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INTERPRETATION OF THE FACIAL SKELETON – POST-TRAUMATIC ASYMMETRY IN PALAEOPATHOLOGY: ON THE EXAMPLE OF SEVERAL CASE REPORTS

ABSTRACT: The presented study is focused on the observation and interpretation of post-traumatic changes in the facial skeleton. In injuries of the facial bones, it is particularly significant during which growth period the fracture occurred. Selected cases came from three differently dated periods to demonstrate some types of asymmetry we encountered in bone remains from archaeological researches – 1) approximately 12th–13th centuries BC – Saqqara Egypt, 2) 5th century – Líbivá Czech Republic and 3) 13th–18th centuries – Křtiny, Czech Republic. All the above-mentioned cases were most likely a consequence of interpersonal violence. It can be assumed that, in the female, the trauma could have been the result of domestic violence. The trauma in the male could rather have arisen during a skirmish. The use of modern clinical data provides the opportunity to interpret the ancient material with a greater degree of accuracy.

KEY WORDS: Facial skeleton – Trauma – Asymmetry of face – Ankylosis

INTRODUCTION

Post-traumatic traces are a common finding in most of larger osteological collections. The character and in particular the reconstruction of the mechanism of injury can assist in the deeper understanding of some aspects of life of previous generations, especially of their living conditions. The presented study is focused on the observation and interpretation of post-traumatic changes in the facial skeleton.

In injuries of the facial bones, it is particularly significant during which growth period the fracture occurred. If there is violation of the integrity of a child's facial bones, i.e. during the growth process, fractures can lead to serious changes in configuration, leaving permanent consequences such as significant facial

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asymmetry. In adult individuals, after the end of skeletal growth, there is no significant asymmetry of the face after bony injury. However, as the splanchnocranium is composed of bones of various thickness, the manifestations of trauma in adulthood are also very varied. Most often these are the result of work accidents or direct hits during interpersonal violence (especially fights or war injuries in males, may be even domestic violence in females) (Redfern 2016, Hájek 1984).

In osteological collections from archaeological researches, healed nasal bone fractures are abundantly represented in the facial region. Fractures of the alveolar processes of the jaws or mandibular fractures are less often seen (Mann, Murphy 1990).

MATERIAL AND METHODS

We chose cases from several differently dated periods to demonstrate some types of asymmetry we encountered in bone remains from archaeological researches.

Three findings of traumatic changes of the mid-facial area arose from an ossuary from modern times under the Church of the Holy Name of Mary in Křtiny (13th–18th century). This ossuary contained the skeletal remains of almost 1 000 individuals (583 skulls according to the number of occipital bones with foramen magnum). Only 141 skulls were fully preserved from this number. However, the splanchnocraniums of most of them were partly damaged.

The next case comes from the burial ground at Líbivá near Břeclav (South Moravia), which belongs to the group of small necropolises that arose in Moravia in an earlier phase of the Migration Period in about the middle of the 5th century (Macháček, Klanicová 1997).

The oldest case of skeletal facial asymmetry originated from the Dutch excavations of the New Kingdom Necropolis at Saqqara, Egypt. In recent decades, the tombs of important officers of the New Kingdom (1550–1069 BC) have been discovered on the site of the Dutch concession. The site is located approximately 300 metres south of the oldest Egyptian pyramid – the Pyramid of Djoser. The case under study was discovered in one of the three chapels of Ptahemwia, who was known as the "Royal Butler, Clean of Hands" during the reigns of Pharaohs Akhenaten and Tutankhamun (1353–1323 BC). Precise dating of the studied skeleton is nevertheless difficult, because nearly all the remains from the chapels were in secondary burial sites.

The basic demographic data (age, sex) were determined according to standard anthropological techniques mentioned in the publication by Stloukal *et al.* (1999). The palaeopathological findings were evaluated according to the criteria mentioned in basic paleopathology textbooks (Aufderheide, Rodríguez-Martín, 1998, Mann, Hunt, 2004). X-ray examinations were performed for assessment of fracture lines in most of the studied cases (according to the possibilities). The data from the publication by Žvák *et al.* (2006) were used for comparison with similar current clinical cases. For reconstruction of the mechanism of injury, the publication by Loyka *et al.* (1976) was referred to.

RESULTS

In two skulls of adult individuals from the Křtiny collection, healed nasal bone fractures were found.

Case No. 1 (female 30–40 years, locality: Křtiny ossuary, K 188, dating: 13th–18th century)

The skull of the 30–40-year-old woman was damaged post-mortem. In particular, on the right side of the facial skeleton, there are traces of a healed fracture in the caudal part of the right nasal bone. The fracture line runs almost parallel to the nasofrontal suture, circa 6–7 cm from the free margin of the nasal bone. It overlaps the median plane within the range of 3 mm and also affects the left nasal bone. The force apparently affected the external nasal region from the right side and, as a result, caused pushing of the lower margin of the left nasal bone in the direction of the nasal cavity. The ventral part of the lamina perpendicularis ossis ethmoidalis is also slightly deviated to the left side. Repair processes are visible on the nasal bones as well as on part of the preserved bony nasal septum. The zygomatic arch on the right side was lost post-mortem, so it was not possible to study in detail the range of lesion in this region (*Figure 1*).

Case No. 2 (male 40–50 years, locality: Křtiny ossuary, K 514, dating: 13th–18th century)

This is a relatively well preserved calvaria of a 40–50-years-old male with signs of a healed fracture in the lower third of both nasal bones. The fracture line has the form of a convex arch pointing towards the nasal root. It starts at the lateral margin of the pyriform aperture approximately 38 mm from the lateral angle

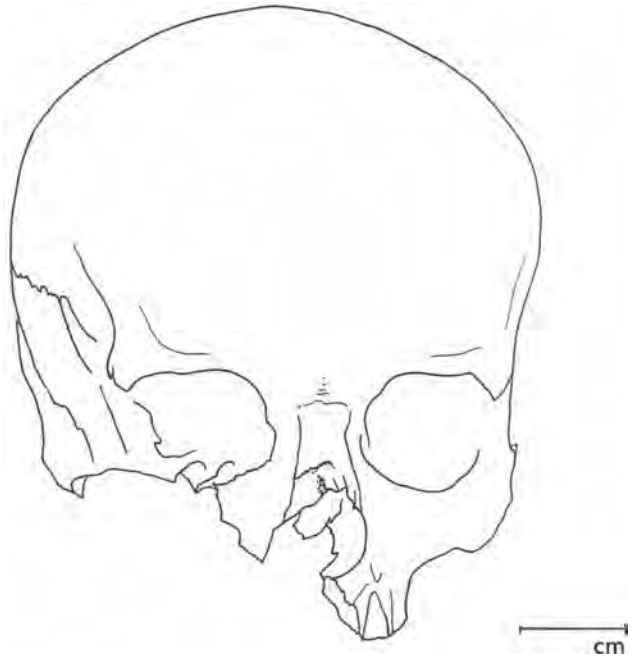

FIGURE 1: The scheme of healed fracture of the right nasal bone on skull of 30–40 years old female (K 188, Křtiny, Czech Republic, 13th–18th century). Scheme by F. Vítámvás.

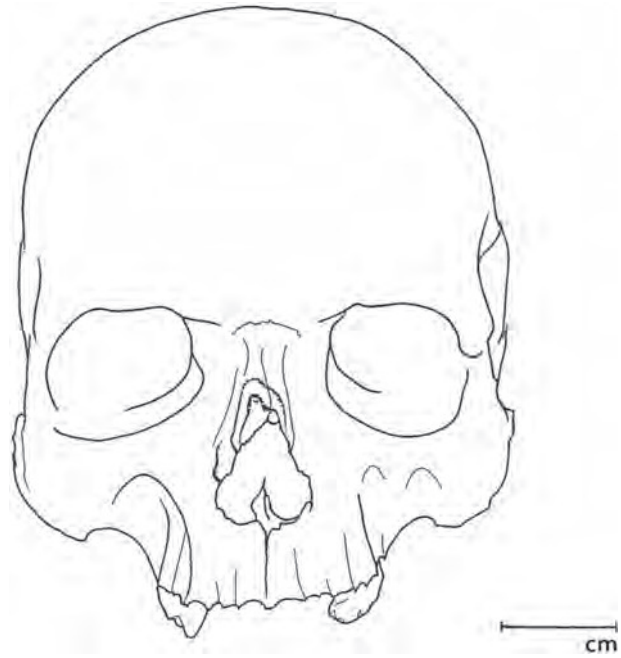

FIGURE 2: The scheme of healed fracture of nasal bones on skull of 40–50 years old male (K 514, Křtiny, Czech Republic, 13th–18th century). Scheme by F. Vítámvás.

of the nasofrontal suture. It continues arcuately over both nasal bones and ends at the left nasomaxillary suture. The force affected the nasal skeleton from the ventral side and slightly pushed the caudal margins of the nasal bones towards the nasal cavity. On the medial side of the left nasal bone, there is a separate fragment with dimensions of 3×3 mm in close proximity to the internasal suture. This fragment is also slightly pushed towards the nasal cavity. The healed thickened fragments of nasal bones are surrounded by a thin layer of newly formed bone tissue (*Figure 2*).

Both the above-mentioned cases were most likely a consequence of interpersonal violence. It can be assumed that, in the female, the trauma could have been the result of domestic violence. The trauma in the male could rather have arisen during a skirmish.

Case No. 3 (female, 20–30 years, locality: Křtiny ossuary, K 417, dating: 13th–18th century)

On the skull of a 20–30-year-old female from the Křtiny ossuary, there is a healed defect in the area of the maxillary alveolar region. It misses almost the whole right incisive bone, except the medial part, where the alveolus for the inner incisor is preserved. Along the distal margin of the alveolus of the right canine towards the pyriform aperture, there stretches a very thin fracture line, almost unrecognisable in places, continuing to the lower margin of the right orbit. The line apparently ran over both nasal bones (destroyed post-mortem) because it is further evident on the frontal process of the maxilla and on the lower margin of the left orbit. Here the line continues towards the frontal margin of the superior orbital fissure and to the temporal surface of the frontal process of the zygomatic bone (where it passes parallel to the margin of the inferior orbital fissure to the lower margin of the suture between the frontal process of the zygomatic bone and the temporal surface of the greater wings of the sphenoid bone). From this site, a thin transversal fracture line runs towards the inner surface of the body of the left zygomatic bone. All evident margins of this lesion are well healed. The pyriform aperture is asymmetric, approximately 7 mm deeper on the right side. The anterior nasal spine is bent approximately 2 mm to the left and the ventral half of the vomer is bent slightly to the right.

The superior orbital fissure in the right orbit is circa 2 mm wider than in the left. There is an irregularly wrinkled spot (5×6 cm) with fine, newly formed bone tissue and a thin fissure (about 3 mm in length) on the

dorsal side of the body of the maxilla. On the latero-caudal margin of the right orbit, there is a healed round defect in the form of a small projection (diameter approx. 1 mm). Unfortunately, the zygomatic bone and the whole zygomatic arch were not preserved, so it is impossible to assess the lesion in greater detail.

Asymmetry appears not only in the area of the incisive bone and pyriform aperture, but also in the different use of the molars during chewing. The 1st and 2nd molars on the right side have just a slight abrasion of enamel on the cusps. On the left side, on the 1st molar there is an abrasion to the dentin (about 1/3 of the tooth), and on the 2nd molar, the abrasion exposed dentin on the disto-buccal cusp.

It can be expected that the trauma was a result of direct violence which occurred in the childhood of the affected individual. The preserved alveolus for the inner incisor on the right side reaches only to half the depth of the alveolus of the 1st incisor on the left side. It is therefore very likely that the base of the 1st incisor was damaged by trauma at the time of the tooth's growth activity. The injury probably occurred from a fall on the face on to a hard object, or possibly from a hard hit to the facial region. It cannot be ruled out that the origin of the trauma was a result of domestic violence (*Figures 3, 4*).

FIGURE 3: The skull of 20–30 years old female with healed traumatic defect of maxillary alveolar complex (K 417, Křtiny, Czech Republic, 13th–18th century). Photo by J. Vachová.

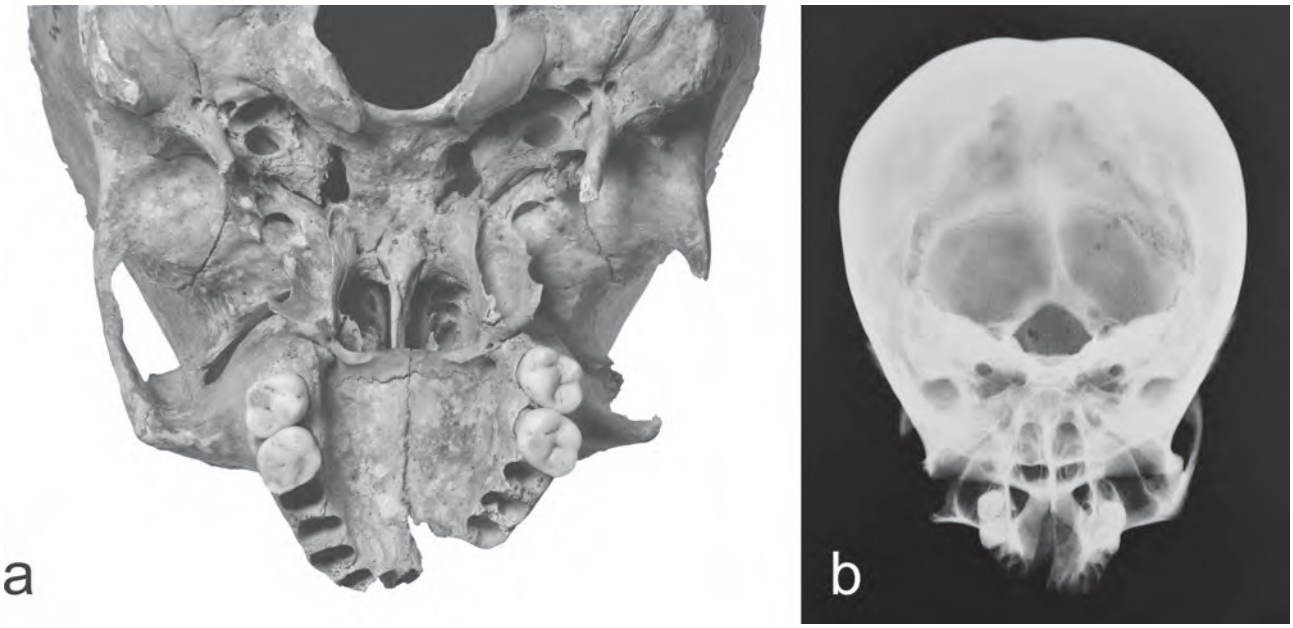

FIGURE 4: a) Detail of traumatic defect of maxillary alveolar complex (basal view); b) X-ray (K 417, Křtiny, Czech Republic, 13th–18th century). Photo by J. Vachová.

Case No. 4 (male 30–40 years, locality: Líbivá near Břeclav, dating: middle of the 5th century)

This is a skull with post-traumatic asymmetry of the facial skeleton. On the right ramus of the mandible, there are traces of a healed fracture of the lower part of the condylar process. The ramus is significantly shortened and the condylar process lies deep under the level of the upper margin of the noticeably reinforced coronoid process. On the surface of the deformed head of the mandible, numerous small cavities are visible and the superficial compact layer of bone is completely destroyed. The affected half of the lower dental arch is noticeably shortened and flattened. The mandible was subluxated and twisted in a medial direction by the thrust of the muscles of mastication. A shallow secondary articular pit, known as the neocotyle, originated in the site of the original articular tubercle. The condylar process remained significantly shorter and narrower with an enlarged head.

The trauma evidently took place during the childhood of the affected individual. The changed anatomical status of the temporomandibular joint (TMJ) led to uneven growth and loading of the affected and healthy side of both jaws. During the further growth of the face, this reality was manifested by significant asymmetry of its central part (*Figure 5*).

Case No. 5 (boy 15–16 years, locality: North Chapel of Ptahemwia, Saqqara, Egypt, dating: about 13th century BC)

Both heads of the mandible and mandibular fossa are changed by a pathological process. The left head of the mandible is flattened irregularly. Its articular surface has tightly fused with the mandibular fossa and the articular tubercle on the lateral side. However, the adhesion field was disturbed by fragments of the skull bones during post-mortem handling. The lower part of the mandibular fossa and the articular tubercle are porous and rough. The tympanic plate and the entrance to the external acoustic porus are thicker and covered in newly created bone tissue (a possible sign of periostitis). The affected head is dorsally inclined, its transversal dimension is 23 mm and the anteroposterior dimension is 22 mm. A pointed 18 mm long protuberance projects in a cranial direction from the pterygoid tuberosity. This protuberance can be regarded as a myositis ossificans, where part of the pterygoid medial muscle fibres were unusually overloaded due to long-term impaired joint mechanics. The mandibular angle creates a protuberance, which is noticeably elongated in a caudal direction.

The right condylar process is also affected by the pathological process; however, the lesion is of a much smaller extent. The mandibular head (maximum length

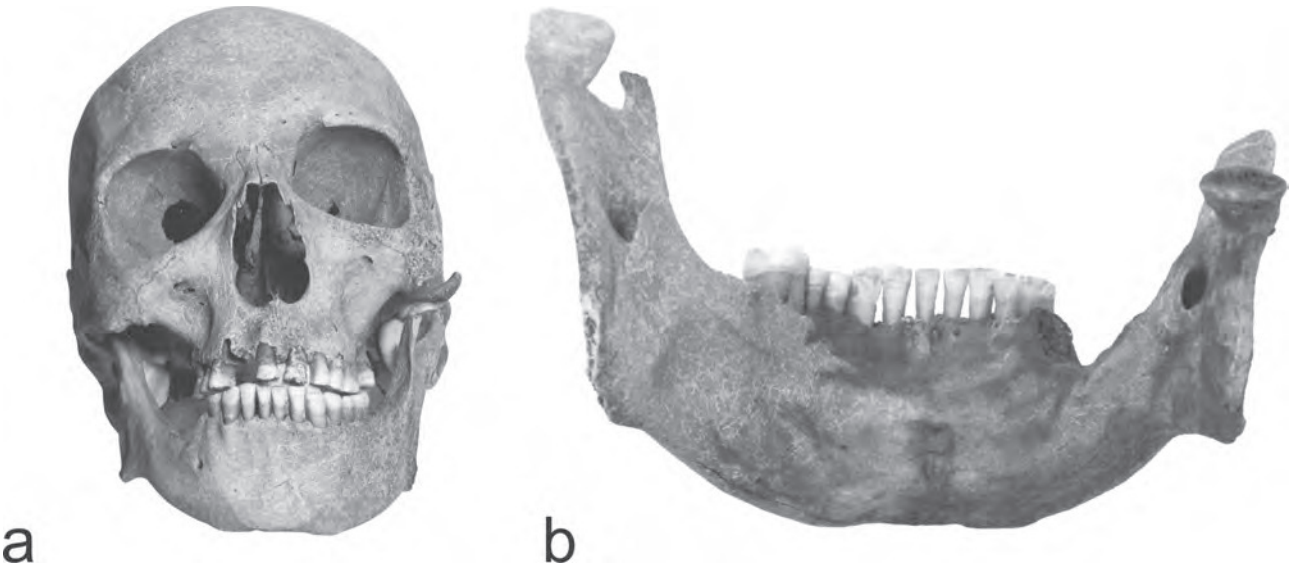

FIGURE 5: a) Skull of a 30–40 years-old man with a posttraumatic asymmetry of a face skeleton; b) the mandible with shortening of the mandibular ramus after fracture of the condylar process. (Grave No 12, Líbivá near Břeclav, Czech Republic, middle of the 5th century). Photo by M. Řičánek.

16 mm, width 15 mm) is flattened and semicircular in the medial half. The head and the mandibular fossa fused totally in the dorsolateral quarter of this part. This adhesion was disturbed post-mortem as in the case of the left TMJ. The tympanic plate of the temporal bone shows signs of slight periostitis. The left chin area is lower (mental protuberance) from the exterior. The left mandibular angle is about 140°, the right angle 135°. The alveolar process is higher in a medial direction, so that the teeth form a high arch in the mid section of the mandibular body. The teeth are cramped in the dental arch, especially the right canine and the 1st premolar, where the canine erupted lingually from the lateral incisor (I2) and the 1st premolar (P1). The 3rd molars (M3) are just erupting on both sides, their crowns protruding approximately 2 mm above the alveolar ridge. Abrasion is more distinctive on the less affected right side of the dental arch, which was probably used for a somewhat longer time than the left side, due to mechanical conditions and pain. Some caries, a dento-alveolar cyst and a thick deposit of dental plaque are apparent on the remaining teeth. For a detailed description of the lesion, see Horáčková, Rühli (2014: 83–94) (*Figure 6*).

DISCUSSION

Mild asymmetry of the facial part of the skull is normal and usually just causes an unpleasant aesthetic problem to the affected individuals. In the differential diagnostics of more prominent asymmetries of the facial skeleton, it is necessary to recognise whether there is a post-traumatic origin of asymmetry, or asymmetry of the face caused e.g. by a congenital defect, tumour or other type of pollutant (Barnes 1994). For the differentiation of the causes of asymmetry, it is usually necessary to evaluate the presence and course of fracture lines, including small fissures around the defect from macroscopic and radiological points of view (Aufderheide, Rodríguez-Martín 1998, Ramba 1990). For example, in Case no. 3, these discreet fissures have essential importance in the differentiation between trauma and palato-gnathoschisis.

The study of asymmetry of the face in past populations is, of necessity, linked to diagnostic criteria in modern populations. The use of modern clinical data provides the opportunity to interpret the ancient material with a greater degree of accuracy.

The resulting range of asymmetry depends especially on the age when damage to the facial skeleton occurred. It is evident that also minor trauma in this area in the period of growth activity leads to serious facial disproportion in adulthood (Ramba 1990).

Nasal bone fractures are usually a component of combined fractures of the facial skeleton. For formation of this type of fracture, a sharp frontal blow to the nasal region is typical, when a dislocated or splintered fracture of the nasal bones occurs (Loyka 1976). These types of injury occur when falling to the ground or when struck by a heavy object in the face

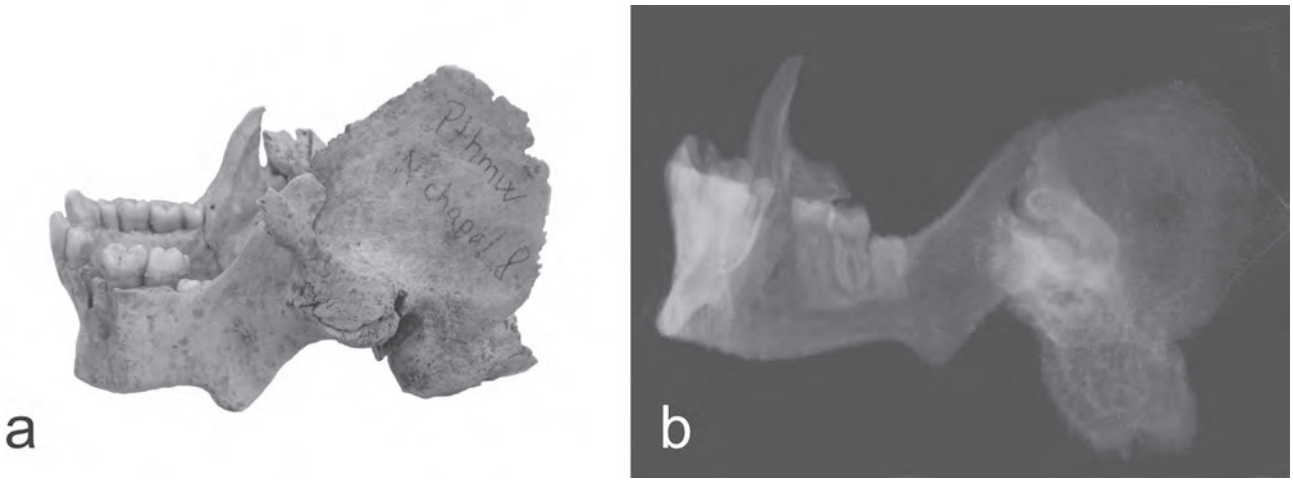

FIGURE 6: a) View to the left temporomandibular joint with ankyloses; b) X-ray photograph of affected temporomandibular joint. (Tomb of Ptahemwia, New Kingdom Necropolis, Saqqara, Egypt). Photo by L. Horáčková. X-ray by Salima Ikram, American University Cairo.

(Ramba 1990). A similar mechanism probably also caused the nasal bone fractures observed on the skulls in Cases 1 and 2.

Maxillary involvement also belongs among the combined fractures of the splanchnocranium, because they are in a close topographical and functional relationship to the other bones of the facial skeleton (Mrázková, Doskočil 2001). Falls to the ground caused by slipping or tripping are prevalent in the mechanism of injury. Often trauma is also caused by another person (fist fights or scuffles).

This type of fracture is most often localised in the frontal section of the maxillae, as in our Case no. 3. This was a combined fracture of the maxillary alveolar complex (Le Fort type II, where the fracture line runs from the nasal bones over the medial and lower parts of the orbit and continues to the frontal part of the maxilla into the area of the pterygoid processes of the sphenoid bone). A similar finding in the Czech Lands was noted e.g. in one skeleton from a triple grave in Dolní Věstonice (DV XVI) (Ramba 2005).

Due to the anatomical differences in the structure of the upper and lower jaws, mandibular fractures occur less often. However, the post-traumatic facial asymmetry is affected by several factors in this type of infliction. The changed mechanism of TMJ movements and the relatively difficult prenatal and postnatal development of the mandible are among these.

The mandible plays a special role in the development of the facial part of the skull and the mechanism of mandibular fracture repair is also unique to the body. Meckel's cartilage is the basis of the mandible in the human embryo. A bony plate arises by enlarging the bony base of Meckel's cartilage externally, which proliferates under Meckel's cartilage. It forks externally of the cartilage, so that the desmogenous ossification creates a type of bone trough opening upwards, which looks like the letter Y in cross section. Meckel's cartilage is rapidly resorbed and is replaced with bone tissue, which blends with the bone of the mandible in a desmogenous way. All these processes are located in the area of the future body of the mandible (Mrázková, Doskočil 1994).

The origin of the mandibular ramus is different. A column of cartilage appears in the area of the future mandibular ramus somewhat later than Meckel's cartilage. This column is surrounded by the bone tissue from the neighbouring connective tissue and undergoes enchondral ossification itself that proceeds from beneath – from the future mandibular angle – upwards to the basis of the mandibular joint. The osification proceeds at the end of the foetal and at the beginning of the postnatal periods of life to the area of the future mandibular neck only. It stops there and cartilage cells realign themselves in the space, so that the cartilaginous mandibular head is attached to the newly formed bone by strips of cartilage and ligament resembling mast anchoring cables. The boundary between these two tissues takes over the function of growth cartilage, from which the mandibular ramus grows in height. This boundary is less strong mechanically. In injuries when a child falls on to the chin, it may happen that the mandibular neck fractures in the mechanically least resistant site. The mandibular neck is subluxed and rotated medially by the pull of muscles. It is not in contact with the mandibular fossa and is rather rapidly resorbed. A new head can originate from the growth cartilage in the mandibular neck, resulting in a new temporomandibular head. This mechanism of fracture repair is unique in the body. The resorption of the broken mandibular head and the creation of the substitute head take some time (several months), in which the mandibular ramus growth slows down or is temporarily or permanently halted (depending on the age of the injured child). Asymmetry of the mandibular apparatus and the face originates from that (Lund 1974, Doskočil 1988, Mrázková, Doskočil 1994).

In the young male from Líbivá (Case 4), it is possible to assume that the facial asymmetry originated as a result of a dislocated fracture of the condylar process of the lower jaw in childhood. According to the range of infliction and the description of similar clinical cases, it is possible to determine the probable accident time for the period before acceleration of facial growth as between 9 and 12 years of age (Ramba 1990). The injury was most probably caused by a fall from a height or a blow to the chin region of the affected individual.

The described case of facial asymmetry can be compared with current clinical cases (Ramba, 1988) when, at the dislocated fracture of the condylar process, not only loss of bone mass around the lesion occurs but also, as mentioned above, resorption of the whole condylar process. After several months, a secondary articular process starts to form, which is, however, delayed in growth. Then reorganisation of bone due to the mutual pressure of bony structures occurs and a shallow secondary articular pit, known as a neocotyle, is created in place of the original articular tubercle. The newly formed condylar process is distinctly shorter, narrower and has an enlarged head.

Similar asymmetry was observed in the Czech Lands e.g. on the skull of a female 35–45 years old from Dolní Věstonice (Dolní Věstonice III) and on the splanchnocranium of a male from Brno III. Both findings are from the Upper Palaeolithic period (25 000–2700 BC) (Vlček, Ramba 1989, Ramba, 2005).

A traumatic lesion of the TMJ can be complicated by secondary degenerative changes, when chronic osteoarthritis develops. Gradually the lysis of the amorphous ground substance of cartilage, disorder of its nutrition and its slow destruction occur, which lead to damage to the subchondral bone. The present granulation tissue is gradually transformed into fibrous tissue, changing into a solid fibrous scar which can ossify and form solid bony connections, known as ankyloses, as seen in the last case (Case no. 5).

It should be emphasised that ankylosis of the TMJ is not a disease as such, but only the terminal stage of a number of diseases. In the studied TMJ, the differential diagnostics of the origin of ankylosis is more complicated, because the TMJ damage may be due to several causes. It was necessary to consider several etiological factors:

1. Macrotrauma – contusion and fracture (with bleeding to the intra-articular space). The most frequent cause of the formation of ankylosis is trauma (about 50–60 %). The risk factors are, in particular, splintered fractures of the articular head. The hypothesis of its origin is the intra-articular presence of blood, which is caused by disruptions to the bone by the injured articular cartilage. In the joint, the gradual formation of fibrous tissue occurs, which ossifies. But in the affected individual, fracture line traces were not noted on the X-ray (despite it being performed under field conditions). For this reason, a fracture had to be ruled out as the cause of ankylosis.
2. Since the TMJ is a paired joint that cannot function alone, osteoarthritis if present (usually in old people), is often symmetrical. Lesions are more severe on the temporal surface than in the mandibular condyle. So we can exclude osteoarthritis as the origin of this ankylosis.
3. We can also exclude systemic disease e.g. rheumatoid arthritis (although it affects about 25 % of TMJ) because its juvenile form avoids the TMJ.
4. We did not consider a tumour origin of the lesion, because no signs of any tumour processes were found.
5. Likewise, we also excluded avascular necrosis, which causes the death of bone tissue due to a lack of blood supply, and which can lead to tiny bone fractures and eventual collapse.
6. A diagnosis of developmental or metabolic disturbances merely from the skeletal fragments was impossible.
7. Other diseases, such as osteomyelitis, complications of mumps, possible spread of middle ear inflammatory process into the joint area are further causes for the formation of ankylosis. Chronic inflammation of connective joint tissues destroys the synovial membrane, cartilage and bone structures. The resulting damage results in stiffness and reduced mobility of the joint.

Due to the age of the deceased, pathological changes in the joint surfaces and tympanic plate, and absence of pathological changes found in other joints, we may only suppose in this case that ankylosis is the result of the terminal stage of TMJ inflammation (probably infection spread from the middle ear).

Middle ear infections are among the most commonly diagnosed diseases worldwide in infants. According to current medical statistics, consultations with physicians for middle ear problems are the most frequent between the 4th and 5th years of life, representing almost 40 % of all diagnoses at this age. According to the WHO (WHO 2004), even today 51,000 children younger than 5 years die of otitis media in developing countries.

We believe that the most likely cause of ankylosis in the boy from the Ptahemwia tomb was the transmission of a massive infection from the middle ear to the TMJ. Cases of otitis media were very common at that time and treatment was very well known from Ancient Egypt. For example, their diagnoses and treatment are mentioned in the Ebers Papyrus dating back to about 1500 BC (Halioua 2002).

In palaeopathological literature, references to TMJ ankylosis are rare (e.g. Alexandersen 1967). Therefore, the described TMJ ankylosis is a rare finding, even in skeletal remains from Ancient Egypt. It is clear from the affection rate that this was a long-term chronic process that required care of the patient.

CONCLUSIONS

For demonstration of some types of asymmetry of the facial skeleton, we chose cases from three differently dated periods. The two cases of healed nasal bone fractures and the one case of maxillary alveolar complex fracture were from the modern age. The case

of significant asymmetry of the facial skeleton as a result of a fracture of the condylar process of the mandible in childhood ranks among early medieval findings.

We relatively often see healed fractures of bones upon evaluation of palaeopathological lesions (e.g. Horáčková *et al.* 2004). By radiographic examination, the source of the fracture lines is distinct and their diagnosis is not difficult. The interpretation of individual findings concerning the mechanism of their origin is usually far more difficult. According to the frequency of occurrence of individual types of injuries in the studied population sample, it is possible to conclude whether they were accidental or anthropogenic injuries. The accumulation of some typical traumas is indicative of war events, or alternatively could be the result of domestic violence tolerated by society.

The findings from the Křtiny ossuary are probably an example of interpersonal violence. However, it is not possible to determine the circumstances of the formation of injuries in more detail.

The individual with facial asymmetry after a fracture of the condylar process (Case 4) came from the generally poor health conditions of individuals from Líbivá. (The burial ground of the Migration period in Líbivá belongs to the group of small necropolis which appear around half of the 5th century in Moravia, Lower Austria and south Slovakia. People buried in these graves most likely belong to rest of autochtonous Suebic population which is under pressure from the Eastern Germanic tribes expanding from the territory of Attila's empire. Both groups collide and gradually assimilate; Tejral 1999). This is evidenced by a high occurrence of tooth decay (in 50 % of adult dentitions), in comparison with collections of the same dating (e.g. Chochol 1958), as well as by the manifestations of degenerative productive processes in young individuals. Conclusions of the medico-anthropological investigation (including the healed fracture of the condylar process of the mandible due to interpersonal violence) are consistent with the archaeologists' hypothesis, who regard the community from Líbivá as a remainder of the original autochthonous Suebic population which had probably been oppressed by the new incoming population (Macháček, Klanicová 1997).

The TMJ ankylosis described in the last case, is among rare palaeopathological findings from archaeological excavations, even in Egypt. It is not possible to comment on the formation of ankylosis unambiguously. In the differential diagnosis, transmission of massive infection from the tympanic cavity must be considered in particular. However, traumatic origin cannot be completely excluded either.

We can only discuss causation, because ankylosis is the terminal stage of some diseases.

Severe damage of the TMJ shows us that this was a process of long duration, which needed treatment and care for the inflicted individual. It is very probable that Egyptian society had a means for the care of handicapped people.

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