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Masticatory loading and soft-tissue plasticity in the mammalian circumorbital region

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Masticatory loading is the key to understanding the plasticity or epigenetic responses of many of the soft and hard tissues of the mammalian skull. Diet-induced variation in the magnitude and/or frequency of masticatory loads influences the organization, functional adaptation and postnatal development of craniofacial systems. While experimental work exists concerning masticatory stress as a determinant of maxillomandibular form, similar research concerning the mammalian circumorbital region of soft-tissue structures remains sparse. Indeed, controversy remains over the function of the circumorbital region, specifically whether the postorbital region in primates and other mammals is responsive to biomechanical loading. This hinders our understanding of evolutionary transformations during primate origins, where the earliest primates evolved a bony postorbital bar from an ancestor with a soft-tissue structure along the lateral orbital margin. To fill this gap, we examined the postorbital microanatomy of white rabbits (Oryctolagus cuniculus). Rabbits exhibit a masticatory complex and feeding behaviors like primates, yet retain a primitive circumorbital region similar to their common ancestor. To address the plasticity and function of soft tissues of the lateral orbital wall, three cohorts of 10 rabbits each were raised from weaning (1 month old) to adulthood (6 months old) on diets of different mechanical properties (under-use, control, over-use). Once sacrificed, tissues were collected from the left lateral orbital wall. Dissections revealed that, rather than the anticipated postorbital ligament, rabbits instead exhibit fibrocartilage. Samples were analyzed histologically and immunohistochemically for general anatomy, fibril architecture, collagen expression/organization, and protein abundance using Western Blot analysis. Preliminary data suggests that collagen fibers are aligned differently, with an overexpression of collagen in the over-use dietary cohort versus both the control and under-use groups. In sum, these experimental findings suggest that the postorbital fibrocartilage is mechanically responsive, which contrasts with the non-masticatory nature of bony elements in the circumorbital region.