

Is craniofacial asymmetry and adaptation for masticatory function an evolutionary process?

MANY workers have investigated asymmetry of primate skulls. Woo¹ carried out direct chordal and arcual measurement on a large number of human skulls from the 26th to the 30th Egyptian dynasties. He found the bones of the cranium exhibited an asymmetry with the right side being larger, reflecting the development of the right hemisphere of the brain. The contralateral side of the facial complex exhibited an asymmetry with the left zygoma and left maxilla being larger. The lower third of the face was not investigated.

Mulick² investigated human facial asymmetry using cephalometric skull radiographs with a three-dimensional grid system of analysis and reported a facial asymmetry in six same-sex triplets, with the larger side being to the left.

Groves and Humphrey³ reported an asymmetry of gorilla skulls (*Gorilla gorilla beringei*) with the left side exhibiting a marked increase in length from the temporal fossa to the gnathion. They postulated that such asymmetry may be consequent to an asymmetry of function of the masticatory system.

The skull complex consists of numerous constituent parts. It is, therefore, the degree of harmony between the parts which determines the symmetry of the whole. The following investigation into human facial asymmetry was devised to establish a method for analysis of overall facial asymmetry in terms of its component parts, each of which can individually vary between the right and left sides.

Sixty posterior-anterior cephalometric skull radiographs of normal children were traced. No child with a degree of clinically evident or unacceptable facial asymmetry or gross deviation of dental arrangements was included.

Six bilateral and four single roentgenographic landmarks were delineated. The single landmarks were: sella; anterior nasal spine; incisal point; menton. The bilateral landmarks were: orbitale; centre of condylar shadow; zygomatic point; upper molar point; gonion; superior extent of condyle.

To assess the relative asymmetry of the component parts of the facial complex, a method of triangulation was used. The roentgenographic landmarks were joined to form triangles on both sides of the midline, representing the right and left mandibular regions, lower, middle and upper maxillary areas and the cranial base regions. The sides of the triangles were measured to the nearest 0.5 mm. and the areas compared with the areas of the equivalent triangles of the contralateral side.

The investigation revealed an overall asymmetry in most cases with the larger side to the left. The cranial base region, lower maxillary region and mandibular region exhibit a left sided excess. The maxillary region showed a right sided excess and the dento-alveolar region the greatest degree of symmetry.

The findings are of interest in that they suggest a compensatory adaptation during growth to effect an integration of the facial components. Scott⁴ suggested that the facial skeleton should be considered as a unit built up of a number of semi-independent regions, each with its own pattern of growth and development. The orbits, nasal cavities and lower border of the mandible show a high degree of independence and are under genetic control in their determination with the dento-alveolar region and lower parts of the nasal cavities showing a greater response to functional variation. These suggestions may be supported by the present findings. The mechanism whereby this occurs may be part of an evolutionary process. Adaptation of the dento-alveolar structures to muscle pressures is well recognised.

It is reasonable to assume that optimal function is provided by maximum cuspal interdigitation of teeth. We accept that this relationship can be arrived at in occlusion (that is, with

the teeth together) even though facial asymmetry may still exist. If in the rest position, or in the habitual postural position of the mandible, the upper and lower teeth are not co-incident about the sagittal plane, then an asymmetrical functional activity of both temporomandibular joint mechanisms must compensate during chewing and non-chewing activities in which the teeth are approximated. This in clinical practice is frequently related to pain and dysfunction and is therefore not a normal adaptation in humans.

To enable bilaterally symmetrical function and maximum intercuspation of the teeth to occur, compensatory changes seem to be operating in man in the growth and development of the dento-alveolar structures which minimise the underlying asymmetry in the spatial arrangement and size of the jaws.

This factor whilst no longer being essential for man's survival with his modern diet may nevertheless be regarded as a possible factor in the evolution and natural selection processes of the subhuman species.

P. VIG
A. B. HEWITT

*The London Hospital Medical College,
The Dental Institute, London E.1.*

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² Mulick, J. F., *Am. J. Orthodont.*, **51**, 112-119 (1965).

³ Groves, C. P., and Humphrey, N. K., *Nature*, **244**, 53-54 (1973).

⁴ Scott, J. H., *Am. J. Orthodont.*, **44**, 507 (1958).

Deltatheridium and Marsupials

THE evidence for the radical transfer of the famous genus *Deltatheridium* to the Marsupialia seems to be partly different from that already presented¹. The cheek tooth formula, a key character separating marsupials and placentals, is questionable for *Deltatheridium*. There are seven cheek teeth, as usual in both groups, and the fourth is molariform, as in marsupials. This is evidence on phyletic affinity only if the primitive state, that of the latest common ancestor, was otherwise. In a manuscript that has circulated privately since 1963 I have argued from diverse evidence that the seven cheek teeth of each group may well be directly homologous with those of the other, with an ambiguity as to the permanent or deciduous premolars. In other words, P₄¹ or DP₄¹ of placentals may well be homologous to M₁¹ of marsupials. If so, a more or less molariform state of the fourth cheek tooth is primitive to both groups and the often nonmolariform state in more or less primitive placentals is secondary. This was why I suggested² that *Deltatheridium* might have one more molar than previously thought; the suggestion is now confirmed. Relative wear of the teeth is a useful but unreliable criterion (ref. 3, footnote on page 86).

Positive evidence, however, comes from the fact that there is a sharp morphological break between the third and fourth cheek teeth. This is characteristic of marsupials but not of primitive placentals or the pantothere quasi-ancestor of both groups, *Peramus*⁴.

If *Deltatheridium* is a marsupial, as seems entirely possible, it is specially similar only to the Stagodontidae^{5,6} among possible relatives. Butler and Kielan-Jaworowska ascribe this similarity to parallelism, but there seems no positive evidence of such. Normal marsupial styler cusps are retained in *Didelphodon* but not *Deltatheridium*, so some divergence is indicated. I prefer to classify the ancestors of marsupials and placentals as marsupials, which increases the probability of allocation of *Deltatheridium* to marsupials without affecting the phyletic evidence.