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Preservation of dental evidence following exposure to high temperatures☆

Anthony J. Hill [a,*], Russell Lain [b,c], Ian Hewson [d]

[a] Victorian Institute of Forensic Medicine and the Department of Forensic Medicine, Monash University, 57-83 Kavanagh Street, Southbank, Vic. 3006, Australia
[b] Oral Surgery and Diagnostic Imaging Department, Sydney Dental Hospital, Sydney, Australia
[c] Department of Forensic Medicine, Glebe, Australia
[d] Director Dental Services, Alfred Hospital, Victoria 3181, Australia

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ABSTRACT

The success of the Disaster Victim Identification (DVI) process relies upon sufficient post-mortem data being recovered to allow for a meaningful comparison with ante-mortem records of the missing person. Human bodies subjected to prolonged high temperatures, as experienced during the Black Saturday bushfires in Victoria, are often reduced to fragile skeletal elements. The dental structures, however, are the most durable tissues of the body and often survive these prolonged high temperatures. Without protecting the fragile remains at the scene and during transportation to the mortuary, disruption of the skeletal and dental elements may occur. This disruption will result in difficulties in obtaining post-mortem evidence and lead to problems during the reconciliation (formal identification) phase of the investigation. In the two case reports presented to illustrate these problems, there was significant loss and degradation of dental structures at the scene and during transportation to the mortuary. In the first case described, where no protection was afforded to the remains, total loss of all anatomical dental structures occurred. In the second case, where protection of the structures was undertaken, vital dental evidence was preserved. As a result of the experience in this particular DVI incident, where remains were exposed to prolonged high temperature and physical damage, new protocols have been formulated. Adherence to these protocols will maximise the recovery and preservation of dental evidence at the scene and during transportation to the mortuary.

1. Introduction

On Saturday the 7th February 2009, the State of Victoria experienced the deadliest bushfires recorded in its history. Temperatures in the preceding days reached 46.4 °C with winds reaching speeds in excess of 115 k/h [1]. According to the Bureau of Meteorology Fire Danger Index, 50 was rated extreme. The Index on February 7th was recorded as 180 [2]. On the Saturday high temperatures, strong winds and extreme local factors created a firestorm which resulted in 173 fatalities. One million acres of land were ravaged, 3500 structures were destroyed and 760 motor vehicles were reduced to burnt out shells [3,4]. It has been estimated that temperatures in some locations of this fire-storm reached over 2000 °C and many of the fire scenes smouldered for days.

Many of the victims of the fires perished in their homes or vehicles as they sought shelter from the intense heat or attempted to flee the inferno. Due to the vast area of the fires and the difficulty experienced by fire-crews in gaining access to some areas, the fires were not extinguished for many hours, often days. As a consequence, some of the bodies were subjected to prolonged high temperatures and in many cases were reduced to extremely fragile skeletal elements [5,6].

Due to the fragmentation of the bodies and the difficulty in recognising body parts at the scene, many sets of remains, during the initial searching, were not completely recovered. Once it became obvious at the mortuary that the remains were not complete, the police scene coordinator was informed, the scene revisited and re-searched. In many instances, total recovery of all remains still did not occur and a further revisit of the same scene was required [7]. It is unreasonable to expect police personnel, untrained in the recognition of body parts, to deal with such remains. It is also unreasonable to expect untrained police personnel to understand the complexity of a scene which contains possible co-mingled remains [8]. The decision to call for expert assistance when applicable, from trained odontologists, pathologists, anthropologists and mortuary technicians early in a scene

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* Corresponding author. Tel.: +61 3 9684 4431; fax: +61 3 9682 7353.
E-mail address: anthonyh@vifm.org (A.J. Hill).

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Table 1
Protocols for preservation of dental structures during recovery.

The remains should be examined at the scene by a forensic odontologist and photographed in situ, before the body is disturbed. Each photograph must include the unique DVI number associated with the deceased person and a scale should be present within the photograph.
Proper and careful exposure of the head and dental structures should be carried out, with all fragile structures being cemented together with cyanoacrylate or a similar substance.
Any dental structures which cannot be reattached should be carefully collected, numbered, photographed, placed in a padded container and appropriately labelled.
Once the head and dental structures have been stabilised they should be wrapped in sufficient plastic protective cover to afford protection and preservation during scene handling and transportation.

investigation would have enabled optimal post-mortem recovery of remains.

Each new body part that was recovered at a scene revisit was assigned a new DVI number. As part of the identification process, an attempt was undertaken to re-associate each body part with a fragmented body portion. This re-association relied upon expertise from odontologists, pathologists, anthropologists, molecular biologists and police. With earlier utilisation of this team of experts identification may have been achieved in a more timely and complete manner.

Teeth and dental structures are durable under extreme conditions of prolonged, high temperatures. This allows for the preservation of both complete dental elements and also small fragile remains from which vital evidence could be obtained. Teeth can be heated to temperatures approaching 1600 °C without appreciable loss of structures [9]. Crowns of teeth will often shatter at extreme temperatures due to the increase in pressure in the matrix of the enamel and dentine as moisture evaporates. The roots of the teeth contain less moisture, are not encased in enamel and are protected by there position within the bone. They are most likely to remain. Crowns with restorations may survive as the prepared filling area may act as a vent to release pressure. Complete dentures, partial dentures and some portions of dental prostheses may simply remain as metal fixtures on which the prosthesis was constructed [10,11].

In cases of fragmentation or incineration, stabilisation and protection of these structures must occur if vital evidence is not to be lost. In all cases this will require full wrapping protection to the fragile structures at the scene, prior to transportation to the mortuary; smaller elements will require placement in specimen jars with appropriate labelling and padding. This approach has been suggested by Griffiths and Bellamy, although these workers focussed on what could be described as 'routine' cases of incineration and had less emphasis on the inclusion of trained odontologists, pathologists or anthropologists at the scene [12].

It is essential during the recovery phase of the DVI process that a thorough search of the scene is undertaken and all body parts identified, recorded, photographed, collected and labelled. Human body parts and very small dental structures, when they are dislodged from their anatomical position and subject to incineration, can be completely overlooked by the untrained investigator. The presence of an expert odontologist can prove an invaluable assistance to investigating police units during this taxing task [13–15]. The failure to collect all post-mortem dental evidence will complicate and delay identification of the deceased.

2. Protocols followed during the Victorian Bushfires

It was established during recovery operations, as part of the Standard Operating Procedures, where possible, medical, dental and anthropological expertise would be called to the scene to assist police units in the identification and documentation of human remains. Where scenes were attended by trained and experienced forensic odontologists, the head and neck region of the deceased was surrounded and secured with a plastic protective wrap before removal from the scene. Fragile structures were stabilized with cyanoacrylate whenever possible. It was felt that this form of protection would preserve the fragile remains until detailed examination was undertaken at the Victorian Institute of Forensic Medicine (VIFM). Whilst it was realised that the protection of these fragile remains could not ensure total preservation, the wrapping ensured that any fractured elements were confined within the wrapping material. The time involved in searching for the dental structures lost during the body movement and transportation was thus greatly diminished. Bony fragments of mandible and maxilla, coronal portions and root fragments of teeth, isolated synthetic crowns and bridges were quickly located within the wrapping material without the necessity to completely search the entire body bag or wet sieve the entire contents to locate these delicate structures (Table 1).

The body bags were transported to the mortuary, a distance of between 35 and 70 km, depending upon the scene site. The body bags were not afforded any additional protection during their transport. They were laid unprotected in the rear of the transport vehicle. The roads between the scene and mortuary were a combination of paved city streets and pot-holed and rutted country roads. Normal movement of the transport vehicles caused the body bags to shift and some damage occurred. Protection of each individual body bag by use of individual caskets or padding protection would have been costly, time-consuming and would have delayed the DVI process.

The following case reports illustrate the necessity for correct preservation of deceased remains during the recovery process at the scene and transportation of the remains to the mortuary. The difficulties resulting from the loss of any material and the impact that such loss has on the reconciliation phase of the DVI process are also illustrated.

3. Case 1

The remains of a deceased person were found in a completely burnt building (Fig. 1). The scene photographs taken at the time of discovery of the deceased clearly show the anterior mandibular

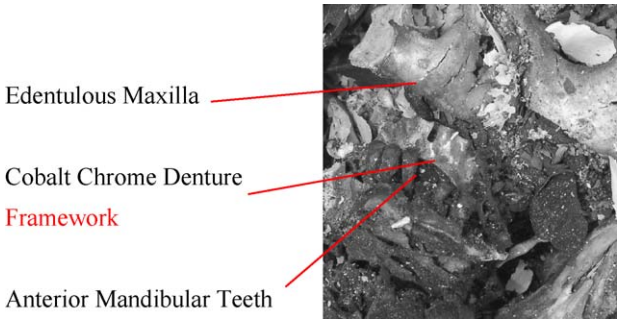

Fig. 1.