**Postnatal development and growth of the human skull**

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Abstract

Soft-tissues of the head compete for space during ontogeny and shape the skull. Several studies have explored such interactions, mostly with respect to cranial base flexion and brain enlargement in-utero. Here we extend and expand on these works by scrutinising postnatal changes of human skull shape more broadly in relation to age and endocranial volume.

MRI datasets were collated from a series of repositories, including PING, NIH and NDAR, and represent 305 individuals from birth to 5 years of age. Landmark co-ordinates of the neurocranium, cranial base and viscerocranium were placed using 3DSlicer 4.5.0 and analysed with MorphoJ 1.06d. Endocranial volumes were available for most individuals and if not were estimated using Volumest in ImageJ.

The first Principal Component (PC1) of skull shape was shown to be highly correlated with age, endocranial volume and centroid size (r=-0.73, p=1.14E-52; r=-0.63, p=8.82E-36; and r=-0.81, p=2.66E-72, respectively). The 16.9% of shape variance captured by PC1 demonstrates a shift in the position and relative size of the petrous temporal bones and the orbits, and also an apparent change in cranial base flexion. PC2-5 showed low but significant correlations with age and size (r = 0.1 to 0.2) and collectively represented less than 27% of the total variance. Partial linear correlations indicated that the highest and most significant correlations were between PC1 and centroid size.

These results suggest that shape and size are intrinsically linked, and that there is a specific shape change with age. These findings will serve as a starting point for more extensive research into postnatal ontogenetic integration of the primate brain and skull.

No ethical approval required as study carried out on ethically approved datasets using consenting patients from PING (https://www.nitrc.org), NIH (https://pediatricmri.nih.gov) and NDAR (https://ndar.nih.gov) databases.