

## Dental Identification after Two Mass Disasters in Croatia

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**Aim.** To determine the usefulness of dental methods in the identification of victims in the railway accident in Zagreb (August 30, 1974) and midair collision of a British and a Slovenian airplane near Vrbovec (September 10, 1976).

**Methods.** There were 152 people killed in the railway accident, and 176 fatalities in the plane crash (63 in the British and 113 in the Slovenian plane). Individual victim identification and autopsy forms, and group identification reports were analyzed.

**Results.** Of the railway accident victims, 111 were identified. Dental characteristics, along with clothes, personal descriptions, personal documents, fingerprints, and jewelry, proved to be decisive in 5% of the cases. All 63 passengers and crew members from the British plane were identified; in 33% of the victims dental features, along with other characteristics, were decisive. From the Slovenian plane 103 victims were identified, 14% exclusively by teeth and 16% by teeth in combination with other characteristics. Ten bodies remained unidentified.

**Conclusion.** The reasons for the small number of dental identifications in the victims of the railway accident were incomplete or unavailable antemortem data provided by relatives and friends of the deceased, and the predominant orientation toward other forensic identification methods. The significant number of dental identifications in the plane crash is explained by the provision of complete and accurate antemortem odontological data. Dental characteristics proved to be particularly valuable in the identification of carbonized victims.

**Key words:** accidents, traffic; accidents, aviation; Croatia; dental records; dentition; disasters; forensic dentistry; railroads

Mass disasters may be caused by natural events, such as severe flooding, earthquake, or volcanic eruption, or they may be associated with human activity, such as mass transport by land, sea, or air (1). Although many victims are never found nor identified, ethical attitudes oblige us to make every effort and use all available methods to find and identify as many as possible. The teeth, as the hardest and most durable part of the human body, serve as one of the most reliable elements in the identification procedure (1-5). Their unique shape, location, external morphological features, histological components, as well as dental restorations, represent key features in determining the identity of each body (6-10).

Our aim was to determine the prevalence of dental identification method used in the identification of victims in a railway accident, which occurred in Zagreb on August 30, 1974, and in the mid-air collision of a British and Slovenian airplane near Vrbovec on September 10, 1976.

### Material and Methods

We analyzed the data on 328 identified victims of these two mass disasters in Croatia. The data were acquired from the Archives of the Department of Forensic Medicine and Criminol-

ogy, Zagreb University School of Medicine, and Zagreb County Court (11-14).

In the railway accident on August 30, 1974, 326 passengers and members of the train crew were assumed to be present on the train. The Hellas Express Number 410, approaching from the East, entered the curve before the Zagreb main railway station at the speed of 103.1 km/h, driving 53.1 km/h above the speed limit. Nine passenger cars separated from the engine and overturned (Fig. 1). In the accident, 152 people were killed and 90 injured (13). The cause of death in all victims were multiple and extensive blunt force injuries.

Police and forensic pathologists from Zagreb, Split, Rijeka, Belgrade, Skopje, and Ljubljana performed identification of the victims. Due to the large number of fatalities, requests for help in identification were broadcast and published in mass media. A dentist with nine years of experience in clinical practice and a forensic expert in the field of dentistry with no former experience in identification procedure (Z. Kaić), volunteered and took part in the identification in recording postmortem dental findings. For the first time in Croatia, the Interpol Form was used to record the postmortem dental data (Fig. 2). The recording of dental data was done on sketches, and in some cases text descriptions and abbreviations in Croatian were used. Teams were formed to interview relatives and friends and to collect data on possible passengers. The identification procedure was concluded on January 17, 1975, four and a half months after the accident.

The identification data on railway accident victims were obtained from 110 individual identification and autopsy files from the Archives of the Department of Forensic Medicine and Criminology. The data on a victim who died in hospital were obtained from the file from the Archives of the Zagreb County Court.



Some files contained a detailed analysis of dental findings, but most had just a remark, made by the identification team, that the means of identification was dental comparison. Therefore the analysis on frequency of different identifying dental findings could not be done for the victims of the plane crash.

## Results

In the railway accident, 111 victims were identified. Dental data and some other identification elements formed the basis for identification in 5% of the cases (Table 1). Antemortem dental data were provided by the victims' friends and family. In all cases, fixed and removable prosthetic appliances were dental identifying elements. Dental age estimation was supportive evidence in three child victims. In 56% of

**Table 1.** Summary data on identification of the victims of the railway accident on August 30, 1974 in Zagreb (152 people killed) and of the midair collision of a British and a Slovenian plane near Vrbovec on September 10, 1976 (63 people killed in the British and 113 in the Slovenian plane)

Basis for identification	No. (%) of identified victims		
	train	British plane	Slovenian plane
Fingerprints	20 (18)	0 (0)	6 (6)
Clothes	18 (16)	0 (0)	10 (10)
Personal description	11 (10)	0 (0)	0 (0)
Dental characteristics	0 (0)	0 (0)	14 (14)
Jewelry	5 (5)	1 (2)	28 (27)
Personal documents	2 (2)	0 (0)	1 (1)
Other	6 (5)	1 (2)	3 (3)
Combination of 2 means	46 (41)	20 (32)	33 (32)
Combination of 3 means	3 (3)	31 (49)	8 (8)
Combination of 4 means	0 (0)	8 (13)	0 (0)
Combination of 5 means	0 (0)	2 (3)	0 (0)
Total identified	111 (100)	63 (100)	103 (100)
Dental and other evidence <sup>a</sup>	6 (5)	21 (33)	16 (16)

<sup>a</sup>No. (%) of the victims identified by dental characteristics in combination with any evidence other than dental.

the cases, identification was based on a single identification element – mostly fingerprints, clothes, personal description, or jewelry, whereas in the rest the identification was based on two or three different elements (Table 1). Forty-one (27%) bodies remained unidentified.

All 63 passengers and crew members of the British plane that crashed in 1976 were identified, and in 33% of the cases, dental characteristics (along with other characteristics) were decisive in positive identification (Table 1). Dental age estimation was supportive evidence in eight child victims (one child victim also had an identifying dental finding). In the Slovenian plane, 103 victims were identified. Carbonization and severe mutilations were the reason why the identification in 14% of the cases was achieved exclusively by teeth. In 16% of the cases, the identification was achieved by teeth in combination with other characteristics (Table 1). According to the list of passengers, it was assumed that 10 bodies remained unidentified (9%).

## Discussion

The results presented in this paper were the pioneering achievements of identification after the mass

disasters on the territory of Croatia. Dental comparison was not a traditional method of identification in Croatia at the time when the railway accident happened, so only few victims were identified by dental comparison in combination with other methods. On the contrary, after the aircraft accident, British and German identification teams achieved a significant number of identifications by dental comparison, and in some cases dental comparison was the only basis for identification.

Many problems were encountered in the identification of victims of the railway accident. Unlike the airplane disaster, there was no list of passengers on the train, and therefore the number and names of passengers were unknown. The interview teams collected information about persons who were believed to have been on the train. The injured survivors were taken care of at several hospitals in Zagreb and some of the survivors left the scene without being registered with or interviewed by the police. The identification team was predominantly oriented toward identification methods of forensic medicine, partly due to objective reasons and partly due to the lack of experience in forensic dentistry. The passengers on the train were mainly from southeastern areas of the former Yugoslavia. Some were on their way to Germany and Austria, where they were employed, and some were foreigners. Antemortem dental data were provided by their friends and families and were often inaccurate. If the dentist had been included in comparison of antemortem and postmortem dental data, and not only in recording postmortem data, possibly more dental identifications would have been made. Since the victims had to be identified as quickly as possible because of high summer temperatures which speeded up the decomposition, and limited space for the preservation of so many bodies, most victims were identified on the basis of a single identification element (Table 1). The need for more identifying elements was confirmed by an error in the identification of one of the railway crash victims: a person was declared dead on the basis of the right hand found at the scene and identified by dactyloscopy; however, it was later found out that the person survived.

The victims of the airplane disaster were mainly foreign passengers, which is the reason why Interpol was involved in their identification. Although the bodies were considerably mutilated and most of the remains from the Slovenian plane were also carbonized, the identification was more successful than that of the railway accident victims – 94%. The list of passengers, available accurate and complete medical and dental records of the victims made the identification process easier, with high quality of antemortem data playing the most important role.

In case of children, dental records are usually of a limited value because of the minimal amount of dental restorations, if any (15). However, dental examination can be valuable in age assessment (15-17). Dental age estimation was supportive evidence in three child victims in the railway accident and in eight child victims from the British plane. After age assessment, identification can be made by exclusion,

depending on the sex and age of a child (15), as it was the case in one 4-year-old victim from the British plane.

Brannon and Kessler (18) classified the problems associated with dental identification in mass disasters as "external" and "internal". In the dental identification of the victims in the two mass disasters described here, the external problems were encountered in dealing with remains, records, and administration, whereas internal problems were probably stress and inexperience.

Dental methods have been continually gaining ground in the identification process of victims, as shown by reports on airline disasters published in the last 15 years (17,19,20). Today, the proportion of victims identified by dental methods is usually higher than in time of the two described disasters that happened in Croatia in 1974 and 1976. For example, in the airline disaster in Malaysia in 1995, there were 34 victims and 19 survivors. Seven victims were identified exclusively by teeth, and dental analysis proved helpful in 18 cases – dental methods were consequently used in 74% of the cases (17). In the Lyon-Strasbourg airline disaster in 1992, positive dental identification was achieved in 44 out of 85 identified victims (52%), and partly matching dental characteristics were achieved in further 12 cases (14%). Only two victims remained unidentified (19). After the Dash 7 airline disaster in 1988 in Norway, all 36 victims were identified and in 32 cases (89%) dental identity was established, mainly by comparison of antemortem and postmortem radiographs (20).

Andersen et al (21) reported on the capabilities and limitations of dental identification of fire victims. In most cases, lateral tooth segments remain undamaged in otherwise severely burnt victims. However, the relevance of dental identification is limited in the identification of fire victims younger than 20 years because of a general improvement in the dental health status of younger generations. In such cases, dental radiographs can be decisive and the use of systematic radiographs as standard practice is recommended (21,22). Periapical exposure has an advantage over bitewing exposure because the former can be used even in the severely burned bodies where only the roots remain in their sockets (22). Orthopantomograms, which enable visualization of the structures of the jaws and related areas, are also very useful in the identification process (23). Kessler and Pemble (24) reported on dental identification of casualties during the military operation "Desert Storm", when 244 victims of the total of 251 were identified by orthopantomograms.

For establishing the identity of older victims the marking of removable dentures – especially full dentures – is of great importance (15,18,21,25). Unfortunately, this is still not practiced in Croatia.

The most important factor for a successful dental identification is the quality of antemortem dental records. The better their quality, the easier and faster the identification of the remains. A study by Delattre and Stimson (26) showed that only 56% of dentists, after self-assessment, felt that their dental records

would be extremely useful in dental identification. The most frequently recorded identifying dental features, other than caries and restorations, were the presence of diastemas, displaced or rotated teeth, and dental anomalies.

Ermenc and Renner (3) examined the quality of dental records in 50 dental practices in Slovenia. Only 29% of the dentists completed an extensive dental survey. The introduction of computers in dental practice has also led to abandonment of the accurate filling out of dental records because the computer programs were totally incompatible for the recording of dental treatments.

Ligthelm (27) stressed the need for international standardization of record-keeping styles – different styles and abbreviations posed a major problem during dental identification of the Helderberg air disaster victims. There is no worldwide list of abbreviations for recording dental findings, and no agreement on a list exists in the Interpol (6).

The old Interpol form used in the Zagreb railway accident contained a list of abbreviations with a legend (Fig. 2). The new Interpol forms have qualities that the old form did not have – the two-digit FDI system is used for recording teeth, and there are boxes for detailed text description of dental status, prosthetic appliances, occlusion, attrition, anomalies, smoking habits, X-ray material, and age estimation. Different colors are used for antemortem and postmortem forms, and sections of both forms listing the same type of data are marked with the same number. Also, a computer dental identification program CAPMI4 (Computer Assisted PostMortem Identification, Version 4.0, US Army Institute of Dental Research, Fort Meade, MD, USA) has been developed and proved to be successful in reducing manual checking and producing lists of the most likely matches.

In cases where it is impossible to determine identity by classical forensic methods, teeth can be used for the isolation of DNA (28-30). This procedure has recently improved forensic practice although it was unknown at the time of the identification of the victims described in this paper. The DNA can be used for sex determination and for establishing full identity when it is possible to compare the specimen with the DNA of relatives (31-33).

The importance of human dentition in victim identification on the territory of Croatia significantly increased during and after the 1991-1995 war, because of the need for the identification of human remains from mass graves (34-37). It has taken some time to form the identification teams and, for the first time in Croatia, a forensically trained dentist was included in the Zagreb identification team. Identification teams have also been founded in Split and Osijek, and on all three locations DNA forensic laboratories have been opened. Out of 1,000 human remains exhumed from mass graves until July 1998, 824 were positively identified. Dental identification was achieved in 25% of the cases and in further 64% dental findings were supportive evidence for the identifications based on some other findings (36).

In 1996, the Chair of Forensic Odontology was established as a part of the Department of Dental Anthropology, and Forensic Odontology was included in the curriculum of the School of Dental Medicine in Zagreb as a mandatory fifth-year course.

Although the teams founded for the identification of war victims gained a lot of experience, there is still a need for teams trained for the identification in case of mass disasters. According to the experience of foreign experts, detailed plans should be made in geographically defined areas (four largest cities of Croatia – Zagreb, Split, Rijeka, Osijek) and sufficient personnel should be trained (1,18,38). Although Croatian dental medicine students gain some basic knowledge in the field of forensic odontology, there is a particular need to educate forensic dentistry experts. The Forensic Dentistry Documentation and Reference Center at the School of Dental Medicine, as an expertise, counseling, education and referent center should also be established. Beside education of forensic dentistry experts, the activity of the Center would include education on methods and standards in forensic dentistry for forensic pathologists and criminologists.

The present medical standards in Croatia provide all citizens with adequate dental care. In 1999, the ratio of the number of dentists to a number of citizens was satisfactory – 1:1,560 – so there is no excuse for not keeping precise dental records. Dentists should be aware of the possibility of mass disasters and of the importance of dental records for the identification of victims. Marking removable dentures should be introduced in everyday practice, and new computer programs for the recording of dental treatments should be tested and approved before introduction. There is also a need for national and international standardization in record-keeping styles and abbreviations, particularly in relation to multinational disasters.

In conclusion, this study has demonstrated the importance of dental identification in mass disasters, especially in the case of burnt victims, when teeth are the only key to the victim's identity. Comparing the results of identification in two mass disasters in Croatia after many years, it becomes clear that there is a strong need for establishing and educating a team of forensic experts trained in identification after mass disasters. Such a team should inevitably include forensic odontologists. The experience of such teams and the quality of antemortem dental data are essential for successful identification.

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