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ASYMMETRY OF FEMALE FACIAL SKELETONS (DOLNÍ VĚSTONICE III AND BRNO III) IN THE LIGHT OF THE RECENT STUDIES

ABSTRACT — *The morphological changes in heads of the mandibular articular process in two Upper palaeolithic skulls from Moravia. Brno III and Dolní Věstonice III are studied. They are recognized as consequences of dislocated mandibular condyle fracture.*

KEY WORDS: *Facial asymmetry — Mandibular trauma — Upper palaeolithic pathology — Gravettian culture — Moravia.*

This study is a part of the main task of the State Plan of Medical Research I-8-4 "The Biomechanics of Man" also "Biomechanics of the Facial Skeleton" to be investigated at the Clinic of Pediatric Stomatology of the Faculty of Pediatrics of the Charles University in Prague-Motol. The research is focused on fractures of the mandibular condyle and the resulting growth asymmetries in the faces of children.

An interesting part of this research was the study of growth asymmetry developed as the consequence of traumatic damage of the condyle in two Upper Palaeolithic human skeletal remains. (*Fig. 1.*)

The first is a find of a female skeleton from a ritual grave in Dolní Věstonice discovered in 1949 by B. Klíma (1963, 1983), anthropologically investigated by J. Jelínek (1954).

There was a conspicuous atrophy on the left-half of the central part of the facial skeleton on the skull of a gracile mature adult female (of about 40 years of age). The left mandibular condyle

has been also deformed. It was believed that the female suffered from the retention of the 3rd left molar and that this condition has extended to the mandibular condyle. Experts did not exclude the possibility of traumatic damage of the left face, with a following paresis of the facial nerve. The women did not die in consequence of the disease, as documented by the attrition of her teeth; they served very well till her death, in spite of the above complication.

Another example of traumatic damage of a mandibular condyle was provided by the find of a ritual grave in Brno-Žabovřesky in the year 1928 by K. Absolon (1929). The skull found here was anthropologically investigated by J. Matiegka (1929). Again, the skeleton is gracile and it belonged to a mature adult female (of 35—45 years) and the shape and dimensions of the mandibular condyles and the mandibular fossae forming the jaw joints showed asymmetries. The asymmetry of the face was not conspicuous and has been complicated by some postmortal deformation of the skull.

In order to assess both cases and to contribute to the explanation of the origin of facial asymmetry and of the mutilation of jaw joint, both morphologically and clinically, it was necessary to eliminate all the interfering inaccuracies in the reconstruction

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of the dentition, and especially of the occlusion of the individual (Dolní Věstonice III) *Fig. 2*.

As it was impossible to make corrections right on the original skull, the corrections of the occlusion has been realized in a cast (Ramba, Vlček). In order to be able to consider the asymmetry of splanchnocranium we asked Dr. J. Jelínek of the Moravian Museum in Brno to lend us the original of skull DV III (*Fig. 3*) for reexamination. The plaster casting with occlusion has been anthropologically documented, both in the form of a drawing and also metrically and the original of the skull was subjected to X-ray examination and was compared with conditions of patients with facial growth asymmetry.

The original of the Brno III find was unfortunately destroyed in the last phase of World War II, for further study we have at our disposal only a cast. Thus no X-raying is possible any more.

1. Asymmetry of the Dolní Věstonice III Skull

The DV III female skeleton was buried in strictly crouched position, with her skull laying on her right face (*Fig. 4*). The covering of the skeleton with a heavy mammoth scapula and the pressure of the soil caused some postmortal deformation of the skull along the axis right-side angle of the mandible — left frontal boss.

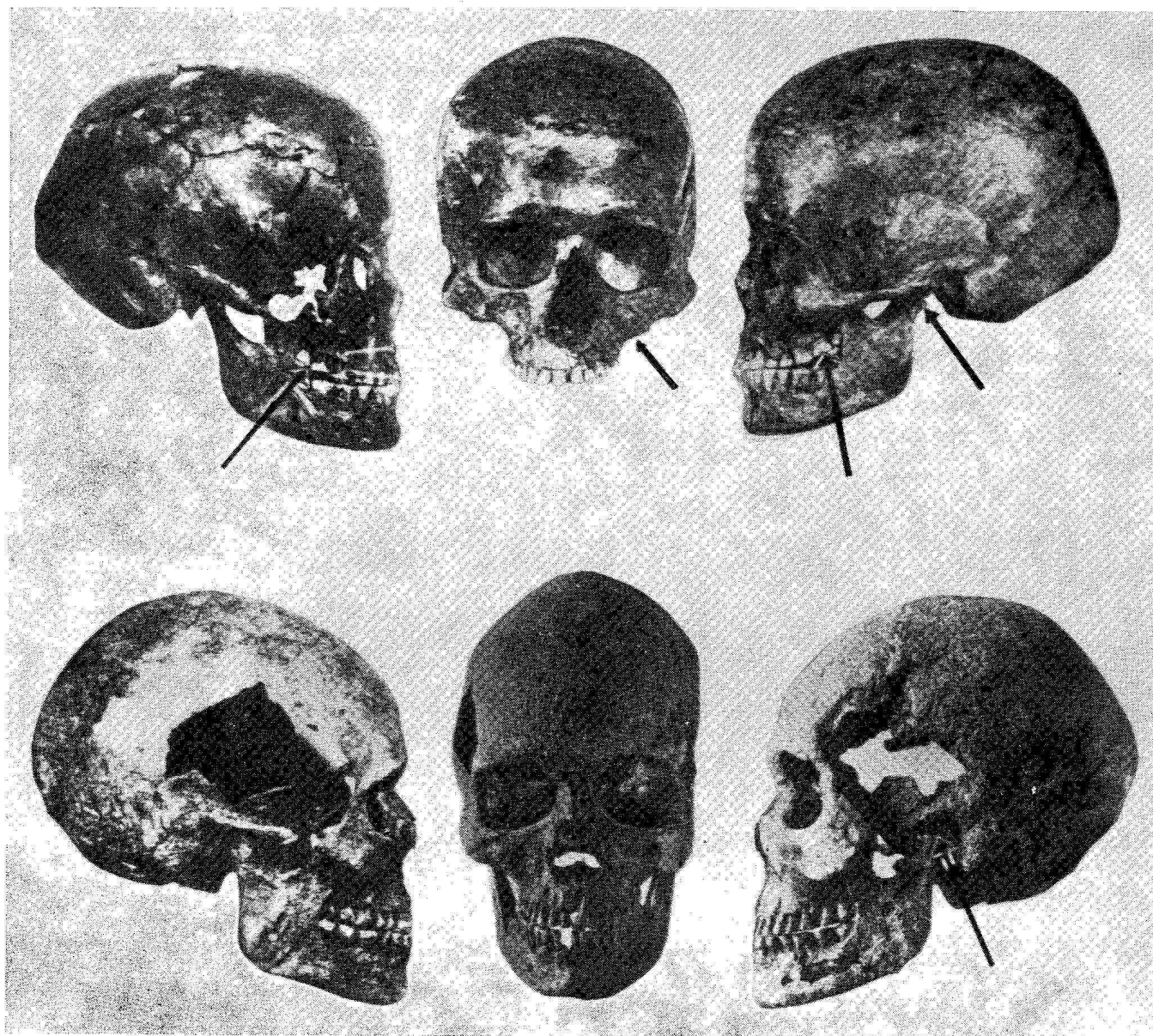


FIGURE 1. Upper palaeolithic skull of Dolní Věstonice III female. The arrow points to mandibular articulation, to maxillary changes and to the third maxillary molar. Upper palaeolithic skull of Brno III. The arrow points to the mandibular articulation.

In spite of these facts the pathological asymmetry of the skull is well perceptible; this holds especially for the facial skeleton. The left-half of the central-third of the face is hypotrophic. In the lower facial third there is a well visible diminution of the left half of the mandible. In frontal view of the skull the asymmetry of the face and of the skull can be expressed by the planes — by the Frankfort horizontal plane, and occlusal plane and to compare with the tangent touching the mental

part of the mandible. The above planes are inclined to the left, i.e. to the side with affected jaw joint.

Metrically this asymmetry can be expressed by the dimensions of the central third of the face. The minimum height of the maxilla (48/3), is 40 mm on the right and 38 mm on the left. By the height of facial field (48/3a) — dimensions 16:17 mm, the height of the cheek bone — 18 : 21 mm; projection vertical line nasion — lower orbital rim (48/5) — dimensions 25 : 29 mm.

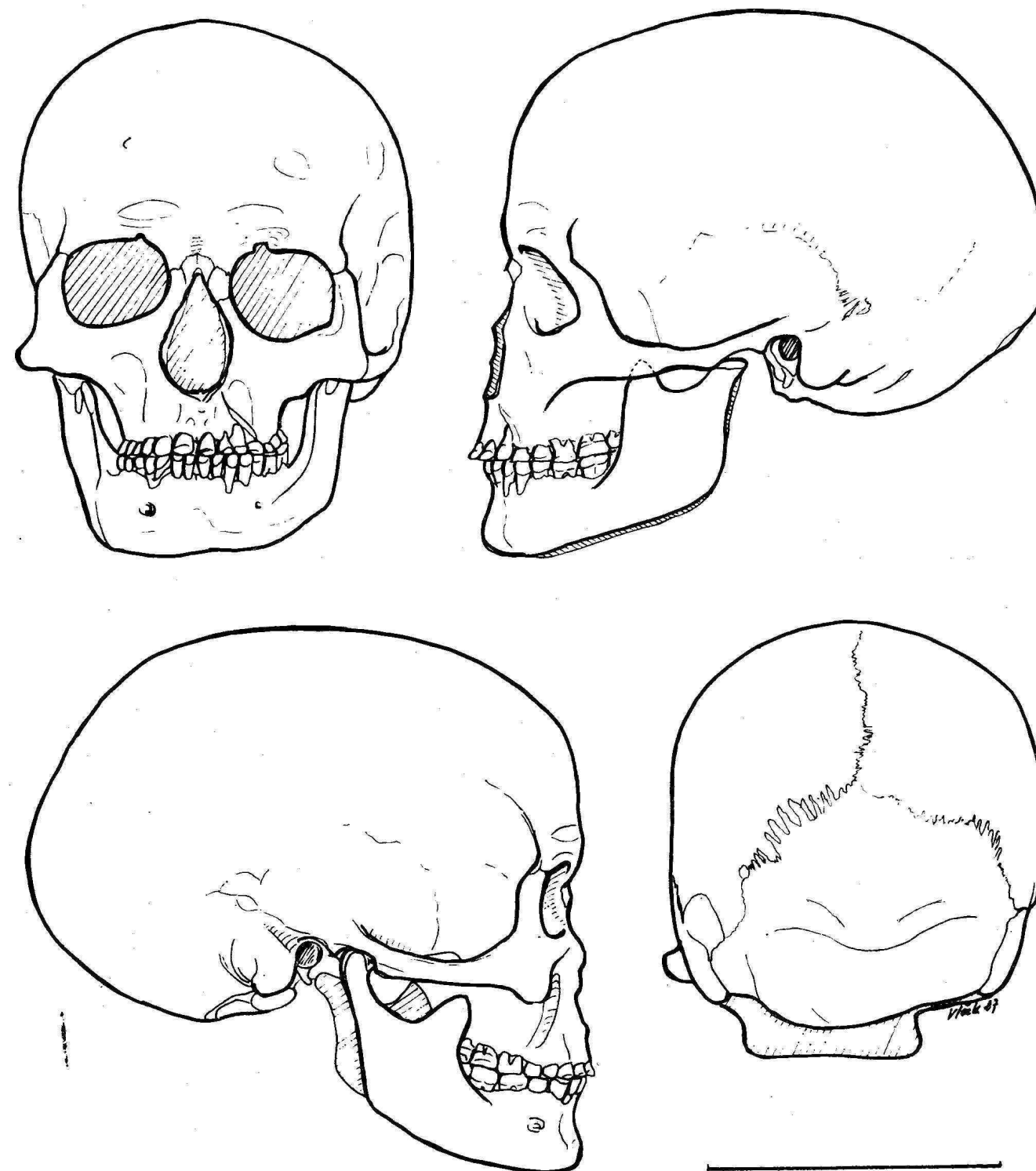


FIGURE 2. The female skull Dolní Věstonice III with the reconstructed occlusion.

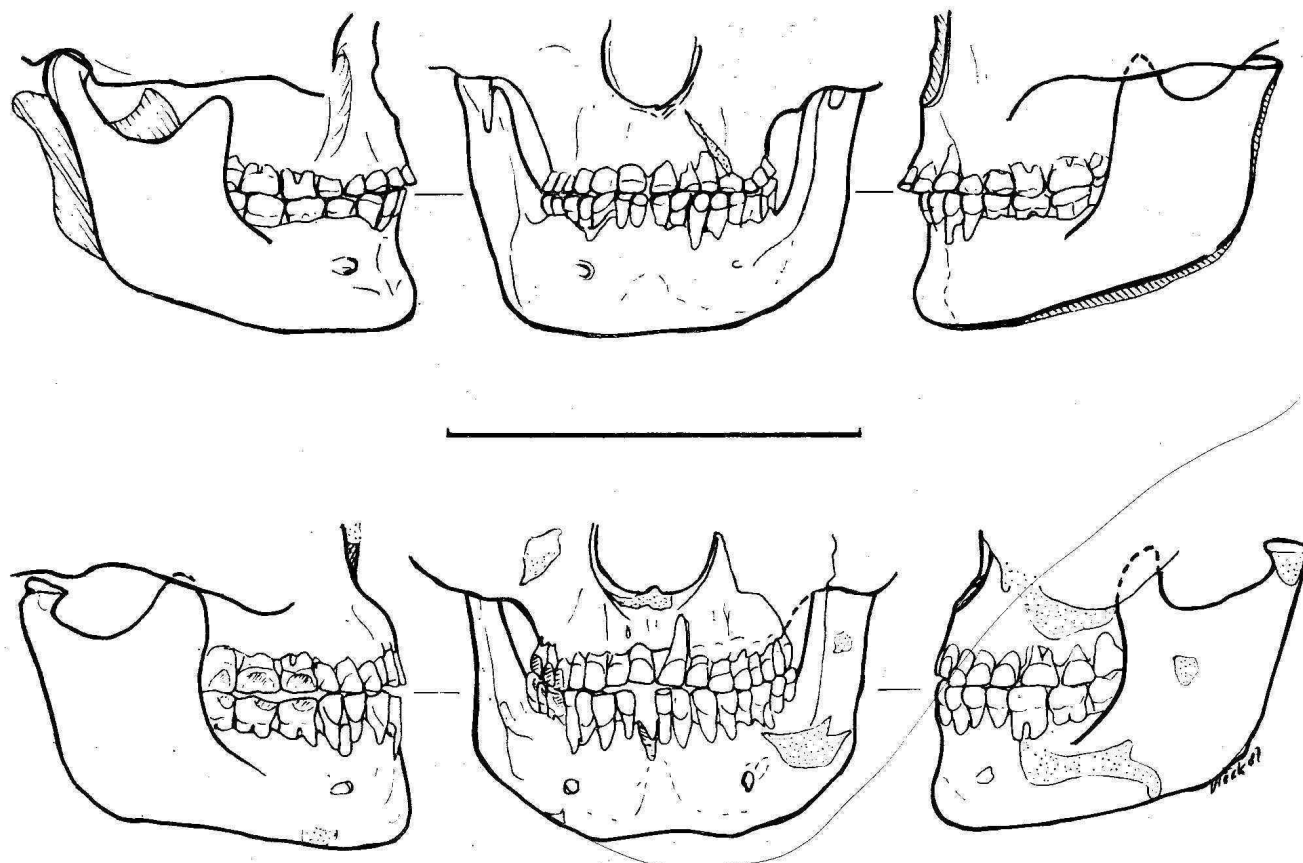


FIGURE 3. Maxillo-mandibular relations in Dolní Věstonice skull after the reconstruction of the occlusion (upper three views) and in Brno III (lower three views).

The flattening of the left facial region is indicated also by the shape of the two lateral margins of the maxilla in frontal view and by the recession of the maxilla on the affected side, well perceptible in basal view.

The facial asymmetry is documented also by the different heights of the two orbits, measuring 29 mm on the right and 31 mm on the left. The left orbit is situated more caudally and dorsally than the right one. However, we should bear in mind that the shift can be partially influenced by the damaging of this region, i.e. by limited reconstruction possibilities.

Besides horizontal asymmetry we can see an asymmetry of the skull by comparing the lines following the sagittal direction. Very conspicuous is the vault-like course of the central plane of the skull observable from above and in the basilar norm.

2. Unilateral changes on the condyle and on the mandibular ramus Dolní Věstonice III and bilateral changes on the condyles of Brno III

On comparing the two condyles and mandibular rami DV III we can conclude (Fig. 5):

a) The left condyle has been mutilated so that roughly at the half of the assumed height of the joint head there is a horizontally oriented triangular surface, with an edge-like margin. On the contact

surface there are 3 separated facets. we shall mention their function further on. The right condyle of the mandible has the usual shape.

b) There are markant differences in the dimensions of the condyles. The width of the right head (normal size) is 21 mm. of the left one (the mutilated) — only 15 mm. The right condyle is 9 mm thick, while the surface of the left condyle has been extended from the front to the rear to 13 mm.

c) The mandibular neck on the mutilated left side greatly differs from the normal neck of the right side. The right condyle is 21 mm above the plane put through the lowest place in incisura mandibulae, while the mutilated left condyle is only 9 mm high.

d) Finally we can find out the changes in the size of the mandibular rami. Most conspicuous is the difference in the height of the ramus, 58 mm on the right, and only 45 mm on the left; the depth of mandible incisure is 14.5 mm on the right and 11 mm on the left. The situation is similar in the width of the mandibular notch; it measures 31 mm on the right and only 24 mm on the left. These data well document the extent of changes affecting the condyle and its neck on the left side, resulting in growth asymmetry of the left mandibular body. The dystopic affection of the left 3rd molar, with its crown oriented to the roots of the 2nd molar can also be explained by the primary affection of the condyle. It seems that its horizontal position

had been caused to a considerable extent also by the fact that it was situated too high in the mandibular ramus. Other dimensions of the ramus, such as its minimum height (41.5 : 41.0 mm), the front coronoidal height (51 : 52 mm) and the width of the mandibular ramus (35 : 35) correlate in both rami.

The conclusion drawn for DV III hold to a lesser extent also for the Brno III skull.

a) The left affected condyle joint surface is flattened, the front part is somewhat extended. In Brno III the joint surface has been flattened and the front is extended also on the right side. The left condyle is slim and is in line with the muscular process, while the right head is medially inclined, i.e. with its centre it is outside the muscular process. The two condyles are roughly of the same height.

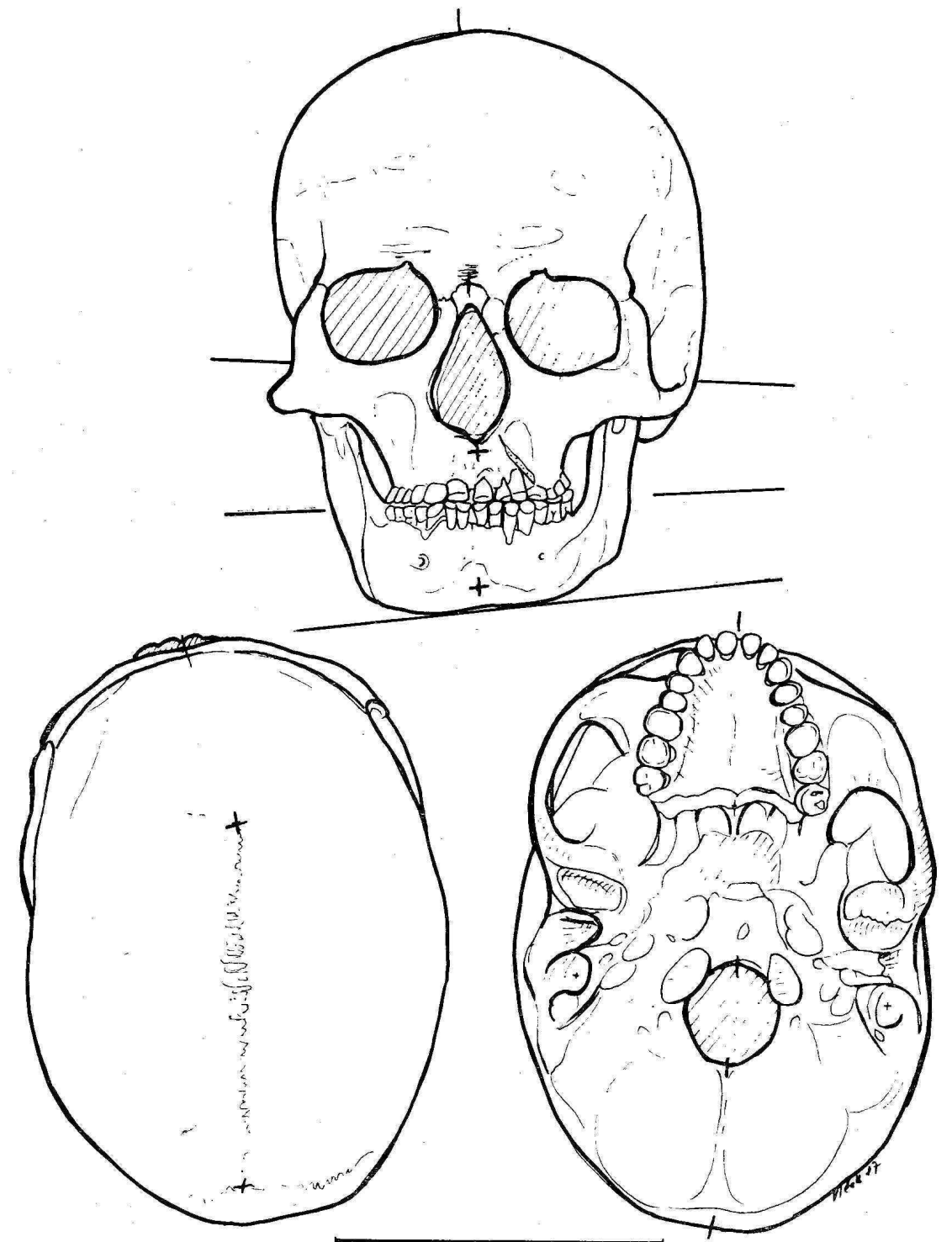


FIGURE 4. The Dolní Věstonice III skull before the reconstruction of the occlusion.

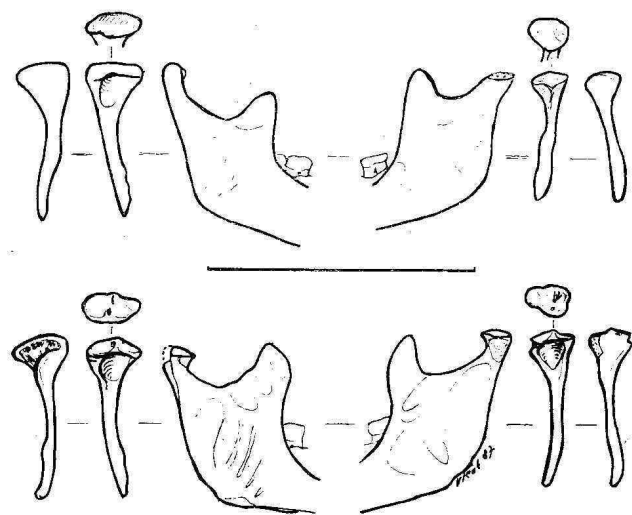


FIGURE 5. Mutilation of the left mandibular articular process in Dolní Věstonice III (upper part of the design) and of the left and right process in Brno III skull (lower part of the design).

b) There is a well perceptible difference in the size of the two surfaces. The right is 21.0 mm wide, the left measures only 16.5 mm in width, the right is 11 mm thick, while the left measures only 12 mm.

c) and d) There are no major changes in the neck of the condyle. The left mandibular angle is cranially lightly shifted out and is flatter. The height of the mandibular body (at the 3rd molars) is 19.5 mm on the left and 23 mm on the right side. In the Brno III mainly the condyles and their flat surfaces have been damaged, on the left side also the distal parts of the mandibular body and the angle are affected.

In general we can say that we have here 3 degrees of development of the mutilation of condyles.

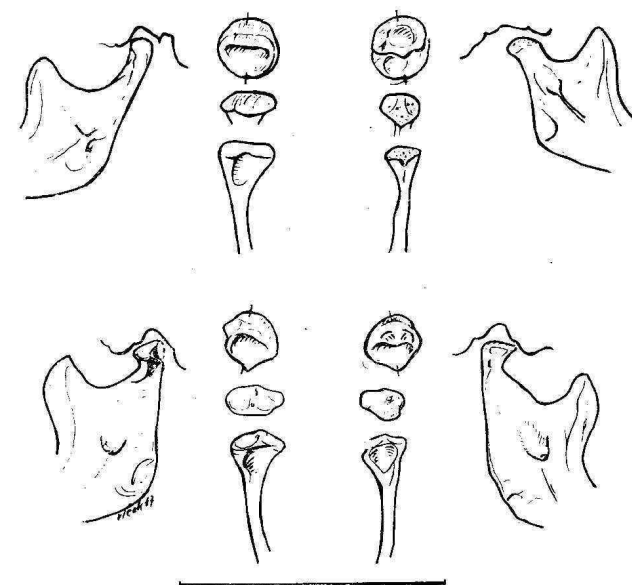


FIGURE 6. Changes in the shape of the articular fossae and mandibular heads in Dolní Věstonice III (upper part of the design) and in Brno III (lower part of the design).

It is very conspicuous in the mandible of DV III on the left side and only slightly indicated on both sides at Brno III.

3. Changes in the shape of mandibular fossae

In DV III the right mandibular fossa is roughly circular in shape and the articular tubercle is rounded off. (Fig. 6). The facies articularis is oriented transversally. Its dimensions: length 21.5 mm and width 24 mm.

In the longitudinal section the mandibular fossa is saddle-shaped and in the front it is limited by a rounded tubercle.

The left mandibular fossa looks quite different. Its dimensions are roughly the same as those of the right fossa (22 and 23 mm), but the joint tubercle is quite flat and is covered by a recently formed smaller mandibular fossa, frontally covering the front edge of the rest of the original condyle surface. This secondary fossa with its shape and dimensions fully matches the mutilated condyle. The contact in the jaw joint has completely changed. The articulation has been shifted frontally high, roughly by half of the original joint surface. A longitudinal section of the fossa well documents the relation between the two fossae.

In the damaged joint the articulation surface of the condyle inside the mandibular fossa has changed, and had direct impact on the formation of the growth asymmetry of the facial skeleton.

In Brno III we find a similar situation, but it is less extensive. On the left articular tubercle, not so flat, there is a minor shallow pit, looking as if impressed, with its dimensions matching the left mandibular condyle. The configuration of the left condyle, although within the norm, shows a certain shift in the contact of the condyle and joint surface.

4. Reconstruction of the occlusion in DV III

The degree of attrition is considerable, practically in all teeth of both the maxilla and mandible (with the exception of the left third upper molar, having no counterpart). This indicates without doubt that the articulation in the lifetime of DV III was perfect, in spite of the described mutilation of the left condyle. The mandible — namely its left side — is clearly asymmetric and there is occlusion only between the teeth of the frontal section. The premolars and molars are not in occlusion, the two dental arches are not against each other, they are situated laterally to each other, and this is very much evident in frontal view. The reconstruction of the upper jaw was therefore incorrect for two reasons: firstly the maxilla's dorsal parts were situated more cranially, and at the same time its dorsal end (with the rear margin of the palatine bones, with the sphenoidalis and with the rear margin of the vomer) rotated to the right, while the region of the premaxilla in the piriform aperture of the nose was situated accurately.

The arrangement of the occlusion was realized on a plaster cast, with the maxilla horizontally separated at the bottom edge of the piriform aperture, and by preserving the main vertical line (passing between the two central incisors) which was shifted down and to the left side in the dorsal section. Thus we have immediately achieved correct occlusion of teeth 7+ to +5. Both left molars (+6.7) were in this position still in infraocclusion. The impression in the plaster cast between teeth +5 and +6 suggest that the reconstruction here too was incorrect. That's why we have separated the alveolar process between the mentioned teeth and the segment thus arising, together with molars (+6.7,8) it was shifted into correct occlusal position of molars 1 and 2.

Thanks to the reconstruction of the relations between jaws in DV III the normal occlusion on the right side is well perceptible (i.e. the state when the mesiobuccal cusp of the upper 1st molar fits the cavity between the cusps of the 1st bottom molar). On the left side there is medium distoocclusion (singular antagonism) when the mesiobuccal cusp of the upper 1st molar is in full contact with the mesiobuccal cusp of its counterpart. Thus the occlusal surfaces of both molars are in full contact. In spite of considerable attrition of all teeth of DV III (with the exception of the upper 3rd left molar) there is a well visible medium distoocclusion. The left half of the lower dental arch is thus situated distally from the normal occlusion by half width of the premolar. In the lower dental arch of DV III we can see also mesiorotation of the 3rd right molar, and distorotation of the 2nd left molar, the tremata between the lower right premolars. There is well perceptible shift of the centre of the dental arch of the mandible to the left (by half of the width the incisor).

5. The importance of facets of the contact surface of the left condyle in DV III

The articulation surface of the left condyle is formed by 3 separate facets (contact surfaces). To make it more clear, we marked them with letters A, B and C. We were interested in their function and we tried to reconstruct the movements on the mandible, first on a plaster cast and later also on the original. In the central position (central occlusion) it is in contact with the secondary mandibular fossa the surface marked with letter A. At the depression (abduction) of the mandible into a position that in a healthy individual might be regarded as a physiological maximum (when both condyles together with the discs shift to the articular tubercles) in DV III occurs a small ventral shift of the left condyle. This movement is accompanied by click and the contact is realized with surface marked with letter B. Maximum depression in this case makes 38 mm (measured between the incisal edges of the left incisors). The right condyle slightly rotates in the mandibular fossa.

Mandible DV III could move away from the maxilla even more, namely to a position regarded

in a healthy individual as a non-physiological maximum (luxation position of the condyle in front of the articular tubercle). In this position the left head moves even more ventrally, so that it moved out from the secondary fossa up to half of its position. In the terminal phase of the mandibular depression the surface C comes into contact with the fossa. We do not exclude the so-called terminal click of the edge of surfaces A and C, but also of the edge of surfaces B and C. The right condyle remains in its fossa. The mandible then shifts markedly to the left. The maximum opening in this position measures 49 mm (Fig. 7).

6. Causes of changes in the morphology of the damaged condyles DV III and Brno III

The causes of the above-described changes in the morphology of both condyles of Brno III and of the left condyle of DV III, together with the growth asymmetry of the facial skeleton can be explained by clinical practice and experiences obtained by tending fractured condyles in children and by following and studying them for a longer period.

Fractures of condyles can be divided into two basic groups: high fractures (the fracture affects the head or the condylar neck) and low fractures (the fracture affects the base of the condyle). Fractures can be further classified according to types. In type 1. the condyle head remains at least partially in contact with the mandibular fossa and the fragment may be shifted or not. The angle enclosed by the two fractured pieces is less than 60°. The 2nd type of fracture is characterized by the dislocation of the condyle outside the mandibular fossa. The angle enclosed by the two fractures exceeds 90°.

Classification of Brno III and DV III according to the above aspects:

BRNO III

The right condyle (flat head with pulled out front edge ventrally and medially slightly inclined) — Type 1., the fracture occurred high at the head — dislocated medially and ventrally. The fragments remained prevalently in contact. Following the healing of the fracture the head has been remodelled however not into its original anatomic shape.

Left condyle (flat slim head with the margin extended (especially in the front part), corresponding small pit on the tubercle of the joint) — 1st type, high fracture of the neck with dislocation (without bone contact with the base of the condyle). A typical case of forming a secondary condyle.

Conclusion: In view of the fact that in Brno III we had a bilateral fracture of condyles with dislocation of fractures, the geometry of the mandible has been affected (through the dissolution of the left condyle). This has resulted in light asymmetry of the left mandible. No major affection of the mandible occurred. By growing a secondary condyle the

affected geometry has been repaired. The central third of the facial skeleton suffered no damage in the course of the further growth and development.

DOLNÍ VĚSTONICE III

Left condyle (at the half of the supposed condyle there is a horizontally oriented surface, with extended edge-shaped margin) — 2nd type, low fracture of the base of the condyle combined with dislocation the fragment has no bone contact with the ramus. The deformed condyle in DV III has been formed secondarily, the original has dissolved.

Conclusion: This type of fracture is dangerous with its late consequences and has anomalous effects on the development of the facial skeleton.

It will be therefore useful to acquaint you with the etiopathogenesis of this little known nosological unit in the traumatology of the facial skeleton of children and to explain you the posttraumatic growth asymmetry of the face following a fracture of a condyle suffered by a young girl known to the archaeologists as adult female skeleton Dolní Věstonice III. The growth asymmetries of the face following the condyle (Hypotrophia arthromandibulo-facialis posttraumatica).

1. It is typical of the asymmetry that it arises following the dislocated fracture of the condyle in a child. Due to the loss of bone contact the dislocated condyle is absorbed after some time. Due to the loss of joint integrity (relation condyle-disc-fossa) there is a change in the line of the main pressure tensions, by preserving the direction in which the forces are acting (the mandible behaves according to the mechanism of elastic bodies). On the basis of a reduced pressure on the jaw and on its surroundings the bone matter is being reduced and the respective half of the mandible is growing more slowly.

2. After several months grows a secondary condyle. In consequence of the slowed-down growth of the mandibular body and of the respective ramus the new condyle does not grow into the mandibular fossa, but somewhat more ventrally, namely in the direction of the ventral margin of the articular tubercle of the temporal bone. The rotating and translational movement of the condyle along the dorsal edge of the articular tubercle the bone get reorganized, namely due to the mutual pressure of the two bone structures. Osteoblastic resorption causes first the dissolution of the cartilage, then also of the bone of the articular tubercle at the place of its contact with the recently formed condyle and the former is immediately replaced through the apposition of new bone lamellas in the defect. This reconstruction results in a well-defined defect (as worn out) at the place of the former articular tubercle, forming a not-too-deep new mandibular fossa, (neokotyl). The new articular process is differing from the known anatomic shapes. It is evidently shorter, and viewed from front to rear it seems leaf-like. As seen from skeletal materials the condyle viewed from above extends into a disk,

with an osteophytic edge around it. Its surface is gently arched and slightly rough. The above described changes are the results of a process of adaptation. It is known in all cases where the joint was damaged and remains under load.

During this period the mandible is shifting to the wounded side, namely with the mouth open. It is the result of affected geometry of the mandible and of muscular equilibrium on the basis of gradual atrophy of both pterygoid muscles. Slowly continues also the atrophy of the masseter muscle on the injured side.

3. In consequence of the above defects develops a *mandibular asymmetry*. If the injury happens to a child in an early phase of its development, the asymmetry becomes more emphasized especially during the 1st period of growth acceleration (between 5—7 years of age).

a) besides reduced and deformed secondary condyle the whole ramus is vertically shortened and the mandibular angle is cranially shifted out

b) the slow-down in the growth of the ramus is accompanied by a stop of the breadth growth, in the ascending direction. At the final stage in frontal view the ramus is situated in the vertical axis

c) the jaw joint is situated medially, or even ventrally, as compared with the joint on the opposite side. The same holds for the position of the ramus too

d) characteristic is the flattened, short and lower body of the mandible

e) the mental symphysis is shifted to the injured side

f) in consequence of the slow down of growth arise also orthodontic anomalies:

- the centre of the dental arch in the mandible is shifted to the injured side
- crossed occlusion (very frequent), one-sided singular antagonism
- compression of teeth on the affected side (with frequent retention and semiretention)
- one-sided deformation of the dental arch, especially in the distal parts
- lingual inclination of premolars, especially of molars of the affected side.

These changes can develop to various extent during the period of growth and development up to the age of 15 years. The difference in clinical picture depends very much on the age in which the injury occurred:

- A: in early age, mandibular asymmetry appears especially during the 1st period of growth acceleration (between the 5th and 7th year of the age)
- B: during the 1st period of growth acceleration or following it. Then the mandibular asymmetry develops in the course of further years, as a rule up to the 2nd period of growth acceleration (12—15 years of age)
- C: immediately before the 2nd growth acceleration or in its course; it is manifested also by mandibular asymmetry, but without affecting markedly other parts of the face.

We can conclude from our observations that the injuries affecting children before the age of 12 years have more serious consequences as regards their impact on other parts of the face (injuries A and B).

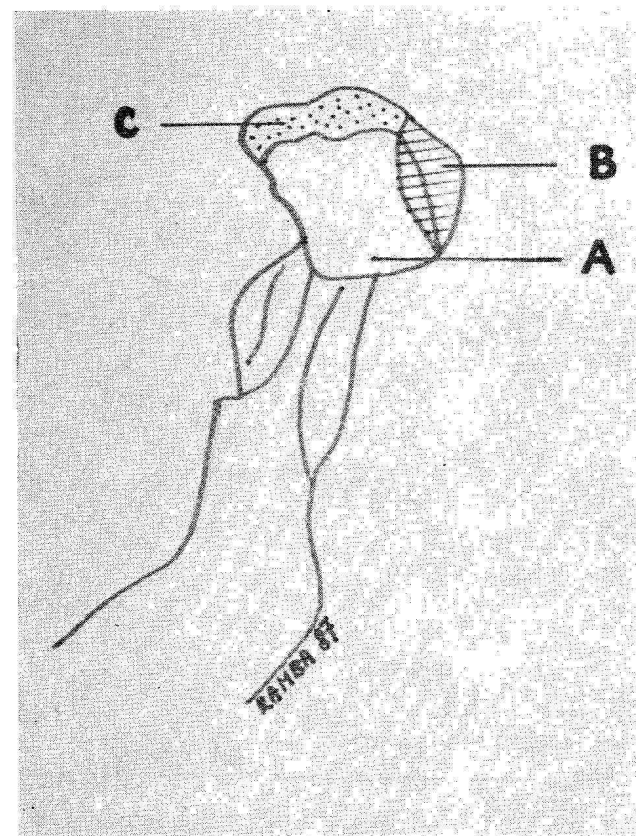


FIGURE 7. The articulation surface of the left condyle in Dolní Věstonice III is formed by 3 contact facets (A, B and C).

Mandibular asymmetry, to wit, has a slowing down effect on the growth of the entire central third of the facial skeleton of the respective side. It is so due to the impairment of the geometry and of the muscular equilibrium. The mandible being pulled upwards by an unbalanced force (being progressively deformed), transfers through its alveolar processes and teeth uneven force flows on the upper dental arch from the two zygomaticomaxillary complexes. This develops also the *asymmetry of the central part of the face*. At frontal view the entire respective half of the face is affected. The changes are stronger on the mandible. They are somewhat smaller in the central part of the face. Especially strongly is manifested the asymmetry on the gracile skeleton of the face.

The complex picture of the *facial asymmetry* arising following the dislocation of fractured condyle looks as follows:

1. The mandible is laterosuperiorly deviated towards the affected side.
2. The occlusion plane becomes strongly inclined and this in turn results in an oblique course of

the rima oris. There are also numerous other orthodontic anomalies.

3. Strong hypoplasia of the zygomatico maxillary transition, including the zygomatic arch.
4. Very conspicuous is the asymmetry in height of the ear lobes as well as the lateral and height asymmetry of the two orbits.
5. The nose skeleton, including the vomer and lamina perpendicularis ossis ethmoidis is also deviated (in the form of arch), but directed to the non-affected side. The deviation affects also the piriform aperture of the nose.
6. The asymmetry is emphasized by the dystrophy of the masticatory muscles, the tongue and the bottom of the buccal part of the affected side.

CONCLUSION

In both individuals of the Moravian Upper Palaeolithic mammoth-hunting population we have without doubt to do with dislocated condyle fractures (in DV III the fracture of the left condyle, in B III bilateral fracture). According to our experience we can presume that in skeleton Brno III the injury occurred about the 2nd period of growth acceleration (i.e. between 12—15 years of age). The DV III suffered the injury at the age of 9—12 years, so that in the course of the 2nd growth acceleration she developed full facial asymmetry. In both cases the cause was presumably trauma of the chin, being the cause of the majority of the fracture of mandibular condyles.

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