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Fetal development of the modern human chin: The 3D shape variation is bounded to spatial arrangement of the hyoid bone, the tongue and suprahyoid muscles

Michael Coquerelle[1,2], Juan Carlos Prados-Frutos[2], Rosa Rojo[2], Jorge Alfonso Murillo-Gonzales[3], Philipp Mitteroecker[4], Markus Bastir[1]

1 - Paleoanthropology group - Department of Paleobiology, Museo Nacional de Ciencias Naturales (MNCN-CSIC), Spain · 2 - Falculty of Medicine, Department of Stomatology, University Rey Juan Carlos, Spain. · 3 - Department of Human Anatomy and Embryology I, Faculty of Medicine, Complutense University of Madrid, Spain · 4 - Department of Theoretical Biology, University of Vienna, Austria

The inverted T-relief shape of the modern human chin (Schwartz and Tattersall, 2000), appears during fetal development (Schwartz and Tattersall, 2000; Coquerelle et al. 2010). Nevertheless, the craniofacial context and factors linked with symphyseal shape during chin development are unclear. During postnatal life, the symphyseal shape changes are highly correlated with the spatial arrangement of the back of the vocal tract, the hyoid bone, the tongue, and the suprahyoid muscles. Using geometric morphometric methods, we test whether the prenatal appearance of the inverted-T shape relief of the labial surface is bounded to the same factors. The sample consists of 3D reconstructed jaw-basicranium-cervical skeletons from 23 high-resolution MRI scanned human fetuses, which range in age from 12 gestational weeks (gw) to term, and 3 CT-scanned neonates prior to 1 month of age. On each specimen, we digitized 679 semi-landmarks including the tongue and geniohyoid muscle insertions at the lingual side of the symphyseal fibroblastic midline as well as the tongue outline. We converted the coordinates to shape-variables by Procrustes superimposition to analyze the average ontogenetic shape changes associated with the inverted T-relief. Our results show that from the 12th to 14th gw the mandibular shape changes dramatically when the head flexes towards the throat and the lateral basicranium grows centripetally. The pharynx, the hyoid bone and the basal tongue become superiorly more deeply enclosed within the oral cavity. At the same time, the symphysis changes from convex anteriorly to vertical as its height increases at the area of the muscle insertions. The basal part of the fibroblastic midline becomes even more prominent relative to the parasagittal bony structures. From the 14th to 17th gw, the basal part of the symphysis projects forwards simultaneously with the posterior inclination of the hyoid bone and the flattening of the tongue. From the 17th to 20th gw, the basilar part of the symphysis relocates underneath the alveolar region, which is very bulged near the canine, simultaneously with the backward and downward positioning of the muscle insertions that follow the descent of the hyoid bone and the base of the tongue down the throat. The mental fossae deepen; the vertical and inferior symphyseal margins sharpen forming the real ridges outlining the inverted T-relief. From the 20th gw to birth, the symphyseal shape does not change substantially. Our results confirm that the development of the inverted T-relief is bound to the space at the back of the vocal tract and the arrangement of the tongue and suprahyoid muscles. The earlier symphyseal shape changes including the fibroblastic midline are similar to those observed in infants after birth. This provides further evidence that the postnatal prominence of the mental region is not particularly related to mastication or speech but is an adaptation to spatial adjustments and constraints.
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References: Coquerelle M., Bookstein F.L., Braga J., Halazonetis D., Weber G.W., 2010. Fetal and infant growth patterns of the mandibular symphysis in modern humans and chimpanzees. J. Anat. 217, 507–520. Schwartz J.H., Tattersall I.,2000. The human chin revisited: what is it and who has it? J. Hum. Evol. 38, 367–409.