F9 Computerized Dental Ranking: A Look at a New Coding Strategy and an Optimized Ranking Algorithm

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The objective of this presentation is to present a new dental coding system and sorting algorithm that can be used with computerized dental ranking software. Currently, software systems are based on detailed coding strategies. Although previous studies have tested these systems utilizing a simpler coding scheme, some degradation was noted especially on larger databases. This study addresses some of those shortcomings by adding a few additional novel codes and by utilizing optimized ranking algorithms. A large reference database was used to accomplish this research. The benefits and shortcomings of this new system will be discussed.

Computerized dental ranks are a powerful tool to assist in the victim identification process. This study will impact the forensic science community by presenting an objective evaluation of a new coding format and optimized ranking algorithm. This evidence-based research will impact the field of forensic odontology by providing solid recommendations on coding and algorithms for use with computerized dental ranking.

For many mass fatality incidents, dental comparison serves as a primary means of victim identification. In order to expedite the comparison of antemortem and postmortem records, computer software is often used to provide a rank of possible matches. In the United States, WinID3 is commonly employed for this purpose due to its proven utility and acceptance in the field. These computer generated ranks provide forensic odontologists with an objective "best-match" tool from which to undertake a more in-depth review of the dental records. It goes without saying that the computer ranks simply provide a starting point for the comparison of dental records. The final evaluation and victim identification should be performed by an experienced forensic odontologist.

Within the field of forensic odontology there is not one universally agreed upon coding system that is used for documenting tooth conditions. The goal of this research is to compare two different coding options and two ranking algorithms. WinID3 codes and ranking algorithms (most hits and least mismatches) were compared with a simplified coding system and concurrent ranking algorithm being tested at New Office of Chief Medical Examiner (OCME).

Intuitively it makes sense that "more is better" with coding since more detailed codes imply a greater level of precision in documenting the dental status and potentially, greater accuracy in the resulting ranks. In addition, more detail in the coding offers the ability to perform "focused" searches (e.g., find all records with a root canal and crown on tooth #30 and #31 but a post only in #30). However, the potential pitfalls of detailed coding may include data entry errors, lack of compliance/understanding, and a slow/tedious charting process. The important consideration for computerized ranking is to utilize a coding format that provides the best results with the least amount of effort.

With WinID there are 36 possible primary codes that are used with the ranking algorithms (Table 1). Most of these codes pertain to the various combinations of surface restorations. There are also 12 secondary codes that can be used along with the primary codes to describe dental status. With the simplified coding system there are only 7 primary codes and no secondary codes (Table 1). The goal with the simplified codes was to develop a system that was easy to interpret, lacked ambiguity, was expedient to code, and would provide some degree of "focused" search capability.

Table 1. Different Coding Formats

WinID Primary Code	OCME Simplified Code	Description
V	V	Virgin (tooth present with no restorative treatment)
U	V	Unerupted
M, O, D, F, L (31 possible combinations)	F	Filled (Tooth present with "routine" filling(s)).
Crowns and Root Canals are not part of the WinID primary codes	S	Special Treatment (Tooth present with "special" treatment such as a Root Canal and/or Crown. A filling with a root canal would receive only the "S" code.)
X	X	Missing Antemortem (This code is used regardless of whether or not the location has been replaced with a denture or bridge.)
X	I	Implant (Entire tooth is missing antemortem, but has been replaced with an implant inserted into the bone.)
J	P	Tooth is/was present, but is not fully observable as to the extent of treatment (e.g., postmortem fracture of crown, empty socket, extreme coronal decay, not fully observable in x-ray)
/	N	Absolutely no information (e.g., portion of mandible missing, or no antemortem information available).

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The role of computer ranking programs is to compare antemortem and postmortem records and quantify the number of matches, mismatches, and possible matches between records. The computer then ranks the various records based on a sorting algorithm (e.g., most matches followed by least mismatches). Matches occur when the code is identical in both the antemortem and postmortem record. Mismatches and possible matches occur due to charting discrepancies which can come in two types: explainable and unexplainable. Explainable discrepancies could be the result a logical progression in dental status (e.g., an occlusal filling (O) could progress to a mesial-occlusal-distal filling (MOD)). Unexplainable discrepancies are physical impossibilities in the progression of dental status (e.g., an extracted tooth (X) cannot become a virgin tooth (V)). Explainable discrepancies would result in a "possible" match in the computer ranking program, while unexplainable discrepancies would result in a "mismatch" in the computer ranking program. Due to charting errors and/or outdated records, both explainable and unexplainable discrepancies are commonly encountered in records pertaining to the same individual.

For this study, a large sample of adult dental data was compiled from numerous National Health and Nutrition Examination Studies (NHANES). The available data consist of approximately 33,000 records. These databases allowed for systematic changes to be made order to test the different coding and ranking methodologies. In order to explore the effect of various levels of coding discrepancies, the NHANES data were systematically modified to reflect various rates of coding discrepancies (Table 2).

Table 2. Rates of Coding Discrepancies Tested

Explainable Discrepancies	Unexplainable Discrepancies	Combination (exp / unexp)
No changes	No changes	No changes
2 teeth per record	2 teeth per record	1 exp. / 1 unexp.
4 teeth per record	4 teeth per record	2 exp. / 2 unexp.
6 teeth per record	6 teeth per record	3 exp. / 3 unexp.

The data were analyzed using the WinID3 coding format (Table 1) and the WinID3 ranking algorithms for Most Dental Hits and Least Dental Mismatches. Since it is possible for there to be ranking ties (e.g., several records all ranked #1), correct ranks were recorded as the number of records "tied with or better than" the correct match. For example, if 27 records were all ranked #1 and the correct match fell somewhere in this group of 27, the "tied with or better than" rank would be 27.

The same data were then converted into OCME's simplified coding format (Table 1) and were run through an optimized set of ranking algorithms. It should be noted that some coding discrepancies will be "self-corrected" when the detailed codes are converted to simpler codes. For example, the simplified format just has one code for a restored tooth irrespective of the surface location, so any discrepancy based on restored tooth surfaces would be "self-corrected" during the conversion.

These results will help forensic odontologists make sound decisions on the coding detail needed for computerized ranking, as well as the optimal sorting algorithms.

Dental Ranking, Dental Coding, Computer Algorithms

