CASE REPORT

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Skull and Photographic Superimposition: A New Approach Using a Second Party's Interpupil Distance to Extrapolate the Magnification Factor

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ABSTRACT: The photographic superimposition technique requires an antemortem photograph to be enlarged to life size and the skull to be photographed from the same angle as the antemortem photograph. This paper describes how the magnification factor can be extrapolated by measuring the true interpupil distance of a second person and the photographic interpupil distance of the suspect and the second party. A closed-circuit television (CCTV) system is used to determine quickly the skull photographic angle. We believe these techniques are viable and easy to perform.

KEYWORDS: criminalistics, physical anthropology, human identification, photography, superimposition, musculoskeletal system, skulls, interpupil distance, magnification factor

Skull and photographic superimposition, also known as photographic superimposition technique, was used as early as 1935 for identifying skeletal remains [*1*]. Briefly, this technique involves the superimposition of a life-size transparency of the skull onto a transparency of an antemortem photograph of the suspect, hopefully enlarged to the correct size and taken from the same photographic angles.

The photographic superimposition technique, therefore, poses two major problems. First, the magnification factor that one should use to enlarge the antemortem photograph to life size is unknown. Second, the transparency of the skull must be made in the same angle as that from which the antemortem photograph was taken and this angle must also be determined.

Many methods have been used in previous reports to obtain the magnification factor. Some forensic scientists have used the dimension of known objects present in antemortem photographs to determine the magnification factors. These known objects included the pattern of a tie [*2*], heights of door gate and wall [*1*], and measurements of dentition [*3*]. The

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known focal length of the camera lens has also been used to magnify antemortem photographs to life size.

The use of the interpupil distance of a second person to extrapolate the magnification factor has not, to the best of our knowledge, been reported before. The second party must be one who has had a full face-view photograph taken with the suspect and must be available for his interpupil distance to be measured.

We have also devised a method using closed-circuit television (CCTV) to eliminate the need to take snapshots of the skull repeatedly from different angles to match that of the antemortem photograph.

Case Report

A taxi was found burnt in a rural part of Singapore and the driver was missing. Several days later, a partially decomposed body with several stab wounds was found in the undergrowth about 1 km from the taxi.

The skull was skeletalized and cleaned up. Photographs were also obtained from the taxi driver's family for a photographic superimposition workup. No dental record was available for a dental identification. Among the photographs was one that showed the suspected deceased had a metal crown on his left upper central incisor. Unfortunately, the upper anterior teeth and some lower anterior teeth were missing and in their place were fresh sockets suggesting that these were a postmortem loss. Another photograph was a direct frontal view of the deceased with his wife. This was used for the following technique (Fig. 1).

Technique

The photograph chosen should be one showing the suspect with a second party, and preferably, a large close-up view should be used. The wife's photographic interpupil distance was

FIG. 1—*Frontal view of the suspect with his wife: used for the measurement of photographic interpupil distance.*

measured using a caliper. We then requested the presence of the suspect's wife and the true interpupil distance was obtained. By a simple division of the true interpupil distance by the photographic interpupil distance, the magnification factor was obtained. The suspect's photographic interpupil distance was then measured and then multiplied by the magnification factor to obtain the true interpupil distance.

A passport photograph of the suspect was obtained and made into a photographic negative. Using the calculated true interpupil distance, the photographic image was enlarged until life size was achieved and a positive transparency was made. The technique just described solved the problem of the magnification factor.

To solve the second problem of obtaining a transparency of the skull taken from the same angle as the passport photograph, the following technique was used. The life-size transparency of the photograph was adhered to a television screen. The skull was mounted on a holder (in this case, a dental cast surveying table) that could be adjusted in any plane. A 1-ft (0.3-m) ruler was mounted next to the skull. The images of the skull and ruler were captured on the television monitor by a CCTV system (Fig. 2). Using the calibration on the ruler as a guide, the size of the image was adjusted until life size was obtained. Next, the skull was rotated so that an image was obtained from an angle that was as close to the photographic transparency as possible. Having adjusted the skull to a satisfactory position, the TV camera was carefully removed from its tripod mount and a still photography camera was mounted on the tripod at the same height and angle as the TV camera. A black-and-white negative of the skull and ruler was taken. Using the ruler as a guide, the negative was enlarged to life size and a positive transparency was made.

A sheet of matte acetate orthodontic tracing paper was placed on the skull transparency and a skull tracing was made. This provided a better visualization of the photographic superimposition later, as important anatomical structures like the orbits, nasal aperture, zygomatic arches and complexes, mandible, and the skull vault were highlighted.

The skull transparency with its tracing and the photographic transparency were then superimposed as accurately as possible on a radiographic view box. The features of correspondence used by us were similar to those used by McKenna et al. [*3*] (Table 1).

Findings

The number of features of correspondence was high; this added weight to the other circumstantial evidence that led us to believe that the suspect was indeed the deceased (Fig. 3).

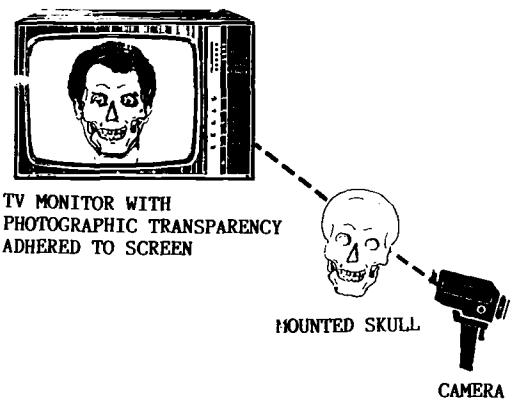

FIG. 2—*Closed-circuit television system used to determine the correct angle from which the mounted skull should be photographed.*

TABLE 1—*Features of correspondence of skull and photographic transparency.*

Nasal aperture with nose
Orbits with eyes
Supraorbital ridge with eyebrows
Midline of maxilla with philtrum
Body and angles of mandible with surrounding soft tissues
Zygomatic complexes with surrounding soft tissues
Lips with dental arches
Hair line with skull vault

In addition, there was a piece of forensic science evidence that was in our favor. On examination of the mandible, the left parasymphyseal region was found to be more prominent than the right side (Fig. 4). Several photographs of the suspect (for example, Fig. 5) showed that the left side of the chin was indeed more prominent than the right. An interview with the suspect's wife confirmed this fact. In view of all the evidence available, our submission that the suspect was the deceased was accepted by the coroner.

Discussion

While the use of the dental treatment records for identifying skeletal remains is a well-tested procedure, no such records were available for our use.

Family snapshots of the suspect showed that he had a metal crown on his upper central incisor. This would have helped greatly in our identification. Unfortunately, the tooth concerned, together with several other anterior teeth, were lost.

In our experience, postmortem loss of the anterior teeth in particular is very common. We believe that this is due to the single conical root that anterior teeth have. With the gradual

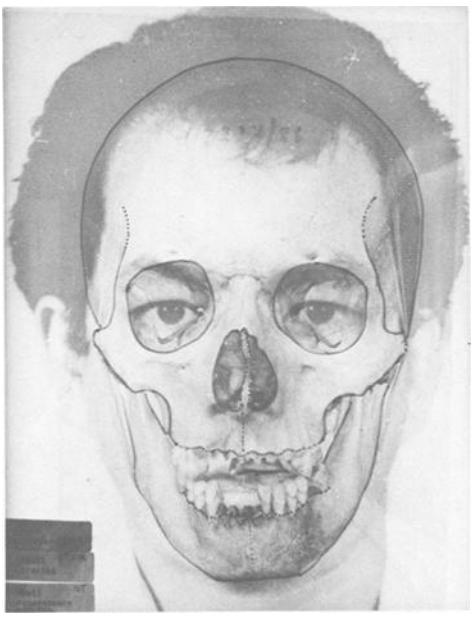

FIG. 3—*Superimposition of the skull transparency with its tracing onto the photographic transparency. A positive identification is achieved.*

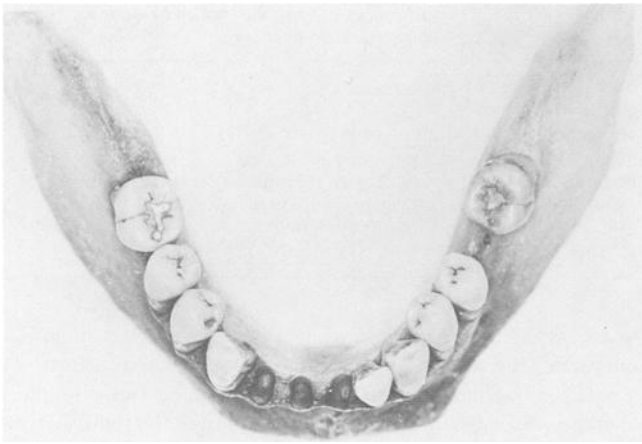

FIG. 4—*Left parasymphyseal region of the mandible is more prominent than the right.*

destruction of the periodontal ligament that hold these teeth to their sockets, they are liable to dislodge easily and be carried away by small animals.

We believe that the photographic superimposition technique does have a role in forensic odontology and methods should be developed to refine this technique.

We have described a method of determining the magnification factor for the purpose of enlarging an antemortem photograph to life size. In our opinion, extrapolation of the magnification factor from a second party who has a photograph taken with the suspect is a viable technique. This is because group photography is common. Provided that both persons in the photograph are facing the camera and a sufficiently close-up photograph is available, measuring the interpupil distance does not pose a great problem.

We have also made use of CCTV to determine the best angle in which our mounted skull should be photographed. We find this technique simple, quick, and inexpensive.

FIG. 5—*Photograph of victim showing left side of chin is more prominent than the right.*

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