## TECHNICAL NOTE

*R. A. Halberstein,*[1] *Ph.D.*

# The Application of Anthropometric Indices in Forensic Photography: Three Case Studies

**REFERENCE:** Halberstein, RA. The application of anthropometric indices in forensic photography: three case studies. J Forensic Sci 2001;(46)6:1438–1441.

**ABSTRACT:** With increasing commercial use of video surveillance to deter crime, physical anthropologists are becoming more involved in the forensic identification of persons based on photographic evidence. Three contrasting case studies from southern Florida are presented that illustrate the utilization of conventional anthropometry in determining the identity of suspects. In each case an arrested suspect and a subject videotaped during the commission of a crime are compared with respect to a series of discrete craniofacial and post-cranial proportions. Each case analysis is supplemented by additional data on earlobe structure, head and facial hair patterns, degree of chin eminence, presence or absence of tattoos, and various aspects of bodily dimensions and physique including height and weight estimations.

**KEYWORDS:** forensic science, forensic photography, video surveillance, anthropometry, criminal identification

*Forensic anthropology,* generally defined as the anthropological reconstruction and identification of persons from their remains, is currently experiencing rapid growth and development as a result of its increasing overlap with the work of medical examiners, criminalists, and law enforcement personnel. While forensic anthropology has traditionally been applied in cases involving freshly skeletonized as well as historic/prehistoric osteological and dental materials, the field is expanding into new areas that focus upon the identification of living people. One example of this trend is the more accurate verification of the identities of crime victims or perpetrators through DNA and other biochemical/genetic analyses of samples of blood, skin, hair, or other soft tissue specimens recovered at a crime scene. A photographic image of an individual recorded during criminal activity represents another type of "human remains" that is under increasing scrutiny by forensic scientists (1,2).

Human identification from photographic evidence is a component of forensic photography in which anthropologists can provide assessments of various anthropometric characteristics, and standardized methods have recently been established for these procedures (3,4). With the recent growth and expansion of commercial usage of videotape surveillance to deter crime, physical anthropologists are increasingly involved in the evaluation of anthropometric measurements and proportions of the displayed head, face, and body toward the solution of criminal cases (5–7).

Over the past quarter century the admissibility of photographs and videotapes has gradually gained greater acceptance in American and British courtrooms, due in part to modernizing photographic technology and improved techniques for the authentication of presented exhibits (8–12). The reliability of photographic evidence, however, is still subject to a number of practical, scientific, and thus legal limitations (13–16).

In this report three separate legal case studies from southern Florida are described that illustrate the utilization of anthropometry in forensic photography as a means of identifying crime perpetrators and assessing the guilt or innocence of arrested suspects. In each example nonparametric statistical tests determined the correlation between the anthropometric proportions of each suspect with those of the photographed perpetrator. Resulting data and conclusions were cited during subsequent legal proceedings in Florida courts. One case eventuated in a judgment of not guilty, and guilty verdicts were rendered in the second and third case. The overall purpose of the present investigation is to provide data that may help to formulate the appropriate methods and statistical analyses for this type of forensic comparison.

## Case Reports

### *Case 1: Not Guilty*

A robbery, including assault and battery, was committed at a convenience store in North Miami, FL, and recorded by surveillance video cameras (State of Florida Case 90-000184). A subject was arrested in the same neighborhood several days later. Following careful examination of the entire tape footage at normal and slow-motion speeds, 16 by 20-in. still photos were produced from the clearest video frames that showed the perpetrator's head in frontal perspective and in *norma lateralis.*

A comprehensive physical examination and forensic anthropometric assessment of the arrested suspect was conducted at the Dade County (Florida) Stockade, utilizing the standardized techniques described by Farkas (17,18), Hall et al. (19), Kolar and Salter (20), and Lohmann et al. (21). Metrically calibrated sliding and spreading calipers (Siber Hegner & Co., Carlstadt, NJ) were placed at specified standard landmark points as delineated by France and Horn (22) and Wolfe et al. (23). A series of nine anthropometric proportions of the head and face were collected (in

The Department of Anthropology, University of Miami, Coral Gables, FL.

Received 17 April 2000; and in revised form 23 Jan. 2001; accepted 23 Jan. 2001.

centimeters), and the live suspect was also evaluated with respect to body height, weight, and facial and head hair texture and distribution patterns. Comparable anthropometric measurements and proportions were derived from the still photograph enlargements of frames from the video, employing the same instruments used in the live suspect examination and the methods outlined by Ferrario et al. (3) and İşcan (4,24).

Anthropometric proportions of the live suspect and photographed perpetrator are compared in Table 1. Two separate nonparametric statistical tests of correlation were run, focusing upon the head and face indices for maximum validity and reliability—Spearman Rank Correlation and Kendall Tau (25,26). The differences between the two sets of values in Table 1 were found to be not statistically significant according to the tests, which yielded *P*-values of 0.006 and 0.0008, respectively (Rho = 0.967; K tau = 0.889). The Pearson *r* test yielded a correlation of 0.926.

The live suspect's head shape was observed to be fundamentally at variance with that of the photographed robber. Jaw contour and facial height differences, relative to head measurements, are also pronounced. Scalp and facial hair patterns were also contrasting with respect to the hairline, sideburn shape, beard texture, and presence/absence of coronal baldness.

*Case 2: Guilty*

A bank robbery was videotaped in Ft. Lauderdale, FL, and a suspect was arrested several hours later in a nearby hotel (U.S. Federal Case 92-6140-CR). Following scrutiny of the tape, an 8 by 10-in. still photo enlargement of a frontal view of the perpetrator was produced from a video frame. Additional frames were analyzed in order to assess earlobe structure, degree of chin eminence according to İşcan's (24) six-fold classification system, presence/absence of tattoos, and various measureable aspects of the photographed person's physique.

The arrested suspect in this case was examined and measured in the Federal Detention Center in Miami, FL, using the procedures, instruments, and landmarks cited in Case 1. Comparable anthropometric dimensions were obtained from the robbery video frame enlargement.

In a similar manner as in Case 1, 12 anatomical proportions/anthropometric indices were compared and statistically evaluated (Table 2). The results indicate a statistically significant correlation between the two sets of values according to the Kendall (K tau = 0.758) and Spearman (Rho = 0.893) tests ($p < 0.01$). Overall head shape, relative ear size, nasal proportions, and degree of chin eminence in the live suspect resembled those features of the photographed robber. Relative mandibular width appeared to differ in the two examples, however. In addition, both individuals had "attached" earlobes, as well as similar patterns of facial and scalp hair.

TABLE 1—*Comparison of standard anthropometric proportions: photograph versus live person. Case 1—Not guilty.*

| No. | Anthropometric Proportion | Photo | Live Person |
|---|---|---|---|
| 1 | head length/head height | 1.16 | 0.93 |
| 2 | mandibular length/head length | 0.35 | 0.50 |
| 3 | jaw length/head length | 0.38 | 0.58 |
| 4 | jaw height/head height | 0.27 | 0.42 |
| 5 | face height/head height | 0.89 | 0.64 |
| 6 | glabella-condylion/head length | 0.50 | 0.62 |
| 7 | condylion-opisthocranion/head length | 0.62 | 0.67 |
| 8 | condylion-opisthocranion/head height | 1.00 | 0.82 |
| 9 | nasal length/face height | 0.28 | 0.35 |

TABLE 2—*Comparison of standard anthropometric proportions: photograph vs. live person. Case 2—Guilty.*

| No. | Anthropometric Proportion | Photo | Live Person |
|---|---|---|---|
| 1 | nasal length/head height | 0.22 | 0.21 |
| 2 | nasal width/head width | 0.26 | 0.26 |
| 3 | nasal width/nasal height | 0.73 | 0.69 |
| 4 | facial height/head height | 0.57 | 0.53 |
| 5 | head width/head height | 0.63 | 0.59 |
| 6 | ear length/facial height | 0.50 | 0.53 |
| 7 | nasal height/ear length | 0.78 | 0.77 |
| 8 | chin width/bizygomatic | 0.48 | 0.44 |
| 9 | jaw width/bizygomatic | 0.70 | 0.96 |
| 10 | jaw width/head width | 0.61 | 0.77 |
| 11 | shoulder-to-shoulder/arm length | 0.60 | 0.53 |
| 12 | upper arm/lower arm | 0.61 | 0.75 |

*Case 3: Guilty*

An armed robbery involving assault and battery was committed at a supermarket in Coral Gables, FL (State of Florida Case 95-24786). The crime transpired in a bathroom, and the perpetrator was photographed during his escape both inside and outside the building. An adjacent "ATM" security camera also provided usable photographic evidence. Within two weeks a suspect was arrested at his workplace in the same vicinity. As in the previous cases, the surveillance tape was reviewed several times at various speeds.

A thorough physical exam and anthropometric assessment of the suspect was undertaken at the Miami-West Detention Center in Miami, FL, using the techniques described previously. The arrested suspect's height, weight, age, limb proportions, foot and shoe sizes, facial and head hair patterns, and other aspects of body physique were also recorded.

Corresponding head and face anthropometric dimensions were obtained from an 8 by 10-in. enlargement of a lateral (profile)—view still photograph produced from the security video. Additional frames were analyzed and measured in order to estimate the photographed perpetrator's height, weight, and age. Hairline and facial hair characteristics were also noted. For reference purposes, measurements were taken of several objects and structures at the crime scene that are visible adjacent to the perpetrator on the videotape, thus providing perspectives for the various body size/proportions estimates—a sign, a grocery cart rack, and a curb section. Limb proportions were used in conjunction with the measured landmarks to determine body height following the method described by Attallah and Marshall (27).

A police composite sketch of the robber, constructed from two eyewitness accounts, was likewise measured and converted to a series of frontal-view anthropometric face/head proportions, as was a verified recent driver's license photograph of the arrested suspect.

Twelve anthropometric proportions and indices were compared and statistically evaluated—i.e., live prisoner vs. photographed perpetrator (Table 3). Both the Spearman (Rho = 0.851) and Kendall (K tau = 0.682) tests suggested a statistically significant correlation between the two sets of values ($p < 0.01$).

General head shape (Item 1 in Table 3), as well as leg/shoe and leg/shoulder ratios (Items 10 and 11), appear similar in the live sus-

TABLE 3—*Comparison of standard anthropometric proportions: Photograph vs. live person. Case 3—Guilty.*

| No. | Anthropometric Proportion | Landmark Measures* | Photo | Live Person |
|---|---|---|---|---|
| 1 | $\frac{\text{head length}}{\text{head height}}$ | $\frac{G-J}{H-U}$ | 0.90 | 0.91 |
| 2 | $\frac{\text{jaw length}}{\text{head length}}$ | $\frac{B-U}{G-J}$ | 0.41 | 0.45 |
| 3 | $\frac{\text{ear length}}{\text{face height}}$ | $\frac{\text{Ear}}{A-F}$ | 0.76 | 0.57 |
| 4 | $\frac{\text{jaw height}}{\text{head height}}$ | $\frac{T-U}{H-U}$ | 0.21 | 0.32 |
| 5 | $\frac{\text{face height}}{\text{head height}}$ | $\frac{A-F}{H-U}$ | 0.45 | 0.51 |
| 6 | $\frac{\text{glabella-condylion}}{\text{head length}}$ | $\frac{G-T}{G-J}$ | 0.52 | 0.58 |
| 7 | $\frac{\text{condylion-opisthocranion}}{\text{head length}}$ | $\frac{T-J}{G-J}$ | 0.49 | 0.77 |
| 8 | $\frac{\text{condylion-opisthocranion}}{\text{cranial height}}$ | $\frac{T-J}{T-H}$ | 0.70 | 0.82 |
| 9 | $\frac{\text{nasal height}}{\text{face height}}$ | $\frac{E-F}{A-F}$ | 0.49 | 0.40 |
| 10 | $\frac{\text{shoe length}}{\text{leg length}}$ | $\frac{\text{shoe}}{\text{leg}}$ | 0.36 | 0.38 |
| 11 | $\frac{\text{shoulder width}}{\text{leg length}}$ | $\frac{\text{shoulders}}{\text{leg}}$ | 0.59 | 0.58 |
| 12 | $\frac{\text{hip width}}{\text{shoulder width}}$ | $\frac{\text{hips}}{\text{shoulders}}$ | 0.91 | 0.82 |

*From Wolfe et al. (23).

pect and the videotaped perpetrator. On the other hand, contrasts may be observed in the size relationships of metric characteristics of the face and head, including ear, nose, and jaw (Items 2 to 9).

Height estimates of the photographed perpetrator, derived from applications of measured dimensions of reference objects appearing in several video frames along with the robber averaged 175.3 cm. The live suspect's shoeless height was recorded as 172.1 cm. The reference objects were also utilized to estimate the waist size of the videotaped individual as 83.8 cm. The live prisoner's waist measured 80.1 cm.

Several anatomical similarities were found in comparing the live prisoner, his driver's license photo, and the police composite sketch. Two illustrative diagnostic anthropometric proportions—relative ear length (ear length/facial height) and relative nasal height (nasal height/facial height)—suggest a close relationship among the three sources of data:

| | Relative Ear Length | Relative Nasal Height |
|---|---|---|
| Police composite | 0.54 | 0.43 |
| Driver's license photo | 0.52 | 0.41 |
| Live suspect | 0.56 | 0.40 |

When the aforementioned frontal-view driver's license photo of the suspect was enlarged and superimposed onto an identically sized copy of the police composite sketch using the methods outlined by Maat (28), definitive resemblances were discovered with respect to hairline configuration, chin structure, degree of zygomatic projection, and several other details of additional morphological features.

## Discussion

Forensic photography is a rapidly developing field with far-reaching applications in assisting criminal investigations (29,30). Due to the well-established observation that different eyewitness accounts of the exact same criminal act may conflict sharply to the point of polar opposition, the scientific analysis of photographic evidence derived from surveillance videotapes is becoming increasingly essential for the completely accurate identification of crime perpetrators and their activities (31,32).

The present study suggests that traditional anthropometric indices of the human head, face, and body dimensions/proportions have an important new application in the comparison of crime suspects with perpetrators photographed during the commission of crimes. Awaiting future researchers in forensic photography is the development of standardized methods for the reliable assessment and statistical analysis of the available crime scene video images. Joseph (33, pp. 1–12) states the following: "Due to its functional equivalence to film, which has a long and settled acceptance as a means of real and demonstrative evidence, videotape has been quite warmly received. Because its basic admissibility is not subject to serious dispute, lawyers have focused their efforts on developing effective forms of videotape evidence. . . . As in civil cases, videotaped views, both of crime scenes and of crime sequelae, are widely used and accepted."

The methods employed in the present investigation help provide a workable preliminary model for the utilization of anthropometric data in forensic photography toward the analysis of crime scenes and players, although several limitations should also be noted. Statistical comparisons of the physical characteristics of photographed and live persons can aid in criminal identification and crime deterrence, provided that certain methodological cautions be considered.

Anthropometric proportions were selected for the present cases rather than absolute measurements. Proportional data would allow for the valid comparison of subjects of different size or when superimposition is impractical (e.g., photograph/live person), and they would also neutralize the potentially confounding effects of variations in camera angles (34). For example, a conclusion that both subjects have long (or wide) noses relative to facial height (or facial width) would be more analytically relevant and revealing than simply stating that they both seem to have long (or wide) noses.

The present research raises questions regarding the choice of relevant statistical tests for photo/live person comparisons. Due to the unusual nature of the samples—in each case two individuals represented by a series of matched proportional measurements, nonparametric correlation tests of derived data would seem appropriate, although they did not prove to be discriminatory according to the final outcomes of the cases and the associated degrees of resemblance in characteristics that are diagnostic of differences in age, estimated body weight, hair patterns, etc. Z-scores were not calculated due to the lack of availability in the literature of comparable anthropometric proportions for the population at large. The resolution of the question of appropriate statistical tests would be particularly important for computer applications in facial recognition and other aspects of human identification from still photographs and videotapes that are currently being developed (35).

## Conclusion

The present cases illustrate the possible roles of anthropometric investigation in the prosecution of criminal cases based upon forensic photographic evidence. These examples highlight the types of problems that might be encountered during the process of human identification from photographic sources. The fact that the correlation test results reported here did not conform more closely to the legal outcomes of the cases will hopefully stimulate further research on these methodological issues and ultimately lead to additional, equally effective applications of anthropological techniques and data analyses in the investigation and deterrence of criminal activity.

*Acknowledgments*

The following individuals deserve thanks for their assistance and advice in this study: Dr. Phillip Walker, Department of Anthropology, University of California, Santa Barbara; Dr. Linda Taylor, Department of Anthropology, University of Miami; William Morris, L.L.D.; Joseph Graham, J.D.; and Kenneth Kucek, J.D.

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Additional information and reprint requests:
R.A. Halberstein
University of Miami
Department of Anthropology
Coral Gables, FL 33124-2005