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Rapid communication

Implantation of radio frequency identification device (RFID) microchip in disaster victim identification (DVI)

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Abstract

The tsunami catastrophe of December 2004 left more than 200,000 dead. Disaster victim identification (DVI) teams were presented with the unprecedented challenge of identifying thousands of mostly markedly putrefied and partially skeletised bodies. To this end, an adequate body tagging method is essential. Conventional body bag tagging in terms of writing on body bags and placing of tags inside body bags proved unsatisfactory and problem prone due to consequences of cold storage, formalin (formaldehyde) embalming and body numbers inside storage facilities. The placement of radio frequency identification device (RFID) microchips inside victim bodies provided a practical solution to problems of body tagging and attribution in the DVI setting encountered by the Austrian DVI team in Thailand in early 2005.

Keywords: Tsunami; DVI; Body tagging; RFID; Microchip

1. Introduction

The tsunami catastrophe of December 26, 2004 in Asia resulted in an unprecedented number of dead bodies having to be processed by disaster victim identification (DVI) personnel. DVI efforts took place, amongst others, in and around Phuket, Thailand, in January 2005. Apart from the challenges presented by the identification process itself, the absolute number of recovered victims in Thailand, for example, was quoted to be 5187 on January 4 by Thai sources and 6337 on February 26 [1] (no final numbers available at publication). This alone required an identification and tagging system to enable processed bodies to be located for repatriation in their various places of storage once their identity was established in the following weeks and months. It was noted that conventional tagging procedures were not always as reliable as required. Among others, it was discovered that (waterproof) felt tip pen markings on white plastic body bags were not always permanent, possibly due to a relevant number of bodies being embalmed with formalin (formaldehyde solution) and antiseptic (Lysol solution), this in turn leading to dissolving of writing on body bags. Furthermore, due to the large numbers of bodies, an orderly storage method was not always possible and bodies had to be stored in close proximity to one another in cold storage, making it virtually impossible to reach and read the lettering on the body bags. It was also decided by local authorities to bury bodies in mass graves, with the option of subsequent exhumation for repatriation or re-identification purposes. Although graves were shallow, definite identification was only possible by digging up the body bag in question, opening it and finding the

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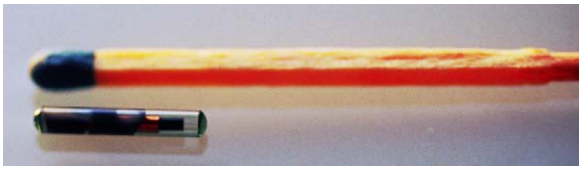

Fig. 1. RFID chip, match included to provide scale.

number tag, which should be inside every body bag according to standards of international DVI.

It was decided to place RFID microchips into the bodies at hand. The available literature contains no reports of this method being applied to dead human bodies in a DVI setting (or otherwise) for tagging and re-identification purposes before. The technical details of RFID tagging for purposes of supply management [2], live wild and domestic [3] animal tagging and waste recycling [4] are well documented. Reports on the feasibility of RFID implantation in living humans [5] as well as identification of human appendages [6] are in existence. No reports on RFID applied in DVI settings were found in the available literature.

2. Materials

The RFID (referred to in the following as ''microchip'') system used (AVID Microchip, Norco, USA[1]) supplied by Pettrac (Bangkok, Thailand) consists of a passive and low-frequency (around 125 kHz) RFID transponder (length 12 mm) (Fig. 1) with an operating temperature range of −16 to 80 °C, a hypodermic application system (12 gauge needle with internal plastic ejector rod, Fig. 2) and a battery-powered mobile reader (Fig. 3) capable of reading AVID, Facavachip and ISO microchips and displaying up to 16 ASCII characters custom programmed into the microchip. Reading distance is up to 15 cm with 12 mm microchip (extendable up to 60 cm by modification of reading apparatus AVID Power Tracker II). The size and structure of the components involved ensures complete mobility and practicability in the field even under adverse conditions such as those encountered by the Austrian DVI team when examining bodies in Thailand (outdoors working area, high heat and humidity, no running water).

The data coded on the chip can be structured entirely according to the client's individual requirements (up to the possible maximum of 16 characters), but usually would consist of a series of unique identification numbers, for example, those recommended for use by Interpol in DVI settings.

[1] American Veterinary Identification Devices (AVID).

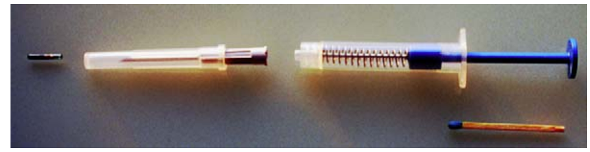

Fig. 2. RFID chip, injection system.

3. Method

The bodies processed had undergone marked to severe putrefaction. In some cases, the skull and other anatomical regions were partly skeletised. In order to prevent chip loss once complete skeletising would be setting in, an area of placement was chosen in which the chip was expected to be lodged firmly inside cranial structures. The maxillary sinus seemed most suited for this purpose and the majority of chips was ultimately placed here. Thus, it was attempted to place the chip into this anatomical region by puncturing the floor of the orbital cavity with the syringe and placing the chip inside the sinus with the injector. However, this was not possible in all cases since the bony floor of the orbital cavity could not always be successfully punctured with the needle, the needle being irreparably bent in some cases.

The region anterior of the sphenoidal sinus (ethmoidal sinus region) was chosen as an alternative placement site in these cases, with placement inside the ethmoidal region or the ethmoidal sinus cells as deep as the needle would allow. During application, orientation of the injector was in a medial and posterior direction. The chosen access route ran through the medial orbital wall, since the thin bone in this region facilitates access to the ethmoidal cells by direct puncturing through the orbit with the needle. This region was chosen as it was hoped that the chip might lodge between adjacent surfaces of the labyrinthine bony structures found here, preventing loss of the chip once soft tissue had completely putrefied and only the bony skull remained.

Fig. 3. PowerTracker II RFID chip reader.

To verify that the chip was operational, a scan by hand scanner was performed immediately after placement of the chip by means of the battery operated hand scanner MultiTag, and later Avid PowerTracker II. After processing, with the body inside the plastic body bag, another scan was performed.

Initially, the cheaper and more portable MultiTag scanner was employed, since it was expected to yield reliable results in the setting at hand. When it was discovered that this scanner did not have sufficient scanning range once bodies had been placed in storage bags, the more costly and bigger Avid PowerTracker II scanner was employed exclusively from then on.

4. Results

In the initially applied format, the microchip was intended for subcutaneous implantation in animals for in vivo identification purposes. Due to its superficial location, low energy scanning procedures were feasible. Typically, maximum successful scanning distance with the initially employed hand scanner was 6 cm.

It was discovered that the chip could be decoded when the body was exposed, but once it had been placed inside the body bag (usually with additional material such as textile coverings), decoding was no longer possible with the MultiTag scanner. This was due to the deep location in the facial skeleton and the additionally applied body swathing and body bags, with the chip then being located beyond the 6 cm reach when the scanner was applied from outside the body bag. The Avid PowerTracker II scanner with a higher energy output was employed, yielding positive reading results in all cases. This scanners' range was specified as being 26 cm (extendable up to 60 cm) by the manufacturer when applied to the chip employed here, which correlates well with the results obtained in practice. The chip could be located and decoded in all cases when applying the Avid PowerTracker II scanner.

The initially chosen storage temperature of $-18\,^{\circ}C$ inside containers had no adverse effects on readability of the RFID chips, with chips being readable in all cases. It was, however, discovered early on in the DVI process that $-18\,^{\circ}C$ led to physical deterioration of plastic storage bags and temperature inside containers was globally set at $-10\,^{\circ}C$ subsequently, with no adverse effects on readability.

5. Discussion and conclusion

In cases such as the Tsunami catastrophe, large numbers of dead bodies accumulate within days and have to be stored and later processed according to DVI procedures [7,8]. Both during storage and after processing, adequate tagging is essential in order to make a consolidation of records, findings and bodies possible. To this end, custom forensic database structures [7] should be in place and functional.

Due to the unorderly accumulation and storage of bodies, written numbers on body bags tend to become obliterated and illegible. Furthermore, tags inside body bags are virtually inaccessible once bodies go into cold storage below $0\,^{\circ}C$ due to freezing of the contents as well as multilayer pile-up inside cold storage. Tags are also virtually inaccessible once bodies are buried, more so in mass graves than in single graves. Formalin (formaldehyde) embalming of bodies in combination with liquefied fat leakage led to supposedly permanent written identification on body bags becoming illegible.

Placing a microchip preferably inside the skull (or any other anatomical region agreed upon beforehand) ensures that this unique identification tag is seated securely in the body and also enables processing personnel to identify processed and stored bodies by their uniquely allocated number.

Beyond this, it ensures that processing personnel can cut short the time having to be spent inside cooling containers (inside temperature set to $-18\,^{\circ}C$ and in some cases high gaseous formaldehyde concentrations) when searching for and retrieving tagged bodies.

It is recommendable to use conventional tagging procedures in DVI settings with manageable amounts of dead bodies in good or average condition. In cases with advanced putrefaction of bodies as well as with formalin embalming of relevant numbers of bodies (or a combination of both), and in cases of cold storage of very large numbers of bodies (as was the case in Thailand in January 2005), the employment of microchip tagging and subsequent attribution and mapping is highly desirable. It is also of note that the life expectancy of the chip is given as being 75 years by the manufacturer.

Competitive pricing of the necessary equipment makes this method attractive even in settings with thousands (or more) dead bodies on hand for DVI processing.

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