Naif Arab University for Security Sciences

Arab Society for Forensic Sciences and Forensic Medicine

Review Article

Dental Evidence as a Sole Human Identifier in World Disasters: A Literature Review with Emphasis on the 2004 Tsunami Disaster

الدليل السني كوسيلة استعراف وحيدة في كوارث عالمية : مراجعة علمية، مع التركيز على كارثة التسونامي عام ٢٠٠٤م

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Abstract

Comparative dental analysis is a quick and relatively simple human identification method. In many disaster incidents, dental characteristics have played an important role in establishing the identity of victims when they were visually unidentifiable. A PubMed search was conducted for publications that specifically discussed the role of dental characteristics in Disaster Victim Identification (DVI). Between 1974 and 2012, 14 papers described 17 disasters in which dental characteristics were used to identify the victims. The percentage of victims identified using only dental characteristics ranged from 0% to 89%. This wide range largely depends on the availability and quality of antemortem dental records provided by dentists. The DVI in Thailand following the Indian Ocean tsunami in December 2004 was unique in involving deceased tourists from more than 30 countries, mostly from Europe. The dental method of identification showed superiority over other identification methods in terms of speed and accuracy of establishing the victims' identity. This paper discusses the role of forensic odontology in establishing the identity of disaster victims, with specific emphasis on the 2004 Indian Ocean tsunami as an example of good practice, during which the author had first-hand experience.

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المستخلص

يعتبر الاستعراف من خلال تحليل الأسنان المقارن من وسائل الاستعراف على ضحايا الكوارث التي تمتاز بالسرعة وببساطة الإجراءات. ولقد كان للخصائص السنيّة دور مهم في تحديد هويّات الضحايا المجهولين في العديد من الكوارث. وأجريت الدراسة من خلال البحث في قاعدة بيانات (PubMed) عن الأوراق العلمية التي نشرت معلومات مفصلة عن أعداد ضحايا الكوارث الذين تم الاستعراف عليهم من خلال الخصائص السنيّة، وأظهر البحث خلال السنوات بين عامي 1974 و 2012م أنه تم نشر 14 ورقة علمية تناولت تفاصيل الاستعراف على ضحايا 17 كارثة جماعية. تراوحت نسب الضحايا الذين تم الاستعراف عليهم من خلال الخصائص السنيّة ما بين 0% و 89%، ويعود سبب اتساع هذا النطاق إلى مقدار ما يتوفر من معلومات وملفات الأسنان ما قبل الوفاة والمقدمة من قبل طبيب الأسنان المعالج ومدى جودتها. ولقد كان للاستعراف على ضحايا كارثة تسونامي المحيط الهندي في تايلاند عام 2004 طابع مميز بسبب وجود أعداد كبيرة من الضحايا السياح المنتمين إلى أكثر من 30 جنسية، معظمها أوروبية. إذ أظهرت نتائج الاستعراف تفوقاً للخصائص السنية كوسيلة استعراف بالمقارنة مع وسائل الاستعراف الأخرى من حيث السرعة والدقة.

تناقش هذه المراجعة دور طب الأسنان الشرعي في تحديد هوية ضحايا الكوارث، مع التركيز بشكل خاص على تسونامي المحيط الهندي عام 2004 كمثال على الممارسة الصحيحة، حيث كان لكاتب هذا المقال خبرة مباشرة بهذه الكارثة بالتحديد.

الكلمات المفتاحية: علوم الأدلة الجنائية، طب الأسنان الشرعي، الاستعراف على ضحايا الكوارث، الخصائص السنيّة.

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1. Introduction

The concept of human identification is based on a process of comparison between antemortem and postmortem human characteristics. In order for any of those characteristics to be considered a scientific method, it must possess two essential qualities: uniqueness and durability.

Fingerprints, DNA and dental characteristics are the three human identification methods that possess uniqueness and durability, and hence are qualified by Interpol as primary human identifiers [1]. When comparable antemortem and postmortem data is made available for any of the three methods, identity can be established solely based on that particular method. Other human characteristics, such as physical identifiers (height, weight etc.) and personal effects (clothes, jewelry etc.) are taken into consideration when performing the comparison, but carry a lesser evidentiary weight. Because the quality of the antemortem and postmortem data cannot be guaranteed before reconciliation, Interpol recommends that examination of the characteristics of all identification methods are conducted on each victim [1].

In a disaster setting, teams are formed for each of the identification methods. Each team consists of at least three groups: one is responsible for ante-mortem data management, which includes examining and collating ante-mortem records brought in by the police, then transcribing them onto Interpol's forms for later comparison. The second is responsible for examining dead bodies and collecting and recording all identifying characteristics from each corpse. And the third group is responsible for examining the information gathered from both ante-mortem and post-mortem teams and to find potential matches, then weighing those matches to establish the level of certainty that a particular corpse belongs to a particular missing person.

2. Teeth for Human Identification

Dental enamel is the hardest tissue in the human body, consisting almost entirely of non-decomposable inorganic material. This makes teeth highly resilient to post-mortem changes (i.e. putrefaction and skeletonization), and to peri-mortem conditions, such as fire and extensive trauma [2]. The same resilience is observed in dental materials which make up the uniqueness of dental characteristics [3], which in turn makes dental evidence the most durable among all other identifiers.

Dental restoration, root canal treatments and dental prosthesis are hand-crafted and irreproducible (Figure-1). The randomness with which dental treatments are performed by the dental practitioner generates an infinite number of concordant points, making the dental evidence very unique, even in its simplest forms [4].

The dental method of identification has an additional advantage related to the diversity of ante-mortem data. For example, whilst it would be ideal to make comparison between an ante-mortem radiograph and its post-mortem counterpart, the ante-mortem radiograph is not always available. Nevertheless, the same dental information can still be extracted from other formats of dental records, such as a dental charts, clinical notes or even treatment codes in a financial invoice. This broadens forensic odontologist's ability to identify the deceased even in situations in which ante-mortem and post-mortem data are not of the same type [5].

2.1 Importance of Dental Records in Disaster Victim Identification (DVI)

Dentists are ethically and legally required to document

Ante-mortem Radiograph

Post-mortem Radiograph

Figure 1- *Ante-mortem and post-mortem dental radiograph showing a dental prosthesis (a bridge) and a root canal treatment of the upper right quadrant. The multiple dental interventions represent an infinite number of concordant points between the radiographs, which presents an identity evidence of considerable weight.*

the dental status of and to register the treatments performed on patients. This documentation is a fundamental component of good clinical practice with which patients will be given the appropriately planned dental care. Maintaining ample dental records is also considered to be legally important for protecting dentists against civil liability in cases of suspected malpractice [6, 7].

Despite this, there is continuing concern about the inadequacy of dentist's record-keeping practices. Brown found that nearly 75% of the cases filed against dentists were associated with poor record keeping upon professional investigations [7]. The dentists' ability to maintain dental records of a high quality, and their compliance with national statutory regulations in this regard, were better when dental records were in digital format by comparison with paper format [8]. Digitization of the dental records would not only improve dental care of patients, but would also expedite the identification of disaster victims, should this be required. In their audit, Kiesser et al. showed that 96% of the ante-mortem dental records rendered useful for foren-

sic identification were computer-generated, by comparison with 38% which were hand-written [9].

Dentists can only be liable against inadequate record keeping practices if regulations in this regard exist. There is no unified global statutory for what constitutes a complete dental record. Therefore, dentists from various countries have demonstrated different approaches to record keeping practices [10]. Educating dentists about the benefits of good record keeping has been proven to positively change their attitudes and to improve their ability to record essential dental information [11], which would be useful for future forensic uses.

Undoubtedly, the success of dental identification is largely dependent on the quality of dental records provided by the dentists. But the diversity of what constitutes a "dental record" would overcome this limitation [5, 12]. For example, dental comparisons can still be performed in the absence of dental radiographs or dental charts when the dentist had only maintained clinical notes of the performed treatments. Verbal dental information can also be provided

by the missing person's family members. The ability of the Forensic Odontologists to transcribe dental information from various sources into a unified ante-mortem dental chart is a feature which augments the availability of comparable dental ante-mortem data.

3. Dental Identification in Mass Disasters

Table-1 shows details of the mass disasters which occurred between 1974 and 2012, in which Forensic Odontology services were employed for the purpose of victims identification. Data related to those disasters were obtained from a PubMed search using the keywords: disaster victim identification, dental identification, and dental characteristics. Only articles showing data related to the total number of deceased victims, the total number of victims identified, and the number of those identified by dental characteristics were included in this review.

Dental characteristics were used in all of the 17 disasters as a sole and/or as a contributory identifier. The total number of victims who were successfully identified was 4998 [13-27, 36]. A considerable diversity is seen in the percentage of dental identification both as being a sole identifier and a contributory identifier. Dumancić et al. showed that dental characteristics could not identify any victim of the two accidents which occurred in Croatia in 1974 and 1976, but were useful as a contributory method in identifying between 5% and 33% of the victims of those two disasters [13].

Stene-Johansen et al. on the other hand, reported that dental evidence was the sole identifier of 89% of the victims of an airplane accident in Norway in 1988 [27], which was attributed to excellent dental records.

Among the 17 reported disasters, the average percentage of victims who were identified using dental characteristics as a sole identifier was 37.8%. This percentage does not seem to be influenced by the number of victims, nor by the nature of the disaster. Interestingly, disasters in which more than 50% of victims were solely identified by dental evidence occurred in European and Scandinavian countries, where dental treatments are appropriately recorded by most dentists.

Moreover, in 11 of the 17 disasters, dental characteristics were used in identifying an average of 37.8% of victims as a contributory factor, which shows the utility of dental characteristics in disaster victim identification, even when dental records are not optimal.

4. The 2004 Indian Ocean Disaster

On the morning of the 26th of December 2004, a massive earthquake occurred in the floor of the Indian Ocean near the shores of Sumatra. It measured 9.1 on the Richter scale and lasted more than 4 minutes [28]. The gigantic tremor of the ocean's floor resulted in a series of waves with enormous energy, equivalent to 10,000 Hiroshima bombs. The unusually shallow depth of the quake's epicenter generated a concentrated energy which displaced millions of tons of water above it, creating a wall of water travelling towards the shores of the Indian ocean in all directions [28]. The wave resulted in severe destruction to the coastal areas in several countries, and was strong enough to travel for approximately 7 hours towards the eastern African shores and still sustain enough energy to result in deaths and destruction in towns thousands of kilometers away from the quake's epicenter [29].

The term tsunami is originally Japanese (tsu meaning harbour and nami meaning wave), which means a very

Table 1- *Details of 17 disasters in which dental evidence was used for identification. The reports come from 12 countries and cover incidents ranging from 1974 to 2012. The impact of dental identification was neither affected by the recency of the disaster, nor by its nature, but by the availability and quality of dental records in various jurisdictions.*

S.No.	Type of Disaster	Country	Year	No. of victims	No. of victims positively identified	Percentage of victims identified solely by dental characteristics (ascending order)	Percentage of victims partially identified by dental characteristics	Ref No.
1	Railway accident	Croatia	1974	152	111	0	5	13
2	Midair collision (British plane)	Croatia	1976	63	63	0	33	13
3	Lockerbie disaster	Scotland	1994	270	253	7	76	14
4	DANA air crash	Nigeria	2012	152	148	10	97	15
5	Midair collision (Slovanian plane)	Croatia	1976	103	103	14	16	13
6	Malaysia plane	Malaysia	1995	34	34	21	50	16
7	Mass graves in Croatia	Croatia	1998	1000	842	25	64	17
8	Christchurch earthquake	New Zealand	2011	181	177	33	14	18
9	Helderberg air disaster	Mauritius	1987	159	15	40	Not reported	19
10	Victorian bushfire	Australia	2009	173	163	46	34	20, 21
11	Indian ocean tsunami	Thailand	2004	4812	2679	41	13	36
12	Lyon-Strasbourg air crash	France	1992	87	85	52	14	22
13	Bus accident 1	Spain	1996	28	28	57	Not reported	23
14	Estonia ferry	Finland	1994	852	93	60	Not reported	24
15	Scandinavian Star ferry	Norway	1990	158	158	68	Not reported	25
16	Bus accident 2	Spain	1997	10	10	80	Not reported	26
17	Dash 7 aircraft	Norway	1988	36	36	89	Not reported	27
	Average					37.8	37.8	

high and large wave generated by an earthquake in the ocean's floor [30]. This natural phenomenon was known to coastal countries, particularly Japan, and did result in death and destruction several times there in the past. By comparison to previous tsunami disasters, the one in 2004 was of a global concern because it affected several nations not familiar with disasters of this nature and extent.

The process of identifying the victims was a particular challenge for the following reasons:

Firstly, the geographical location of the quake's epicenter resulted in destruction in at least 9 countries positioned along the rim of the Indian Ocean. The coastal areas of those countries included highly-populated cities and towns, which significantly increased the number of deaths. Moreover, the coastal terrain was flat, which allowed the wave to move further inland causing a more severe destruction. The topographical factors made this disaster one of the deadliest in history [28].

Secondly, the timing of the disaster, which occurred at the peak of the holiday season when a large number of families were spending their break time in many of the tourist destinations on the tropical coastal areas. The fact that families were grouped together and died away from countries of origin resulted in a delay in listing them as missing, and made the collection of ante-mortem data a very difficult task. And because many of the victims of this disaster were biologically related, the collection of DNA reference samples was particularly challenging [31].

Thirdly, the tropical climate of the affected countries resulted in a rapid decomposition of the dead bodies, rendering almost all deceased victims visually unidentifiable only days after its onset [32]. Some identifiers, such as fingerprints and DNA, were also gradually degrading as a result of rapid decomposition and bad body storage conditions during the first weeks after the disaster. The culmination of those factors made the collection and comparison of identification data (both ante-mortem and post-mortem) very challenging.

Among all affected countries, Thailand in particular, faced an added challenge. Whilst the other countries were dealing with dead bodies of their nationals, Thailand had a post-mortem community from more than 30 nations [33], most of whom were tourists visiting from Europe and Scandinavia. In order to identify these tourists and repatriate them to their home countries, a detailed post-mortem examination of every deceased person was needed.

Parallel to that, collection of all ante-mortem identifiers for all missing persons from all involved countries was required. This was a massive and complex task that would require unprecedented international collaboration at diplomatic, scientific and financial levels. A previous example to be followed did not exist, and nations needed to meet and discuss how to turn this collaboration into reality [34].

It took several days to lay down the most appropriate plan for Disaster Victim Identification (DVI). The management of this process was carried out by Interpol, and the Interpol DVI guidelines and forms were followed meticulously. DVI teams from several countries were deployed to Thailand to work in one of four main locations: three temporary mortuaries in Takua Pa, Mai Khao and Krabi, and one centralized data collection and reconciliation center named Thai Tsunami Victim Identification–Information Management Center (TTVI-IMC) [33].

The size of this disaster necessitated the use of an intelligent computer system that could sort, categorize and match a large diversity of human characteristics. For the

matching task to be meaningful, each characteristic should be given a weight that corresponds to its presumed rarity among the post-mortem population.

The system used in the 2004 Indian Ocean tsunami was DVI System International [35], developed by PlassData. This, originally a Danish program, was superior to other available DVI systems as it replicated Interpol's disaster victim identification forms, which guaranteed continuity between the manually-filled forms and their electronic counterparts.

The dental section of the DVI System International was based on an algorithm of numerical values. Each ante-mortem and post-mortem match had a predetermined value which was originally set according to their commonality in a particular community. However, the multinational composition of the 2004 tsunami meant that those values would not necessarily be applicable to the dental characteristics observed in this disaster. A later significant update to the system was to give it the ability to automatically change the weight of each dental characteristic after calculating each characteristic's commonality among a specific disaster population. The system would continue to calculate those values and update them as long as ante-mortem and post-mortem data are being entered onto it [35].

The early months of the tsunami DVI operation showed a remarkable peak in dental identifications in comparison to fingerprints and DNA. At the end of March (three months into the DVI operation), 951 victims were identified; of those, 837 (88%) were identified solely by dental characteristics. Towards the end of the 12-month DVI operation, more than 41% of victims were identified by dental characteristics alone, and 12.9% were identified by a combination of methods including dental characteristics (Figure-2) [36].

The success of dental identification in this large disaster was attributed to the high quality dental records of tourists coming mainly from European countries. End of disaster analyses showed a gross discrepancy in the rate of dental identifications between Thai and non-Thai nationals [37]. While 94.4% and 75.5% of European victims had dental charts and dental X-rays, only 18.1% and 0.8% of Thai nationals had the same [37]. As a result, 76.4% of European victims were dentally identified by comparison with only 2% of those of Thai nationality [37].

Although the dental comparison maintained a superior position as the most frequently used identification method throughout the whole 12-month DVI operation, it did slow down in later months. This is attributed to the fact that victims who had excellent dental records were already identified and repatriated, and Forensic Odontologists were gradually managing victims with incomplete or non-existing dental records.

Despite the inadequacy of dental records in the later months after disaster, forensic odontology remained an important identifier when it was used to narrow down possible matches for DNA and fingerprints. This significantly saved time spent in cross matching one set of ante-mortem data with all post-mortems and vice versa, by excluding impossible matches which contain incompatible inconsistencies in the dental characteristics and dental age mis-matches.

Often, dental comparisons would yield non-conclusive dental matches (classified as possible or probable identifications), which was insufficient to establish the identity. Nevertheless, those types of reconciliation outcomes were augmented with other weaker identification methods and eventually led to a satisfactory conclusion of identity.
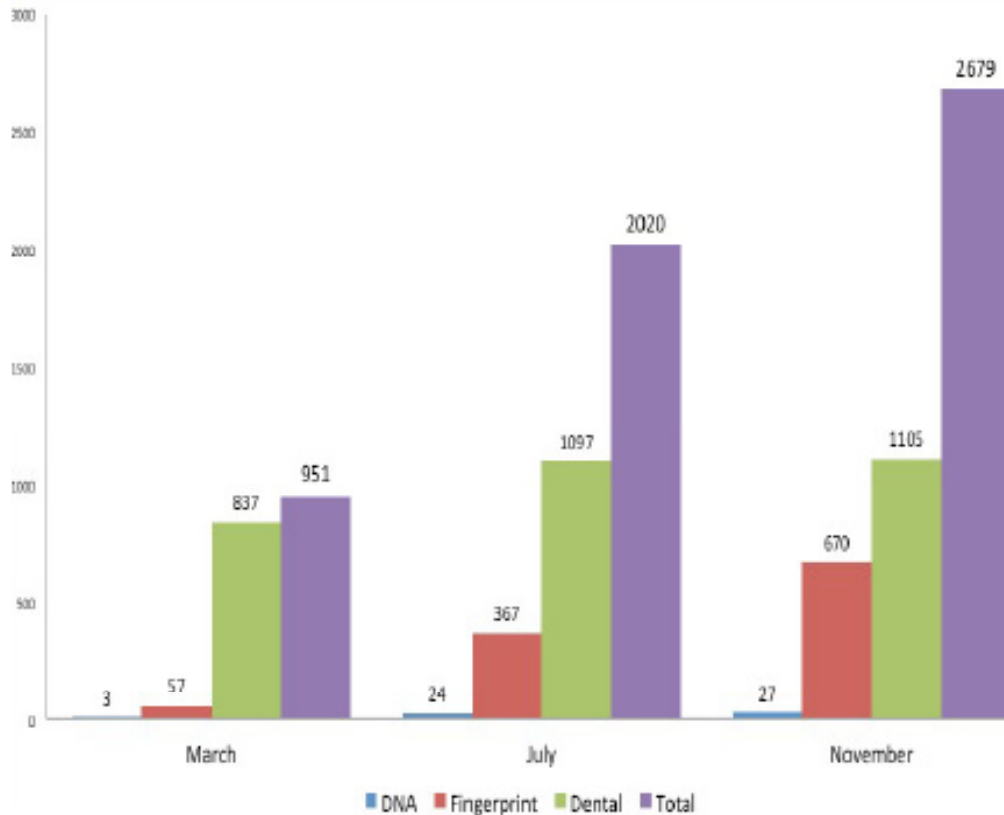
Figure 2- *Chart showing the total number of identified victims throughout the first 11 months of Indian Ocean tsunami, and the number of victims identified per primary identifier. (Data obtained from Schuller-Götzburg and Suchanek [36] with modifications).*

Photographs of the missing persons became a useful substitute for improper or absent dental records. By looking for peculiar features appearing in the anterior teeth and matching them with those of the deceased, forensic odontologists were able to establish the identity of some victims, or at least to reach a possible or probable identification [38]. The angle from which the photograph was taken during life needed to be reproduced when photographing the deceased. This required taking a series of photographs from different angles until morphological similarities were satisfactory. This technique alleviated some of the shortcomings of dental identification that were secondary to poor dental records.

Whilst high resolution facial photographs are becoming widespread, their post-mortem counterparts might not always be available. Identification by superimposition might be unsuccessful if the anterior teeth are damaged due to trauma or fire. In some cases, DNA samples are extracted from the dental pulp, which requires a tooth to be removed from the deceased. Unfortunately, in some cases an anterior tooth rather than a posterior tooth is removed for this purpose, and this can impede the overall identification if the DNA comparison is not successful. Forensic geneticists should be aware of the potential of utilizing anterior teeth for alternative identification techniques, and seek healthy teeth for DNA extraction from posterior rather than anterior dentition.

5. Conclusion

Natural and man-made disasters leave multiple fatalities which need to be identified by comparing information about various characteristics retrieved from the dead bodies with the corresponding information collected about the missing persons while they were alive. Several papers have discussed the usefulness of dental records in human identification and showed that when dental records are available, identification by comparative dental analysis is swift, easy and inexpensive. The diversity of what constitutes a "dental record" means that dental identification can still be viable as a contributory identification method even when the ante-mortem dental records are poor. Health authorities must lay down and enforce guidelines and policies regulating dental record-keeping practices for their utility in disaster victim identification.

Conflict of interest
None.

References

1. Disaster Victim Identification guide 2014. Lyon, Interpol; 2014 (http://www.interpol.int/INTERPOL-expertise/Forensics/DVI-Pages/DVI-guide)

2. Reesu GV, Augustine J, Urs AB. Forensic considerations when dealing with incinerated human dental remains. J Forensic Leg Med. 2015; 29:13-7. https://doi.org/10.1016/j.jflm.2014.10.006, PMid:25572078

3. Bose RS, Mohan B, Lakshminarayanan L. Effects of elevated temperatures on various restorative materials: an in vitro study. Indian J Dent Res. 2005;16(2):56-60. PMid:16372794

4. Madi HA, Swaid S, Al-Amad S. Assessment of the uniqueness of human dentition. J Forensic Odontostomatol. 2013;31(1):30-9. PMid:24776439

5. Pretty IA, Sweet D. A look at forensic dentistry--Part 1: The role of teeth in the determination of human identity. Br Dent J. 2001;190(7):359-66. https://doi.org/10.1038/sj.bdj.4800972a, https://doi.org/10.1038/sj.bdj.4800972

6. Leeuw W. Maintaining proper dental records. Dental Assistant, 2014, 83(2):22-3, 26-30, 32-4. PMid:24834675

7. Brown L. Inadequate record keeping by dental practitioners. Aust Dent J. 2015;60(4):497-502. https://doi.org/10.1111/adj.12258, PMid:25431111

8. McAndrew R, Ban J, Playle R. A comparison of computer- and hand-generated clinical dental notes with statutory regulations in record keeping. Eur J Dent Educ. 2012; 16(1):e117-21. https://doi.org/10.1111/j.1600-0579.2011.00684.x, PMid:22251334

9. Kieser JA, Laing W, Herbison P. Lessons learned from large-scale comparative dental analysis following the South Asian tsunami of 2004. J Forensic Sci. 2006; 51(1):109-12. https://doi.org/10.1111/j.1556-4029.2005.00012.x, PMid:16423233

10. Kogon S, Banting DW, Sandhu H. Foreign-trained dentists' perceived knowledge and skills after graduation from a structured two-year program. J Dent Educ. 2011; 75(8):1098-106. PMid:21828304

11. Chong JA, Chew JK, Ravindranath S, Pau A. Clinical audit teaching in record-keeping for dental undergraduates at International Medical University, Kuala Lumpur, Malaysia. J Dent Educ. 2014; 78(2):206-12. PMid:24489028

12. Dierickx A, Seyler M, de Valck E, Wijffels J, Willems G. Dental records: a Belgium study. J Forensic Odontostomatol. 2006;24(1):22-31. PMid:16783953

13. Dumančić J, Kaić Z, Njemirovskij V, Brkić H, Zecević D.Dental identification after two mass disasters in Croatia. Croat Med J. 2001;42(6):657-62. PMid:11740850

14. Moody GH, Busuttil A. Identification in the Lockerbie air disaster. Am J Forensic Med Pathol. 1994;15(1):63-9. https://doi.org/10.1097/00000433-199403000-00014, PMid:8166119

15. Obafunwa JO, Ogunbanjo VO, Ogunbanjo OB, Soyemi SS, Faduyile FA. Forensic odontological observations in the victims of DANA air crash. Pan Afr Med J. 2015;20:96. PMid:26213597 PMCid:PMC4506801

16. Nambiar P, Jalil N, Singh B. The dental identification of victims of an aircraft accident in Malaysia. Int Dent J. 1997;47(1):9-15. https://doi.org/10.1111/j.1875-595X.1997.tb00671.x, PMid:9448783

17. Brkic H, Strinovic D, Kubat M, Petrovecki V. Odontological identification of human remains from mass graves in Croatia. Int J Legal Med. 2000;114(1-2):19-22. https://doi.org/10.1007/s004149900130, PMid:11197622

18. Trengrove H. Operation earthquake 2011: Christchurch earthquake disaster victim identification. J Forensic Odontostomatol. 2011;29(2):1-7. PMid:22717907

19. Ligthelm AJ. The Helderberg air disaster forensic odontological investigations. J Forensic Odontostomatol. 1994;12(1):15-8. PMid:9227085

20. Hinchliffe J. Forensic odontology, part 3. The Australian bushfires - Victoria state, February 2009. Br Dent J. 2011;210(7):317-21. https://doi.org/10.1038/sj.bdj.2011.239, PMid:21475281

21. Bassed R. Forensic Odontology in the Aftermath of the 2009 Australian Bush Fires. Proceedings of the American Academy of Forensic Sciences. Annual Scientific Meeting Seattle, February, 2010. Page 270. Can be accessed at: https://www.aafs.org/wp-content/uploads/ProceedingsSeattle2010Rev07-24-12.pdf

22. Hutt JM1, Ludes B, Kaess B, Tracqui A, Mangin P. Odontological identification of the victims of flight AI. IT 5148 air disaster Lyon-Strasbourg 20.01.1992. Int J Legal Med. 1995;107(6):275-9. https://doi.org/10.1007/BF01246872, PMid:7577688

23. Martin-de las Heras S, Valenzuela A, Villanueva E, Marques T, Exposito N, Bohoyo JM. Methods for identification of 28 burn victims following a 1996 bus accident in Spain. J Forensic Sci. 1999;44(2):428-31. https://doi.org/10.1520/JFS14480J

24. Soomer H, Ranta H, Penttilä A. Identification of victims from the M/S Estonia. Int J Legal Med. 2001;114(4-5):259-62. https://doi.org/10.1007/s004140000180, PMid:11355406

25. Solheim T, Lorentsen M, Sundnes PK, Bang G, Bremnes L. The "Scandinavian Star" ferry disaster 1990 - a challenge to forensic odontology. Int J Legal Med. 1992;104(6):339-45. https://doi.org/10.1007/BF01369554, PMid:1515361

26. Valenzuela A, Marques T, Exposito N, Martín-De Las Heras S, García G. Comparative study of efficiency of dental methods for identification of burn victims in two bus accidents in Spain. Am J Forensic Med Pathol. 2002;23(4):390-3. https://doi.org/10.1097/00000433-200212000-00019, PMid:12464820

27. Stene-Johansen W, Solheim T, Sakshaug O. Dental identification after the Dash 7 aircraft accident at

Torghatten, Northern Norway, May 6th, 1988. J Forensic Odontostomatol. 1992;10(1):15-24. PMid:1429934

28. Tibballs G. Tsunami: The Most Terrifying Disaster. Carlton Publishing Group; 1st edition, 2005. PMCid:PMC1720176

29. Danschutter DR. Tsunami: response to a disaster. Critical Care Nursing Clinics of North America, 2005,17(4):481-94. https://doi.org/10.1016/j.ccell.2005.08.005, PMid:16344216

30. Merriam-Webster online dictionary; 2015 (http://www.merriam-webster.com/dictionary/tsunami)

31. Brenner CH. Some mathematical problems in the DNA identification of victims in the 2004 tsunami and similar mass fatalities. Forensic Science International, 2006,157:172–180. https://doi.org/10.1016/j.forsciint.2005.11.003, PMid:16361074

32. Morgan OW, Sribanditmongkol P, Perera C, Sulasmi Y, Van Alphen D, Sondorp E. Mass fatality management following the South Asian tsunami disaster: case studies in Thailand, Indonesia, and Sri Lanka. PLoS Medicine, 2006, 3(6):e195. https://doi.org/10.1371/journal.pmed.0030195, PMid:16737348 PMCid:PMC1472696

33. James H. Thai tsunami victim identification overview to date. Journal of Forensic Odontostomatology, 2005, 23(1):1-18.

34. United Nations News Centre. UN launches unprecedented multiple effort to aid victims of Asia's devastating tsunami; 2004. http://www.un.org/apps/news/story.asp?NewsID=12914#.VM3wjMbYn8k).

35. Andersen Torpet L. DVI System International: software assisting in the Thai tsunami victim identification process. J Forensic Odontostomatol. 2005; 23(1):19-25. PMid:16223022

36. Schuller-Götzburg P, Suchanek J. Forensic odontologists successfully identify tsunami victims in Phuket, Thailand. Forensic Sci Int. 2007; 171(2-3):204-7. https://doi.org/10.1016/j.forsciint.2006.08.013, PMid:17029859

37. Petju M, Suteerayongprasert A, Thongpud R, Hassiri K. Importance of dental records for victim identification following the Indian Ocean tsunami disaster in Thailand. Public Health. 2007;121(4):251-7. https://doi.org/10.1016/j.puhe.2006.12.003, PMid:17276465

38. Al-Amad S, McCullough M, Graham J, Clement J, Hill A. Craniofacial identification by computer-mediated superimposition. J Forensic Odontostomatol. 2006, 24(2):47-52. PMid:17175836