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Review

Forensic considerations when dealing with incinerated human dental remains

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ABSTRACT

Establishing the human dental identification process relies upon sufficient post-mortem data being recovered to allow for a meaningful comparison with ante-mortem records of the deceased person. Teeth are the most indestructible components of the human body and are structurally unique in their composition. They possess the highest resistance to most environmental effects like fire, desiccation, decomposition and prolonged immersion. In most natural as well as man-made disasters, teeth may provide the only means of positive identification of an otherwise unrecognizable body. It is imperative that dental evidence should not be destroyed through erroneous handling until appropriate radiographs, photographs, or impressions can be fabricated. Proper methods of physical stabilization of incinerated human dental remains should be followed. The maintenance of integrity of extremely fragile structures is crucial to the successful confirmation of identity. In such situations, the forensic dentist must stabilise these teeth before the fragile remains are transported to the mortuary to ensure preservation of possibly vital identification evidence. Thus, while dealing with any incinerated dental remains, a systematic approach must be followed through each stage of evaluation of incinerated dental remains to prevent the loss of potential dental evidence. This paper presents a composite review of various studies on incinerated human dental remains and discusses their impact on the process of human identification and suggests a step by step approach.

1. Introduction

Teeth are the most indestructible components of the human body and may remain more or less intact for many years beyond death. They are biologically stable and contain information about the physiological and pathological events in the life of the individual which remain as markers within the hard tissues of the teeth.[1] Any therapeutic activity by a dentist in the form of restorations and prostheses may modify an individual's dentition in a more or less unique manner. It is the role of the forensic dentist to assess this biological and chemical information, and use it in the identification of an unknown body.

Dental identifications of human remains have always played a key role in mainly natural and man-made disaster situations and, in particular, in the mass casualties associated with aviation disasters. The identification is essential from both the humanitarian and the religious points of view as well as for judicial reasons. Some reports say that the identification, which is based on the dental documentation, leads up to 43–89% of a successful process and it is still a method of choice.[2]

Human identification through dental remains is a well-established and reliable method.[3] Dental identification requires a comparison of post-mortem and ante-mortem dental records.[4] A comparative method of dental identification involves establishment to the highest degree of certainty that the remains of the decedent at the site of death and details in the ante-mortem dental records are of the same individual to confirm identity.[2] In some instances, though high quality dental records are available, the dental remains and recognizable features of prior dental work recovered from the scene are unrecognizable.[5] In the absence of ante-mortem data, the forensic dentist creates a composite post-mortem dental profile based on the observable dental features which helps to narrow the search for the ante-mortem details.[6] A post-mortem dental profile will typically provide information on the deceased's age, ancestry background, sex and socio-economic status.[7] The lack of a tentative identification or failure to locate

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dental or similar ante-mortem records is a more common reason for an odontological investigation to fail.[8]

Identification of the deceased from facial appearance is possible in a high proportion of cases, but there may be circumstances where putrefaction, physical damage or loss of tissues may prevent or render facial recognition unacceptable.[1] In these circumstances, fingerprinting is the next line of investigation as it is the most accurate method of identification of people. But it is of limited value in cases of disfigured, decomposed, burnt or fragmented bodies. On the other hand, teeth and dental restorations are extremely resistant to destruction by fire. They retain a number of their original characteristics, which are often unique and hence offer a possibility of rather accurate and legally acceptable identification of such remains.[9] Therefore, it is the duty of the forensic dentist to examine the oral structures or skeletonised remains with the purpose of describing the life events of the individual which may be permanently recorded in the teeth. Such information, at best may result in a positive identification, either using dental records or other information available at the time.[1]

The importance of teeth for identification is because of their highly mineralised composition, which makes them resistant to the influences of the external environment. They are not changed by postmortem decomposition and usually withstand to flames, alkalis or even to weak acids.[10]

Incineration events could result from airline and automobile accidents, bombings, or wrongful cremation[11] while other incidents such as house fires, suicides, unlawful killing and cremation of the victim's body, have also been observed. A complex task for the forensic odontologist results when a victim has been incinerated to the point where only a few fragments of teeth and bone remain.[12]

During fire incidents, the anterior teeth receive the greatest impact *in-vivo,* with the maximum protection to posterior teeth. The lips and cheeks initially provide some insulation until the muscles contract with increasing heat and drawback to expose the anterior dentition.[13] The tongue also gives some protection to the lingual aspect of the lower dentition.[14] The alveolar bone and the gingivae also provide additional heat protection for the roots. Therefore, these findings should be taken into consideration as a majority of experimentation has been done on extracted teeth.

The factors influencing the effects of fire on teeth are[4]: a. duration of exposure, b. presence of materials (in addition to the tissues) interposed between the teeth and fire, and c. temperature alteration by substances used to quench the fire. Although teeth and restorative materials are generally impervious to destruction, high temperatures of fire can destroy or alter them greatly. The dental remains retain some degree of their anatomical configuration following burning but are reduced in size and extremely fragile.[4]

2. Other specific dental characteristics of forensic importance

The teeth are hard and brittle objects and can be modified by chewing patterns or by certain occupational habits. For example, characteristic notches in the incisal edges are observed on the teeth of seamstresses who run cotton through their teeth prior to threading needles. Cobblers are said to hold small nails or tingles in their mouths prior to tapping them into the welt of a shoe, and the passage of the nail through the incisal gap may also produce characteristic wear patterns. Operators in battery factories are said to acquire acidic demineralisation of the anterior teeth due to the vapours arising from the materials used and all of these features may give some guide to the identity of the unknown person. Various restorations in the mouth should be carefully charted and described, not only in terms of their position, but also their size, design, materials used, linings inserted below them and any other specific features. All of these may be useful in a final identification.[1]

A thorough review of past literature demonstrated that the charred dental remains could be analysed using stereomicroscopy, histology, radiography, scanning electron microscopy (SEM) and Energy dispersive X-ray spectroscopy (EDS). These methods could be used to study colour changes, surface alterations and microscopic changes in enamel, dentin and cementum. Taking photographs, contemporaneous notes of the extra-oral and intra-oral findings would be wise in case of accidental damage or fragmentation.[13]

3. Methods of physical stabilization of ashed teeth in incinerated remains

A situation frequently confronting forensic scientists is the extreme fragility of the teeth in incinerated human remains. This has become a significant problem in preserving the dentition for evidentiary purposes. At any crime or accident scene involving bodies that have been incinerated, being aware of the fragile nature of the remains is of paramount importance. Attendance of the forensic odontologist is often requested to preserve the dental structures before any disturbances initiate disintegration.

The colour changes that occur during incineration may be useful in order to predict the degree of fragility of the dental tissues. In general, the teeth that have a dark or charred appearance are not as delicate as those that are 'porcelain white' in appearance.[13,14] In deciduous teeth, however, the fragmentation process begins at low temperatures even before charring of the organic components occurs.[15] It would be prudent to employ a stabilization technique as a matter of course in this scenario.

The results of a questionnaire sent to forensic anthropologists and forensic odontologists by Mincer et al. (1990)[16] disclosed that the most popular methods used were impregnation with a solution of polyvinyl acetate or application of cyanoacrylate glue. Various materials have been employed for stabilization in the laboratory such as clear acrylic spray paint, hair spray, spray furniture varnish, clear fingernail polish, and quick-setting epoxy cement, polyvinyl acetate polymer in acetone, or self-curing clear dental acrylic resin. Though all substances tested successfully stabilized the incinerated teeth, Mincer et al. (1990)[16] stated that cold cure acrylic spray or a runny mix (using a horsehair brush) is the material of choice for dental stabilization as it is inexpensive, convenient and simple to use.

Hill et al. (2011)[17] found that during the recent Australian bush fires, wrapping the heads of the victims after stabilization at the site enabled the containment of evidence even if transportation causes further displacement of the dental structures.

When dealing with any Incinerated dental remains, a systematic approach has to be followed by the investigator in the interest of maintaining the integrity of the dentition through each stage of the evaluation of incinerated remains while preventing the loss of potential dental evidence. Hence, we suggest the following step by step approach in Fig. 1.

4. Macroscopic changes to the dental tissues with increasing temperature

Many studies indicate that colour is the most obvious change with increased temperature.[14,15,18] The first change to enamel, dentine and cementum was darkening to a greyish-brown, when they were exposed to 300 °C.[18] A similar pattern of discolouration at this temperature has also been seen in deciduous teeth.[15] The colour change is thought to be due to heat energy denaturing the bonds within the helical collagen molecules. The collagen then