Rapid communication

Forensic odontologists successfully identify tsunami victims in Phuket, Thailand

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Abstract

More than a year has elapsed since the seaquake in South-East Asia in December 2004, and more than 92% of the non-Thai victims have been identified. About 80% of the non-Thai victims were identified by dental information. This high success rate of dental identification in Thailand was a matter of surprise for many forensic experts.

Identification based on dental information is a highly efficient, reliable and rapid procedure. The conclusions drawn from the identification of tsunami victims in Thailand were recently discussed at the 17th Meeting of the Standing Committee on Disaster Victim Identification of Interpol in Lyon, and may be used to formulate new guidelines for the identification of victims.

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Keywords: Forensic odontology; Dental identification; Tsunami; DVI

1. Introduction

The devastating consequences of the seaquake in South-East Asia in December 2004 led to the greatest international effort undertaken so far to identify victims of natural catastrophes. Since the 28th of December 2004, International DVI (Disaster Victim Identification) teams have been working in Phuket/ Thailand to identify the victims of the disaster. The teams mainly consist of police officers, forensic odontologists, medicolegal experts, fingerprint and DNA specialists.

In specially equipped disaster sites, about 4280 bodies of victims in the region around Phuket were placed in refrigerated containers and their PM (post-mortem) data were documented by medicolegal experts, police specialists and forensic odontologists. The PM data include the medical characteristics routinely registered at a limited internal forensic autopsy, as well as DNA samples, fingerprints, personal possessions, and a detailed dental status together with bitewings and/or periapical radiographs [1–4].

In order to process the ante-mortem (AM) data obtained from the victims' native countries through police inquiries and to compare these with the data collected at the tsunami site, the TTVI-IMC (Thai Tsunami Victim Identification-Information Management Center) was installed in Phuket/Thailand [5].

As a rule, victims of devastation can only be identified by three primary identification characteristics: dental status, fingerprints and DNA. By 23rd March 2006, about 15 months after the catastrophe, 1847 (90.36%) of the 2044 missing foreign victims had been identified. Of the 1603 known missing Thai victims, 1193 (74.42%) have been identified thus far, but the number of Thai victims is probably larger than the number of missing persons. The overall ID rate is 83.3%.

Significant conclusions may be derived from the number of cases identified at the TTVI-IMC by means of the various methods at 3, 7 and 11 months after the catastrophe.

2. Method of dental identification

Comparison of dental data in Phuket/Thailand was based on the registered data of victims (PM data) and missing persons (AM data). By 23rd March 2006,

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3647 AM and 3680 PM cases had been entered into the computer system DVI System International (Plassdata, Denmark) [9]. In order to classify the victims' dental status, all information pertaining to the condition, treatment, and position of their teeth are clearly designated by a three-digit code. The FDI tooth numbering system was used as the standard. Two odontologists entered the characteristics in a standardized dental DVI protocol (F2 DVI form of the Interpol).

AM information, particularly X-rays and treatment charts, are collected in the patient's native country, checked by forensic odontologists, and passed on to the TTVI-IMC Phuket/Thailand.

PM dental investigations are conducted at the site as a separate part of the forensic medicine autopsy. Periapical X-rays and two bitewing X-rays are obtained and developed immediately. Five polaroid or digital photographs, i.e. one frontal and two lateral views, and one occlusal view each of the upper and the lower jaw, are obtained. As a rule the mandible is disarticulated for a more exact investigation.

The TTVI-IMC consists of two sections, namely the AM/PM section, and the reconciliation section. In the AM/PM section, the AM and PM dental data of the victims were entered into the DVI Systems International program by two forensic odontologists. Identification belongs in the reconciliation section. AM and PM data are compared to identify concurrences by a routine run in the DVI Systems International program. Such "matching" is performed automatically at night by the computer program. A list of possible corresponding matches in the order of probability is checked manually by a forensic odontologist. The latter classifies the hits suggested by the computer into one of the following categories: "probable" or "established", "possible", "insufficient evidence" or "excluded".

If the AM and PM data yield a positive identification, the "established" cases are checked first by the reconciliation team coordinator. A second check is performed by a Thai dentist. Confirmed identifications are submitted to the ID board. After approval from the ID board, the Thai authorities accept the identification and issue the official death certificate.

As the AM and PM file match was mandatory in order to perform an AM–PM comparison by the computer, the file match was a very important step to verify the victims' identity.

3. Dental ID ratio

We analyzed the results of identification based on the various methods at 3, 7 and 11 months after the seaquake and after commencement of the identification procedure.

The state of identification on 28th March 2005, i.e. 3 months after the seaquake, is shown in Fig. 1 (ID by method). A total of 951 victims had been identified by this time; 837 (88%) by their dental status alone and 57 by their fingerprints.

Fig. 2 shows the number of identifications, divided by method, on 29th July 2005. By this time 2020 victims had been identified: 1097 (54%) by their dental status alone, and a further 331 (16.6%) by a combination of their dental status and other methods. In all 1428 (70.7%) identifications were based on the victims' dental status while 367 were identified by their fingerprints.

On 13th November 2005 (Fig. 3) we had registered a total of 2679 identified victims: 1105 by their dental status and a further 346 victims by a combination of their dental status and other methods. In all 1451 victims were identified by dental status while dental identifications accounted for 54.16% of the total number of identifications.

4. Discussion

Identification based on dental information is a highly efficient, reliable and rapid procedure. The quality of AM data is the sole regulatory parameter. This is evidenced by the different success rates achieved for Thai and non-Thai victims. Due to the poor availability of AM dental data for the Thai population, only a small number of Thai victims could be identified by this procedure. The dental identification rate for foreign victims, on the other hand, is about 80% [10,11].

AM dental treatment data such as those provided by bitewings and periapical radiographs, OPTG and treatment records as well as plaster models, are very significant because only recent AM data of high quality allow rapid and reliable dental identification of the victims. If the dental data are scarce or old, the investigator must utilize all available methods of identification and the assistance of experienced forensic odontologists to achieve a reliable result.

However, the use of this method is limited in children and adolescents, who will have undergone no or very little dental treatment, as well as edentulous persons.

The quality of PM data, on the other hand, is naturally better, except in cases of destruction or loss of teeth or parts of the jaw, because PM data provide a comprehensive and standardized
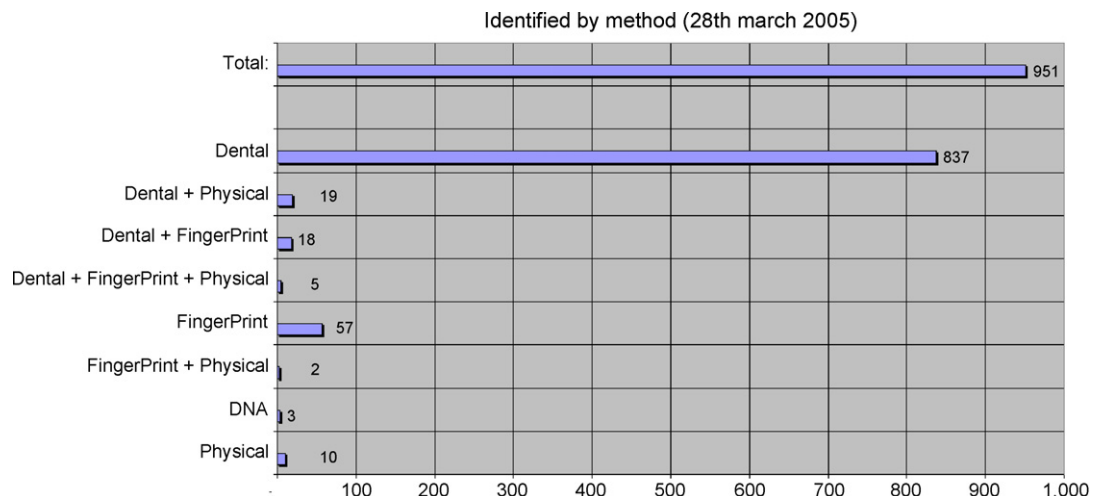

Fig. 1. As of 28 March 2005: Total number of identifications 951; 837 by dental status alone and 42 by dental and other methods. In all 879 by dental status.
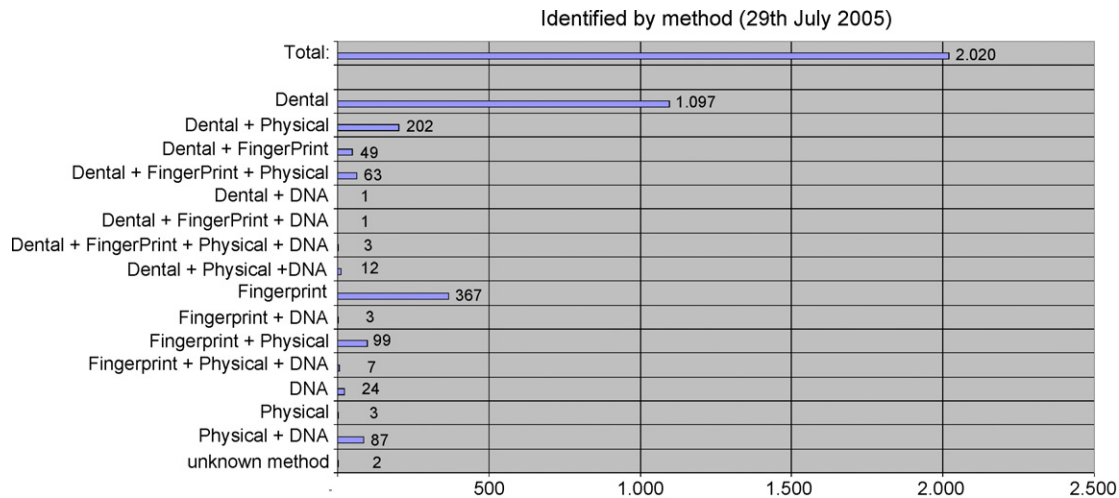
Fig. 2. As of 29 July 2005: Total number of identifications 2020; 1097 by dental status alone and 331 by dental status and other methods. In all 1428 by dental status (70.7%).

account of the individual's current dentition. PM data should be obtained by performing six periapical and two-bite wing X-rays. The use of a mobile pantomograph device and digital techniques is currently under discussion.

DNA samples should be taken after all the conventional records and X-rays have been obtained. For DNA analysis, two canines were extracted [6]. Repeat examinations are rendered difficult when teeth are extracted. Besides, extraction of teeth makes it impossible to superimpose AM X-rays on PM X-rays or obtain new PM X-rays. Therefore, the most suitable tooth for DNA analysis is the canine rather than a molar because canines are preserved in most cases, are vital, and possess a large pulp chamber.

The DVI International Systems software, which is used to detect concurrences and facilitate the identification procedure, is being improved. Here again, the enormous experience gained from this catastrophe is of great value.

A further aspect that deserves attention is clear labelling of the victims [7,8]. Due to the highly stressful circumstances at the beginning of the catastrophe the victims were, in part, labelled diversely. This led to significant additional organizational effort later on. Therefore, one of the aims of the 17th Meeting of the Standing Committee on Disaster Victim Identification of the Interpol in Lyon was to establish international guidelines for victim codes.

AM codes start with the international telephone code of the victim's native country while PM codes start with the international telephone code of the country whose team performs the autopsy. In the future, AM data will be entered by an experienced odontologist in the victim's country so that these data can be accessed rapidly all over the world through Internet databases. Thus, the risk of AM data or X-rays being lost in transport will be minimized.

The search options and search routines of the DVI Systems International program will be improved. Canines are used for DNA analysis. If the canines are not available the premolars are used. The pulp chambers of these teeth are of adequate size, and well protected from denaturation.
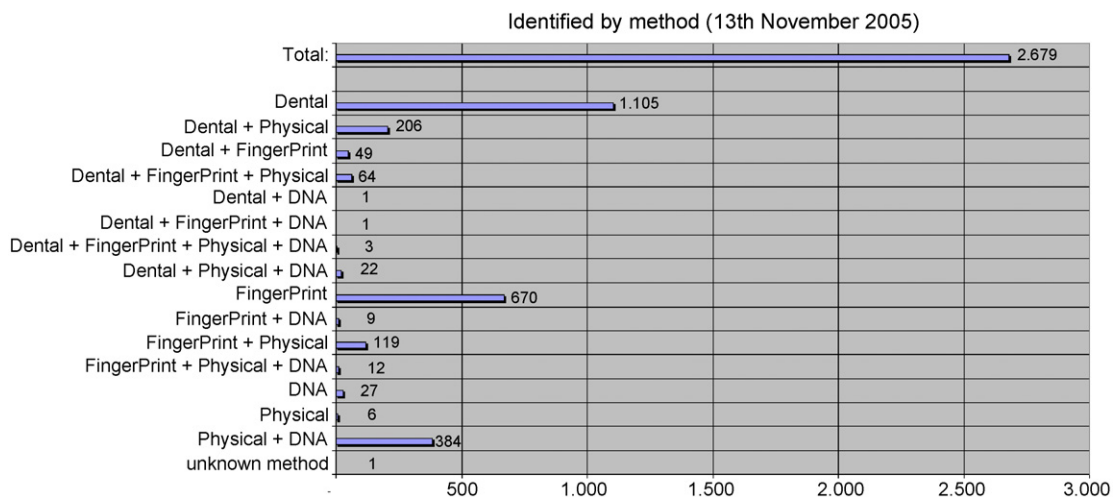

Fig. 3. As of 13 November 2005: Total number of identifications 2679; 1105 by dental status alone and 346 by dental status and other methods. In all 1451 identifications by dental status (54.16%).

The victims will be coded by inserting markers in the jaw cavity. This will ensure clear allocation of the victims from the very start.

The Interpol form F2 will be extended internationally to include graphic information about the root of the teeth.

In Phuket/Thailand, the TTVI-IMC evaluated the various identification methods at different time points. The following was observed.

After the first 3 months, 837 of 951 identifications (88%) were based on the victims' dental status. The large majority of these were non-Thai victims. The Thai authorities performed a selection of the victims immediately after the tsunami occurred. Asian-looking victims were separated from those of Caucasian appearance and were initially treated at the respective sites by Thai individuals. Later on the Thai victims were also transported to the international sites, autopsied, and the information processed at the TTVI-IMC. Hence a large majority of the identified persons were non-Thai victims, for whom ante-mortem dental data of high quality were easily and rapidly available.

The discrepancy between dental identifications and identifications based on fingerprints and DNA became larger over time; an increasing number of identifications were performed by the dental method. The majority of non-Thai victims with good AM data were identified during the first 6 months. It took longer to identify victims with poor AM or PM dental data. Thus, for some victims it was necessary to perform a renewed dental investigation and obtain new X-rays. These procedures were, in part, neglected at the beginning of the identification procedure. This was due to delayed receipt of dental data for the non-Thai victims and the increasing number of Thai victims who were primarily identified by fingerprints. Until 29th July 2005, 1428 of the 2020 identified victims had been identified by their dental status. This equals an ID rate of about 70%.

Subsequently, the number of identifications based on the dental status alone became stagnant because increasing quantities of non-dental information, such as fingerprints became available, and their ante morten registration was started. Thus, the victims were identified by various methods.

Furthermore, a large majority of Thai victims could be identified by their fingerprints because such biometric data are included in their identification cards.

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