AMERICAN BOARD OF FORENSIC ODONTOLOGY (ABFO)

Standards and Guidelines for Evaluating Bitemarks

Revised 2-19-2018

Preface

ABFO standards and guidelines are dynamic and can be modified in response to developments in the field following ABFO policies and bylaws. These standards and guidelines were developed with consideration of the current status of the discipline. The appendices to this document include a glossary of terms (Appendix 1), factors influencing the interpretation of bitemarks on skin (Appendix 2), lists of potential uses of bitemark evidence (Appendix 3), and checklists for specific procedures (Appendices 4, 5, and 6).

These Standards and Guidelines are not intended to be contrary to any jurisdiction's laws and statutes.

1. Standards

a. An ABFO Diplomate shall be familiar with and adhere to ABFO Standards.

b. An ABFO Diplomate shall document, review, and consider all evidence received and collected.

c. An ABFO Diplomate shall be familiar with the current literature, and use established analytical methods for pattern, patterned injury, and bitemark evidence. These can be supplemented with other techniques or methods.

d. Final reports shall include the results of all analyses.

e. Terms used in a manner different from the guidelines shall be explained in reports and in testimony.

f. An ABFO Diplomate shall not express conclusions unconditionally linking a bitemark to a dentition.

g. An ABFO Diplomate shall not give expert testimony outside her/his recognized area(s) of expertise.

2. Guidelines

a. Guiding Principles

i. Objectivity (see Appendix 1)

Odontologists should remain objective in all phases of investigation, analysis, comparison, and reporting of their casework, including minimizing all forms of bias.

ii. Nature, Value, and Limitations of Bitemark Evidence

Odontologists should discuss and explain the nature, value, and limitations of bitemark evidence with investigative and legal authorities involved, including the relationship of the bitemark evidence to the presence or absence of other physical evidence.

iii. Blinding

1) Whenever possible, the same odontologist should not collect evidence from both persons with patterned injuries purported to be bitemarks and persons of interest whose dentitions may or may not have caused the bitemark. Another dentist should be engaged to collect such evidence in order to minimize bias.

2) When only one person of interest is proffered, the odontologist should engage another dentist to produce a "dental line-up" of dentition evidence. If utilized, the dental line-up evidence should include evidence from the person or persons of interest and from other individuals as foils. (see Foil in Appendix 1)

a) The dental line-up evidence should be similarly produced, developed, and presented to avoid disclosing identifying information.

b) There should be no gross discrepancies in the general arrangement and number of teeth present for selected foils.

3) When multiple persons of interest are proffered, the odontologist should include one or more foils to supplement the dental line-up.

4) When comparing dentition evidence and bitemark evidence, the odontologist making the comparison should not have access to dentition information disclosing the identity of a person of interest. All comparison dentition evidence within the dental line-ups should be anonymized.

iv. Independent Verification

1) Before submitting a final report, odontologists should seek independent verification in the form of a second opinion from a minimum of one ABFO Diplomate.

2) Odontologists engaged for independent verifications should be blinded to the conclusions of the referring odontologist and blinded to information that would reveal identifying information regarding persons of interest.

b. Terms indicating a pattern or patterned injury is or is not a bitemark

i. Human Bitemark – human teeth caused the pattern

Criteria:

1) The pattern demonstrates class characteristics of human teeth, including prosthetic replacements when present.

2) The discernable features are sufficient such that other causes for the pattern were considered unlikely or excluded.

3) A curvilinear pattern or patterned injury generally circular or oval and often consisting of two opposing arches that may or may not be separated at their bases by unmarked space. Sometimes only one arch is clearly visible.

4) Individual marks, impressions, abrasions, contusions, striations, or lacerations from specific teeth may be found within the pattern.

5) A central area of contusion is sometimes present.

6) In severe human bitemarks, material may be forcefully removed from the medium bitten.

7) The marks present reflect the size, shape, arrangement, and distribution of the contacting surfaces of teeth. (The contacting surfaces of human teeth include the incisal and occlusal surfaces of teeth and may also include the lingual surfaces of anterior teeth.)

8) Some marks made by individual teeth can be recognized and identified based on the class characteristics and location relative to other features.

9) The size and shape of each visible arch conforms to the varying ranges of size and shape of the human dentition.

ii. Not a Human Bitemark – human teeth did not cause the pattern.

Criteria: The pattern or patterned injury does not include features demonstrating the class characteristics of human teeth.

iii. Inconclusive – There is insufficient information available to support a conclusion of whether or not a pattern or patterned injury is a human bitemark.

Criteria: Features demonstrating the class characteristics of human teeth are incomplete, distorted, or otherwise insufficient.

c. Terms relating or linking a dentition to a human bitemark

i. Excluded as Having Made the Bitemark

Criteria: The bitemark demonstrates class characteristics or individual characteristics that could not have been caused by the dentition.

ii. Not Excluded as Having Made the Bitemark

Criteria*:* The bitemark demonstrates class characteristics or class and individual characteristics that could have been caused by the dentition. There are no unexplainable discrepancies between the features of the bitemark and the dentition. The dentition is not excluded from the population of dentitions that could have caused the bitemark.

iii. Inconclusive

Criteria*:* There is insufficient information to support a conclusion whether or not the bitemark could have been caused by the dentition.

d. Bitemark: Definition, Characteristics, and Evidentiary Value

i. Bitemark definition

A physical alteration or representative pattern recorded in a medium caused by the contact of the teeth of a human or animal. (see 2.b.1. *supra* for a comprehensive definition of a human bitemark)

ii. Characteristics of human bitemarks

1) Class characteristic

A feature, trait, shape, or array that distinguishes a bitemark from other patterns or patterned injuries. An expected finding within a class or group.

2) Individual characteristic

A feature, trait, shape, or array that represents an individual variation within a group rather than an expected finding within that group.

a) Arch characteristic

An arch characteristic is a type of individual characteristic that is displayed in a pattern representing the arrangement of multiple teeth in a dentition or bitemark. (e.g. arch shape, arch size, rotated teeth, teeth displaced toward the facial or lingual, teeth drifted toward the mesial or distal, diastemata).

b) Dental characteristic

A dental characteristic is a type of individual characteristic seen in a bitemark that represents an individual tooth variation (e.g. wear pattern, chips, notches, fractures, dental anomalies).

iii. Evidentiary value of human bitemarks

1) General considerations:

a) After a pattern or patterned injury has been determined to be a human bitemark, an odontologist should evaluate the information in the bitemark for forensic significance or evidentiary value. The evidentiary value of the information should be determined to be sufficient before initiating comparisons to dentitions (see criteria at iv.2 *infra*).

b) Induced distortion of the skin from biting action and other factors related to the nature of human skin can affect the recording of the dental features, arch size, and arch shape in the bitemark.

c) Certain factors influence the interpretation of bitemarks on human skin. (see Appendix 2)

2) Criteria for Determining Evidentiary Value

Conditions and features of bitemark evidence that indicate sufficient evidentiary value for comparisons to dentitions include but are not limited to these criteria:

a) The bitemark pattern was adequately photographed both without and with a reference scale a) in place, and b) on the same plane as the pattern or injury. (Note: Image management software cannot correct for deficiencies in this criterion.)

b) Images used for comparison are properly focused, adequately illuminated, suitably exposed, and made with the plane of the image receptor either a) parallel to the plane of the portion of the bitemark being imaged, or b) not parallel to the portion of the bitemark being imaged but the images can be corrected for the angle known as theta (θ) using image-management software.

(see Theta (θ) in Appendix 1)

d) Either the maxillary or mandibular arch or both arches can be located and the midline of one or both arches can be determined.

e) Some marks caused by individual teeth can be seen and recognized based on their class characteristics and/or location relative to other features.

f) The size and shape of each arch conforms to the variations of the size and shape of the human dentition.

e. Bitemarks made by Permanent, Mixed, and Primary Dentitions

i. The criteria used to distinguish bitemarks made by an adult's teeth *versus* bitemarks made by a child's teeth should be based not on size alone, but also on the differences of the class characteristics of the permanent

dentition and the primary dentition. Class characteristic features should be visible in the bitemark.

Bitemarks made by children and adolescents during their mixed dentition phase may exhibit characteristics of permanent and primary dentitions.

3. Linkage Terminology

The ABFO standards and guidelines indicate that if sufficient information is available to support conclusions, bitemark linkage conclusions should only a) exclude or b) not exclude (*include*) a dentition. The specific terms found in 2.c. are: a) for exclusion, Excluded as Having Made the Bitemark, and b) for inclusion, Not Excluded as Having Made the Bitemark. Stronger terms of attribution are not condoned by the ABFO (see Standard 1.f.)

The following guidelines sections comprise the Best Practices for evidence collection, analysis, comparison and reports. Best Practices should be followed by odontologists whenever possible and practical.

4. Evidence Collection

From Questioned Patterns, Patterned Injuries, Bitemarks, Persons of Interest, and Dentitions

a. General considerations

i. A questioned bitemark is a pattern or patterned injury that may or may not be a bitemark.

ii. A dentition or subject dentition refers to the teeth of a known person of interest that may or may not have caused a bitemark.

iii. The odontologist who collects the evidence from a questioned pattern, patterned injury, or bitemark should not also collect evidence from the dentitions of known persons of interest (see 2.a.iii.1).

iv. If only one person of interest is proffered, then a line-up of dentition evidence from persons of interest and foils should be employed. (see Foil in Appendix 1) Foils should be persons unrelated to the case but with similar dentitions. (see 2.a.iii.2).

v. An odontologist performing comparisons should be blinded to the identities of persons of interest and their dentitions (see 2.a.iii.4)

vi. Evaluation of bitemark evidence includes:

1) Examination of questioned patterns and patterned injuries to form conclusions, if the evidence allows, of whether or not they are bitemarks

2) Interpretation and analysis of those questioned patterns or patterned injuries that are concluded to be bitemarks

3) Comparison of evidence from bitemarks containing sufficient evidentiary value to evidence from subject and foil dentitions, and

4) Formation of opinions, if the evidence allows, of whether a bitemark is excluded or not excluded as being caused by the subject and foil dentitions

vii. Following evidence-based evaluation and analysis and if the evidence is sufficient, comparisons of bitemarks to subject and foil dentitions can be undertaken. These steps should follow established guidelines. Together they constitute a forensic physical comparison.

viii. Because bitemark evidence evaluations, analyses, and comparisons fall within the knowledge spectrum described in state and federal rules of evidence as "scientific, technical, or other specialized knowledge that can be helpful to the court," the admissibility of bitemark evidence in a legal proceeding is a determination made solely by the court.

b. Case information

i. Case agency, case number, and date of examination should be noted and can also appear on the reference scale utilized for photographs.

ii. The names of subjects should be recorded, if available, as well as the place of examination. However, information produced for blinded second opinions or independent verifications of conclusions should omit names or other identifying information

iii. The medical or legal authority that requested or provided authorization for the odontology examination should be documented.

c. Chain of custody

i. Receipt of any evidence by the odontologist should be clearly documented using appropriate chain of custody, including the case name and number, time and date of delivery, an inventory of the evidence delivered, and from whom the evidence was received, along with the recipient's signature.

ii. Release of evidence by the odontologist should be similarly documented.

iii. A copy of the chain of custody should be retained as part of the case record.

iv. The odontologist should place his/her mark and date of examination on each item of physical evidence, such as dental casts, CDs, DVDs, photographs, etc. in a non-diagnostic area using a method that does not materially alter the item or evidence.

d. Evidence collection from questioned bitemarks

i. General considerations

1) In the context of this section the terms questioned bitemark, pattern, and patterned injury can be used interchangeably.

2) Initial evidence collection from a questioned bitemark can be a one-time event without the possibility of a follow-up examination. When the odontologist is involved in the initial examination, collection of evidence from the site(s) should include the methods of documentation described below.

3) Evidence that was collected by others may be provided. Odontologists should assess such evidence and proceed only if the forensic significance or evidentiary value of the evidence justifies continuing the analysis.

4) Legal permission in the form of a written consent, search warrant, subpoena, or court order should be obtained from the appropriate authority prior to investigative procedures and should be noted in the reports.

ii. Documentation

1) General descriptors

a) Case agency
b) Case number
c) Examiner
d) Age, sex, and race of bitemark recipient

2) Pattern location

a) Anatomical location of patterned injuries
b) Surface contour
c) Tissue characteristics
d) Object (medium) description, if not human skin

3) Pattern or injury features

a) Size
b) Shape
c) Nature (abrasion, contusion, laceration, avulsion)
d) Other (indentations, incisions, unusual features)

4) Pattern description

a) Orientation of maxillary/mandibular dental arches
b) Locations of midlines
c) Individual tooth marks
d) Unmarked areas
e) Tooth rotations, translations or anomalies
f) Summary

iii. Orientation photographs

Prior to other evidence collection procedures, orientation images should be exposed to document the identity of the object or person, case information, and clearly demonstrate the location(s) of the questioned bitemarks.

iv. Swabbing

If not already accomplished, each questioned bitemark should be swabbed for biological evidence following the proper protocols for the jurisdiction.

v. Photography

1) Under normal circumstances the pattern or patterned injury should be photographed using a high quality digital camera. Whenever possible the photographic procedures should be performed by or under the direction of the forensic odontologist.

2) Once the orientation images have been exposed as recommended in 5.d.iii. progressively closer photographs should be sequentially exposed of each questioned bitemark.

3) Images should be of sufficient resolution to allow for enlargement to life-sized dimension without pixilation.

4) Photographs of the pattern or patterned injury should be exposed without and with a properly placed and labeled reference scale (e.g. ABFO No.2© or similar).

5) In some cases, it can be beneficial to obtain serial photographs of the patterned injury over time.

6) Both ambient and artificial lighting can be used, as well as infrared (IR), reflective ultraviolet (UVA)**,** and alternate light source (ALS) imaging when indicated.

7) Video imaging can be used *in addition* to conventional still photography.

vi. Impressions

1) Impressions should be taken of the surface containing questioned bitemarks, especially when three-dimensional properties are present. The impression materials used should meet American Dental Association (ADA) specifications and should be documented by name, including lot number and expiration date, in the report.

2) Impressions should be taken of the dentition of a person with a questioned bitemark to assess the possibility of a self-inflicted bitemark. Or, in case the person with the questioned bitemark may have bitten another person that was involved in the incident.

a) Adequate support should be provided for the impression material.
b) Impressions should be poured with appropriate ADA listed materials following the manufacturer's directions. The resulting casts should be labeled and stored following appropriate chain of custody.

vii. Checklist – A checklist for Evidence Collection from Questioned Bitemarks is at Appendix 4

e. Evidence collection from persons of interest

i. General Considerations

1) Subject dentitions are the teeth of persons of interest.

2) Prior to collecting evidence from persons of interest, the odontologist should ensure that a written search warrant, court order, or other legal consent has been obtained from the appropriate authority, or the subject person in the case of informed consent.

3) Court documents or consent as in 2) above provide legal authority for the collection of the evidence listed below. Copies of these documents should be retained as part of the case record.

4) Whenever practical, the odontologist who collects the evidence from a questioned bitemark should not also collect evidence from the dentitions of persons of interest. An exception exists if, in the judgment of the odontologist, a questioned bitemark could have been self-inflicted. In these cases, the odontologist should also collect evidence from that person's dentition.

5) Similarly, whenever practical, a second odontologist or another dentist should collect evidence from persons of interest following the guidelines below.

6) If only one person of interest is proffered, in order to produce a dental line-up a second odontologist or dentist should collect or provide evidence from other individuals who are foils with similar dentitions to the person of interest.

ii. Evidence collected should include:

1) Demographic and other identifying information
2) Dental treatment records, if available

iii. Photography

To the extent possible, photographic documentation should include:

1) Extraoral photographs
2) Full face
3) Right and left three-quarter profiles
4) Right and left full profiles
5) Intraoral photographs (with retractors and mirrors as needed):

a) Anterior view with teeth closed
b) Anterior view with teeth slightly parted
c) Anterior view with mandible protruded
d) Anterior view demonstrating maximal opening
i) with reference scale

ii) without reference scale

e) Lateral views, both left and right sides

f) Occlusal views of each arch

g) Additional photographs that may provide useful information

h) Images of surfaces of test bites with and without reference scales

6) Video imaging can be used *in addition to* conventional still photography

iv. Intraoral examination

The dentist performing the intraoral examination should document the condition of the teeth, including the following:

1) Missing teeth
2) Fractured teeth
3) Mobile teeth
4) Condition of the periodontium
5) Maxillary and mandibular tori
6) Tongue and lip piercings and/or jewelry
7) Other unusual intraoral features or anomalies

v. Impressions

1) Maxillary and mandibular impressions should be taken. Both conventional and digital impression techniques utilized in clinical dentistry are acceptable.

2) For conventional impressions, ADA-listed materials should be used following established dental impression techniques. Dental casts should be produced from impressions following established techniques.

3) For digital impressions ADA-listed optical scanner and laser scanner techniques are acceptable.

a) The digital files from the scans can be used for digital analyses utilizing appropriate software techniques.

b) Alternately, the digital files can be used following established techniques to produce physical dental casts

4) If removable prostheses are present, impressions should be made both with and without the prosthetic appliances *in situ*.

5) The inter-occlusal relationship should be recorded using ADA-listed materials and techniques.

vi. Sample or test bites should be recorded using ADA-listed materials and appropriate techniques. These items should be labeled, photographed, and retained.

vii. Dental casts

1) If physical casts from either conventional or digital impressions are produced, master casts should be prepared. For master casts produced from conventional impressions, ADA-listed Type III dental stone prepared according to manufacturer's instructions should be used following established dental techniques. Master casts may also be made from digital files from digital 3D scans using fit for purpose ADA-listed materials.

2) Additional casts can be poured from polyvinylsiloxane or polyether impressions or fabricated from digital files. Each subsequent model poured should be sequentially labeled to indicate the order of production.

3) If the original conventional impressions are taken using alginate or similar materials, duplicate casts can be produced from an impression of the master cast made using ADA-listed materials for duplication.

4) Duplicate casts should be appropriately labeled and the master cast utilized to produce the duplicate should be noted.

5) Master casts should not be altered. All tests and experiments should be performed using duplicate casts.

viii. Other evidence

Upon request, additional reference samples can be collected and stored with appropriate authorization and following established protocols.

f. A checklist for dentition evidence collection is at Appendix 5

5. Bitemark Analysis

a. General considerations

i. Bitemark analysis in the context of this section refers to the analysis of patterns or patterned injuries that may or may not be bitemarks, as well as the continued analysis of patterns or patterned injuries that in the opinion of the odontologist are bitemarks.

ii. Once an odontologist forms an opinion that a pattern is a human bitemark, the odontologist should complete the analyses of that bitemark before making any comparisons to the dentitions of persons of interest.

iii. Comprehension of dental and oro-facial anatomy and morphology, plus an understanding of dental treatment modalities, are required for evaluation and interpretation of a pattern or patterned injury caused by human teeth.

b. Interpretation of a Pattern or Patterned Injury as a Bitemark

i. Assessment of a pattern

1) Determining the orientation of the marks caused by maxillary and/or mandibular teeth. The relative size and morphological differences visible in the pattern may support differentiation between marks from the maxillary and mandibular arches. Assessments may include, but are not limited to:

   a) Locating within the marks the position(s) of the midline(s) of the maxillary and/or mandibular arches. Midline(s) of the maxillary and mandibular arches may be determined either by noting the central incisors visible in the mark, or by determining the midpoint of each arch.

   b) Locating marks caused by specific teeth by examining the anatomical morphology of the incisal edge and occlusal surface patterns.

   c) Locating areas without marks potentially due to missing, fractured, unerupted, partially erupted, malformed, or ectopic teeth.

   d) Locating features that indicate rotations, translations, or other anomalies caused by specific teeth.

   e) Performing a manual or computer-assisted metric analysis of the overall and specific features of the questioned bitemark.

   f) Locating drag marks (e.g. abrasions, striations) in relation to specific teeth induced by motion during the act of biting.

2) Summarize the features that form the pattern including:

   a) Class characteristics of:

      i) Primary dentition
      ii) Mixed dentition
      iii) Permanent dentition

   b) Individual characteristics

      i) Individual arch characteristics
      ii) Individual dental characteristics

   c) Anomalies or other unusual features

3) Form conclusion

ii. Graphic aids

Odontologists can use graphic aids to assist in the analyses or to demonstrate features of a questioned bitemark. For example, a software

program can be used to optimize an image or to create demonstrative graphics.

c. Conclusions and Opinions

Following completion of the bitemark analyses, conclusions should be made following ABFO terminology guidelines (see 2.b and 2.c). A list of features that support the conclusion(s) should be included.

6. Bitemark Comparisons

a. General considerations

i. An unknown exhibit (i.e. questioned bitemark), for which the odontologist is attempting to identify the origin, should be compared to the known reference exhibit(s) (i.e. dentition evidence).

ii. Only patterns and patterned injuries that the odontologist has concluded are human bitemarks should be compared to the dentitions of persons of interest.

iii. Patterns and patterned injuries the odontologist has concluded are animal bites can be compared to the dentitions of animals of interest.

iv. Bitemark analyses should be completed before comparisons to dentitions are undertaken.

v. To the greatest extent possible, odontologists should be blinded to information about the dentition evidence that would disclose the identity of a person of interest.

vi. Whenever possible, a second odontologist or other dentist should collect the dentition evidence from persons of interest and from foils and then provide that evidence in a manner that allows odontologists performing comparisons to be blinded to the source.

vii. Bitemark comparison conclusions are odontologists' opinions derived from evaluations and analyses based on education, training, knowledge, skill, and experience.

viii. An odontologist should recognize that many human dentitions are similar and that bitemarks are not always accurately recorded in human skin. Opinions that exclude or do not exclude persons of interest should only be made in cases in which information is sufficiently clear and distinctive to allow those opinions.

b. Methods of comparison

i. Overlays

1) Overlays are tools useful for comparing a dentition to a pattern or patterned injury determined to be a bitemark. Overlays can be hollow

volume, solid volume, semi-transparent, or other representations of the biting surfaces of subject or foil dentitions.

2) Overlays can be computer generated from 2D or 3D scans of the subject or foil dentitions, 2D photographic images of the teeth or dental casts or 2D or 3D scans of dental casts.

3) Odontologists should confirm that the overlays and the images to which they will be compared are identically sized.

ii. Test bites

1) Test bites are made by producing simulated bites in a medium using dental casts. The medium used for the test bites can be dental wax or other ADA-listed dental materials, animal skin, human skin, or other media. Test bites can be made in more than one medium.

2) Test bites can be used to produce overlays. The overlays can be manually or computer generated and compared to or superimposed over same-sized images of the bitemark.

3) Test bites can be useful to analyze similarities or differences between the test bites and the bitemark. Analyses can be completed side-by-side or utilizing an overlay technique.

iii. Additional comparison techniques may include, but are not limited to:

1) Exemplars of the subject's dentition compared to corresponding-sized images of the bite pattern

2) Life-sized casts of subject's dentition compared to life-sized images or 3D casts of bitemark patterns

3) Manual or computer-generated comparisons

4) Digitization and computer enhancement of images

5) Use of computer software to assist in performing comparisons

6) Stereomicroscopy

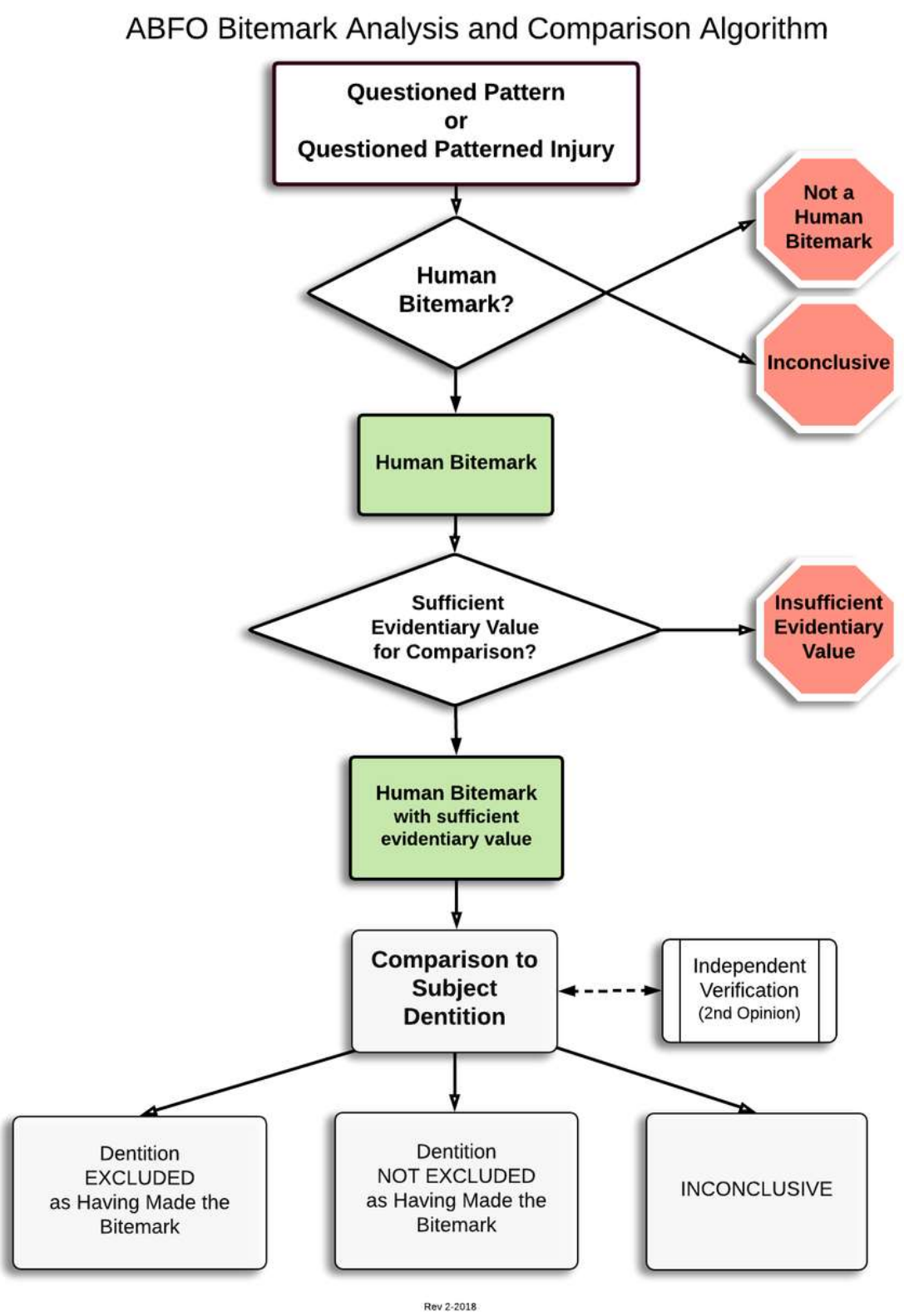
7) Scanning Electron Microscopy

c. Conclusions

Conclusions should be expressed following ABFO Standards and Guidelines. A list of features supporting conclusions should be included.

d. ABFO Bitemark Analysis and Comparison Algorithm

The algorithm is intended as a graphic aid to odontologists. See following page.


ABFO Bitemark Analysis and Comparison Algorithm
Questioned Pattern or Questioned Patterned Injury
Human Bitemark?
Not a Human Bitemark
Inconclusive
Human Bitemark
Sufficient Evidentiary Value for Comparison?
Insufficient Evidentiary Value
Human Bitemark with sufficient evidentiary value
Comparison to Subject Dentition
Independent Verification (2nd Opinion)
Dentition EXCLUDED as Having Made the Bitemark
Dentition NOT EXCLUDED as Having Made the Bitemark
INCONCLUSIVE
Rev 2-2018

7. Bitemark Evidence Reports

a. General considerations

i. The guidelines below apply generally to preliminary, interim, and final reports.

b. Independent verification

i. An odontologist investigating a human bitemark case should seek independent verification in the form of a second opinion from a minimum of one ABFO Diplomate before submitting a final report. (see 2.a.iv).

ii. A second opinion checklist is at Appendix 6

c. Components of bitemark evidence reports may include:

i. Introduction – Background information for the case. For example, what was requested, by whom, when requested, and why the request was made.

ii. Inventory of evidence received – Evidence submitted to the odontologist, including how and when acquired.

iii. Inventory of evidence collected – Type, source, and authority for evidence collected by the odontologist, evidence collected, official exhibit number assigned to the items of evidence collected, collection location, and date and time custody of each exhibit was accepted.

iv. Findings regarding pattern – Opinion stated using ABFO terminology.

v. Analysis – Methods employed, including the times and dates when the analyses took place.

vi. Results – Outcomes of analyses and comparisons.

vii. Conclusion – Conclusions and opinions of the relationship between each bitemark and dentition using ABFO terminology (see 2.b). Only one term of conclusion should be used for each comparison.

viii. Disclaimer – Optional statements can be included to convey that the opinion(s) are based on the evidence examined. For example, the odontologist can reserve the right to file subsequent reports should other evidence become available.

8. Appendices

Appendix 1 – Glossary of Terms

Appendix 2 – Factors Influencing the Interpretation of Bitemarks on Human Skin

Appendix 3 – Uses of Bitemark Evidence

Appendix 4 – Checklist for Evidence Collection from Questioned Bitemarks

Appendix 5 – Checklist for Evidence Collection from Dentitions of Persons of Interest

Appendix 6 – Checklist for Second Opinions in Bitemark Evidence Cases

APPENDIX 1
Glossary of Terms Used in Standards and Guidelines

Bitemark (*bite mark* and *bite-mark* are also acceptable forms)

- A physical alteration with a representative pattern that is registered in a medium caused by the contact of the teeth of a human or animal

Class Characteristic

- A general characteristic that defines a category of items or objects but alone is insufficient to establish identity
- A feature, trait, or pattern that distinguishes the human dentition from other items or objects or the dentitions of animals
- A feature, trait, or pattern that distinguishes a bitemark from other patterned injuries

Dental Prosthesis

- An artificial replacement of one or more teeth and/or associated structures

Dentition

- The teeth in the dental arches

Excluded

- In relation to bitemark evidence, a subject or foil dentition that is eliminated as having caused a bitemark

Exemplar

- A demonstrative example or model of an item or object(s)
- In bitemark evidence comparisons, exemplars are used to demonstrate the shape, size and position of the biting surfaces of the dentition

Foil

- In the context of a dental line-up for bitemark evidence comparisons, an individual or evidence from an individual that is not a person of interest but rather a distractor

Guideline

- An item, action, or level of practice or conduct that is recommended or suggested but not mandatory

Individual Characteristic

- A characteristic caused by intentional, unintentional, or accidental changes during use, development, etc. that are exceptional and can be used to individualize or identify a specific item or object
- A feature, trait, or pattern that represents an individual variation rather than an expected finding within a defined class or group

Not Excluded

- In bitemark evidence comparisons, a dentition that cannot be eliminated from having caused a bitemark

- The dentition is included in the population of dentitions that could have caused the bitemark
- Results of a comparison that determines the absence of unexplainable discrepancies

Objective

- Developing and maintaining neutral and unbiased attitudes, approaches, and opinions that are based on the available evidence

Pattern

- A distinctive shape, form or array
- In the context of bitemark evidence, a distinctive shape, form or array that appears in or on tissue or in or on a medium other than tissue

Patterned Injury

- An injury in tissue with distinctive shape, form or array indicating the characteristics of the contacting surfaces of the object(s) that caused the injury

Perimortem

- Occurring at or about the time of death

Person of interest

- An individual or subject who may or may not be associated with an event
- In the context of bitemark evidence, an individual or subject who had or may have had access to an individual who received a bitemark during a specified time interval

Shall

- The referenced item, action, or proscription is mandatory

Should

- The referenced item, action, or proscription is recommended

Standard

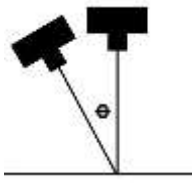
- A compulsory (i.e. mandatory) item, action, or level of practice or conduct

Subject Dentition

- The teeth of a person of interest that may or may not have caused a bitemark

Theta (θ)

- In the context of pattern or patterned injury evidence photography, when an image is recorded with the plane of the image receptor not parallel to the portion of the pattern being imaged, theta (θ) is the angle between an imaginary line perpendicular to the image receptor plane extended to a point on the surface imaged and an imaginary perpendicular line from an optimally placed camera's image receptor plane extended to that same point



APPENDIX 2
Factors Influencing the Interpretation of Bitemarks on Human Skin

1. Human skin factors

    a. Type
    b. Thickness
    c. Pigmentation
    d. Nature of underlying tissues
    e. Viscoelasticity
    f. Anisotropy (orientation to skin tension lines)
    g. Hysteresis (short term only)
    h. Vital response to injury

2. Injury factors

    a. Contusion
    b. Abrasion
    c. Laceration
    d. Incision
    e. Avulsion

3. Biting dynamics factors

    a. Movement during biting by person biting or person bitten
    b. Force of the bite
    c. Positional changes during and after biting

4. Age of the person bitten

    a. Properties of human skin can change with age
    b. Skin of older persons can respond to trauma with varying degrees of contusion, abrasion, laceration, and other effects
    c. Skin of older persons can heal differently compared to the skin of younger persons

5. Health of the person bitten

    a. Systemic diseases can affect the response of skin to trauma
    b. Effects or side effects of medications can affect the response of human skin to traumas

6. Other

    a. Healing process changes in bitemarks on living subjects. Examples:
        i. Edema presence, progression, and resolution
        ii. Contusion presence, progression, and resolution
        iii. Scab formation and resolution
        iv. Scars, fibrosis, and permanent skin changes

    b. Postmortem changes in bitemarks on deceased subjects

APPENDIX 3
Uses of Bitemark Evidence

Bitemark evidence may be used to:

1. Document aspects of violence

2. Provide a profile of the dentition of a person of interest

3. Compare information from bitemarks to subject or foil dentitions

4. Provide a potential physical and temporal link between a recipient of a pattern or patterned injury and the dentition of the perpetrator

5. Support or refute the history of events that is reported by individuals in a legal proceeding

6. Further potential uses (from Silver, W.E., Souviron, R.R. (2009). *Dental Autopsy*. Boca Rotan, FL: CRC Press.):

    a. A bitemark can indicate the infliction of pain

    b. Bitemarks can be offensive, defensive, or consensual

    c. Bitemarks usually indicate acts of violence

    d. A bitemark can cause permanent injury; for example, avulsion of an ear, finger, nose or other body part

    e. Bitemarks of high evidentiary value with distinctive markings can yield clues about the dentition of the questioned dentition – even in the absence of a formal comparison

    f. Bitemarks in different stages of healing can indicate episodic infliction of injuries or abuse over time

    g. Absence of any vital skin reaction (e.g. hemorrhage, swelling, etc.) can be indicative of a bitemark caused following death

    h. Relative positions of the participants in violence involving bitemarks can vary. The location and orientation of bitemarks can provide odontologists with clues to interpret the dynamic interchange

    i. Anatomical locations of some bitemarks indicate that the bitemarks could not have been self-inflicted

    j. Presence of a bitemark should prompt medical personnel or members of the death investigation team to collect salivary evidence

APPENDIX 4
Checklist for Evidence Collection from Questioned Bitemarks

1. Initial Steps

   a. Case data documentation

      i. Identification data
      - ☐ Case agency
      - ☐ Case number
      - ☐ Examiner

      ii. Pattern location data
      - ☐ Anatomical location
      - ☐ Surface contour
      - ☐ Tissue characteristics
      - ☐ Object (medium) description, if not human skin

      iii. Pattern or patterned injury features data
      - ☐ Size
      - ☐ Shape
      - ☐ Nature (abrasion, contusion, laceration, avulsion)
      - ☐ Other (3D features, indentations, incisions, unusual features)

      iv. Pattern description data
      - ☐ Orientation of maxillary/mandibular dental arches (if visible)
      - ☐ Locations of midlines (if visible)
      - ☐ Individual tooth marks
      - ☐ Unmarked areas
      - ☐ Features indicating tooth rotations, translations, or anomalies
      - ☐ Summary of overall features

   b. Orientation photographs

   ☐ Orientation images exposed prior to other evidence collection to document characteristics of the person or object, the case number and date, and anatomical location(s)

   c. Swabbing

   ☐ If not completed by other investigators, each bitemark swabbed for DNA following proper protocols for the jurisdiction. If there is no jurisdictional protocol, the double-swab method is used

2. Photography

☐ High-quality digital camera used. Photographic procedures are performed by or under the direction of the forensic odontologist

☐ Appropriate ambient or artificial lighting (or both) utilized

☐ Overall orientation images then progressively closer images exposed of each bitemark

☐ Images of sufficient resolution for enlargement to life-size without pixilation

☐ Photographs exposed without and with a properly placed and labeled ABFO No.2© or similar reference scale

- ☐ Reference scale is a) in the same plane as, and b) adjacent to the portion of the pattern or patterned injury being imaged
- ☐ Camera sensor and lens face are parallel to both the plane of the reference scale and the plane of the pattern being imaged
- ☐ On curved or compound curved surfaces, multiple images are exposed with the camera sensor, lens face, reference scale, and the pattern in the same plane

☐ For a living person or person recently deceased, sequential photographs of the injury over time

When indicated, in addition to conventional visible light photographs, ☐ Infrared (IR), ☐ Ultraviolet (UVA), or ☐ Alternative Light Source (ALS) images are exposed

☐ Video imaging *in addition* to conventional still photography as indicated

3. Impressions

☐ Impressions of the surface containing the pattern or patterned injury when 3D properties are present using ADA-listed materials and named in the report, including lot number and expiry date

☐ Impressions of the dentition of the person with the bitemark to assess possibility of self-inflicted bite or to determine if they may have also bitten another person

☐ Suitable support provided for the impression material

☐ Impressions are poured using manufacturer's instructions and casts are labeled and retained following appropriate chain of custody

4. Chain of Custody

☐ Evidence received, collected or developed is clearly documented using appropriate chain of custody showing the case name and number, time and date of delivery, an inventory of the evidence delivered, and from whom the evidence was received along with his/her signature

☐ Similarly document any release of evidence by the odontologist

APPENDIX 5
Checklist for Evidence Collection from Dentitions of Persons of Interest

1. General Considerations

☐ Ensure appropriate search warrant, court order, or legal consent has been obtained

☐ Copies of these documents are retained as part of the case record

☐ Impressions of the dentition of the person with the bitemark to assess possibility of self-inflicted bite or to determine if they may have also bitten another person

☐ Another dentist collects dental evidence from persons of interest and foils. Blinded exemplars are provided to the odontologist for analysis but identities of persons contributing exemplars are not released.

2. Evidence Collected Should Include

☐ Demographic and other information specific to the subject

☐ Dental treatment records, if available

Photographs – to the greatest extent possible, photo documentation includes:

A. Extraoral photographs
- ☐ Full face
- ☐ Right and left three-quarter profiles
- ☐ Right and left profiles

B. Intraoral photographs (with retractors and mirrors as needed)
- ☐ Anterior view with teeth closed
- ☐ Anterior view with teeth slightly parted
- ☐ Anterior view with mandible protruded
- ☐ Anterior view demonstrating maximal opening
  - ☐ With reference scale
  - ☐ Without reference scale
- ☐ Lateral views, both right and left sides
- ☐ Occlusal views of each arch

C. Additional images
- ☐ Maxillary and mandibular surfaces of test bites with and without reference scale
- ☐ Video imaging in addition to conventional still photography as indicated

Intraoral examination

A. Condition of the teeth
  - ☐ Missing teeth
  - ☐ Fractured teeth
  - ☐ Mobile teeth

B. ☐ Condition of the periodontium

C. ☐ Presence of maxillary and/or mandibular tori

D. ☐ Presence of tongue and/or lip piercings and jewelry

E. ☐ Other unusual intraoral features or anomalies\

Impressions

- ☐ Maxillary and mandibular impressions taken with ADA-listed materials using appropriate dental impression materials
- ☐ If removable prostheses are present, impressions made both with and without the prosthetic appliances *in situ*

- ☐ Inter-occlusal relationship recorded using approved materials and techniques
- ☐ Alternate impressions using approved intraoral 3D scanners as needed
- ☐ Sample or test bites recorded using appropriate ADA-listed materials and techniques, and these records photographed and retained

Dental casts

- ☐ Master casts prepared from impressions using ADA-approved Type III dental stone following manufacturer's instructions and accepted techniques.
- ☐ Master casts may also be made using approved materials from 3D scans as needed.

Swabbing

- ☐ If not completed by other investigators, buccal swabs should be collected and stored following established protocols

APPENDIX 6
Checklist for Second Opinions in Bitemark Evidence Cases

1. Case identifiers
   - ☐ Name and/or identifier recorded of person or object bitten
   - ☐ Notation of dentitions of persons of interest and foils blinded
   - ☐ Status of recipient of patterned injury noted
     - ☐ Alive when injury occurred and alive when evidence collected
     - ☐ Alive when injury occurred and deceased when evidence collected
     - ☐ Deceased when injury occurred

2. Requesting agency
   - ☐ Name of agency noted
   - ☐ Case contact person and title at agency noted
   - ☐ Date of retention noted
   - ☐ Chain of custody documented

3. Dates
   - ☐ Date questioned bitemark made noted, if known
   - ☐ Date of initial evidence collection procedures noted
   - ☐ Dates of additional evidence collection procedures noted

4. Examination and documentation of questioned bitemark
   - ☐ Date, Place, & Time of examination noted
   - ☐ Others present at examination noted
   - ☐ Other experts or consultants used noted

     Description of the bitemark
     - ☐ Anatomic location of mark noted
     - ☐ Size and shape of mark noted
     - ☐ Type of tissue involved or type of medium if not human tissue noted
   - ☐ Documentation (photographic and other) appropriate for the nature of the injury
     - ☐ Exceptions noted in case specific comments below
   - ☐ ABFO terminology used to describe whether or not the pattern is a bitemark
   - ☐ Evidentiary value considered to support proceeding to comparison of bitemark(s)
   - ☐ Dentition cast acquisition and production techniques documented
   - ☐ Dental line-up utilized
   - ☐ Approved comparison technique(s) used
     - ☐ Other comparison techniques used
   - ☐ ABFO linkage terms used
   - ☐ Appropriate blinding procedures used
   - ☐ Second opinion written report produced following ABFO report writing guidelines

Case specific comments: