

ARE A MINIMUM NUMBER OF CONCORDANT MATCHES NEEDED TO ESTABLISH IDENTITY IN FORENSIC ODONTOLOGY?

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ABSTRACT

Forensic odontology plays an important role in the identification of human remains. While numerous studies²⁻⁶ have proven conclusively the uniqueness of the human dentition, forensic odontologists worldwide remain divided about the need for a minimum number of concordant points to confirm dental identification^{4,6,9-16}. This study reviewed 690 cases from the archives of the Forensic Odontology Unit, The University of Adelaide, to determine the validity of using a minimum number of concordant points to positively identify human remains. It was found that positive identification had been established using a varying number of concordant points. Although the incidence of positive identification was more frequent with a minimum of 12 concordant points, there were numerous cases where 12 or more concordant points failed to achieve a positive identification. Identities were also confirmed in some cases using less than 12 points of correspondence. There appears to be no basis for defining a minimum number of concordant points necessary before a positive identification can be made on dental evidence. Rather, the findings of this study reinforce the view that each case has its own individuality and should be treated as such. (*J Forensic Odontostomatol* 2003;21:6-13)

Key words: Identification categories, concordant points, dental statistics

INTRODUCTION

Identity refers to the characteristics by which a person may be recognised. Dental identity may be broadly defined as the total of all characteristics of the teeth and their associated structures which, while not individually unique, when considered together provide a unique totality.

Identification of the unknown individual is important in the present-day world for legal and humanitarian reasons¹, indeed Haglund and Morton² considered identification of an individual to be the most important aspect of forensic odontology. The underlying tenet for dental identification is that combinations of dental characteristics are never the same in any two given individuals and numerous researchers³⁻⁶ have elaborated on the uniqueness of individual human dentitions. This individuality, however, does not ensure that all cases can be positively identified.

Based on the quality and quantity of concordant points available different 'levels' or 'categories' of identification can be assigned to cases that indicate their proximity to a positive identification. For example, McKenna⁷ proposed the following categories: (1) positive identification; (2) highly probable identification; (3) consistent with but equivocal; (4) impossible to identify; (5) inconsistent with; and (6) definitive exclusion. Similarly, Silverstein⁸ recommended a classification of: (1) positive identification; (2) possible identification; (3) insufficient evidence; and (4) exclusion.

The Forensic Odontology Unit at the University of Adelaide uses the following identification terminology:

Confirms identity: where identity is proven beyond reasonable doubt, including radiographic comparisons.

Strongly supports identity: where there is a high level of concordance between postmortem and ante-mortem information without radiographic support.

Supports identification: where explainable differences exist between the two sets of information.

Does not confirm or exclude identification: involves cases with minimal or insufficient information (either postmortem or ante-mortem).

Excludes identification: contains unexplainable inconsistencies that comprehensively indicate a mismatch.

Various researchers have focussed on the number of teeth or features required to establish a positive identification. Following the approach used for fingerprint identification, Keiser-Nielsen⁴ proposed that 12 concordant points be the required number for a positive dental identification and other researchers^{5,6,9} have agreed that a minimum number of concordant points are needed to establish positive identity.

The tendency to link the probability of identity based on the number of points of correspondence has its limitations. Hill¹⁰ stated that emphasis on numerical indices could be misleading and confusing to legal professionals and lay people. Locard (cited in Taroni *et al*¹¹) considered that there was more to the evaluation of identification than the mere counting of characteristics, while a few researchers^{9,12} have

reported that just one identical radiographic characteristic may be sufficient to establish identity. It is also accepted that the recovery of only a single tooth or jaw fragment may be enough to confirm a positive identification, provided appropriate ante-mortem records are available¹³. Other authors¹⁴⁻¹⁶ have reported positive identifications based on unique and unusual points of concordance but a review of the literature indicates a lack of consensus about the need for a minimum number of concordant points for positive dental identification. This study aimed to determine the need for a minimum number of concordant points for dental identification, based on 21 years of experience in 690 identification cases at the Forensic Odontology Unit, The University of Adelaide.

MATERIALS AND METHODS

The archives of the Forensic Odontology Unit house a total of 1302 cases, 612 of which involved non-identification cases including bitemark cases (305), age determination (125), missing persons (81), homicides (60) and skeletal remains (41). The remaining 690 cases involved identification of unknown persons, and these were accessed in this study.

All cases that required identification were reviewed with the objective of establishing the number of concordant points used in each instance, thereby



Antemortem



Postmortem

Fig.1: Radiographs showing teeth with similar morphology (Courtesy: Forensic Odontology Unit archives, University of Adelaide)

determining the need for a minimum number of concordant points in positive dental identifications.

Determination of identity involves matching postmortem data with ante-mortem records. The data may include morphology of teeth, the restorations contained in them, as well as associated anatomical structures and pathological processes. In an attempt to encompass all characteristics used frequently in the dental identification process a broad term "*concordant point*" has been defined. For this study, if a sound tooth were found to be matching in both the postmortem data and ante-mortem records (Fig. 1), this was classified as one *concordant tooth*. If a tooth with a restoration were found to be matching in both sets of data (Fig. 2), the concordance would still be with respect to one tooth. The restoration in this tooth is a *concordant feature* and was not considered separately since it was already a part of the concordant tooth except in instances where there was severe fragmentation or loss of the dental tissues and the restoration had been dislodged and found alone. Similarly, if the postmortem and ante-mortem radiographs revealed a pathological feature such as a cyst, this was considered as a *concordant characteristic*; as was the presence of an amalgam tattoo, extraction socket, trabecular bone pattern, etc.

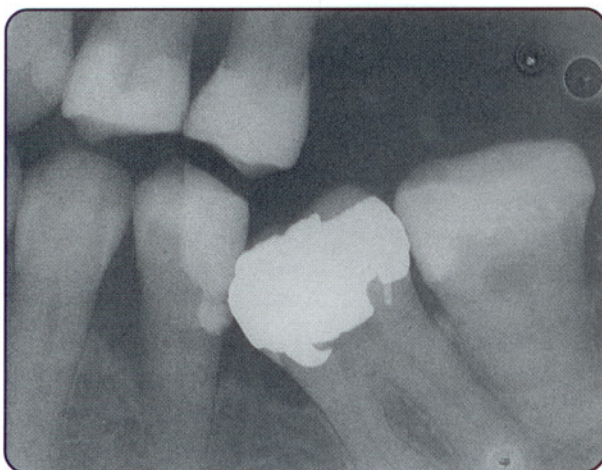
In summary, features within the domain of a tooth were considered to be a part of the concordant tooth and were not considered separately. Those features

beyond the domain of the tooth were automatically acknowledged as concordant characteristics. Concordant teeth and concordant characteristics constituted *concordant points*.

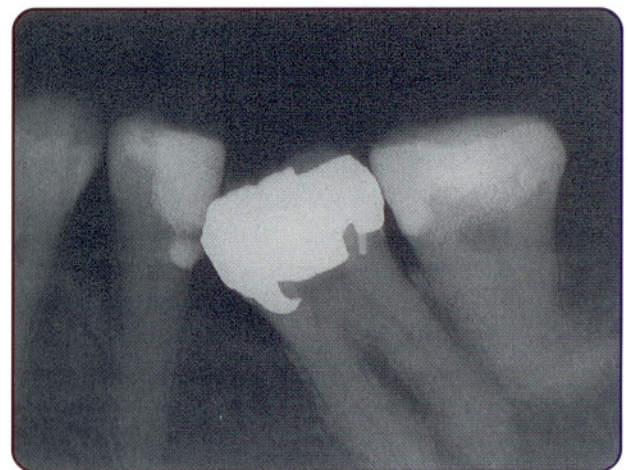
RESULTS

Of the 690 identification cases reviewed, 104 cases were identified visually, by fingerprints or other methods, and hence did not require a dental input. Eighty-three of the 690 cases did not have any available dental records and hence an attempt at identification was not possible. Five-hundred-and-three cases of identification had some form of dental record available of which 245 (48.7%) 'confirmed' identity while 258 did not. These 258 cases were categorised as follows: 40 (7.9%) 'strongly supports' identification; 166 (33.0%) 'supports' identification; 50 (9.9%) 'does not exclude or confirm' identification; and 2 (0.04%) 'exclusion' of identity.

The 245 cases that 'confirmed' identity used concordant points ranging in number from 1 to 33 (Fig. 3). Forty-eight (19.6%) cases used between 1 and 11 concordant points. One-hundred-and-ninety-five (79.6%) cases used 12 or more concordant points of which 35 (14.3%) used between 12 and 16 concordant points, 51 (20.8%) between 17 and 22 points, 56 (22.9%) between 23 and 27 points, and 53 (21.6%) between 28 and 33 points. Radiographic evidence aided 72 of the 245 (29.4%) positively identified cases. Fifty-eight of these used 12 or more



Antemortem



Postmortem

Fig.2: Radiographs showing teeth with identical restoration patterns. The restorations in the teeth are not considered as separate concordant points (Courtesy: Forensic Odontology Unit archives, University of Adelaide)

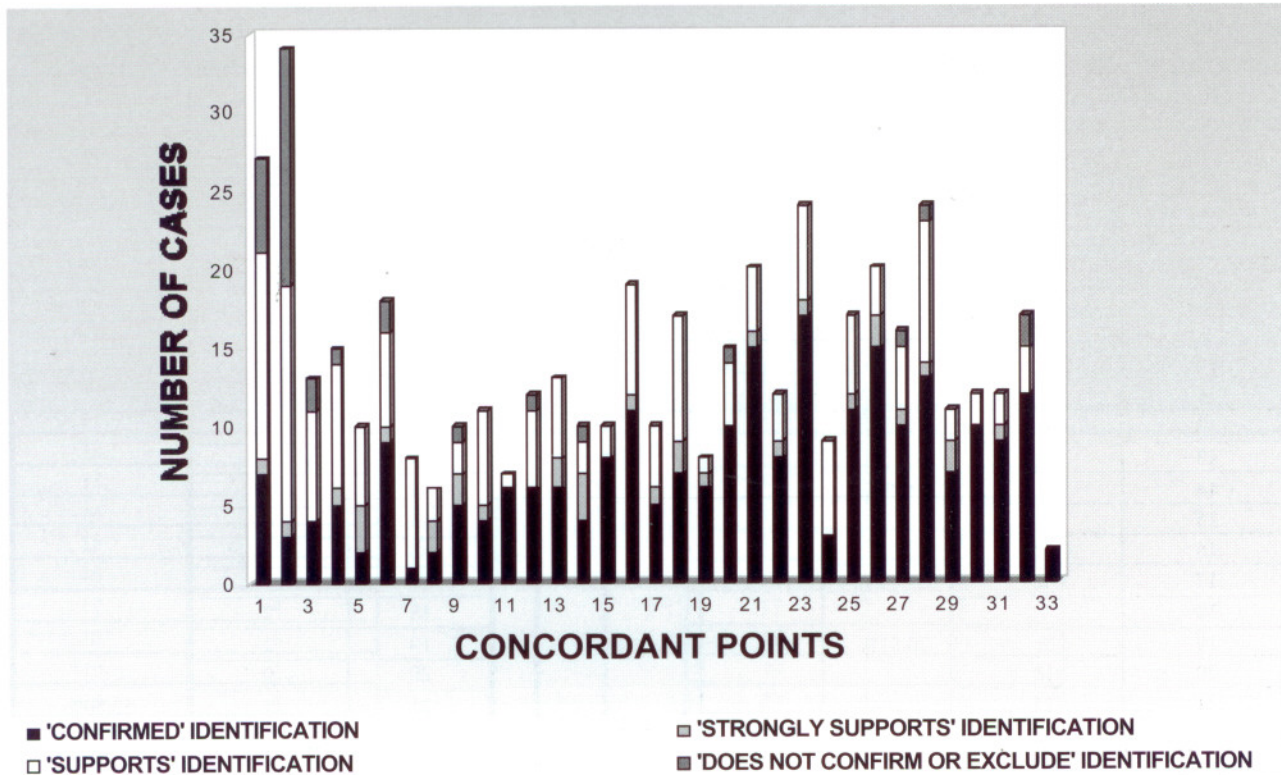


Fig.3: Frequency of concordant points in 'Confirmed', 'Strongly Supports', 'Supports' and 'Does not Confirm or Exclude' cases of dental identification

concordant points, emphasising the importance of quality radiographs in positive dental identification. Two cases were positively identified using video-superimposition alone, for which the number of concordant points was not available.

Fig. 3 also shows 40 cases that 'strongly support' dental identification, with concordant points ranging from 1 to 32. Twenty-six (65.0%) of these 40 cases were lacking in complete ante-mortem dental records, while 15 (37.5%) presented either limited postmortem dental remains, nomenclature differences in the comparison process or charting errors in the ante-mortem records. Twenty-one (52.5%) cases used 12 or more concordant points.

One-hundred-and-sixty-six identification cases with dental records contained evidence only to 'support' the identification. Of these, 95 (57.2%) had incomplete ante-mortem records while nomenclature differences and charting errors contributed to 28

(16.9%) cases. Limited post-mortem details of the dental status, severe peri-mortem trauma and incineration of remains contributed to 18 of the 166 (10.8%) cases. In addition, unlabelled dentures featured in 14 (8.4%) of the cases. Eighty-seven of the 166 (52.4%) cases provided 12 or more concordant points, yet failed to establish a positive identification (Fig. 3). There was a high frequency of 2 concordant points in this category due to the presence of 7 cases with unlabelled complete dentures (one denture was taken as one concordant point).

Fifty of the 503 cases with dental records 'neither confirmed nor excluded' identification (Fig. 3). Of these, 21 (42.0%) had incomplete dental records and 11 (22.0%) had limited post-mortem data or peri-mortem trauma. Thirteen cases of unlabelled dentures ensured that the frequency of 2 concordant points was the highest (Fig. 3). Identity was 'excluded' in 2 cases due to obvious discrepancies that could not be explained in any way.

Concordant Points	Frequency of Occurrence	Percentage of Concordant Points		Strong X-ray Evidence
1	7	19.59%		14 Cases
2	3			
3	4			
4	5			
5	2			
6	9			
7	1			
8	2			
9	5			
10	4			
11	6			
12	6	14.29%	79.59%	58 Cases
13	6			
14	4			
15	8	20.81%		
16	11			
17	5			
18	7			
19	6	22.86%		
20	10			
21	15			
22	8			
23	17	21.63%		
24	3			
25	11			
26	15			
27	10			
28	13			
29	7			
30	10			
31	9			
32	12			
33	2			

Table 1: 'Confirmed' Dental Identification

Concordant Points	Frequency of Occurrence	≥ 12 Concordant Points
1	1	
2	1	
3	0	
4	1	
5	3	
6	1	
7	0	
8	2	
9	2	
10	1	
11	0	
12	0	52.50%
13	2	
14	3	
15	0	
16	1	
17	1	
18	2	
19	1	
20	0	
21	1	
22	1	
23	1	
24	0	
25	1	
26	2	
27	1	
28	1	
29	2	
30	0	
31	1	
32	0	

Table 2: 'Strongly Supports' Dental Identification

DISCUSSION

Of 245 cases in which identity was 'confirmed', between 1 and 11 concordant points were used for 48 cases. This means that 19.6% of all 'confirmed' cases were based on fewer than 12 concordant points which was suggested as 'a minimum' for positive dental identification by Keiser-Nielsen⁴.

Fifty-two percent of cases that 'strongly supported' identification, 52.4% of cases that 'supported' and 14% that 'did not confirm or exclude' identification were based on 12 or more concordant points, making a total of 44.6% of cases that could not be positively identified despite having 12 or more concordant points. Hence, the presence of a minimum of 12 concordant points does not always establish a positive dental identification.

Keiser-Nielsen⁴ suggested the use of 'a minimum' of 12 concordant points for positive dental identification but the basis for selecting 12 concordant points as a threshold was not explained beyond "joining our fingerprint colleagues". The rationale for this minimum to be 'safe' was not explained, nor has the rationale for equating one 'extra-ordinary' feature to two 'ordinary' features, or how this is statistically possible. The premise of Keiser-Nielsen's argument that 'an ignorance of the frequency of occurrence of dental characteristics would undermine the value of a single unique feature' cannot be justified, because the uniqueness of the human dentition is beyond doubt.

Concordant Points	Frequency of Occurrence	≥ 12 Concordant Points
1	13	
2	15	
3	7	
4	8	
5	5	
6	6	
7	7	
8	2	
9	2	
10	6	
11	1	
12	5	52.41%
13	5	
14	2	
15	2	
16	7	
17	4	
18	8	
19	1	
20	4	
21	4	
22	3	
23	6	
24	6	
25	5	
26	3	
27	4	
28	9	
29	2	
30	2	
31	2	
32	3	

Table 3: 'Supports' Dental Identification

Twenty-six of 40 (65%) cases that 'strongly supported' dental identification, 95 of 166 (57.23%) that 'supported' and 21 of 50 (42%) cases that 'did not confirm or exclude' identity lacked complete ante-mortem records. These incomplete dental records were a result of failure on the part of the dentist to record the existing dental status of the patient upon initial appointment or because the patient had changed dentists more recently, with the later treatment records being unavailable. There were two cases for which strong radiographic evidence relating to trabecular bone pattern and root morphology respectively were available, but the absence of restorations perhaps prompted the odontologist to rule out a positive identification.

Concordant Points	Frequency of Occurrence	≥ 12 Concordant Points
1	6	
2	15	
3	2	
4	1	
5	0	
6	2	
7	0	
8	0	
9	1	
10	0	
11	0	
12	1	14%
13	0	
14	1	
15	0	
16	0	
17	0	
18	0	
19	0	
20	1	
21	0	
22	0	
23	0	
24	0	
25	0	
26	0	
27	1	
28	1	
29	0	
30	0	
31	0	
32	2	

Table 4: 'Does not Exclude or Confirm' Dental Identity

Nomenclature differences and charting errors contributed to 28 of 166 (16.9%) cases that 'supported' and 13 of 40 (32.5%) cases that 'strongly supported' dental identity. In all, incomplete dental records undermined a positive dental identification in 142 of 503 (28.2%) identification cases with dental records, while nomenclature differences and charting errors contributed to 41 of 503 (8.2%) cases. This, once again underlines the importance of complete and accurate ante-mortem dental records to enable a positive dental identification.

Limited post-mortem details of the dental status, severe peri-mortem trauma and incineration of remains contributed to 18 of 166 (10.8%) cases that

'supported' identification, 2 of 40 (5.0%) of 'strongly supported' and 11 of 50 (22.0%) cases that 'did not confirm or exclude' identity. In all, 31 of 258 (12.0%) cases that 'strongly supported', 'supported', 'did not exclude or confirm' and 'excluded' identity were influenced by peri-mortem effects on the dental tissues which reinforces the importance of complete and intact recovery of teeth to give a better chance of positive identification.

Unlabelled dentures contributed to a total of 27 of 258 (10.5%) cases that could not be positively identified and the need for legislation to make denture labelling mandatory should not be forgotten.

The present study has shown that a positive identification can be obtained from as little as one concordant point but that concordant points used to establish identity in fact ranged from 1 to 33. A total of 195 cases were positively identified using 12 or more concordant points. This, however, does not imply that the likelihood of a positive identification is increased with a minimum of 12 concordant points since it has also been found in the current study that 12 or more concordant points were recorded in 44.6% of cases that could not be positively identified.

One of the most frequent reasons for non-confirmation of identity was incomplete or unavailable ante-mortem dental records, a common occurrence which once again emphasises the dependence on them for dental identification. In addition, the use of different nomenclatures provided a constant reminder of the need for uniformity in charting teeth, and for the odontologist to be familiar with a number of recording systems. Positive dental identification depends upon the quality of information available in addition to the quantity, including availability of radiographs, presence of multiple restorations and/or unique features in the dentition.

CONCLUSION

The legal and societal needs for positive identification place the forensic odontologist in a position of great responsibility. The need for a minimum number of concordant points in a positive dental identification is not supported by this study, which reinforces the importance of treating each case on its individual

merits. A single concordant point may be sufficient to confirm identity, while a full mouth series of radiographs may not prove positive identification if details are lacking. The forensic odontologist must be aware of the circumstances under which a single extraordinary dental feature may be used for identification and its uniqueness should be gauged and utilised accordingly. In accidents involving a limited number of people whose names are known, the points used for identification could be limited to a unique tooth/feature/characteristic for distinguishing the victims, however, in instances of mass casualties, a unique feature may not be extraordinary enough to identify an individual. Ultimately, the discretion of identification lies with the forensic odontologist who must be aware of the repercussions of a mis-identification and be satisfied that the conclusions can be justified in a court of law, the ultimate peer review¹⁷.

ACKNOWLEDGEMENTS

The authors acknowledge the support of both the Minister for Police in South Australia and the South Australia Police.

The authors would also like to thank Professor Grant Townsend for his guidance and invaluable input, Dr. Helen James for her continued support and Mrs. Elaine Formenti for secretarial assistance.

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