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Photographic Superimposition

REFERENCE: Dorion, R. B. J., **"Photographic Superimposition,"** *Journal of Forensic Sciences*, JFSCA, Vol. 28, No. 3, July 1983, pp. 724-734.

ABSTRACT: The term of photographic superimposition has been applied for a number of techniques in forensic medicine and dentistry. The comparison of an antemortem photograph to that of a skull is one such procedure. Technical information and potential sources of difficulty are discussed. Finally, two cases illustrate the use and misuse of this technique in arriving at a positive identification.

KEYWORDS: odontology, photography, superimposition

The *Webster's New Collegiate Dictionary*, seventh edition, defines superimposition as: "To lay or impose on something else—the act of superimposing or the state of being superimposed."

For our purposes it is the placement of a postmortem record over a comparable antemortem record. The records usually deal with the physiognomy, anatomy, or histology of a structure. The following records are those most often compared.

POSTMORTEM RECORD	ANTEMORTEM RECORD
(a) X-ray films	(a) X-ray films
dentition	dentition
skeleton (particularly skull)	skeleton (particularly skull)
trabecular patterns	trabecular patterns
sinus configuration	sinus configuration
(b) Photographs	(b) Photographs
dentition	dentition
skeleton (particularly skull)	any part of the body particularly the head
trabecular patterns	
corpse or part thereof (nonputrified state)	
facial reconstruction	
facial restoration	
(c) Direct comparison	
dentition	portraits
skeleton (particularly skull)	paintings
trabecular patterns	busts, and so forth
corpse or part thereof (nonputrified state)	
facial reconstruction	
facial restoration	

Received for publication 25 Sept. 1982; revised manuscript received 30 Nov. 1982; accepted for publication 13 Dec. 1982.

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Records are not always mutually compared, that is, an X-ray is not necessarily compared to an X-ray. As an example, a postmortem X-ray may be compared to an antemortem photograph. Suffice it to say that similar records are desirable.

The antemortem record serves as the standard for comparison. The postmortem record is compared to that standard. The inference is that the antemortem record is a reliable static record. Paintings, portraits, and busts are characteristically and scientifically unreliable for comparison purposes. X-ray films and photographs are two dimensional. Other photographic problems include:

(a) photographic equipment:
  (1) the camera,
  (2) the type of lens,
  (3) the focal length and aperture,
  (4) the size of the film,
  (5) the film characteristics and speed,
  (6) the source and direction of the light, and
  (7) the distance to the subject;

(b) developing equipment:
  (1) the chemicals and procedures used for developing the negative,
  (2) the type and characteristics of enlarger and enlarger lens,
  (3) the focal length and aperture of enlarger lens,
  (4) the distance,
  (5) the characteristics of the developing paper, and
  (6) the chemicals and procedures used in developing the print; and

(c) subject matter:
  (1) soft and hard tissue outlines,
  (2) flexion and extension,
  (3) right and left lateral movement,
  (4) rotation around an axis (torsion),
  (5) time interval and changes since the original photograph and the time the person was reported missing,
  (6) time interval and changes since the person was reported missing and the death of the person, and
  (7) time interval and postmortem changes.

Additional problems can be introduced if the original negative is not available for comparison. A rephotographed print may alter the original conditions.

These problems are compounded when dealing with X-ray films because unlike photography, the film is behind the subject and the source of radiation is in front or vice versa. The source of radiation, equipment characteristics, distance to subject, and subject to film are additional potential sources of difficulty.

Recently video [*1*] and computer systems have been introduced to compare postmortem to antemortem records. These systems are tremendously versatile but can add new major sources of error, notably optic, electronic, or logistic in origin. It is ironic that while antemortem records serve as the standard for comparison purposes, less technical information and fewer controls are exercised over them generally than are over postmortem records. This is particularly true with photography.

Probably no other forensic science expert uses antemortem and postmortem X-rays for comparison as frequently as does the forensic dentist. The reasons are principally that the dental and surrounding osseous structures are significantly unique and personal. When dental treatments are performed these characteristics become even more personal. The relative stability of dental tissues postmortem is reknowned. Skull and antemortem photographic su-

perimposition present a different set of problems and challenges. In the latter, postmortem and antemortem points of comparison are by their essence, different.

Review of the Literature

There are several articles dealing with facial restoration [2-6], a mention of montage [2], and facial reconstruction [7-10].

The consensus of opinion seems to indicate that extreme caution is to be used if a positive identification is the ultimate goal when using these techniques. Corroborative evidence will tend to reinforce a possible identification. The terms possible, probable, and positive denote an increasing order of scientific assurance from hypothesis to fact.

Standard dental comparison has been accepted as a positive means of identification for years. Yet it is only fairly recent that one has seen articles regarding superimposition using dental structures [11-14]. The first of these articles assumes that there are positive correlations between facial type and tooth configuration. Moreover there is much reliance upon the lower jaw and tooth position (of the centrals) to obtain proper angulation. The former can be displaced while the latter can be moved mechanically or pathologically. Antemortem and postmortem photographic problems are not mentioned.

Tedeschi et al [2] mentions the superimposition of frontal sinuses, trabecular patterns, cortical contours, and bone surfaces. The author concludes that antemortem and postmortem photographs by overlays should be used for exclusionary purposes only. However, he states that antemortem photographs and photographs of the skull can lead to a possible identification. Positive identification can result [15] if the antemortem photograph is suitable, that is, if a full face or profile view and the quality of the photograph is acceptable. A technique for obtaining similar angles of skull to photograph is described. There are some errors and omissions with this technique.

In contrast, one author [13] states that it is doubtful that a nondental photograph would be the sole basis for a positive identification although it may be the determinant of an exclusion. Another author [16] is more categoric. The assertion is that a full face or near full face antemortem photograph should be used for general information only and cannot be used for positive identification since magnification and angulation of the original picture is unknown. It is conceivable that two faces of completely different sizes may have similar skeletal characteristics.

Different thicknesses of tissue overlying the skull is dealt with in articles on facial reconstruction [7,9,10]. Krogman [5] states that there is little change in dimensions between the skull and the live individual.

Basak et al [17] present a mathematical treatment of superimposition.

Two cases of skull and antemortem photographic superimposition are the Ruxton and Dobkin cases. These are reported by Glaister [18]. Information on the techniques, equipment used, as well as the antemortem photographs are not mentioned.

Various other articles [3,4,6,19-22] offer little or no technical data.

Case 1

In April of 1976, a partially decomposed body was discovered in another jurisdiction. The technique of skull to antemortem photographic superimposition was used in that jurisdiction as a basis for positive identification with a high degree of medical certainty.

Case 2

On 2 Nov. 1979 skeletal remains were found in a wooded area at Millstream, Bonaventure County in the Province of Quebec. The forensic science investigation suggested that the skeleton was that of a white male 157.5 to 162.6 cm (62 to 64 in.) tall and weighing ±54 kg

(±120 lbs) (notching of a belt and height). The cause, manner, and time of death was unknown although the latter was estimated as a "recent" demise with a minimum of two years.

Dental and anthropologic expertise established an age of 25 to 30 years at the time of death. The dental status was very poor with multiple chronic abcesses, both of dental and periodontal origin and with no evidence of fillings. The only fragment of clothing found was that of a blue trenchcoat. The identity of the victim remained unsuspected until June of 1980.

By July, an enlarged copy (Fig. 1) of a photograph of the suspected victim was examined. The suspected victim was a mentally retarded individual reported missing in May 1973 8 km (5 miles) from the discovery of the skeleton. He was a white male, age 25, 162.6 cm (64 in.) tall, 60 kg (133 lbs), wearing a blue trenchcoat at the time of his disappearance. There were no medical or dental records for comparative purposes. He had often complained of dental pain and swelling but had never visited a dentist. He had not been seen since 1973. There were no social, judicial, banking, or other legal documents that might suggest that he had survived.

An attempt at skull and antemortem photographic superimposition began in August. By June 1981 a conclusion based upon photographic superimposition, scientific findings, and corroborative and circumstantial evidence could not eliminate the victim as the missing person. In fact, each phase of the investigation supported and reinforced the probabilities that the victim was the missing person. The Coroner accepted the findings and declared that the missing person and the victim were one and the same person.

Materials and Methods

Several methods were devised to solve the technical problems encountered.

Lacking technical information (equipment and materials) used in producing the original photograph the following points were deduced from studying the enlarged copy of the photograph. The subject to film distance was approximately 95.25 cm (37.5 in.) with a 100-mm

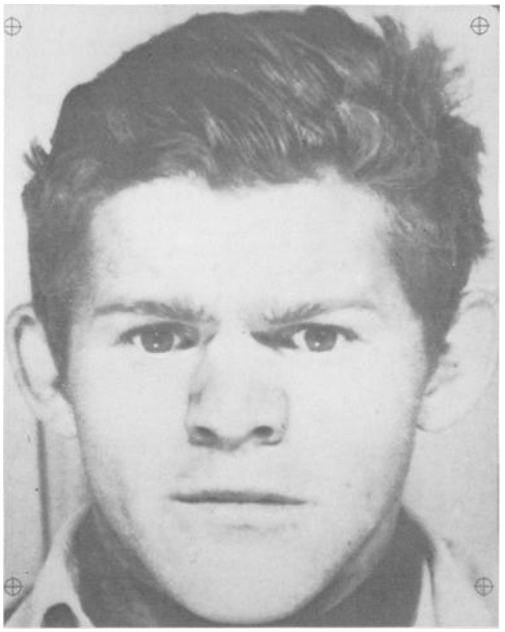

FIG. 1—*Enlarged photograph of suspected victim.*

lens. The photograph was further enlarged to a 1:1 ratio using reference points of the *skull* as the standard. Optical distortions created by enlargement were minimized. The latter was then made into a 1:1 transparency and mounted on an X-ray viewbox.

Method 1

A Graflex 4 × 5 camera with a 135-mm lens at *f*-4.5 was mounted directly in front of the skull at a distance of 95.25 cm (37.5 in.) (Fig. 2). The use of a smaller formula camera may create problems when enlarging. A beam splitter and front surface mirror were arranged so as to reflect the image of the subject's photographic transparency (Fig. 3). Note that the distance between the camera and the skull is identical to the total distance between the camera and the reflected transparency.

By varying the intensity of the mounted quartz lights in front of the skull one could get a superimposed image (skull and transparency) when viewing through the camera.

The skull was mounted on a tripod with a pivoting head. Thus, a similar angulation of the skull to the transparency could be achieved. This includes flexion and extension, right and left lateral movement, as well as rotation around an axis. By removing the beam splitter and

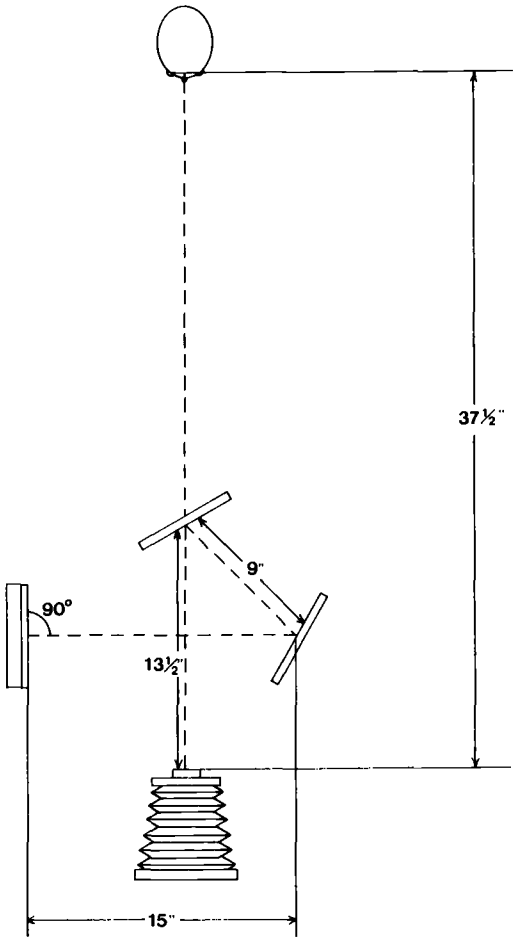

FIG. 2—*Graflex 4 × 5 camera with a 135-mm lens at f-4.5 was mounted directly in front of the skull at a distance of 95.25 cm (37.5 in.).*

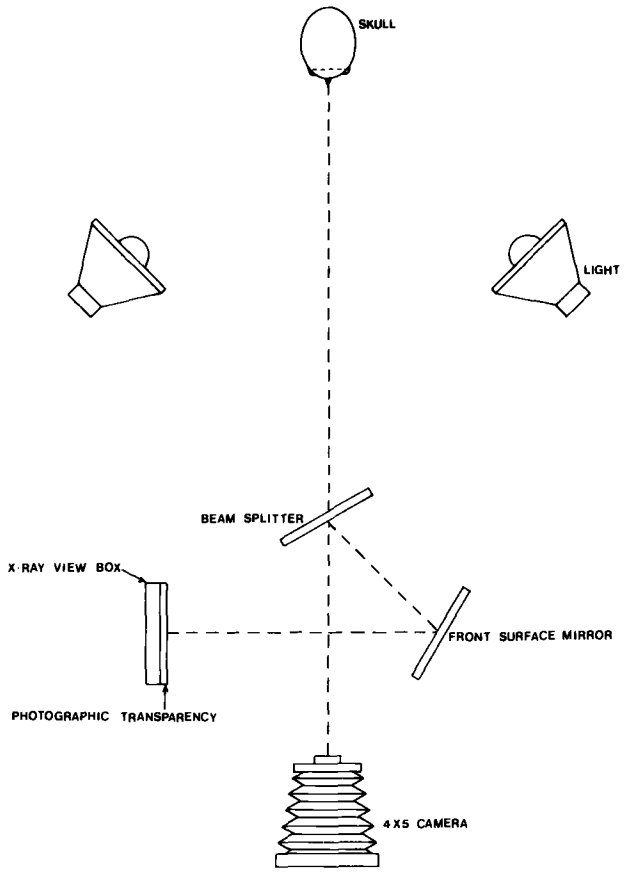

FIG. 3—*A beam splitter and front surface mirror were arranged so as to reflect the image of the subject's photographic transparency.*

photographing the skull one would have a similar orientation of the skull to the transparency (Fig. 4).

Method 2

The Graflex 4 × 5 camera is replaced by a video camera. The optical and electronic problems encountered using this system are inconsequential since both skull and transparency are equally and identically affected. One could not say the same with the use of two cameras, or two monitors or mixers, or so on. This was found to be the best method of obtaining a quick and precise angulation of the skull to the transparency. By varying the intensity and direction of the light on the skull one could study the overall image for particular characteristics versus those on the transparency (Figs. 5 to 7).

Method 3

The video camera was mounted 92.25 cm (37.5 in.) from the zygomatic processes of the skull. The 1:1 photographic transparency was mounted directly in front of the skull. Lights were placed in front of and in back of the transparency. A movable white cardboard was used to enhance certain highlights or points of interest on the photographic transparency. At

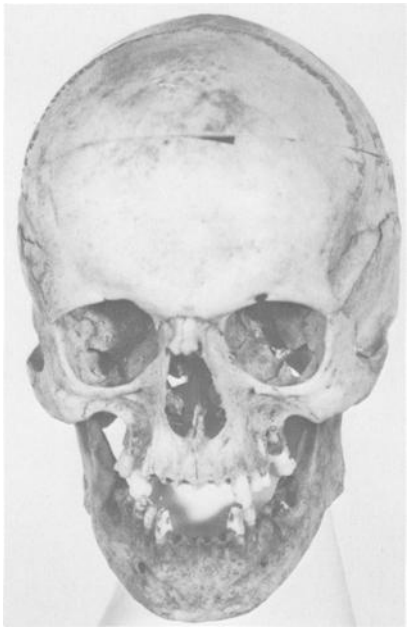

FIG. 4—*Photograph of skull.*

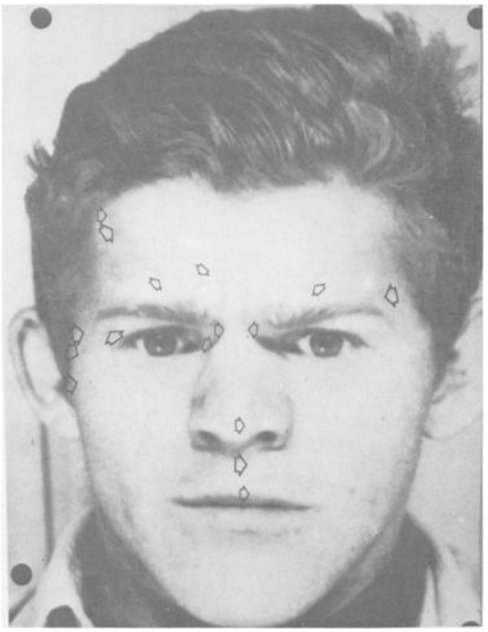

FIG. 5—*Soft tissue outlines of particular interest.*

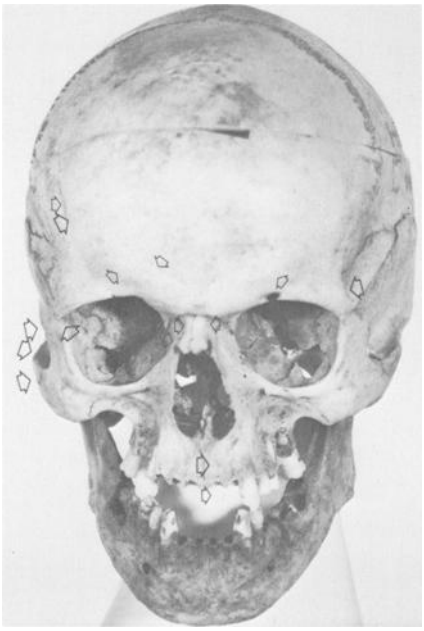

FIG. 6—*Corresponding osseous structures and outlines to Fig. 5.*

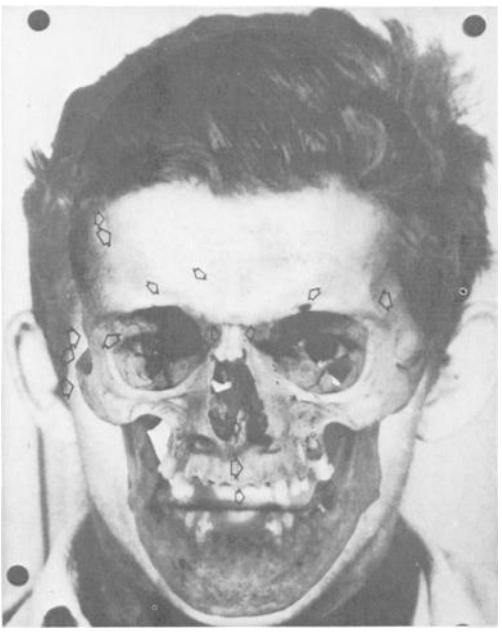

FIG. 7—*Antemortem photograph and skull superimposition with respective points of interest.*

the same time this would block out the skull's characteristics for the same region. By this means the entire skull and photographic transparency could be studied point for point. Despite the slight distance discrepency between the skull and camera and the transparency and camera, the optic and electronic distortions were quite similar in both cases (Fig. 8). One could probably achieve the same or better results using Method 2 with a movable cardboard although this was not attempted. In either case, the reader is reminded that only one video camera and monitor were used in order to negate optical and electronic distortions of the transparency and the skull.

Discussion

Despite the lack of technical information regarding the initial photograph an attempt at skull and antemortem photographic superimposition was achieved with a reasonable degree of success. After these results were obtained it was found that the original photograph was taken with the Auto Photo Camera Model 9 A, Serial No. 1851 between 27 Nov. 1967 and

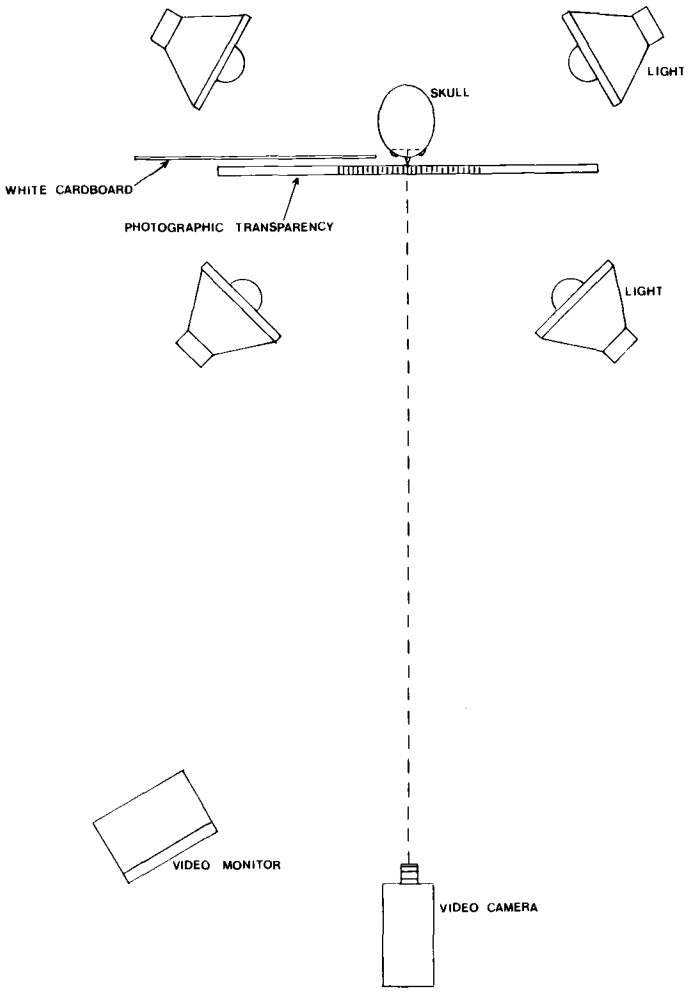

FIG. 8—*Method 3 is demonstrated, where the video camera was mounted 92.25 cm (37.5 in.) from the zygomatic processes of the skull.*

27 June 1970. The type of lens used was made by Ilex Optical Co. of Rochester, NY. The focal length and aperature was 100 mm at *f*-4.5 to 5.5. The size of the original film was 5 by 3.9 cm. Positive film by Kodak was used. The light source was three General Electric incandescent lights positioned two above and one below and to the right of the subject's head. The distance between subject to film was 132 cm (44.8 in.). There was no developing equipment necessary as it was positive film and the chemicals used for developing the film was made by Christie Chemicals. This technical data could now serve to produce a precise skull and photographic superimposition. This technical information in itself is not sufficient however. Additional expertise is required. The comparative phase is not analogous to comparing fingerprints, the dentition, tool marks, tire marks, or comparison of other inanimate objects. One is comparing soft tissue outlines to bony and dental charactertistics. This demands knowledge of anatomy and dentistry to mention but two subjects (Figs. 1 and 4–7).

Cases 1 and 2 were both identified as being the same individual. In May 1982 Case 1 was positively identified by fingerprints as being someone different from the original identification.

Conclusion

A misidentification by photographic superimposition of skull and antemortem photograph was exposed. Some technical data used to arrive at the correct identification were presented. The reader is reminded that photographic superimposition of skull and antemortem photographs should not serve as the sole basis for positive identification. All other standard, reliable, and tested methods of identification should prevail. Should the latter prove fruitless and photographic superimposition positive, it should be corroborated by all available scientific findings and circumstantial evidence.

Acknowledgments

I wish to thank the following persons who were instrumental in the realization of this project: Dr. Jean-Paul Valcourt, Director, Laboratoire de médecine légale, Ministry of Justice, Province of Quebec, Montreal; Dr. Ian Powell, Department of Applied Optics, National Research Centre, Ottawa; Dr. Nick Klonaris and Tadao Furue, Central Identification Lab, U.S. Department of Defense, Honolulu, HI; M. Jean-François Bellemare, Photography Section, Quebec Provincial Police, Montreal; and M. Léo Arsenault for his permission in allowing the publishing of his son's photograph.

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