

H. Brkic · D. Strinovic · M. Kubat · V. Petroveckii

Odontological identification of human remains from mass graves in Croatia

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Abstract This paper reports the results and methods of dental identification of 1000 human remains exhumed from mass graves in Croatia up to July 1998. Personal identification of the victims was performed at the Department of Forensic Medicine and Criminology at the School of Medicine in Zagreb. A forensic odontologist participated in the identification process by carrying out the dental identification. A total of 824 victims were positively identified, while 176 victims remained unidentified. Dental identification based on available dental antemortem data was achieved in 25% of the cases. Dental identification based on dental charts was achieved in 35%, on x-rays in 15%, on photographs of teeth in 22%, on interviews in 18%, and on confirmation by odontologists in 10% of the cases. Teeth, in combination with anthropological parameters, age, sex and height, as well as other specific characteristics such as tattoos, personal identification cards, clothes, jewellery and DNA, were helpful for identification of 64% of the victims, but the significance for the identification was not dominant. Only in 11% of the cases was identification achieved by other relevant means and teeth not used at all. Identification procedures in Croatia will continue until another 1700 people who are still missing or kept as prisoners of war since the aggression on Croatia in 1991 are found and/or identified.

Key words Teeth · Forensic dentistry · Human rights · Identification · War

H. Brkic (✉)
Chair of Forensic Odontology,
Department of Dental Anthropology,
School of Dental Medicine University of Zagreb, Gundulićeva 5,
10000 Zagreb, Croatia
e-mail: hrvoje.brkic@zg.tel.hr, Fax: +385-1-4802159

D. Strinovic · M. Kubat · V. Petroveckii
Institute for Forensic Medicine and Criminology,
School of Medicine University of Zagreb, Salata 11,
10000 Zagreb, Croatia

Introduction

Apart from natural disasters and traffic accidents, wars also represent a form of mass disasters in which a large number of people can disappear or die [1]. The war that started after disintegration of the former Yugoslavia, resulted in large numbers of missing or killed persons in this European region. The war in Croatia that lasted from 1991 until 1995, resulted in more than 16,000 killed and missing persons. Many of the missing have later been found, but many were unfortunately killed [2]. The process of searching, exhumation and identification of the war victims from the individual and/or mass graves was carried out during the war and is still ongoing. The analysis of teeth as the best preserved parts of the human body, proved to be the basic and irreplaceable method of identification, as well as the best source for the DNA isolation and its use in the difficult identification cases. [3, 4].

In this paper, we present the methods used for the establishment of the identities of the human remains exhumed from mass graves in Croatia, as well as the results of the dental comparisons performed.

Materials and methods

This paper presents the results and methods of dental identification of 1000 human remains exhumed from 68 mass graves up to July 1998. The mass graves were mostly found with the help of surviving witnesses, by collecting the data from written or verbal statements given by the witnesses who lived in the regions. Most of the graves were found in the eastern and southeastern parts of the territory of the Republic of Croatia (Eastern and Western Slavonia, Banovina, Kordun, Lika) that were occupied until the end of war. The size of the graves varied according to the number of buried bodies and ranged from 3 to 750 bodies per grave. The quality and the quantity of the human remains for identification varied depending on the different conditions in which the bodies were buried e.g. type of soil and weather conditions. The exhumations and identifications were carried out by the members of the Croatian Governmental Commission for the missing persons and post-mortem remains usually in the presence of the members of the UN Commission for Human Rights and Physicians for Human Rights. After the graves were opened, the remains were carefully exhumed

and put into the black plastic bags in which they would be transported to the site of the forensic postmortem procedure. Personal identification of the victims was performed at the Institute for Forensic Medicine and Criminology at the School of Medicine in Zagreb. A forensic odontologist participated in the identification process by carrying out dental comparisons. The postmortem analysis of teeth and jaws was performed according to the ABFO guidelines [5, 6]. All oral-dental characteristics were carefully recorded in the postmortem Interpol Disaster Victim Identification forms and in the computer program CAPMI 4.0 [7]. Teeth were also used for the estimation of dental age thus classifying the exhumed bodies in several age groups: early childhood (up to 3 years old), childhood (from 4 to 12 years old), adolescence (from 13 to 23 years old), middle-age and elderly [8, 9, 10, 11]. Sex was determined by the forensic anthropologist based on the shape of the pelvis and by the forensic odontologist based on the index of the craniofacial skeleton [12]. The results were concordant in the majority of the cases. Forensic genomic DNA and mitochondrial DNA (mtDNA) identification based on the polymerase chain reaction (PCR) procedure on DNA isolated from dental pulp and dentine were applied in several cases where dental comparison and other traditional forensic methods were insufficient or unsuccessful [13, 14].

Results

Up to July 1998, the remains of 1714 human corpses had been exhumed in Croatia. Out of this number, 714 bodies were examined and already identified in the field, while another 1000 were transported to the Institute for Forensic Medicine and Criminology in Zagreb where the examination was completed. Out of these 1000, consisting of 768 males and 232 females, 824 victims were positively identified, while 176 victims remained unidentified (Table 1). Dental identification based on available dental antemortem data (e.g. charts, x-rays, photos, interviews, and dental supports) was achieved in 25% cases (Fig. 1). Dental identification based on dental charts was achieved in 35%, x-rays in 15%, photographs in 22%, interviews in 18%, and on confirmation by odontologists in 10% of the cases (Fig. 2). Teeth, in combination with anthropological parameters, e.g. age, sex and height, as well as with other specific characteristics such as tattoos, personal identification cards, clothes, jewellery and DNA typing, were helpful for the identification of 64% of victims. Only in 11% of the cases was identification achieved by other relevant methods and teeth were not used at all, often because teeth and skull were not available (Fig. 1).

Dental characteristics that were most significant for the identification were the size, shape and material of prosthetic appliances (30%), antemortem teeth extractions (25%), amalgam and composite restorations (20%) and dental caries (10%). Anthropological variations of the

Table 1 Sex distribution and distribution of identified and unidentified victims

Sex	No. exhumed	No. identified (%)	No. unidentified (%)
Male	768	633 (82.4)	135 (17.6)
Female	232	191 (82.3)	41 (17.6)
Total	1000	824 (82.4)	176 (17.6)

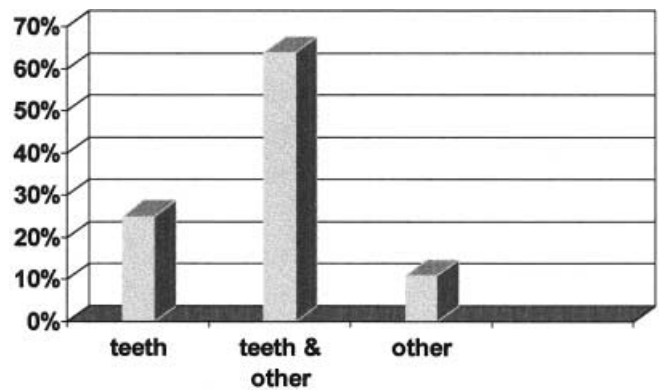


Fig. 1 The distribution of identified victims by means of identification (*teeth* percentage of victims identified only by means of dental comparison, *teeth and other* percentage of victims in which dental characteristics supported other evidence, *other* percentage of victims in which identification was achieved by other relevant means)

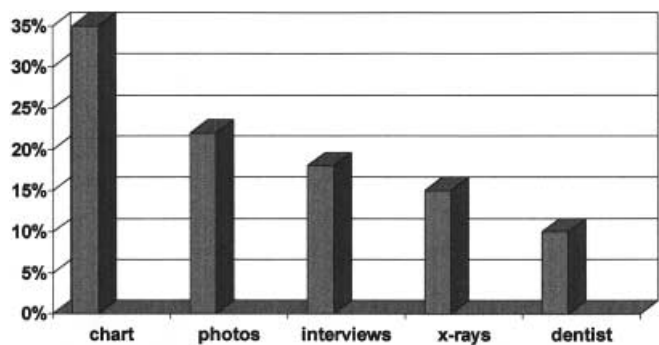


Fig. 2 The distribution of a.m. dental sources for identification (*chart* dental charts, *photos* family photos, *interviews* verbal data from friend and relatives, *x-rays* intraoral and extraoral x-rays, *dentist* dentists recognized their own work)

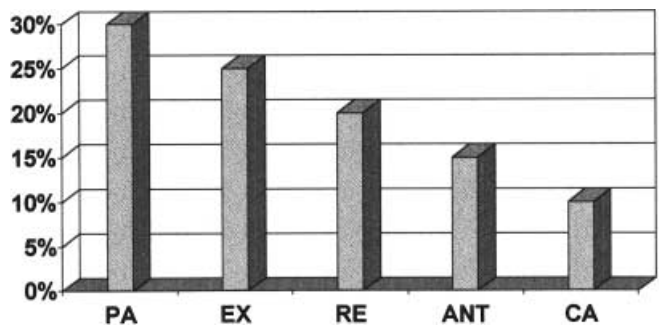


Fig. 3 The distribution of the most common dental characteristics for identification (*PA* prosthetic appliances, *EX* antemortem teeth extractions, *RE* restorations, crown and root fillings, *ANT* dental anthropological parameters: shape, size, colour, position, *CA* dental caries)

teeth, such as shape, size, colour and position, as well as the age, were used in all of the cases confirming and completing the identification. In only 15% of the cases were these used as the starting point for the identification and later confirmed with another 3–5 traditional identification procedures (Fig. 3).

Discussion

Since World War II there have been several mass disaster in Croatia that required forensic odontological identification of victims. Chronologically the disasters were:

1. In 1971 a plane crash above the island of Krk
2. In 1974 a rail accident in Zagreb
3. In 1976 a plane crash above Vrbovec near Zagreb [15, 16].

After each of these mass disasters the identifications were conducted mainly by international experts with the help of local experts.

The break-up of former Yugoslavia and the war in Croatia starting in 1991, resulted in the biggest ever mass disaster in the territory of Croatia [2]. A total of 16,000 people have been killed or are missing in Croatia during the war that lasted from 1991 until 1995 and they were mostly civilians. Although the forensic experts of the Institute for Forensic Medicine have had earlier experiences with identification after mass disasters, it has still taken some time to form the disaster identification teams that could completely cover the increased demand for identifications caused by the war situation. Apart from forensic pathologists, disaster identification teams also include a forensic odontologist, anthropologist, an X-ray expert and the DNA laboratory. Because of the ever-increasing volume of work, the team has been progressively growing and now consists of 12 experts and 12 additional support staff [17]. The biggest problem in the identification procedure was insufficient antemortem data because access was difficult due to destruction of records during the war. The team for collection of antemortem data from the surviving relatives consisted of volunteers, mostly students of the School of Medicine University of Zagreb or the Red Cross members. Although they interviewed thousands of persons, the dental antemortem data were almost non-existent. In addition, the existing dental antemortem data were not only insufficient, but also incomplete and unprofessionally recorded. Mistakes were also possible during the postmortem analysis and comparisons according to Brannon and Kessler [18], and McCarroll et al. [19], leads to an increase in the probability of errors occurring because of the stress under the war conditions.

Dental antemortem data were either destroyed in the war or barely existing. Another difficulty was that most of the victims were elderly farmers who had not visited a dentist for years and no dental records were available [20]. Prosthetic dental appliances were numerous and very helpful in the identifications because the surviving relatives of the victims could identify them because of shape, colour and position. Although marking of prosthetic appliances is not usual in Croatia, they were also helpful in the identifications but only when supported with other identification procedures [21, 22, 23].

The difficulties encountered during the identification of exhumed victims from the mass graves were described by Strinovic et al. [20] and Griffiths and Oettle [24]. The

results of dental identifications achieved on the civilian victims of war exhumed from the mass graves in Croatia, are inferior to those achieved on the victims of other types of mass disasters. This is due to the destruction of antemortem medical and dental records [17, 20, 24, 25]. The forensic DNA analysis proved to be an irreplaceable procedure in the identification process, but on the other hand prolongs it and makes it more expensive [26, 27, 28]. The analysis of genomic and mtDNA is now performed routinely in Croatia in identification cases. Dental tissues, especially root dentine, proved to be the best source of DNA even in the cases where bodies had been buried in soil for more than 6 years [29, 30]. In numerous cases DNA analysis was used as the final method for confirmation of questionable identities where other classical procedures of identification failed.

The experience of the disaster identification team in Croatia and the results achieved in the identifications of bodies exhumed from the mass graves have proven the importance and the need of the analysis of teeth for identification purposes. By the estimation of dental age at the moment of death and by the use of teeth and dental tissues as DNA sources for determination of the identity.

Today, at the end of the twentieth century we are participating in the most extensive operation in forensic odontology that is giving us the opportunity for daily on-the-job training on new cases. Identification processes in Croatia will continue until another 1700 people who are still missing or have been kept as prisoners of war since 1991, are found and/or identified.

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