

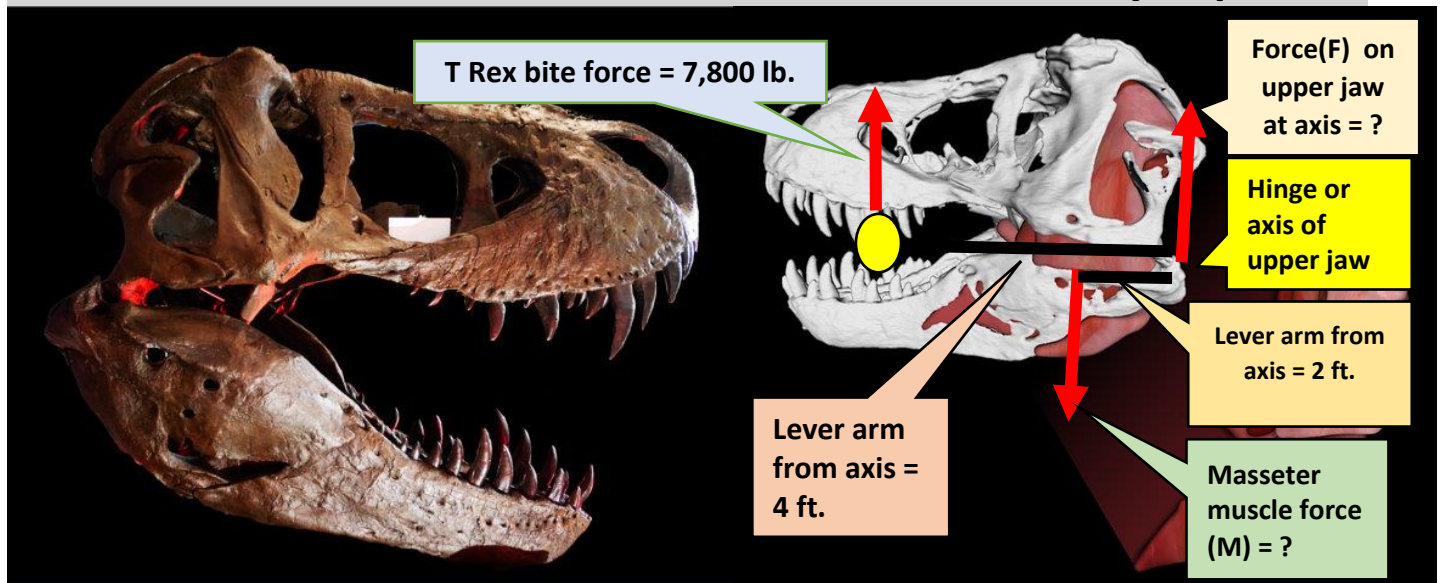
# STATIC & ROTATIONAL EQUILIBRIUM

Unit 15 Dr. John P. Cise

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New York Times , May 18, 2017, by Nicholas St. Fleur. Dedicated to my Father & Engineering Teacher, John W. Cise

## Between a T. Rex's Powerful Jaws, Bones of Its Prey Exploded



New research suggests that the Tyrannosaurus rex crushed its prey with **7,800 pounds of force.**

It's no surprise that the Tyrannosaurus rex had a mighty bite, but just how powerful were its gigantic chompers? A study published Wednesday suggests that the terrifying carnivore crushed its prey with a jaw-dropping 7,800 pounds of force — more than double what any living species can deliver. Even bone, according to Dr. Erickson. The finding helps provide more evidence to the idea that the T. rex shattered bones and swallowed the fragments for sustenance. The behavior, known as extreme osteophagy, is seen today in carnivorous mammals like gray wolves and spotted hyenas, but not in reptiles. The researchers also found that the tips of each T. rex tooth generated a pressure of about 431,000 pounds per square inch, which is higher than any animal ever estimated. The shape, size and spacing of the T. rex's long, conical teeth made it well equipped to channel the force from its jaws into bone-crushing results.

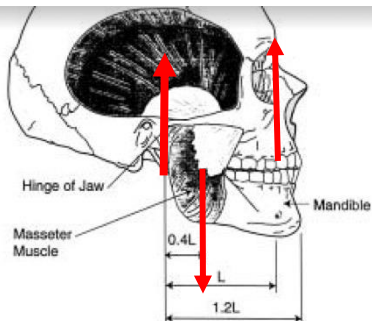


Figure 3.22. Schematic view of an adult skull showing some of the teeth and the masseter muscle that provides the closing and chewing action of the lower jaw (mandible). The dimensions are in units of  $L$  which is the distance of the first bicuspid from the hinge of the jaw.  $0.4L$  is the approximate location of the masseter muscle from the hinge and  $1.2L$  is the distance of the central incisor from the hinge. The value of  $L$  is typically about 6.5 cm for women and 8 cm for men. (Image modified by Ken Ford, original image Copyright © 1994, TechPool Studios Corp. USA.)

**INTRODUCTION:** Goal with this application is to find Masseter ( $M$ ) muscle force & hinge (axis) force ( $F$ ) on upper jaw of Dinosaurs T Rex & human (see graphic at left). The concepts to be used is when  $\alpha = 0$ ,  $\Sigma T = 0$ , & when  $a = 0$ ,  $\Sigma F = 0$ . Thus, two Equations can be set up to find the two unknowns.

**QUESTIONS:** (a) In the case of T Rex's upper jaw find masseter Muscle force  $M$  & hinge force  $F$ ?, (b) For the human upper jaw (see left)  $L = 8$  cm. for a man where bite (8 lb.) is made on some food object. For the human, find hinge force ( $F$ ) [also called axis force], and force ( $M$ ) made by masseter muscle?

**HINTS:** In each case (T Rex & Human) set up two equations to solve for the two unknowns in each case.

**ANSWERS:** (a) T Rex:  $M = 15,600$  lb. ,  $F = 7,800$  lb.,  
(b) For human:  $M = 20$  lb.,  $F = 12$  lb.