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Video Superimposition at the C.A. Pound Laboratory 1987 to 1992

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ABSTRACT: William R. Maples practiced many aspects of human identification using simple and relatively inexpensive video superimposition equipment. Identification of skulls by comparison to known photographs was a primary concern. Clear, smiling photographs revealing the spatial relationships of the teeth to one another led to uncomplicated positive identifications. However, without benefit of dentition, how accurate was an identification based on the alignment of soft tissues with the underlying skull? Most importantly, how often would a false positive result when anterior dentition were not available?

A study conducted by this author and Dr. Maples used three human heads and 98 profile and full-face photographs. A 0.6% incidence of false match resulted when both views of the face were used. Lateral view and frontal view superimpositions were identified incorrectly in 9.6% and 8.5% of the sample respectively. As a result, multiple photographs from varying angles were requested for superimposition identity cases.

Additional applications in laboratory case work were developed for the equipment. Light boxes under the television cameras allowed radiographic comparisons. Video taped comparisons of antemortem and postmortem radiographs were shown to medical examiners and families as proof of identification.

Dr. Maples and this author were also involved in several cases in which photographs taken by a surveillance or ATM camera were compared to court ordered photographs of an alleged perpetrator. One case, which went to trial, led to the conviction of a habitual criminal under Florida statute. This individual had a condition known as Stahl's ear, a deformation of the cartilaginous structure. The ear was seen clearly in many of the ATM camera photographs and was aligned easily with the known photographic sample.

KEYWORDS: forensic science, forensic anthropology, William R. Maples, human identification, video superimposition, skull/photograph comparison, photograph/photograph comparison, radiographic comparison

Video superimposition and it's varied applications were areas of active research and casework for Dr. William Maples and this author at the C.A. Pound Laboratory from 1987 until 1992. Dr. Maples became interested in the technology at a presentation of skull-face superimposition at the American Academy of Forensic Sciences meeting in 1976 (1). In late 1986, with the dedication of the C.A. Pound Laboratory, he was able to pursue these interests. One of his first purchases for the new laboratory was video superimposition equipment. State of the art equipment at that time included two high resolution black and white television cameras, an electronic mixing board, a video monitor, and two super VHS video recorders (Fig. 1).

Multiple uses in forensic investigations were developed with this equipment. This paper discusses three applications of video superimposition to forensic case work: skull/photograph superimposition, radiographic comparison, and photograph/photograph superimposition. The first application, comparison of an unknown skull with a photograph of the putative deceased, became an immediate area of interest. A case involved the identification of a 15-year-old-female victim of homicide with no dental records or medical X-rays. The girl, missing for 10 days, was mostly skeletonized in the high heat and humidity of Florida. Her identity was based on a superimposition of her skull and face with particular concentration on the alignment of her teeth.

The second technique, comparison of antemortem and postmortem radiographs for identification purposes, is a common technique in forensic pathology and anthropology (2,3). Healed trauma, anomalous structures, skeletal and dental morphology, and trabecular patterns are analyzed for congruence between radiographs. A superimposed comparison of X-rays proved useful when the areas of interest were small or hard to visualize with side by side or overlay techniques. We found that superimposing the images enhanced the clarity of the comparison greatly.

Third, a comparison of crime scene surveillance or trap camera photographs with photographs of the suspected perpetrator came to be an area of interest for us. Due to the poor quality of most scene photographs, this technique was used more often for exclusion of suspects. However, a case is presented in this paper in which a match between photographs taken at an ATM and court ordered photographs of the suspect was used in the prosecution of an aggravated assault and robbery.

Skull/Photograph Superimposition

Identification of unknown skulls by comparison with images of a person, whether painted or sculpted, were first applied to confirm the identify of historical figures (4–6). Photographic methods have employed a wide variety of technique in aligning face and skull (7–20). These procedures usually involve a still photograph of the skull which is overlayed with the facial photograph. Electronic video equipment simplifies the process and in various forms uses two video cameras and a mixing device to superimpose two images (21–29).

The exact alignment of numerous teeth with nearly infinite variation in size, shape, and positional relationships constitutes a positive identification (13,20). The question remained, however, as to the reliability of video superimposition for positive identification without anterior dentition, relying on just the facial soft tissues and

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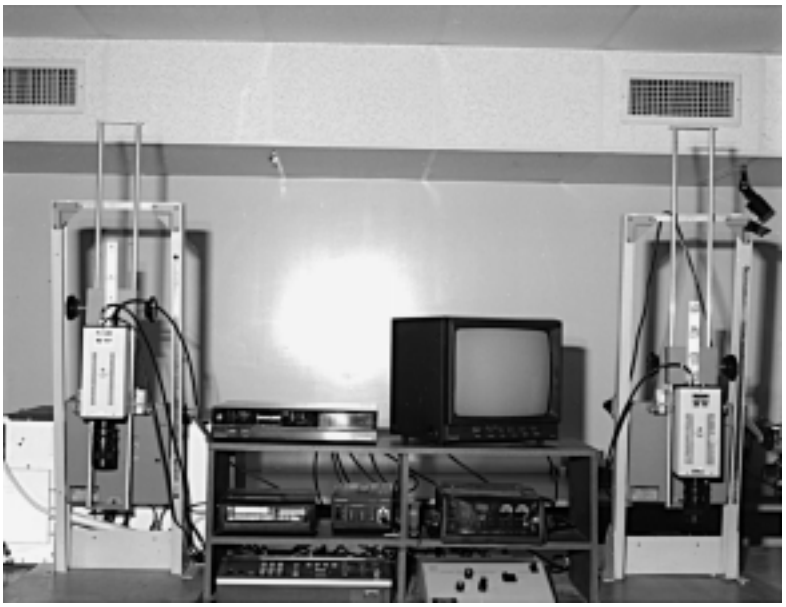

FIG. 1—*Video superimposition equipment.*

underlying bone. Most importantly, how often would a false positive result when anterior dentition were not available?

To answer these questions, three white male human heads aged 19, 57, and 81 years old, were purchased from an anatomical board. The heads were photographed in front and profile planes and defleshed. Each head was compared to 100 sets of mug shots supplied by the local sheriff's office. The adult, white male mug shots included front and profile views of the head. Some photographs were cropped improperly or the subject had too much facial hair, thus a total of 97 profile photographs and 98 full-face photographs were utilized.

Criteria for a good match between skull and photograph were developed using the three skulls in the test sample and several positively identified forensic case skulls. The skulls were compared to their known facial photographs to determine the exact relationship between bony areas and surrounding soft tissues. Twelve requirements for each view are outlined in a previous publication (30).

None of the photographs in the sample were of the subject skulls. Thus, a match between skull and photograph represented a misidentification. Profile view and full-face superimpositions were incorrectly identified in 9.6 and 8.5% of the sample respectively. The full-face comparisons were completed at a different time than the profile view comparisons. After all the data were collected, it was found that on two occasions a skull matched the full-face photograph and the profile photograph of the same individual. This resulted in a 0.6% incidence of misidentification when a skull was compared to both views (30). These data led us to request multiple photographs from widely varying angles when it was necessary to prove or disprove identity by superimposition.

Antemortem/Postmortem Radiograph Comparison

The video superimposition set-up proved useful for antemortem and postmortem radiograph comparisons. Often in such comparison, there are no anomalous or pathological features. The comparison is between skeletal structures that are common to most of the human population. It becomes necessary to find variation in the gross and internal morphology of the osseous elements. If the remains are conflagrated, or fragmented by other methods, the body areas available postmortem may be limited to minute areas of trabecular bone such as the alveolar bone between tooth sockets. Comparison of bone fragments such as these are often all the evidence available for identification.

To align a small area of trabecular bone, multiple postmortem X-rays were usually necessary to reproduce the exact angle of the X-ray beam through the bone to the plane of the film. Once the matching postmortem film was produced, the X-rays were placed on light boxes and the image was captured by the television cameras and viewed on the monitor. The ability to enlarge the X-rays to a size that is comfortable to work with and to make horizontal and vertical passes with the cameras to ensure exact alignment of structures, sometimes a few millimeters in size, aids the analyst's confidence in the identification. To enhance the viewability of the comparison we sometimes photographed the antemortem X-ray, and a print with the blacks and whites reversed was prepared. This clarified the differentiation between antemortem and postmortem films.

The radiograph comparisons were recorded on video tape so they could be shown to family members, medical examiners, and district attorneys for proof of identification. A taped presentation directed the eye of the viewer to a particular structure in an X-ray. As the tape moved slowly between the two radiographs, the viewer could more accurately interpret the skeletal or dental morphology.

Photograph/Photograph Superimposition

Photographs taken by a surveillance or trap camera at an ATM, convenience store, or bank oftentimes lead to a suspect. In many cases, the photographic or video evidence is the sole link of a perpetrator to a crime. We applied the video superimposition equipment to compare scene photographs with known photographs of a suspect.

We evaluated cases for merit prior to accepting them. We compared a photograph of the suspect, often a mug shot, to the photographs or video tape from the scene. If many shared characteristics warranted continuation with the case, permission of the subject

or a court-order was obtained to allow us to take known photographs of the suspect. The scene material was evaluated for the clearest views of the suspect's face with good focus and the least amount of graininess. These were made into a contact print that accompanied the photographer to the session with the suspect. This material was referred to often during the photo shoot. Recreating the angle of the face to the camera, as it was recorded in the scene photographs, was the objective.

After the comparative analysis of the faces, three conclusions were possible: exclusion, possible but not conclusive, and match. Exclusion of the suspect was a frequent finding. In one case, several calls from citizens indicated a single suspect, who was in no other way linked to the crime. Although the perpetrator, caught on film by a trap camera, and the suspect looked similar, careful analysis of the facial proportions excluded the suspect. We worked a few cases where the two sets of photographs gave a match; however, the quality of the scene photographs was not sufficient to warrant positive identification. In one case, there were two female suspects and both matched the grainy scene photographs.

One particularly interesting case of a match led to presentation in criminal court of a video tape with four photograph/photograph comparisons (Figs. 2–4). The circumstances were an assault, theft of an ATM card, and theft of money from bank accounts via ATM withdrawal. Thirty-seven photographs were taken of the perpetrator at the ATM machine over the course of several hours. Full left and right profile shots, as well as multiple angles over the front of the face, were available.

The clinching factor in the positive identity of the perpetrator was a congenital deformation of the cartilaginous structure of the ear, known as Stahl's ear. The deformed right ear was seen clearly in many of the ATM camera photographs and was aligned easily with the photographs taken of this fellow under court order (Fig. 4) (31). The guilty verdict resulted in the conviction of an habitual criminal who was sentenced to life in prison.

Discussion and Conclusions

In all three techniques, the quality of known and questioned photographs or radiographs is essential. The photographs we received for skull/photograph identification were commonly mug shots, driver's licenses, or family photos. Driver's license photographs are usually full face and benefit from the enlargement capabilities of the equipment. Mug shots and family photographs often represent varying angles to the camera film plane. We requested at least two quality photographs with an attempted difference of 90 degrees between the two.

When comparing two sets of photographs, the scene photographs must be focused and show useful characteristics of the face of the perpetrator. We examined frequently the photographs with a stereomicroscope to ascertain the amount of grain, clarity of features, and shadow detail. Obstructing factors such as facial hair, long head hair, hats, scarves, sun glasses, masks, and shadows can render crime scene photographs useless.

Antemortem radiographs differ in clarity of the osseous structures. Soft tissue thickness has great influence, thus, skull radiographs tend to be clearer than abdominal X-rays. Postmortem radiographs, however, need not be of poor quality. With a deceased body, or portions thereof, the amount of radiation exposure is not an issue. Bearing this in mind, the antemortem radiographs need to be evaluated first for structures that lend themselves to comparison. Simple trabecular patterns found just medial to the cortex of long bones are acceptable, whereas the trabeculation in calcanei, verte-

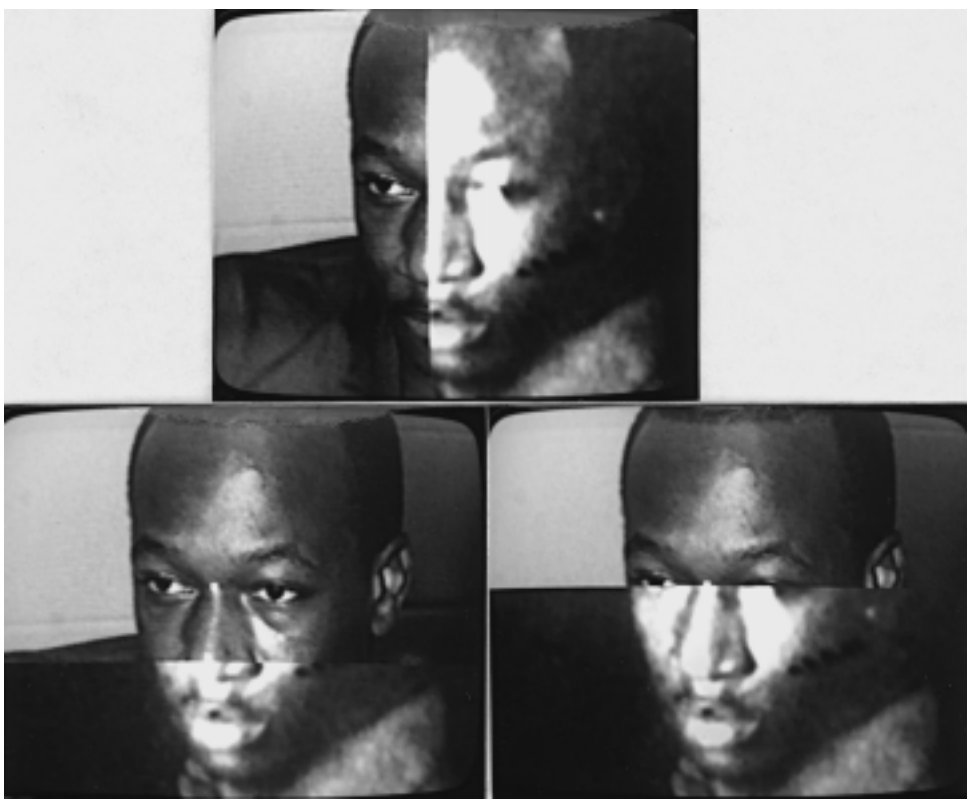

FIG. 2—*Full face match.*

FIG. 3—*Left profile match, normal left ear.*

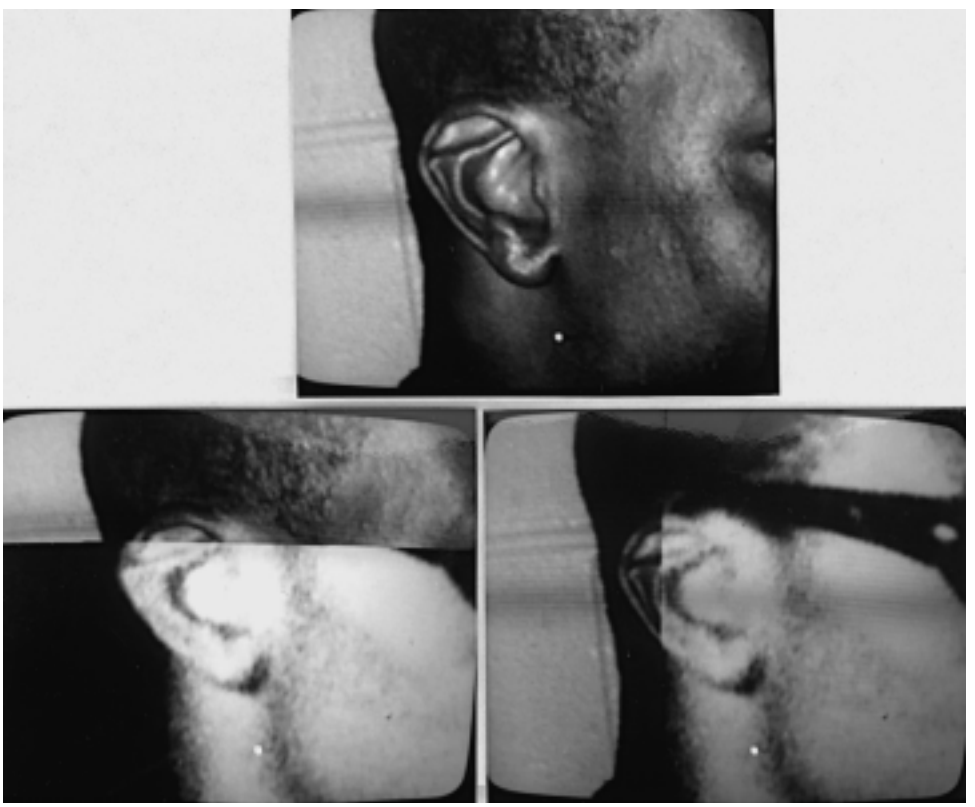

FIG. 4—*Close-up of deformed right ear.*

bral bodies, and the metaphyses of long bones are too complex for comparative purposes. After an area has been selected, a clear and exactly aligned postmortem radiograph can be attained with a little effort.

As with many techniques in forensic science, the experience of the analyst and the integrity of the equipment is of premier importance. The superimposition work was completed by anthropologists who spent many hours comparing skulls to photographs, photographs to photographs, and radiographs one to another.

The equipment described in this article does not include a computer. This alleviated cost and perhaps added credibility to the comparisons. Computer assisted superimposition can ease the comparison process (29); however, computer software can also be used to manipulate images. This fact might be used to plant doubt by a wily attorney. For example, the defense attorney asked how we got our computer to put sunglasses on his client's face as he viewed a fade from one photograph to the other on the video tape discussed above in photograph/photograph superimposition. When we stated no computer was involved, he knew this was not an avenue for imparting doubt to the jury.

The results obtained in the skull/photograph study were helpful in multiple areas. Skull/photograph superimposition is complex in that one is not comparing the same item. A thorough study of known skulls with their own photographs is necessary to understand the complex relationship of soft tissue to bone in the face. This was accomplished by comparing the study skulls with their known facial photographs and also known identity cases. With two notable exceptions (25,32) this area was not well-defined in the literature until the publication of our results (30).

In conclusion, we were also able to quantify the rate of misidentification that could be expected of an experienced practitioner of skull/photograph superimposition. In over 25 photograph/skull superimposition cases that Dr. Maples and I worked between 1988 and 1992, the identity of the individual has yet to become an issue in the courtroom. However, the 99% accuracy rate for video superimposition with no anterior dentition and widely varying facial photographs makes it's acceptance in court possible and reasonable.

Radiographic and photographic comparisons are more straightforward in that the same object is compared. Video superimposition equipment enhances the comparison by enlarging the areas being compared and allowing for a video tape of the analysis that can be slowed enough for a viewer to see the results clearly.

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