SUPREME COURT OF THE STATE OF NEW YORK
COUNTY OF NEW YORK: PART 42

THE PEOPLE OF THE STATE OF NEW YORK -against- CLARENCE DEAN, Defendant.	REPLY TO POST-FRYE HEARING BRIEF REGARDING FORENSIC ODONTOLOGY Ind. No. 4555/2007

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Preliminary Statement

Clarence Dean was indicted and charged with Murder in the Second Degree in 2007. In October 2008 the prosecution disclosed a report prepared by Dr. Lawrence Dobrin indicating a link between Clarence Dean and a bitemark found on the breast of the murder victim.

This brief is submitted in reply to the Frye motion and brief submitted by counsel for Clarence Dean and to the filed by the Innocence Project as amicus in this case. This reply is based upon the testimony and evidence adduced at the Frye hearing conducted in this matter as well as upon attendance at meetings of the Forensic Odontology section and other sections of the American Academy of Forensic Science, journal articles, transcripts of other proceedings, and conversations with Dr. Thomas J. David, Dr. Robert Shapiro, and Brad Gessner, prosecutor in Summit County, Ohio.

Introduction

This Frye hearing is an attempt by the defense to upend over thirty years of judicial acceptance of bitemark testimony in New York and to urge the Court to ban forensic odontology testimony, a step not taken in any jurisdiction in the United States. The defense claims that approximately a dozen exoneration cases in which bitemark comparisons provided some of the evidence against the accused, coupled with recommendations in the 2009 National Academy of Science report "Strengthening Forensic Science in the United States: A Path Forward (NAS Report) means that evidence from bitemark analyses and comparisons are no longer accepted as reliable and must be precluded from courtrooms. The defense is wrong.

Forensic Odontology: Practitioners and Procedures

Any discussion of bitemark evidence must start with a clear understanding of the protocols and procedures involved in forensic odontology and the experience and skills necessary to collect bitemark evidence, analyze bitemarks and compare those marks to suspected biters. It is also important to understand the central role played by forensic odontology's accrediting body, the American Board of Forensic Odontology (ABFO) in setting and maintaining standards for the conscientious practice of forensic odontology.

Forensic dentists undergo standard medical dental training during which they take the same courses as medical students in pharmacology, physiology, histology and anatomy of the oral and facial structures. Then, forensic dentists undergo additional training, and candidates for certification by the American Board of Forensic Odontology (ABFO) have a daunting list of requirements to meet before they are eligible for Diplomate status. Candidates must take a recognized forensic odontology course of study, attend a minimum of five autopsies, perform a minimum of 35 forensic dental cases, including a minimum of seven bitemark cases, five age estimations and at least 20

victim identifications (10 in which they must personally take the postmortem radiographs and five in which they must personally perform resection or surgical exposure), testify or give depositions at least twice, pass an examination, and fulfill a number of other forensic odontological tasks including research, publication and affiliation with a medico-legal organization such as a medical examiner or coroner's office. Diplomates face recertification every five years.

Dr. David Senn, who testified on behalf of the prosecution, has been a dentist for over 40 years. He was a dental officer in the Army, had a general dentistry practice for 20 years, and has served on the forensic odontology staff of the Bexar County Medical Examiner's Office in San Antonio, Texas for 20 years, nine of them as Chief. He is also a Clinical Assistant Professor at the University of Texas Health Science Center, where he heads the two-year post-doctoral program in forensic odontology. This program, the only one of its kind in the United States, attracts dentists from around the world. He is board certified by, and past-president of, the American Board of Forensic Odontology. (As described below, the ABFO serves to establish standards for and to certify qualified specialists in forensic odontology.) Dr. Senn is co-chair of the forensic odontology subcommittee of the FBI's Scientific Working Group for Disaster Victim Identification (SWGDVI). He is Secretary of the Forensic Specialties Accreditation Board (FSAB). As a member of the federal Disaster Mortuary Operational Response Team (DMORT), Dr. Senn spent 52 days working with the Office of the Chief Medical Examiner in the wake of the September 11th attacks helping to identify the dead. He also responded as a DMORT team member to recover remains of astronauts after the Shuttle Columbia crash and after hurricanes Katrina and Rita. All told, he has participated in the identifications of over 500 people.

As a forensic odontologist, Dr. Senn responds to hospitals and morgues to conduct analyses of patterned injuries suspected to be bitemarks in child abuse, elder abuse and intimate partner

abuse cases, murders, sexual assaults, and barroom brawls. He performs age estimations for immigration and other authorities. He also consults in civil cases involving personal injury, standard of care and state board actions against other dentists. He has examined in excess of 300 patterned injuries suspected to be bitemarks.

He has testified many times as an expert in forensic odontology for both the prosecution and the defense; notably, he was retained (or worked pro bono) for the Innocence Project in three separate cases.

Dr Senn was the co-editor of the two most recent forensic odontology textbooks, the Manual of Forensic Odontology, 5th Edition and Forensic Dentistry, 2nd Edition. He contributed chapters to other forensic dentistry textbooks, including Dental Clinics of North America, Bite Mark Evidence, 2nd Edition, the Manual of Forensic Odontology, fourth and fifth editions and Forensic Dentistry, 2nd Edition. He has also written many articles for peer-reviewed journals, including the Journal of Forensic Sciences and the Journal of Pediatric Dentistry, and he testified before the National Academy of Sciences during their review of forensic science.

Victim Identifications

Making victim identifications from features of the teeth and jaws requires the same tools and skills related to bitemark analysis and comparison. When there are 32 teeth and the mouth is intact, forensic dentists find it a relatively simple matter to identify individuals through dental records. However, forensic dentists often work successfully with much less information. Working with extremely compromised samples from disaster victims, Dr. Senn has made identifications from very small bone or tooth fragments. He demonstrated making a positive identification from x- rays that showed parts of only three teeth, and explained how one individual was identified multiple times using 17 different jaw and tooth fragments, all belonging to one victim at the World Trade Center.

Bitemark Analysis and Comparison

Dr. Senn describes bite marks as "patterned injuries." Dr. Senn explained the procedures involved in bitemark analysis and comparison, from evidence collection through analysis and comparison to drawing conclusions and writing a report. His testimony was accompanied by over 100 color slides, which powerfully illustrated his points using photographs of actual cases.

Typically, police, emergency room physicians or medical examiners call a forensic dentist to examine a suspected bitemark. (In fact, while he was on the witness stand testifying in this case, Dr. Senn received a cellphone photo of a suspected bite from a doctor in a Texas pediatric emergency room, requesting advice.) The forensic dentist's first step is to ascertain that someone has swabbed the injury for salivary residue in the hope of recovering the biter's DNA. If forensic dentists swab the area themselves, they use a two-swab method. They wet the first swab with sterile saline and scrub it over the injury. This maximizes sample recovery by leaving moisture that forensic dentists then collect with a second dry swab. Following swabbing, the forensic dentist or a forensic photographer will take progressively closer orientation photos to document the injured area of the victim's body, whether on a hospital bed or a gurney in a morgue.

After that, the forensic dentist will take additional photographs to document and detail the features of the patterned injury. Some photos should include a measuring device called the ABFO #2 scale, to insure that comparisons can be made between images that are the same size and can then be reliably compared.

Forensic dentists may use special photographic techniques, including fluorescent photography, color and gray scale photography, ultraviolet photography (for surface detail, especially of abrasions), and infrared photography, which allows light to penetrate beneath the skin's surface to

examine subcutaneous details. All of these techniques are part of the documentation and preservation of the injury as evidence in a given case.

Forensic dentists may take impressions of three-dimensional features, including tooth impressions and drag marks on the skin, to capture those features as well as the curvature of the skin. They take these impressions using the same vinylpolysiloxane (VPS) material dentists regularly use to make bridges and crowns.

Finally, in cases where the victim is dead, forensic dentists may remove and retain the bitten tissue. To do this, they place a custom-made ring around the bitemark, glue and then suture it to the skin to preserve its orientation and anatomical shape and then surgically remove the entire area from the body. By harvesting the tissue, forensic dentists can examine damage done beneath the skin's surface. Once skin is harvested, forensic dentists can perform a process called transillumination. They place light behind the harvested tissue to expose injury patterns not visible from the surface. Even in cases where the tissue is not removed, forensic dentists can expose and see damage by making an incision through the injury.

Is it a Bitemark?

After collecting evidence, the vital first step forensic dentists take is to determine whether an injury is, in fact, a bitemark. Using class characteristics of bitemarks such as oval, elliptical or curved interrupted linear patterns including visible individual marks made by individual teeth, distinguishing characteristics may enable forensic dentists to determine what types of teeth may have made them. In addition, central contusions or ecchymosis may appear as redness or bruising in the center of the mark. An incision into that contusion may show bleeding into subcutaneous tissue and fat caused by crushing or blunt force trauma by the teeth causing capillaries to burst and leak blood into surrounding tissues.

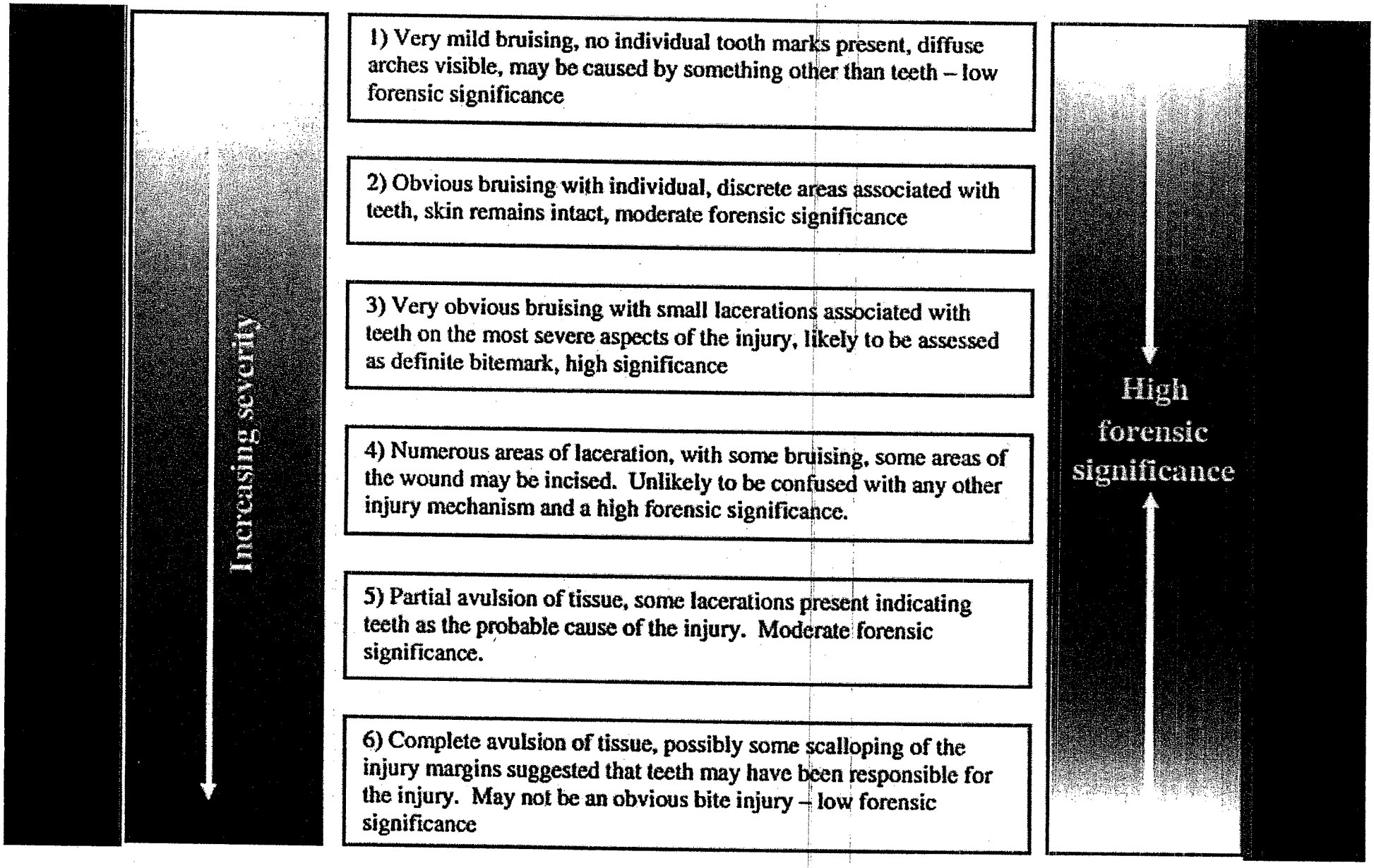
The ABFO has three categories to indicate levels of confidence about whether a patterned injury is a bitemark:

1) It is a bitemark, meaning teeth created the pattern and other possibilities were considered and excluded; 2) It is suggestive of a bitemark, meaning the pattern is suggestive of a bitemark but there is insufficient evidence to reach a definitive conclusion at this time; and 3) It is not a bitemark; teeth did not create this pattern.

Of course, if the forensic dentist lacks sufficient evidence to make a determination, he would render no judgment. Dr. Senn estimates that, of the 50 suspected bitemarks he evaluates a year, up to 85% of them are not suitable for analysis.

Severity of the Bite

It might seem that the more severe a bitemark, the more evidence it will yield, but that is not so. The least and the most severe bites may give the least information. British forensic odontologist Dr. Ian Pretty developed a severity scale, indicating that bitemarks at either end, from mild bruising on the one hand to complete avulsion or traumatic tearing away of tissue on the other, have low forensic significance. This is because either type of injury could have been caused by something other than teeth. However, those injuries in the middle of the severity scale, with very obvious markings from individual teeth including bruising and laceration, drag marks and compression artifacts are more likely to be assessed as bitemarks, and are of higher forensic significance.


Increasing severity
1) Very mild bruising, no individual tooth marks present, diffuse arches visible, may be caused by something other than teeth – low forensic significance
2) Obvious bruising with individual, discrete areas associated with teeth, skin remains intact, moderate forensic significance
3) Very obvious bruising with small lacerations associated with teeth on the most severe aspects of the injury, likely to be assessed as definite bitemark, high significance
4) Numerous areas of laceration, with some bruising, some areas of the wound may be incised. Unlikely to be confused with any other injury mechanism and a high forensic significance.
5) Partial avulsion of tissue, some lacerations present indicating teeth as the probable cause of the injury. Moderate forensic significance.
6) Complete avulsion of tissue, possibly some scalloping of the injury margins suggested that teeth may have been responsible for the injury. May not be an obvious bite injury – low forensic significance
High forensic significance

Creating a Biter Profile

A forensic dentist should be able to tell from a bitemark that has evidentiary value not only which marks were made by the upper and lower teeth, but which individual teeth made individual marks. Once he has collected photos of the bitemark, the forensic dentist may be able to create a "biter profile." The best practice is that the forensic dentist does this before he looks at any suspect's teeth, so nothing about the suspect's dentition introduces bias in the creation of the profile. Sometimes a forensic dentist will use computer programs to enhance the images and to make the comparison process simpler and more consistent between suspects. Dr. Senn described how he would use a computer drawing tool to mark each of the features in the bitemark he could see, using lines, outlines and dotted lines. He described the use of the universal numbering system to identify the specific tooth he suspected made particular marks. He may also use the features seen in the patterned injury to predict possible dental features of the person who made the mark.

Collecting Suspect Exemplars

The forensic dentist who examined and recorded the information from the patterned injury or bitemark should not collect evidence from the suspect(s); the best practice is to use another dentist for this task. That dentist should take photos of the suspect sufficient to identify him by face. Then, the forensic dentist should take intraoral photos to show details of the teeth. In order to show the relative heights and lengths of the teeth, the forensic dentist should take pictures from multiple angles including directly from the front. He should focus additional photos, including some taken using a mirror if needed, directly toward the biting surfaces of the teeth. The dentist should have the suspect bite down into some appropriate material such as dental wax that records prints of the suspect's teeth. In addition, the dentist should make impressions of the suspect's upper and

lower teeth, using appropriate dental materials, and create dental models from those impressions. If this has not already been done, the forensic dentist should also collect DNA samples from the suspect using accepted cheek swabbing techniques. Dr. Senn uses, teaches and recommends that the forensic dentist employ yet another best practice if there is only one suspected biter and ask independent associates to gather models and create a "dental line-up" ensuring that the examining forensic dentist does not know which model belongs to the suspect.

Forensic dentists should use a properly calibrated flatbed scanner along with an ABFO scale to scan the models and a properly placed ABFO#2 scale. The resulting images can be used to create exemplars, including "hollow volume overlays" which captures the outline of each of the suspected biter's teeth. Comparisons can be made using both the scanned images and the actual models.

The Comparison Process

Dr. Senn described placing the hollow volume overlays of each suspect's upper and lower dentition on the same screen with same-scaled images of the bitemarks. He compared them by moving each overlay over the bitemarks, one at a time. Both the image of the bitemark and the hollow volume overlay contain a ruler to insure they are scaled the same. If Dr. Senn saw drag marks in the bitemark, he could move the overlay along the path of the drag marks to see whether they are consistent. Dr. Senn described the features he would compare, including arch shape and width, and the size, width, alignment and rotation of specific teeth.

Conclusions

Based upon ABFO Bitemark Terminology guidelines, the forensic dentist may come to any of the following conclusions to relate a suspected biter to a bitemark: The Biter, The Probable Biter, Not Excluded as the Biter, Excluded as the Biter, or Inconclusive. The guidelines specify that these

links are stated to "reasonable medical, dental or scientific certainty". This means that the linkage term "The Biter" does not indicate absolute certainty but only reasonable certainty. The ABFO standards for bitemark terminology include the following caveat: Terms assuring unconditional identification of a perpetrator, or without doubt, are not sanctioned as a final conclusion.

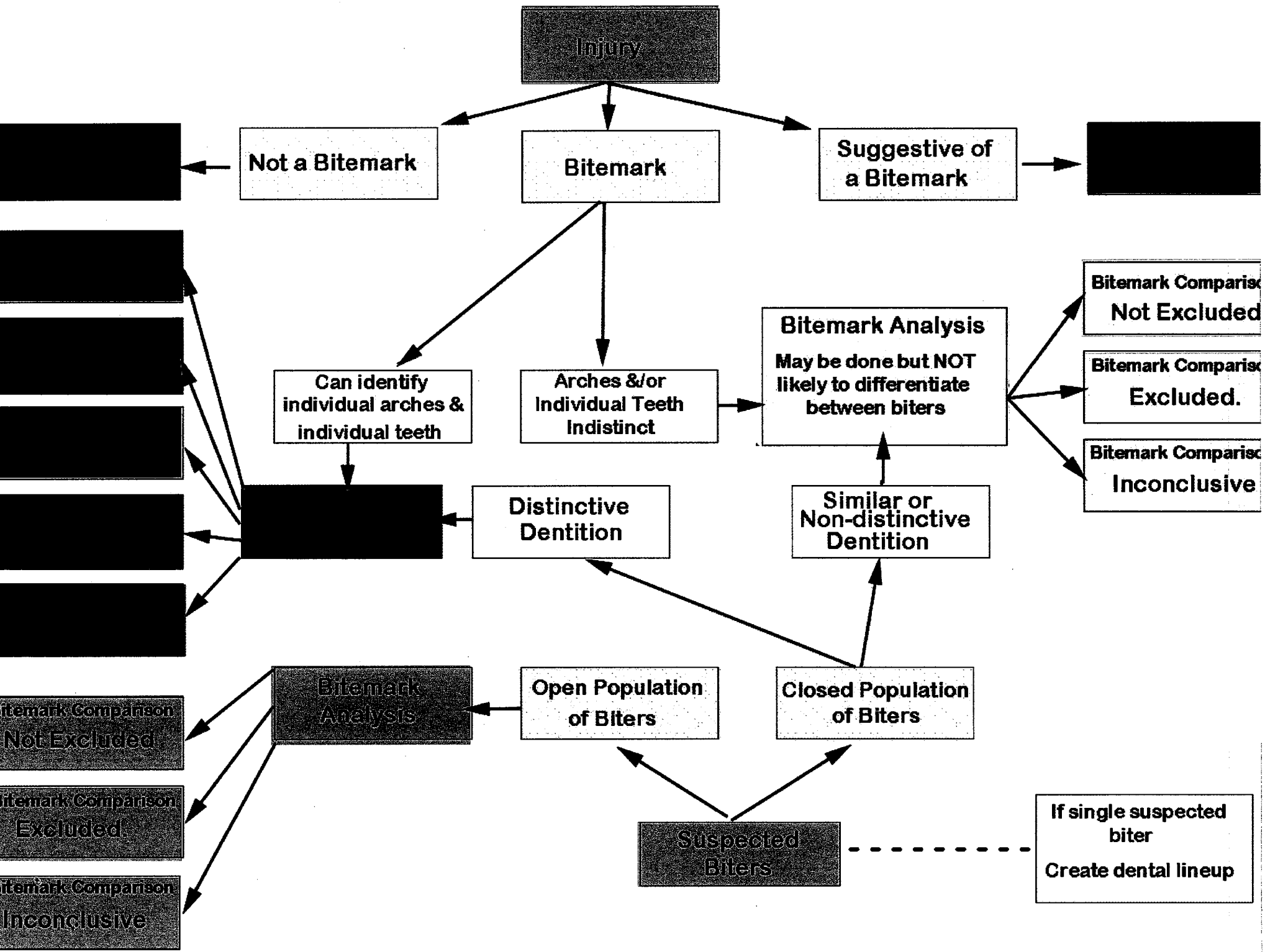
Dr. Senn also described the difference between a "closed" population with a limited number of potential suspects, and an "open" population where anyone could be a suspect. Dr. Senn said that it would be difficult to link a single person to a bitemark as "The Biter" in an open population, based on pattern (bitemark) evidence alone, absent other corroborative evidence such as DNA or a witness who observed the bite. He noted however, that a majority of his forensic odontology cases involve abused children in a closed population, where a limited number of people have access to the child. In those cases, with a high level of distinctive bitemark and a high level of distinctive dentition in a suspect, Dr. Senn said he would make any ABFO linkage conclusion supported by the evidence.

The ABFO

The American Board of Forensic Odontology (ABFO) was established under the auspices of the National Institute of Justice and the American Academy of Forensic Sciences in 1976. The mission of the ABFO is to establish, enhance, and revise as necessary standards of qualifications for those who practice forensic odontology and to certify as qualified specialists those voluntary applicants who comply with and satisfy the requirements of the Board. The ABFO is comprised of individuals who are national and internationally recognized experts, and is accredited by the Forensic Specialties Accreditation Board as a forensic specialty offering board certification to qualified dentists. The ABFO has a meeting each February in conjunction with the annual meeting of the American Academy of Forensic Sciences. At this meeting, the ABFO offers lectures and workshops

on dental identification, dental age estimation, bitemark evidence management and expert witness testimony. The ABFO's Examination and Certification Committee conducts Diplomate certification examinations for new applicants and periodic recertification examinations for current members.

The ABFO publishes a 187- page Diplomates Reference Manual that includes the ABFO Bitemark Methodology Guidelines. These guidelines detail methods to collect and preserve bitemark evidence, collect evidence from suspected biters, describe bitemarks, compare exemplars to bitemarks, and the use of specific methods and tools to enhance bitemarks for analysis. The guidelines also define terms indicating degrees of confidence that an injury is a bitemark and terms relating a suspected biter to a bitemark. The Guidelines describe the bitemark case review policy and set out bitemark report writing formats. An important Guideline revision was added in February 2013 when the ABFO voted to include a bitemark flow chart or decision tree, included below. Properly used, the decision tree will guide forensic odontologists' investigatory paths leading to proper conclusions based on the quality of the bitemark and the teeth of the suspected biters. This new guideline offers specific recommendations for forming degrees of linkage conclusions based on the quality of both injury features and suspected biter dentitions. (The report in the instant case, initially written in 2008, will be reviewed to see whether changes consistent with the new guidelines are required.)


Injury
Not a Bitemark
Bitemark
Suggestive of a Bitemark
Can identify individual arches & individual teeth
Arches &/or Individual Teeth Indistinct
Bitemark Analysis
May be done but NOT likely to differentiate between biters
Bitemark Comparisc
Not Excluded
Bitemark Comparisc
Excluded.
Bitemark Comparisc
Inconclusive
Distinctive Dentition
Similar or Non-distinctive Dentition
Bitemark Analysis
Open Population of Biters
Closed Population of Biters
itemark Comparison
Not Excluded.
itemark Comparison
Excluded.
itemark Comparison
Inconclusive
Suspected Biters
If single suspected biter
Create dental lineup

Definition of Terms

The Innocence Project attempts to define terms with the following footnote, on page 9 of their amicus brief: "Hereinafter, the terms "bite mark evidence" or "bite mark analysis" are used to describe "positive bite mark evidence" or testimony from a forensic dentist that a bite mark is either consistent with the dentition of an alleged perpetrator, or that the bite mark was in fact made by an alleged perpetrator. This should be distinguished from evidence that establishes that a given individual was *not* the person who produced the bite mark in question."

This bit of sophistry is a transparent attempt to live in the best of all possible defense worlds—one that precludes forensic odontology testimony when it inculpates but allows the defense to embrace forensic odontology when it exonerates. The definition proposed by the Innocence Project is factually incorrect, and it cannot stand.

Dr. Thomas J. David, immediate past president of the ABFO, a DMORT team member and veteran forensic dentist with 35 years' experience who consults frequently with medical examiners, prosecutors and defense attorneys, explains what is wrong with the proposed word play. He says the terms "bitemark evidence" and "bitemark analysis" are not interchangeable and should not be used to describe only so-called "positive" bitemark evidence or testimony. Bitemark evidence is properly described as tangible evidence of a patterned injury, most often in the form of photographs, but can include exemplars or impressions. Collecting bitemark evidence is the first step in a multi-step process. After obtaining evidence of a patterned injury, the forensic dentist determines whether the injury is a human bitemark. If the answer is yes, the next question is whether there is sufficient evidentiary value in the bitemark for comparison to potential biters. If there is insufficient evidentiary value, no comparison can be done. If sufficient evidentiary value exists, comparisons can be made. Thus, the entire process has three phases:1) evidence collection;

2)analysis of evidence; and 3)comparison of evidence. All forensic investigative processes must have the first two steps; a much smaller number proceed to step three. Therefore, a description of bitemark evidence or bitemark analysis as positive evidence or testimony that links a suspected biter is, in fact, wrong. Any opinion concerning linkage of a potential biter to a bitemark is a bitemark comparison, not an analysis. However, once a bitemark comparison is undertaken, then all of the possible linkage terms must be considered together. The would include not only the conclusions listed by the Innocence Project, "consistent" (not excluded) and "bitemark was in fact made by an alleged perpetrator"(biter) but also the other possible linkage opinions—excluded, inconsistent and insufficient evidence. All five of these linkage terms are part of the same process if and when a comparison is undertaken. It is impossible to separate exclusion from consideration along with the other terms; they all require the same thought process. The same analysis is done to come to an exclusion as to come to an inclusion, the same features used to exclude can be used to include, and in some circumstances excluding all but one can lead to inclusion. Dr. David's conclusions mirror Dr. Senn's testimony, as well as the ABFO guidelines, above.

The NAS Report

The defense cites the 2009 National Academy of Science advisory report "Strengthening Forensic Science in the United States: A Path Forward" over a combined 20 times in their briefs to support their claim that forensic odontology is scientifically unsound. Nothing in the NAS report supports that conclusion, and no jurisdiction in the United States has outlawed bitemark testimony in response to the NAS report. First, it is important to look at what the NAS report does *not* do. The report does not claim to be an authoritative treatise on any forensic science. The 286 page report expends less than four pages on a discussion of forensic odontology (NAS report at 173-177.) The brief treatment of forensic odontology is not surprising, given that "the NAS committee decided

early in its work that it would not be feasible to develop a detailed evaluation of each forensic discipline in terms of scientific underpinning, level of development and ability to provide evidence to address the major types of questions raised in criminal and civil litigation." Nor was the report authored by experts in each forensic field; while the committee had numerous academics and statisticians, no forensic odontologists made the cut. And while the NAS report unquestionably suggests federal regulation of forensic science, the NAS report does not state that forensic odontology as a field should be discredited.

Nowhere does the NAS report urge, as the defense claims, that forensic odontology is based on methodologies not accepted by the relevant scientific communities. To the contrary, the NAS report states that there are well-established guidelines for the collection of evidence, for example, various forms of photography, dental casts, clear overlays, computer enhancement, electron microscopy and swabbing for serology or DNA, that are well-established and non-controversial. While the report notes that bitemarks on the skin will change over time and can be distorted by the elasticity of the skin, the unevenness of the surface bite and swelling and healing, these are features that are well-understood by forensic dentists and their analyses and comparisons take those and many other factors into account. . The NAS report notes with approval the caution the ABFO dictates when setting the standards for reaching conclusions of linkage between a biter and a bitemark, pointing out the ABFO caveat that "Terms assuring unconditional identification of a perpetrator, or without doubt, are not sanctioned as a final conclusion." The NAS report notes the significance of bitemark analysis and comparison, citing the fact that bitemarks are seen most often in cases of homicide, sexual assault, and child abuse.

Nowhere does the report state or even imply that forensic odontology should be deemed inadmissible under either Frye or Daubert. That point was addressed clearly by a federal judge,

Harry Edwards, who is Chief Justice for the D.C. Circuit and co-chair of the NAS Committee. In his address to Congress on the subject of the NAS report, Justice Edwards said, "The question of whether forensic evidence in a particular case is admissible under applicable law is not co-terminus with the question of whether there are studies confirming the scientific validity and reliability of a forensic science discipline."

The policy recommendations summarized in the NAS Report are not intended to determine the admissibility of evidence, but to determine the need, if any, to create a federal regulatory agency devoted to the standardization of forensic science

The fairness of the entire NAS inquiry, at least with regards to forensic odontology, has been called into question by Dr. Senn, who personally testified before the NAS Committee. It is fair to say that no one was more aware of the failings of some forensic dentists that was Dr. Senn as he prepared to testify before the NAS committee. And nowhere has the adage "no good deed goes unpunished" been more starkly illustrated than by the use to which his testimony has been put. Dr. Senn pointed out in detail how the NAS committee 'cherry-picked" journal articles for negative findings while ignoring the positive and cited an article that repeatedly and erroneously called a survey a "proficiency exam" when it was not. He showed how the reports of some biased researchers were log-rolled in a frenzy of circular citations.

Dr. Senn testified at our hearing that the NAS Committee ignored much of what he had to say. "My answers included these things: Forensic odontologists understand the anatomy and the function of teeth and the dynamic mechanics of biting. A competent, skilled odontologist can produce biter profiles from bite patterns that exhibit sufficient information to have evidentiary value. Competent forensic odontologists will conform to the American Board of Forensic Odontology bite mark methodology guidelines for evidence collection, evidence comparison and for

report writing, and for ethics. The state of the art is defined by forensic odontologists who are capable of using all the known evidence collection and comparison modalities and collect the modality that's appropriate for the case in question. And employ blinding techniques to inhibit bias or observer effect and evidence collection, evidence analysis, and even employing dental lineups. And they seek second opinions from independent, blinded, competent forensic odontologists and engage in continuing study and research to improve themselves and forensic odontology and abide by the code of ethics and conduct. None of those items were included or mentioned or even referred to in the report." (Senn transcript p. 118).

Both federal and state courts have interpreted the NAS Report as acknowledging the need for further research and regulation in forensic science, not as an affirmative directive demanding judges "to take the drastic step of excluding long accepted forms of expert evidence." United States v. David Brian Stone, (2012 U.S. Dist. LEXIS 8973 12) (denying defendant's motion to exclude expert testimony regarding latent fingerprint identification on the basis of the NAS Report). Federal courts have gone so far as to say that "while an important contribution to the evaluation of numerous forensic fields, the report does not bind federal courts." United States v.Aman, 748 F. Supp. 2d 531, 536 (E.D. Va. 2010) (finding that expert testimony in fire investigation, fingerprint analysis, gas chromatography/mass spectrometry were founded on the use and application of reliable methodologies in their respective fields and denying defendant's motion to exclude). In Gee v. United States, 54 A.3d 1249 (D.C.2012), the D.C. Court of Appeals ruled the trial court was correct in refusing to find that the NAS report was reliable authority on the issue of friction ridge analysis, and found that no other court had accepted the relevant portions of the report as a learned treatise. In Pettus v. United States, 37 A.3d 2013 (D.C. 2012) the D.C. Court of Appeals discussed the NAS report in the context of handwriting identification. The Court rejected the amicus argument that the NAS Report taken as a whole amounts to a critique and repudiation of the

supposed science underlying all forensic analysis based on pattern-matching, except for DNA. The Court found, "The Report is much more nuanced than that... the goal is not to hold other disciplines to DNA's high standards," since "it is unlikely that most other current forensic methods will ever produce evidence as discriminating as DNA." (Id. at 226). The Court further noted, "Yet in virtually no instance...does the Report imply that evidence of forensic expert identifications should be excluded from judicial proceedings until the particular methodology has been validated."(Id. at 226).

In 2010, the Kansas Court of Appeals addressed the legitimacy of forensic odontology evidence in light of the recommendations made by the NAS Report. State of Kansas v. Lopez-Martinez 2010 WL 2545626 (Kan. App.) The court held that the NAS Report was not binding authority and should not be treated as such. In New York, the NAS Report has received little if any judicial attention. (See People v Carreira, 27 Misc. 3d 293 (NY City Ct 2010) mentioning the NAS Report in regards to hearsay requirements and forensic analyst lab reports). In New York, no federal or state court has yet to order the suppression of expert testimony in a criminal trial based on the NAS Report's recommendations.

Forensic Odontology is Not a Lab Science

While acknowledging that Forensic odontology is an "experienced-based" forensic method like many other disciplines, the NAS Report nonetheless complains that there is a lack of empirical and statistical data to support concepts like match rate, error rate, the uniqueness of human dentition, or the ability of human skin to transfer and maintain a pattern. Forensic odontology is not a hard science like DNA analysis, where researchers can sit at a lab bench and perform the same experiments over and over to establish ground truths. Each bite is a unique event. Even consecutive bites inflicted rapidly between the same biter and victim will each be different, as the

victim reacts to pain by moving away as quickly as possible, each moment changing the relative positions of the biter and victim. We cannot inflict extremely violent test bites on large numbers of people for the purpose of research. The difficulty in constructing useful experimental models for bitemark scenarios was starkly illustrated by the problems Dr. Mary Bush was unable to surmount, which are discussed below.

Forensic odontology is an observational science, where the skill and experience of the forensic dentists informs his good judgment in a particular case. In this way forensic odontology is much like forensic pathology. We cannot, for example, investigate the effects of gun shot wounds on human beings by lining people up and shooting them. Nor can we determine the lethal dose of a drug like fentanyl by dosing volunteers and gradually increasing the dosage until we kill them. Instead, we have to wait for gun shot victims or overdose victims to come to the morgue and make our observations. We rely on the training, skill and experience of the forensic pathologist and the forensic odontologist to come to the right conclusions. We can expose deficits in their education and experience and identify ways in which they deviate from best practices and standards through vigorous cross-examination and presentation of experts with different opinions, if those opinions are forensically sound.

Defense Expert Mary Bush

The defense presented Dr. Mary Bush in an effort to disparage the scientific underpinnings of forensic odontology. They refer to Dr. Bush as a forensic odontologist. She is not. While she is a licensed general dentist and a professor of dentistry, Dr. Bush has no experience whatsoever in real world forensic odontology. She has never seen a real bitemark firsthand, never collected evidence in a real world bite mark case, never taken photographs of a real bitemark, never collected a bitemark impression in a victim, never swabbed a real bitemark for DNA evidence, never harvested the skin

of a deceased victim of a real bitemark, never processed evidence in a real world bitemark case, never created Adobe Photoshop enhancements of a bitemark, never collected evidence from a suspected biter, never created an acetate overlay or a hollow volume overlay of a suspected biter's teeth in a real case, never done an analysis and comparison in a real bitemark case, and never written or presented a report on the findings of analysis and comparison in a real world case. She is not a member of the FBI's Scientific Working Group for Disaster Victim Identification, nor is she a member of the federal Disaster Mortuary Operational Response Team. She has not participated in disaster victim identification other than to aid in the chemical analysis of filling materials in three tooth fragments recovered by other people in the aftermath of a Buffalo plane crash. She is not a Diplomate of the American Board of Forensic Odontology, and by her own admission would not meet their rigorous standards for certification.

For these reasons it is perhaps unsurprising that the two experimental models Dr. Bush and her colleagues designed in an attempt to test what they considered to be important aspects of forensic odontology failed to replicate any aspect of violent real world biting situations or to provide useful information about real world victims or real world teeth.

Dr. Bush and her team devised two basic experiments. One purported to be an attempt to determine how reliably teeth leave imprints in skin. It involved the use of dental models mounted in a vice grip and pinched against the skin of a cadaver hard enough to leave indentations of the tooth models in the cadaver skin. The second purported to determine whether human dentition was unique. It involved placing dental models on a flatbed scanner, then performing various statistical calculations regarding the scanned dental models. Dr. Bush described her experiments, which were also documented in articles in the Journal of Forensic Sciences.

The cadaver studies were performed on cadavers taken from morgue coolers and defrosted to "room temperature". Then, stone dental models mounted in Home Depot vice grips were placed on the cadaver skin and were pinched for a length of time sufficient to created indentations in the skin. Those indentations were photographed quickly because they disappeared in a matter of minutes as the skin rebounded.

Dr. Bush conceded that there were numerous differences between her experimental model and real world victims, real world jaws, real world teeth and real world bitemarks.

Living bodies, of course, behave much differently than cadavers. First of all, living bodies register at approximately 98.6 degrees F. Living skin is a complex organ system, with blood flowing through a vast vascular network, pumped by the human heart, all of which gives the skin resiliency, flexibility and strength. Skin is rich in pain receptors, which cause a living person to react to the pain of biting and to quickly move away from the source of that pain, even if that movement inflicts further injury. When blood vessels are broken, say by being bitten, blood flows into surrounding tissue. And when skin is damaged, the body tries to protect itself by releasing chemicals called postaglandins and histamines, which cause inflammation. This is the body's attempt to minimize bleeding and minimize tissue damage. And then, the body starts to heal, sending out cells to repair skin by scarring or regeneration.

Cadavers, on the other hand, have no vital reactions whatsoever; they are dead. Instead of raising the cadaver temperature to 98.6 degrees, the Bush team used them at "room temperature" which she guessed was approximately 70 degrees F. She concedes there was no scientific reason to expect that cadaver skin would behave the same as live skin at any temperature, much less when that cadaver skin is cooled down almost 30 degrees. She did not record the temperature, gender, age, occupation, cause of death, ethnicity, condition, skin type or color of any of the cadavers, except to

note that none of the cadavers were Black, since the indentations they intended to photograph were not visible in photos of Black skin. She could not account for the degree of decomposition that would naturally occur in the cadavers, but agreed that decomposition starts within minutes after death. She conceded that the cadavers did not move, feel pain, bleed, bruise, inflame, heal, or scar.

A real human jaw is far different than the vice grip device used in the experiment. When a human jaw opens it moves in two separate ways. A human jaw hinges and translates so that the joint comes out of the socket so one can open wide enough to take a big bite. In addition, a lower jaw can move from left to right and jut in and out. When teeth in a human jaw are positioned to take a bite of something, they are in what is called protrusive occlusion, where the lower jaw protrudes and the biting edges of the top and bottom teeth come together to more efficiently rip or tear the food.

Dr. Bush concedes that the vice grips, unlike a human jaw, were capable of moving in only one direction, up or down. She also agreed that the teeth were mounted not in a biting position but in centric occlusion, where the top teeth overlap the bottom and the back of the front teeth contact the front of the back teeth, which is different than the position real teeth take during a bite and is more likely to pinch than bite. Additionally, Dr. Bush admitted that in some studies she combined a set of lower teeth from one person with a set of upper teeth from a different person, a configuration that could never occur in real life.

Dr. Bush testified that "slow and steady, even pressure" was kept on her biting mechanism for up to 19 seconds. She conceded that slow, steady and even pressure is far different from what would occur in a real bite and she said that 19 seconds was an "unreasonably long" biting time, far in excess of what would happen in real life. She conceded that they were unable to break the skin

with their experimental vice grip pinch motions, while in real life biters often rip or tear skin and sometimes bite body parts clear off the victim.

Dr. Bush described the process used to photograph the indentations left in the cadaver skin by the pinching device. After the cadaver was pinched, she would immediately climb up onto a ladder and take a picture. This had to be done quickly, as the indents faded within a few minutes, leaving nothing behind. She agreed that distortions created by the pinching device would be present in the photographs. She did not record the time lag between pinching and picture-taking, nor did she take photos at different time intervals to record how differently the pinch marks would appear over time. She conceded that the short interval between pinching and photography was another significant difference from a real world situation. In the real world, photos of wounds are not taken for hours or days after infliction, not within minutes. And, instead of disappearing within minutes, bitemarks last for days or weeks, changing appearance over time and sometimes leaving permanent scars.

Dr. Bush maintained that none of these differences between the real world and her model detracted from the validity of her experiments. Instead, she defended her choice of cadavers and the vice grip pinching device, saying that by controlling all the "variables" present in a living victim of a real world bitemark, and by ignoring the bruising, bleeding, abrasions, contusions, dragmarks and other features that forensic odontologists rely on when analyzing and comparing bitemarks to suspected biters, she could better focus on the indentations left by the vice-grip device. This was so, she maintained, even though those indentations would not be visible to, or used by, a forensic odontologist in a real world bitemark case.

Dr. Bush acknowledged that in her publications describing these experiments, she used the following phrases: "The authors understand that the use of cadaver skin may not replicate living

tissue," "It is acknowledged that cadaver skin differs from living tissue, with its lack of inflammatory response and potential subcutaneous bleeding;" "The authors understand that the use of cadaver skin may not replicate living tissue, and the distortional capabilities may be different in vital versus non-vital tissue;" and "It is acknowledged that experiments occurred on cadaver skin and that results may differ on live tissue."

The second set of experiments Dr. Bush conducted were an attempt to determine whether each person's dentition is unique. While it is impossible to compare the teeth of every person in the world, or every person who has ever lived, Dr. Bush attempted to design an experiment that would prove or disprove uniqueness. Her experiment involved scanning tooth models provided by a company that makes dental appliances and then applying a statistical process called Procrustes analysis. Procrustes analysis, or "one size fits all" was named for a mythical Greek figure, who invited travelers to sleep in his magical bed which he promised would fit all comers. In fact, if travelers were too tall for the bed, Procrustes would chop off their legs; if they were too short, he would stretch them to fit. In either case, he won, because when they died as a result of his ministrations, he would take all their stuff.

Procrustes analysis was developed to measure large numbers of samples in aid in biological research. It was used, for example, to analyze fish scales to determine whether fish were of the same species. In Procrustes analysis, in order to compare the shapes of various things, the sizes of those things are "normalized" or made uniform, even though they might be vastly different in real life. For example, a dime, a dinner plate and the planet Earth would be "normalized" and would be deemed to be the same under Procrustes analysis.

Dr. Bush "normalized" the scanned models, making the teeth and the arches all the same size, regardless of their actual dimensions. Then, she placed dots called landmarks on each item. In

Dr. Bush's experiment, the width of the teeth were disregarded and landmarks were placed only along the length, because, as Dr. Bush testified, it was "hard" to see the tooth width in the scans. Using only the middle six teeth per dentition, Dr. Bush applied between two and three landmarks on each tooth, creating a series of straight lines rather than the outline of the tooth. She then performed a Procrustes analysis, which meant that those landmarks, or data points, are compared by computer. The goal was to see how many sets of teeth were "the same", that is, within a certain "Procrustes distance" from each other. Those parameters were set by Dr. Bush. The farther the "Procrustes distance" the more dissimilar two items would be. The closer the "Procrustes distance" was, the more alike those items would be. Despite the fact that two of the exact same dentitions were scanned, landmarked and examined, Dr. Bush determined that none of the sets of teeth were exactly the same, including the identical set. Two sets of teeth were deemed to be very similar or "the same", based on the positions of the landmarks she applied. Dr. Bush testified that with regards to the two dentitions she deemed to be very similar or "the same", she never examined either of the stone models from which the scans were made, in order to see what differences might be apparent to the naked eye. Instead, her analysis relied entirely on the 2 or 3 landmarks she applied, which disregarded the majority of the information presented by the models. Her methods were vastly different from what a forensic odontologist would do in a real life case, that is, to make a feature by feature visual examination of two items offered for comparison. And, according to testimony by Dr. Karen Kafadar, an expert in applied statistics called by the defense, Dr. Bush's procedures also violate protocols used generally in pattern impression analysis. According to Dr. Kafadar, in real world cases, after computers sort data, humans must make a visual comparison of actual specimens to render an opinion. Dr. Kafadar testified that this is true in pattern impression evidence analysis in fields like fingerprint comparisons, ballistics, handwriting comparisons in questioned document cases, and bitemark analysis and comparison. She noted whatever data is not

collected is then ignored. Dr. Kafadar testified that a flawed experimental model is likely to produce flawed results and that no statistical analysis will rescue a poorly designed experiment.

These "scanned dentition" studies failed to disprove that dentitions are unique, despite the conclusions claimed by Dr. Bush. In fact, based on Dr. Bush's conclusions that no two sets of dentitions were exactly the same, with a zero degree of difference, she in fact proved that the dentitions she examined were unique.

Notwithstanding the obvious flaws in her experimental models, and her acknowledgment that her work was preliminary at best, and has never been replicated or validated by other researchers, Dr. Bush maintained that her experiments support the proposition that forensic odontology lacks scientific rigor and could not aid the finders of fact in a criminal or civil case. Her reluctance to recognize that her experimental models are not analogous to real life demonstrates her distance from the actual practice of forensic dentistry. (A detailed criticism of the Bush cadaver experiments in the form of a Letter to the Editor of the Journal of Forensic Sciences by a distinguished panel of board certified forensic odontologists is attached in the Appendix. A detailed criticism of the Bush scanned dentition uniqueness studies, in the form of a second Letter to the Editor of the Journal of Forensic Sciences by a similarly distinguished panel of board certified forensic odontologists is also attached.)

Applicable Legal Standard

In determining the admissibility of expert witness testimony New York state courts follow the standard established in Frye v. United States, 293 F. 1013, 1014 (D.C. Cir. 1923); see also People v. Middleton, 54 N.Y.2d 42, 49 (1981); People v. Wesley, 83 N.Y. 2d 417, 423 (1994). Frye requires that testimony of an expert witness concerning a new or novel scientific theory be established as reliable or generally accepted by the relevant scientific community. People v.Wernick, 89 N.Y.2d 111

(2001). Frye "emphasizes counting scientists' votes, rather than verifying the soundness of a scientific conclusion." People v. Wesley, 83 N.Y. 2d 417, 439 (1994). A particular procedure need not be "unanimously endorsed" by the relevant scientific community, however the science or technology must be "generally accepted" as reliable. People v. Middleton, 54 N.Y.2d (holding that identification through bite marks is accepted within the scientific community). When a party is granted a Frye hearing to challenge the admissibility of generally accepted expert testimony they bear the burden of demonstrating that the method is no longer accorded general scientific acceptance. Here, the defense has failed to show that the methods commonly used in forensic odontology are unreliable or are no longer generally accepted.

The make-up of the relevant scientific community is and should be those who have the knowledge, training and experience in bitemark analysis and who have actually done real world cases. We enter a looking-glass world when the defense urges that the Court ignore the opinions of working men and women who make up the ranks of board-certified forensic odontologists, who respond to emergency rooms and morgues, who retrieve, preserve, analyze and compare evidence, who make the reports and who stand by their reasoned opinions under oath. The defense would instead have this Court rely on the opinions of statisticians, law professors and other academics who do not and could not do the work in question. When Dr. Kafadar and her NAS committee created the NAS report, they wrote a summary assessment of forensic odontology. In it they said that "the majority of forensic odontologists are satisfied that bite marks can demonstrate sufficient detail or positive identification..." She agreed in her testimony that statement did, indeed, reflect the majority opinion among the scientific community of forensic odontologists. Drs. Senn, Bush and Kafadar all agree that dentists are, by virtue of training and experience, uncommonly good at pattern recognition, thorough their long years of examining dental x-rays and comparing them with prior images for signs of change. In addition, by virtue of their experience making incisions in skin and

monitoring the skin's healing, dentists spend lots of time focused on the reaction of skin to injury. Common sense and experience tell us that dentists are well-positioned to acquire the skills necessary to perform the tasks integral to forensic dentistry.

And while it is some relief to know that Drs. Michael West and Michael Bowers no longer plan to testify in bitemark cases, that reluctance could be traced to something other than a sudden epiphany about forensic dentistry. Neither is still certified by the ABFO, having resigned under fire. Dr. Bowers admitted publicly and under oath that he deliberately manipulated the evidence in a criminal case in Alabama. Dr. West has been publicly proven wrong by Dr. Senn and other forensic dentists in several high-profile cases, notably for mistaking crawfish bites for human bites and for attributing those bites to people later exonerated by DNA .

Admissibility of Bitemark Testimony in New York

In People v. Middleton, 54 N.Y.2d 42 (1981) the New York Court of Appeals held that the reliability of the bite mark evidence as a means of identification was sufficiently established in the scientific community to be admissible as evidence in a criminal case. The Court of Appeals found that techniques such as photography, freezing of tissue samples, taking of dental molds and visual observation were generally accepted and approved by the majority of experts in the field of forensic odontology. Middleton, 54 N.Y.2d at 53. The Court of Appeals further noted that since these techniques were "accepted as reliable by all of the appellate courts having been presented with bite mark comparison evidence it was unnecessary to subject these well-established methodologies to a Frye hearing in New York." Middleton, at 49-50

Again in People v. Smith, 63 N.Y.2d 41, (1984) the New York Court of Appeals affirmed the reliability of bite mark comparison evidence, holding that photographs of bite marks on different victims compared with a stone dentition of the suspected biter's teeth is an accepted technique in

the field of forensic odontology. In Smith, forensic odontologists used two methods not addressed in Middleton. First, the forensic odontologists compared a stone dentition of the defendant's teeth, and a wax impression made therefrom, with a photograph of the bite mark on the deceased victim's breast. Second, the expert compared a photograph of the bite mark on the victim's breast with a photograph of a bite mark wound created by the defendant on the nose of another victim four years earlier. As Dr. Bush did at this hearing, the defense expert in Smith argued that the "skin is not a good medium for registering bite marks", noting distortion caused by "differences in the elasticity of skin and in skin properties depending on the affected area of the body." (Id. at 62). The Court of Appeals was not persuaded by defense expert's argument and held that no error had been made by the trial court in admitting the photo-to-photo comparison of the bite marks as evidence.

In People v. Bethune 105 A.D.2d 262 (2nd Dept. 1984) the Appellate Division reaffirmed the Court of Appeals' holdings in Middleton and Smith. The court expressly stated that "in New York, it is recognized that bite mark evidence, i.e. the comparison of impressions made upon a person's body with the dentition of another, has gained general acceptance in the scientific community as a reliable means of identification, and such evidence is therefore admissible in a criminal case." As in Middleton and Smith, the forensic odontologists in Bethune compared models made from the victim's teeth and corresponding aluwax impressions with photographs of the bite mark scar on the defendant's arm.

Exonerations

Although expert testimony in the field of forensic odontology has been admissible in New York since 1981, forensic odontology, like all areas of science, is subject to human error. Accuracy and reliability of bite mark comparison and identification relies heavily on the experience and

training of each individual expert. It is the individual experts, not the methodologies in the field of forensic odontology, who have caused the wrongful convictions noted in the defense's brief. Forensic dentists can make mistakes, as can surgeons and airline pilots, submariners and subway conductors. The fact that all human endeavors are subject to error is not a reason to stop them.

Each wrongful conviction represents a failure of the criminal justice system and a personal tragedy for the individuals involved. However, mistakes by unskilled, untutored or unscrupulous forensic dentists do not implicate every forensic dentist or forensic odontology as a whole.

Two New York cases listed by the defense illustrate some common issues. In 1992, Roy Brown was convicted in upstate Cayuga County for the murder of a social worker who had threatened to remove his children from his custody. Evidence presented by the prosecution included prior threats the defendant made against the victim, the defendant's admission to killing a girl and that he "would often bite people when angry." People v. Brown, 82 N.Y.2d at 555. A forensic odontologist called to examine the seven bite marks found on the victim's body concluded that the defendant's dental impressions and bite marks on the body shared an identical bite patterns, including the same location of three missing teeth. In 1993, the Appellate Division, Fourth Department confirmed Roy Brown's conviction. Later, the Court of Appeals denied the defendant's appeal. Subsequent DNA testing revealed that O'Donnell was not the perpetrator.

In 1998, James O'Donnell was convicted of attempted sodomy and second degree assault of a Staten Island woman. The victim identified the defendant as her attacker in both a photo array and a live line-up. A second eyewitness confirmed the victim's identification of the defendant as the attacker. When questioned about his whereabouts on the morning the victim was sexually assaulted, the defendant provided police with an alibi that police later determined was false. In addition to this

evidence, a forensic odontologist identified the bite mark left on the victim's hand as consistent with the defendant's teeth. DNA testing later revealed that O'Donnell was not the perpetrator.

Yet another case, this one from Ohio, involved Douglas Prade, a former police officer who in 1998 was convicted of killing his estranged wife. He refused to sign the final divorce decree that would have removed him as beneficiary of her life insurance, and he knew through listening to her phone calls that she was about to announce her engagement to another man. Evidence besides a bitemark through clothing on the victim's arm consisted of hundreds of hours of wiretaps Prade illegally made of his wife's phone calls, calculations in his own handwriting listing his outstanding debts and how much money he would have left over after using his dead wife's insurance proceeds to pay them off as well as a false alibi he asked a friend to provide. Post-conviction testing on the victim's lab coat which she wore on her hospital rounds revealed an unknown DNA profile, and formed the basis for the recent vacatur of the conviction. Dr. Bush testified in that post- conviction hearing regarding her cadaver and uniqueness studies in an attempt to discredit bitemark testimony. In her decision, Judge Judy Hunter described Dr. Bush's testimony and said she found "...the premises and methodologies problematic..." Prosecutors are appealing the reversal; the defendant's convictions for the illegal wiretaps stand.

In neither Brown , O'Donnell nor Prade was bitemark testimony the sole piece of evidence presented against the defendant. To discredit the entire field of forensic odontology in response would require disregarding the other testimonial and physical evidence of the defendant's guilt presented by the prosecution.

On its websites and in many presentations and publications, The Innocence Project describes the causes of wrongful convictions. The Innocence Project blames faulty eyewitness accounts for most wrongful convictions. The solution by the criminal justice system has been to

strengthen eyewitness testimony by putting new lineup and photo array procedures in place. The Innocence Project likewise blames "false confessions" for many wrongful convictions. The solution by the criminal justice system has been to strengthen confidence in confession evidence by videotaping statements. In neither situation have the courts considered wholesale preclusion of the "offending" testimony.

The same techniques described by Dr. Senn, such as photography, freezing of tissue samples, taking of dental molds and visual observation have satisfied the Frye standard for admissibility since the Court of Appeals decision in in Middleton in 1981. Those same techniques are recognized, approved and prescribed by the American Board of Forensic Odontology. There is no evidence that contradicts the efficacy of these methods. The testimony of forensic dentists should be admissible at trial to assist the jury in evaluating the bite mark evidence in criminal and civil cases.

The Importance of Forensic Odontology

There is no greater measure of the importance that forensic odontology plays in the criminal justice system than the priority the Innocence Project places on obtaining the advice of board-certified forensic dentists when the freedom of their own clients is at stake. They obviously set great store by the testimony of Dr. Senn and his colleagues. When challenging the bitemark evidence in the cases of Bennie Starks and Robert Lee Stimson and Kennedy Brewer and Levon Brooks, the Innocence Project got Dr. Senn and a team of other forensic dentists to review the evidence. The Innocence Project was pleased with the results of their analysis and comparison of the bitemark evidence and submitted those results to the court. And when the Innocence Project itself was under fire, when they were sued by the medical examiner in another bitemark case, it was again Dr. Senn whom they asked to analyze bitemark evidence and again his report they relied on in their defense.

This past February, after making a presentation to the Forensic Odontology Section of the American Academy of Forensic Sciences about a client named William Richards, the California Innocence Project asked current ABFO president Greg Golden for help finding forensic dentists to review Mr. Richard's case, which involves bitemarks. Were the Court to preclude this important category of evidence, many innocent lives could be ruined.

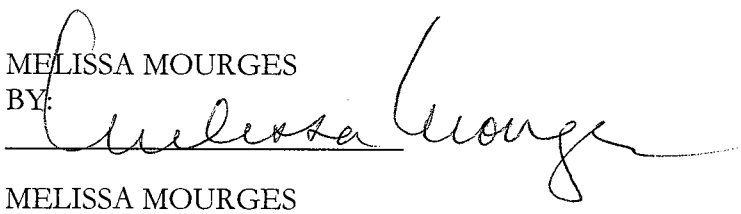
It is important to remember how valuable the testimony of forensic dentists is in cases where the finder of fact, be it judge or jury, needs help to interpret this complicated evidence. Dr. Senn testified about a recent case where he examined bitemarks on a toddler who spent time with her mother, the mother's live-in boyfriend, a babysitter and the babysitter's child. The mother's boyfriend was the immediate suspect and was ordered by a judge to stay away from home while the investigation was pending. Dr. Senn identified the bitemarks as having been inflicted by the babysitter's child, lifting a cloud of suspicion from the innocent boyfriend. In another child abuse case, reported by Dr. Robert Shapiro, director of the Mayerson Center for Safe and Healthy Children at Cincinnati Children's Hospital in Ohio, a baby girl came in with what the pediatric ER physicians thought were bites inflicted by a child. The forensic dentist who examined the baby identified the mother as the source of the bites, and the mother confessed to the abuse. The child was removed from her custody and saved from further harm.

Conclusion

Forensic odontology, involving every phase of the process, from collection of pattern injuries suspected to be bitemarks, to analysis of that pattern injury, to comparison of bitemarks to suspected biters and the linkage conclusions made therefrom, has been and continues to be reliable and generally accepted within the relevant scientific community. The testimony of Dr. Senn as well as the detailed direction given by the American Board of Forensic Odontology regarding every

phase of forensic dentistry proves that forensic dentistry meets the Frye standard, and should remain admissible in court.

Respectfully submitted,
May 16, 2013
New York, New York

MELISSA MOURGES
BY: 

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Appendix

Commentary on:

Miller, R.G., Bush, P.J., Dorion, R.B.J., Bush, M.A., *Uniqueness of the dentition as impressed in human skin: a cadaver model.* J Forensic Sci, 2009. **54**(4): p. 909-14.

Bush MA, Bush PJ, Sheets HD (2011) *Statistical evidence for the similarity of the human dentition.* J Forensic Sci, 2011. **56** (1): p.118-23

Sheets, H.D., Bush, P.J., Brzozowski, C, Nawrocki, L.A., Ho, P, Bush, M.A., *Dental shape match rates in selected and orthodontically treated populations in New York State: a two-dimensional study.* J Forensic Sci, 2011. **56**(3): p. 621-6.

Sir:
The three studies listed above published in the Journal of Forensic Sciences present the results of experiments the authors have designed and conducted regarding the uniqueness of the human dentition. Examinations of the design, methods and the results of these studies show flaws raising serious questions about the authors' conclusions.

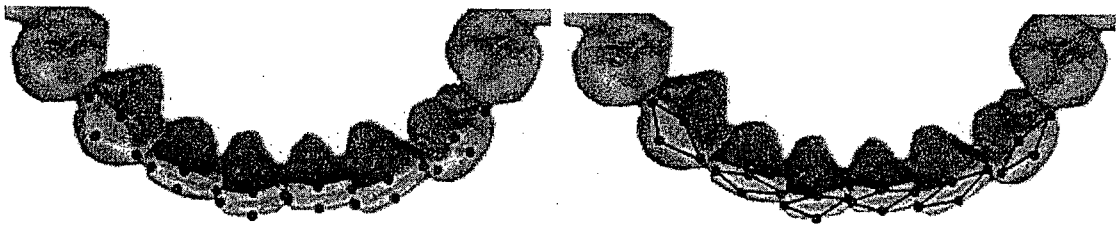
Two Dimensional (2D) Studies:

In the 2D studies of the human dentition, the authors state that they were able to identify "matches" among human dentitions. The "matches" were declared when the measurable Procrustes distances were so small that the specimens were deemed "indistinguishable".

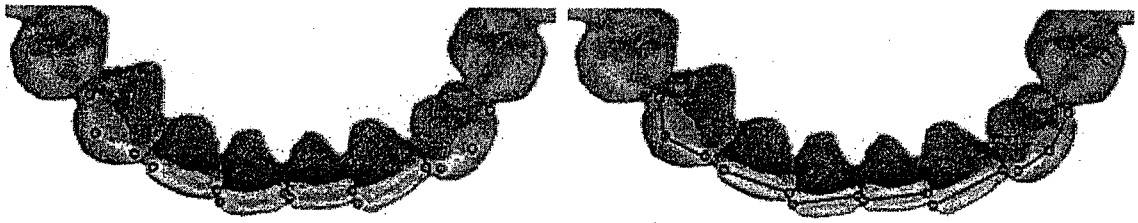
The Procrustes method chosen for these experiments raises concern. The Procrustes shape analysis used is designed only to look at shape and to ignore size. In their studies, the authors used a flatbed scanner to capture images of dental stone models, then applied Procrustes methodologies which attempt to make ALL of the specimens the same size and then proceed to compare the shapes of the dentitions. All human dentitions are not the same size.

The authors elected to only examine the *x*-axis (mesial-distal width) of the lower anterior teeth and ignore the *y*-axis (the facial- lingual width) as a matter of convenience. A previous study by Keiser et al[1] in 2007 using both the *x*- and *y*- axes in performing similar experiments examining the uniqueness of the human anterior dentition found the human dentition to be unique. The authors claim to have repeated the Keiser study but only using the single *x*-axis. The explanation provided for not including the *y*-axis by the authors was that they were not able to clearly see the delineation between the end of the incisal edge and the beginning of the lingual edge of the lower anterior teeth in their scanned images, thus choosing not to include this axis when doing their study. In effect, the authors arbitrarily elected to ignore significant available data from the Keiser study while claiming that they repeated that study to reach their conclusion that the human dentition is not unique.

Whereas the Keiser study included both *x*- and *y*-axis data, which defined a plane of the biting area of the incisal edges of the lower anterior teeth, the authors only marked mesial-distal length of the teeth with two landmarks (three landmarks on the canine), which geometrically defines a line. The biting area of the incisal edges of the lower anterior teeth is not a line; rather, it is a plane. After making all of the specimens the same size, the authors of these studies used the two landmarks (line) to represent the entire biting area of the lower anterior teeth (completely ignoring the width of the tooth) when they extracted the landmarks for the Procrustes analysis.



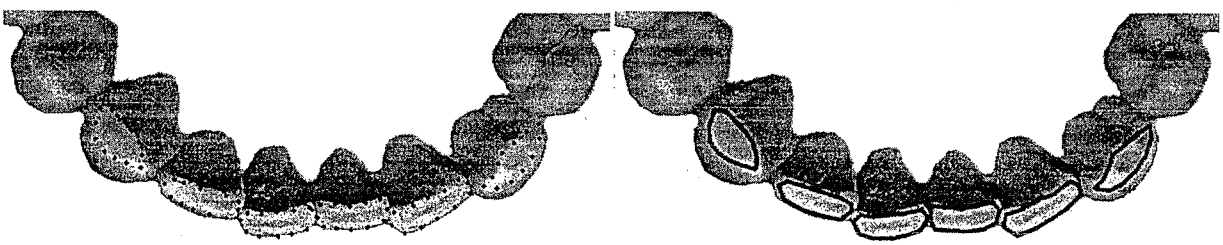
Simulated Kieser et al 4 landmarks/tooth (L) and Procrustes projections (R)
Landmarks are enlarged to facilitate viewing



Simulated Bush et al 2 or 3 landmarks/tooth (L) and Procrustes projections (R)
Landmarks are enlarged to facilitate viewing

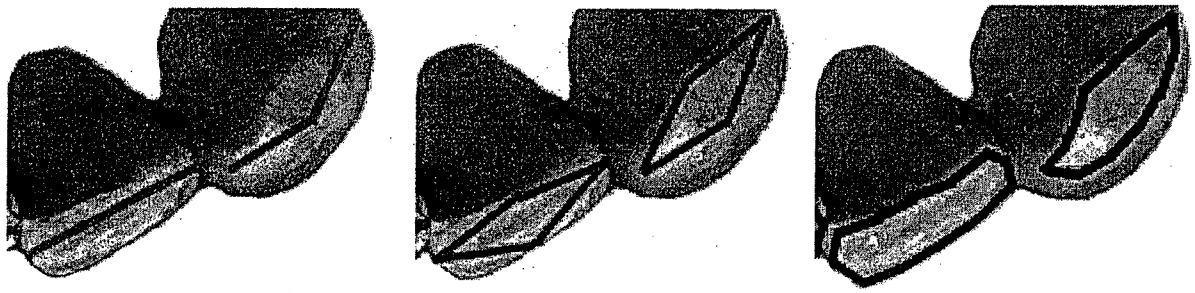
In two dimensions, both width and length are variables that must be considered when comparing tooth shape. Further, since all human dentitions are not the same size, ignoring size and comparing "line" representations of individual teeth is illogical if the goal of the study is to compare the shape and tooth positions of individual dentitions with regards to uniqueness.

In fact there is no valid reason to avoid using more extensive landmark and semi-landmark choices, 8 or even 12 points for each tooth in order to create more representative projections for analysis.



12 points **4 landmarks and 8 semi-landmarks per tooth**

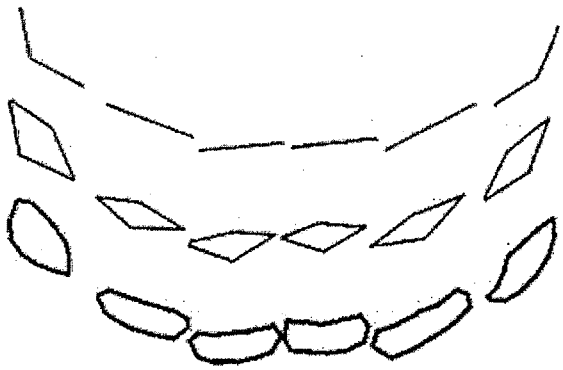
The resulting projections would more accurately depict the actual shape and size of the biting surfaces of the anterior human dentition than either the Kieser et al or Bush et al projections.



Bush et al
2 or 3/tooth

Kieser et al
4/tooth

Extensive
8 or 12/tooth



Lower anterior six teeth as depicted from top to bottom
by Bush et al landmarks,
Kieser et al landmarks,
and by Extensive landmarks

The subject papers authors' projections do not represent the full facial-lingual dimensions of the teeth. Improper image acquisition resulted in the inability to see or analyze the accurate shape or dimensions of the biting surfaces of the teeth, reducing the authors' projections to lines between improperly placed data points.

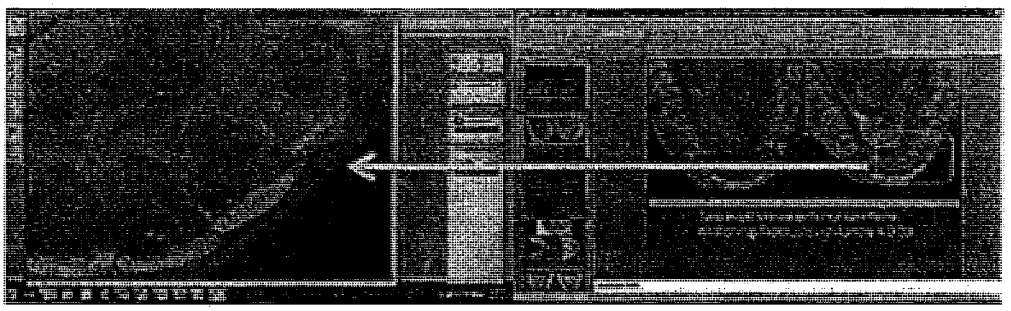
According to Robinson et al[2], it is critically important to be sure the digital image acquisition is done with the dental stone models positioned so the incisal edges of the anterior teeth are parallel to the platen of the scanner if a scanner was used or to the front of the camera lens if a digital camera was used for image capture. If the authors had properly positioned the dental stone models when they scanned, the line angle between the incisal and lingual (or buccal) would have been detectable. They could easily have placed the landmarks on the facial and lingual surfaces as they had done on the mesial and distal surfaces.

Robinson et al state that a "... potential source of error is in the subjective orientation of the tooth surface when its two-dimensional image is captured."[4] "One would expect that small changes in the orientation of the occlusal surfaces would have a greater impact on the recorded

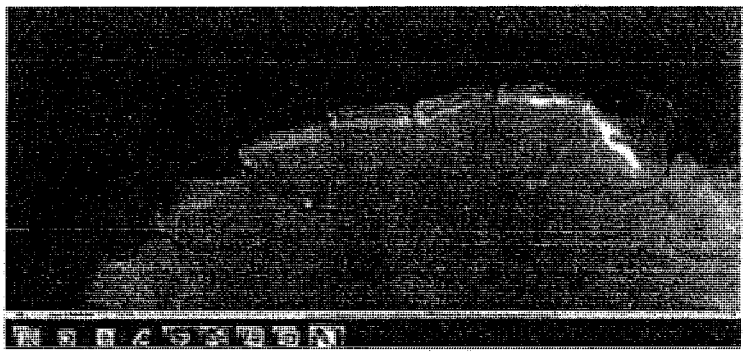
landmark configurations...".[3] The authors of the subject papers do not describe the methods used to insure the models had been properly placed on the scanner platen when they used the flatbed scanner to capture the images. Their inability to be able to define the facial or lingual margin of the incisal edge (and thus excluding the *y*-axis) suggests improper model orientation during image capture with the scanner.

An additional significant flaw in these studies involved the placement of the landmarks. Robinson et al state "... for these methods to perform well, landmarks must be reliably located. Otherwise this can lead to problems later in an analysis. Inconsistencies between operators in the positioning of landmarks will result in inconsistent representations of shape. 'Real' differences will become diluted by increased residual variance and statistical power will be reduced, lessening our ability to reject false hypotheses."[5] and "...more than 80% of occlusal variation in shape was found to be attributable to inconsistencies in the landmark representations..."[6]

When the landmarks placed by the authors were examined, it was clear that the landmarks were not accurately placed. The images of one pair of models identified by the authors as "...being so similar as to be indistinguishable..." were enlarged to the point where the images just began to pixilate. The authors' placement of the landmarks on the mesial and distal most extent of the associated teeth was examined. Virtually none of the landmarks were within one pixel of the actual end point of the widths of the teeth. In their studies on tooth shape, Robinson et al state that "Landmarks were positioned using a mouse-controlled icon, accurate to a single pixel and which could be repositioned at any time during the landmark identification, if required."[7] No such attempt at accuracy was undertaken by the authors.



Arbitrary Placement of Landmarks
According to the 2000 and 2002 Procrustes studies by Robinson, et al, improper placement of landmarks "will result in false representations of shape"



Example of properly placed landmarks within one pixel of the tooth margin

These two critical sources of error- improper orientation of the dental stone models when scanned and improper placement of the landmarks- considered together render any conclusions stated by the authors regarding the uniqueness of the human dentition as unsupportable.

One final failure of the authors in reaching conclusions that the human dentition is not unique to an individual involves the end point of their studies. When the Procrustes analysis was completed and they discovered dentitions that they judged to be "...so similar they are indistinguishable...." they made no attempt to retrieve those specimens and visually compare them. The author's use of the Procrustes analytical program only describes a mathematical probability that lower anterior dentitions defined by two or three improperly placed landmarks per tooth (the overall dimension of which were arbitrarily adjusted to be as similar in size as possible) for two specimens *may* result in a "match" within a defined measurement error. The final comparison regarding the actual similarity between two dentitions requires retrieval of the specimens predicted to possibly match and visually comparing them.

The authors report they were able to detect "matches" between specimens with their methodologies. Recalling that they were using lines to represent individual tooth shape on dentitions that were adjusted to the same size, exactly what meaning does "match" have? Since the actual size of the individual dentition is critical in comparison studies of shape, it would be an absolute requirement to retrieve the dental stone models of specimens determined to "match" and visually compare them before declaring they are "...so similar they are indistinguishable..." as the support for their conclusion the human dentition is not unique. When asked to produce the models deemed by their research to "match" so the models could be visually compared, the authors stated that the models were no longer available.[8] The inability to provide these models for examination prevents any independent confirmation of their research. This situation violates scientific principles and places serious doubt on the validity of the conclusions stated in these studies.

Three Dimensional (3D) Studies

For their 3D studies, these authors did not have access to actual dental models. The images of the dental models that the authors used in the 3D studies were virtual images sent to them by a third party vendor. They do not state how the dental models were scanned so no information regarding the digital creation of the images as viewed is available. In typical 3D dental image capture programs, the image of the scanned dentition seen on the computer monitor is an animated rendering of the actual dentition as seen using an imbedded viewer program. In addition, these programs allow for only a small amount of magnification that usually does not approach the level of magnification required to accurately place data points, landmarks, or semi-landmarks. These factors severely limit the ability of authors to correctly identify features and then properly place the landmarks that were used for the Procrustes analysis.

Compounding the issues surrounding the inability to enlarge the images are the limitations of animated renderings of the dentitions such that the animations do not precisely recreate the anatomic status of the actual dentition. The animations smooth and round sharp edges and create a surface sheen on the models that do not reflect the real life dentition. These distortions in the

image appearing on the computer monitor raise serious issues regarding the ability to accurately place the landmarks.

The authors indicate that they identified a position with the 3D scanned models that optimized the incisal edges and locked the image in that position before proceeding to place the landmarks. When the next investigator viewed the same image to place the next set of landmarks, there is no explanation of what measures were taken to validate the orientation of the virtual model so the landmarks were being placed with the model in the same three dimensional position. As stated earlier in the Robinson et al study, small variations in the position of the dentitions seriously complicates accurate placement of the landmarks.[9] The authors do not address these issues in their articles.

Perhaps the most significant flaw in their experimental design is the fact that they never saw the actual dentitions or had any of the actual models for the 3D studies. As was pointed out in the 2D studies, if there is a "match" of dentitions such that their compared Procrustes measurement distance falls below the established measurement error, the authors had no ability to retrieve the actual models to visually compare these "matches". It is a leap of faith to accept the conclusion that a Procrustes analysis identifying dentitions that are "..so similar as to be indistinguishable..." without a physical and visual comparison of the actual dental models justifies a conclusion that the human dentition is not unique to individuals.

In conclusion, the authors did not document that they used appropriate methods in acquiring the images in the 2D studies, did not incorporate any methods to insure the orientation of the animated 3D images was the same between operators when the landmarks were placed and did not use methods to insure proper placement of landmarks in either the 2D or 3D studies. Each of these is a foundational requirement before undertaking a Procrustes shape analysis. Failing in any of these basic requirements individually questions the results of the experiments; failing in all renders the results of these studies unsupportable.

In actual bitemark cases, the dentitions of the population of suspected biters are the only dentitions being compared both to each other and to an actual bitemark. When viewing this population of suspected biters, there are visually obvious differences between these dentitions, making them unique when compared to each other. The uniqueness of the human dentition in the population of the whole world is not of great importance, as it can never be proved or disproved. "The fact that an imaging device and computer is able or unable to distinguish between similar dentitions bears no relevance to the day-to-day comparisons that are done largely by the human eye."[10] Had the authors taken the final step to visually compare the actual models of the dentitions that their Procrustes analyses showed to "match", they would have seen with their own eyes that the compared dentitions were not "...so similar as to be indistinguishable..."

The studies listed above have not proven the human dentition is not unique. The flaws incorporated in these studies are significant and collectively invalidate any conclusions reached by the authors. It is difficult to believe that they expect the scientific community to accept on faith that a numerical prediction of a "match" using Procrustes analytic methods is enough proof to proclaim that the human dentition is or is not unique. Visually comparing any specimens they

claim "match" would readily show individualizing characteristics between those specimens such that they in fact DO NOT match.

Perhaps knowing this is the reason none of their studies include visual comparisons of scaled images of dentitions or the dental stone models stated to be "matches". The inability to retrieve the dental models claimed to be "indistinguishable" in their 2D studies so that independent investigators can confirm or question their findings casts serious doubt on their methodology and conclusions. Never having had the actual dental models in the 3D studies precludes the possibility of any investigator visually comparing the specimens they claim "match".
The use of these flawed studies as a basis for conclusions regarding the uniqueness or individuality of the anterior human dentition is unsupportable. Testifying in courts of law by one of the authors (Dr. Mary Bush) in bitemark evidentiary hearings based on their own unconfirmed studies, that the human dentition is not unique represents an opinion that is, at best, premature. Regarding testimony by Dr. Bush in *State of Ohio v Douglas Prade*, presiding Judge Judy Hunter wrote in her opinion " While the Court appreciates Dr. Bush's efforts to study the ability of human dentition to transfer unique patterns to human skin, the Court finds the premises and methodology of her studies problematic." [11] If viewed from a more critical viewpoint, such testimony may represent opinions influenced by bias which would be reprehensible and inexcusable. We choose, rather, to believe that it is the inexperience of Dr. Bush in actual bitemark analysis casework that may have caused her to be unduly influenced by others for whom advocacy is allowed.

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3. Impact of landmark reliability on the planar Procrustes analysis of tooth shape; Robinson D. L.; Blackwell, R. G.; Stillman, E. C.; Brook. A. H.; Archives of Oral Biology 47 (2002) pg.553

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November 30, 2012

Commentary on: Bush, M.A., R.G. Miller, P.J. Bush, R.B.J. Dorion, *Biomechanical factors in human dermal bitemarks in a cadaver model.* J Forensic Sci, 2009. **54**(1): p. 167-76.,
Commentary on: Miller, R.G., P.J. Bush, R.B.J. Dorion, M.A. Bush, *Uniqueness of the dentition as impressed in human skin: a cadaver model.* J Forensic Sci, 2009. **54**(4): p. 909-14.,
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Commentary on: Bush, M.A., H.I. Cooper, R.B. Dorion, *Inquiry into the scientific basis for bitemark profiling and arbitrary distortion compensation.* J Forensic Sci, 2010. **55**(4): p. 976-83.

Sir:

The four papers listed above report the authors' investigations into aspects of bitemark evidence. These papers detail the authors' experimental designs for creating and then analyzing patterns impressed by models of human teeth into cadaver skin. Experimental design flaws are incorporated into the methodology for each of these papers. Flawed designs lead to flawed conclusions including those stated by the authors and those inferred by readers.

The experimental design flaws include:

1) The use of cadaver skin as an analogue for living human skin and the unsound management and documentation of the cadaver subjects;
2) The device used to create the simulated patterns and the improper set-up of the device;
3) The methodology used to apply simulated biting forces to create the patterned injuries;
4) The timing for image capture of those transitory patterns
5) The failure to recognize the nature and significance of the transitory patterns and distortion created, reported, and analyzed;
6) The failure to recognize the relationship between the patterns created, reported, and analyzed in these experiments to patterns analyzed in actual bitemark cases.

The authors included the four following statements in their papers regarding the use of cadaver skin."The authors understand that the use of cadaver skin may not replicate living tissue." (1) "It is acknowledged that cadaver skin differs from living tissue with its lack of inflammatory response and potential subcutaneous bleeding."(2) "The authors understand that the use of cadaver skin may not replicate living tissue and the distortional capabilities may be different in vital vs. nonvital tissue."(3) "It is acknowledged that experimentation occurred on cadaver skin and that results may differ on live tissue."(4). Despite these statements of limitation and the availability of living skin analogue choices, the authors selected cadaver skin for their studies. There is no published information validating the use of cadaver skin for the evaluation of the distortion seen in human bitemarks in actual cases.

The methodology employed in the management of the cadaver subjects was also questionable. Cadavers were stated to have been stored at 4°C then allowed to "warm to room temperature" before test "biting" was performed. No justification for the decision to make test bites at room temperature was offered. Since the skin temperature of living persons when they are bitten is very likely close to body temperature, did the authors hypothesize that creating simulated bites on room temperature subjects was preferable in some scientific way to those created at body temperature, morgue cooler temperature, or some other temperature?

No information was offered for the time required for warming the cadavers from 4°C to room temperature, for what temperature was selected for room temperature, or if and how the cadaver temperatures were actually measured. In sworn testimony, one author has stated that they did ***not*** measure the body temperatures, and that the actual temperatures of the cadavers were "a guesstimate". The time required to warm a body from 4°C to 21.5°C would be quite long, at least several hours, and would likely result in an increase in the rate of decomposition.

No information was reported regarding the age, sex, ethnicity, skin type, cause and manner of death, time interval since death, the health status in life or other variables for the test subjects.

Each of these issues and their combined effects further complicate the problems involved with the differences in the biomechanical properties of living skin and dead skin. As previously stated, living skin analogue choices were and are available for these studies.

Dental models of human teeth mounted on a vise grip clamp were utilized to create the test patterns on cadaver skin. A vise grip clamp is a rudimentary tool used by welders and others to hold or stabilize construction materials. The device is unsophisticated with a simple hinge that does not resemble the complex hinge-excursion-translation movements of the human mandible. The vise grip clamp does not allow for the anterior translations of the lower "jaw" to replicate the positions achieved by humans during biting. Devices that more nearly replicate the human biting mechanism are available.

For these studies the dental models used to create the simulated bite patterns were mounted on the hinge device in centric occlusion. Since the rudimentary vise grip device cannot allow for translation, the teeth models should have been mounted into the relationship most commonly seen in actual biting scenarios characterized by a protrusive lower jaw position with the upper and lower anterior teeth in an end-to-end relationship.

Astonishingly, in some of their experiments, the lower teeth models of various individuals were mounted opposing the upper teeth model of a single ***different*** individual.(2) This research design is irrational and suggests a misunderstanding of the principles of human biting dynamics. The authors attempted to ameliorate this research design choice by stating that they did not examine the patterns made by the upper teeth in that study (looking at the patterns created by only one of the two arches is itself an interesting decision). That rationalization ignores that biting patterns are created by the compression of skin between distinctively paired and related upper *and* lower teeth. Substituting a single set of maxillary teeth models opposing multiple mandibular teeth models is flawed methodology for pattern analysis.

Additionally, instead of attempting to re-create or even simulate actual human biting scenarios, the vise grip mounted dental models were clamped onto the cadaver skin for extended periods. "Bite force was generated by a clamping mechanism to provide for a steady, controlled application." and "The range of time needed to reach the target load of 20 kg was 13–19 sec, as the load was applied in a slow, steady pace." (3)

These research design scenarios bear no similarity to the dynamic and violent encounters involved in actual human biting.

Perhaps the most flagrant flaw in the experimental design of these studies was the misconception that the patterns they created, the distorted cadaver skin with tooth depressions, were related to patterns analyzed by forensic odontologists in actual bitemark cases. Their analyses of the distortions in these patterns formed the bases for their conclusions. No statements of qualification can mitigate that they were carefully analyzing transient distortion improperly created and recorded. What they were studying, in fact, was pinched, distorted skin

with teeth depressions. All of those primarily distorted features faded, rebounded or otherwise disappeared and left no traces, features, or dimensions similar to those seen in actual bitemark casework.

Teeth depressions into skin are features very rarely seen when actual bitemark case evidence is collected. Exacerbating the flawed pattern creating methodology was the faulty experimental design for imaging the pinched skin and teeth depressions in cadaver skin for analysis. Photographing these features required capturing the images quickly after creation before they rebounded and disappeared.

When human teeth bite human skin, the skin is crushed between the upper and lower teeth creating an induced distortion described by Sheasby and MacDonald as one of the forms of Primary Distortion. (5) Primary distortion may include "tenting" of tissue and individual tooth depressions...and both disappear with time. These phenomena are clearly illustrated in several images seen in Dorion's *Bitemark Evidence, 2nd Edition*.(6) Those images clearly illustrate that images of patterns taken soon after bite infliction look markedly different than those taken hours and days later. The time required for primary distortion to diminish and disappear varies depending on multiple factors including the age, sex, and skin type of the person bitten as well as the biomechanical properties of living skin, the individual tooth features and the level of bite force applied. The timing for imaging primary distortion is critical as rebounding begins immediately and continues until complete. Each pattern and the induced distortion would change continuously from just after creation until resolved. Images of an individual pattern captured at 30 seconds after creation could be very different from images captured after 10 minutes. Analyzing primary distortion at any one point during this period is pointless. Serial images or video recording could have been helpful in understanding the process.

In actual bitemark situations primary distortion certainly occurs…but forensic odontologists do ***not*** analyze these primary distortion features, principally because those features are no longer visible when evidence is collected.

The authors confirmed that they were aware of the transient nature of the patterns they created in their studies, stressing that their photographs had to be made quickly before the tooth depressions rebounded. "Three photographs were taken immediately after each bitemark." and "All photography took place within 10 min of bite marks as many indentations showed signs of rebound."(1) In every case for these studies the photographs were taken within ten minutes after pattern creation. Images of the sites of the experimental patterns that were recorded more than 10 minutes after creation were either not made or not published.

In actual casework, evidence is never collected within that limited time frame, and even if possible, no competent forensic odontologist would limit analysis to evidence collected within ten minutes after the bitemark was created. In actual casework, patterned injury images are optimally recorded over days and even weeks.

Summary

It is unsound methodology to record and analyze transitory primary distortion features created by inappropriate experimental design. The use of that flawed information to formulate conclusions about the nature of features seen in actual bitemark cases is unacceptable.

The factors involved in the development of their flawed experimental design are unclear. A contributing factor may be the relative inexperience of some of the authors in bitemark analysis in actual cases, some authors have never examined an actual case. Another consideration is motivational or conformational bias stimulated by the apparent views of some authors of their roles in "researching" the reported findings of the NAS report.(7) It is not

surprising that some of the authors have subsequently expanded their horizons into fingerprint and footwear pattern analysis.

This commentary addresses flaws in the experimental design and does not deal with the statistical or mathematical methodology utilized. However, as Altman stated in *Practical Statistics for Medical Research*, "In practice we should be most concerned about possible bias in the design of the study. Indeed, if the design of the study is unacceptable for some reason, the paper is statistically unacceptable regardless of how the data were analysed." (8)

It is unusual that research with experimental design flaws of the extent seen in these papers escaped the scrutiny of the multiple authors involved. It is unfortunate that these same flaws survived the peer review process unchallenged.

It is outrageous that any of these authors would go into courts of law and give sworn testimony citing this research as the basis for conclusions or opinions relating to actual bitemark casework, especially considering that no independent research has validated or confirmed their methods or findings. This violates important principles of both science and justice.

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*The opinions stated are those of the authors of this letter alone and do not represent the opinions of any group, institution, or organization with which they may be affiliated.

SUPREME COURT OF THE STATE OF NEW YORK
COUNTY OF NEW YORK

THE PEOPLE OF THE STATE OF NEW YORK

-against-

CLARENCE DEAN,

Defendant.

REPLY TO POST-FRYE HEARING BRIEF REGARDING FORENSIC ODONTOLOGY

IND. NO. 4555/2007

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