



A counterpoint response to the American Board of Forensic Odontology's Position Paper

Support for the Use of Thermoplastic Bite Impressions to Aid in the Identification of Missing and Unknown Children

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This paper presents a response to the editorial opinion expressed in the position paper "Promotion of the Use of a Thermoplastic Material to Aid in the Identification of Unidentified Human Remains," published on page 14 of this issue of the JOURNAL OF THE MASSACHUSETTS DENTAL SOCIETY. No references were cited in that paper. Because the mission of the American Board of Forensic Odontology (ABFO) is to "promote and enhance the science of forensic odontology" and realizing that the ABFO Guidelines on bite mark evidence has failed law enforcement in several high-profile cases in the past,¹ it is necessary to publish a referenced response addressing some of the statements that were made in the ABFO article.

The ABFO board, in its unreferenced opinion, has ignored the evidence and scientific basis needed to appreciate and understand the important role that thermoplastic bite impressions can play in helping to address the cause of missing and exploited children, victims of crimes or accidents, or those affected by natural or terrorist-related disasters.

Hundreds of thousands of thermoplastic bite impressions (Toothprints®) have been taken by thousands of dentists and trained dental personnel over the past few years, and these have been used and supported by large numbers of professional and philanthropic organizations, including law enforcement. Some ABFO board members may not even have had the experience of fully participating in office or community programs, and others may never have taken or analyzed any bite impressions themselves. The efforts of the numerous other forensic dentists and those individuals on emergency response teams around the country who endeavor to develop identification systems that improve the content and context of dental records should be applauded.

To that end, three statements that form the basis for the ABFO position on the use of thermoplastic bite impressions are reviewed here, and a discussion on current technology available to dental forensics is presented.

Misstatement No. 1

"Until a method of digitally mapping the impressions of teeth for comparison is attained, the utilization of thermoplastic impressions of teeth for identification should be considered limited."—ABFO 2004

Computer-guided profilometry and three-dimensional digitization have been reported since the early 1990s.² By the year 2000, projects such as Arizona State University's PRISM:3D Knowledge had developed next-generation techniques for 3D modeling, visualization, and quantification. Dr. Anshuman Razdan, director of PRISM, wrote: "... we can measure width, height, depth, surface area and volume of teeth ... the beauty of 3D data is that these are easily and accurately computed." More recently, HYTEC Inc. has perfected the use of Flash CT scans, a 3D scanning system with specific and proven applications in the dental field.³ This system will generate high-resolution polygonal mesh data and might even suggest that digitized images of only one or two teeth could set a new standard in future identification protocols. This finding would be particularly important in forensic odontology because, to date, there is no consensus for defining a minimum number of concordant points necessary before a positive identification can be made on dental evidence.⁴ Scans of thermoplastic bite impressions have been done generating 25–50 microns definition of tooth and arch imprints.

In 1985, Buchner stated that recovery of only a single tooth or jaw fragment may be enough to confirm a positive identification.⁵ Clearly, a digital image of a tooth taken in this thermoplastic impression material, with resolution to 25–50 microns, showing the characteristic cusps, grooves, and ridges, would certainly enhance the opportunity to confirm an individual's identity. If the teeth also had a sealant or restoration placed, the margins would present further differentiation from one individual to another.

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Other digital mapping techniques have also been described. In 1998, Lindqvist et al. reported a 3D photographic technique developed for the use of bite registration. The authors showed that they were able to reconstruct 3D coordinates from digitized 2D photographic data and that this technique would fulfill demands for scientific applications on clinical material.⁶ Although not as accurate as direct digitalization of the Flash CT (and also requiring a greater number of steps), thermoplastic bite impressions could be digitally mapped by this second technique. And further, in 2003, Bell confirmed that dental study models generated from impressions could be digitized using recent advances in stereophotogrammetry for 3D imagery.⁷ Thermoplastic bite impressions, like the earlier wax-bite impressions, would allow the fabrication of study models, which can be captured in 3D by using photostereometric techniques and digital formatting.

Recognizing that the digital mapping of teeth has been available for some time and that thermoplastic bite impressions have been photographed, scanned, and quantified to an amazing degree of accuracy, makes the thermoplastic bite impression technique a promising adjunct for use in forensic dentistry. Failure of the ABFO to keep up-to-date on current technology which has applications in forensics should not generate unreferenced opinion published as a position paper.

Misstatement No. 2

“... would need to be certain that the bite impression was . . . taken within a reasonable time preceding its use.”—ABFO 2004

Orthodontic study models, when available, almost routinely serve and are used by forensic dentists as an adjunct in identity cases. Many cases of adult identity have been aided by the availability of orthodontic study models made from impressions taken when the unknown victim was a child. These identifications

have been made by comparisons of the tooth characteristics, not precluded by the movement of the teeth.

Many dentists, most certainly pediatric dentists and orthodontists trained in growth and development, are aware of the plethora of scientific literature available exploring changes in dental arch characteristics. Composite mean patterns of dental arch changes in the dentition of the growing child have been presented since the late 1950s.⁸ Many orthodontic growth parameters have been identified, with some more predictable than others, but computerization of these data sets for use in forensics as biometric comparative analyses is clearly within the realm of today's technology.

Misstatement No. 3

“There are current systems in place (e.g., dental radiography) that provide information on the human dentition . . . in a more accurate and expedient manner.”—ABFO 2004

On this point, the reference to and the suggestions of the use of dental radiographs as “more accurate and expedient” may be true in many cases, but as stated in ABFO Body Identification Guidelines: “most dental identifications are based on restorations, caries, missing teeth, and/or prosthetic devices which may be readily documented in the record.”⁹ Any radiographic-based identification system has some obvious and significant limitations: number and quality of radiographic images, angulation and distortion of images, variations in images generated at different times, film orientation and placement, and bite opening caused by radiographic positioning devices. The limitations would be even further evident in cases where no restorations were present at all, and of further lessened value in cases of non-carious dentitions. In fact, 80 percent of permanent teeth affected by dental caries are found in only 25 percent of children.¹⁰

These limitations become even more significant in cases where composite restorations reduce the usefulness of radiographs. In 1999, Chesne et al.¹¹ showed that 40 percent of tooth-colored dental materials tested could not be detected radiographically with a sensitivity that would be demanded for identification purposes. As composite restorations continue to replace silver amalgam, this dilemma would be expected to become even more problematic over time. To quote ABFO board member Dr. John Kenney: “We can't see the margins [of the fillings] as easily with new types of materials, as with old metal fillings . . . dentistry is getting too cosmetic; it's too good.”¹²

Saliva, DNA, and Scent

Although not addressed in the position paper and dismissed as not being in the scope of the ABFO, there are many other dentists and individuals from the dental community who are involved in DNA analysis and salivary scent/chemistry issues, and who are knowledgeable about these forensic applications. Research has shown that saliva captured on a thermoplastic bite impression and stored at room temperature has produced a nuclear DNA genetic profile almost three years after the bite impression was taken.¹³ As technology for DNA retrieval and testing is rapidly improving, sensitivity of this testing in the future will allow for accurate analysis from even minimal or degraded samples.

One comment on scent dog tracking: Ongoing research by a leading authority using German shepherds and bloodhounds found that the dogs had no difficulties or problems readily tracking off thermoplastic bite impressions eight months after the bite impression was taken on a five-year-old boy.¹⁴ It is expected that Toothprints will be shown to provide a scent source for tracking children for the period of time between recommended periodic retakes of bite impressions.



Without access to these community identification programs, many children, particularly those in poor inner-city or rural areas, might have no other recent dental record except their thermoplastic bite impression.

Community Child Identification Programs

Another point to address is the statement the ABFO made to “*encourage the use of other more conventional forms of dental information record keeping.*”—ABFO 2004

The bite impression concept was introduced in Massachusetts at Tufts University in 1985 and was mentored by Dr. Stanley Schwartz, former Massachusetts state forensic dentist and past president of the ABFO.¹⁵

Since the 1980s, there has been no consensus in dentistry in terms of which one technique would “fit” all situations. The reason for this dilemma is that it is recognized that in any given situation, the useful biometric identifier may be different. While fingerprints and photographs had historically been recommended by the National Center for Missing and Exploited Children, dental organizations have advocated for inclusion of a dental component. The American Academy of Pediatric Dentistry and the American Dental Association have passed resolutions encouraging a dental component to all child identification programs. Limitations of dental chartings are not only obvious but also well known to forensic dentists, who have actually confronted all the shortcomings that the obtainment and review of nonstandard, antemortem records present. The ABFO did not define what other conventional form of dental information it would recommend for community child identification programs. The possibilities, however, are limited: Dental chartings? Radiographs? Oriented intraoral photographs? Bonded microdisks? Alginate impressions? The 80-member ABFO must agree that none of these methods are very practical for use in a community program setting.

In a subsequent publication, an officer of the ABFO “welcomed . . . development of a national database of [dental] bite wafer registrations.”¹⁶ It’s hard to

imagine another local or national organization that would agree with such a concept. All information provided through child identification programs should be kept only by the parents. This has been and continues to be the recommendation of the Massachusetts Dental Society.¹⁷

In Massachusetts alone, more than 200,000 children have been “toothprinted” through the MasoniCHIP program, which is supported by the current state forensic dentist, Massachusetts Dental Society, Massachusetts Crime Prevention Officers Association, and Massachusetts Dental Assistants Association.

Other philanthropic organizations, 15 state dental societies, civic organizations, and other state and national organizations—such as the National Center for Missing and Exploited Children and the American Institute on Domestic Violence—support, sponsor, or run community-based child identification programs that include the use of thermoplastic bite impressions. These programs provide comprehensive identification biometrics that will be readily available to law enforcement and child-find organizations. This is important because, nationwide, many children may not have access to dental care, may not have routine or periodic dental visits, and may not have recent radiographs or restorations on which most identifications are based. Without access to these community identification programs, many children, particularly those in poor inner-city or rural areas, might have no other recent dental record except their thermoplastic bite impression.

Differences Between Bite Marks and Bite Impressions

In comparing thermoplastic bite impressions with bite marks—the markings of anterior teeth in skin and foodstuffs—a thermoplastic bite impression records up to 3 mm of tooth characteristics in a thermoplastic material, which has been shown

to be more accurate than alginate.¹⁸ Thermoplastic bite impressions will capture the size and shape of the teeth, the relationship of the teeth within the arch, the position of the maxillary and mandibular arches to each other, and even restoration and sealant margins. Although bite mark evidence accuracy reported by the ABFO showed that accuracy scores were significantly correlated with bite mark certainty and forensic value ($p < 0.001$ in both cases)¹⁹, a number of high-profile cases of doubtful misconceptions showed that bite mark testimony by ABFO members was “faulty science.” As mentioned previously, thermoplastic bite impressions have enjoyed broad support—but support of bite mark evidence testimony has come mostly from inside the ABFO. Criticism of bite mark analysis even within the ABFO has called for evaluation of the “basic weakness and failings of this field’s underpinnings.”²⁰ A prominent professor of law stated that “bite marks probably ought to be the poster child for bad forensic science.”²¹

The thermoplastic bite impression technique falls within the realm of “physical comparison methodology,” as does bite mark analysis. Thermoplastic bite impressions are an accurate recording of the entire dentition in a dimensionally stable impression material; bite marks are not. As stated earlier, thermoplastic bite impressions have enjoyed broad support, both within and outside of dentistry. Bite mark analysis, on the other hand, has been called to task, having failed the victims, those wrongly convicted, and society as a whole by putting innocent people behind bars. It is counterintuitive for the ABFO to criticize thermoplastic bite impressions while supporting bite mark analysis. The art and science of forensic odontology as it applies to any dental records used for comparisons, whether it be bite marks or bite impressions, will ultimately be based on *both* science and common sense.

Conclusion

To discourage the use of thermoplastic bite impressions, which additionally define dental characteristics of tooth size and shape, tooth anatomy, restoration and sealant margins, position of teeth within the arch, and relationship of the dental arches, would be an unconscionable mistake if only for the one child or family that would benefit. For the ABFO to ignore or fail to recognize the important role that salivary DNA or salivary scent on the wafer for dog tracking might play in any given case only serves to minimize the efforts of the many organizations, dentists, and dental personnel who do see the value of comprehensive identification programs. Digitization of the bite impression enhances several new and exciting applications.

The ABFO conclusion that thermoplastic bite impressions "should not be completely discouraged" instead might better serve dentistry's efforts and children nationwide by reading that "thermoplastic bite impressions should be encouraged, because even with some limitations, the technique may help a family to find or identify their child." ■

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