

CASE REPORT

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Methods for Identification of 28 Burn Victims Following a 1996 Bus Accident in Spain*

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ABSTRACT: A car collided head-on with a bus containing 56 passengers plus the driver. A few seconds after the crash, the bus caught fire and 28 persons (15 male and 13 female) lost their lives. All the deceased were almost completely incinerated. To establish the identity of the victims, the judge in charge of the case designated a multidisciplinary Identification Commission. Postmortem procedures included a general external examination, routine photographs, dental examination, dental (intraoral and extraoral) and general radiographs (chest, ankle, etc.), and complementary biological methods for identification (e.g., DNA analysis). The antemortem information, including dental and medical records available, were transcribed onto the INTERPOL disaster victim identification forms. The detailed ante- and postmortem information were compared manually. In this disaster dental identity could be established in 57% of the victims, whereas dental evidence did not allow by itself the identification of 12 burned victims. Odontological examination and complementary radiographic procedures were found to be accurate, economic and rapid methods of identifying badly burned victims in this bus accident.

KEYWORDS: forensic science, mass disaster, identification, disaster planning

The identification of victims of a mass disaster is essential from both a humanitarian and a religious point of view as well as for judicial reasons. From a legal point of view, the establishment of the identity of a dead person is necessary for the settlement of wills, the granting of probate, life insurance payments and the disposal of the deceased's estate. On a humanitarian level, victim identification is important for families to be able to claim their relative for proper funeral rites according to their religious beliefs.

In the Spanish justice system, judges have authority over the examination and analysis of forensic evidence and the overall man-

ner in which a case is prosecuted and resolved. When a mass disaster occurs, the judge in whose jurisdiction the disaster takes place is responsible for investigating when, where and how the victims died, and also who they were. At the inquest the judge requires evidence for the identification of the victims. In the subject catastrophe the judge requested the assistance and appointed a multidisciplinary Identification Commission (ID-Commission) for the identification of the victims. The ID-Commission consisted of ten policemen (from the Identification Department of the Guardia Civil), two forensic odontologists and pathologists (experts on 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.

When a catastrophe occurs, identification is always difficult due to the large number of bodies and mutilations (1–10) and requires the involvement of multidisciplinary teams. Identification of human remains is dependent on two factors—first, the availability of sufficient antemortem information obtained from records and relatives, and second, the existence of sufficient postmortem material for the recording of identification data. Identification of fire victims is very difficult due to serious damage and/or disintegration of the bodies of the deceased. The importance of dental evidence in the identification of burn victims has been emphasized in a number of case reports and in papers dealing with mass disasters (8,11–14). This paper deals with the methods of identification used in a bus accident with 28 burn victims.

A bus with 56 passengers plus the driver was returning to Bailen (Jaen, Spain) after a day in the Sierra Nevada Mountains (Granada, Spain) on 28 February 1996. At 10 P.M. just 5 km before reaching the home city, a car collided head-on with the bus. A few seconds after the crash, the bus caught fire. The fire started at the front of the bus and spread rapidly to the back. The bus burned until the rescue teams arrived on the scene one hour after the accident happened. Of the 56 passengers and the driver, 28 persons lost their lives, 20 were injured and only 9 passengers were unhurt. The deceased victims were recovered from the bus throughout the night, labeled with a number and transported to a temporary mortuary in the closest city (Bailen) for forensic examination and identification.

Methods of Identification

The principal aim of the investigation was to establish the identity of the victims. The investigation was performed according to the following procedures.

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Postmortem Procedures

1. *Location of the bodies and photography at the scene of the accident*—Because of the circumstances of the accident most of the victims (except the bus driver) were found piled upon each other at the back of the bus. Bodies were registered with a number by the Guardia Civil identification team under the direction of the judge. In this case, forensic odontologists and pathologists were not present at the scene of the accident. The bodies were introduced into plastic bags to minimize damage during transportation to the temporary mortuary. Routine photographs were taken by specialists in photography from the Guardia Civil Team at the scene of the accident.

2. *Postmortem general examination*—Complete postmortem examinations of all the victims were performed over a period of three days. A relatively large hall at the Casa de la Cultura in Bailen was chosen as the temporary mortuary. The lack of water, inadequate ventilation and the nonexistence of a refrigeration system forced the decision, after the first few hours of work, to transport the bodies to another location. An old factory in the same town, where three large refrigerators were available, was used as the second temporary mortuary where putrefaction of the bodies was slowed down and there was enough space for adequate storage of the bodies. Corpses were kept at 4°C until the postmortem procedures were performed.

A postmortem general examination of each victim was performed by the forensic pathologists at the temporary mortuary. Data were registered in the INTERPOL disaster victim identification (DVI) form. An external examination was carried out for anatomical characteristics. All the deceased were completely charred. Nevertheless, in all cases it was possible to establish the sex by routine inspection. In each case, long bone measurements were performed in order to estimate the height of the individuals, with some difficulties and limitations due to destruction produced by the fire. In one case postmortem fingerprints were taken by experts from the Guardia Civil identification team.

Routine photographs of the bodies were taken at the temporary mortuary. A video recording was made during all the postmortem procedures. General radiographs (such as chest and skull radiographs) were taken in all cases. Clothing was almost completely destroyed or very badly burned due to the fire so that only fragments remained. Some fragments of clothing were attached to a few bodies to the axilla and perineal areas which become protected by the adoption of the pugilistic attitude frequently seen in fire victims. Only those specimens clearly attached to the bodies (shoes, belts, trousers, etc.) were taken into consideration for identification of the victims. It was not possible to recover any documents. In a few cases personal belongings such as watches, chains, necklaces, and rings were recovered from the bodies. Every item was properly labeled with the same number as the body and introduced into a plastic bag.

3. *Postmortem dental examination*—Two teams of two odontologists each (one forensic and one general dentist) recorded the postmortem odontological data. Thus, the dental examination was carried out by two odontologists per case; while one forensic odontologist examined the teeth the other filled in the form and observed and monitored the registration.

The postmortem dental examinations of each victim included macro-photography, registration of the postmortem pink INTERPOL DVI-form and radiography. Impressions were taken and

models made in two cases for further comparison with a specific treatment (expansion plaque for upper teeth). Simple inspection was almost always impossible because of *rigor mortis* and the state of destruction of the bodies. Resection and removal of the mandible was carried out. The procedure consisted of a soft facial tissue and muscle dissection, and then an ostectomy of the mandible behind the wisdom teeth was performed in each case. Major skull, face, and jawbone destruction were present due to very high temperatures (more than 1000°C). Moreover, incineration of enamel and dentin produced fragmentation of dental structures. Severe damage of the anterior teeth was found in approximately 85% of the burn victims.

A detailed postmortem registration of the teeth was performed in each case using the following categories: intact/sound, filled (restoration material, surfaces, root fillings), missing teeth (extracted, postmortem lost), and fixed (crowns and bridges) and removable prosthetics. Presence of disturbances of tooth eruption (i.e., ectopic-transpositioned-retained-impacted teeth), and various types of malocclusions (i.e., deep bite, crossbite, crowding and spacing) were registered. Fractures of teeth and jawbones, and any pathological changes in the soft tissues or in jawbones (i.e., infections, torus palatinae) were recorded as well.

Postmortem dental radiographs were taken including, in most cases, periapical and extraoral (lateral and posteroanterior skull radiographs). Two mobile X-ray units for intraoral and panoramic projections were used. An assistant radiologist participated in the work of taking both extraoral and other general radiographs.

4. *Complementary biological methods for identification*—Biological specimens (intracardiac blood and deep quadriceps tissue samples) were taken from each body in order to be able to perform complementary DNA analysis for identification of the victims. Genetic typing was carried out by experts from the DNA laboratory at the Guardia Civil's headquarters in Madrid. DNA was extracted by the Chelex method (15) and submitted to PCR-based typing. DNA samples were amplified at two polymorphic loci (DQalpha and D1S80); according to previously published protocols (16,17).

The Antemortem Material

After the accident, a complete list of the passengers was available by unhurt passengers and relatives' manifests. Police officers managed to collect most of the technical information from inquiries from the relatives. Antemortem photographs of the victims were supplied by relatives. Medical and dental information was obtained by direct contact with the victims' dentists and physicians. Dental or medical antemortem records supplied were transcribed onto the INTERPOL DVI-forms by two forensic pathologists and odontologists. The fact that this accident occurred in the same city where the victims had lived made the collection of antemortem material relatively easy and fast. In this case, the general dentist practitioners helped to interpret their own patients' dental charts; therefore it was possible to minimize the mistakes in relation to transcription of dental antemortem data into the INTERPOL DVI-forms.

Comparative Identification

The detailed antemortem and postmortem records (INTERPOL DVI-forms) and radiographs were compared manually. The comparison was made by two separate teams: one deal with the group of female victims and the other with the male victims. Each team was composed of one forensic odontologist and pathologist, one

odontologist, and one police officer with the full-time assistance of two policemen. 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 elaborated and signed by a representative of the ID-Commission, including two forensic odontologists and pathologists and three members of the Guardia Civil identification team.

Results and Discussion

In Spain, the judge in charge of the case has the ultimate responsibility for the identification of corpses. The ID-Commission that was called in this specific mass disaster consisted of a multidisciplinary team including Guardia Civil officers and forensic odontologists and pathologists. Although they never had worked together before, they were specially trained in human identification procedures.

Table 1 shows the classification of case material with regard to age and gender. Examination for identification were performed on 28 bodies (13 females and 15 males). The mean age of the victims was 22 ± 12 years (age ranged = 5 to 48 years) and 60% were under 20 years of age. A combination of identification methods was used in order to establish the identity of each victim in this mass disaster. In each case, an identification method allowed by itself to establish the identity. Nevertheless, other complementary methods of identification were taken into account for reinforcement of identity conclusions. Table 2 presents the most relevant method to draw identity conclusions. Cases are classified by method of identification with regard to age. Identification by dental methods could be established in 57% of the victims. In a review of 54 disasters occurring between 1951 and 1988 (18), dentistry contributed in 43% of the identifications. Percentages of dental identity established were higher in other mass disasters (from 68 to 89%) (8,14) than in the present material. 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 injuries (19). In this disaster, due to the serious lack of dental remains or the

absence of dental antemortem records, odontological evidence did not allow by itself the identification of 12 of the burn victims (43%). However, in some cases dental methods were a contributing factor for identification in combination with other methods. The identification procedures performed by four odontologists were accomplished in a total of 90 h. Therefore three hours work per victim was the average time used for dental identification.

The large number of children and young people among the victims (60% of cases were under 20 years of age) caused special problems for identification. Dental identification was relevant in this age group. In fact, 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. The assessment of age in this group proved to be of great importance. Establishment of age was carried out by dental eruption and mineralization of permanent and deciduous teeth through the study of extraoral radiographs (lateral skull radiographs) according to methods described by other authors (20–24).

When use of other methods for identification of the victims was unsuccessful, the ID-Commission decided to perform DNA analyses. Identification of victims through genetic typing of DNA is a precise method which may have certain disadvantages in mass disaster situations. In this accident, there were members from the same family involved. Therefore, in a few cases it was necessary to amplify DNA from the deceased in order to make a comparison of the genetic material obtained from another nonidentified victim. Genetic analyses allowed identification of nine victims out of the 28 bodies (32%). New PCR-based DNA testing is usually successful on degraded tissue specimens, such as those potentially found in mass casualty situations. These testing methods are becoming cheaper, faster and less expensive than they have been in the past. However, the case report here indicates that dental identification is still a preferred method due to its accuracy, relative speed, and efficiency. PCR-based DNA typing is a reasonable alternative to dental identification when case circumstances do not allow dental records comparisons.

In one case, identification was established by personal effects (ring and shoes). The two remaining cases were identified by medical methods such as radiological comparison of frontal sinuses and old fracture and orthopaedic treatment in the ankle. The contribution of antemortem radiographs to comparative identification procedures was essential. Antemortem radiographs were available in 11 of the 28 victims. In this disaster, the type of antemortem radiographs helped to decide the appropriate projection for the postmortem radiographs. Dental and general radiographs may play an important role in human identification due to their accurate recording of anatomical landmarks, pathological changes or any medical or odontological treatment. Table 3 presents the usefulness of radiographs as a contributing identification method for the victims in this bus accident. Postmortem lateral skull radiographs revealed information about dental eruption and mineralization of teeth in five cases. Identification by exclusion was possible by the establishment of age in three out of those five cases. Intraoral radiographs (occlusal and periapical) were used for identification of eight victims through the study of disturbance of tooth eruption, incomplete extraction of a molar or specific dental treatments. Finally, radiographic comparison of antemortem radiographs available in medical records, such as posteroanterior skull projections, chest (vertebral shape) and ankle radiographs (orthopaedic treatment of an ankle fracture), were useful in the identification of three victims.

TABLE 1—Classification of the case material with regard to age and gender.

Age (years)	Female	Male	Cases (n)	Percentage
≤10	3	1	4	14
11–20	4	9	13	46
21–40	4	4	8	29
41–48	2	1	3	11
Total	13 (46%)	15 (54%)	28	100

TABLE 2—Relevant methods of identification of the victims (n = 28) with regard to age.

Method	Age (years)				Cases	Percentage
	≤10	11–20	21–40	41–48		
Dental	4	9*	2	1	16	57
DNA	0	4	4	1	9	32
Medical	0	0	1	1	2	7
Personal effects	0	0	1	0	1	4
Total	4	13	8	3	28	100

* In one case identification was established by both dental methods and fingerprints.

TABLE 3—Usefulness of radiographs as a method of identification of the victims.

Type of Postmortem Radiograph	Number of Cases	Major Criteria for Identification
Posteroanterior skull radiograph	1	comparison of frontal sinus shape
Lateral skull radiograph	3	dental eruption and mineralization
Lateral skull radiograph	2	dental mineralization and DNA
Lateral cervical column	1	vertebral shape
Lateral + posteroanterior ankle	1	orthopaedic treatment ankle fracture
Occlusal	1	disturbance of tooth eruption
Periapical	1	disturbance of tooth eruption
Periapical	5	dental treatment (filling)
Periapical	1	incomplete extraction of molar

The multidisciplinary Identification Commission established the identity of all the burn victims in this bus accident using a combination of methods. We can conclude that odontological and other complementary radiographic procedures may be powerful, accurate, economic and rapid methods of identifying burn victims. From this experience we also conclude that when a mass disaster occurs, a well-prepared organization, planning and experienced personnel are essential to reach successful identification of the victims. In this mass fatality, the close cooperation between the forensic pathologists and odontologists and the Guardia Civil identification team was of great importance for the establishment of the identity of the victims. Nevertheless, it is recommended that special identification teams be developed in Spain to assume responsibility for the identification work in mass disasters.

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