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On the jaws of lamniform sharks

The 15 species of lamniform sharks vary widely in feeding niche, including piscivores, megacarnivores and filter feeders. The functional morphology of their feeding apparatus is difficult to study in vivo due to their large size, rarity and/or pelagic habit. To determine whether, and how, skeletal structure and performance vary with ecology, we examined the cranial skeleton of all lamniforms and two non-lamniform species using computed tomography (CT). First, we quantified shape-based descriptors of jaw structure along jaw length, such as polar moment of area, slenderness ratio, mineralized cross-sectional area, and anatomical orientation of the cross-section's major axis. These data then allowed us to assess the contribution of shape to skeletal mechanics (e.g. resistance to bending, torsion, and buckling), to locate areas of reinforcement and define their magnitude, and to describe the probable primary orientation of loading. Our results suggest diet-specific structural organization in the jaws, but also broad consistencies across species. The mineralized tissue of the jaws is arranged to resist flexion ~5–20 times better than if it were a solid rod of circular cross-section, lower than maxima reported for durophagous species. Jaws are heavily mineralized (i.e. have comparatively small lumina) at their ends with tissue organized to resist torsion and flexion (i.e. exhibiting high polar moment, compressiform cross-section) in areas beneath teeth and/or at joints and muscle attachments. Highly eccentric upper jaw cross-sections tend to be mirrored in lower jaw shape. These data suggest that skeletal geometry in sharks may be organized in predictable ways, as in bone, to resist dominant loading regimes. We discuss results in the contexts of shark phylogeny and the potential mechanical demands of predation.