H82 Temporomandibular Joint Morphology and the Assessment of Potential Commingling

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After attending this presentation, the participant will understand the morphology of the temporomandibular joint and the correlation of osteometric variables of articulating structures of the cranium and mandible. The utility of correlated osteometric variables of articulating structures

of the temporomandibular joint (TMJ) in the association of disarticulated human remains or the identification of commingled remains will be demonstrated.

This paper has two objectives:1) to document the correlation between measurements of adjacent articular surfaces and structures, specifically of the temporomandibular articulation, and 2) to demonstrate the utility of correlated osteometric variables of articulating structures of the temporomandibular joint in the identification and association of disarticulated human remains, even when portions of the cranium or mandible are missing or damaged.

Background: In many forensic and archaeological contexts, an individual's remains may become scattered or commingled. Often, the forensic anthropologist is called upon to address the concerns of minimum numbers of individuals and the association of elements of a single individual. In those cases of disassociation, the relationship of the cranium to the mandible may be uncertain. When attempting to associate a cranium and mandible, several features are often observed which could indicate that separate elements are from the same individual: 1) proper occlusion of the maxillary and mandibular dentition, 2) close fitting articulation of both mandibular condyles into the glenoid fossae, and 3) overall similar physical appearance due to postmortem taphonomic activity. However, these assessments can not be made if the cranium and/or mandible have been damaged due to perimortem/postmortem trauma and scavenging damage resulting in the loss of dentition and/or skeletal structures. Differential weathering of skeletal elements can also confound the association efforts.

These confounding factors were manifested in a recent forensic case. Skeletal remains were discovered in the Muttontown Preserve, Long Island, New York, on November 10, 2001. The initial anthropological examination indicated extensive weathering and rodent gnawing on the cranium which resulted in the loss of the majority of the maxilla, maxillary dentition, the malars, zygomatic arches, glenoid fossae and articular eminences, mastoid processes and other cranial structures. The cranium and mandible also displayed differential weathering. The first anthropologists to examine the remains stated in their report that, "The bicondylar breadth formed by the mandibular condyles does not correspond to the breadth of the tempomandibular fossae indicating at least the possibility that the basicranium and mandible represent two individuals." They further state, "The best explanation for the poor fit of the mandible to the basicranium is that the mandible and skull have undergone considerable postmortem distortion caused by weathering and other factors." An anthropological reexamination was conducted on the skeletal remains on May 19, 2003. The reexamination revealed that the first anthropologists failed to take into account the extent of damage to the glenoid fossae produced by the rodent gnawing. If one were to extrapolate the original size and breadth of the glenoid fossae, the mandibular condyles would articulate quite well with the calvarium. The remaining portions of the glenoid fossae articulated well with the mandibular condyles. There was no evidence of warping or postmortem distortion of the mandible or calvarium due to weathering. These visual assessments raised two questions: 1) How much of the glenoid fossae and articular eminences had been removed due to rodent gnawing?, and 2) How consistent were the visual assessments/interpretations with the actual TMJ morphology?

This investigation is designed to determine the degree to which metric measurements of articulating TMJ structures of the cranium and mandible are correlated, and determine if a cranium and mandible can be associated through morphometric analysis. The study sample comprised 47 individuals form the American Museum of Natural History, New York; seven individuals from the documented anatomy collection with know age, sex and race, and 40 individuals from the Heidenheim Cemetery, Wurtenberg, Germany Collection. Fourteen measurements of the cranium and mandible were taken, measurements that were most likely to reflect joint congruence of the TMJ. These measurements document the morphology of the glenoid fossae, articular eminences, and mandibular condyles. All measurements were taken with a sliding and spreading caliper to the nearest 0.1 mm. A correlation analysis technique was utilized to investigate the relationship between the measurements of the bony structures of the TMJ. As expected, strong correlations exist between cranial measurements, mandibular measurements, and between the cranial and mandibular measurements of the bony structures of the TMJ. Of particular interest are the correlations between Biglenoid Breadth (BGB) and Biendoglenoid Breadth (BEB) (0.86707), and Biarticular Breadth (BAB) and Bicondylar Neck Breadth (BCN) (0.81645). These strong correlations indicate that individual cranial and mandibular variables could be utilized in regression analyses to predict missing or damaged variables. A test of their potential predictive value was made utilizing the forensic case discussed above.

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Due to extensive rodent gnawing of the cranium, several measurements of the cranium and TMJ could not be taken with the exception of Biendoglenoid Breadth (BEB). All measurements of the mandible could be made. A regression analysis was conducted to predict Biglenoid Breadth (BGB) from Biendoglenoid Breadth (BEB), which resulted in a predicted breadth of 113.85mm. A regression analysis was conducted to predict Biarticular Breadth (BAB) from Bicondylar Neck Breadth (BCN), which resulted in a predicted breadth of 114.14mm. Biglenoid Breadth (BGB) and Bicondylar Breadth (BIC) were strongly correlated (0.82264), and possessed an average difference (BGB - BIC) of 3.7mm. The observed BIC measurement of 110mm and the predicted BGB and BAB measurements of 113.85 and 114.14 respectively clearly indicate that the mandibular condyles would have articulated completely with the original glenoid fossae and articular eminences.

Conclusions: When presented with disassociated or commingled skeletal remains, it is necessary for the forensic anthropologist to accurately reallocate those remains to specific individuals. Instigated by a recent forensic case involving a possible commingled cranium and mandible, this project investigated the congruence of the temporomandibular joint articulation and assessed the possibility of predicting the morphology of the missing skeletal element from the morphology of the adjacent skeletal element present. This research has proven the utility of articulation congruence in the prediction of missing element morphology and measurements of the TMJ, and illustrated the potential for allocation of disassociated skeletal elements. This research has also supported the visual assessments and interpretations made on the forensic case discussed above; that the cranium and mandible were from the same individual and that there was no evidence of warping or postmortem distortion of the mandible or calvarium due to weathering. **Cranial and Mandibular Measurement**

Measurement	Definition
BGB	Biglenoid Breadth; Distance across the most lateral extension of the glenoid fossae
BAB	Biarticular Breadth; Distance across the most lateral extension of the articular eminences
BEB	Biendoglenoid Breadth; Distance between the left and right endoglenoid processes
BIC	Bicondylar Breadth
BCN	Bicondylar Neck Breadth

Temporomandibular Joint, Skeletal Element Association, Commingled Remains

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