Public Abstract

First Name:Henry
Middle Name:P
Last Name:Tsai
Adviser's First Name:Casey
Adviser's Last Name:Holliday
Co-Adviser's First Name:
Co-Adviser's Last Name:

Graduation Term:SS 2015
Department:Pathobiology Area Program
Degree:PhD

Title:Archosaur hip joint anatomy and its significance in body size and locomotor evolution

Archosaurs (crocodylians, birds and their extinct relatives) underwent numerous evolutionary transitions in limb morphology and body size, reflecting a diverse suite of postural and behavioral adaptations. Among archosaurs, saurischians (sauropodomorph and theropod dinosaurs) evolved a wide diversity of hip joint morphology and locomotor postures, as well as spanning seven orders of magnitude in body size. The very largest saurischians possessed incongruent hip joints, in which the bony ends of the femur and the acetabulum (hip socket) differ in shape and size. This observation has led to the suggestion that gigantic saurischians built their joints using large volumes of soft tissues. Nevertheless, the lack of hip joint anatomical data in extant archosaurs and the general poor preservation of joint soft tissues in fossils hinder functional inferences of archosaur hip joints, thus complicating our attempts to understand the posture, locomotor behavior, ecology, and evolution of this diverse clade. This thesis investigates the anatomy and homology of articular soft tissue in the archosaur hip joint, reconstructs the evolutionary transition of hip joints in Saurischia, and infers the correlated evolution of hip joints and body size in the sauropod and theropod lineages.

In the first study, I described the soft tissue anatomies and their osteological correlates in the hip joint of archosaurs and their sauropsid outgroups, and infer structural homology across extant sauropsids using dissection, imaging, and histology. This study provides new insight into soft tissue structures and their osteological correlates in the archosaur hip joint, allowing anatomical inferences of once-present joint soft tissues in fossil archosaurs.

In the second study, I used maximum likelihood ancestral state reconstruction and osteological correlates to infer major trends in hip joint soft tissue transitions within sauropodomorphs and theropods, and tested the integration between femoral and acetabular structures. Results of this study indicate that sauropodomorph hip joints underwent few concerted transitions, followed by subsequent stasis in soft tissue anatomy throughout Sauropoda. In contrast, the theropod hip joint is characterized by mosaic evolution within the stem lineage, such that bird-like hip joints independently evolved in multiple theropod clades.

In the final study, I used 3D imaging techniques and phylogenetically correlated correlations to test the relationship among hip joint dimensions, morphological characters, and body size of saurischian dinosaurs. Giant theropods and sauropods convergently evolved highly incongruent bony hip joints. In sauropods, the femoral head was capped a thick layer of hyaline cartilage, which functioned to resist massive axial compressive loads. In contrast, theropods covered their femoral head and neck with thinner hyaline cartilage, and maintained the femoral neck-antitrochanter articulation to accommodate shear forces during femoral abduction and axial rotation. These results indicate that the archosaur hip joint underwent divergent transformations in soft tissue morphology reflective of body size, locomotor posture, and joint loading. Moreover, these studies provides the basis for reconstructing hip joint function, hindlimb posture, and locomotor evolution of archosaurs, as well as expanding the body of comparative knowledge on vertebrate joint and cartilage biology.