Teeth are critical markers of our present and past, how we eat, how we evolved. They are relatively hard and brittle with a complex microstructure, and are thereby of considerable interest to biomaterials scientists. It is hypothesised that specific tooth forms are adapted to resist fracture, in order to accommodate the high bite forces needed to secure, break down and consume food. Three distinct modes of tooth fracture are identified: longitudinal fracture, where cracks run vertically between the occlusal contact and the crown margin (or vice versa) within the enamel side wall; chipping fracture, where cracks run from near the edge of the occlusal surface to form a spall in the enamel at the side wall; and transverse fracture, where a crack runs horizontally through the entire section of the tooth to break off a fragment and expose the inner pulp. Simple, explicit equations are presented expressing critical bite force for each fracture mode in terms of characteristic tooth dimensions. Distinctive transitions between modes occur depending on tooth form and size, and loading location and orientation. Attention is focused on the relatively flat, low-crowned molars of omnivorous mammals, including humans and other hominins, and the elongate canines of living carnivores. Allusion to the conical dentition of reptiles and the columnar teeth of herbivores is also made, to highlight the generality of the methodology. How these considerations impact on dietary behaviour in fossil and living species is considered.

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