Assessment of Composite Restorations and Their Unique Features in Forensic Identification of Unidentified Human Beings

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ABSTRACT

Background: Dental identification mainly involves the comparison of antemortem and postmortem records. Keiser-Nielson (1980) recommended restored tooth surfaces as the smallest unit to consider in the comparison of dental restorations for identification purposes. Unique appearance of radiographic images of amalgam has led to their application in dental forensic. The present study aimed to investigate the value of composite restorations and their features in forensic identification.

Methods: The antemortem sample included 40 periapical radiographs of anterior teeth with class III composite restorations which had been taken at least one year before the study. Ten randomly selected recent radiographs of the same subjects along with two radiographs from other patients were regarded as postmortem samples. Afterward, 12 dentally trained examiners were asked to match the 12 radiographs of group 2 with those of group 1 and to determine which features of the teeth (e.g. shape, contour, and surface) had helped them.

Results: Ten examiners were able to correctly match all of the 12 images. According to kappa coefficient, the inter-rater agreement was high (0.8-1.0). The shape of the restoration was the most useful feature in identification.

Conclusion: A composite restoration has a unique radiographic morphology that can be used for human identification. Therefore, if the antemortem radiograph of a single composite restoration is available, its comparison with a postmortem radiograph can help identify unidentified human beings.

►*Implication for health policy/practice/research/medical education: Composite Restorations and Their Unique Features in Forensic Identification of Unidentified Human Beings*

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1. Introduction:

Forensic Odontology is the branch of Forensic Medicine that plays a significant role in human identification, particularly when facial recognition by family members, relatives, and friends is impossible (1-5).

Dental identification mainly involves the comparison of antemortem and postmortem records including charting, photography, radiography, and modeling that are accepted as one of the most reliable and effective identification procedures used today for single cases or for mass disasters. Comparing antemortem and postmortem dental radiographs, which are common components of patient records, is a simple, and sometimes the only, way of reliable human identification (6, 7).

Teeth and restorations are the most durable parts of human body. They can survive for long periods, even if the body is immersed in acid or affected by other factors such as water and fire (8). According to Keiser-Nielson (1980), restored tooth surfaces may serve as the smallest units to consider in the comparison of dental restorations for identification purposes (9).

Since amalgam restorations have unique radiographic morphology and can be easily identified in both antemortem and postmortem radiographs, they are generally examined in dental identification (10, 11). However, the rising demand for esthetic restorations has led to replacement of amalgam with composite resins (12). According to the American Dental Association Council on Dental Materials, Instruments, and Equipment radiopacity is one of the five basic requirements of any restorative material (13). However lack of radiopacity made the radiographic detection of the first composite resins difficult, adding filler particles in their matrix has solved the problem (14).

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Most previous studies have evaluated amalgam restorations whose very high radiopacity causes observation error and reduced detection of details. Composite resins, on the other hand, possess lower radiopacity (15-22) and have rapidly superseded amalgam due to their desirable physical properties, feasibility, and of course esthetic features (23).

Although research has predominantly focused on class II posterior composite restorations, composite resins are mainly used for class III and IV restorations of anterior teeth. Moreover, despite the popularity of bitewing radiographs in dental research, the principal diagnostic technique for anterior teeth (where composite resins are chiefly used) is periapical radiography.

Bahavathi and Sundaresan (2013) suggested that composite restorations have unique shapes and can thus be used in identification of human remains (24). Likewise, Zondag and Phillips (2009) evaluated the discrimination potential of composite restorations of premolars for human identification. They concluded that when a single composite restoration shows identical morphology in antemortem and postmortem radiographs, the image is unique and the 12 contractual features are not required for dental identification (25).

Meanwhile, Phillips and Stuhlinger (2009), assessed the discrimination potential of amalgam restorations of molars for identification of human remains. Again, similar morphology of antemortem and postmortem radiographs of an amalgam restoration indicated the uniqueness of the image and could serve as a sole criterion in human identification (10).

In a study on validity of dental records for identification of unidentified human remains, Zahrani could identify all individuals but with different degrees of certainty. The mean identification percentage was 79.49% and the rest (20.51%) was attributed to dynamic dental changes and human errors in initial charting (26).

The present study analyzed periapical radiographs of class III and IV composite

restorations of anterior teeth. Unlike previous research which mostly synthesized radiographic images and used their duplicates as postmortem images, we included living subjects. Dental radiographs obtained at least one year before the study and recent radiographs of the same individuals were considered as antemortem and postmortem images, respectively.

2. Materials and Methods:

In an analytical, cross-sectional study, 40 patients who paid their second visit to dental clinics of Isfahan (Iran) and had archived periapical radiographs of class III composite restorations of anterior teeth were randomly selected. Since unnecessary X-ray exposure is unethical, the patients were only included if they required radiography for the purpose of routine check-ups or the assessment of an adjacent tooth.

The archived radiographs which had been taken at least one year prior to the study were extracted. Finally, 40 periapical images of class III composite restorations of anterior teeth obtained through parallel, digital radiography were considered as the antemortem sample (SET 1) and numbered consecutively from 1 to 40. Moreover, 10 recent radiographs of the same patients besides the two extra images (from other individuals) were also randomly selected, regarded as the postmortem sample (SET 2), and labeled as A-M. The selected teeth did not have any other form of restoration (e.g. posts and pins), fractures, or abrasion.

Twelve observers including one student in their final year, one dentist, one post-graduate of Oral and Maxillofacial Radiology, one Oral and Maxillofacial Radiologist, one Radiology Technician, one post-graduate of Esthetic and Restorative Dentistry, one Specialist of Esthetic and Restorative Dentistry, one forensic odontologist and one Forensic Medicine Specialist were asked to match the 12 images in group 2 with relevant images in group 1 and record the results.

Correlation between SET 1 and SET 2 is based on table 1.

The collected data was analyzed with appropriate statistical methods. Inter-rater agreement was examined through calculating kappa coefficient.

3. Results:

The result given by each and every examiner was documented by recording the number of exact matches between SET1 and SET2.

The results showed that out of the 12 examiners, 10 examiners scored 12/12, 1 examiner scored 11/12 and 1 examiner scored 10/12 (Table 2).

The results show that 10 observers were able to match all the 12 images correctly, success rate of 100%, one observer was able to match 11 images correctly, and success rate of 91.66%, one observer was able to match 10 images, success rate of 83.33%.

According to the calculated kappa coefficients, the inter-rater agreement 0.83 (between 0.8 and 1.0) which signifies very good agreement.

4. Discussion:

Nowadays forensic dentistry plays a major role in the identification of those individuals who cannot be identified visually or by other means, so dental practitioners should be known about the methods of dental identification in order to help the process of human identification.

The 12 examiners in this study were selected at random from various specialties in

Table 1: Correlation between set 1 and set 2.

Nr of random postmortem radiographs picked from Set 2:	Set 1	Set 2
1	12	G
2	39	B
3	20	I
4	7	H
5	3	A
6	32	L
7	28	F
8	24	D
9	5	J
10	14	C
11	No Matching	K
12	No Matching	E

Table 2: The result of examiners matching 12 radiographs of Set 2 with the 40 radiographs of Set 1.

Examiner	Score
1	10/12
2	12/12
3	12/12
4	12/12
5	12/12
6	12/12
7	12/12
8	12/12
9	11/12
10	12/12
11	12/12

relationship with restoration, radiography, and forensic, not equally from each specialty since the objective of this study was not the comparing ability of examiners from one specialty being better than the other, although the results shown that two observers who were not in communication with dental patients directly (radiology Technician and forensic Medicine Specialist) could not match all the images correctly.

Unlike other researchers, e.g. Phillips 1983 (27), Buchner 1985 (28), Williers and Phillips 1998 (29), and Borman and Grondahl 1990 (30), who studied amalgam restorations, we evaluated composite restorations. Despite the proven discrimination potential of amalgam restorations, they lack ideal radiopacity and are almost supplanted by composite resins.

On the other hand, although the majority of previous studies have performed bitewing and panoramic radiography, periapical radiography is commonly used for the assessment of anterior teeth where composite restorations are generally placed (6, 10, 31).

It is worth noting, we used periapical radiographs obtained through parallel technique. Two exposure techniques may be employed for periapical radiography: the paralleling technique and the bisecting angle technique. The paralleling technique provides less image distortion and reduces excess radiation to the patient but the bisecting technique include image distortion and excess radiation due to increased angulations involving the eye and thyroid glands. So, the paralleling technique is better for identification (32).

Another remarkable feature of the current study was the use of old radiographs (taken at least one year prior to the study) of living individuals as the antemortem sample and the same subjects' recent radiographs as the postmortem sample. In contrast, most studies in this field have investigated phantom teeth and synthesized radiographs and their duplicates as antemortem and postmortem samples, respectively (10, 24). Although, they had to match the images by analyzing the radiographic appearance of the restoration alone and not that of the teeth but the natural teeth would have given a more challenging comparison.

Our findings confirmed the uniqueness of composite restorations and their value in human identification. Similar results have been previously reported by Bahavathi and Sundaresan, 2013 (24) and Zondag and Phillips, 2009 (25).

Many radiological techniques are used for human identification; however, any of them depends on the availability of previous image record for comparison. Therefore, it is very important to emphasize the necessity of keeping adequate dental recording for all dental patients and to make them available to the proper authority whenever needed in the future.

5. Conclusion:

Radiographs of composite restorations are unique and can serve as reliable tools in proper human identification. More precisely speaking, comparison of antemortem and postmortem radiographs of a particular composite restoration can aid in identification of unidentified human beings.

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7. References:

1. Pretty IA, Sweet D. A look at forensic dentistry-Part 1: The role of teeth in thedetermination of human identity. Br Dent J. 2001;190:359-66.
2. MacLean D, Kogon S, Stitt L. Validation of dental radiographs for human identification. J Forensic Sci. 1994;39:1195–200.
3. Kogon D. Long-term validation study of bitewing dental radiographs for orensic identification, J. Forensic Sci. 1996;41:230–2.
4. Wood RE, Kogon S. Dental radiology considerations in DVI incidents: a review. Forensic Sci Int. 2010;201:27–32.
5. Kvaal SI. Collection of post-mortem data: DVI protocols and quality assurance. Forensic Sci Int. 2006;159:12–4.
6. Pinchi V, Zei G. Two positive identifications assessed with occasional dental findings on non-dental X-rays. J Forensic Odontostomatol. 2008;27:34–8.
7. Jain AK, Chen H. Matching of dental X-ray images for human identification. Pattern Recogn. 2004;37:1519-32.
8. Robinson FG. Dental practice that aid the general practitioner and forensic dentist. Gen Dent. 1998:203-5.
9. Keiser-Nielsen S. Dental identification: Certainty V probability. Forensic Sci. 1998;9:87-97.
10. Phillips VM, Stuhlinger M. The discrimination potential of amalgam restorations for identification: Part 1. J Forensic Odontostomatol. 2009;27:17-22.
11. Villiers CJ, Philips VM. Person identification by means of a single unique dental feature. J Forensic Odontostomatol. 1998;16:17-9.
12. Bush AM, Bush BS, Miller RG. Detection and classification of Composite Resins in Incinerated Teeth for Forensic Purposes. J Forensic Sci. 2006;51:636-42.
13. American Dental Association. Obstacles to the development of a standard for posterior composite resins. Council on Dental Materials, Instruments, and Equipment. J Am Dent Assoc. 1987;115:722-4.
14. Salzedas LMP, Louzada MJQ, Filho AB. Radiopacity of restorative materials using digital images. J Appl Oral Sci. 2006:14:147-52.
15. Espelid I, Tveit AB, Erickson RL, Keck SC, Glasspoole EA. Radiopacity of restorations and detection of secondary caries. Dent Mater. 1991;7:114-7.
16. Curtis PM Jr, von Fraunhofer JA, Farman AG. The radiographic density of composite restorative resins. Oral Surg Oral Med Oral Pathol. 1990;70:226-30.
17. Goshima T, Goshima Y. Radiographic detection of recurrent carious lesions associated with composite restorations. Oral Surg Oral Med Oral Pathol. 1990;70:236-9.
18. Tveit AB, Espelid I. Radiographic diagnosis of caries and marginal defects in connection with radiopaque composite fillings. Dent Mater. 1986;2:159-62.
19. Bouschlicher MR, Cobb DS, Boyer DB.Radiopacity of compomers, flowable and conventional resin composites for posterior restorations.Oper Dent. 1999;24:20-5.
20. Willems G, Noack MJ, Inokoshi S, Lambrechts P, Van Meerbeek B, Braem M, *et al*. Radiopacity of composites compared with human enamel and dentine. J Dent. 1991;19:362-5.
21. Hara AT, Serra MC, Haiter-Neto F, Rodrigues AL Jr. Radiopacity of esthetic restorative materials compared with human tooth structure. Am J Dent. 2001;14:383-6.
22. Imperiano MT, Khoury HJ, Pontual MA, Montes MJ, da Silveira MF. Comparative radiopacity of four low viscosity composites.Braz J Oral Sci. 2007;6:1278-82.
23. Cruvinel DR, Garcia LF, Casemiro LA, Pardini LC, Pires-de-Souza FC. Evaluation of radiopacity and microhardness of composites submitted to artificial aging. Mater Res. 2007;10:325-9.
24. Bahavathi AH, Sundaresan B. A study of composite restorations as a tool in forensic identification.J of Forensic Dental Sciences. 2013;5:35-40.
25. Zondag H, Phillips VM. The discrimination potential of radio-opaque composite restorations for identification: Part 3. J Forensic Odontostomatol. 2009;27:27-32.
26. Zahrani AA. Identification of unidentified human remains validity of dental records. Pakistan Oral & Dental Journal. 2005;25:3-6.
27. Philips VM. The uniqueness of amalgam restorations for identification. J Forensic Odontostomatol. 1983;1:33-8.
28. Buchner A. Identification of human remains. Int Dent J. 1985;35:307-11.
29. Villiers CJ, Philips VM. Person identification by means of a single unique dental feature. J Forensic Odontostomatol. 1998;16:17-9.
30. Borrman H, Grondahl HG. Accuracy in establishing identity be means of intraoral radiographs. J Forensic Odontostomatol. 1990;8:31-6.

31. Phillips VM, Stuhlinger M. The discrimination potential of amalgam restorations for identification: Part 2. J Forensic Odontostomatol. 2009;27:23-26.

32. Mourshed F, McKinney AL. A comparison of paralleling and bisecting radiographic techniques as experienced by dental students. Oral Surg Oral Med Oral Pathol. 1972;33(2):284-96.