New research disproves common assumption on cranial joints of alligators, birds, dinosaurs

March 28 2017

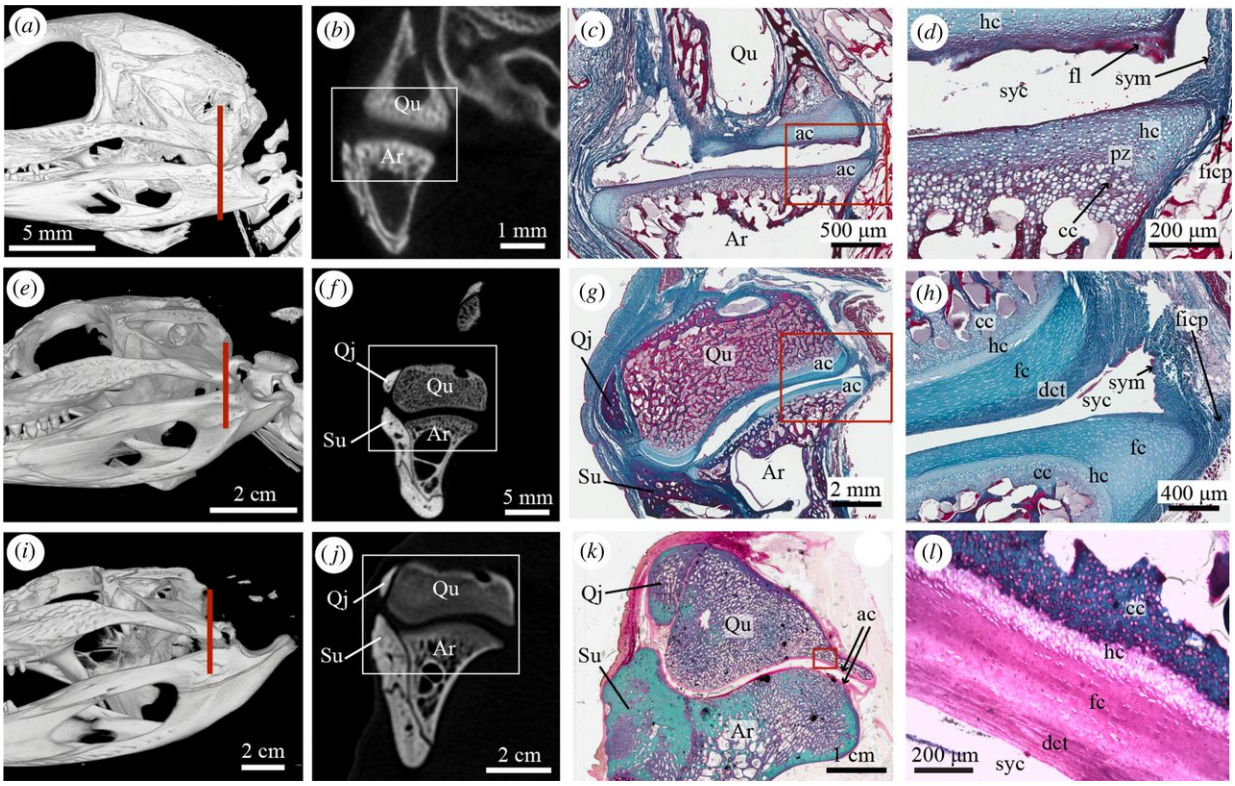
Credit: University of Missouri-Columbia

Paleontologists have long assumed that the shape of joints in the skulls of dinosaurs, and their closest modern relatives alligators and birds,

reveals how much movement is allowed in their skulls. Researchers from the University of Missouri School Of Medicine recently discovered that although alligators, birds and dinosaurs have a similar skull-joint shape, it no longer can be assumed that this lone fact can determine movement.

"While investigating joints located within the heads of alligators, we found their peg-and-socket shape does not necessarily indicate movement capabilities as it had often been assumed," said Alida Bailleul, Ph.D., a post-doctoral research fellow in the MU Department of Pathology and Anatomical Sciences. "By examining the joints through a microscope, we were able to see that they were missing the fluid-filled cavity and cartilage needed for movement."

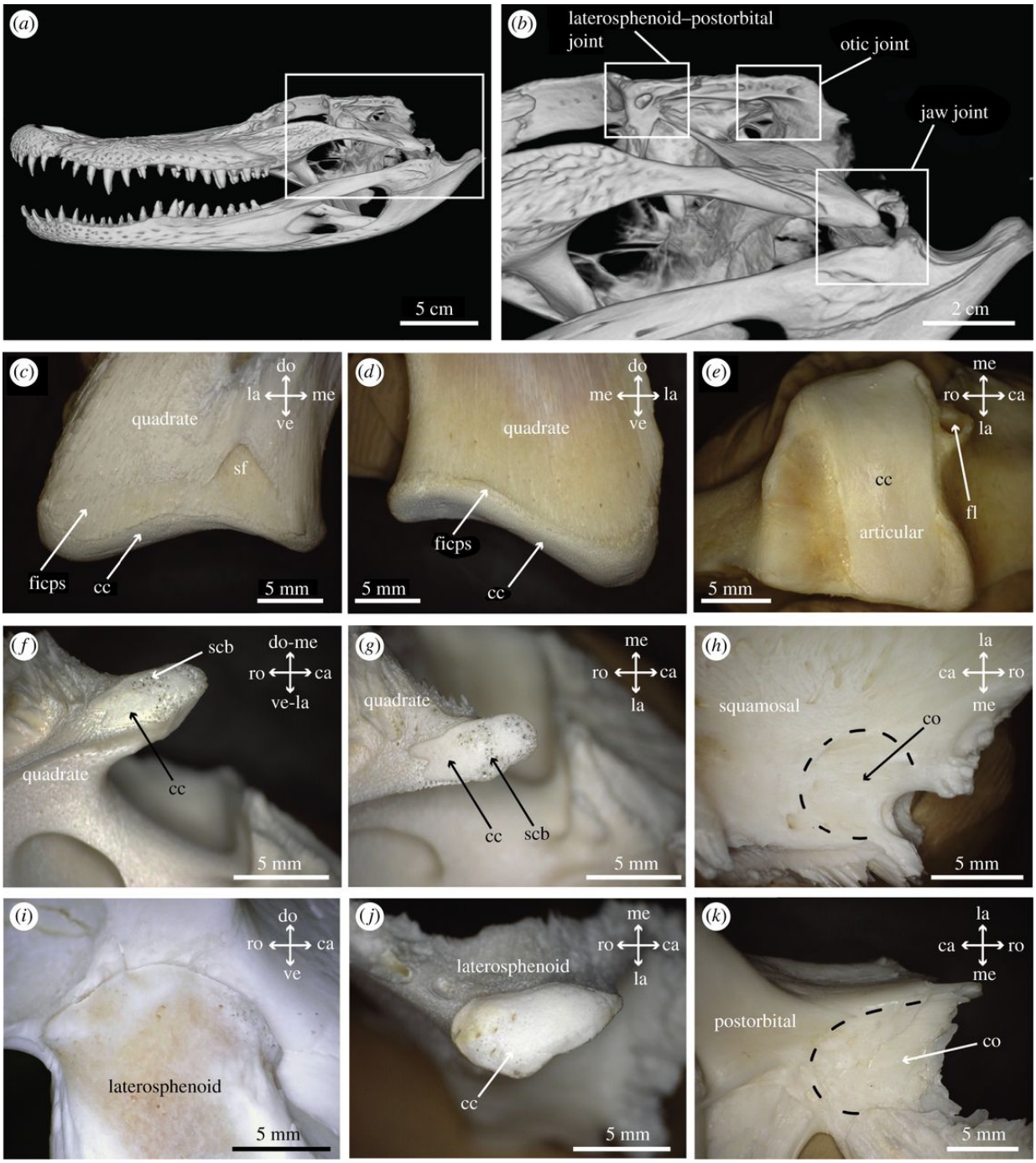
According to Bailleul, both humans and animals have joints that are built to work like a peg and socket, such as the knee or the elbow joints. She said it is the composition of these peg-and-socket joints, made up of cartilages and fluid-filled cavities, that facilitate movement. There also are pegs and sockets in the heads of alligators that researchers widely assumed were built similar to knee joints with a cavity, fluid and cartilage on both sides. However, when the researchers examined the joints under the microscope, they found that they had a different internal structure with cartilage on only one side, an element that may reflect the bones' embryological origins.



Micro-computed tomography and histology of the synovial jaw joint of hatchling (a-d), juvenile (e-h) and adult American alligator (i-l) demonstrate articular cartilage-covered joint surfaces and a synovial cavity bounded by a fibrous joint capsule. Three-dimensional CT reconstructions are shown in a hatchling (a), juvenile (e) and an adult alligator (i). Red lines indicate plane of CT and histological sections in (b,f and j), respectively. Associated thin-sections from the white boxes in (b,f and j) are shown, respectively, in (c,g and k) followed by higher magnifications in (d,h,l), respectively. Specimen numbers: OUVC10606 in (a,b), MUVC-AL050 in (c,d), MUVC-AL623 in (e,f), MUVC-AL075 in (g,h), MUVC-AL721 in (i,j), MUVC-AL039 in (k,l). ac, articular cartilage; Ar, articular; cc, calcified cartilage; dct; dense connective tissue; fc, fibrocartilage; ficp, fibrous capsule; fl, fibrous layer; hc, hyaline cartilage; pz, proliferative zone; Qu, quadrate; Qj, quadratojugal; Su, surangular; syc, synovial cavity; sym, synovial membrane. Credit: Alida M. Bailleul, Casey M. Holliday

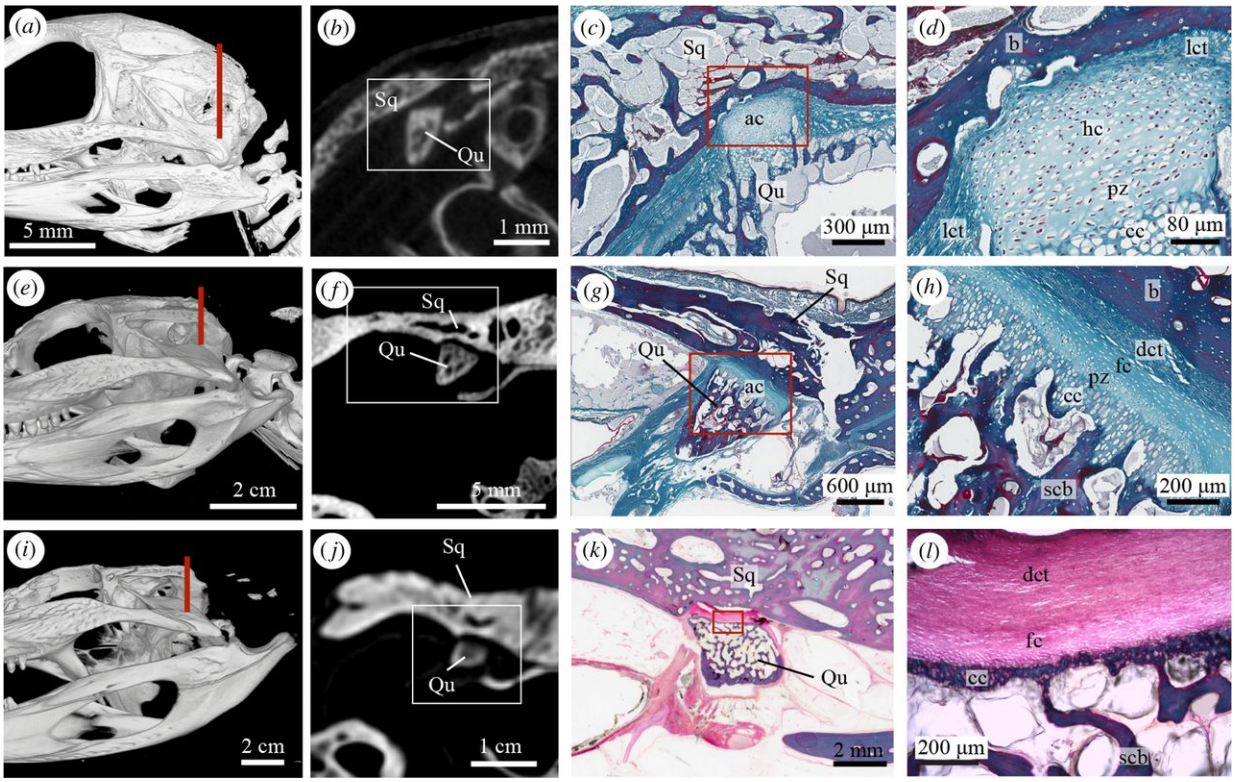
"We have these two great lineages of archosaurs? alligators on one side

and birds on the other? that maintain these joints regardless of how they use their skulls," said Casey Holliday, Ph.D., associate professor in the Department of Pathology and Anatomical Sciences and co-author of the study. "Despite all the evolutionary changes animals have made, they can't quite always change everything."



Three-dimensional micro-computed tomographic (μCT) reconstructions and osteological photographs of condylar cranial joints in American alligators. (a) Three-dimensional CT reconstruction in an adult alligator in left lateral view (b) close-up of the white box in (a) shows the three condylar joints of interest. (c) Caudal view of left quadrate shows osteological correlates of jaw joint capsule; (d) rostral view of left quadrate showing osteological correlates of jaw joint capsule; (e) dorsal view of left articular showing articular surface of jaw joint; (f) dorsolateral view of the left otic process of quadrate; (g) dorsal view of left otic process of quadrate showing the articular surface; (h) ventral view of left squamosal showing the shallow cotyle for the otic process; (i) ventrolateral view of left capitate process of laterosphenoid showing articulation with postorbital; (j) dorsal view of left capitate process showing the articular surface of laterosphenoid; (k) ventral view of the left postorbital shows the shallow cotyle of the LS-PO joint. Specimen numbers: MUVC-AL721 in (a,b); MUVC-AL806 in (c-h) and in (k); MUVC-AL008 in (i); MUVC-AL 805 in (j). ca, caudal; cc, calcified cartilage; co, cotyle; do, dorsal; ficps, fibrous capsule scar; fl; fulcrum; la, lateral; me, medial; ro, rostral; scb, subchondral bone; sf, siphonium foramen; ve, ventral. Credit: Alida M. Bailleul, Casey M. Holliday

Although crocodilians' skulls have evolved to bite down with immense pressure, they still have not managed to lose these joints that, according to Holliday, are vestiges of joints found in the ancestors of birds and crocodiles and are likely useless. On the other hand, the same joints in birds evolved new cartilages and cavities, and increased mobility, an important adaptation for bird feeding behavior and diversity.



Micro-computed tomography and histology of the non-synovial otic joint in hatchling (a-d), juvenile (e-h) and adult American alligator (i-l) demonstrate the unique morphology of the articulation between the condylar otic process of the quadrate capped with primary articular cartilage, and the fibre-filled cotyle of the squamosal. Three-dimensional CT reconstructions are shown in a hatchling (a), juvenile (e) and an adult alligator (i). Red lines indicate planes of CT and histological sections in (b,f and j), and (c,g and k), respectively, followed by higher magnifications in (d, h, and l). Specimen numbers: OUVC10606 in (a,b), MUVC-AL050 in (c,d), MUVC-AL623 in (e,f), MUVC-AL075 in (g,h), MUVC-AL721 in (i,j), MUVC-AL039 in (k,l). ac, articular cartilage; b, bone; cc, calcified cartilage; dct; dense connective tissue; fc, fibrocartilage; hc, hyaline cartilage; lct, loose connective tissue; pz, proliferative zone; Qu, quadrate; scb, subchondral bone; Sq, squamosal. Credit: Alida M. Bailleul, Casey M. Holliday

The study, "Joint Histology in Alligator Mississippiensis Challenges the

Identification of Synovial Joints in Fossil Archosaurs and Inferences of Cranial Kinesis," was published in *Proceedings of the Royal Society B*, the scientific journal of the UK National Academy of Sciences.

More information: Alida M. Bailleul et al. Joint histology inchallenges the identification of synovial joints in fossil archosaurs and inferences of cranial kinesis, *Proceedings of the Royal Society B: Biological Sciences* (2017). DOI: 10.1098/rspb.2017.0038

Provided by University of Missouri-Columbia