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Forensic Dental Cremation Recovery and Analysis-A Review Article

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Forensic Dental Cremation Recovery and Analysis-A Review Article

Hari Krishnan [α], Devika Kumar [σ], N. Girija [ρ], Thamarai Selvan [Ѡ], Taruna Malhotra [¥] & Niveditha Manoharan [§]

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I. Introduction

The systematic recovery and analysis of incinerated teeth can provide information related to age, sex and even help the forensic investigator to positively identify the victim. Teeth being the most resilient structure of the human body, are commonly preserved with the dental works at least partially after cremation. Various studies have been conducted around the globe on this and very relevant conclusions have been made. It is very important for a forensic investigator to have deep understanding in these studies because it can be used in a variety of ways not only to establish the identity but also in finding leads to solving crimes.

II. Search, Recovery and Laboratory Procedures

Archeological method of evaluation is the most reliable method to recover the cremated teeth. The extend of the cremains have to be estimated before excavation. One of the reliable ways for searching is by establishing grid pattern, Christopher W.Schmidt in his book "The analysis Of Burned Human Remains" states that the grid can vary from 1×1m to 5×5 m but this can be enlarged or decreased as per needs(1). Excavation of the cremains can be done with a soft towel or with tongue depressors or wooden sticks. Schmidt also emphasizes the chances of finding cremains in small drainage ways or animal burrows nearby. Sieving of sediments through a 1/8 in screen is important in recovering minute samples from the scene.(1)

While Schmidt advices to transport the recovered specimen in plastic bags which is kept into labelled glass or plastic vials(1), Fairgrieve SI suggests to transport the cremains in a paper bag to promote gradual drying if they are moist and to prevent the growth of mildew (2)

Cleaning the teeth using soft tooth brush and tap water is the first step in the laboratory. The examiner should note down and document the findings on the specimens like restorations or any pathological condition. Schmidt recommends to keep a fine mesh screen on the drain while washing specimen in the sink.(1)

Mineer et al in 1990, reported that clear acrylic spray paint is a good stabilizing agent for reconstruction because of its ready availability and affordability(3). But reconstruction of fragments less than 1/8 in is extremely difficult (1). One of the challenging task in reconstruction of the fragments is to distinguish the anterior root from the posterior root. Usually, in severely burned molars root will separate and each separated root will look almost like anterior roots. In 2005 Schmidt reported the presence of the notch or spur on molar root which is absent in anterior root and found it possible to reconnect separated posterior roots by matching corresponding spurs and notches(1,4)

III. Analysis

a) *Cremated Dental Tissues*

One of the most reliable means of determining the positive identifications of charred remains is through the comparison of ante mortem odontological records with the post mortem odontological observation of the victim. Teeth are the ideal source of information to draw upon for individualization due to the fact that they are the most indestructible components of the human body. This statement is supported by the paleontological recovery of teeth exceeding that of bone. (Robinson et al 1998).

Even though the facial soft tissue and tongue acts as an effective insulator to the teeth, prolonged exposure to fire or higher temperature can directly affect the teeth by fracturing enamel, cementum and dentine. Bohnert et al in 1998 studied the effect of fire on the skull and concluded that when human body is exposed to a fire temperature of 670-810°C by 20 minutes only sparse soft tissue remains in the face. The dental

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remains even in such an advanced state of destruction have the potential to provide the location and types of dental works (Robinson et al 1998) [5].

In addition to the routine crown analysis of the dental cremains, tooth root analysis is a very important step in establishing the identity of the victim. The roots are commonly preserved intact due to the protected nature of being situated in the alveolus. This may be compared to the anti-mortem dental records for similarity. Extra care should be taken to examine the discontinuity in the cemento-enamel junction. In such areas an expert can locate the remnants of a filling which are no longer present. Confirmation of evidence of dental work using a scanning electron microscope is recommended in these situations (Fairgrieve, 1994)[6].

b) Microscopy

The study of incinerated dental tissues microscopically provides valuable information about the maximum temperature to which it is exposed. In 1975, Harsanyi reported the appearance of small crevices in enamel at 300°C and increase in size and number as the temperature increases. By 500°C, he observed a crevice network and multi-angular plates. The formation of granules on the surface of the enamel occurs at 700°C while a fusion of the granules was visible at 900°C. At 1000°C enamel microstructure is unrecognizable[7]. Shipman et al. did a similar study in 1984 and reports a 'dimple' development at the surface of enamel as the temperature approaches 300°C. He noticed the formation of rounded particles by 500°C[8]. However, both the studies agree that the previously formed granules will coalesce into larger, smooth globules and eventually fuse below 1000°C.

As per Harsanyi 1975, in cementum by 300°C the evaporating water results in a lifting of the tissue layer from the underlying dentine. By 700°C a finely granular surface is observed, and he reports that the original cemental structure is no longer visible. When the temperature reaches 900°C he observed granular surfaces which is penetrated by deep and wide crevices and the original structure was found to be decomposed. Dentine when heated to 300°C, dentinal tubules are found opened but the morphology seemed to be unaffected. By 700°C he reports the narrowing of tubules, and anastomoses between tubules was not visible by 900°C and by 1300°C structures have decomposed and fused into granules of varying size [7].

c) Pulp Tissue and DNA

The extent of the cremation is a major determining factor in the success of isolating and amplifying DNA. If there is surviving fibrous muscle tissue and cartilaginous material, then there is a strong possibility of obtaining DNA. Once the body has been reduced to calcined bone fragments and powdered, the DNA extracted prior to cremation was compared with that extracted from commercially prepared remains (vonWurmb-Schwark, 2004)[9]. The DNA which is extracted after the cremation did not confirm to that of pre cremation DNA that was profiled by STR's because the remains were likely contaminated through processing and handling. This only leaves the DNA from teeth as possible means of identification since the pulp is protected and isolated in the chamber from external contaminations (Duffy 1989, Sweet and Sweet 1995)[10][11].

Williams et al in 2004 started the use of DNA from incinerated deciduous dentition as a means of sexing cremains. They found that they were able to isolate and analyze DNA, specifically the amelogenin locus for sex determination. Deciduous teeth which were subjected to temperature from 100 -500°C for 15 minutes, out of which some teeth which were heated to 400°C provided a reliable source of DNA but not all [12].

Duffy et al in 1991, in their study experimented with fresh pig head subjected to an open fire. A temperature of 500-700°C produced only 75°C in the pulp chamber of the pigs teeth. But cremation remains with calcined dentition and with heat induced fractures are not candidates for DNA analysis of any type[13].

d) Restorations

Using identical temperature scheme Savio et al 2006[14] examined the effect of heat on restored teeth having amalgam, composite and endodontic fillings. The changes observed in various restorative materials can be used to calculate the maximum exposure temperature and a skillful and careful examiner can predict the fuel responsible for the damage.

Up to 600°C amalgam and composite restorations showed no change in shape and dimensions. The amalgam restoration on exposure to 800 - 1000°C didn't show any dimensional change but large fissures were formed at the junction between the dental tissues and fillings. At the same temperature composite restoration was in place but in an altered shape. At 1100°C amalgam restorations partially maintained its shape whereas composite restoration showed remarkable alteration of shape.

Endodontic fillings showed no change up to 200°C. At 400°C radiopacity which was less regular was seen. There was a presence of radio transparent areas and the shape and dimension was slightly altered. From 600-1100°C all these features could be appreciated with an additional specific "honeycomb" appearance.

The melting point of restoration with gold purely depends upon the percentage of gold in the filling material. It is clear that irrespective of the material used, the restorative material serves as an aid to identify the individual and estimate the temperature attained by the dental structures in question. Correlating with fire resistance of different material will provide the maximum temperature to which the tooth and the dental work is exposed. However, the range of material used in restorative dentistry is truly overwhelming and special study has to be conducted for different products.

e) Dental Prosthesis

As per the study conducted by Kalpana et al in 2010,Ni-Cr metal crown at temperature 400 °C for 5 min showed little loss of glaze. By around 15 min the marginal seal was lost at the cervical area. By 30 minutes, the crown was blackened and the crown could be displaced. When the temperature was increased to 1100°C for 15 minutes, the crown showed a rough, crumpled surface and decomposed core leading to dislodgement. [15]

In case of ceramic crown, 400°C for 5 min produced loosening of crown without much change in color or texture. Till 15 min, there was no change for ceramic, but there was a distinct margin resulting in shifting of crown, as per the observation. 30 min produced pitted surface with slight discoloration, core creased resulting in displacement of crown. 1100°C for 15 min resulted in loss of morphology, change of glaze, texture to uneven patchy pattern and displaced/ exfoliated crown[15].

In case of complete denture prosthesis, when it was heated in the skull to 400-600°C for 10 min, only front teeth of the acrylic denture was burnt. When the heating was continued to 16 min, till the region of premolar was burnt (Rotzher et al 2004)[16].

f) Dental Implants

Berketa et al in 2010 tested the survival of batch numbers within dental implants following incineration. They found out that the batch number of the implants survived heating to 1125°C when an abutment was attached to the same. Those implants without abutment following incineration revealed that their numbers were totally obscured by the oxidation layer formed [17].

In another study, Berketa et al 2011 evaluated the reliability of implants for person identification after cremation by placing implants in fresh adult sheep head which is incinerated to a maximum temperature of 780°C. He concluded that implants resisted the features such as size, shape, thread and pattern necessary to identify the type of implant. But the detachment of implant from the mandible could have implication for scene recovery. As a conclusion Berketa et al recommends to collect debris from around and below the location of head[18].

g) Mass Disaster

Mass disasters is usually recognized as any event in which there is a sudden occurrence of a large number of deceased individuals. In cases like aircraft crash, where cremation of remains to the point of calcination may occur, victims are usually identified through the use of recovered dental structures (Barsley et al 1985)[19]. In explosions, building fire etc., establishing even the minimum number of individuals deceased is a tough job. A reliable way to manage the situation is to use an area of the skeleton that is particularly dense and less likely to be eradicated by a perpetrator for estimation of the number. The region of the first molar (M1) socket in the mandible can be a reliable region to examine. The advantage of this is that the mandible in this area is very dense with a bone thickness that approaches 1 to 2 cm. Further, if there is no M1 socket, the body of the mandible in this area is dense enough that it typically survives a fire[2] . Thorough search of the scene and recovery of even the minutest sample is mandatory in these cases. When very small fragments have been found from the site, scanning electron microscope will be of much help. Oblaker et al in 2002 used SEM/EDS to determine the elemental composition of the specimen. Bones and teeth have diagnostic proportions of calcium and phosphorous which can be used to distinguish it from other materials.

IV. Conclusion

Identification of the cremains is the primary duty of a forensic scientist, and the expertise of the scientist is tested by the condition of the cremains recovered. Thorough knowledge about the heat induced alterations of dental and associated structures, careful searching of the scene and accurate reconstruction of the recovered specimens, sometimes to the microscopic level is necessary for positive identification of the victims. Since a large amount of population is undergoing Orthodontic treatment these days an extension of the study can be done on Orthodontic brackets and wires to understand the heat resistance.

Dentistry is a field in which new materials from different manufactures are often being introduced. Standardization of materials used for dental work should be monitored by the dental practitioners and manufactures to provide ideal properties including thermal resistance.

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