

## **Overview of the Use of Toothprints Thermoplastic bite impressions to Aid in Dental Identification...(and other clinical applications).**

**David A. Tesini, DMD, MS ; Associate Clinical Professor, Tufts University School of Dental Medicine, Private Pediatric Dentistry/Orthodontic Practice, Natick, MA  
April, 2005**

Thermoplastic bite impressions can play a defining role in helping to aid in the cause of missing and exploited children, victims of crimes or accidents, or those affected by natural or terrorist related disasters. It can help track children missing from a family gathering or lost on a hiking trip. It can provide a salivary DNA sample, and may in the future be routinely used in all private practices to evaluate progression of toothwear.

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 they have been used and supported by large numbers of professional and philanthropic organizations including law enforcement. I applaud the efforts of the numerous forensic dentists and individuals on emergency response teams around the country, whose efforts are directed to development of identification systems that will improve the content and context of dental records.

Specifically, several concepts on bite impressions are reviewed and a discussion on current technology available to dental forensics is presented.

### **Concept 1: Digital Technology Aids Forensics**

Computer guided profilometry and three dimensional digitization has been reported since the early 1990's.<sup>i</sup> 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.<sup>ii</sup> This system will generate high resolution polygonal mesh data and might even suggest that digitized images of only one or two teeth might set a new standard in future identification protocols. This 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.<sup>iii</sup> Scans of thermoplastic bite impressions have been done generating 25-50 microns definition of tooth and arch imprints.

Buchner, 1985<sup>iv</sup>, stated that recovery of only a single tooth or jaw fragment may be enough to confirm a positive identification. 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 further had a sealant or restoration placed, the margins would present further individuality from one person to another.

Other digital mapping techniques have also been described. In 1998 Lindquist, et al reported a 3D photographic technique developed for the use of bite registration. They

showed 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.<sup>v</sup> 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, Bell 2003 confirmed that dental study models generated from impressions could be digitized using recent advances in stereo photogrammetry for 3D imagery.<sup>vi</sup> Thermoplastic bite impressions, like the earlier wax bite impressions, would allow the fabrication of study models, which could be captured in three dimensions using photostereometric technique and digital formatting.

#### . Concept 2: Predictability in Changing Dentitions

Orthodontic study models, when available, almost routinely serve and are used as an adjunct in identity cases. Many cases of adult identity have certainly 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 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 1950's.<sup>vii</sup> 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 for identification purposes is clearly within the realm of today's technology.

#### Concept 3: Adjunct to Clinical Record

As stated in ABFO ( American Board of Forensic Odontology) 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."<sup>viii</sup> 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.<sup>ix</sup>

These limitations become even more significant in cases where composite restorations reduce the usefulness of radiographs. In 1999, Chesne, et al<sup>x</sup> showed that 40% of tooth colored dental materials tested could not be detected radiographically with a sensitivity that would be demanded for identification purposes. As composite restorations are replacing silver amalgam this dilemma would be expected to become even more problematic over time. To quote one ABFO board member..."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."<sup>xi</sup>

Recognizing that the (1) digital mapping of teeth has been available for some time and (2) 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.

#### Concept 4: Saliva, DNA and Scent

Many other dentists and individuals from the “dental community” that are involved in DNA analysis and salivary scent/chemistry issues, and are knowledgeable of these forensic applications are excited about the extended use of bite impressions in this field. 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.<sup>xii</sup> 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 Shepards 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.<sup>xiii</sup> 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.

#### Concept 5: Community Child Identification Programs

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.<sup>xiv</sup>

Since the 1980’s 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. 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 well known to forensic dentists who have actually confronted all the shortcomings that the obtainment and review of non standard antemortem records present.

We would also need to consider what other conventional form of dental information could be recommended for community child identification programs. The possibilities, , are limited... Dental Chartings? Radiographs? Intraoral photographs? Bonded

microdisks? Alginate impressions?..... none of these methods are very practical for use in a community program setting.

Although an officer of the ABFO ( American Board of Forensic Odontology 'welcomed ...development of a national database of (dental) bite wafer registrations'<sup>xv</sup> , there is rightly, no other local or national organization that would agree with such a controversial concept. All information provided through child identification programs should only be kept by the parents. This has been, and continues to be the recommendation of the Massachusetts Dental Society and is strongly supported by the founder and national spokesperson for the comprehensive MasoniCHIP program nationwide.<sup>xvi</sup>

In Massachusetts alone over 200,000 children have been "toothprinted" through the Masonic CHIP program. It is supported locally by the current Massachusetts State Forensic Dentist, the Massachusetts Dental Society, the Massachusetts Crime Prevention Officers Association and the 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 which include thermoplastic bite impressions. These programs provide comprehensive identification biometrics that will be readily available to law enforcement and child find organizations should the need arise. This is important because many children nationally may not have access to dental care, they may not have routine or periodic dental visits, and they may not have any 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.

#### Concept 6: Differences Between Bite Marks and Bite Impressions

In comparison of thermoplastic bite impressions with bite marks (the markings of anterior teeth in skin and foodstuffs) a thermoplastic bite impression records up to 3 millimeters of tooth characteristics in a thermoplastic material, which has been shown to be more accurate than alginate.<sup>xvii</sup> It 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 showed that accuracy scores were significantly correlated with bite mark certainty and forensic value ( $p < 0.001$  in both cases),<sup>xviii</sup> a number of high profile cases of doubtful and wrongful convictions based on bite mark testimony resulted in the label as 'a faulty science'. As mentioned previously, thermoplastic bite impressions have enjoyed broad support. Criticism of bite mark analysis within the ABFO has called for evaluation of the "basic weakness and failings of this field's underpinnings." Hopefully, if technology in the field of bite mark analysis progresses, applications can be made to the more detailed thermoplastic bite impression technique.

The thermoplastic bite impression technique falls within the realm of 'physical comparison methodology' (as does bite mark analysis), and when properly taken, these impressions are an accurate recording of the entire dentition in a dimensionally stable impression material. 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

Thermoplastic bite impressions 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 (restoration margins/sealants etc) Digitization of the bite impression enhances several new and exciting applications in the evaluation of toothwear and digital record keeping. Thermoplastic bite impressions should be encouraged by all practitioners because, if even only for one family, the technique may help to find or identify their child.

### References Cited:

- 
- <sup>i</sup> Soma K, Kuroki T, Nakamura T, et al. Three dimensional digitization: method for evaluating morphological differences between teeth. Bull Tokyo Med Dent. 38(1):1-8, 1991
- <sup>ii</sup> Tesini D, Thompson T. Applications of Digital Images Derived from Toothprints Thermoplastic Bite Impression Wafers. J Mass Dental Society 53(4):46-8, 2005
- <sup>iii</sup> Acharya AB, Taylor JA. Are a minimum number of concordant matches need to establish identity in forensic odontology? J Forensic Odontostomatol 21(1):6-13, 2003
- <sup>iv</sup> Buchner A. The identification of human remains. Int. Dent J 35:307-11, 1985
- <sup>v</sup> Lindqvist B, Welander U, Mahler R. A three dimensional photographic method for documentation and measurement of dental conditions. J Orofac Ortho 59(2):90-9, 1998
- <sup>vi</sup> Bell A, Ayoub AF, Siebert P. Assessment of the accuracy of a three-dimensional imaging system for archiving dental study models. J. Orthodontics 30(3):219-23, 2003
- <sup>vii</sup> Moorees CFA, Dentition of the Growing Child: A Longitudinal Study of Dental Development Between 3 and 18 years of age. Cambridge Harvard University Press, 1959
- <sup>viii</sup> [www.abfo.org/ID](http://www.abfo.org/ID). ABFO Body Identification Guidelines, accessed Sept. 20, 2004
- <sup>ix</sup> Vargas CM, Crall JJ, et al, Sociodemographic Distribution of Pediatric Dental Caries: NHANES III, 1988-1994 JADA 129(Sept)1229-1238 (1998)
- <sup>x</sup> Chesne AD, Benthous S, Brinkmann B. Forensic identification value of radiographic images in determining tooth colored dental filling materials. Archiv fur Kriminologie 203(3-4):86-90, 1999
- <sup>xii</sup> Looking for clues in his work as a forensic dentist, John Kenney seeks to give victims back their identity' (NW Edition) Chicago Tribune, Chicago, IL. January 3, 1999 pg 1.  
<http://pqasb.pqarchiver.com/chicagotribune/doc37746757>
- <sup>xiii</sup> Genetic Technologies, Inc., Glencoe, MO 63038  
<http://www.caninesforkids.net/scent-research.html>
- <sup>xiv</sup> Tesini DA, O'Malley KD, Schwartz S. Development of Bite Impression Technique for Use in Identification of Unknown and Missing Children. J Mass Dent Society 34(2) 1985
- <sup>xv</sup> Illinois Dental News, Posted January 18, 2005. John P. Kenney, DMD, MS. [www.ISDS.org](http://www.ISDS.org).
- <sup>xvi</sup> Personal communication with Dr. David Harte, founder and national spokesperson for MasoniCHIP program.
- <sup>xvii</sup> Xie D. Evaluation of Toothprints®: Non-published test report. Kerr Dental 6/11/2004
- <sup>xviii</sup> Results of the 4<sup>th</sup> ABFO Bite mark Workshop-1999. Forensic Science International 124(2-3):104-111, 2001.