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Dentalna identifikacija žrtava cunamija u Phuketu, Tajland

Dental Identification of Tsunami Victims in Phuket, Thailand

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Sažetak

U prosincu godine 2004. podmorski je potres stvorio plimni val koji je uništio velik dio obale Indijskog oceana. U toj je katastrofi poginulo oko 250.000 ljudi. **Is-pitanici i postupci:** U Phuketu, ljetovalištu u Tajlandu, pod nadzorom Interpola u usklađenom postupku identifikacije žrtava katastrofe, sudjelovali su stručnjaci iz 20 zemalja, kako bi identificirali više od 3680 poginulih, pripadnika 39 narodnosti. Na početku su ustanovili postmortalna standardna obilježja (PM). Antemortalni podaci (AM) o stradalima poslani su u Tajland i uneseni u računalni program DVI System International (Plass Data Software, Danska). Upis postmortalnih podataka (PM-a) i primarne identifikacijske karakteristike, odjeća i fizičke oznake (na primjer ožiljci), obavljani su vrlo standardizirano na mjestu nesreće u Phuketu. Posebna se pozornost posvećivala antemortalnim podacima (AM-u), osobito podacima o stomatološkom liječenju (male rentgenske snimke, ortopantomogrami-OPTG-i i zubni kartoni). **Rezultati:** Nakon godine dana stopa identifikacije od 55% dokazala je uspješnost te metode. Od 3680 službeno poginulih, 3272 osobe moglo se identificirati. To znači stopu identifikacije od 87,77%, a od toga broja 44% je identificirano na temelju zubnoga statusa. **Zaključak:** Identificirano je oko 92% turista, te 53% od 1600 Tajlandana. Dakle, ukupna je stopa identifikacije 22.studenoga 2006. iznosila 70%.

Zaprimljen: 29. srpnja 2007.

Prihvaćen: 16. listopada 2007.

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Ključne riječi

forenzična stomatologija; dentalna identifikacija; prirodne katastrofe

Uvod

U 8 sati 26. prosinca godine 2004. podmorski potres jakosti 9 stupnjeva prema Richterovoj ljestvici s epicentrom na obali Sumatre, podignuo je razoran plimni val koji je ubio više od 250.000 ljudi u osam država (Indoneziji/Sumatri, Šri Lanki, Indiji, Tajlandu, Mijanmaru, Maldivima, Maleziji i Bangladešu). Od oko 3600 žrtava u Phuketu u Tajlandu, mnogi su bili turisti iz 38 zemalja. Zbog toga je u identifikaciju žrtava uložen golem međunarodni napor.

Introduction

At 8 a.m. on December 26, 2004 a seaquake of 9.0 on the Richter scale, with its epicenter at the coast of Sumatra, caused a devastating tidal wave that led to the death of more than 250,000 human lives in 8 countries (Indonesia/Sumatra, Sri Lanka, India, Thailand, Myanmar, Maldives, Malaysia und Bangladesh). Many of the approximately 3,600 victims in Phuket/Thailand were tourists and foreigners from 38 countries. This led to a hitherto unparalleled international effort to identify the victims.

Tijela se moglo jednoznačno identificirati na temelju samo triju primarnih značajki – prema dentalnom statusu, otiscima prstiju te DNK analizom.

Najviše je stranih turista bilo u ljetovalištu Phuketu u Tajlandu. Od 28. prosinca 2004. do prosinca 2005., međunarodne su ekipe za identifikaciju žrtava (Disaster Victim Identification) surađivale kako bi identificirale poginule u toj elementarnoj katastrofi. Činili su ih uglavnom stomatolozi-forenzičari, policijski službenici, medicinsko-pravni stručnjaci te specijalisti za otiske prstiju i DNK analizu.

Sačuvati tijela u improviziranim mrtvačnicama, bilo je na početku velik problem. Trupla su se vrlo brzo raspadala zbog razmjerno visoke zimske temperature od 25°C.

Većina od gotovo 3600 tijela pronađenih u području Phuketu prevezena su u rashladne spremnike (s temperaturom od -18°C) na lokaciji broj dva u sjevernom dijelu grada. Odmah su očitavani i postmortalni podaci stradalih tijela.

Pregledani postmortalni podaci podijeljeni su u dva specifična dijela, poput medicinskih karakteristika rutinski unesenih tijekom ograničene forenzično-medicinske autopsije (na primjer ožiljci, usadci u dojke, pace-makeri, ortopedski implantati, itd.), zajedno s otiscima prstiju i uzorkom DNK, a poseban je odjel bio zadužen za detaljne zubne statuse, uključujući i fotografije, ugrizne i/ili periapikalne radiografske snimke (1-4).

Kako bi se u policijskoj istrazi skupili antemortalni podaci iz matičnih zemalja žrtava te ih se usporedilo s postmortalnim podacima na mjestu katastrofe, osnovan je u Phuketu u Tajlandu Centar za identifikaciju žrtava cunamija – Information Management Center (TTVI-IMC) (5).

Žrtve cunamija mogle su se prepoznati jedino uz pomoć triju primarnih identifikacijskih karakteristika – prema zubnim statusima, otiscima prstiju te DNK analizom. Dana 21. studenoga 2006., gotovo dvije godine nakon katastrofe, u Phuketu i okolici identificirane su 3272 žrtve od ukupno 3795. Od njih su 1956 bili stranci, a 1316 Tajlandani. Još je neidentificirano 417 tijela, a 106 se čuva u rashladnim spremnicima i čeka se njihov odvoz u matične zemlje. Broj žrtava prijavljenih mjerodavnim službama svaki je dan bio drugačiji. Tijekom prva tri mjeseca najučinkovitija je bila identifikacija uz pomoć zubnog statusa. Nakon toga razdoblja bilo je moguće identificirati veći broj žrtava prema otiscima prstiju. Identifikacija kombinacijom nekoliko metoda bila je češća nakon lipnja godine 2005.

Victims could be unequivocally identified only by three primary characteristics, namely their dental status, fingerprints, and DNA.

The largest number of foreign victims were registered in Phuket/Thailand. This led to the greatest international effort undertaken so far to identify victims of natural catastrophes. From December 28, 2004 to December 2005, international DVI (Disaster Victim Identification) teams have been working in Phuket/Thailand to identify the victims of this disaster. The teams mainly consist of forensic odontologists, police officers, medicolegal experts, fingerprint and DNA specialists.

At the initially improvised sites, preservation of the victims was a major problem. The corpses began to decay rapidly at the relatively high winter temperature of 25°C.

The majority of the approximately 3,600 bodies of victims in the region of Phuket were placed in refrigerated containers at -18°C at site 2, which was located in the northern part of Phuket. The PM (post mortem) data of the victims were collected.

Examination of the PM data was divided into specific sections such as medical characteristics routinely registered at a limited forensic-medicine autopsy (e.g., scars, implantation of breast implants, pacemaker, orthopedic implants, etc.), a fingerprint and a DNA sample section, and a separate section for the victims' detailed dental status including photographs, 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 (5-11) and compare these data with the PM data collected at the tsunami site, the Thai Tsunami Victim Identification – Information Management Center (TTVI-IMC) was installed at Phuket/Thailand (5).

Victims of devastation can only be identified by three primary identification characteristics, namely their dental status, fingerprints, and DNA. On November 21, 2006 – nearly two years after the catastrophe – 3,272 of the 3,795 dead persons had been identified in and around Phuket. Of these, 1,956 were foreigners and 1,316 were Thai. 417 cases were yet unidentified and 106 identified victims were preserved in cool containers in Thailand, still awaiting repatriation. The numbers of victims reported by the official authorities fluctuated on a daily basis.

Identification by dental status was most successful during the first three months. After this time a larger number of victims could be identified by their fingerprints. Identification by a combination of several methods was done more frequently from June 2005 onward.

Ispitanici i postupci

Dentalna identifikacija

Identifikacija žrtava usklađivala se u Centru za identifikaciju žrtava cunamija (TTVI-IMC) u Phuketu u Tajlandu. Usporedba zubnih podataka temeljila se na postmortalnim dentalnim podacima o žrtvama skupljenima na lokacijama gdje su stradale i na antemortalnim podacima o nestalim osobama iz zubnih kartona njihovih stomatologa. Interpolov obrazac za AM-podatke žute je boje, a onaj za PM-podatke je ružičast. Obrazac F1 sadržava podatke poput imena žrtvina stomatologa te imena osobe koja je upisala podatke, a obrazac F2 sadržava podatke o zubnom statusu. Ostavljeno je i mjesto za unos dodatnih podataka ili specifičnih detalja o žrtvinoj stomatološkoj povijesti bolesti, kao što su tehnički oblici liječenja ili opis okluzije.

Antemortalni podaci, posebice rentgenske snimke i kartoni liječenja dobiveni iz pacijentove domovine te izvorni dokumenti koji se odnose na te nalaze, prosljeđeni su TTVI-IMC Centru u Phuketu.

Postmortalne zubne istrage provedene su na lokacijama u sklopu posebnog dijela forenzično-medicinske autopsije. Odmah je obavljeno rentgensko snimanje zuba te su slike hitno razvijene (Sl.1.).

Snimljeno je i pet fotografija - jedna frontalna, dvije lateralne te po jedna okluzalna za svaku čeljust. U pravilu je mandibula eksartikulirana, kako bi se omogućio precizniji pregled (Sl.2.). Na mjestu stradanja zubni su se podaci rukom upisivali u ružičasti (PM) obrazac F2, pod lozinkom sastavljenom od triju slova.

Dva su forenzična stomatologa unosila AM i PM podatke u računalni program DVI System International (Plass Data Software, Danska - Sl.3.). Za klasifikaciju žrtvinih zubnih statusa, svi su podaci o njihovom stanju, liječenju te smještaju zuba jasno određeni troznamenkastom šifrom u standardiziranom DVI-protokolu na Interpolovim F1 i F2 obrascima (Sl.4.). Koristio se FDI sustav za označavanje zuba.

U Odjelu za pomirbu Centra za identifikaciju žrtava cunamija (TTIV-IMC-a) uspoređeni su AM i PM podaci kako bi se odredile sličnosti. Takva je usporedba automatski obavljena na računalu s programom DVI System International. Svaku moguću kategoriju koju je kompjutor predložio, specijalist je klasificirao u jednu od sljedećih kategorija: "potvrđeno", "vjerojatno", "moguće", "nedostatni dokazi", "isključeno".

Sve "potvrđene" slučajeve najprije je kontrolirao voditelj ekipe, zatim tajlandski stomatolog, a nakon toga objavljeni su na identifikacijskoj ploči.

Materials and methods

Dental Identification

Identification of victims was coordinated at the Thai Tsunami Victim Identification - Information Management Center (TTVI-IMC) in Phuket/Thailand. Comparison of dental data was based on the registered PM data of victims at the sites and the AM data of the missing persons from their dentists at home. The Interpol form sheet for AM data is yellow while that for PM data is red. The F1 form sheet includes data such as the victim's dentist and the name of the person who collected the data while the F2 form sheet includes the status of the victim's teeth, and also provides space for additional entries or specific details about the victim's dental history such as technical treatment or occlusion.

At the TTIV-IMC the AM data, particularly X-rays and treatment charts, are collected in the patient's native country and the original documents pertaining to these findings are passed on to the TTIV-IMC Phuket/Thailand (10,11).

PM dental investigations are conducted on site as a separate part of the forensic medicine autopsy. Periapical and bitewing X-rays are obtained and developed immediately (Fig. 1). Five 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 exarticulated for a more exact examination (Fig. 2). At the site the dental data were filled by hand into the red (PM) F2 form sheet by means of a three-letter code.

AM and PM data were entered in the computer program DVI System International (Plass Data Software, Denmark) by two forensic odontologists (Fig. 3). In order to classify the victims' dental status, all information pertaining to their condition, treatment, and position of teeth were clearly designated by a three-digit code in the standardized dental DVI protocol F1 and F2 DVI form of Interpol (Fig. 4). The FDI tooth numbering system was used as the standard.

At the reconciliation section of the TTIV-IMC, AM and PM data were compared for concurrence (Fig. 5). Such "matching" was performed automatically at night by a computer of DVI System International. All hits suggested by the computer were classified by the specialist into one of the following categories: "established", "probable", "possible", "insufficient evidence" or "excluded".

All "established" cases were first checked by the reconciliation team leader, subsequently by a Thai dentist, and then posted on the ID board.



Slika 1. Lokacija 2 – Phuket u Tajlandu: Odjel za pregled zuba s jedinicom za rentgensko snimanje te razvijanjem. Barem dvije ugrizne snimke snimljene su kod svake žrtve.

Figure 1 Site 2 Phuket/Thailand: Dental examination section with the X-ray unit and developer. At least two bitewing X-rays of every victim were taken.



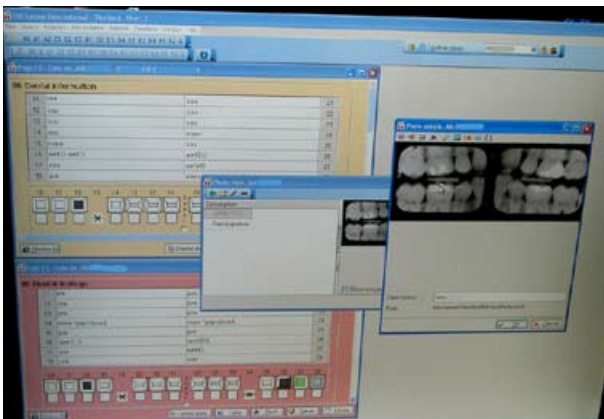
Slika 2. Kako bi se bolje procijenio i registrirao zubni status, mandibula je eksartikulirana, a podaci su ručno uneseni u interpolove obrasce F1 i F2. Detaljni zubni status uključivao je fotografije i ugrizne i/ili periapikalne rentgenske snimke.

Figure 2 In order to better assess and register the detailed dental status, the mandible was exarticulated and the data were entered manually into the F1 and F2 forms of Interpol. The detailed dental status included photographs and bitewings and/or periapical radiographs.



Slika 3. Unos PM podataka (ružičasta podloga) zubnog statusa obavila su dvojica forenzičnih stomatologa, u AM/PM-ovu Odjelu TTVI-IMC-a. Obavili su i komparaciju s rentgenogramima.

Figure 3 Data entry of PM (red background) dental status by two forensic odontologists, at the AM/PM section of the TTVI-IMC, and comparison with X-rays.



Slika 5. Sparivanje AM i PM datoteka u Uredu za pomirbu, uz program DVI System International.

Figure 5 Matching an AM and a PM file at the reconciliation office, using the DVI System International program.

Page F2 - Case no.

86 Dental information

11	cof MD	cof M	21
12	sou	cof M, amf L	22
13	sou	sou	23
14	cof MOD	amf OD	24
15	amf MOD	amf MOD	25
16	mcc	mcc	26
17	car MO	gai MOL	27
18	mis	mcc	28

18	17	16	15	14	13	12	11	S	21	22	23	24	25	26	27	28
X																X
X																X
48	47	46	45	44	43	42	41	P	31	32	33	34	35	36	37	38

48	mis	mis	38
47	abu mcc	mcc rlx	37
46	mam mcp	sou	36
45	abu mcc	amf MOD	35
44	amf OD	car V	34
43	sou	amf D	33
42	sou	sou	32
41	car V	mpm	31

87 Specific data

Upper Jaw		Lower Jaw	
<input type="checkbox"/> Crown	<input type="checkbox"/> Bridge	<input type="checkbox"/> Crown	<input type="checkbox"/> Bridge
<input type="checkbox"/> Partial denture	<input type="checkbox"/> Edentulous	<input type="checkbox"/> Partial denture	<input type="checkbox"/> Edentulous

Slika 4. Interpolov obrazac F2 za AM podatke (žuta podloga) u DVI System Internationalu (Plass Data Software, Danska). Svaki je zub (FDI nomenklatura) obilježen minimalno troznamenkastom zaporkom.

Figure 4 AM F2 Interpol form (yellow background) in the DVI System International (Plass Data Software, Denmark). Every tooth (FDI nomenclature) was reported on with a minimum three-digit code.

DNK analiza

Na početku se vjerovalo da je žrtve cunamijski moguće identificirati samo DNK analizom. No, ona se zapravo pokazala problematičnom, jer su se zbog vrućine mišići žrtava vrlo brzo raspada- li. Osim toga tajlandski su zakoni zabranjivali prijevoz trupala iz zemlje, a to se odnosilo i na uzor- ke DNK. Daljnje su prepreke bile velike količine uzoraka, visoka cijena analize te složena potraga za laboratorijem koji bi brzo i točno mogao obra- diti toliku količinu uzoraka. Postupak identifi- kacije mogao je službeno početi tek nakon što su se riješila ta pitanja te nakon što je pronađen odgo- varajući DNK-laboratorij. Dakle, trenutačna stopa identifikacije postignuta tom metodom nije u skla- du s pravim mogućnostima toga načina identifi- kacije (6). Uzorci skupljeni za internu, ograničenu forenzičnu autopsiju uključivali su 10 centimetra- ra kosti femura, 10 centimetara rebara, dva zuba, prema mogućnosti očnjaka (kutnjaci i pretkutnja- ci također su se koristili). Metoda je bila posebice uspješna kod djece i žrtava s vrlo malo ili bez ika- kvih stomatoloških podataka, ili ako se nisu mogli dobiti otisci prstiju.

Nakon dugog selekcijskog postupka obavljena je DNK-analiza u Međunarodnom laboratoriju (ICMP - International Commission of Missing Persons) u Bosni. Njegov je zadatak bio da za Ujedinjene naro- de identificira žrtve rata u toj državi.

Otisci prstiju

Identifikacija prema otiscima prstiju bila je vrlo važna, posebice kod žrtava lokalnoga podrijetla. Naime, nakon određene stanke mjerodavna su tijela omogućila pristup službenim otiscima tajlandskih žrtava (otisak kažiprsta na osobnoj iskaznici).



DNA analysis

Initially it was believed that the victims of the tsunami catastrophe could only be identified by DNA analysis. In fact, DNA analysis proved to be problematic because the muscles of the victims de- composed rapidly at the high temperatures. Further- more, initially the laws in Thailand prohibited the dispatch of parts of corpses from the country; these include DNA samples. The large quantity of sam- ples, the high cost of their analysis, and finding a laboratory that could process the large numbers of samples with a high rate of success were further hin- drances. The identification procedure could be offi- cially started only after these issues had been clari- fied with the authorities in Thailand and a suitable DNA laboratory had been found. Therefore, cur- rently the rate of identification achieved with this method is not in line with the actual potentialities of the method (6). Ten centimeters of bone from the femur, 10 cm of rib, and two teeth, preferably canines (molars and premolars were also used initially), are taken as samples by the limited internal forensi- c autopsy. The method is particularly successful in chil- dren and victims for whom little or no dental infor- mation and/or no fingerprints are available.

After a long selection process, DNA analyses are being performed by the ICMP (International Com- mission of Missing Persons) in Bosnia. This organi- zation runs a laboratory in Bosnia and was original- ly established by the UN to identify victims of the war in Bosnia.

Fingerprints

Identification by fingerprints, particularly in the case of local victims, has gained importance. After a certain delay, the officially registered fingerprints of Thai victims (index finger on the identity card) are being provided by the authorities.

Slika 6. Oljušteni dermalni vrhovi prstiju za ispitivanje otisaka

Figure 6 Stripped dermal fingertips for the fingerprint investigation.

Suprotno očekivanjima, otisci vrlo dobre kvalitete mogli su se dobiti i nakon dugog razdoblja poslije smrti. Čak su se i ljuštili dermalni otisci s vrhova prstiju (Sl.6.), a korisni su podaci dobiveni i kratkim prokuhavanjem vrhova prstiju.

Taj je način omogućio identifikaciju mnogih domaćih žrtava, dakle, Tajlandčana za koje nije bilo opširijih antemortalnih zubnih datoteka.

Rezultati

Različite su metode dale različite stope identifikacije u razdoblju od tri, sedam i jedanaest mjeseci nakon podmorskog potresa.

Krajem ožujka godine 2005. (tri mjeseca nakon katastrofe) identificirana je 951 žrtava, i to 837 (88%) na temelju zubnih kartona i 57 zahvaljujući otiscima prstiju.

Krajem srpnja 2005. identificirano je 2020 žrtava - 1097 (54%) isključivo prema zubnom statusu, a 331 (16,6%) kombinacijom zubnog statusa i drugih oblika. Ukupno 1428 (70,7%) identifikacija obavljeno je na temelju žrtvina zubnog statusa, a 367 prema otiscima prstiju.

Dana 13. studenoga godine 2005. (Sl. 7) bilo je registrirano ukupno 2679 žrtava - 1105 prema zubnom statusu i 346 kombinacijom zubnog statusa i drugih metoda. Sveukupan broj žrtava identificiranih prema zubnim kartonima iznosio je 1451. Dentalne su identifikacije činile 54,16% ukupnog broja identifikacija. Ukupan broj identificiranih (2679) činilo je 886 Tajlandčana i 1793 stranca. Nismo imali podatke o diferencijaciji identifikacijskih metoda za Tajlandčane i ne-Tajlandčane.

Treba istaknuti da se svaki dan mijenjao broj stradalih prema podacima Ureda za statistiku TTVI-IMC-a, jer je bilo vrlo teško doznati točan broj poginulih zbog velikoga broja žrtava i nasumičnog razaranja.

Rasprava

Događaj u Phuketu u Tajlandu istaknuo je značenje identifikacije i rad forenzičnog stomatologa, u usporedbi s DNK analizom, te je tako vraćena važnost tim stručnjacima.

Identifikacija na temelju stomatoloških podataka vrlo je uspješna, pouzdana i brza.

Kvaliteta antemortalnih podataka jedini je pravi parametar. To dokumentiraju različite stope uspješnosti postignute kod žrtava Tajlandčana i ne-Tajlandčana. Zbog slabe dostupnosti AM-dentalnih podataka kad je riječ o tajlandskoj populaciji, stope

Contrary to expectations, fingerprints of very good quality could be obtained after a long period of time post mortem. Even the stripped dermal prints of the fingertips (Fig. 6) or brief boiling of the fingertips yielded usable fingerprints.

This permits identification of many Thai victims for whom we lack extensive AM dental records.

Results

The various methods yielded different rates of identification at three, seven and eleven months after the seaquake.

At the end of March 2005 (three months after the seaquake) 951 victims had been identified, 837 (88%) by their dental status alone and 57 by their fingerprints.

At the end of July 2005, 2,020 victims had been identified: 1,097 (54%) by their dental status alone and a further 331 (16.6%) by a combination of their dental status and other methods. In all 1,428 (70.7%) identifications were based on the victims' dental status while 367 were identified by their fingerprints.

On November 13, 2005 (Fig. 7) we had registered a total of 2,679 victims: 1,105 by their dental status and a further 346 by a combination of their dental status and other methods. In all 1,451 victims were identified by their dental status. Dental identifications accounted for 54.16% of the total number of identifications. The total number of identifications (2,679) consisted of 886 Thai and 1,793 non-Thai victims. We had no data concerning differentiation by ID methods for Thai and non-Thai victims.

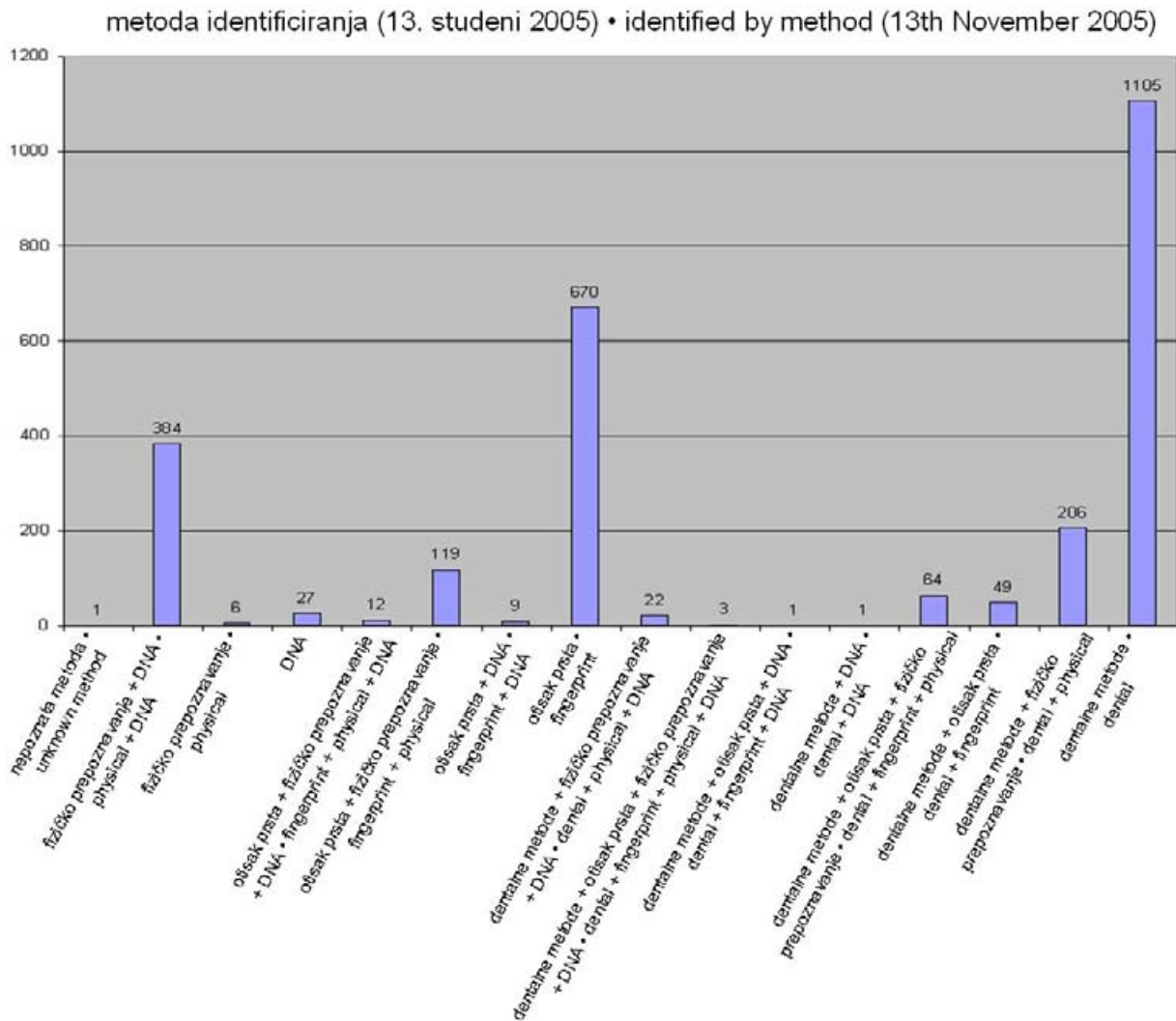
It should be mentioned that the victim counts differed daily at the TTVI-IMC statistics office because it was difficult to maintain accuracy, given the large number of victims and the random nature of the destruction.

Discussion

This incident at Phuket/Thailand showed that the identification of victims by the forensic odontologist has regained importance compared to DNA analysis.

Identification based on dental information is a highly efficient, reliable and rapid procedure.

The quality of AM data is the only real 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, the ID rates by this procedure are not high.



Slika 7. Identifikacijski status dana 13. studenoga 2005. Ukupan broj identifikacija je 2679, 1105 uz pomoć zubnoga statusa, a 346 kombiniranim i drugim metodama; sveukupno 1451 (54,16%) zubnim statusom.

Figure 7 ID status of 13 November 2005. Total number of ID 2679, 1105 by dental status and 346 in combination with dental status and other methods; in all 1451 (54.16%) by dental status.

identifikacijskih podataka postignutih tim načinom nisu bile visoke.

Antemortalni podaci o liječenju, poput onih dobivenih ugriznim i periapikalnim rentgenskim snimkama, ortopantomogramima i kartonima liječenja te sadrenim modelima, vrlo su važni, jer samo recentni visokokvalitetni AM-podaci omogućuju brzu i točnu identifikaciju. Ako su podaci šturi ili stari, istražitelj se mora poslužiti svim dostupnim metodama, uz pomoć iskusnog forenzičnog stomatologa kako bi se postigli pouzdani rezultati.

No, uporaba te metode ograničena je na djecu s rotacijom zuba i na adolescente s vrlo malo zubnih intervencija, točnije na one bez ikakva zubnog liječenja i dentalnih rentgenskih snimki te na bezube osobe.

AM dental treatment data such as those provided by bitewings and periapical radiographs, OPTG and treatment records as well as plastercast models, are very significant because only recent AM data of high quality allow rapid and reliable 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 in order to achieve reliable results.

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

The quality of PM data, on the other hand, is better, except in cases of destruction or loss of teeth or

S druge strane, kvaliteta postmortalnih podataka bila je bolja, osim u slučaju uništenja ili gubitka zuba ili dijelova čeljusti, jer ti podaci daju komprehenzivne i standardizirane dokaze o trenutnom stanju denticije pojedinca. PM-podaci mogu se pribaviti snimanjem šest periapikalnih i dva bitewing rentgenograma te fotografija frontalnog aspekta, bočno s objiju strana i s okluzalnog aspekta.

Zbog DNK-analize istražitelji su ekstrahirali 10 centimetara humerusa i rebra te dva zuba. Najbolji zub za DNK-analizu je očnjak, jer je u većini slučajeva najbolje sačuvan, najvitalniji je i ima veliku pulpnu komoru (6). Kod molara, posebice kod šestice, pulpna je komora veća. No, kako ti zubi rano niču, često su podvrgnuti stomatološkom liječenju, punjenju kanala, ili čak potpuno nedostaju. Vađenje kutnjaka, a oni su vrlo važni u identifikaciji, onemogućilo bi postmortalne istrage.

Softver DVI International Systemsa (Plass Data Software, Danska), koji se koristio u detekciji sličnosti među podacima, neprestance se poboljšava, čime je olakšan postupak identifikacije. Moramo ponovno upozoriti na veliko i vrijedno iskustvo stečeno u toj katastrofi. Ipak, ograničavajući je čimbenik taj što je potrebno previše različitih zaporki u opisu zubnoga statusa. Softver Win ID3 (James McGivney, St.Louis, SAD) traži manje od 20 zaporki. Kako su one na DVI International Systemsu visoko specifične, vrlo je velika mogućnost pogrešne interpretacije. Još nešto treba uzeti u obzir kod WinID3, naime, taj je program besplatan.

Mrežno utemeljen softver "DAVID" ID razvili su australski stručnjaci (7). Godine 2005. taj softver još nije bio završen. Program je unaprijeđen i dovršen 2006. Nakon što su se shvatile poteškoće stomatologa poslije cunamija, rabio se softver DVI Systems Internationala. David je mrežni program koji se može koristiti bilo gdje u svijetu, na bilo kojoj računalskoj platformi te će biti dostupan kao besplatan.

Daljnji podatak koji moramo istaknuti jest jasno obilježavanje žrtava (7-10). Zbog vrlo stresnih okolnosti na početku obrade, žrtve su djelomice obilježavane neujednačeno, a više puta koristili su se različiti sustavi numeriranja. Kasnije se to uskladilo. Naime, Interpol u Lyonu i Odbor za identifikaciju žrtava cunamija (Standing Committee on Disaster Victim Identification) odredili su smjernice za davanje zaporaka žrtavama (11,12). Tako su antemortem zaporke počinjale međunarodnom zaporkom žrtvine matične zemlje, a one postmortem imale su međunarodnu telefonsku zaporku zemlje iz koje potječe ekipa koja je obavljala autopsiju.

parts of the jaw because PM data provide a comprehensive and standardized account of the individual's current dentition. PM data should be obtained by performing six periapical and two bitewing X-rays and photographs of the frontal aspect, from both sides, and from the occlusal aspect.

For DNA analysis the investigators extracted 10 cm of the humerus and rib, and two teeth. The most suitable tooth for DNA analysis is the canine because it is preserved in most cases, is most vital, and has a large pulp chamber (6). In molars, particularly the 6th molar, the pulp chamber is larger. As these teeth erupt early, they are very frequently subjected to dental treatment, root filling, or may even be entirely absent. Extraction of the molars, which are very important teeth for identification, would render follow-up investigations impossible.

The DVI International Systems software (Plass Data Software, Denmark) which is used to detect concurrences and thus facilitate the identification procedure, is being continuously improved. Here again, the enormous experience gained from this catastrophe is of great value. However, one limitation is that far too many codes are used to describe the dental status. The WinID3 software (James McGivney, St.Louis, USA) uses less than 20 codes to describe the dental status. As the DVI International Systems code is highly specific, the risk of misinterpretation is very high. A further aspect to be considered is that WinID3 is freeware.

The web-based "DAVID" ID software was developed by an Australian group (7). This software had not been fully developed in 2005. In view of the post-tsunami problems encountered by odontologists who were obliged to use the DVI Systems International DAVID, the program was upgraded and completed in 2006. DAVID will be a web-based program for use anywhere in the world, on any computer platform, and will be made accessible as freeware.

A further aspect worth mentioning is clear labeling of the victims (7-10). Due to the highly stressful circumstances at the beginning of the catastrophe the victims were, in part, labeled in a non-uniform fashion and also labeled several times using different numbering systems. This led to significant additional organizational effort later on. Therefore, the Interpol in Lyon and the Standing Committee on Disaster Victim Identification established international guidelines for victim codes (11,12). AM codes start with the international telephone code of the victim's native country while PM codes start with the inter-

Korištenje uređaja s radio-frekvencijom (RFID - Radio Frequency ID) - mikročipova, predmet je vrlo čestih rasprava u objavljenoj literaturi. Mikročipovima se koriste veterinari u identifikaciji životinja. Jedna je belgijska skupina opisala ugradnju RFID-mikročipova u kutnjake (13). No, ta eksperimentalna metoda imala je stopu neuspjeha od 10%. Podaci iz dugoročnog praćenja pod žvačnim opterećenjem za čipove ne postoje, a oni se ne mogu ugraditi u zube s velikom pulpnom komorom ni blizu okluzalne površine. Na temelju etičkih razmatranja, uporaba te metode ograničena je na vojnike ili na specifične skupine.

Meyer i suradnici (13) opisali su ugradnju mikročipa postmortem ispod kože ili u maksilarnu sinuse. Čini se da je to korisna mjera u obilježavanju žrtava. Ipak, najveća udaljenost prijma emitiranoga signala od 15 centimetara, ili 60 centimetara uz tzv. PowerTracer, učinila je tu metodu neprikladnom za naše potrebe.

Taj sustav ne može nadomjestiti vizualno obilježavanje. Jedan se njegov oblik sastoji od žutih plastičnih oznaka za uho žrtve i to s utisnutim brojem kakav se koristi u stočnoj industriji. Takva je oznaka otporna na kemijsko i biološko djelovanje, a može se rabiti na bilo kojoj lokaciji s truplima ili čak i na vrećama za mrtva tijela.

Trajanje postupka identifikacije također je vrijedno spomena. Tijekom prvih triju mjeseci nakon katastrofe, identifikacija prema zubima iznosila je visokih 88% svih identifikacija. Taj se postotak nakon toga ravnomjerno smanjivao. Tada su na važnosti dobili drugi oblici identifikacije, poput onih prema otiscima prstiju. S vremenom je bilo sve više žrtava identificiranih prema dvjema metodama ili više njih. Na početku je identifikacija pomoću zubnog kartona davala najbrže rezultate, jer je na mjestu katastrofe bilo mnogo forenzičnih stomatologa, a antemortalni zubni podaci bili su im najprije dostupni (11, 12, 14). Nakon cunamija bilo je teško dostaviti AM-podatke u područje katastrofe, zbog rijetkih letova zrakoplova. Kanadska je ekipa razvila tehniku prijenosa tih podataka i rentgenskih snimki na PDF-privitku na više stranica (15), tj. uz pomoć internetskih datoteka. Taj se način pokazao korisnim u prijenosu podataka u područja zahvaćena elementarnom katastrofom i s uništenom infrastrukturom.

Druge metode tek treba analizirati. Antemortalni i postmortalni podaci, uključujući i AM-otiske prstiju te uzorke DNK, tek se trebaju prikupiti. Potrebno je steći i dostatno iskustvo prije rutinskog korištenja te metode za identifikaciju.

national telephone code of the country whose team performs the autopsy.

Implantation of a radio-frequency identification device (RFID) – a microchip – has been extensively discussed in the published literature. RFID microchips are used by veterinarians to identify animals. One Belgian group described the implantation of a RFID microchip in the molar (13). This experimental method was associated with a 10% failure rate of RFID microchips. Long-term data under chewing conditions do not exist and the RFID chip cannot be implanted into teeth with a large pulp chamber or close to the occlusal surface. Based on ethical considerations, the use of the method is limited to soldiers or specific groups.

Implantation of a RFID microchip post mortem below the skin or in the maxillary sinuses was described by Meyer et al. (13). It appears to be a useful measure for tagging victims. However, the reading distance of 15 cm, or 60 cm using a so-called PowerTracer, is inadequate for our purposes.

This system cannot replace a visual labeling system. One such system consists of using yellow plastic earmarks with a branded number, such as that used to mark cattle. This mark is resistant to chemical or biological influences and may be introduced at any body site or even on the bag of the corpse.

The temporal course of identification by the various methods is also worth noting. During the first three months after the catastrophe, identification by teeth constituted as many as 88% of the total identifications. This percentage reduced consistently thereafter. Other methods such as identification by fingerprints gained importance. With time, an increasing number of victims were identified by two or more methods. Initially, identification by dental status was the method that yielded the fastest results because a large number of forensic odontologists were present on site, and AM dental data (11, 12, 14) could be procured rapidly. After the Tsunami it was difficult to bring dental AM records into the region of the catastrophe because flights were scarce at this time. The Canadian team developed a technique to transmit AM dental data such as X-rays and dental records by multi-page PDF files (15). This method is useful to transmit data into regions of catastrophe with a destroyed infrastructure.

Other methods will have to be tested. AM and PM data, including AM fingerprints and DNA samples will have to be collected. Adequate experience will have to be gained before these methods can be routinely used for the purpose of identification.

Mogućnost imerzije vrhova prstiju u kipuću vodu, dala je kvalitetne otiske i nakon što je prošlo dosta vremena od žrtvine smrti. Takva učinkovita identifikacija mnoge je iznenadila. Tražili su se otisci prstiju žrtava iz njihove domovine, što je katkada bilo teško jer su više od mjesec dana bili odsutni od kuće. Kod žrtava tajlandske narodnosti, mnogo ih je identificirano prema otisku prstiju, jer su bili arhivirani kod mjerodavnih lokalnih tijela.

Identifikacija DNK analizom nije bila previše uspješna tijekom cijelog razdoblja (14). Otežavala ju je činjenica da se tijela, to jest neki njihovi dijelovi, nisu mogla transportirati izvan zemlje bez dopuštenja državnih službi. Brzi raspad mišića nametnuo je potrebu za drugim uzorcima iz kojih je teže izdvojiti DNK. Zatim, zbog odabira odgovarajućeg laboratorija koji bi mogao kvalitetno istražiti tolike količine uzoraka te cijene takvog ispitivanja, vodile su se dugotrajne rasprave među državama uključenima u cijeli postupak. Ta je metoda postala važna tek nakon što je Međunarodni odbor za nestale osobe u Bosni preuzeo cijeli postupak DNK identifikacije.

Prvih pet mjeseci nakon katastrofe bili su uspješni, jer su recentni antemortalni zubni podaci o nestalim osobama iz zemalja s dobrom infrastrukturom dentalne skrbi, bili uglavnom pristupačniji od ostalih podataka (10, 11, 15, 16).

S razmjerno manjim trudom pribavljene su ugrizne i periapikalne snimke žrtava te su omogućile forenzičnim stomatolozima brzu usporedbu s antemortalnim rendgenogramima, čime se došlo do nepobitnih dokaza. Dakle, identifikacijska metoda prema zubnom statusu dokazano je vrlo uspješna i učinkovita, što se potvrdilo nakon podmorskoga potresa u jugoistočnoj Aziji.

The possibility of immersing fingertips in boiling water yielded fingerprints of good quality even a long time after the victims had died. As a result, the efficiency of identification by fingerprint was a matter of surprise for many. The victims' fingerprints at home were actively searched for – a pursuit that proved difficult one month after the victims had left their homes. Particularly in the case of Thai victims, a large number could be identified by fingerprints because their fingerprints had been archived at the local authorities' offices prior to issuing their passports.

Identification by DNA analysis yielded low success rates during the entire period (14). Such identification was rendered difficult by the fact that corpses or parts of corpses could not be transported out of the country without the permission of the Thai authorities. Rapid decay of muscles required other samples, from which it was more difficult to extract DNA. Furthermore, the selection of a suitable laboratory that could investigate such quantities of samples in adequate quality, and the cost of such investigation, led to lengthy discussions between the countries involved. Only after the ICMP (International Commission of Missing Persons) in Bosnia had taken over the entire procedure of DNA-ID did this method start to gain importance.

The first five months after the catastrophe were particularly successful because recent AM dental data of missing persons from countries with a good infrastructure for dental care were, in general, more easily available than any other information (10, 11, 15, 16).

Relatively less effort was needed to obtain bite-wings and periapical radiographs of the victims, and forensic odontologists were able to compare them rapidly and easily with the AM X-rays and thus provide conclusive evidence. Therefore, the ID method by dental status proved to be extremely successful and efficient after the seaquake in South-East Asia.

Abstract

In December 2004 a seaquake and its resulting tidal wave devastated large coastal regions in the Indian Ocean and cost about 250,000 human lives. **Material and Methods:** In order to identify more than 3,680 victims from 39 nations in the area of Phuket/Thailand under Interpol's coordinated efforts, more than 20 countries participated in the identification process at the Thai Tsunami Victim Identification – Information Management Center (TTVI-IMC). Standard operating protocols of post mortem (PM) procedures were established. The ante mortem (AM) data of the victims were sent to Thailand and entered into the software program DVI System International (Plass Data Software, Denmark). **Results:** Registration of post mortem data (PM), such as primary identification characteristics, as well as clothing and physical features (e.g. scars), was performed in a highly standardized manner directly at Phuket/Thailand. Ante mortem data (AM), including information about dental treatment (miniature radiographs, OPTG and treatment chart) were given particular attention. Only recent AM data of good quality permitted rapid and reliable identification of the victims. After one year the dental ID rate of about 55% proved the significance of the method. Of the 3680 officially registered victims who had died, 3272 could be identified. This equals an identification rate of 87.77%, of whom 44% were identified by their dental status. **Conclusion:** Ninety-two per cent of the approximately 2,050 non-Thai victims, and 53% of the 1600 Thai victims, were identified. Thus, the overall ID rate per 22.11.2006 was 70%.

Received: July 29, 2007

Accepted: October, 16, 2007

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Key words

Forensic Dentistry; Dental Identification;
Natural Disasters

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