WAS THE EARLY HOMINID BRAIN MUSCLEBOUND?

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INTRODUCTION

Stedman et al. [1] explored the possible influence that a gene encoding the myosin heavy chain (MYH) might have on the development of hominid masticatory muscles, mandibles and brains, with explicit attention to causal relationships between genetics and morphology in development and evolution. In this context, we read their concluding statement that "findings on the age of the inactivating mutation in the MYH16 gene raise the intriguing possibility that the decrement in masticatory muscle size removed an evolutionary constraint on encephalization..." as embodying a testable hypothesis.

METHODS

It was noted [1] that "experimental animal models of the masticatory muscle resection or transposition have demonstrated the correlation between craniofacial morphology and the force of masticatory muscle contraction" [2]. However, in the rabbits subjected to manipulation of the temporal muscle attachment, no statistically significant changes in brain size were documented; while skull width decreased, length increased, suggesting conservation of endocranial volume. Classic experiments in this area include those in which Washburn [3] removed various muscles from one side of the skull in newborn rats, producing temporal lines either absent altogether or displaced far down in the temporal fossa; but brain endocasts were unchanged on the operated side.

Observationally, many domestic animals have jaws, teeth and brains that all are evolutionarily reduced relative to their wild ancestors. In comparison with skull morphology of *Canis lupus arctos*, cranial capacities of husky dogs are diminished along with measures of jaw size [4]. Among free-living hominoid primates, the largest nonhuman cranial capacity was recorded for a West African gorilla [5]. Its endocranial volume of 752 cc not only exceeds by 40% the average for 400 conspecifics, but also is higher than many of the fossil hominid crania for several hundred thousand years following the 2.4$\pm$0.3 my time estimated for the MYH16 mutation. The large gorilla skull also had a markedly high sagittal crest, indicative of massive jaw muscles.

Among extant humans, jaw musculature also can vary quite independently of endocranial volumes. For example, Smith Sound Eskimo were characterized by skulls high in internal volume that nonetheless externally showed markings for the large temporal muscles developed from a traditional diet that required heavy chewing. One male exhibited an intertemporal distance of only 7 mm, less than in some gorillas with endocranial volumes less than half as great [6]. His cephalic index ([head breadth/head length]x100) was 73.1, reflecting a low ratio of cranial width to anterior-posterior length. However, this pattern was not interpreted to mean that a more elongated form of the hominoid skull is produced by greater lateral pressure of the temporal muscles, but rather that higher temporal lines are due to the more reduced insertion area for temporal muscles on skulls elongated for other reasons. Although the most dolichocephalic skull in the sample [7], its cranial capacity was 1545 cc, nearly at the 1563 cc mean for 9 skulls, some of which differed in proportions. An older study [8] of microcephalic human skulls discussed by the same author [6] showed that in these, the intertemporal distance varied tenfold (from 5 to 50 mm), while cephalic index ranged from 75 to 85 (dolichococephalic to brachycephalic), with the lowest intertemporal distance occurring in the most brachycephalic skull. Furthermore, the form of these small-brained skulls was not attributable to premature suture fusion, since the sutures remained open in most of the specimens. Last, the skull of LB1, a very small human discovered recently on the island of Flores, Indonesia, combines a low endocranial volume, in the range of 380 mm^3 [10] to 430 mm^3 [11], with a mandibular corpus that is proportional to its size.

RESULTS AND DISCUSSION

The experiments and observations outlined above establish that in mammals, including hominoid primates, there is no effective constraint by masticatory muscles on encephalization.

CONCLUSION

Our findings demonstrate that the size and attachment of jaw muscles make their marks principally on the external surfaces of the skulls rather than determining internal forms and volumes. Consequently, the idea that the early hominid brain was fettered by muscles whose confines were struck off by a single mutation stands as intriguing but as yet unproved. Nonetheless, it is important to note that although "Recently, evolutionary studies have been revitalized and revolutionized by an infusion of genetics into paleontology and systematics"[9], much of the promise remains to be realized.

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