THE DISCRIMINATION POTENTIAL OF AMALGAM RESTORATIONS FOR IDENTIFICATION: PART 1

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ABSTRACT

The dental identification of human remains utilizes the matching of dental restorations. The radiographic images of amalgam restorations are paramount in this process. The compound amalgam restoration has a unique radiographic morphology and can be readily identified in both antemortem and postmortem data. To test the radiographic morphology of compound amalgam restorations, 10 out of 40 Typodont teeth, restored by students, were tested for their discriminatory potential by 12 examiners. The results showed that the radiographic morphology of compound amalgam restorations can be accurately matched by dentally trained personnel. This suggests that in cases where accurate radiographic material is used for dental comparison, less than 12 concordant features are necessary for positive dental identification. If the antemortem and postmortem radiographic images of a compound amalgam restoration are exactly the same then this feature is unique and identification can be achieved by a single concordant feature.

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INTRODUCTION

In the process of forensic dental identification the reason for collecting and correlating antemortem and postmortem data is to compare these data and thereby identify an individual. The aim of the comparison is to examine the features of the same jaw sector, single tooth or even a tooth surface for concordance between antemortem and postmortem data.[1] There is no way of knowing how correctly a given restoration is depicted in an antemortem odontogram that was sketched by a dentist or the assistant, and a comparison based on a drawing of a restoration contour or cavity outline is never safe. Keiser-Nielsen (1980) recommended that the restored tooth surface as depicted in the odontogram be regarded as the smallest 'unit' to consider in the comparison of dental restorations for identification purposes. Thus 12 concordant features are required for a positive dental identification. The comparison of the most recent antemortem radiographs with those taken postmortem is one of the safest methods of comparison of dental features. The concordance of both the written data and the radiographs are usually used to establish identification.

No physical or dental feature is unique; if it were it would only have occurred once throughout history. However, any physical feature does possess a certain discrimination potential according to its frequency of occurrence; the more frequently it occurs the less characteristic it is.[1] In an expansion of the study by Keiser-Nielsen[1], Fellingham & Kotze[2] indicated that at either end of the range where, on the one hand a mouth of almost entirely normal teeth or, at the other end, an almost edentulous mouth, there are few possible configurations. One is then unlikely to be able to identify the persons with any degree of certainty. In the central part of the range, however, where the subject may have an assortment of decayed, missing or filled teeth, a specific configuration is likely to be rare and should lead to identification in most cases. While 12 concordant features are considered the minimum requirement for dental identification by Keiser-Nielsen[1], it has generally been found that this number of features cannot always be established. One or more extraordinary features could be involved and these should be accorded their appropriate degree of importance.[3] Keiser-Nielsen considered an extraordinary feature as one that does not occur in more than 10% of the population. One extraordinary feature may be sufficient, in certain circumstances, to make a positive identification. Two cases were presented by de Villiers and Phillips[4] in which the identification of two individuals were made

utilizing one extraordinary dental feature in each case.

The measure of uniqueness of the patterns of amalgam restorations in the upper and lower dentition was investigated by Phillips[5] in which he found that the patterns of amalgam restorations in the first molar were relatively common and therefore had a low measure of uniqueness. If however the pattern of the amalgam in the first molar was combined with the patterns in one or more other teeth, then the measure of uniqueness increased markedly and improved the likelihood of identification of that person.

The standard dental radiographic pictures of the teeth, however, provide a morphological view of amalgam restorations that is possible to duplicate and used for comparison purposes in identification procedures. In a study by Borrman and Gröndahl[6] in which the radiographic appearance of teeth and restorations of two sets of bitewing radiographs were compared by seven dentally trained observers, all observers were able to identify all the cases in which simple restorations were present. The question is whether the radiographic image of a single compound amalgam restoration in a posterior tooth is unique.

Aim

The aim of this study was to investigate the uniqueness of the radiographic image morphology of standardized compound amalgam restorations in molar teeth with regard to their discriminatory potential for dental identification purposes.

MATERIALS AND METHODS

The undergraduate conservative dentistry teaching program utilizes 'Typodont' acrylic teeth to train students to prepare cavities and to restore these teeth with silver amalgam. Forty of these 'Typodont' teeth were collected in which three surface amalgam restorations (mesio-occlusal-distal restoration) had been placed by fourth year dental students. The 'Typodont' teeth were numbered from 1 to 40 and placed in pairs into an acrylic mould to standardize their position for radiography. The cone of the X-ray machine was placed at right angles to the buccal aspect of the teeth and a radiograph taken to simulate a standard 'bitewing' dental radiograph. The images of the teeth from the twenty pairs of radiographs were labeled 1 to 40 (Figs.1a & 1b) and regarded as 'antemortem' images. A second set of radiographs, duplicates of the first set, was taken of each of these teeth and random alphabetic symbols were allocated to each radiograph for each tooth; these were considered as 'postmortem' radiographs. From this 'postmortem' group, 10 randomly selected radiographs Set 2 (Fig. 2) were chosen to compare with those of Set 1. These sets of radiographs were examined by 12 dentally trained personnel. The entire Set 1 and the ten radiographs from Set 2 were supplied to each of the examiners who were required to match the individual 'postmortem' radiographs (Set 2) with the 'antemortem' radiographs (Set 1). The examiners consisted of two Prosthodontists, two Maxillo-facial Radiologists, three Dentists, an Oral Pathology registrar, two Oral Hygienists, a Dental Radiographer and a Forensic Dentist. Their success rates of matching the radiographic images were recorded (Table 1).

RESULTS

The result of each of the observers was documented as the successful matching of all 10 'postmortem' radiographs (Set 2) within the 40 'antemortem' radiographs (Set 1).

Ten out of 12 examiners were able to match all 10 of the 'postmortem' radiographs, to the 'antemortem' set; two examiners obtained 9 out of 10 correct (Table 1). [To correctly match all 10 randomly selected radiographs successfully within a set of 40, was mathematically shown to be 1 possibility in $1{,}179 \times 10^9$ (1,179 billion)*.]

* Consultant Statistician: T J van Wyk Kotze

DISCUSSION

Twelve concordant antemortem and postmortem dental features have been regarded as essential to obtain absolute certainty of identification from a written dental record. Each decayed, missing or filled tooth is regarded as a *concordant unit* when it appears in both records. If however one or more extraordinary features are involved these are accorded a greater degree of importance and less than 12 concordant features are required for identification. One unique feature has been shown to be sufficient to make a positive identification.[4] The comparison of dental radiographs has been considered a highly reliable method for identification purposes, but the success rate of

matching antemortem and postmortem records is dependent on the skill of the observer.

Table1: *The results of matching 10 'postmortem' with 40 'antemortem' radiographs*

Observer	Score out of 10	Examiner
1 (VMP)	10	Forensic Odontologist
2 (PvZ)	9	Prosthodontist
3 (CN)	10	Maxillo-facial Radiologist
4 (GN)	10	Maxillo-facial Radiologist
5 (NP)	9	Prosthodontist
6 (AR)	10	Maxillo-facial Radiographer
7 (MS)	10	Dentist
8 (MC)	10	Registrar
9 (OH1)	10	Student Hygienist
10 (OH2)	10	Student Hygienist
11 (CdH)	10	Dentist
12 (JD)	10	Dentist

This table shows 10 examiners matched all the radiographs; two examiners matched 9 out of 10

Borrman et al[6] found that experienced examiners were all able to successfully match simple amalgam restorations from radiographic material. The results of the examiners in our study showed that the radiographic morphology of a compound amalgam restoration is easily identifiable within a group of radiographs when the 'antemortem' and 'postmortem' radiographic images are identical. In this study 10 out of 12 dentally trained examiners were able to match all the radiographic images correctly; two examiners scored 9 out of 10. This indicated that the radiographic morphology of the compound amalgam restoration is highly distinctive for identification purposes.

In a mass disaster where there is fragmentation of human remains, obtaining enough dental material to make an identification requiring 12 concordant points is often impossible. The radiographic morphology of dental restorations, roots and bony trabecular patterns are often used as identification criteria in these situations. After the removal of caries from a tooth and the repair of that tooth with a silver amalgam restoration, the radiographic shape of that restoration when viewed on a bitewing, periapical or Pantomographic radiograph has a very distinctive shape that can be matched in both the antemortem and postmortem radiographs. The placement of a lining material in the cavity prior to the amalgam filling will correct most of the irregularity of the floor of the cavity and produce a layer of material between the amalgam and the dentine that may also produce a distinctive radiographic image. It is most unlikely that two individual compound amalgam restorations can have exactly the same radiographic image; the thickness of the amalgam restoration together with the irregular occlusal surface morphology is highly distinctive in each restoration. This suggests that when undertaking identification using dental radiographs, if the postmortem radiographs are accurate duplicates of those taken antemortem, then the radiographic images of the amalgam restorations have a greater discriminatory potential than a single concordant unit as stated by Keiser-Nielsen.[1] If the two images are exactly similar then this image can be regarded as highly extraordinary, if not unique.

CONCLUSION

It is the opinion of the authors that a single compound silver amalgam restoration has a radiographic morphology that is so distinctive that it is possible for one restoration to be used for the identification of an individual.

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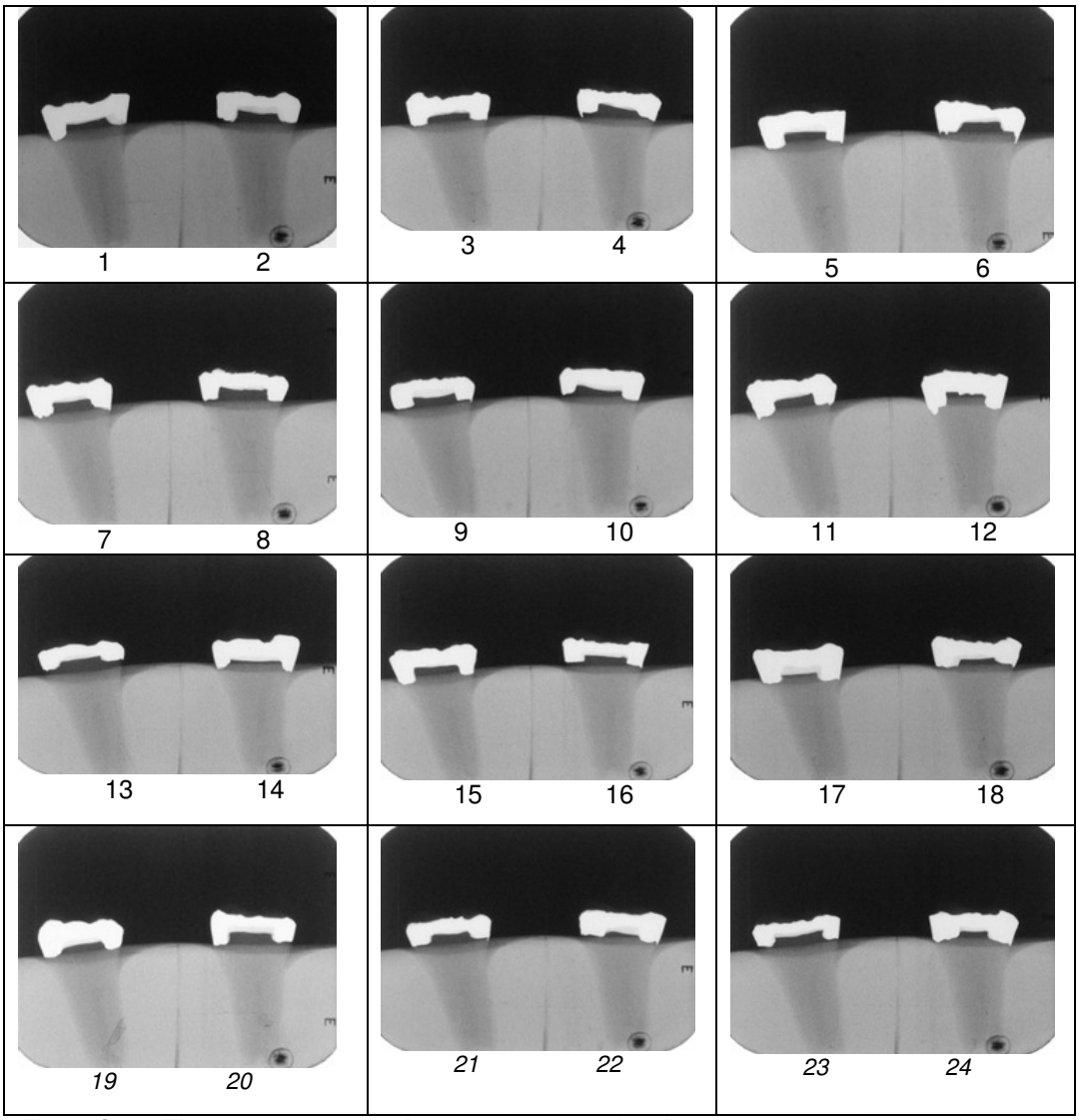


Fig1a: *Set 1. The 'antemortem' set of 40 dental radiographs of amalgam restorations - teeth 1 to 24*

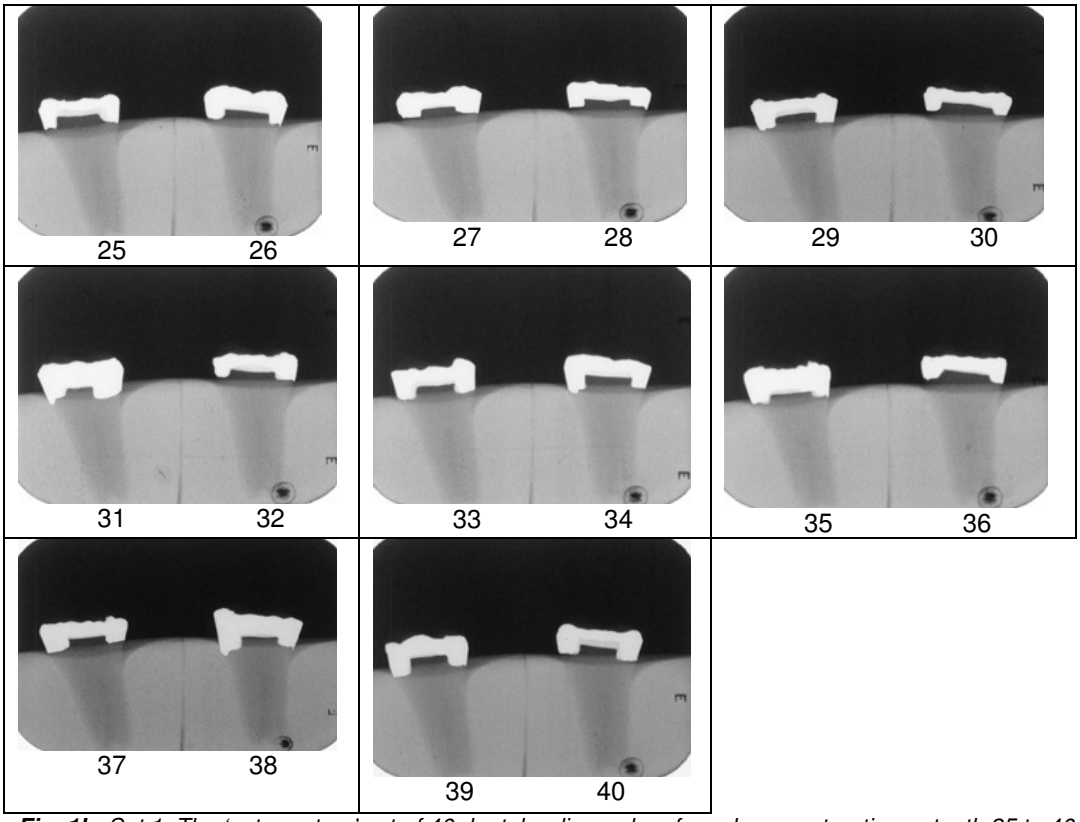
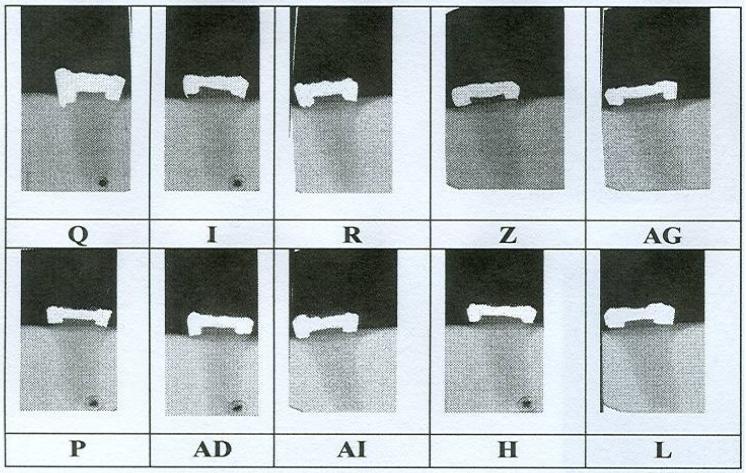


Fig. 1b: *Set 1. The 'antemortem' set of 40 dental radiographs of amalgam restorations - teeth 25 to 40*

Diagram 2: Set 2. The 10 randomly selected 'post mortem' radiographs chosen for comparison with Set 1.



Solution:
Q = 38, I = 4, R = 7, Z = 9, AG = 23, P = 16, AD = 20, AI = 3, H = 30, L = 27

Fig. 2: Ten randomly selected 'postmortem' radiographs.

REFERENCES

1. Keiser-Nielsen S. Person Identification by Means of the Teeth. John Wright & Sons. Bristol. 1980:54-72.

2. Fellingham SA, Kotze TJ vW. Probabilities of dental characteristics. Contribution to a workshop on Forensic Odontology. University of Stellenbosch, Dental Faculty, Tygerberg. 1980.

3. Phillips VM, Scheepers CF. A comparison between fingerprint and dental concordant characteristics. J Forensic Odonto Stomatol, 1990;8:17-9.

4. De Villiers CJ, Phillips VM. Person identification by means of a single unique feature. J Forensic Odonto Stomatol, 1998;16:17-21.

5. Phillips VM. The uniqueness of amalgam restorations for identification. J Forensic Odonto Stomatol, 1983;1:33-8.

6. Borrman H, Gröndahl H-G. Accuracy in establishing identity by means of intraoral radiographs. J Forensic Odonto Stomatol. 1990;8:31-6.

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