

Case Study CSE 891: Forensic Odontology

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Outlines

- History and status of forensic odontology
- Dental Anatomy
- Main applications
- Comparison to other forensic biometrics
- Famous Cases
- Computer aided forensic odontology

Definition

Forensic odontology is the application of dental principles to legal issues

Applications:

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

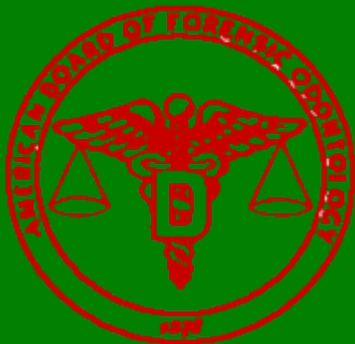
History

- 66 A.D.: Lollia Paulina's body identified
- Casualty ID in Revolutionary War
- 1849
 - Vienna Opera House fire
 - Dental identification evidence first admitted in U.S. court system



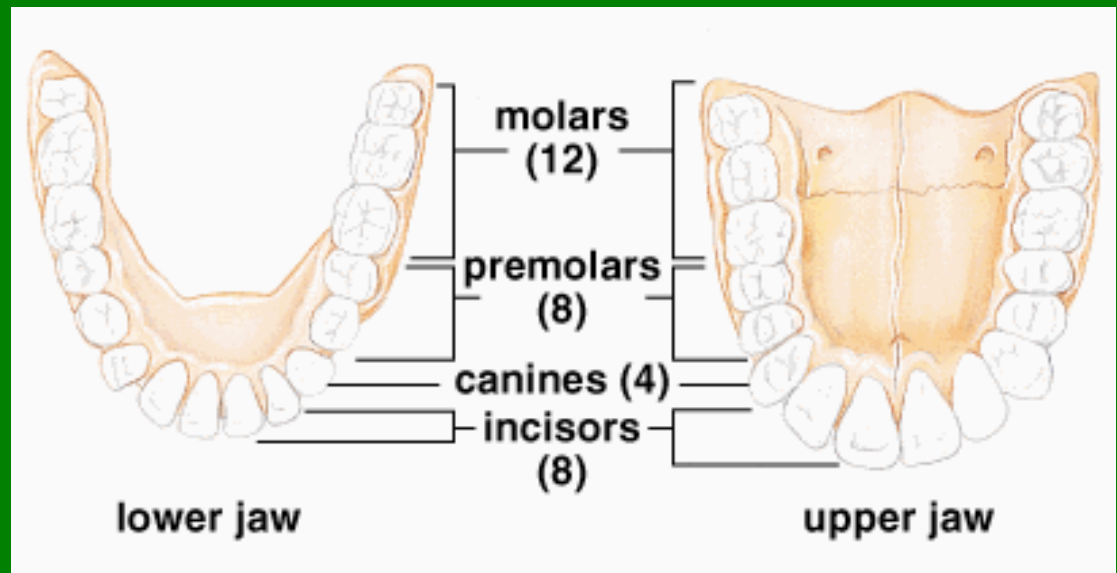
Training

- No specific training required to practice
- Most are practicing dentists
 - Undergraduate education
 - Dental school
 - Possible specialized training
- Admittance into professional groups
 - May have further requirements for admittance



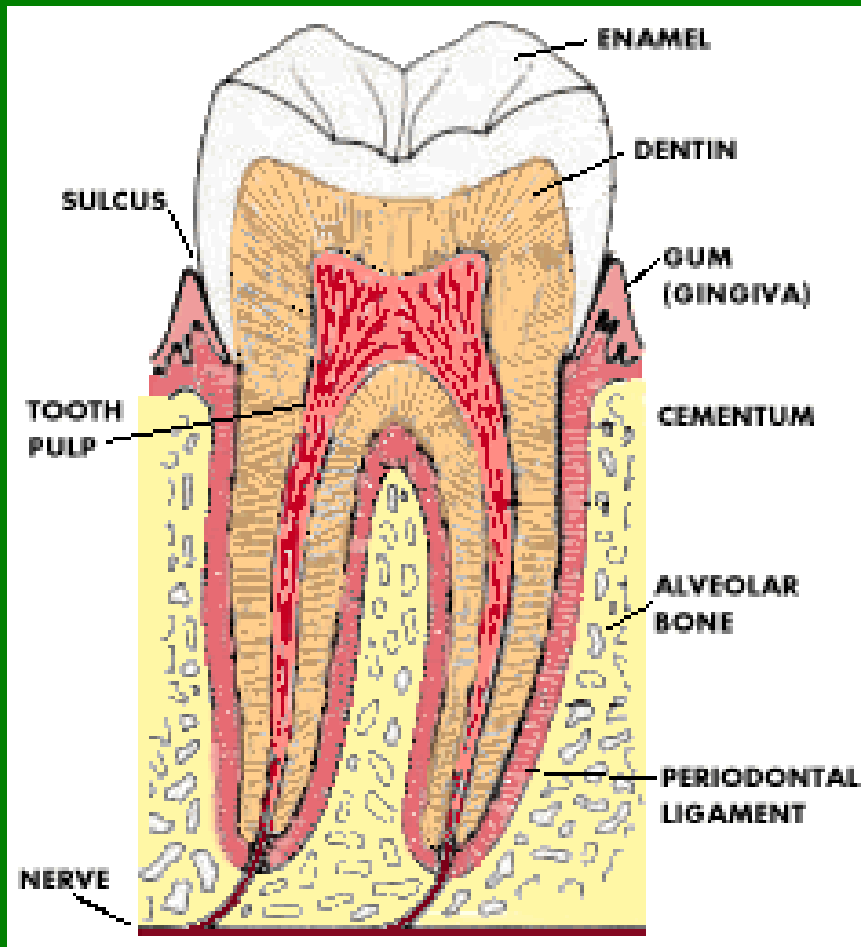
Dentition

- ~ 32 teeth
- 4 tooth types
 - Incisors
 - Canines
 - Premolars
 - Molars
- Orientation/Size
- Root Structure

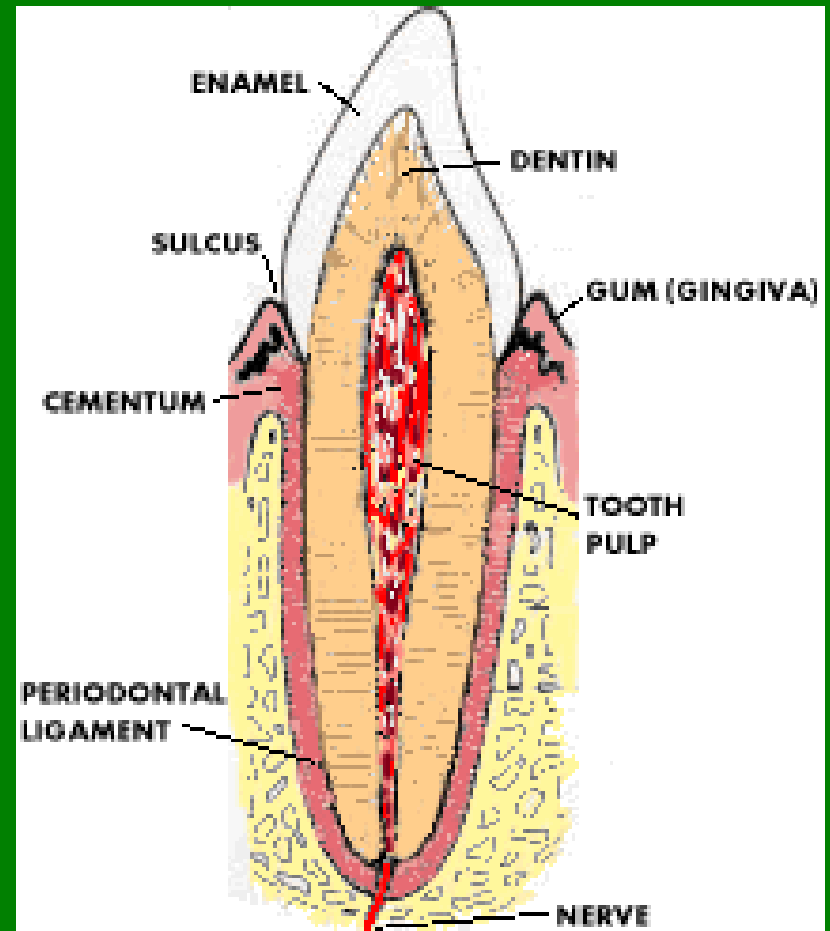


Tooth Composition

Molar



Incisor



Dental Restorations

- Crowns
- Fillings
- Root canal
- Bridge
- Extractions



Individuality of Teeth

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

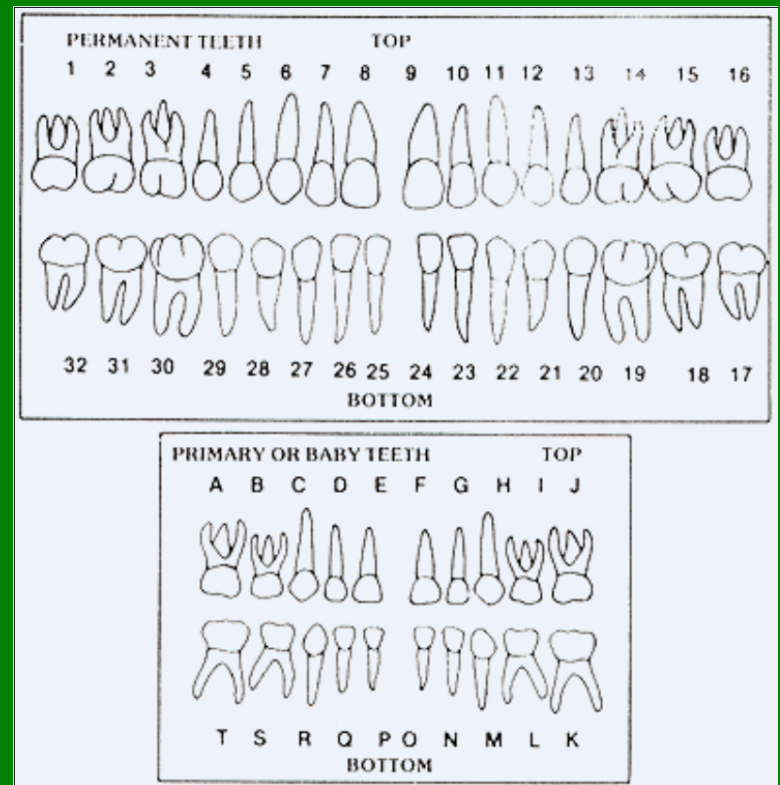


Main Applications

- Individual Identification
- Mass Disaster Identification
- Bite mark Analysis

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



Identification

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

Age Determination

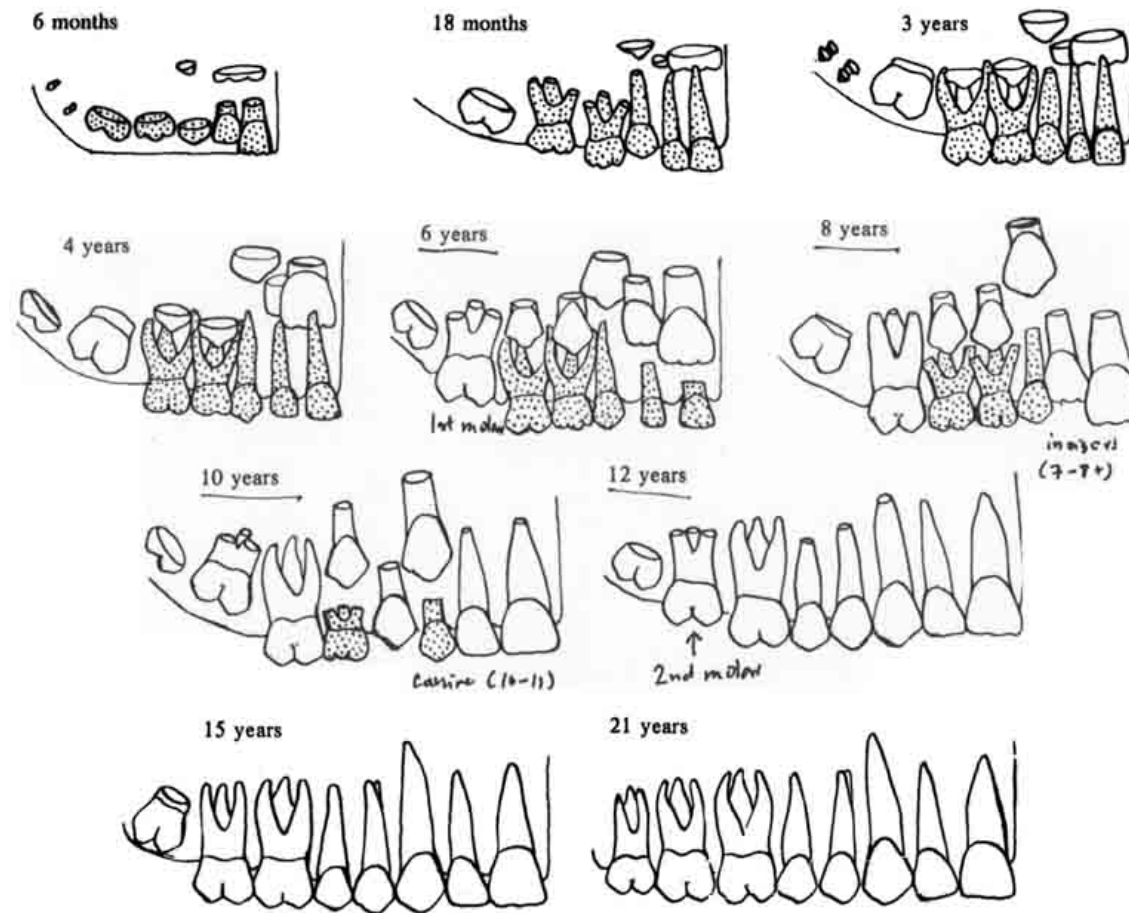


Figure 3.3A Average developmental stages of the human dentitions from 6 months of age to 21 years. Stippled teeth represent the milk (deciduous) dentition.

Age Determination Chart

Table 1 – Ages of Eruption for Deciduous and Permanent Dentition

	Tooth	Maxillary	Mandibular
Deciduous Dentition	central incisor	7.5 mo.	6 mo.
	lateral incisor	9 mo.	7 mo.
	canine	18 mo.	16 mo.
	first molar	14 mo.	12 mo.
	second molar	24 mo.	20 mo.
Permanent Dentition	central incisor	7-8 yr	6-7 yr
	lateral incisor	8-9 yr.	7-8 yr.
	canine	11-12 yr.	9-10 yr.
	first premolar	10-11 yr.	10-12 yr.
	second premolar	10-12 yr.	11-12 yr.
	first molar	6-7 yr.	6-7 yr.
	second molar	12-13 yr.	11-13 yr.
	third molar	17-21 yr.	17-21 yr.

Mass Disaster Identification

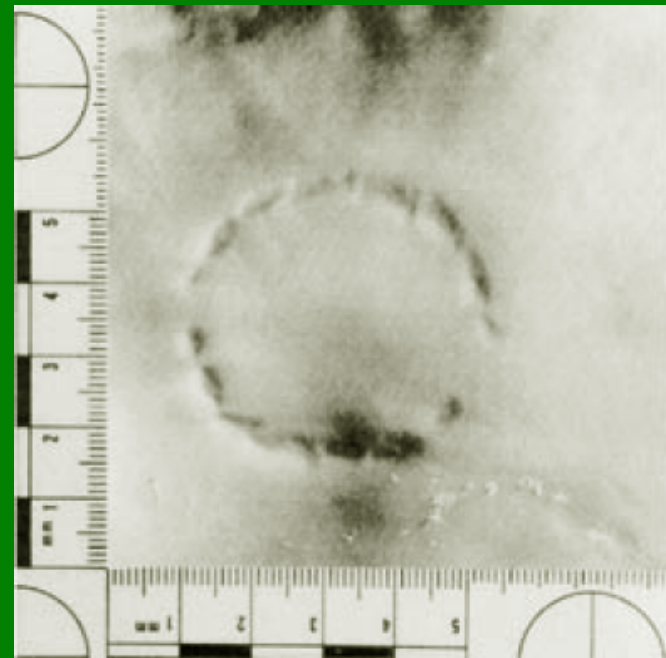
- Completed in the same manner as individual identification
- Organization of antemortem and postmortem data is essential
- Large scale problems can occur

Mass Disaster Dental ID Teams

- Postmortem Team
 - Generates dental profile and radiographs
- Antemortem Team
 - Collects/organizes antemortem data
- Records Comparison Team
 - Compares postmortem and antemortem data

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

Analysis

- 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

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.

Famous Cases

- Bite mark analysis
- Identification

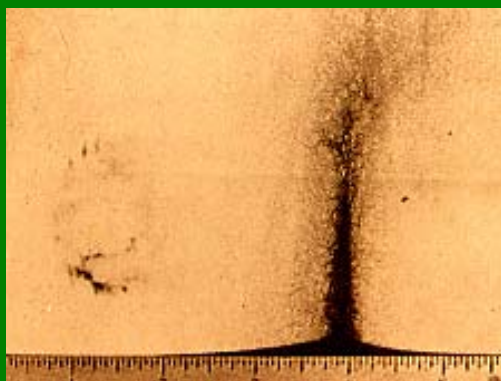
Dental Programs

- National Dental Program
 - In 1997, The Criminal Justice Information Services Division (CJIS) of the FBI created a **dental task force** (DTF).
- State Dental Program
 - Three states: Maryland, Washington, and California
 - Best Collectors of Dental Records (>10%)

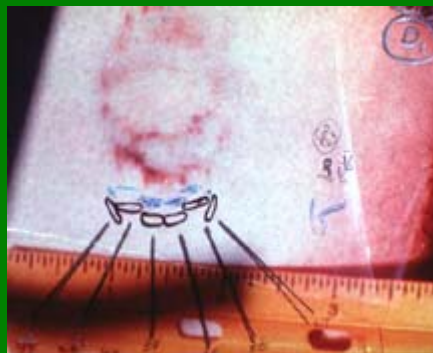
	TOTAL CASES	CASES WITH DENTAL	PERCENT CASES WITH DENTAL
Wyoming	45	13	28.8%
Idaho	170	31	18.2%
New Hampshire	76	13	17.1%
Florida*	5,806	756	13%
Washington	2,152	271	12.6%
Vermont	72	9	12.5%
Maine	108	13	12%
Montana	134	14	10.5%

Cases – Ted Bundy

- The most famous bite mark case



The bite mark was on the body of a victim



Transparent overlays superimposed



Wax bite exemplar

Cases – 9/11



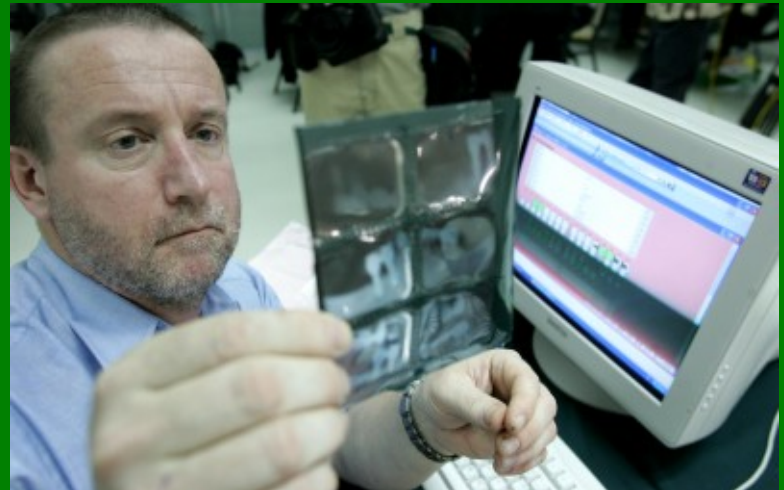
- At ground zero, among 973 victims identified in the first year (with only one method), about 20% of victims were identified using dental records.

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



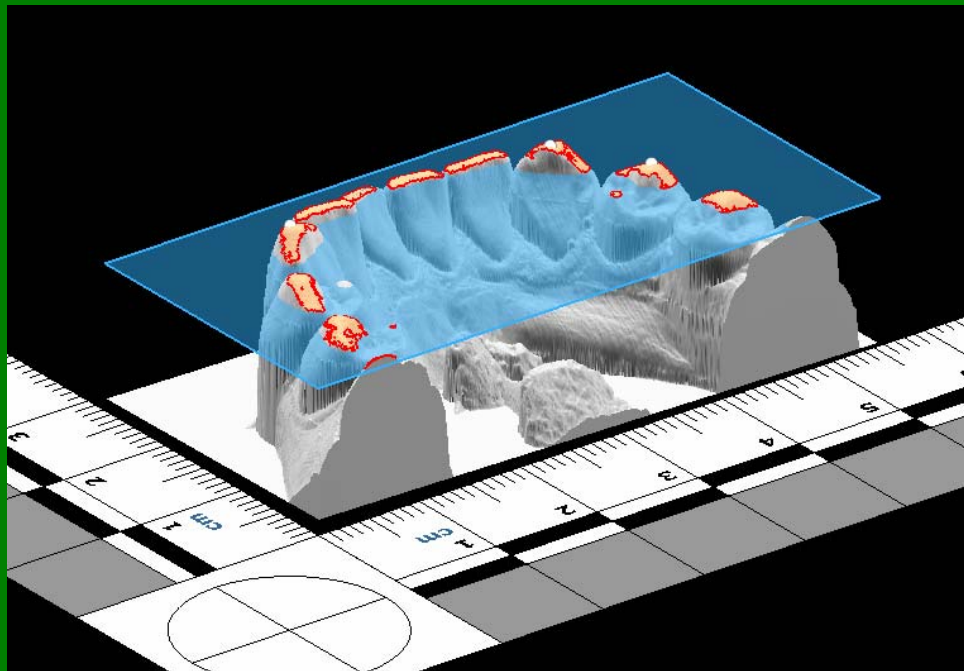
A forensic expert examines a film of the teeth of a tsunami victim in Phuket of Thailand, on Jan. 11, 2005.

Computer Aided Forensic Odontology

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

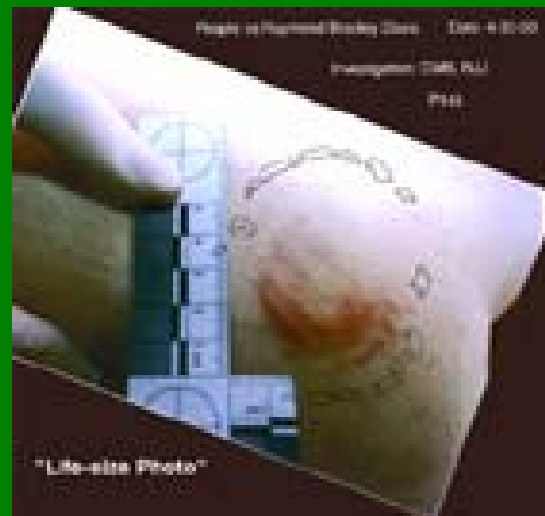
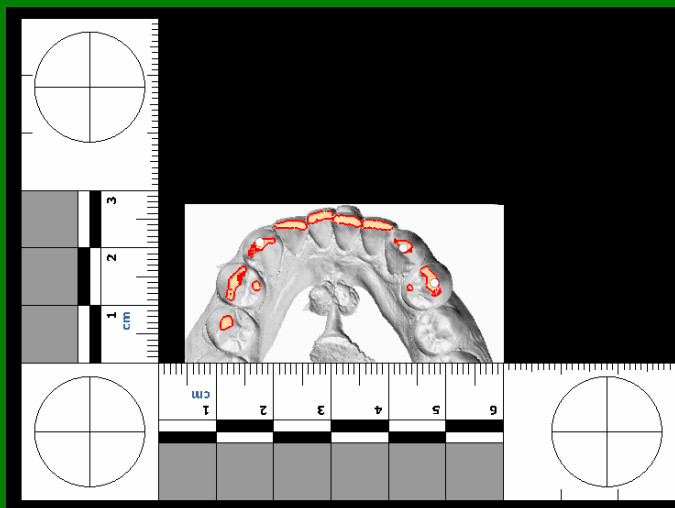
Bite mark Analysis Using 3D Scans

-- DentalPrint



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

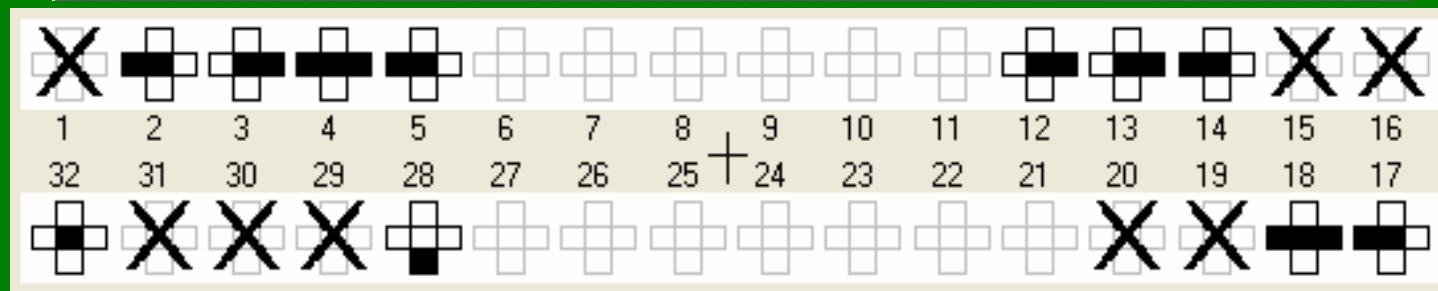
Bitemark Analysis Using 3D Scans -- DentalPrint



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

Matching Using Dental Codes

- CAPMI / WinID



1 X
2 OD
3 MO
4 MOD
5 OD
6 V
7 V
8 V

9 V
10 V
11 V
12 OD
13 OD
14 MO
15 X
16 X

17 MO
18 MOD
19 X
20 X
21 V
22 V
23 V
24 V

25 V
26 V
27 V
28 F
29 X
30 X
31 X
32 O

OdontoSearch

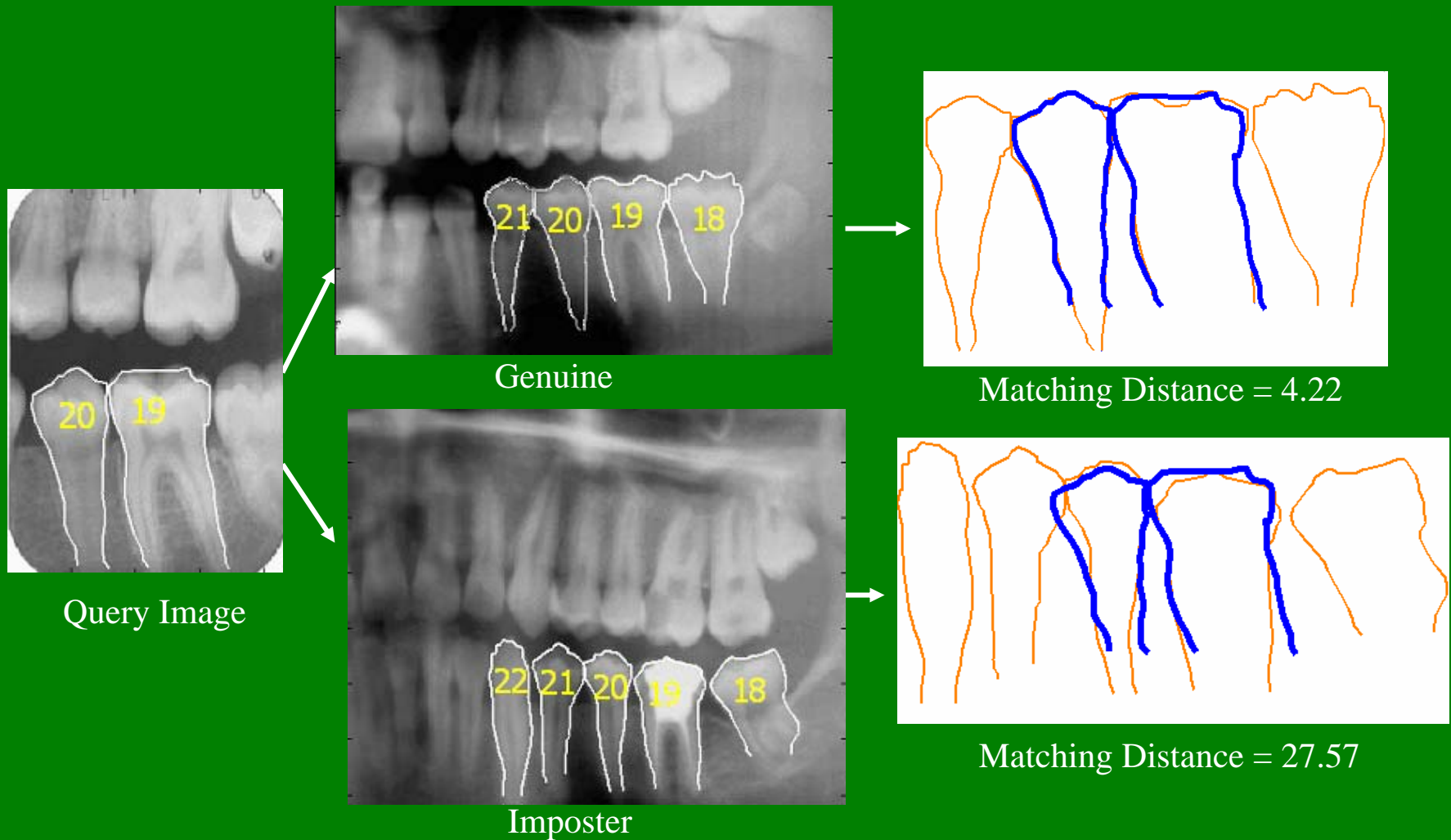
- Different people may have the same dental codes
- In the past, the strength of a match between a PM dental code and an AM dental code is based on the clinical experience of the dentist
- OdontoSearch provides an objective means of assessing the frequency of occurrence for a dental code

OdontoSearch

TABLE 6—The ten most frequent dental patterns from the Detailed TSCOHS data with only molars and premolars.

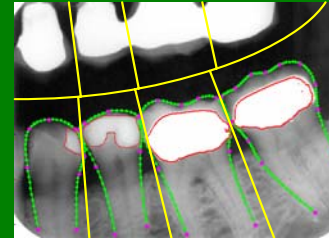
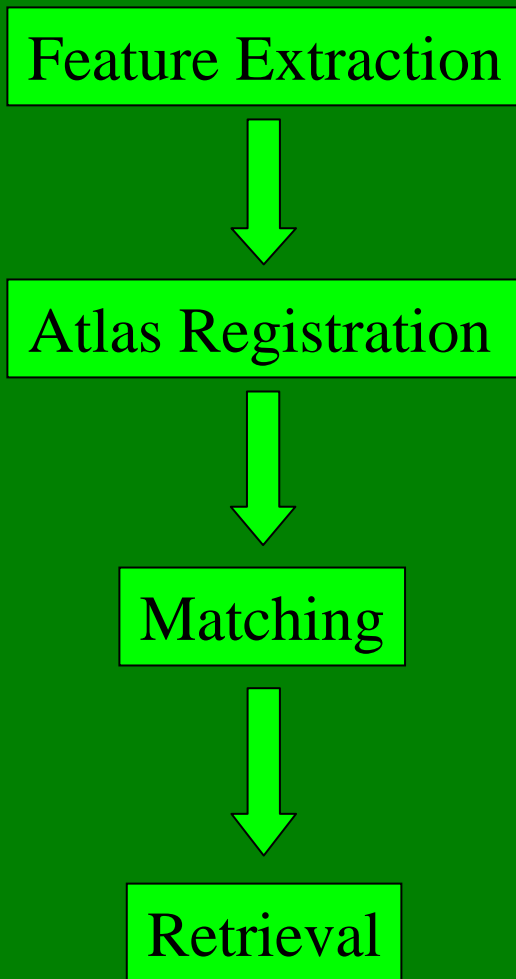
Detailed TSCOHS with ONLY MOLARS and PREMOLARS (N=19,422)										
Dental Pattern (Universal Charting of posterior teeth)								Number	Percent	
RIGHT	V	V	V	V	V	V	V	LEFT	2,633	13.557
	V	V	V	V	V	V	V		107	0.551
	V	O	V	V	V	V	V		100	0.515
	V	V	V	V	V	V	V		96	0.494
	V	V	V	X	X	V	V		80	0.412
	V	V	V	X	X	V	V		70	0.360
	V	V	V	V	V	V	O		63	0.324
	V	V	V	V	V	V	O		62	0.319
	V	O	V	V	V	V	O		54	0.278
	V	O	V	V	V	V	O		51	0.263
Unique Dental Patterns								12,928	66.56	

Automatic Dental Identification System



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

System Architecture



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16



32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17



Summary

- History and status of forensic odontology
- Dental Anatomy
- Main applications
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References

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