IDENTIFICATION OF THE LIVING & DEAD BY DENTAL MEANS

AN INTRODUCTION TO FORENSIC DENTISTRY

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FORENSIC ODONTOLOGY

Forensic Odontology is the application of dentistry in legal proceedings deriving from ANY evidence that pertains to teeth.

History

- The earliest known identification from teeth is in 1775 by Paul Revere.
- Paul Revere made a silver bridge for one man. The man was killed in the Revolutionary War.
- Body was in mass grave and identified by his silver dental work.

Why Teeth?



Every human body ages in a similar manner, the teeth also follow a semi-standardized pattern. These quantitative measurements help establish relative age of person.

Each human has an individual set of teeth which can be traced back to established dental records to find missing individuals.

Teeth is made of enamel (hardest tissue of the body) so it can **withstand trauma** (decomposition, heat degradation, water immersion, and desiccation) better than other tissues in body.

Teeth are a **source of DNA**: dental pulp or a crushed tooth can provide nuclear or mitochondrial DNA that to help identify a person.

Who practices Forensic Odontology and what do they do?

- Forensic dentists help:
  - *Identify human remains (individual and mass)*
  - *Analyze bite marks*
    - Bite marks are compared to known teeth molds to find origin of bite injuries
  - *Estimate age of the victim and perpetrator*
  - *Trace dental malpractice*

History of Forensic Odontology

- 66AD – First body identified using teeth
  - *Lollia Paulina*
- Revolutionary War
  - *Paul Revere was the first forensic dentist in the United States because he identified fallen revolutionary soldiers.*
- 1849 – Mass deaths at Vienna Opera House Fire
  - *Dental evidence is first admitted into court system in US*

Uses of Forensic Odontology

- The scope of forensic odontology is wide and includes the identification of victims of transport accidents, gunshot, and incineration in vehicles and house fires.

Definition

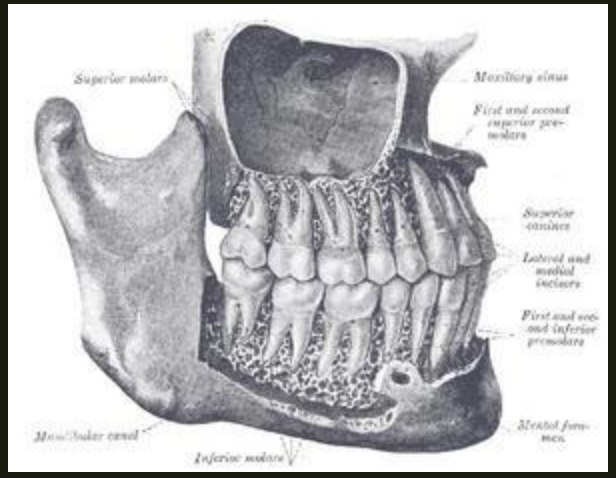
Forensic odontology is the application of dental principles to legal issues

Applications:

- Individual Identification
- Mass Disaster Identification
- Bite mark analysis
- Dental Malpractice

Hardest part of body attached TO jaws. IT serves to help digest food, act as a defense mechanism, etc. teeth are made of a crown with enamel surrounding a pulp.

TEETH



WHY Teeth?

- Enamel is the hardest substance in the body
- Can withstand heat up to 6,000 degrees
- Resistant to decomposition
- Teeth of pre historic man found after 1.5 million years
- Unique features on dentition characteristic of each individual

The dentition in Person Identification

- Identification of found human remains
- Identification in mass fatalities
- Identification of the living

Mass Disasters

- Mtongwe ferry
- Bukoba ferry
- Athi River Train Fire
- Kibwezi train accident
- Abidjan plane crash
- Marsabit plane crash
- Duola Plane crash
- Kyanguli school fire Bombolulu school fire
- Sunbeam building crash
- Sanchangwan tanker explosion
- Saradidi tanker explosion

- Nakumatt downtown fire
- Kikambala bomb blast
- 1998 Nairobi Bomb blast
- Kampala Bomb Blast
- Post election violence
- September 9/11
- Tsunami Indonesia 2005
- Tsunami Japan 2011

Earth, Wind and Fire

Methods of Dental Idetification

- Comparative Methods:

Comparison of ante mortem dental records versus Post mortem dental records

Records include: Dental Charts, Dental models, radiographs, clinical photographs

Dental X-rays

Teeth Basics

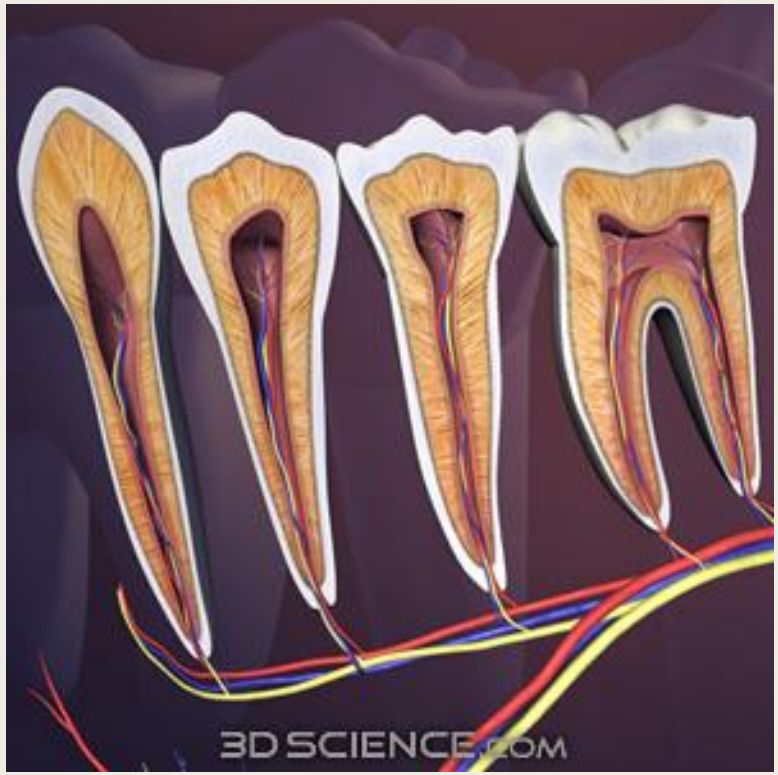
Approximately 32 teeth in adult mouth

Four types of teeth:

- *Molars*
- *Premolars*
- *Canine*
- *Incisors*

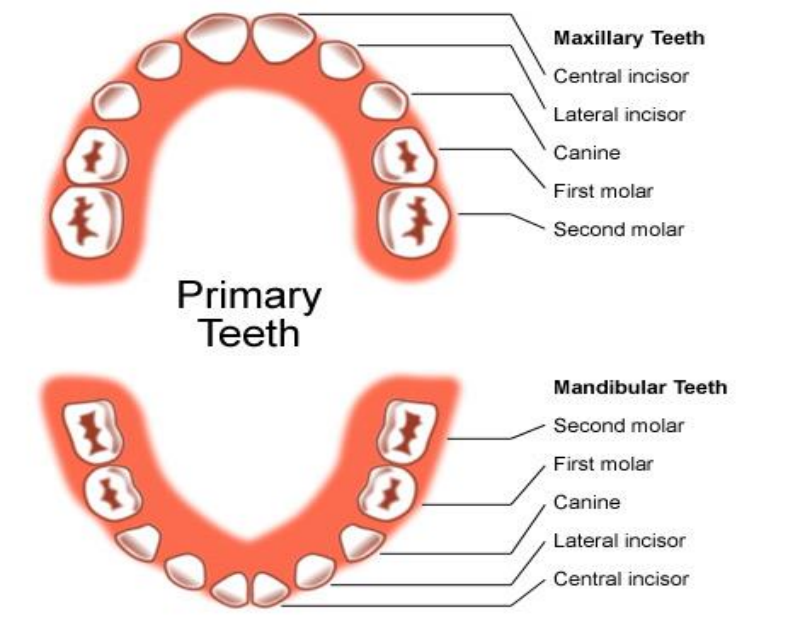
Teeth differ in:

- *Size*
- *Shape*
- *Root type*

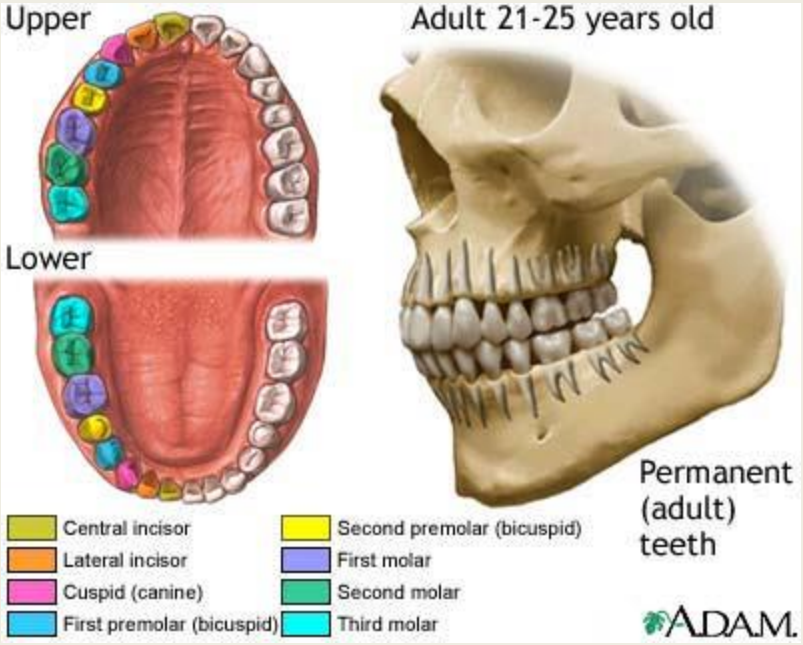


Types of teeth.
Left to right: Incisor, Canine, Premolar, molar.

Teeth through the years



Primary teeth sprout from milk buds and are temporary. Once they fall out, permanent teeth as seen on the other side appear.



- Permanent adult teeth come in when primary teeth fall out; they are permanent because they establish roots inside the gums. Third molar come in around the mid teenage years.

Standard Teeth Development for Age Determination

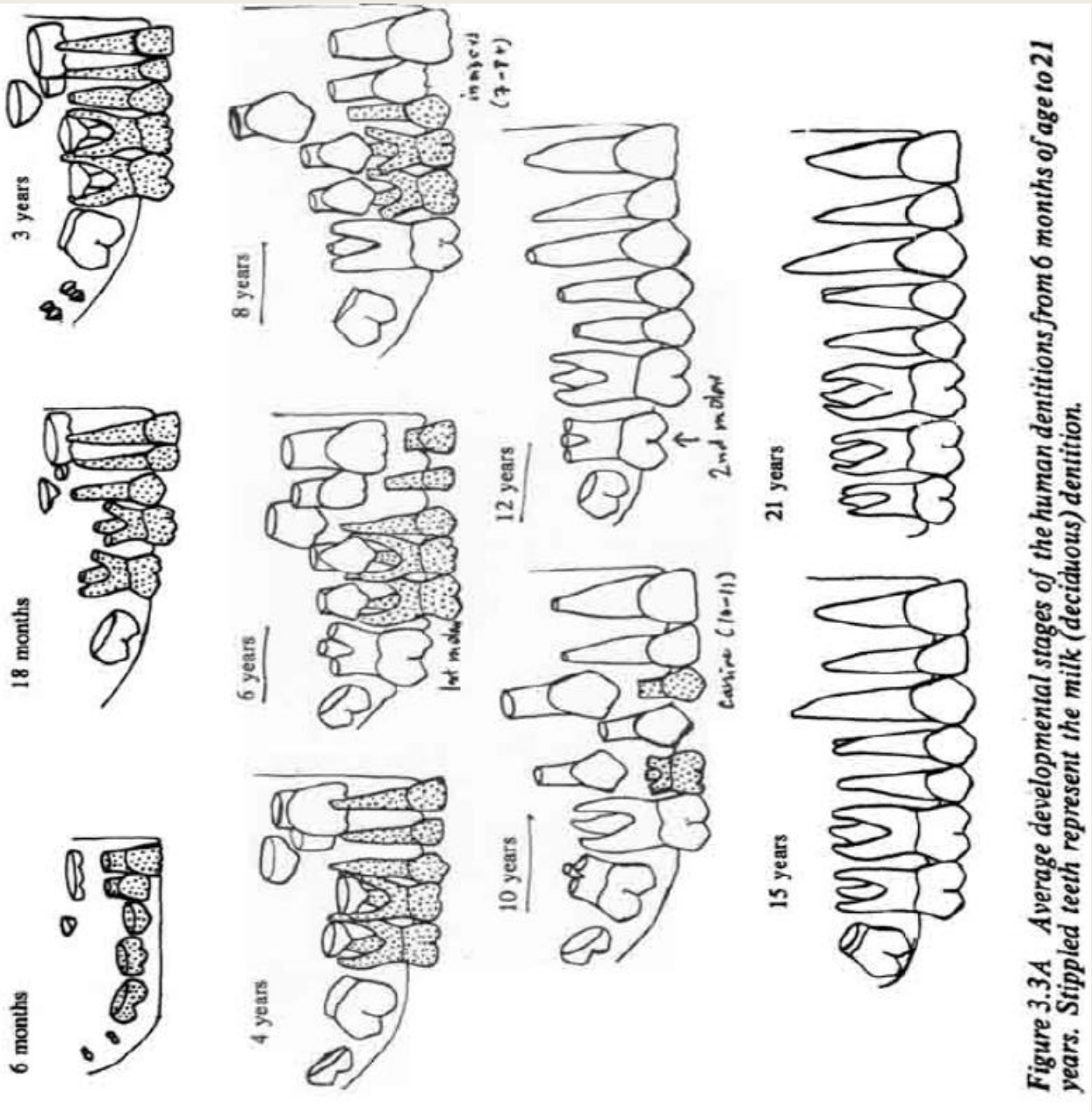


Figure 3.3A Average developmental stages of the human dentitions from 6 months of age to 21 years. Stippled teeth represent the milk (deciduous) dentition.

Individuality of Teeth

- Many combinations of restorations
- Size/Orientation can vary greatly
- Variable numbers of teeth
- Variable root structure

Individual Characteristics

Size of tooth

Shape of tooth

Shape of root

Placement of tooth

Quantity of teeth

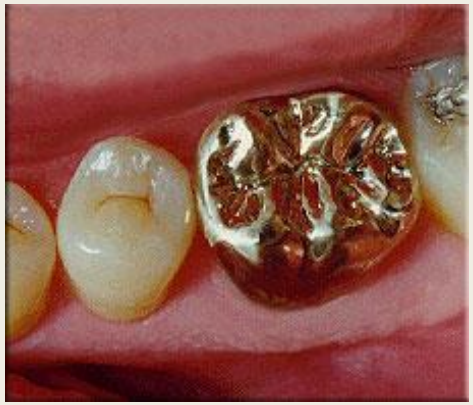
Combinations of dental work done:

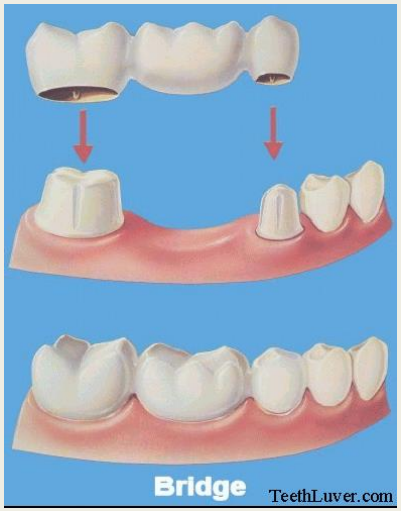
- *Crowns*
- *Extractions*
- *Bridge*
- *Fillings*
- *Root canals*

Various dental work

Dental Restorations

- Crowns
- Fillings
- Root canal
- Bridge
- Extractions





COMPARATIVE METHODS VS RECONSTRUCTIVE METHODS

Comparative methods of Identification

- Postmortem description is generated
  - *Radiographs taken*
- Possible identities known?
  - *Yes: Comparison to antemortem data*
    - Match strength determined
  - *No: Biological profile generated*

B.C. CORONERS' SERVICE
DENTAL IDENTIFICATION FORM

CORONER CASE No. 98-129-0008
DATE: 09 December 1998
INVESTIGATING CORONER S. Pellain
EXAMINATION SITE Vancouver City Morgue
LOCATION Port Hardy
CORONERS FORENSIC UNIT CASE # 98-123
POLICE FILE No. 98-2317
AUTOPSY No.
POLICE AGENCY RCMP Port Hardy
HOSPITAL
POLICE INVESTIGATOR Cst. M. Gillman
PATHOLOGIST

CIRCUMSTANCES OF EXAMINATION Skeletal remains found on Nov 09, 98 in the area of Quail Point, Port Hardy, B.C. Tentative I.D." "-DOB 01 Aug 19

UPPER RIGHT | UPPER LEFT
LOWER RIGHT | LOWER LEFT

CODE: Shade all restorations on Chart. Outline Prosthetic Appliances. Circle the appropriate descriptions

Follow Code:
A. Amalgam
S. Composite
G. Gold
SE. Fissure Sealant
TF. Temporary Filling
TC. Temporary Crown
GC. Gold Crown
PC. Porcelain Crown
PFM. Porcelain / Metal Crown
SC. Stainless Steel Crown
EN. Root Treatment
BR. Bridge Work (bracket & shade)
PP. Partial Denture (bracket & describe)
X. Missing
PX. Posthumously missing
NR. Not Recovered

1. Mottled Enamel
2. Enamel Hypoplasia
3. Discolouration
4. Staining
5. Calculus
6. Abrasion
7. Attrition
8. Erosion
9. Fractured Enamel
10. Rotation
11. Malpositioned Teeth
12. Malocclusion
13. Unerupted Teeth
14. Supernumerary Teeth
15. Retained Deciduous Teeth
16. Unusual Restorations
17. Unusual Appliances
18. Cyst Formation
19. Post
20. Pin
21. Caries
22. Congenitally Absent
23. Extruded paste material
24. Buccal restoration remains
25.

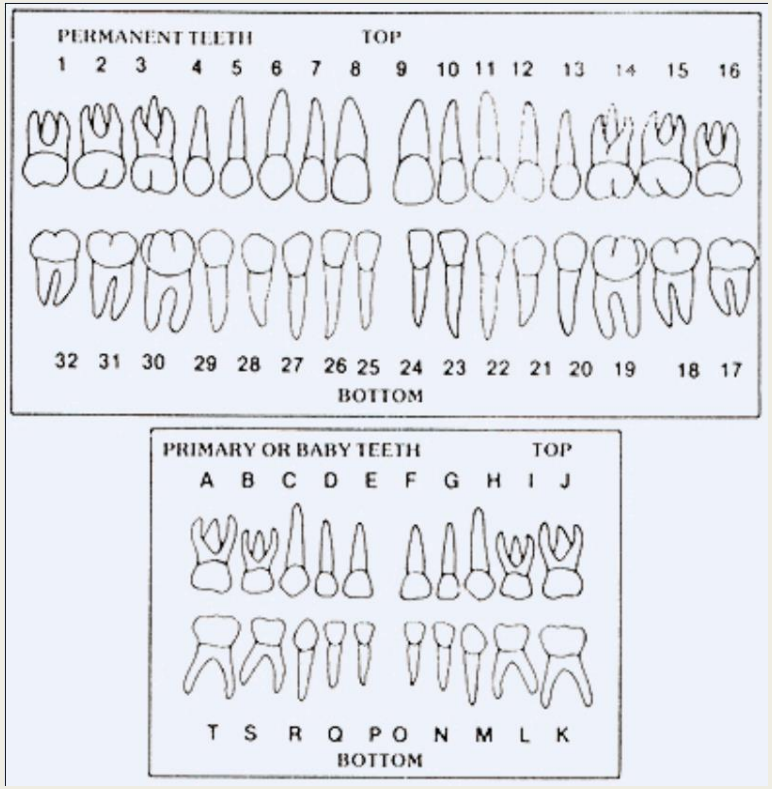
Post mortem dental x-ray . Yes / No
Photos . . . . . Yes / No
Study Models . . . . . Yes / No
Jaws disarticulated . . . . . Yes / No

Occlusion: Unreconstructable

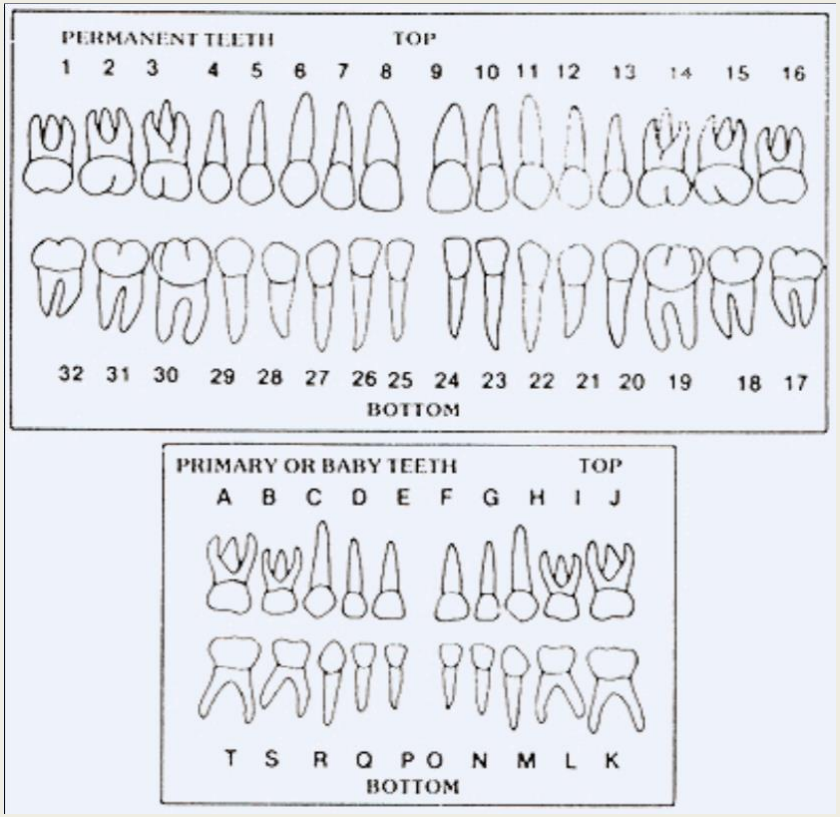
Remarks: Caucasian deposits green, root heathwaith unique, likely to track "peg-shaped" #22 Extracted and retained #1

The Universal System

- Each tooth has a specific number
- Each surface of the teeth are classified
  - *Notes extractions, fillings, orientation, etc.*
- Primary dentition noted with upper case letters



Analyzing Teeth



- The Universal System
  1. *Teeth are given a specific number. (Primary teeth are given specific capital letter)*
  2. *Any dental work done on surface is noted*
  3. *Sheets kept on dental file forever. When person is missing, files are transferred to the missing person's office*

Identification

Individual Identification

Postmortem description is generated

- *X rays and radiographs*

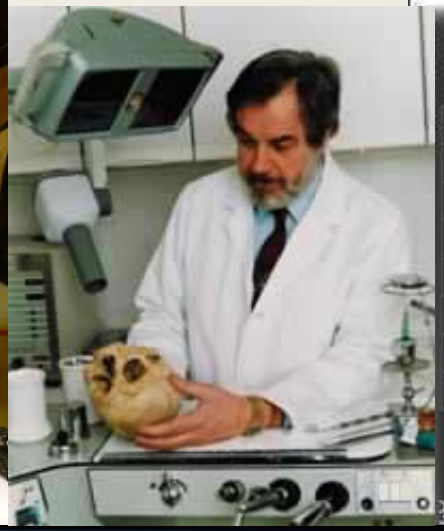
Positive identification is compared to ante-mortem data

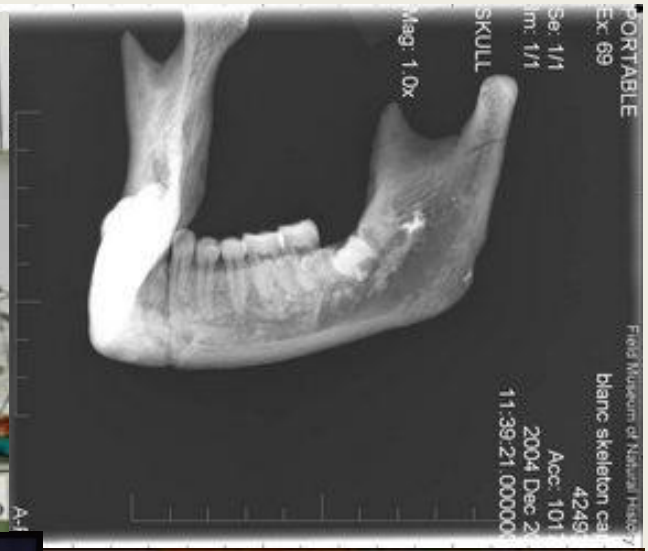
Negative identification, a biological profile is generated

Mass Identification

- Same process is used as individual identification
- Organization is crucial
- Family is asked to come identify the body, and narrow down the pool of victims.

Various Teeth Found





Dental X-rays

Reconstructive Methods

- Age

Prenatal period

Childhood period (Mixed dentition stage)

Adolescence up to 24 years

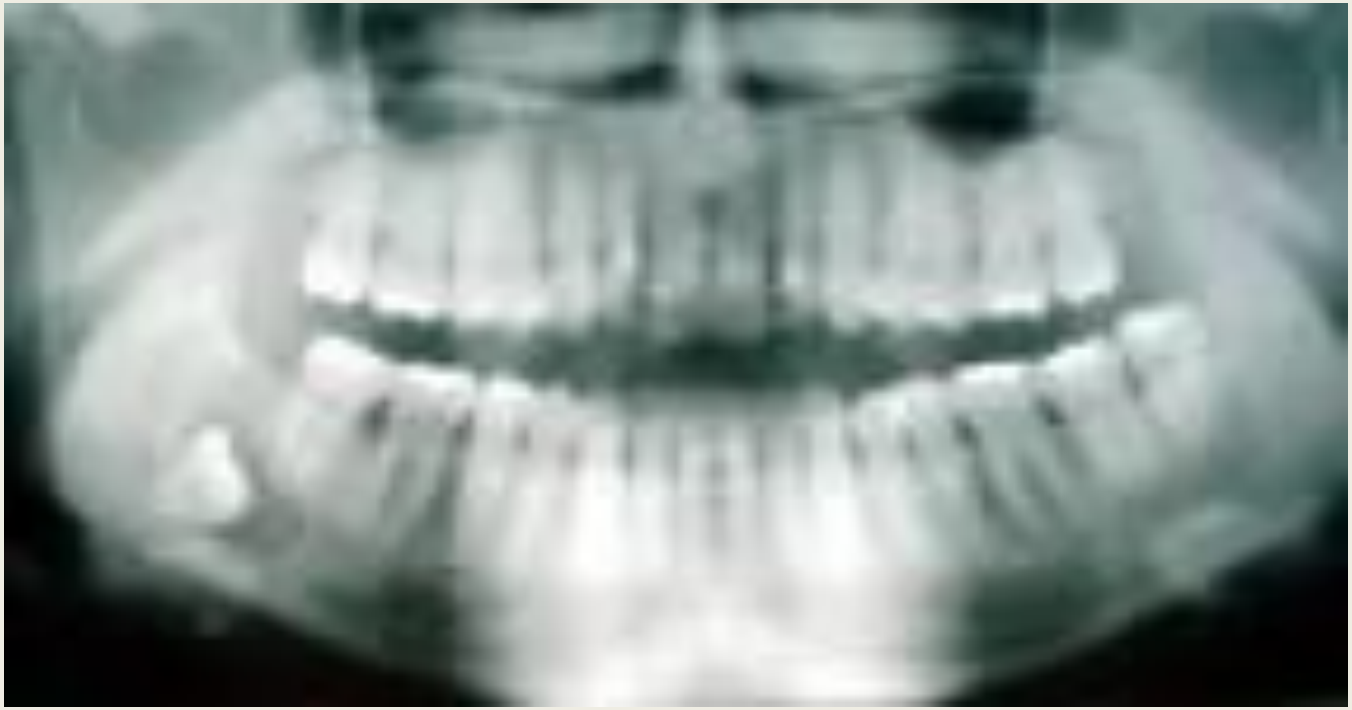
Why are teeth amenable to age estimation?

- Dentinal incremental lines
- Neonatal incremental line
- Eruption patterns follow a precise chronological order for given population groups
- Crown and root calcification follow a precise chronological order
- Case study1: Ruiru Rape cases
- Case study 2: Miracle babies

Age estimation


R
L

Case Studies: Ruiru rape cases & Miracle babies



Age Determination

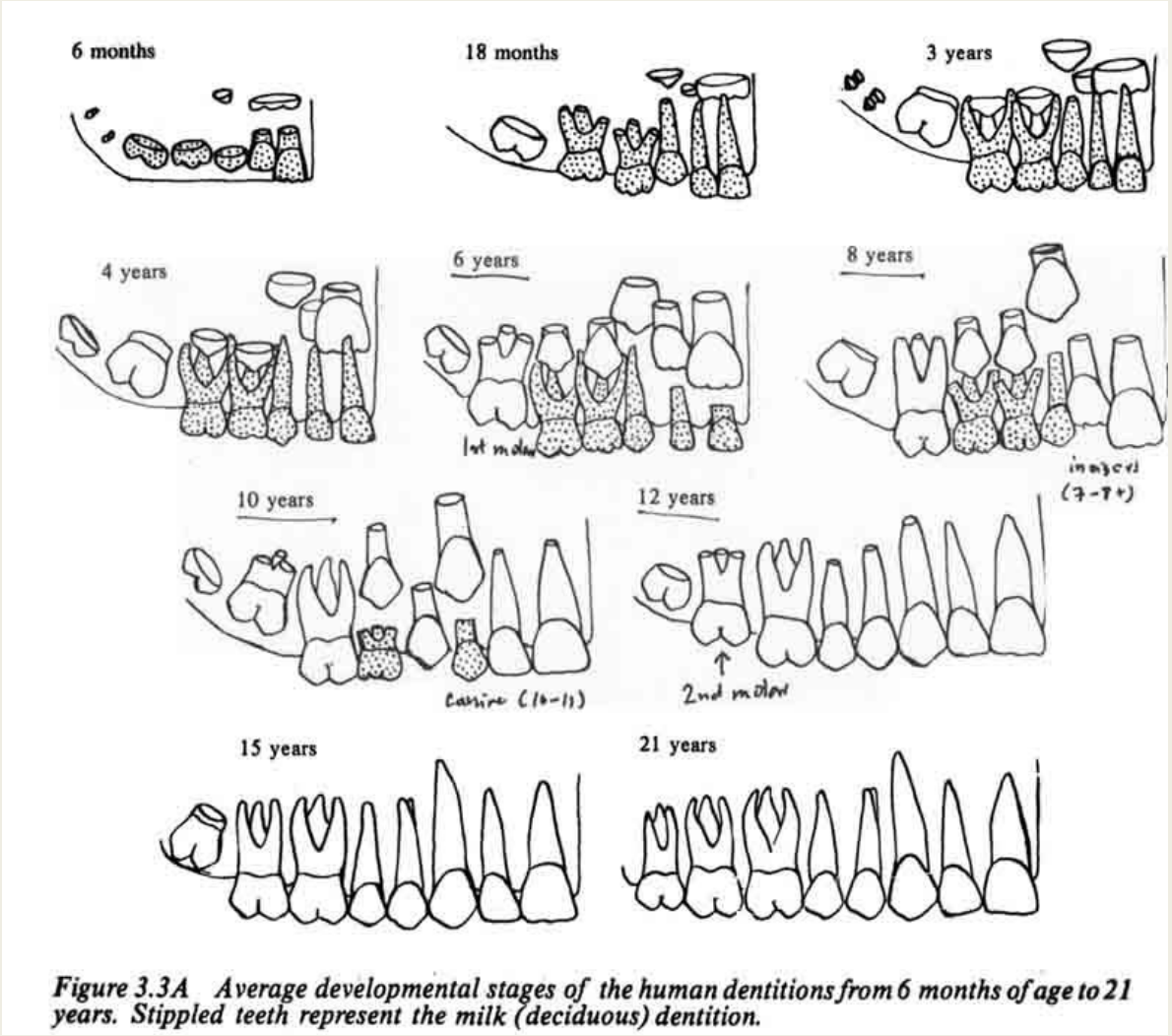
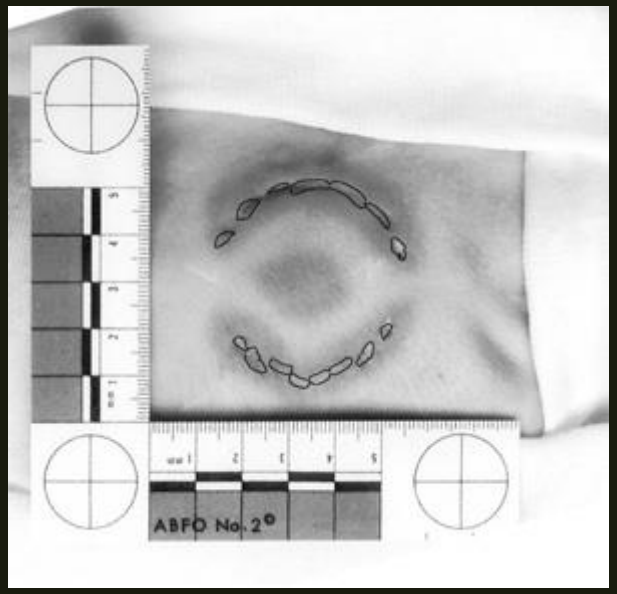


Figure 3.3A Average developmental stages of the human dentitions from 6 months of age to 21 years. Stippled teeth represent the milk (deciduous) dentition.

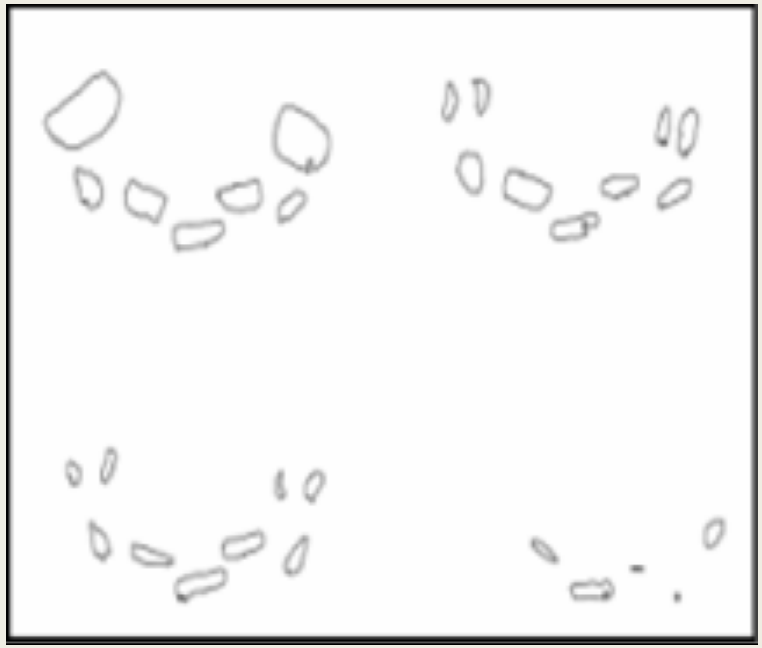


BITE MARKS

Impressions from teeth found on skin or items left at a scene.

Usually outline teeth placement.

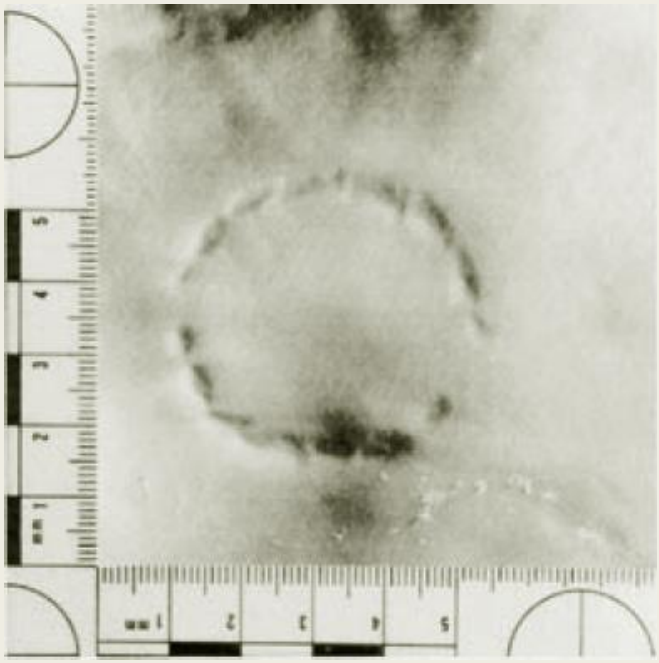
Where are bite marks found?



- Impressions left on food, skin or other items left at a scene.
  - *Porous surfaces that absorb the impact enough to make an impression*
  - *Impressions vary*
    - Depending on the pressure applied, the impression will show accordingly. The more pressure there is, the more detail to the bite.

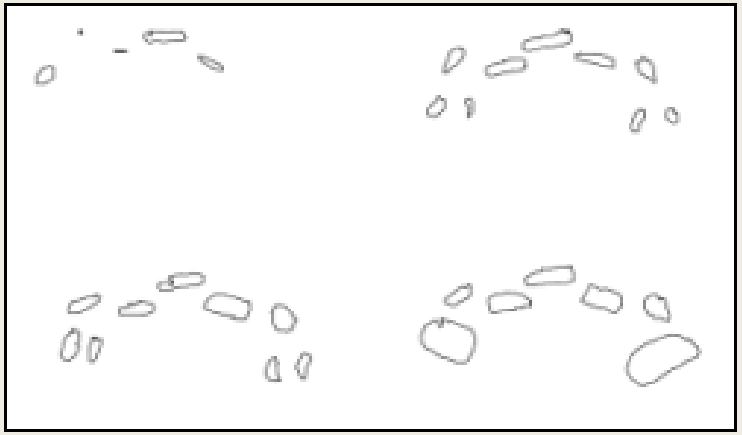
Bite mark analysis

- Can be used to link a suspect to a crime
- Impressions left on food, skin or other items left at a scene



Impression Variation

- Each dentition can produce variable impressions
- Change based on pressure and surface of contact



Impressions from the same dentition

Comparison to Other Forensic Biometrics

	Dental	DNA	Fingerprint
Robustness to Decomposition	High	Mid.	Low
Accuracy	Mid.	High	High
Time	Short	Long	Short
Enroll Rate	Low	High	Low
Instrument required	Mid.	High	Mid.

Analyzing bite marks

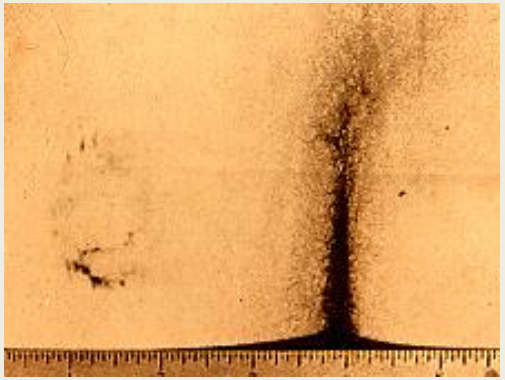
- Bite marks are photographed with a scale
  - *Bite marks on skin are taken over repeated intervals*
- Casts of impression are taken
- Impression traced onto transparencies
- Casts of suspects teeth are taken
- Comparison between suspect cast and bite mark

Various Bite Marks

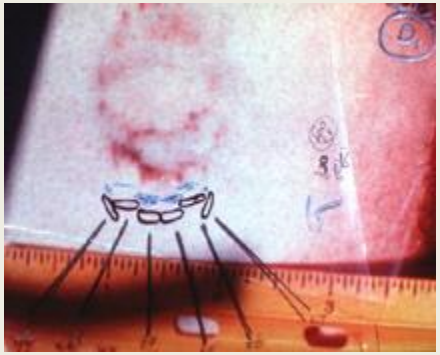
Famous Cases

- Bite mark analysis
- Identification

Cases – Ted Bundy



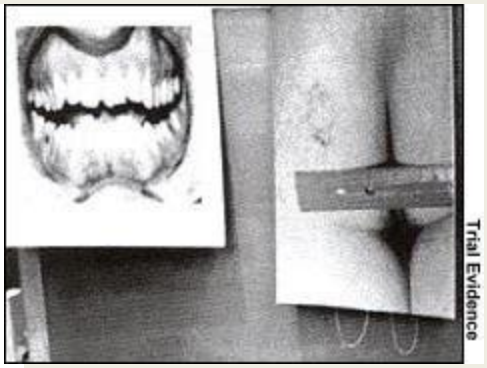
The bite mark was on the body of a victim

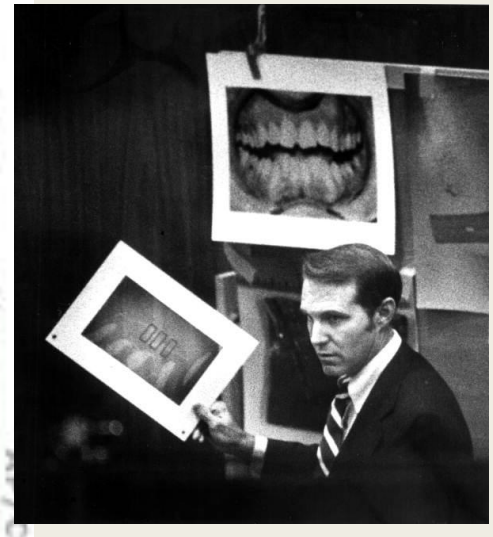


Transparent overlays superimposed

Wax bite exemplar

State of Florida v. Ted Bundy





Evidence, various pictures from trial

Ted Bundy, was an American serial killer who murdered numerous young women between 1974 and 1978.
He confessed to 30 murders, however the total amount of victims remains unknown. He would bludgeon his victims, then strangle them to death. He engaged in rape and necrophilia.

Cases – 9/11

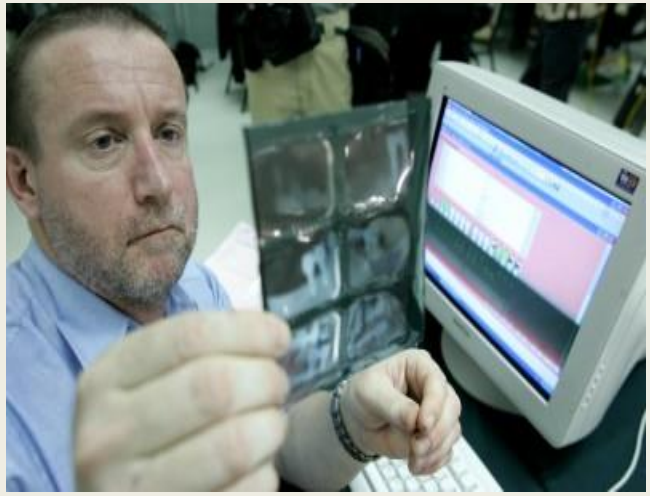
- At ground zero, among 973 victims identified in the first year (with only one method), about 20% of victims were identified using dental records.

Cases – Asian Tsunami

"Around mid-March, (of some 800+ identified bodies) 90% were identified by dental records …

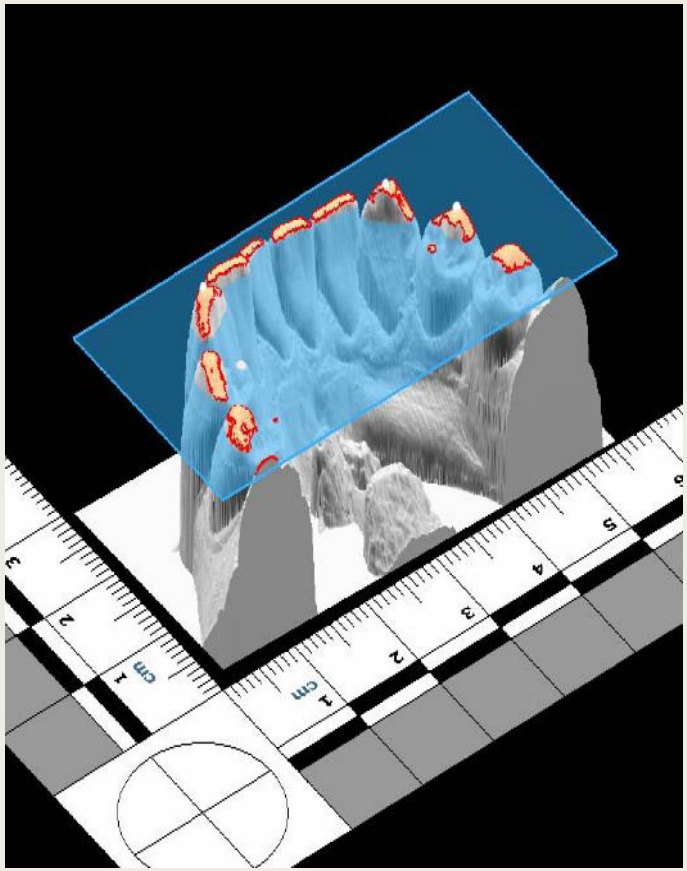
If you post pictures of your loved ones on the bulleting boards/web boards, choose picture with a broad smile so that front teeth can be seen. A better approach is to post dental X-ray films and leave email/phone number of the dentist."

----- Tsunami Relief website



A forensic expert examines a film of the teeth of a tsunami victim in Phuket of Thailand, on Jan. 11, 2005.

Computer Odontology

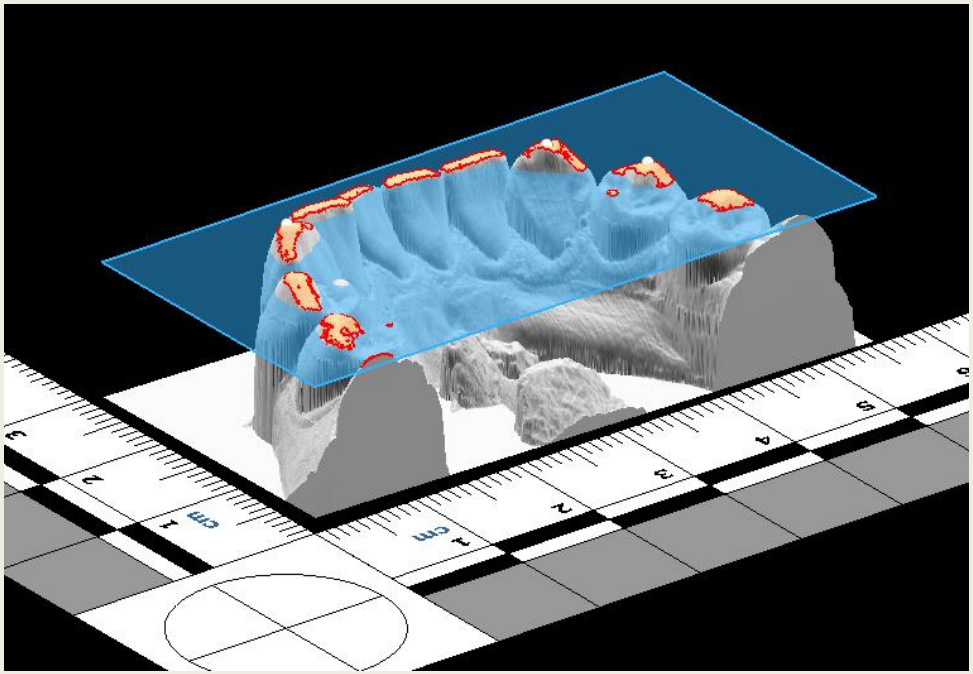


- Automatic dental code matching
  - *Bites are run through the computer to find a match*
- OdontoSearch
  - *Compare a data base of missing peoples, felons, government workers*
- Automatic dental identification system
  - *A few minutes will produce a list of people who have the same dental code number*
- 3D Bite mark analysis
  - *3D scans of dental casts are used to generate overlays using various pressure and deviation.*
  - *The overlays are compared with the photograph of the bite marks.*

Computer Aided Forensic Odontology

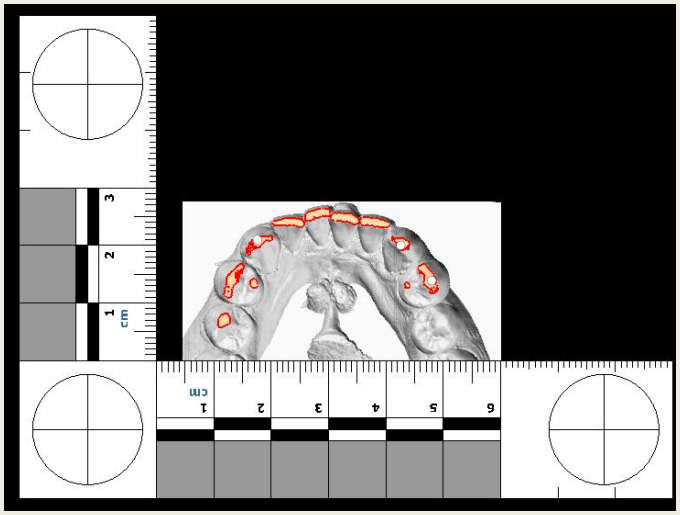
- 3D Bite mark analysis
- Automatic dental code matching
- OdontoSearch
- Automatic dental identification system

Bite mark Analysis Using 3D Scans -- DentalPrint



3D scans of dental casts are used to generate overlays using various pressure and deviation.

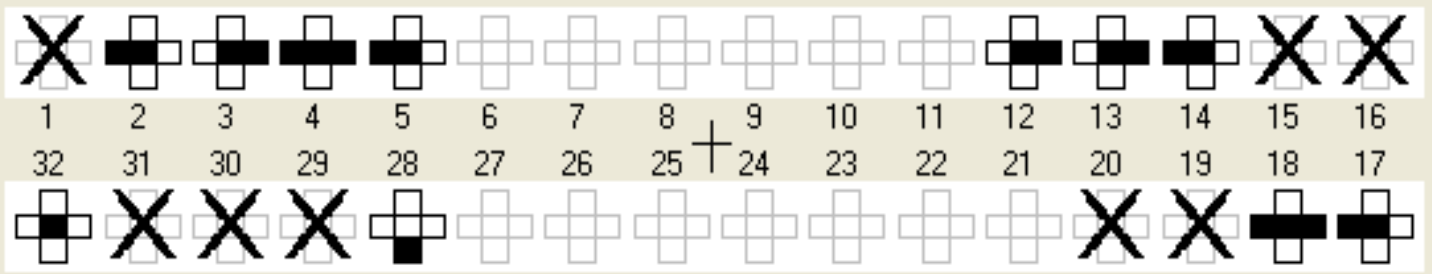
Bitemark Analysis Using 3D Scans -- DentalPrint



The overlays are compared with the photograph of the bite marks.

Matching Using Dental Codes

- CAPMI / WinID



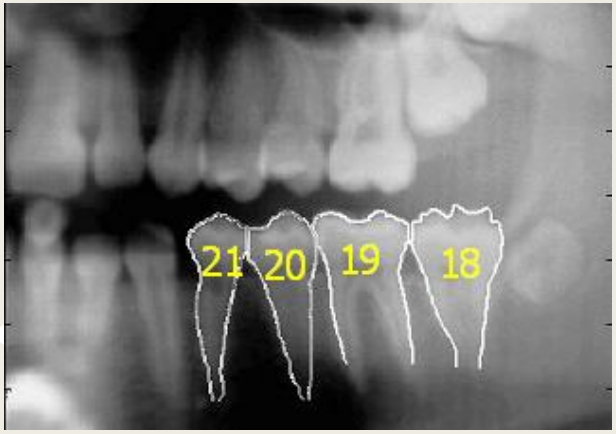
1 X	9 V	17 MO	25 V
2 OD	10 V	18 MOD	26 V
3 MO	11 V	19 X	27 V
4 MOD	12 OD	20 X	28 F
5 OD	13 OD	21 V	29 X
6 V	14 MO	22 V	30 X
7 V	15 X	23 V	31 X
8 V	16 X	24 V	32 O

OdontoSearch

- Different people may have the same dental codes
- In the past, the strength of a match between a PM dental code and an AM dental code is based on the clinical experience of the dentist
- OdontoSearch provides an objective means of assessing the frequency of occurrence for a dental code

Automatic Dental Identification System

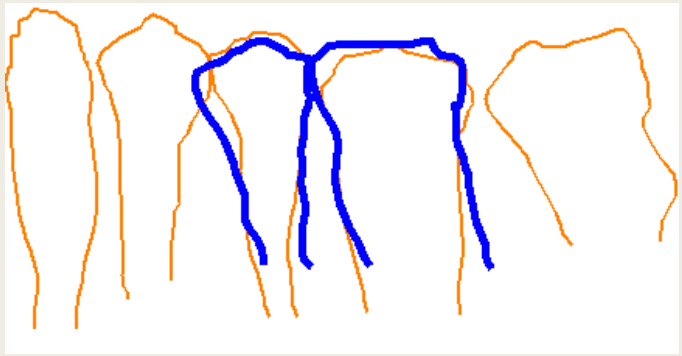
Query Image



Genuine

Matching Distance = 4.22

Imposter

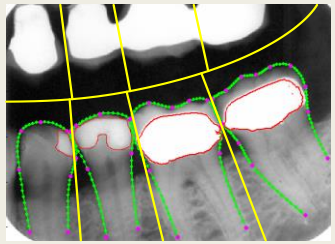


Matching Distance = 27.57

Genuine image has a smaller matching distance than the imposter image. Images with smaller distance are included in the candidate list.

System Architecture

Feature Extraction



Atlas Registration

Matching

Retrieval