CASE REPORT

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Radiographic Reconstruction of Root Morphology in Skeletonized Remains: A Case Study

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ABSTRACT: This is a case study in the application of a laboratory technique first described by Dr. Brion C. Smith in the *Journal of Forensic Sciences* in January 1992. Our study evaluated a human skull that showed perimortem and/or postmortem tooth loss. It was discovered in 1991 and deemed to have no usable dental information due to severe alveolar bone destruction. In 1994, using minor modifications of Dr. Smith's technique, we sealed off the open tooth sockets and injected a radiopaque material which, after radiographic analysis, revealed previously unobserved dental information. This report demonstrates that root morphology can be reconstructed. This yields radiographic information that may be useful in the identification of unknown human remains.

KEYWORDS: forensic science, forensic odontology, root morphology, radiographic reconstruction, human identification

This case study is based on a technique published by Brion C. Smith, D.D.S. in the *Journal of Forensic Sciences,* Vol. 37, No. 1, pp. 176–184, (January 1992). Dr. Smith used a human skull laboratory specimen and took radiographs of the skeletonized dentition prior to postmortem extraction of the teeth. Dental impression material enhanced with a radiopacifier was injected into the resulting root sockets, and post extraction radiographs were taken. A comparison was made of the pre- and post-extraction radiographs to determine if root morphology of the teeth could be reproduced after postmortem dental loss. Dr. Smith positively concluded that this is a simple, inexpensive and reversible technique that enables reconstruction and documentation of dental evidence in skeletal remains.

Materials and Methods

The human skull used in this study was found by a California Highway Patrol officer on March 6, 1991, on Highway 33, in Ventura County, California. The officer had been on "accident patrol," as this highway is tortuous, and cars that go off the side of the road are not easily spotted. The skull, with no mandible, was the only human remains found at the site (Fig. 1). No extensive site excavation was done because the terrain was very steep, and was also the dumping site of a Caltrans work crew, which had used the area to deposit mud and debris from rain-induced mudslides. It was also suspected, because of this dumping practice and the lack of other remains, that the skull may have been brought by a bulldozer from a distant location and deposited at the site. The skull was examined by Drs. O'Halloran, Bowers, and Suchey. Dr. Judy Suchey, a forensic anthropologist, determined that the skull was most likely that of a Caucasian or Hispanic female at least 30 years of age, although black and mixed race individuals could not be ruled out. There was severe destruction of the maxillary alveolar processes (Fig. 2—alveolar sockets. Tooth sockets #4, #5, and #6 are identified by number. Note the porosity of the cancellous bone.). The anterior alveolus was entirely destroyed, and only one small root tip remained in the area of #11 (Fig. 3—alveolar sockets with #11 tooth fragment. Individual sockets are identified by tooth number.). The right and left maxillae had linear notches superior to the molar teeth. These were possibly caused by a tool used for dismemberment.

FIG. 1—*Human skull.*

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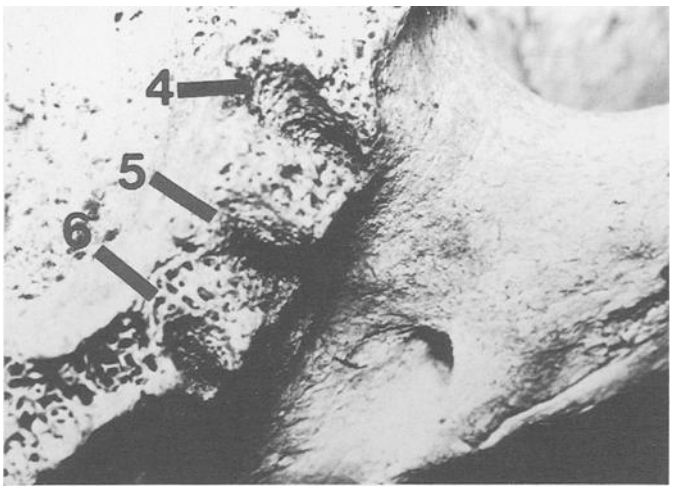

FIG. 2—*Alveolar sockets. Tooth sockets #4, #5, and #6 are identified by number. Note the porosity of the cancellous bone.*

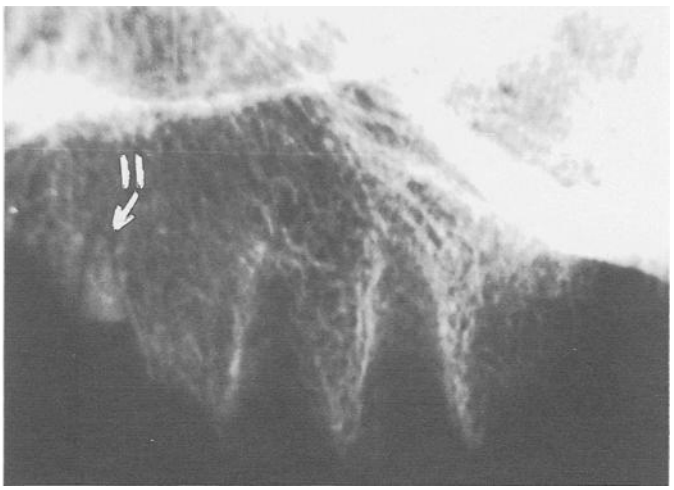

FIG. 4—*1991 postmortem radiographs. Note tooth fragment #11.*

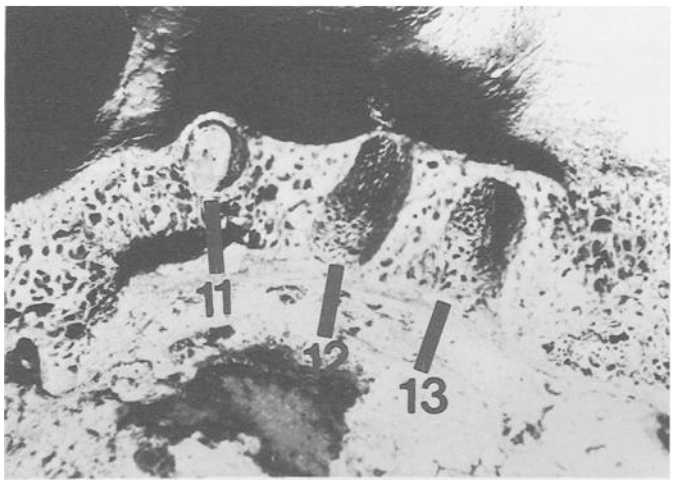

FIG. 3—*Alveolar sockets with #11 tooth fragment.*

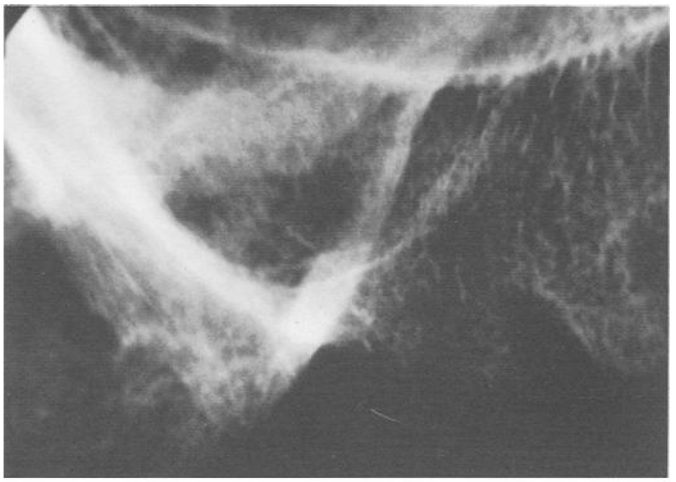

FIG. 5—*1991 postmortem radiographs.*

Postmortem radiographs of the skull had been taken in 1991. They revealed no distinguishing dental features at that time (Figs. 4 and 5—1991 postmortem radiographs. Note tooth fragment #11.). It was deemed that there was insufficient dental information to aid in the identification of the decedent. In 1994 we decided to try the technique described by Dr. Smith. The skull was gently cleaned of debris with water and a soft toothbrush. The remaining socket areas were sealed with up to five layers of Duro Super Glue® (Loctite Corp.). The cyanoacrylate was applied with a fine paintbrush and allowed to thoroughly dry between coats. Multiple coats were needed in most areas because the lamina dura and cortical bone of the maxillae were missing. The remaining bone was extremely porous. Three of the four socket walls were present in the areas that were to be reconstructed. The facial aspect of the dental sockets was missing. A method was developed to replace this structure, without changing the root morphology. After experimenting with several dental waxes, we reproduced the facial wall with a radiolucent dental material called Adaptol® (Jelenko Dental Health Products). This material is softened in hot water and molded into the desired shape. The purpose of replacing the facial alveolar wall was to hold injectable impression material within the confines of the alveolar dental socket. Injectable impression material is commonly used for making crown and bridge impressions of teeth (a Type II, silicone based dental material: Cuttersil Light® (Miles, Inc). This impression material, combined with 98% barium sulfate powder (proprietary), was mixed per manufacturer's instructions. The amount of powder used was one teaspoon to three inches of impression material. The impression material was injected into the socket areas with a CR® dental syringe (Fig. 6-skull: after addition of impression material). Radiographs of the maxillary alveolar areas were taken after the impression material set. Special care was taken in the angulation of the film so that the radiographs were oriented to maximize the mesial-distal width of the socket. This avoided introducing any error from the placement of the reconstructed facial aspect of the sockets. The radiographs were taken, using both large and small periapical dental films, with a General Electric dental X-ray unit at 15 mA, 70 kvp for 1/5 s.

Results

The resulting radiographs show dental detail not previously seen in the original periapical radiographs. The fused roots of teeth #2 and #15 are now seen. In addition, the morphology of the apices

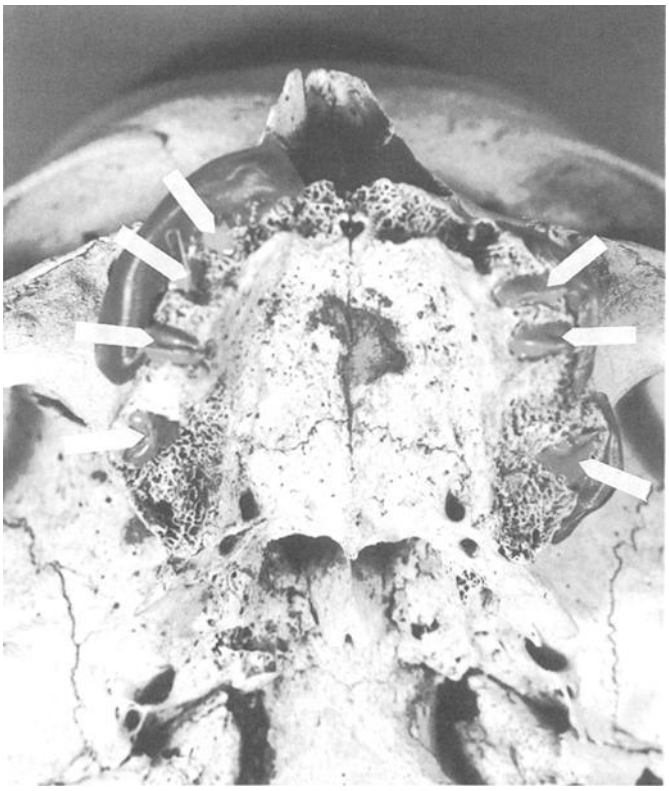

FIG. 6—*Skull after addition of impression material.*

of teeth #12 and #13 is clearly shown (Figs. 7, 8, 9—1994, following the application of the radiopaque dental material).

Discussion

From Dr. Smith's article, we know that this technique works under laboratory conditions. In this real case study, modifications had to be made because of the condition of the skeletal remains. Despite Dr. Smith's admonition against using more than one coat

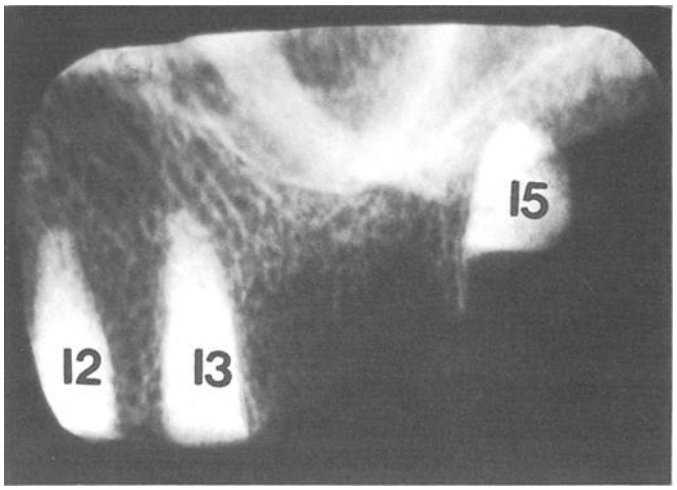

FIG. 7—*1994 postmortem radiographs, following the application of the radiopaque dental material.*

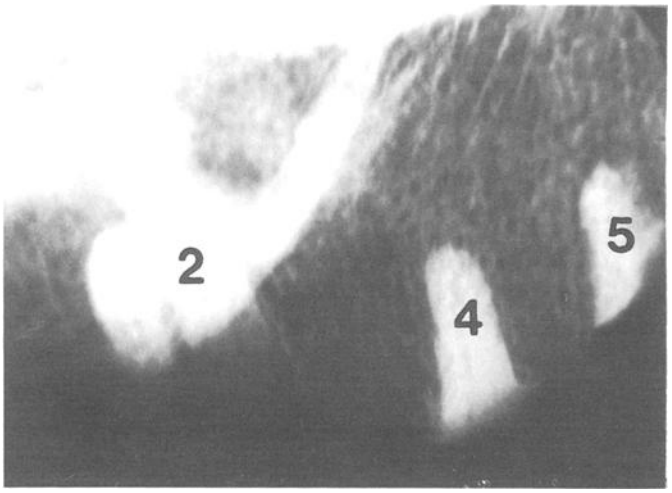

FIG. 8—*1994 postmortem radiographs, following the application of the radiopaque dental material.*

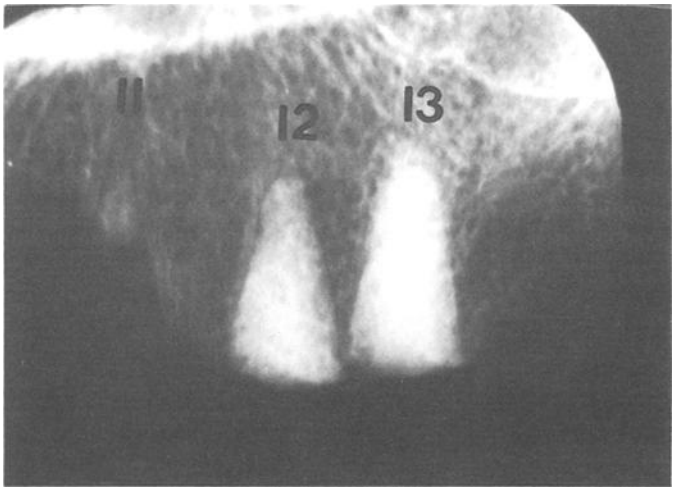

FIG. 9—*1994 postmortem radiographs, following the application of the radiopaque dental material.*

of sealant, we felt it was necessary to use up to five layers of cyanoacrylate in the root sockets because of the severe destruction and lack of cortical bone in these areas. In order to contain the flow of the dental impression material, it was also necessary to develop a method to replace the missing facial bone without causing dimensional distortion of the existing root morphology. We experimented with several materials and opted for a thermoplastic dental compound that is easily molded, adheres to bone, is easily removed, and is radiolucent. With these minor modifications, we were able to obtain postmortem radiographs that include additional anatomical root information, and at least one area of distinctive maxillary root morphology. This morphology is seen in Figs. 8 and 9 where tooth #12 now has a tapered root tip. Tooth #13's root now shows a tapered root tip, a mesial apical curve and a mesial "bulge" in the apical third. These postmortem radiographs are currently being compared to antemortem radiographs made available to us by the California State Department of Justice.

Conclusion

We had to develop necessary modifications to Dr. Smith's protocol because of the bone destruction in this particular case. This did not exist in his laboratory study. Our assessment affirms the method described by Dr. Smith. It is useful and has a place in the armamentarium of techniques used by forensic odontologists. Our additions to his technique may provide additional postmortem dental information in cases where the human skeletal remains are severely traumatized; either by intent, or by the environment.

Reference

(1) Smith BC. Reconstruction of root morphology in skeletonized remains with postmortem dental loss. J Forensic Sci, 1992;37(1): 176–84.

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