

3-D statistical skull and face model: development and application in the design and outcome analysis of craniofacial surgery

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The aim of this study is to develop and validate a protocol to generate a statistical 3-D virtual model based on a normative dataset of adult skulls and faces.

A series of 200 CT scans, and 200 facial surface scans will be used to determine the normative dataset. The average adult skull and face will be computed using a geometric morphometric technique, which generates a statistical 3-D virtual model. The 3-D model will be validated by comparing anthropometric measurements in the model to those derived from evaluation of each component skull and face image in the series. The norms and variations about the norms will be evaluated.

The *Cranioplasty Evaluation* will test a clinical application of the skull model in surgical planning. In a series of 25 additional skull CT's, bilateral cranial defects of varying size and location will be created *in silico* (a computer simulation). The normative skull will be used to predict a suitable implant shape for the missing piece, and the accuracy of the technique will be evaluated by comparing the implant to the intact skull.

The *3-D Morphological Outcome Study* will evaluate the application of the 3-D statistical virtual face model in analyzing morphological outcomes of surgery. In a retrospective series of 100 consecutive consenting adult patients with unilateral orbital fractures, facial surface scans will be obtained. The morphological outcomes of primary orbital fracture repair will be quantitatively evaluated in terms of residual asymmetry, and compared to the normative dataset. The evaluation will include a comparative analysis of 3D statistical models representing the study and normative populations, respectively.