Digital Laser Scans Used in Morphometric Analysis of Human Skulls to Demonstrate Dental Occlusal Function — Part I

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Analysis of human skulls is a delicate and difficult process. Much of the significant work that has been done in this area of study, morphometrics, have been conducted with analog, direct measurements — calipers, dividers, rulers, grids and/or custom designed "guides".

In an attempt to better understand the functional relationship of the dental occlusion to the bony morphology of the skull and mandible, direct measurement and/or analog models did not provide the data needed to complete the study.

After analog models and study protocols had been created, studied and reviewed, a decision to seek more detailed measurements was taken. The first studies were done with radiographic techniques and attempted correlation to photographic evidence. The distortional aspect of the radiographs rendered such techniques useless. Other attempts were made with 3-D, corrected CTScan and this technique also proved difficult to manage.

An introduction to Dr. John Kappelman at the University of Texas at Austin, Department of Physical Anthropology allowed us to use a Minolta Laser Scanner. During the first, introductory, visit to the physical anthropology laboratory, and after several hours of discussion, a skull sample was selected from their collection and a trial laser scan was made to test the apparatus and to verify that this technique could provide data related to our supposition/thesis.

The sample was scanned using a Minolta Vivid 3-D scanner, the scan was transferred to a Dell dual processor work station. The scans were imported into INUS Technology, Inc. *Rapidform* for direct measurement.

The trial scan was used to restate our thesis and protocol. We then set a date to use the anthropology laboratory for laser scans of arbitrarily selected human skulls. The selected specimen came from a private collection of 7

skulls which had been acquired over a period of time with no insight as to the nature of this study, and therefore arbitrary as to their use, and from an arbitrary selection of skulls from the University of Texas Dental Branch at Houston.

Skulls selected at the Dental School had to have a full compliment of teeth and were selected in three categories - youth (deciduous or mixed teeth), adolescent (all permanent teeth with little wear), and adult (permanent teeth in varying stages of wear). Ethnicity was not considered (or known) in the selection process. A group of 24 skulls was selected that fit the basic criteria, grouped as to age and then a non-professional staff member was asked to pick any 6 of the closed, skull cases, the skulls were not visible.

With skulls in hand, we spent 3 of 5 promised days in the Anthropology Laboratory at the University of Texas in Austin. Each skull was photographed at a standardized focal length and then scanned from the inferior surface. The scanning process surveyed the base of the skull, the glenoid fossa, the occipital tubercle, the surfaces of the teeth and the hard palate. No mandibles were scanned.

Multiple scans were made of each skull to obtain the surfaces required to complete the study. These scans were assembled into single composite 3-D image which could be manipulated as needed for the purposes of the study. The composite 3-D images were compared to the physical specimens for accuracy of detail and measurement.

These images have been used, with the appropriate software, to make linear, angular, and complex spherical studies of multiple surfaces in the 3-D composite image. Of greatest interest in the early analysis was finding a mathematical solution for correlated angular function of the wear surfaces of teeth (facets) and the guide (glide) angle on the medial aspect of the glenoid fossa, Zola's Tubercle[1].

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This work is original; no comparable work is seen in the research literature.

Topics of papers to follow —

1. The detailed analysis process and initial results.
2. Refinement of the measurement process and re-evaluation of the data.
3. Submission of the digital data to non-linear mathematical resolution.
4. Results of the mathematical analysis and implications for studies of dental occlusal function and tooth wear.

References

1. Zola A and Rothschild E. A., J Pros Dent., Posterior Condyle Positions in Unimpeded Jaw Movements, 1962, Sept-Oct, Vol. 11, No. 5, pp 873-881