TECHNICAL NOTE

John J. I. McKenna,[1] *M.Phil.*

A Method of Orientation of Skull and Camera for Use in Forensic Photographic Investigation

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ABSTRACT: The ability to obtain accurate superimposition of the image of the teeth from ante- and post-mortem dentitions is a prerequisite of photographic superimposition. A prototype skull and camera holder is described that enables this to be achieved quickly and simply. The position of the skull relative to the attitude of the face in the photograph can then be documented and hence reproduced as required.

KEYWORDS: odontology, dentition, superimposition, musculoskeletal system, skull, photography, cameras, holder

The ability to submit documented data, based on scientific principles, for use in a court of law to substantiate any forensic science investigation is highly desirable. In such a setting it is essential that statements made are technically well founded [*1,2*].

In this regard, the technique of photographic superimposition of antemortem photographs over postmortem skulls to establish personal identification has gained increasing credibility in recent years [*3-5*]. A method of using measurements taken from the postmortem dentition to enlarge an antemortem photograph of the suspected victim to life size has been introduced to enable the exact superimposition of the images of the teeth from both skull and photograph [*3*].

A further and logical refinement of this technique is the development of a skull holding device which permits a readily reproducible alignment of camera to skull, so that the proper orientation of the skull to the attitude of the face in the photograph is achieved at a correct magnification. Although holders designed to allow movements of the skull in the three planes of space have been described recently [*3,6*], neither appear to have the facility for reproducing the orientation of the camera to the skull in an exact and recordable manner. Furthermore, as one of them [*6*] appears to rely exclusively on the use of the video cassette recording technique of photographic superimposition, the final image must be affected because of the distortion created by the curvature of the monitoring screen.

The purpose of this paper is to describe a prototype skull and camera holder designed to overcome these problems. The author prefers the term "goniometer" because the distance

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[1]Staff specialist, Dental Clinical School, Westmead Hospital, Westmead, New South Wales, Australia (deceased).

and angular measurements of the position of the camera relative to the skull can be recorded and can be reproduced easily and quickly.

The Principles

The method of stereometric craniometry has been devised from a stereometric analysis procedure used in geology [7]. The principles use three projections of latitude, longitude, and distance to reduce a three-dimensional object into a two-dimensional contoured and easily understandable image which affords the necessary information of the shape. This technique is similar to the Mercator projections in the mapping of land masses.

Materials and Methods

The theoretical concept of the goniometer is shown in Fig. 1. It consists of two circles at right angles to each other rotating about a common center where the object to be photographed is placed. In application, there is a horizontal base circle on which is mounted a vertical arc, capable of rotating through 360°, on that base.

In the goniometer (Fig. 2), the vertical arc is formed by a camera bearing arm capable of rotating through a total of 200° of the sphere (that is, 180 and 10° below the equatorial plane on each side). Both the base and the arc are calibrated, incorporating a Vernier scale, which allows two of the coordinates to be recorded accurately. These coordinates are akin to the angles of elevation and azimuth in cartography, that is, the latitude and longitude readings used to locate places on a map. The third coordinate is the radius of the circle from the object at the common center of the sphere to the camera lens at its periphery.

Two crossed hairline directional sights are placed at right angles to each other, the one

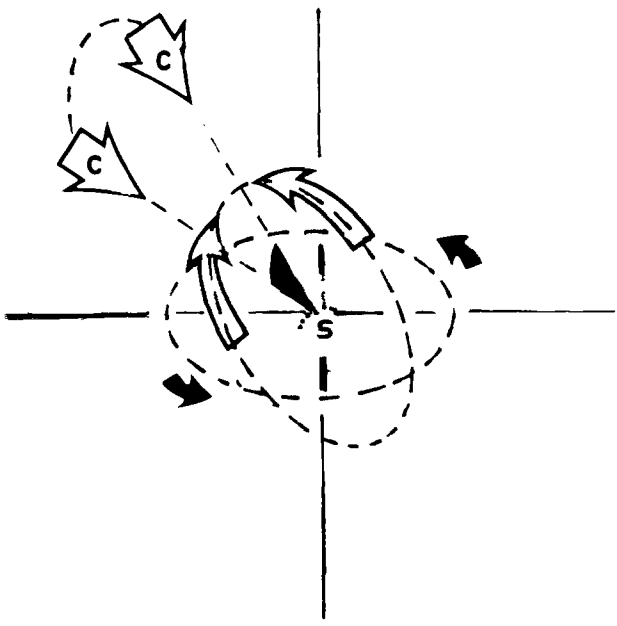

FIG. 1—*Schematic representation of the principles of a goniometer where the camera* (c) *is at a fixed distance from the specimen* (s). *The camera can be rotated 360° horizontally and 200° vertically about the specimen which is so positioned that a distinctive reference point is the exact center of rotation.*

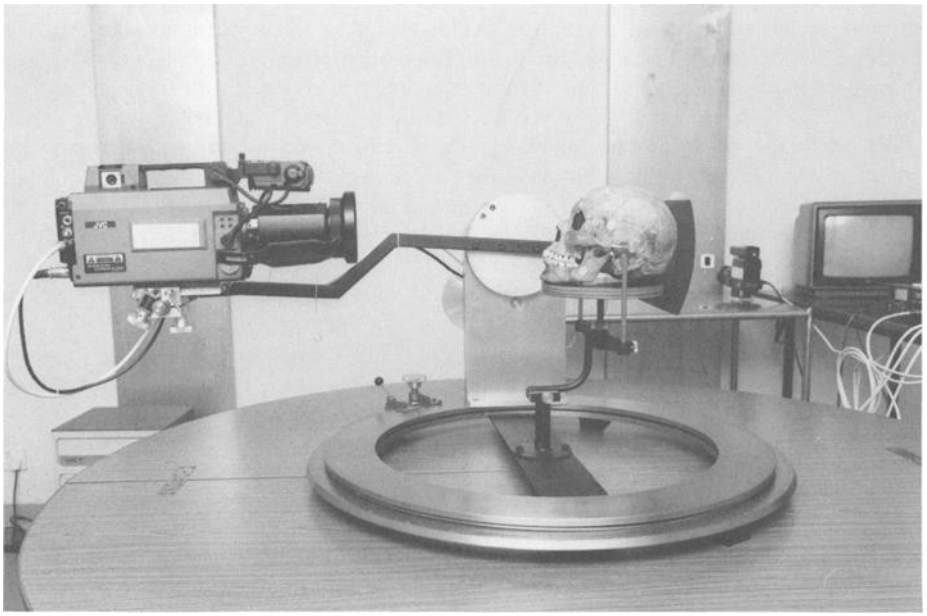

FIG. 2—*Photograph of the goniometer with a video camera mounted. The distinctive anatomical reference point chosen on this skull is the midline between the central incisor teeth at their incisal edges.*

over the camera lens and the other in a sighting window of the pillar which controls the movement of the camera. The skull is aligned through the sight in the pillar to a distinctive anatomical reference point, considered to be appropriate for optimal photographic superimposition (for example, the line between the central incisor teeth at their incisal tips), and clamped into position. A video camera is then focused through a transparent lens cap sight on this reference point and is secured in position. This allows the camera to traverse the skull in circles, with their common center as the chosen anatomical reference point on the skull, to any recordable angular position within the horizontal base and vertical arc. The video camera projects the image of the skull onto a television monitoring screen. A second video camera focused on the antemortem photograph also projects an image to the monitor screen. Use of a special effects generator [*6*] enables the size of the images of the skull and photographs to be matched by superimposition of the respective dentitions. The correct attitude of the skull to the face in the photograph can be achieved by the traversing of the camera focused on the chosen anatomical reference point of the skull. The angular coordinates are then recorded.

The camera bearing arm of the goniometer described here has the facility for interchange of cameras. The video camera can be replaced by a still photography camera at exactly the same radial distance and in the same angular axes as determined by the video camera. Overlay transparencies can then be prepared from the still photographic negatives for presentation in a court of law [*3*], thus enabling a static display of the resultant superimposition without the distortion created by the monitoring screen.

Discussion

It is now appreciated that images of teeth visible in an antemortem photograph provide an in-focal-plane size determinant for its enlargement to life size [*3*]. It is most unlikely, how-

ever, that details of the type of camera, the lens size, or the exposure used, together with the distance at which the portrait or snapshot was taken and the precise attitude of the head, will be available for the selected photograph. It is imperative, therefore, that laboratory procedures used in identification by photographic superimposition be scientifically sound and account effectively for these unknown variables before the actual matching process is begun.

The interchanging facility for cameras on the bearing arm of the goniometer results in a still photographic image which eliminates the distortion of the monitoring screen. Obtaining the correct skull attitude as that of the face in the photograph is difficult and can be very tedious if video photography is not used, especially where several victims have to be identified by photographic superimposition. To achieve it by still photography alone would require a visual alignment of the skull into an attitude judged to be the correct position followed by several photographic exposures at measured angles both above and below and to the right and left of the selected anatomical reference point [*8*]. While the use of video cameras in the technique of photographic superimposition for personal identification has been described [*5,6,9*], superimposition by this method alone is inexact because of distortion generated by the convexity of the monitoring screen. The resultant image, therefore, does not appear in true perspective.

The proposed goniometer enables the exact skull attitude to be obtained through video camera photography by the superimposition of the images of the teeth in the skull and antemortem photograph comparatively quickly. The coordinates can then be recorded and still photography introduced so that correctly enlarged and aligned life sized images of minimal distortion become available for detailed analysis. A documented report, based on scientific principles, can then be presented in a court of law, and, together with overlay transparencies of the superimposition, should allow lay people to understand and evaluate the evidence in a more critical way.

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Address requests for reprints or additional information to
Dr. A. P. Barrett
Dental Clinical School
Westmead, N.S.W. 2145
Sydney, Australia