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Species group identification for isolated fossil teeth of macaques using geometric morphometrics

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Macaque fossils are abundantly discovered from Pleistocene localities in Europe and Asia. Most of the fossil specimens are isolated teeth that are generally identified only as *Macaca* sp. In this study, we tried to distinguish species groups of 28 isolated fossil teeth from Pleistocene cave sites in Chongzuo area, Guangxi ZAR, China. We investigated the morphological variations of the lower third molar of extant four species groups of macaques to compare the fossils. We scanned the occlusal crown surface of 213 teeth by a 3D laser scanner and set 12 landmarks on the surface images. Then, we performed principal component analysis and discriminate analysis using 3d configurations of these landmarks. As a result, all Chongzuo specimens fall within the range of extant Asian macaques, suggesting that they belong to extant three species groups. Three species groups of macaques were sympatrically distributed in Chongzuo area since the early Pleistocene.

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Does shape really matter?

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Finite Element Analysis (FEA) involves high temporal and computational costs and, hence, only one element is often modeled representing a whole group. This may imply an issue depending on the group form variability. We performed a FEA validation test to check whether subtle changes applied to the anthropoids' patellar apex arise on biomechanical variations during knee flexion. We modified the volume, length, inclination, and shape of an apex virtually added to the originally apex-less patella of *Gorilla*. A total of 9 modified models were analyzed. Quadriceps muscle and patellar tendon attachments were defined as constrain areas. The patellar articular surface was divided into three strips and a pressure was applied in three different steps (from distal to proximal), with an increasing inclination, to simulate knee flexion. Von Mises stress distribution color maps and values were obtained at the mid-sagittal section of the patellae. We did not find quantitative differences among patellae (only the patella with a shorter apex than the original shows some qualitative differences). Overall, changes on the apex's shape do not affect stress distribution and magnitude in modified models. Hence, our test reveals that certain changes on patellar shape do not alter its general mechanic response and supports the use of one model/group in FEA.