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The application of dental methods of identification to human burn victims in a mass disaster

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Abstract This paper deals with the usefulness of dental identification in the case of 28 human burn victims of a bus accident in Spain. Postmortem forensic procedures for identification were used including general external examination, routine photographs and radiographs and complementary biological methods. Dental identification was also used and a description of the method is presented. Dental identification was established in 57% of the cases. When victims were less than 20 years of age, the success rate of identification by dental methods was higher (76% of victims in this age group). The assessment of dental age allowed the establishment of identity of four victims. We recommend that dental procedures be used in human identification after mass disasters. Odontological and radiographic procedures are powerful methods when dealing with burn victims.

Key words Human identification · Dental method · Mass disaster

Introduction

In the last few decades, identification by dental means has been described as one of the most reliable methods for identification of victims in mass disasters [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16] and when one individual must be identified [17,18]. Visual recognition of facial features in badly burnt human victims is often impossible and identification by fingerprints may not be possible due to the degree of destruction of the bodies. Dental identification may be based on pathological conditions, disturbances of tooth eruption, malocclusions and on dental treatment. The identity of an individual may be established on the basis of the uniqueness of concordant ante- and postmortem dental features. A comparison between antemortem records and postmortem findings may thus often lead to identification or provide convincing proof to rule out a particular identity.

The aim of this study was to present the results and discuss the advantages and limitations of the dental method in the identification of 28 burn victims of a bus accident. All the deceased were almost completely incinerated. We describe the most relevant cases where the identity was established by the dental method and discuss the dental comparison process.

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Material and methods

Details about the accident, planning and personnel involved in the identification procedures have been described previously [19]. Briefly, a car collided head-on with a bus at 2200 h on 28 February 1996 on a major highway in southern Spain. A few seconds after the crash, the bus caught fire and 28 of the 57 passengers lost their lives.

Complete postmortem examinations of the 28 victims were performed in a temporary mortuary in Bailen (Jaen, Spain) by a multidisciplinary identification commission (ID-Commission). The ID-Commission consisted of ten police officers (from the Identification Department of the Guardia Civil), two forensic odontologists and pathologists (experts in human identification procedures from the Department of Forensic Medicine of the University of Granada, Spain), two general odontologists, one forensic pathologist and one assistant radiologist. Examination for identification was performed on 28 bodies (13 females and 15 males), the mean age of the victims was 22 years (age range 5-48 years) and 17 victims (60%) were under 20 years of age. Standard postmortem forensic procedures, including general external examination of each victim by the forensic pathologists at the temporary mortuary, routine photographs, general radiographs and biological methods (DNA analysis) were used as described previously [19]. In addition, postmortem dental examination was performed and dental comparison process was carried out according to the procedure presented.

Postmortem dental examination procedure

Postmortem dental examination of each victim included oral macrophotography, completion of the postmortem pink Interpol DVI form and radiography. Impressions were taken and models made in two cases for further comparison where one victim had received specific treatment (expansion plaque for upper teeth). Inspection of the oral cavity was performed after resection and removal of the mandible. In some cases, where major skull, face and jawbone mutilation and fragmentation of dental structures were present, due to the very high temperatures (more than 1,000 °C), identification of the victims by dental means was more difficult. The extent of fire injury to the dentition was classified according to the categories proposed by Andersen et al. [18]. A detailed postmortem registration of the teeth was performed in each case using the following categories: intact/sound, filled (e.g. restoration material, surfaces, root fillings), missing teeth (e.g. extracted, postmortem loss) and fixed (e.g. crowns and bridges) or removable prosthetics. Disturbances in tooth eruption (i.e. ectopic, transposed, retained, impacted teeth) and various types of malocclusions (i.e. deep bite, crossbite, crowding and spacing) were also recorded. Fractures of teeth and jawbones and any pathological changes in the soft tissues or in jawbones (i.e. infections, torus palatinae) were also recorded. The dental examinations were carried out by two odontologists per case (one forensic and one general dentist) and one forensic odontologist examined the teeth while the other filled in the form and monitored the process.

Postmortem dental radiographs were taken including, in most cases, periapical and extraoral (lateral and posteroanterior) skull radiographs. A mobile dental X-ray unit was used for intraoral projections. Lateral and posteroanterior skull radiographs had been made with a mobile X-ray unit, and the exposures were taken at 7 mA/sg and 60 kV. An assistant radiologist helped to take both extraoral and other general radiographs and the radiographs were developed in a nearby hospital.

Collection of antemortem material and comparative identification

After the accident, police officers compiled a complete list of the passengers and collected most of the technical information from inquiries from other passengers and relatives. Antemortem photographs of the victims were supplied by relatives. Medical and dental information was obtained by direct contact with the dentists and family doctors of the victims. Dental or medical antemortem records supplied were transcribed onto the Interpol DVI forms by the forensic pathologists and odontologists. The fact that this accident occurred very near the city where the victims had lived made the collection of antemortem material relatively easy and fast. General dental practitioners helped to interpret their own patients' dental charts and it was therefore possible to minimize mistakes in the transcription of dental antemortem data into the Interpol DVI forms. Antemortem radiographs were included in 11 of the 28 records, but only six of these were dental exposures with either periapical or panoramic roentgenograms.

The detailed antemortem and postmortem records (Interpol DVI forms) and radiographs were compared manually by two separate teams, one for the group of female victims and the other for male victims. Each team consisted of one forensic odontologist and pathologist, one odontologist and one police officer with the full-time assistance of two other police officers. The results obtained were discussed between the two teams in order to draw comparable conclusions. A report with a declaration of identity for each victims was prepared and signed by representative members of the ID Commission, including two forensic odontologists and pathologists and three members of the Guardia Civil identification team.

Results and discussion

Identity of victims established by the dental method was possible for 16 victims (dental identification established in 57% of the cases). Table 1 shows the number of subjects identified in this mass disaster by means of odontological methods according to age and sex. Of the victims under 20 years of age, 76% were identified by the dental method alone. The identification procedures performed by four odontologists were accomplished in a total of 90 h. Thus 3 h of work per victim was the average time needed for dental identification.

In a review of 54 disasters [6], dental methods contributed to 43% of the identifications, but identification by dental methods was higher in other mass disasters (68–89%) [10, 12] than in the present case. The success rate of dental identification will vary considerably depending on the nature of the accident, the nationality and country of residence of the victims, the incidence of dental treatment, the availability of adequate dental records, and the degree of dental injury [13, 18, 20]. Although substantial dental remains were present in the majority of the victims, in 46% of cases fire damage to the anterior teeth in one or both jaws was observed. Approximately half of the other cases (49%) showed damage which fitted into the categories grade 3 and 4 (damage to anterior and posterior teeth bilaterally or fragments of jaw bone including teeth and/or roots, respectively) [18].

In 12 of the victims (43%) dental comparison could not be performed due to complete destruction of the teeth or the absence of dental antemortem records. However, in five cases (18%) dental methods contributed to identification in combination with other methods [19]. In these cases, conclusions could be drawn only in terms of probability for dental identity, i.e. probable or possible. An exact calculation of the probability of identification should be performed in relation to contemporary data on dental status from the Spanish population. Rare or complex dental treatments may carry more weight than more common ones [18, 21].

In this mass disaster a list of those alleged to have been on the bus was available immediately after the accident. No inaccuracies were found and therefore the dental information for the listed passengers matched the identified remains.

On the basis of the specific oral findings in the group of victims identified by dental method, cases were classified into the following categories (Table 2):

Table 1 Number of subjects identified by the dental method, according to age and sex

Sex	Age (years)	
	≤ 20	≥ 21
Female	5	2
Male	8	1
Total	13 (76%)[a]	3 (27%)[a]

[a] Values in parentheses represent percentage of subjects identified by the dental method in relation to total number of victims in each age group (≤ 20 years, $n = 17$ and ≥ 21 years, $n = 11$)

Table 2 Pathological findings and type of radiographs used for dental identification

Category	Pathological findings	Age (years)	Sex	Specific observations	Radiographs
I. Oral pathology	Disturbances of tooth eruption	12	M	Ectopic upper lateral incisors	Occlusal
		18	M	Agenesia lower premolars	Periapical
	Malocclusions	13	M	Expansion plaque	None
	Pathological changes in bones	11	M	Torus palatinae	None
	Dental pathology	30	M	Deep carious lesions	Periapical
II. Dental treatment	Fillings	20	F	Amalgams	Periapical
		17	M	Composites	Periapical
		21	F	Composites	Periapical
		19	M	Molar sealants	None
	Root canal treatment	15	M	Root filling	Periapical
	Extracted teeth	46	F	Multiple extractions	None
		20	F	Incomplete extracted molar	Periapical
III. Establishment of dental age	Dental eruption and mineralization	9	M		Lateral skull
		5	F		Lateral skull
		5	F		Lateral skull
		10	F		Lateral skull

Category I: Subjects with an oral pathology such as (a) developmental disturbances of tooth eruption, (b) malocclusion, (c) pathological changes in the maxilar or mandibular bones, or (d) dental pathology.

Category II: Subjects with dental treatment such as (a) fillings (i.e., amalgam, composite, etc.), (b) root canal treatment, or (c) extracted teeth.

Category III: Establishment of dental age through the study of dental eruption and mineralization of teeth.

Although antemortem dental radiographs, including periapical and extraoral radiographs, were available in only six cases, the contribution of postmortem radiographs to the identification procedures was essential because of their accurate recording of pathological changes or odontological treatment. Postmortem lateral skull radiographs revealed information about dental eruption and mineralization of teeth. In four cases, identification was possible by establishing the dental age. Intraoral radiographs (occlusal and periapical) were used to identify eight victims through the study of disturbances in tooth eruption, incomplete extraction of a molar or specific dental treatment.

The large number of children and young people among the victims (17 out of 28 were under 20 years of age; 60% of the victims) caused special problems for identification because of the very low number of dental treatment in this group. Dental methods of identification were used to establish the identity of 100% of the children aged less than 10 years and 70% of the victims between 11 and 20 years of age. The assessment of age by dental methods in this group proved to be of great importance. Age was assessed by dental eruption and mineralization of permanent and deciduous teeth through the study of extraoral radiographs according to methods described by other authors [22, 23, 24, 25, 26]. Using this technique it was possible to establish which was the older and younger girl between two girls aged 6 and 5 years old, respectively. Bearing in mind the wide variations in eruption patterns in the general population, this method should be used with extreme caution and other methods of identification should also be used.

The results presented here demonstrate the success of the dental method alone for the identification of burn victims. We conclude that odontological and other complementary dental radiographic procedures may be powerful methods of identification when dealing with burn victims, especially when other types of evidence are not available. On the basis of our experience and of similar published reports, it is essential to emphasize the need for a standardized system of recording dental findings and to ensure that dental identification procedures will be used in all identification processes. A well trained team of experienced forensic odontologists should be prepared to operate when a mass disaster occurs.

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References

1. Cairns FY, Herdson PB, Hitchcock GC, Koelmeyer TD, Smeeton WMI, Syneck BYL (1981) Aircrash on Mount Erebus. Med Sci Law 21:184–188
2. Eckert WG (1982) The Rockne crash. American commercial aircrash investigation in the early years. Am J Forensic Med Pathol 3:17–27

3. Ayton FD, Hill CM, Parfitt HN (1985) The dental role in the identification of the victims of the Bradford City Football Ground fire. Br Dent J 159:262–264
4. McCarty VO, Sohn AP, Ritzlin RS, Gauthier JH (1987) Scene investigation, identification and victim examination following the accident of Galaxy 203: disaster preplanning does work. J Forensic Sci 32:983–987
5. Stahl CJ, McMeekin RR, Ruehle CJ, Canik JJ (1988) The medical investigation of airship accidents. J Forensic Sci 33:888–898
6. Clark DH (1989) Postmortem dental identification in mass disaster. PhD dissertation, University of London
7. Eckert WG (1990) The Lockerbie disaster and other aircraft breakups in midair. Am J Forensic Med Pathol 11:93–101
8. Clark DH (1991) Disaster victim identification. J Br Assoc Immed Care 4:58–61
9. Clark DH (1991) Dental identification in the Piper Alpha oil rig disaster. J Forensic Odontostomatol 9:37–45
10. Solheim T, Lorentsen M, Sundnes PK, Bang G, Bremnes L (1992) The "Scandinavian Star" ferry disaster 1990 – a challenge to forensic odontology. Int J Legal Med 104:339–345
11. Spencer DE, Berk JK (1992) Identifying fire victims: the East Bay firestorm. J Calif Dent Assoc 20:52–57
12. Stene-Johansen W, Solheim T, Sakshaug O (1992) Dental identification after the DASH 7 aircraft accident at Torghatten, Northern Norway, May 6th, 1988. J Forensic Odontostomatol 10:15–24
13. Clark DH (1994) An analysis of the value of forensic odontology in ten mass disasters. Int Dent J 44:241–250
14. Ludes B, Tracqui A, Pfitzinger H, Kintz P, Levy F, Disteldorf M, et al (1994) Medico-legal investigations of the Airbus A320 crash upon Mount Ste-Odile, France. J Forensic Sci 39:1147–1152
15. Hutt JM, Ludes B, Kaess B, Tracqui A, Mangin P (1995) Odontological identification of the victims of flight AI.IT 5148 air disaster Lyon-Strasbourg 20.01.1992. Int J Legal Med 107: 275–279
16. Brkic H, Strinovic D, Slaus M, Skavic J, Zecevic D, Milicevic M (1997) Dental identification of war victims from Petrinja in Croatia. Int J Legal Med 110:47–51
17. Douglas WO (1993) Identification of the fragmentary, burned remains of two US journalists seven years after their disappearance in Guatemala. J Forensic Sci 38:1372–1382
18. Andersen L, Juhl M, Solheim T, Borrman H (1995) Odontological identification of fire victims-potentialities and limitations. Int J Legal Med 107:229–234
19. Martin-de las Heras S, Valenzuela A, Villanueva E, Marques T, Exposito N, Bohoyo JM (1999) Methods for identification of 28 burn victims following a 1996 bus accident in Spain. J Forensic Sci 44:428–431
20. Brannon RB, Kessler HP (1999) Problems in mass-disaster dental identification: a retrospective review. J Forensic Sci 44: 123–127
21. Keiser-Nielsen S (1977) Dental identification: certainty v probability. Forensic Sci 9:87–97
22. Schour I, Massler M (1941) The development of the human dentition. J Am Dent Assoc 20:379–427
23. Moorees CFA, Fanning EA, Hunt EE (1963) Age variation of formation stages for ten permanent teeth. J Dental Res 42: 1450–1502
24. Haavikko K (1974) Tooth formation age estimated on a few selected teeth. A simple method for clinical use. Proc Finn Dent Soc 70:15–19
25. van Heerden PJ (1985) The mesial root of the third mandibular molar as a possible indicator of age Dissertation for Diploma in Forensic Odontology, London Hospital Medical College
26. Mincer HH, Harris EF, Berryman HE (1993) The ABFO study of third molar development and its use as an estimator of chronological age. J Forensic Sci 38:379–390