TECHNICAL NOTE

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Digital Video Image Capture in Establishing Positive Identification

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ABSTRACT: Positive identification of skeletonized, decomposed, or disfigured victims lacking clinical records is a difficult endeavor. However, videotapes of family and social activities can be analyzed using the frame isolating technique of video image capture by inexpensive means. A rare skeletal Class III malocclusion and dental peculiarities in a decomposing 3-year old lacking a clinical history were compared to videotapes taken of a suspected victim shortly prior to her disappearance. Overlaying transparent dental tracings from digitized skeletal remains onto selected frames of the videotape (and reversing this process) produced the identification and hastened the entire investigation.

KEYWORDS: forensic science, digital image capture, positive identification, forensic odontology, videocamera

One of the most challenging tasks of medicolegal investigation is establishing positive identification. Unfortunately, achieving this goal is hardly routine. Anthropologists have relied most heavily upon time-proven methods of radiographic comparison of antemortem and postmortem dental and/or skeletal attributes.

Of recent, scanning electron microscopy, CT scans and DNA typing have been successfully used to this end (see, among others, 1–6). However, no matter how innovative or ideal, even recent developments require strong antemortem medical or dental records. Securing positive identification is especially frustrating when children are too young to possess clinical histories. Even when resorting to subjective anthroposcopic methods of facial reconstruction and photographic superimposition (see 7, for review), anthropologists may still become frustrated by the lack of recent, high-quality photographs with exposed dentition.

This article outlines a simple procedure of frame capture (or grabbing) off of standard VCR tape to compare against skeletal remains for positive identification.

Case History

The desiccating remains of a young child were discovered in an attic crawl-space of an apartment complex in April, 1995, in Knoxville, Tennessee. Although the identity of the decedent was suspected, the condition of the remains, absence of dental and medical records, and the unavailability of a recent photograph prohibited utilization of standard identification techniques. The anthropological autopsy confirmed an age of 3 to 5 years against missing person data. In addition, perimortem fracture and warping to the left frontal bone near the coronal suture and postmortem saw marks on the cranium associated with discovery of the body were noted.

Radiographic examination of the remains at the Department of Radiology at the University of Tennessee Medical Center, Knoxville, demonstrated a Class III malocclusion (Fig. 1). Orthodontia generally recognizes four classes of malocclusion, i.e., Class I, II-1, II-2, and III (8), based upon the antagonistic relationship between the anterior teeth, molars, and arch symmetry (9,10). Class variations include malposed teeth (Class I), arch asymmetry and/or skeletal discrepancy (Fig. 2). In comparison to "normal" centric occlusion, a Class II malocclusion, in lay terms, is an overbite

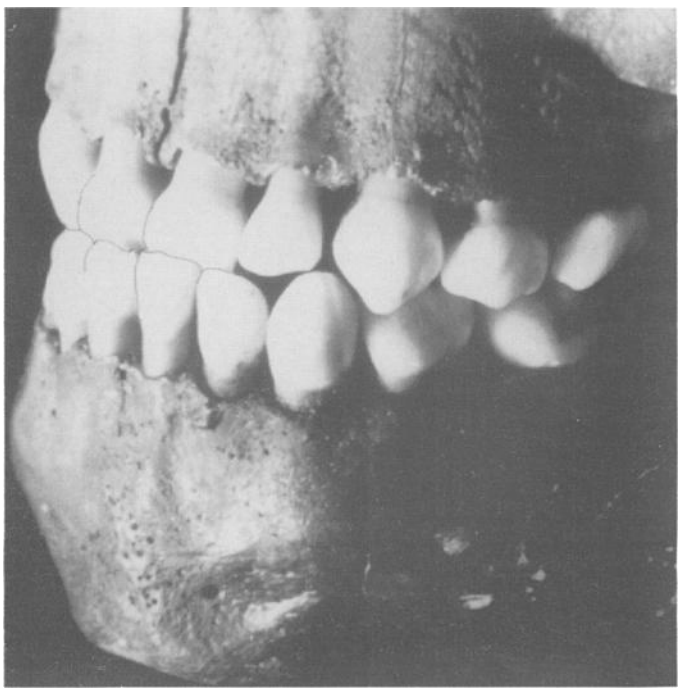

FIG. 1—*Skeletal Class III malocclusion with tooth margins enhanced to illustrate occlusal relationship.*

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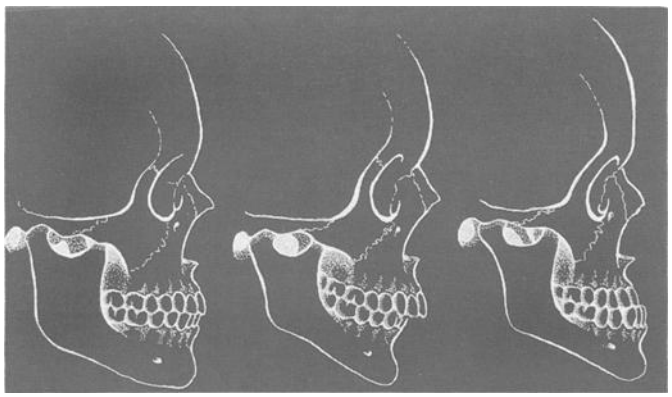

FIG. 2—*Drawing of the three major classes of malocclusion. Class I (left) is typified by anterior tooth crowding; Class II (center) is an "overbite" characterized by maxillary prognathism and/or retrusive mandible. In addition to Class II-1 (the illustration), Class II-2 displays this prognathism and overlap of the maxillary lateral incisors. Class III (right) is an "underbite" characterized by hypertrophic mandible and/or retrusive maxilla.*

whereas a Class III malocclusion is an underbite. Though both maxilla and mandible may contribute to skeletal dysplasia, most occlusal variation is associated with deviations in mandibular growth (10,11). The frequency of Class III occlusal events among 3-to-5-year-old Caucasian children is between 3 and 5% (Smith RT. personal communication 1996, 12). Malocclusions have been noted in 89% of 12-year-olds, of which, only 2% are designated as a Class III (13).

Materials and Methods

Two videotapes filmed six weeks prior to the victim's disappearance in 1992 became the antemortem evidence used in identification. Because the individual displayed several prolonged smiles revealing teeth, there was sufficient evidence for comparison to the skeletal remains.

Our initial attempts to isolate single frames using the "pause" option on a standard VCR machine to isolate single frames on broadcast-quality television monitors failed to produce the resolution and scale required to confirm or reject a match. To generate high-resolution reproductions, i.e., photographs, from the videotape we implemented a technique which isolates or grabs single frames using digital video image capture. This process converts the analogue video signal into a digital format using a video hardware system that simply connects into the parallel port of any computer. At present, the *Snappy* video device produces the highest-quality resolution of captured images at 1125 by 1500 pixels. Currently, this hardware costs less than two hundred dollars.

Using a 64,000 or greater color capable video system and a basic graphics package (we used *Adobe Photoshop*), it is possible to enhance, scale, and overlay images (or segments of images) captured from videotape. These captured regions can then be outputted in the form of color photocopies, 35-mm slides or CD/ROM. Also, images can be transmitted via cellular modem for interactive purposes.

The videotapes were placed in a standard VCR connected by the *Snappy* device to the computer. With the machine on "play," the technician "captured" or isolated several single frames that we considered best representative of the victim's unique dental attributes, i.e., malocclusal event (Fig. 3). Three specific images were enlarged and color-enhanced to refine the best detail on the

FIG. 3—*Teeth revealed in captured videotape images selected for comparison.*

dentition, occlusion, and interproximal spacing. A similar procedure was followed for the skeletal remains by positioning the cranium to replicate the antemortem position of the child's head depicted in the videotape. These captures of the skeletal remains were imported directly through the videocamera resulting in a very high degree of clarity (Fig. 4). Optimal results are achieved from tapes recorded on the "SP" mode which generates two hours of film per tape and produces ideal image quality. Pairs of antemortem and postmortem images were incorporated into three separate computer files (Fig. 5). For each set, the dentition of the skeletal/dental image was isolated, converted to a transparency and over laid on the image captured from the videotapes (Fig. 6).

Scaled photocopies of the captured frames with the overlays and the original videotapes were viewed by the University of Tennessee, Department of General Dentistry where four faculty identified several unique attributes.

FIG. 4—*Isolated images positioned to replicate the angles of the heads depicted in Fig. 3.*

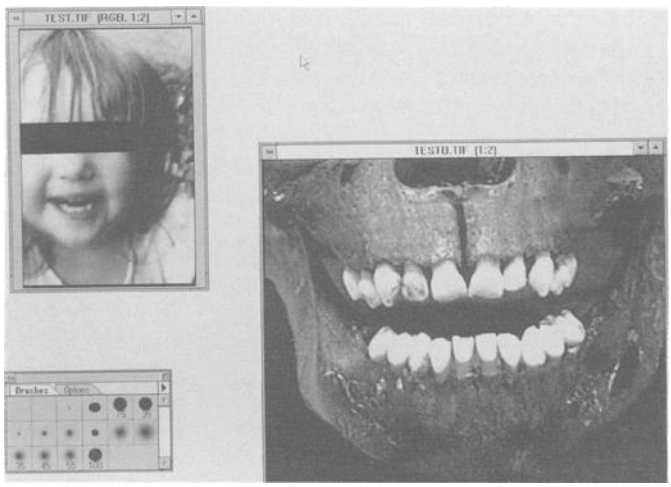

FIG. 5—*Image manipulation using Adobe Workshop of one pair selected for comparison.*

FIG. 6—*Isolated dental image of the remains (left) migrated with the captured tape image (center) and merged for comparison (right).*

Results

Wear facets, i.e., polished attrition surfaces, characteristic of the Class III occlusal pattern were visible on the labio-incisal aspects of the maxillary deciduous central and lateral incisors and the lingual surfaces of the mandibular incisors (Fig. 7). The mandibular deciduous left canine is rotated or tipped facially and there is a wide interproximal region between the maxillary deciduous lateral incisor and maxillary deciduous canine. These attributes result, in part, from the Class III malocclusion and can be compared to the antemortem tape and skeletal remains. Positive identification was established using these points and assessing the occlusal relationship of the specific malocclusion. As mentioned, the clinical incidence of a Class III malocclusion among Caucasian children aged 3–5 is less than 5%. The actual number of missing 3-year-old in east Tennessee possessing this dental feature is negligible, thereby increasing our likelihood of securing an identification. At this writing, while we await results of DNA bone analysis, a juvenile has pleaded guilty to abduction and murder.

Conclusions

Through a non-traditional manipulation of digital video image capture from videotape, an interdisciplinary team of anthropologists, dentists and computer-graphic experts were able to establish a positive identification. Although we know this system, as described here, is not without shortcomings, we feel that in circumstances in which the identity of the victim is highly suspected, it can be reliably and routinely used for establishing identity. We reiterate that the existence of a rare Class III malocclusion, specifically, increased the likelihood of making this identification. Nevertheless, this discussion will lead to recognition, implementation, and creation of other more advanced computer-graphic techniques for positive identification. Since the use of this procedure in the spring of 1995, recent computer graphic developments enable iso-rendering and 3-dimensional surface scanning which offer more advanced and refined techniques for video assisted identification. Though our efforts were focused on matching a skeletal/dental variation, we suggest this technique can be readily tailored for matching entire faces, segments of facial contour and/or profiles (14).

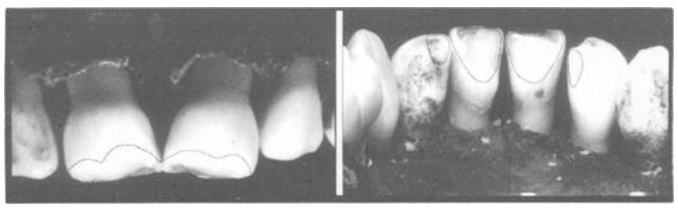

FIG. 7—*Attrition facets highlighted on the labio-incisal edges of the maxillary central incisors and on the lingual surface of the mandibular incisors.*

Another aspect must be considered when new methods are presented, applicability and practicality. Consider the number of family and social events or routine daily occurrences that are preserved on videotape. Standard photography is rapidly being replaced by video as the photo albums of the nineties. In fact, in one decade nationwide sales of camcorders have more than quadrupled from a mere 500,000 sold in 1984 to over 3.5 million in 1994 (15). This rise in consumer popularity coupled with technological advancement has been accompanied by steady decreases in cost and the development of better quality, cheaper camcorders available to more American families. Furthermore, ownership of a videocamera seems to know no socioeconomic boundary. Unfortunately, visits to the physician and dentist, especially, are often secondary considerations when financial constraints are pending. However, even the lack of physician and dental visits by smaller children can be compensated by a detailed examination of family videotapes.

Digital video image capture is one such technique that can be added to our battery of methods for establishment of positive identification. Such is particularly valid when the suspected decedent has not lived long enough or required the clinical attention to have established antemortem records. Partnering our investigations with audiovisual and computer-graphic experts not only enhanced our purpose but expedited the entire identification process.

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