H62 A Performance Check of Ear Prediction Guidelines Used in Facial Approximation Based on CT Scans of Living People

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The goal of this presentation is to report quantified data on established ear prediction methods used in facial approximation.

This presentation will impact the forensic science community by communicating to peers the strength and weaknesses of ear prediction methods.

Facial approximation is the method used to predict the appearance of the face from a skull. This face can then be advertised in the hope that somebody recognizes it, possibly generating leads that may assist in the identification of the skeletal remains. For facial approximation to work effectively, it is important for prediction methods to be valid and accurate. This applies to all components of the face, including the ears. Currently several prediction rules have been published and widely employed with respect to the *pinna* or outer part of the ear, but few empirical validation studies have been conducted.

In this study, previously published ear prediction methods using seventy-eight living individuals of known age and sex who had been subjected to CT-scans were examined. The sample is composed of 43 males and 35 females with a mean age of 41.4 years (18-84 years, SD = 18.8 years). Osseous and cutaneous surfaces were reconstructed using the half-maximum height algorithm of the TIVMI software (Treatment and Increased Vision in Medical Imaging, developed by Bruno Dutailly, Université de Bordeaux). Landmarks and associated angles and measurements were collected to quantify the orientation and size of the mastoid process, nasal bones, nose and outer ear regions. Lobe attachment and supramastoid crest development were also visually assessed. These data enabled us to examine the following well-known ear prediction rules:

1. The main axis of the ear is oriented parallel to the major axis of the posterior mandibular ramus (Welcker 1883).
2. The height of the ear approximates the height of the nose (and a variation using an additional two millimeters (Ullrich and Stephan, in press) and the width of the ear equals half its height (Gerasimov 1949, 1955).
3. A large and broad ear is related to a massive and prominent mastoid process and the inverse regarding small ears; upper ear protrusion is also related to a strong development of the supramastoid crest (Gerasimov 1955).
4. Anterior projection of the mastoid process is associated with free lobes; and inferior projection of the mastoid process with attached lobes (Fedosyutkin and Nainys 1993).
5. The ear is oriented parallel to the profile angle of the nose (Wilkinson 2004).

Student *t-tests*, correlation matrices and cross table analysis were performed to evaluate the above mentioned prediction rules and to assess asymmetry, sexual dimorphism, and age trends within the sample. None of the empirical rules concerning the reconstruction of the ears reported in the literature proved reliable in our sample. The gross approximation of the height of the ears from the height of the nose was observed (mean error = 5 mm), however, no correlation was found between these two measurements. Although the width of the ear is not half of its height, the two were correlated (r = 0.56), and the width averaged 0.6 of the height (mean error of the estimate = 2 mm). In addition, no bony dimensions collected on the mastoid region were found to correlate with ear dimensions ($r < 0.3$). The only additional relationships between the soft and hard tissue that we observed were that a strong supramastoid crest appears to be linked with a free ear lobe (χ^2 = 5.65; df = 1; *p-value* =

0.02). However, the inverse is not true, subtle mastoid crests are associated with both free and attached ear lobes and height and width of the ear appears to be influenced by age ($r < 0.38$) and sex (*p-value* < 0.01).

These findings indicate that classic ear prediction rules hold little value for accurate prediction in facial approximation. Future efforts should be made to examine other relationships between the ear and the skull.

Facial Approximation, Facial Reconstruction, Pinna