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Stabilisation of dental structures of severely incinerated victims at disaster scenes to facilitate human identification

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ABSTRACT

Fatalities due to fire events such as bushfires, domestic and industrial fires and vehicle accident related incineration, leave victims with limited prospects of being accurately identified. Due to their morphology and anatomical position teeth are uniquely protected in incineration cases and via comparison to dental records often provide the only scientifically valid means of identification. However, extreme heat and direct exposure to flame can render the teeth extremely fragile and vulnerable to damage and loss especially during collection and transportation to the mortuary. Here we highlight the advantages of forensic odontology assistance at the scene of such events and discuss techniques and protocols applied to actual cases in which these processes were used to facilitate the identification of incineration victims.

1. Introduction

Identification of deceased victims is required for legal and ethical reasons.[1] In the case of severely incinerated victims identification is especially problematic as fire destroys physical evidence such as facial appearance, clothing, documents, tattoos, fingerprints, and hair.[2] Fire can also completely destroy soft tissues limiting available DNA and at very high temperatures DNA in skeletal elements can also be severely degraded.[3] Past history reveals that identification by dental comparison can be successful in these circumstances[4–8] however; the effects of heat also compromise dental postmortem information. Extreme heat can leave teeth, especially those in the anterior dentition, in an extremely fragile state susceptible to crumbling from only minor forces.[9,10] To maximise the collection of dental data and hence increase the likelihood of positive identification in these cases, the attendance of a trained odontologist at the scene prior to transportation of the body to the mortuary is advised. The odontologist is able to identify fragmented and displaced dental structures, stabilise fragile remains and in the case of extreme fragility perform examination and data collection prior to transportation. However, odontologists often receive little training in preparation for scene attendance and there is no or scant information in the published literature with regards to appropriate operating procedures. This paper discusses the potential effects of incineration on oral structures, methods to improve stabilisation of remains, and presents standardised operating procedures (SOP) developed for casework addressing preservation and collection of remains and health and safety for the attending odontologists.

2. Discussion

The effects of fire on teeth are particularly evident on the anterior dentition, which has less protection from soft tissues. The enamel crown of a tooth may separate from the body of the tooth if exposed to extreme temperatures[11] and surviving structures can become extremely fragile and susceptible to crumbling from even minor forces.[9,10] In the 2009 Victorian (Australia) bushfires, the fires were still burning after 4–5 h[12] and even after 24 h the temperatures recorded on some bodies were still at 600–700 °C.[13] Separation of tooth crowns lead to a loss of information for comparison with antemortem dental records. In these cases, root morphology placement and angulations, bony features, including sinuses, and anomalies provide the only information for comparison. Posterior tooth crowns while less likely to be lost often fracture, and may dislodge becoming wedged against the neighbouring or opposing crowns (Fig. 1). Loss of anatomical structures and

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Fig. 1. Posterior tooth crowns fractured and wedged against the neighbouring or opposing crowns.

dental restorations can occur not only during the fire event but also during lifting of the head, removal of the body from the immediate scene to the body bag and subsequent transportation to the mortuary.[10] In the 2011 Christchurch (New Zealand) earthquake, where incineration events occurred, a forensic odontologist was deployed with the police disaster victim identification (DVI) scene teams to assist with locating, securing and preserving dental and facial material for this very reason.[14]

Recommendations arising from the 2009 Victorian (Australia) bushfires, suggest that recovery procedures should not be commenced until after consultation with forensic medical/scene specialists, especially where comingling is a possibility.[15] Frequently, media and community pressure to recover all remains as quickly as possible occurs, but rushing the process of careful retrieval can often be self-defeating as evidence may be lost or damaged. Searching for the separated material and reconstruction for radiographic analysis at the mortuary creates delays for the relatives and increases doubt (as an opinion is now required on how this information is reconstructed).

Wrapping of the head of incineration victims prior to transportation can help retain and protect dental structures. When using plastic wrap for protection of the head, Hill et al. observed that less damage was sustained to the dental evidence and any dislodged remains were confined within the wrapped area.[16] Griffiths and Bellamy also suggested that the head should be protected with a shock-absorbent layer during transportation.[17] This however does not completely stop damage due to transportation or the pressure of the wrapping itself if it is not applied appropriately.

To improve the retention of dental material, stabilisation methods applied directly to the oral structures can be employed.[18,19] A number of methods for stabilisation have been reported in the literature,[20,21] including the application of a cement such as cyanoacrylate.[17] While this method is useful, cement is difficult to apply and it sets extremely rigid making separation of the jaws at examination difficult. Reviewing other methods of stabilisation, Grevin advocated the use of a glue gun [22]; Fairgrieve advocated the use of PVA water based glue [23]; whilst Mayne, Correia and Beattie suggested soaking bone fragments in diluted PVA for 1 min.[24] An adhesive that is safe to spray can more easily cover large areas. Fauzi highlighted the use of commercially prepared clear enamel gloss in a spray can (Dulux©, Melbourne, Australia),[25] however, volatile vapors emitted from the petrochemical spray may compromise a scene if testing for accelerants is required. Clag™ paste (wheat paste) has also been advocated; it can be diluted and applied as a spray.[26] This mixture is simple to use, readily available, non-toxic, easily portable, inexpensive, non-compromising to dental/radiographic examination and free of volatiles.[26] A study by Mincer et al. examined a number of different stabilisation methods and reported that in all cases, whatever materials was used, treated remains were better preserved than untreated remains.[18]

Since 2015 in South Australia, odontologists have been routinely deployed to the scene of severe incineration deaths. During the period 2015–2016 our odontologists attended a total of eight incineration scenes involving thirteen victims. Six of these scenes were vehicle accidents, one was a bushfire and the eighth case was self-immolation in a motor vehicle. Positive identification was facilitated by dental comparison for all but one of these victims. For the victim that was unable to be identified antemortem dental records were not available so dental comparison could not be performed despite the availability of substantial postmortem data. To facilitate routine attendance at scenes our team has developed a standard operating procedure (SOP), addressing occupational health and safety issues (OH&S), the selection of a stabilising agent and optimal workflow. These considerations are discussed below with reflection on the scenes attended. The SOP developed by our team is presented in Table 1.

2.1. Standard operating procedure (SOP)

Without training it is unlikely that all scene respondents would operate in the most efficient and coordinated way. A detailed SOP acts as a plan to maximise efficiency and ensure safety of all scene attendants. All members should read and understand the SOP before being placed on an oncall roster.[27] As with all forensic casework preservation of chain of evidence is vital. To facilitate this we advocate that a document outlining all events and considerations or issues (a running sheet) be created at the time of initial notification as memory lapses may occur. This also establishes a pattern of orderly behaviour.[28] The maintenance of a fully stocked scene bag including the premixed stabilising agent of choice considerably reduces preparation time, ensures that all items required are collected, and facilitates prompt arrival at the scene.[29] Scene bags need to be readily available so they could be stored both at home and at the forensic office. It is prudent where possible for odontologists to work in pairs for assistance in both physical and mental tasks.[27] If this is not possible then police or emergency personnel can be enlisted to assist with documentation and placement of necessary tools. Documentation of departure time and transport details can also assist in the debrief stage to discuss improvements in any delays that might have occurred.

Upon arrival at the scene consultation with the scene commander, (noting the commanders' name and time of arrival for the record) allows a brief of the situation and safety issues present to be undertaken and a plan to be developed. An overview of the scene and the designated paths of foot traffic will aid in forming a search and retrieval plan. It is important that the commander is aware of who and where personnel are at all times to control the situation.[30] Assistance with photography by attending police with specific training in scene photography frees the hands of the odontologist for stabilisation and retrieval tasks and allows the collection of all photographic records in one place.[30] A high resolution portrait image of the head taken before the body is moved can prove extremely useful for comparative analysis with ante mortem photographs and dental data, as well as assisting in assessing if material has been lost during collection and transport.[27]

Following stabilisation and retrieval of remains, a revisit to the head site in some cases reveals further information including loose teeth, implants, and facial piercings.[31] Ensuring that all dental and circumstantial evidence is recorded, collected and protected will