FOREBRAIN ENLARGEMENT AMONG NONAVIAN THEROPOD DINOSAURS

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The gross size and shape of the brain is often preserved in extinct vertebrates with well-ossified braincases, such as dinosaurs. The volume within the braincase, termed the endocast, is the space occupied by the brain, cerebrospinal fluid, and surrounding tissues. Endocasts of most nonavian dinosaurs differ little in size and shape from those of living reptiles (Jerison, 1969, 1973; Hopson, 1977, 1979). Birds, in contrast, have dramatically increased the volume of the brain relative to body mass and enlarged the cerebrum (forebrain) relative to total brain volume, as seen in a partial endocast of the early fossil avian Archaeopteryx (Jerison, 1973; Bühler, 1985). The enlargement of the avian brain and, in particular, the cerebrum is believed to have begun among small-bodied nonavian theropods, such as dromeosaurids (Sues, 1978; Currie, 1995) and troodontids (Russell, 1969; Currie, 1985). Reconstructing the evolutionary sequence that led to forebrain expansion in birds has been difficult because complete endocasts are not available for many of the closest relatives of birds (i.e., oviraptorosaurs, dromeosaurids, troodontids). Furthermore, scaling ambiguities hamper such comparisons, because the body size of theropods closest to birds is at least one order of magnitude greater than that of the earliest avians.

We present here an alternative means of assessing brain and forebrain expansion among nonavian theropods. We use Carcharodontosaurus (Sereno et al., 1996) and Tyrannosaurus (Osborn, 1912), two large Late Cretaceous theropod dinosaurs that have similar adult body mass but differ in phylogenetic proximity to Aves (Holtz, 1994; Sereno, 1997). Carcharodontosaurus and other allosaurids were large-bodied predators that diverged from coelurosaurian theropods by the Early Jurassic (Fig. 1). Tyrannosaurids, including Tyrannosaurus, are large-bodied coelurosaurids that diverged from the lineage leading to avians by the Late Jurassic. The similar adult body mass of Carcharodontosaurus and Tyrannosaurus permits direct comparison of their brain volumes.

An endocast was made from a complete and undistorted braincase of an adult individual of Carcharodontosaurus (Fig. 2A, C). A Tyrannosaurus endocast (Fig. 2B, D) was made from a sagittally-sectioned adult braincase and checked against a partial unsectioned endocast from a syndactylophonte referred to as Carcharodontosaurus (MMS 51-2004). Assuming ratios of the thickness of the dural coverings to the volume of the brain in cross-sectional slices throughout the endocast are similar...