing present. Most likely, the operation was performed by the scraping method.

Klecany (Praha-východ district)

Early Middle Ages, 10th century A.D., cemetery site of "Klecany I"

All 37 graves dated to the 10th century were uncovered during the rescue excavation of the Early-Middle-Ages

cemetery site at Klecany conducted by N. Profantová in 2005 (later called "Klecany I"). Another 20 graves were uncovered during the following seasons of years 2006 and 2007. The skull of an individual from one of the most socially distinguished graves (number 22/I-2005) – the warrior with an axe – shows evidence of an artificial operation (skeleton with added number NM Praha P7A 40732).

Description

The fragments of skull are incomplete, strong damage to the postcranial skeleton have persisted. The cranial bones are medium robust with synostosed sutures. The glabella is marked; the supraorbital ridges and frontal eminences are mildly developed. The body of the mandible is high with a

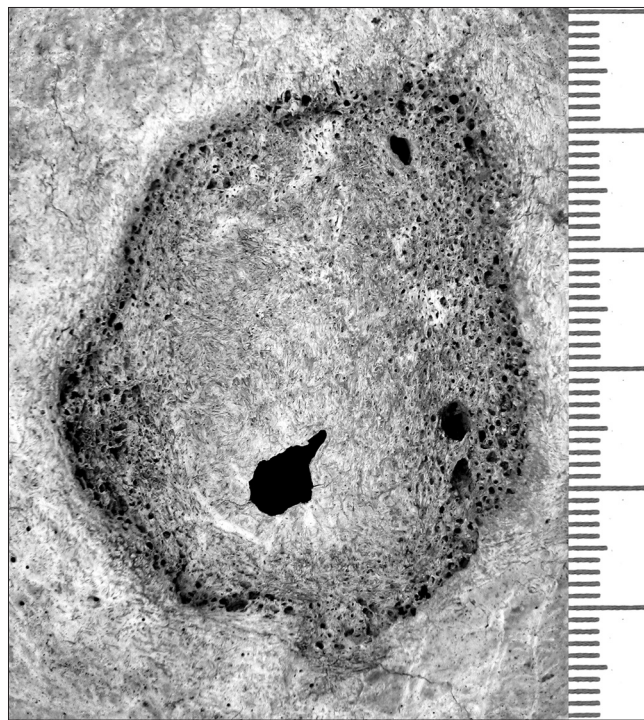


FIGURE 4. Klecany (Praha–Východ district). Detail of unfinished trepanation on the skull from grave No. 20/2000 (added number NM Praha P7A 40657) afflicting the outer compact and the diploic bone. Photo J. Likovský.

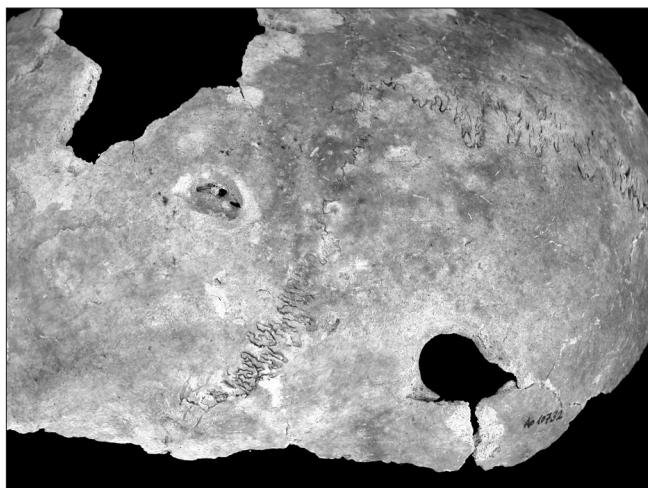
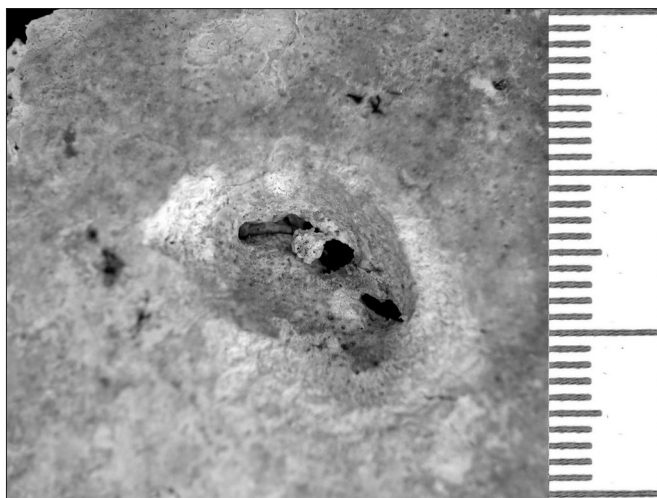


FIGURE 5. Klecany (Praha–Východ district). View of the damaged skull of the individual from grave No. 22/I-2005 (added number NM Praha P7A 40732), with evidence of a healed injury and of an artificial intervention. Photo J. Likovský.

slightly prominent chin and straight gonial angle. The teeth are strongly abraded. The postcranial skeleton is moderate to robust, with the strong relief of muscles insertions and fully fused epiphyses. The individual was most likely a man, 45–60-years-old at death (Stránská 2005b).

Two holes can be seen on the skull (*Figure 5*). In the left part of the frontal bone, approximately 15 mm from coronal suture, there is an old healed injury – circular depression, 12×10 mm in diameter. The injury breaks through the entire bone; at the upper edge there is still evidence of a small hole and on the inner side there are traces of an inner compact bone abruption. The edges are smooth which might be evidence of surgery. Roughly in the middle of left parietal bone, there is a hole approximately 13×18 mm in diameter with a damaged back edge (*Figure 6*). The edges are healed, slightly sloped to the hole. This is a case of injury treatment, posttraumatic trepanation.



Malín (Kutná Hora district)

Middle Ages, 1st half of the 13th century A.D.

During the construction of a pool and sewerage in the village of Malín during 2003 and 2004, F. Velímský conducted a rescue excavation and unearthed human skeletal remains from various periods (first half of the 13th century A.D., Early – High Middle Ages, Old Únětice culture, and undated). Two skeletons – one of a young man and second of an adolescent man – which were lying in a wide common grave in a stretched position in the East-West direction (grave 1 in probe IV/03) are dated to the 1st half of the 13th century A.D. On the second skull, which was later given the number NM Praha P7A 40622, traces of an artificial operation were found.

Description

A damaged skull and slightly damaged postcranial skeleton persisted from the skeletal remains of individual No. 2 from double-grave 1. The skeleton from the left side of the double grave was lying extended and the skull rested on the occiput. The ovoid middle robust skull has mildly developed muscle attachment sites, open cranial sutures, strongly shaped external occipital protuberance, small frontal eminences, distinctly formed glabella and small mastoid processes. The body of the mandible is high with mildly sloped ramus, wide and averted angles and slightly prominent chin (*Figure 7*). The postcranial skeleton is mildly robust with medium developed muscle attachments; the epiphyses are in the final stage of synostosis. The sex-determining traits of the pelvis are masculine. It is a skeleton of an adolescent man aged 18–20 years (Stránská 2005a, Velímský *et al.* 2007).

Several different injuries caused during different periods can be seen on the skull (*Figure 8*). In the left parietal bone, alongside with sagittal suture, there are traces of an old injury. A healed cut and other two connected depressions, approximately 20 mm in diameter, might have originated by a blunt injury. The characteristic of the depression edge

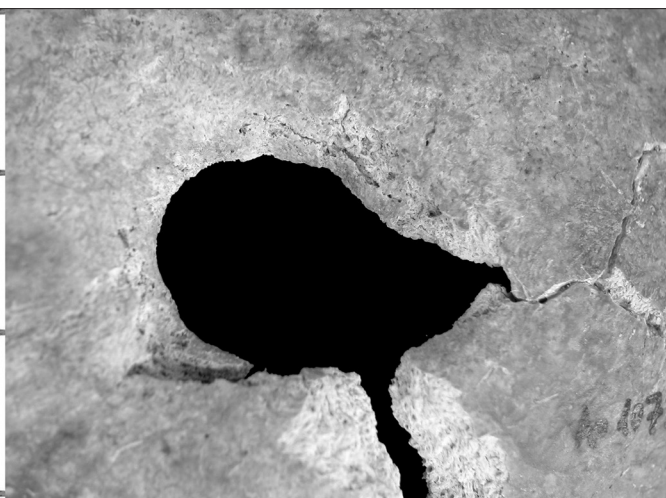
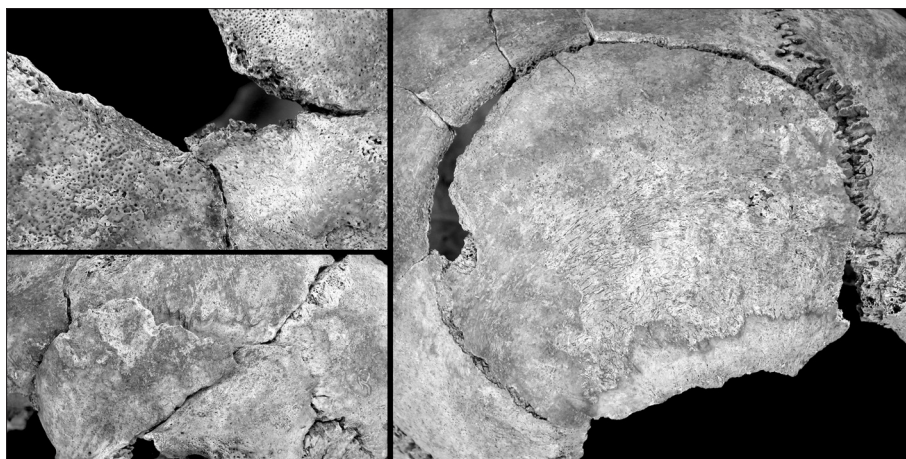


FIGURE 6. Klecany (Praha–Východ district). The detail of treated injury on frontal bone and trepanation on parietal bone of the individual from grave No. 22/I-2005 (added number NM Praha P7A 40732). Photo J. Likovský.



FIGURE 7. Malín (Kutná Hora district). Grave No. 1 in probe IV/03, the individual with inv. number NM Praha P7A 40622. The skull in left view, with visible trepanation. Photo J. Likovský.

FIGURE 8. Malín (Kutná Hora district). Grave No. 1 in probe IV/03, the individual with inv. number NM Praha P7A 40622. Skull injuries – healed blunt injuries on the left parietal bone (upper left), unhealed slashing injury in the squama of petrous bone on the left side (lower left), a cut in parietal bone on the right side (right). Photo J. Likovský.



points to a surgical treatment. The injuries are healed. Another healed slashing injury 35 mm in length went through the suture coronal on the right side. The other two injuries are not healed: the right parietal bone is cut up perpendicularly in a sagittal plane – the stroke went from the back to the region of the parietal tuber on the right. The upper edge of the splinter makes an arch from the squamous suture to the coronal one with the horizontal diameter of 85 mm. The second unhealed slashing injury covers the entire squama of the petrous bone and continues to the left parietal bone reconstructed from a lot of fragments.

In the region under the parietal tuber, an uneven opening with maximum size of 37×26 mm has a smooth edge slightly sloped to a puncture. Most likely, it is evidence of a posttraumatic trepanation or the surgical treatment of the injury (Figure 9). The inner surface of the parietal bone in this area is smooth, with no traces of inflammatory complications.

Staré Mýto (Ústí nad Orlicí district)

Middle Ages, 13th century A.D.

The investigation in Staré Mýto, in the suburb of Tisová, was conducted by M. Richter and J. Sigl between 1986 and 1987. One part of the medieval cemetery site dated from the 13th and 14th centuries was exposed. In total, 95 individuals from 79 graves and from other various materials were unearthed in Staré Mýto. The skull with an artificial operation was found in grave No. 70, which is dated to the 13th century A.D. This grave contained three different finds: the burial itself, some attached bones, and three attached skulls – two of them were deposited to the North and one to the South of the burial. The northern skulls have been marked as A (see below) and B, respectively. Only the cranium without the frontal bone and a fragment of mandible survived from the skull B. Four bigger fragments of cranium and maxilla are preserved from the southern skull.

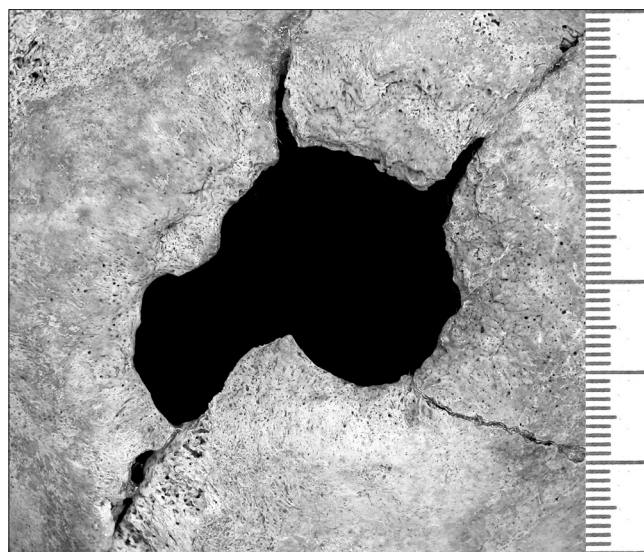


FIGURE 9. Malín (Kutná Hora district). Grave No. 1 in probe IV/03, individual added number NM Praha P7A 40622. Detail of healed trepanation in the region under the parietal tuber on the left side. Photo J. Likovský.

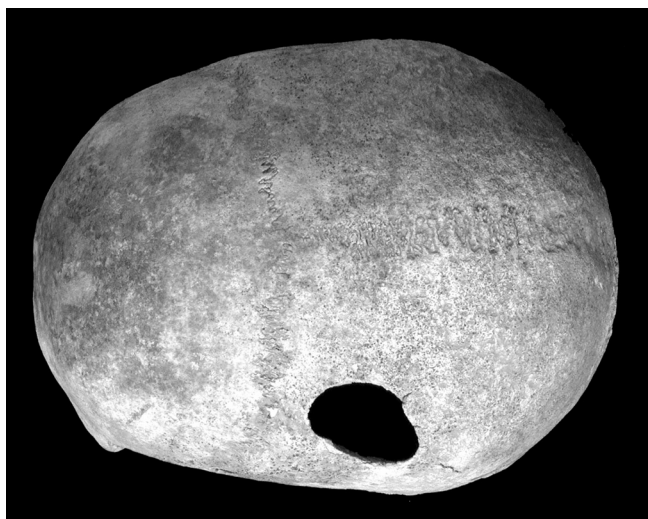


FIGURE 10. Staré Mýto (Ústí nad Orlicí district), grave No. 70, the northern skull A, vertical view with trepanation. Photo P. Velemínský.

Description

From the northern skull marked A, only an incomplete cranium and a fragment of cranial base are preserved (Figure 10). The neurocranium is moderately robust with an elongated ellipsoid outline in vertical view, a medium-strongly formed glabella and supraorbital ridges, a receding forehead and a simple arch of parietal profile. The cranial sutures are obliterated; the course of sagittal suture is varying and contains the wormian bones. The nasal bridge is narrow and of medium depth. The sex-specific traits of the skull indicate an older man (Blajerová 2002).

In the left parietal bone, there is an almost elliptic opening of 33×24 mm in size. The outer edge of the opening is sharp and widens to the inside. On the inner side of the upper perimeter, the inner compact bone is broken off. The damage affects the sulcus arteriae meningeae mediae (Figure 11). The trepanation was performed by cutting. On the back perimeter, there is a well preserved incision through the bone, the outer layer of compact bone is slightly

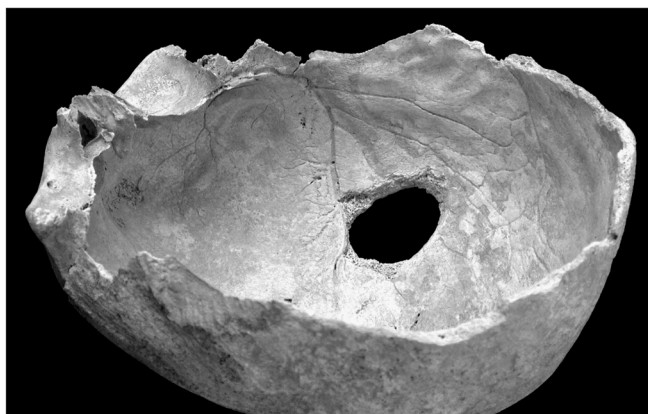


FIGURE 11. Staré Mýto (Ústí nad Orlicí district), grave No. 70, the northern skull A, internal view with the trepanation opening and clear visible sulcus of the middle meningeal artery. Photo P. Velemínský.

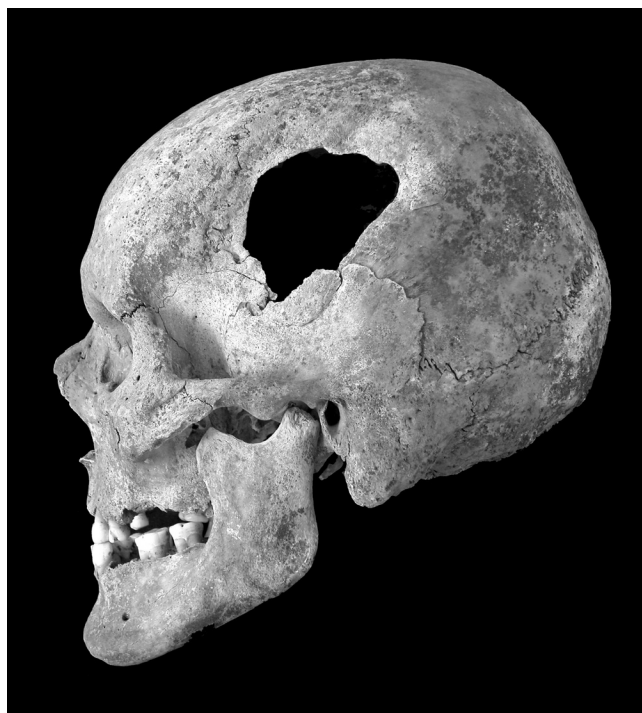


FIGURE 12. Žatec (Louny district), Chelčického náměstí, sector 10, grave No. 1, added number NM Praha P7A 39965. Skull in the left view, with trepanation opening. Photo J. Likovský.

raised and cracked at the lower edge. In this area, the widening of the cut to the inside is most noticeable.

Žatec (Louny district)

Middle Ages, 11th – 13th century A.D.

An archeology investigation on Chelčického náměstí in town of Žatec was conducted by P. Čech during the seasons of 1997 and 1998. An early medieval cemetery site with an expected, unknown sacred building was found in 1993. The beginning of the burial activities is dated to the early 11th century A.D., based on the discovery of S-shaped earrings. The burial activities terminated at the turn of the 12th century A.D. Overall, skeletal remains of 258 individuals were exposed. In the grave No. 1, in the sector 10, only a skull and a mandible were found, the skull reveals a prominent artificial operation – later the skull was given the number NM Praha P7A 39965.

Description

The dolichocranic, robust skull has a receding forehead, a strongly formed glabella, large mastoid processes and prominent zygomatic arches. The body of the mandible is high, the gonial angles are averted and the chin is strongly prominent (Figure 12). These characteristics possibly indicate male gender. The teeth are medium abraded, the cranial sutures are synostosed.

In the left parietal bone, there is a roughly semi-circular hole with the lower edge slanted in the dorsal direction at an angle of 45 degrees from straight. The maximum size of the hole is 54 mm on the lower skew edge; the maximum

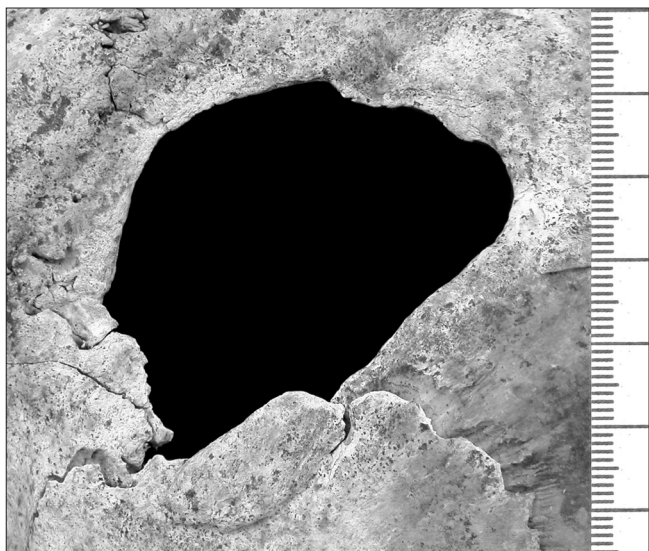


FIGURE 13. Žatec (Louny district), Chelčického náměstí, sector 10, grave No. 1, added number NM Praha P7A 39965. Close-up view of the healed trepanation in the left parietal bone touching squama of the petrous bone. Photo J. Likovský.

height – measured perpendicularly to the slanted lower edge – is 38 mm (Figure 13). The edge of the defect, which touches the lower part and also several millimeters of squama of petrous bone, is smooth and slightly sloped to the defect. The affected diploic bone is completely healed in all areas.

In the left zygomatic and parietal bones, approximately in the place of the hole vertex, there are traces of a healed slash injury. This indicates a martial injury caused by a right handed stroke. On the inner surface of the skull, around

the hole, there are no traces of a pathological process like inflammation or reparation of intracranial bleeding. This is a case of surgical treatment of a skull injury; fragments of bone were removed and the entire edge of hole was neatened by using most likely the simplest, scraping method of trepanation.

Kutná Hora – Sedlec (Kutná Hora district)

Middle Ages, 12th – 15th century A.D.

The last find of a trepanned skull comes from the rescue investigation conducted by F. Velímský in Kutná Hora-Sedlec. Behind the presbytery of the Assumption Cathedral, a section of a multiple-stage medieval cemetery (295 graves in total) was discovered in 2007.

The skull in question was unearthed from grave No. 41 (probe II/07), together with other skeletal remains of an adult man.

Description

Slightly damaged skull of an almost spheroid vertical outline, with moderate build, has moderately developed relief of muscles, however, on the mandible angles, it is strongly developed (Figure 14). The glabella and supraorbital ridges are medium prominent, the forehead is almost perpendicular, the frontal eminences are strongly formed, the occiput is flattened, the mastoid processes are moderate, the mandible angles are averted laterally, the main cranial sutures are in the process of closing. The jaw bones bear the unevenly, in places strongly abraded teeth. The metric characteristic of the skull is eurymetopic and hyperbrachycranic. The postcranial skeleton is robust, with strongly formed muscle relief, which agree with the gender diagnosis according to both the pelvis and the cranium (only



FIGURE 14. Kutná Hora – Sedlec (Kutná Hora district), probe No. II/07, item 41. Trepanned skull in frontal and vertical views. Photo J. Likovský.

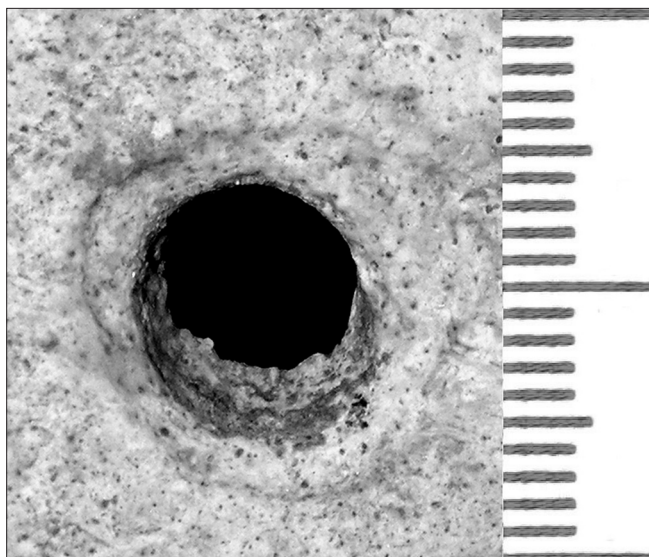


FIGURE 15. Kutná Hora – Sedlec (Kutná Hora district), probe No. II/07, item 41. Close-up view of the frontal bone with healed trepanation made by the drilling method. Photo F. Velímský.

the shape of forehead has a female character). The age at death was approximately 35–50 years.

In the frontal bone, on the median line and 20 mm in the front of the bregma, there is a small round opening, 8 mm in diameter. The edges are healed (*Figure 15*). Moreover, the outer surface of the frontal bone is slightly lowered around the bone hole mentioned above (in the form of round depression of 15 mm in diameter). This surgery was performed by the drilling method.

Skull with Missing Date

A trepanned skull with a mandible was found among anthropological material rescued from the Institute of Archaeology of Czech Academy of Sciences after the flood in 2002; the skull was deposited in a box which was destroyed, and which bears – like the skull itself – no signature. This find does not correspond with any published description of a trepanned skull. It might be a skull coming from the depository of some regional museum, which was centralized in the newly founded Department of Archaeology at the State Institute of Archaeology in 1951, or the skull might originally come from the charnel-house and recently served as a teaching aid at some institute of anatomy or a clinic. We can assume this because the teeth of both jaws were originally wired together and the wire was removed after the reconstruction of facial part of the skull.

Description

The entire surface of the neurocranium is afflicted with rootlet erosion, the skull is dolichocranic, with strongly formed glabella, strongly marked supraorbital ridges, receding forehead and slightly marked frontal eminences. The mastoid processes are big, the body of the mandible is of medium height, the angles are straight and the cranial sutures are close to the synostosed stage. The high number of wormian bones in lambdoid suture (*Figure 16*) is striking.

Above the lateral section of lambdoid suture, on the right side, a roughly semi-elliptic opening of 35×36 cm in size can be seen. Its lower edge reaches to the area of the wormian bones in lambdoid suture but they were removed



FIGURE 16. Undated skull. Left lateral and posterior views, wormian bones in the lambdoid suture. Photo J. Likovský.

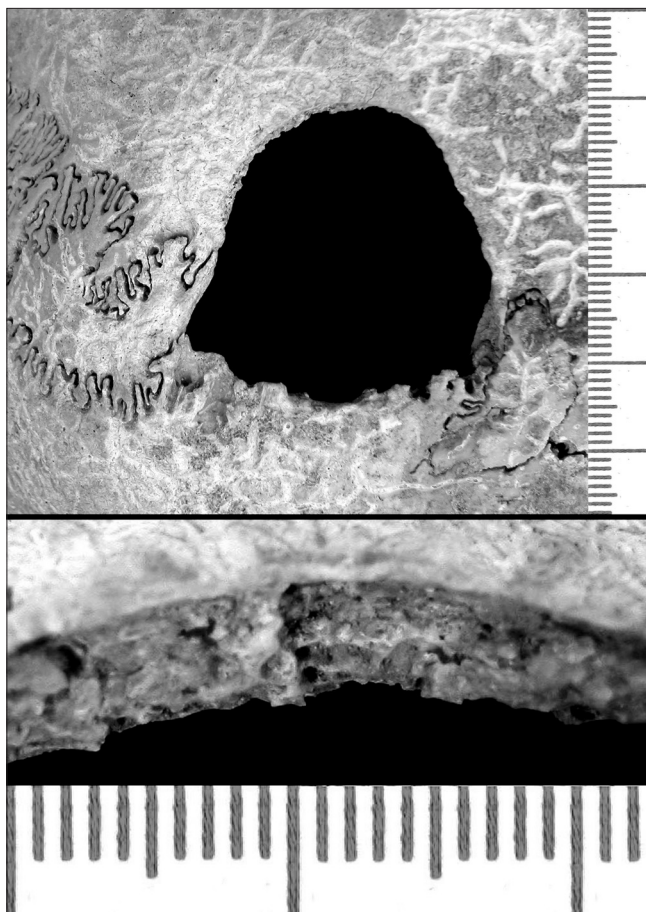


FIGURE 17. Undated skull. Unhealed trepanation reaching the region of wormian bones in the lambdoid suture on the right side – detail (above); upper edge of trepanation – detail (below). Photo J. Likovský.

in this section. The upper edge is healed, the front part widens to the inside. The upper part of this trepanation was performed by cutting, while the lower part was enlarged by removing the wormian bones (*Figure 17*). There are no evident traces of healing on the edge.

Trepanation Methods Used

The methods of trepanation used in the past have been published many times (Chochol 1967, Steinbock 1976, Aufderheide, Rodríguez-Martín 1998, Malyková 2002). The scraping method – i.e. the gradual removal of outer compact, diploic and inner compact layer of cranial bone with the use of a sharp-edged tool – is the most common method of skull opening (*Figure 18*). The findings of skulls operated on using the scraping method from the Czech territory are dated from the Chalcolithic period to the Middle Ages (Malyková 2002). When the scraping method is used, the risk of intracranial damage (damage of meninges, arteries, brain) is relatively low which is indicated by the lowest percentage of non-healed operations resulting from this method (Likovský, Malyková 2004). The scraping method was also used for skull trauma treatment; especially to treat sharp edges of impression fractures after the loose bone fragments were removed.



FIGURE 18. Scraping technique used for treatment of skull trauma or for intentional skull opening. Photo J. Likovský.

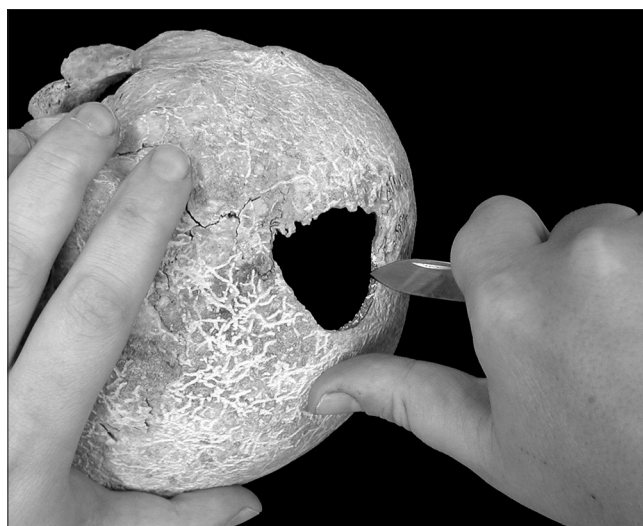


FIGURE 19. One of the possible techniques of cranial bone cutting. Photo J. Likovský.

In the case of the skulls mentioned in this paper, the scraping method was used on the skull from La Tène period from Tišice, on both Early-Middle-Ages and medieval skulls from Klecany, on the skull from Malín, and the skull from Žatec. The trepanations in the skulls from Tišice, from the cemetery site of Klecany I, from Malín, and from Žatec were performed with the intention to treat an injury (see below).

The cutting method – gradually cut groove into the cranial bone, whether through one round (*Figure 19*) or several right-angled (straight) lines intersecting at their ends (Aufderheide, Rodríguez-Martín 1998) – brings a higher risk of damage to the intracranial structures. Only one skull from Czech territory, on which this method was performed, has been recorded so far: the skull from

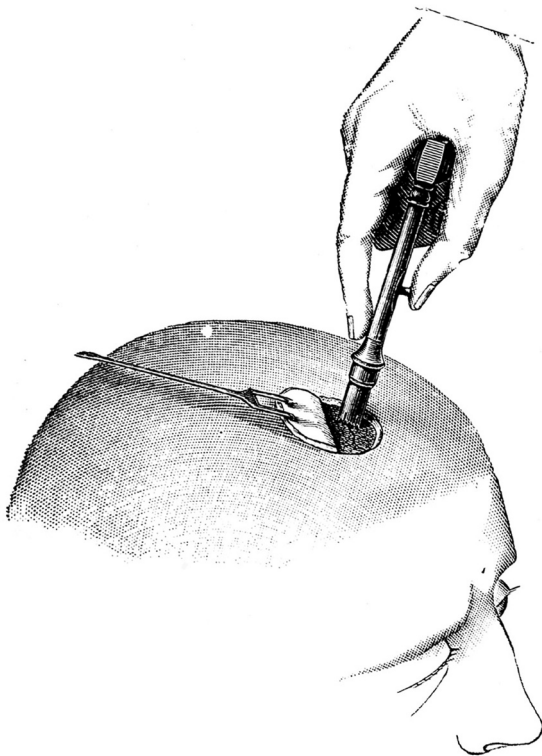


FIGURE 20. Trepanation with use of a trepan (Esmarch – Kowalzig 1899).

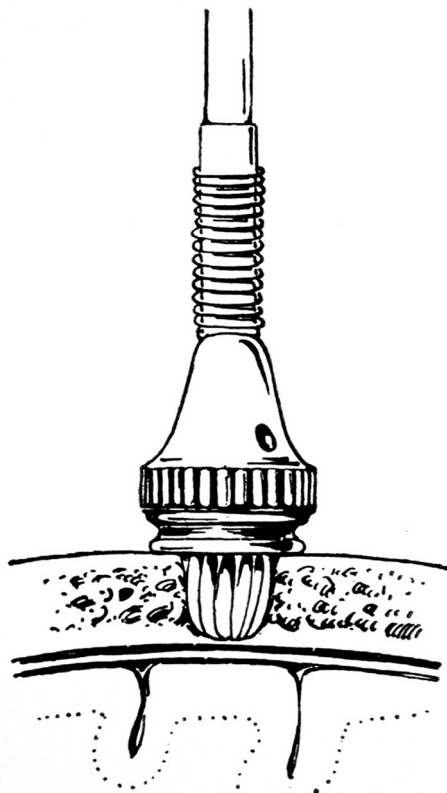


FIGURE 21. Trepan with a protective board by Sudeck (Peiper 1933).

Prague 5-Smíchov, dating to the Middle Ages. However, the use of this method in this case is disputable – most likely it is a secondary enlargement of an older operation. The patient did not survive the surgery (Chochol 1967). Also in the skull from Staré Mýto and in the undated skull, there is no evidence of a healing process. In both of these findings, trepanation was performed in an unusual way: on the skull from Staré Mýto the cut widens to the inside, and on the undated skull the presence of loose wormian bones in the lambdoid suture was used to enlarge the opening.

The drilling method includes two different styles. The first one – to make a lot of small openings and then to connect them by cutting – was recently described in the case of an undated skull from Museum in Sedlčany, Příbram district (Smrčka, Kuželka 2002), and besides this, in the two finds belonging to the Únětice culture from the village of Smolinec, Louny district (Matiegka 1918a, Matiegka 1928, Strouhal 1965). The second method uses a special round tool called trepan, its diameter is the same as the diameter of the later opening. The use of such a tool is recorded only in one case in the Czech territory: a skull dated to the modern period from Praha 1 – the Church of Our Victorious Lady (Kostel Panny Marie Vítězné) with two unhealed trepanations on the right parietal bone, which were performed by a trepan of 11 mm in diameter (Vlček, Stloukal 1971).

The skull from Kutná Hora – Sedlec was trepanned using a trepan having eight millimeters in diameter (Figure 20). In addition, on the outer compact bone, in the vicinity of the opening, a slightly uneven round imprint (15 mm in diameter) can be seen. This may be the evidence that the tool with a so-called protective board was used. This board protected the tool from penetrating too deep into the bone. This type of trepan was used in modern times (for example **Sudeck's trephine** – Figure 21). However, radiocarbon dating has confirmed that the skull from Kutná Hora dates to the Middle Ages, which makes this find unique.

REASONS FOR TREPANATIONS

Posttraumatic treatment is for now the only evident reason for skull trepanation in archaeological findings. In other cases, when there are no signs of trauma, we can only point to the disputable similarity with the reason for skull opening we know from aboriginal people in remote areas of the world (Malyková 2002, Malyková 2004).

As a result of the earlier excavations, we know of several posttraumatic treatment trepanations from Trmice, district of Ústí nad Labem (Chochol 1984), Vikletice, district of Chomutov (Chochol 1968) – both Corded Ware culture; a double trepanation dated to Únětice culture on the skull from Prague 5-Malá Ohrada (Chochol 1987), and a skull from Prague 7-Bubeneč dated to La Tène period (Chochol 1967). Two medieval findings of posttraumatic trepanation come from Chrastany, Rakovník district (Blajerová 1978), and Kouřim, Kolín district, respectively (Chochol *et al.*

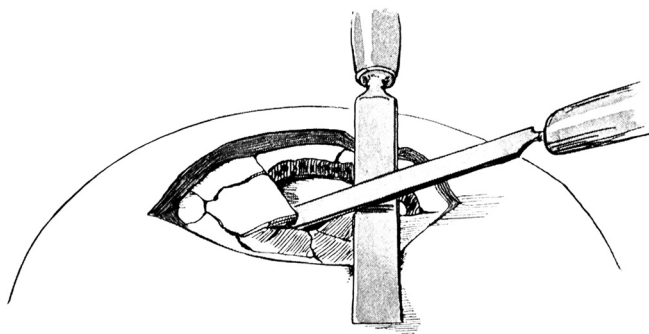


FIGURE 22. Removal of cranial bone fragments from an impressive fracture (Peiper 1933).

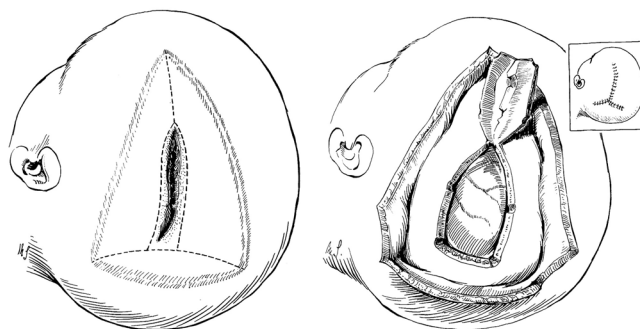


FIGURE 23. Removal of bone fragments on the edge of slashing injury, and technique of skin cover closure (Peiper 1933).

1959). The skull with treated trauma, attributed to Prince Spytihněv I, Duke of Bohemia, represents a disputable case of trepanation (Frolík *et al.* 2002 vs. Vlček 1997, Brůžek *et al.* 2002).

The technique of removing skull fragments from traumatic lesions most likely did not evolve much over the ages – except in developing more sophisticated and more special tools for this operation (Figure 22). They were used for treatment of both blunt trauma and cutting

trauma done with a wide edge (Figure 23). Such cases are described in ancient surgery books (e.g. Esmarch, Kowalzig 1899, Peiper 1933).

As mentioned above, skulls from Tišice, "Klecany I" cemetery site, Malín, and Žatec, are examples of the treatment for a skull injury. In the other cases, the reasons for trepanation are not known. The posttraumatic conditions accompanied by a headache or disturbance of consciousness, intracranial hypertension, as well as other

FIGURE 24. "Extraction of Stone of Madness" oil, oak, 32.5×28.0 cm (from Vacková 1989).



neurological diseases or mental distribution could be a possible reason for the surgery. The so-called "magic-therapeutic" reason for trepanation (Lisowski 1947) could also include a post-stroke health condition – the positive effect of trepanation for lowering intracranial hypertension has been reported many times.

A motif of "cure of folly", known from renaissance pictures, is based on an Old Dutch notion that eccentric behavior is caused by "stone in a head". Whether these operations can be considered as trepanation – at least in some individual cases – is disputable. This "surgery" was usually offered to gullible villagers by itinerant quacks. During this pretend operation, a stone was "extracted" from a bleeding incision usually made on patient's forehead (Hall 1991). Regardless, some figures and their symptoms pictured on these paintings deserve our attention. Two of the most famous "stone of madness extraction" paintings are "Surgeon" by Jan van Hemessen, dated around 1555, in Museo del Prado, Madrid (Anonymous 1995), and a painting called "Cutting out the Stone of Madness" by Pieter Bruegel the Elder from Saint-Omer from the middle of 16th century A.D.; a similar scene is depicted also in an engraving of the same title (Schott *et al.* 1994). The tableau "Treatment of Madness", now in Museo del Prado, Madrid, is the oldest painting about this subject (Vacková 1989). The picture is attributed to Hieronymus Bosch, but he probably did not paint it himself, he is definitely the author of the background landscape (Bosing 1993). On the Czech territory, there is one painting called "Extraction of Stone of Madness" or "Operation of Madness", probably from the Emperor Rudolph II's collection. The painting is attributed to follower of Bosch. A lost Bosch picture with

different setting than "Cure of Folly" was a model for this painting (Vacková 1989). The painting, dated before 1600 (Figure 24), was in the collection of National Gallery in Prague and now it is on display in Royal Canonry of Premonstratensian's picture gallery at Strahov. A disproportional figure of the patient is worth mentioning. His head and torso, unlike the other people in the picture, are disproportionately large in comparison to his gracile extremities. The man who is bandaging another's forehead suffers with obvious hypertelorism and the way he holds the scarf tips suggest missing fingers or oligodaktylism. These abnormalities are part of some congenital syndromes which are also accompanied by mental retardation (Žižka 1994).

There is also another possible reason for trepanation, intracerebral bleeding. The skull may be opened to get gain access to the ramification of the middle meningeal artery (Figure 25) on the inner side of the parietal bone in order to stop the bleeding – this method has been published many times since the 19th century (Esmarch, Kowalzig 1899). The evidence of intracerebral bleeding can be definitely identified only if the patient survived long enough for healing process to leave traces on the inner side of the cranial bone. Archaeological findings of skulls with healed intracerebral bleeding are recorded, too – one from La Tène period (Likovský, Drda 2003), next two from 8th – 9th c. A.D. at Nové Zámky, Slovakia – but only with the injury and without trepanation (Hanáková, Stloukal 1966, Likovský *et al.* 2005).

TREPANATION SURGERY COMPLICATIONS

The possible complications of trepanation can be observed only if clear pathological changes are visible on the cranial bone around the place of the trepanation cut. The skull from Staré Mýto (Ústí nad Orlicí district) has a visibly disturbed sulcus arteriae meningeae mediae (Figure 26)

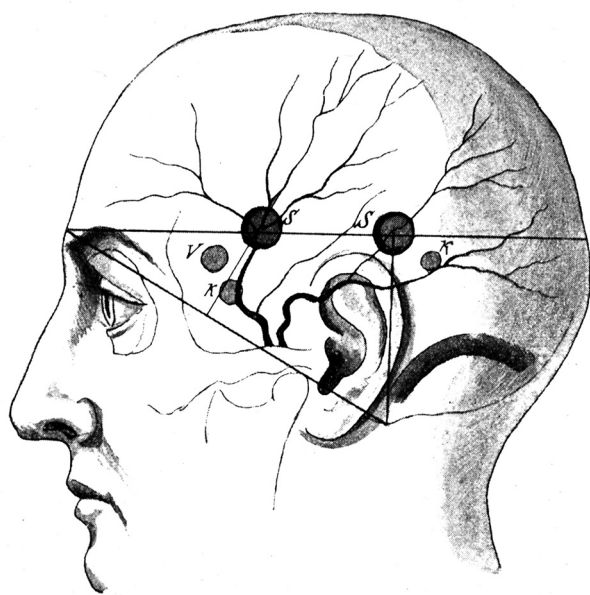


FIGURE 25. Access to the branches of middle meningeal artery in order to stop the bleeding (Esmarch – Kowalzig 1899).

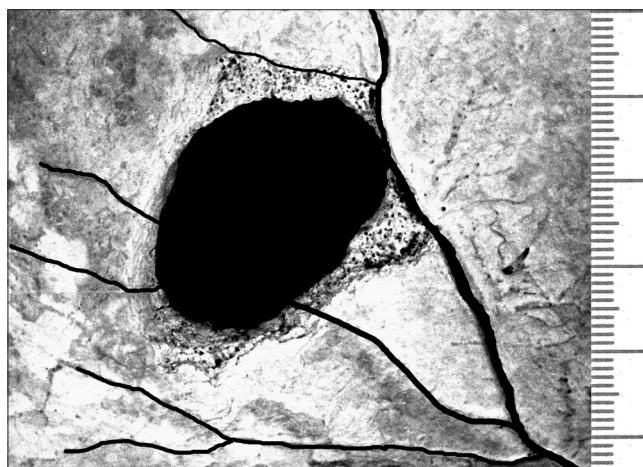


FIGURE 26. Staré Mýto (Ústí nad Orlicí district), grave No. 70, northern skull A. Close-up view of trepanation from inside, with highlighted branches of the middle meningeal artery. Photo J. Likovský.

and, in addition, the incision was made above the dominant leftbrain hemisphere, where important brain functions are located. Bleeding from the cut arteria is a possible cause of peroperative death (furthermore, the skull was opened by the less delicate method – cutting). The question is, whether the intracerebral bleeding might have been – on the contrary – the reason for surgery.

The unfinished operation on the skull from "Klecany II" cemetery site (Prague–East district) suggests that the subject died during the operation but there is no evident cause of peroperative death.

The finding from Žatec (Louny district) is an example of a healed operation; the individual survived for a long time. Both the war injury itself and the treatment of this injury by making a large incision on cranial skeleton are very serious interventions. The patient with such a large affliction supposedly suffered from neurological complications, permanent and/or temporary, which most likely could include paralysis of right side extremities or some form of the speech impediment.

SUMMARY

Skull trepanation – the intentional removing of cranial bone with the aim of opening cranial cavity – is one of the oldest surgical operations. The latest findings did not bring any new information about the possible reason for trepanation in the past. In most cases, with the exception of posttraumatic treatment, the reason for trepanation remains obscure. Based on operations known from recent history, we can only assume that various health conditions might have been the indication for trepanation.

This paper presents a diversified group of eight trepanned skulls. One is dated to the La Tène period, six to the Early Middle Ages or Middle Ages, and one skull is undated. Four trepanations can be considered as posttraumatic treatment, the other skulls show no pathological changes that could be the reason for such an operation. These trepanations vary in the technique: the scraping method prevails; two operations were performed by cutting and one by drilling with a trepan. Only one operation was unfinished – the large scraping trepanation with only the outer compact bone and the diploic bone removed. Both operations performed by cutting did not show any evidence of healing process – in one case the opening touches the imprint of middle meningeal artery on the inner side of the skull. The question is whether this fatal complication was caused by the operation, or – on the contrary – the intracerebral bleeding was the reason for surgery.

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