An Analysis of the Thoracic and Intracranial Pressures During Constriction by Kingsnakes

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Abstract:

How a predator effectively kills its prey plays a key role in predator-prey relationships, and has been an important factor in the evolution of every species, including snakes. Specifically, the multitude of methods that snakes have evolved to incapacitate their prey has partially offset their seemingly disadvantageous limbless form. Constriction behavior has played a key role in their evolution and success and involves the wrapping or winding of their body around prey while contracting their muscles. Although our understanding of how constriction effects prey has changed over the last century, not all hypotheses have been thoroughly tested. The known hypotheses underlying the mechanisms of constriction currently include suffocation, cardiac arrest, blunt force trauma, and neural damage. Further, current research suggests that ectothermic animals (amphibians and reptiles) are not susceptible to many of the known constriction mechanisms. However, current research does not easily explain how constricting snakes are able to quickly disable and feed on ectothermic prey. A recently raised hypothesis (the red-out effect) states that some prey animals may be experiencing high pressures in their heads during constriction, effectively shutting down their nervous system. This hypothesis has never been tested but potentially explains how some constricting snakes can kill other reptiles effectively. Here, we seek to quantify both the thoracic and cranial pressures in prey that are constricted by snakes. To do this, two Harvard Pressure Transducers are attached via fluid filled systems to the thoracic and cranial cavities of the mouse. When constriction is initiated the pressure exerted on the body will be transferred to the skull where they will be recorded simultaneously. Trials produced a significant and positive correlation between thoracic and cranial pressures ($r=0.55$, $P<0.03$) and while there is a correlation between variables, thoracic pressures were consistently higher than cranial pressures. There is a significant difference between the thoracic (111.1 ± 45.45 mm Hg; mean ± SD) and cranial pressures (27.1 ± 17.78) exerted on mice ($t_{17}=9.95$, $P<0.001$). This data would provide evidence for the red-out hypothesis and produce the first quantitative evidence of how pressure is transferred from the body to the cranium during constriction.