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THERMAL EFFECTS ON EXTRACTED HUMAN TEETH / CALEFACTION EFFECTS OF HEAT ON EXTRACTED TEETH

Forensic Dentistry

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ABSTRACT

Context: Identification of human remains in mass disasters is a difficult process. Forensic investigations involving severely burned human remains, dental analysis stands alone as other means of identification are often destroyed. Teeth are the most indestructible components of thehuman body. They are structurally unique as they possess the highest resistance to most of the environmental effects like fire, desiccation, decomposition and prolonged immersion. Hence in cases of most natural as well as manmade disasters, teeth may provide the only means of positive, personal identification of victims in an otherwise unrecognizable body.

Aim: The main aim of the present study was to investigate the morphological& Histological changes in freshly extracted permanent human teeth after exposure to an experimental range of temperature for certain period of time.

Methods: Twenty-five freshly extracted permanent human teeth were subjected to an experimental range of temperatureranging between50°C to 600°C for 15 minutes. Teeth were then examined for morphological and histological changes.

Statistical Analysis: Evaluation of physical and microscopic findings and correlate them with experimental range of varying temperature.

Result: The morphological change and histopathological changes such as change in colors and the structure of teeth were observed at varying experimental temperature ranging from lower to higher.The changes in the specimens includes tissue fragmentation, dentin, pulpal remnants, and cementum vapor bubbles within dentinal tubules, charring and tissue shrinkage

Conclusion: Analysis of burned up remains of dental tissue can provide additional forensic information in victim identification because the type and severity of morphological and histological changesat various temperature remains consistent.

KEYWORDS

disaster, dental tissue, Investigation, temperature

INTRODUCTION:

Fire accidents are one of the most common cause of morbidity and mortality worldwide. Heat-induced alterations to teeth can be of great interest in forensic dentistry.Identification of human remains in mass disasters is a difficult task.[1] Identification of burnt bodies starts with the objects that have remained with the body. Teeth are considered to be the most non- destructible components of the human body and have the highest resistance to most extreme environmental effects like fire, desiccation, and decomposition because of their particularly resistant composition and protection by soft tissues.[2]

when dental evidence remains, accurate knowledge of morphological and histological alterations in teeth subjected to high temperature can provide additional valuable clues in fire and crime investigations.[3]Most of the morphological changes in the oral and dental hard tissues & restorations can be examined directly by the naked eye without any aid, but microscopic examination can be very useful mainly to identify the changes that the dental tissues have undergone so that temperatures they were exposed to can be estimated. Hence the present study was undertaken to investigate structural damage in freshly extracted teeth on heating, at different temperatures for a specified period of time in the laboratory and; physical and microscopic findings were correlated to the temperature.

MATERIALS AND METHODS:

The present study was conducted in Department of Oral Pathology & Microbiology, Chhattisgarh Dental College & Research Institute. Twenty-five freshly extracted permanent human teeth were collected from the Department of Oral & Maxillofacial Surgery.

Inclusion criteria:

Freshly extractedpermanent human anterior and posterior teeth free from any carious lesion and effects of external trauma.

Exclusion criteria:

1. Teeth with carious lesions, fractures [coronal or radicular] were excluded from the study
2. Teeth which have received crown, onlay or inlaywere excluded from the study.
3. Teeth with abnormal morphology and developmental defects were excluded from the study.
4. Endodontically treated extracted teeth with displaced /fractured restorations.

After extraction, all the teeth were debrided with 3% solution of hydrogen peroxide to remove any attached calculus and debris, rinsed thoroughly with tap water and fixed in 10% buffered Formalin solution for minimum of 24-48 hrs. The teeth were then divided into five groups of five teeth each (2 incisors, 1 premolars& 2 molar). The teeth were subjected to following temperature for 15 min.

Groups	Temperature	Time duration
First group	50°C	15 min
Second group	80°C	15 min
Thirdgroup	100°C,	15 min
Fourth group	300°C	15 min
fifth group	600°C	15 min

A custom made stainless steel tray was used that could withstand high temperature in the furnace. Loops of 23-gauge orthodontic wire were made and attached to the stainless-steel plate to keep the teeth in the upright position so that all the surfaces of tooth receive equal

temperature, the tray with teeth in position was placed in the in the electric muffle furnace (Figure 1)&was subjected to a specified temperature for each group as mentioned above for a period of 15 minutes. The heating process involved gradual heating of teeth to the specified temperature, and holding the temperature for 15 minutes. The teeth were then gradually cooled to room temperature before taking out from the furnace.After heat treatment, the teeth were again fixed in 10% buffered formalin for 24 hrs.

Teeth were then examined by naked eyes for any physical/morphological changes such as change in color,surface texture or morphology that occurred. Then the teeth were subjected fordecalcification in strong acid (Formalin-5ml, Nitric acid -15ml, Distilled water- 100ml)(Figure3)

The decalcifying solution was changed every day, and the teeth were examined and documented for any significant physical changes during the process. Sponginess of dentin was considered to be the end-point of decalcification. After completion of the decalcification all the teeth were washed in running tap water to remove any remaining acid from the teeth.The teeth were than processed as routing technique followed by impregnation and embedding. Sections of 4 µm thickness were made using semiautomatic microtome and stained with Hematoxylin and Eosin to correlate the microscopic findings to the temperature.

RESULTS:

The morphological changes in the structure of teeth were observed included change in color ranging from creamy yellow to brownish black.Changes in enamel were not considered for histological examination as enamel were completely lost during decalcification procedure.

Microscopic evaluation of specimens revealed fragmented tooth sections with identifiable dentin, pulpal remnants, and cementum.

On examination following morphological and histological changes in teeth were observed.

At 50ºC – there were no significant changes noticed in morphology as well as histology of the teeth.

At 80ºC – Significant changes were observed in the morphology and histology of teeth.Morphological changes include change in color which changes to creamy yellow to brown.Along with few cracks in enamel. Histology of dentin showed slight cohesion of dentinal tubules.

At 100ºC –all the teeth in this group showed changes in morphology and histology. Morphological changes include change in color to reddish brown, cracking of enamel along with some with loss of enamel.Histological changes include decreased stainability and Dentin showed cohesion of dentinal tubules with splitting between the clusters giving rise to "wicker basket pattern".

At 300ºC – at this temperature the morphological changes include chattering of enamel and dentin in most of the areas, change in color to graying black, the fragments of teeth completely disintegrated as soon as they were put in to the decalcifying solution.So, further processing and sectioning of these teeth were not carried out.

At 600ºC - The tooth appeared totally burnt, the surface of the crown and the root became white,Teeth become very fragile and broke during handling.Rest of the fragment disintegrated completely during decalcification and no further processing and sectioning were done

Temperature	Morphological changes			Histological changes	
	Color	Enamel changes	Effect in decalcifying solution	Staging	Histology
50°C	No changes	No change			
80°C	Color creamy yellow to brown	few cracks in enamel	No change	No change	Dentin showed uniform widening of Dentinal tubules
100°C	color to reddish brown	Numerous cracks in enamel along with loss in some areas	Rapid Decal cification	Decrease stainability	Dentin showed cohesion of dentinal tubules with splitting between the clusters giving rise to "wicker basket pattern"
300°C	color to graying black	fragments of teeth	Completely disintegrated in decalcifying solution	-------	no further processing and sectioning were done
600°C	Teeth were totally burnt	Completely disintegrated in decalcifying solution	-------	no further processing and sectioning were done	

DISCUSSION:

In forensic odontology, a great deal of effort goes into identifying the victim. One method of identification in forensic odontology is to examine the burned bodies and their fine traces, as well as to examine the resistance of teeth exposed to high temperature.[4]

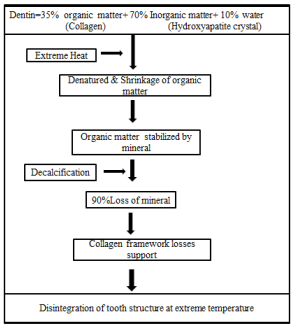
One of the first studies on identification of human remains by dental examination goes back to 1897 and was carried out following the fire at the Bazar de la Charite, France.[5]

Historically teeth and dental materials have been studied to aid the identification process of human remains. The study of incinerated teeth, including their histology, is an important part of forensic fire investigation where investigators have mainly used the unique nature of teeth to identify victims. However, morphologic and microscopic tissue alterations caused by incineration may provide useful information about the temperature and duration of exposure to fire. Controlled laboratory incineration of teeth and their histologic evaluation have the potential to create valuable data for this dental tissues.[6]

Enamel is made up of 96% mineral, whereas dentin is composed of 70% minerals, and 35% organic component, mainly type 1 collagen.[7]Mineral content helps stabilize collagen in dentin against thermal denaturation and shrinkage. But after decalcification minerals are lost and only a framework of collagen is left behind, which is destroyed at higher temperatures leads to disintegration of teeth in decalcification fluid. The higher the temperature more is the destruction of collagen framework and more is the disintegration of tissue in decalcification fluid (Illustration 1).[8]

In the present study, the widening of dentinal tubules was seen at 80°C temperature that can be attributed due to the heat leading to the formation of intratubular water vapor, which in turn caused widening of dentinal tubules.

Wicker basket pattern was seen at 100°C in few areas which could appear due tocombination of three changes that heating may induce-Loss of inorganic matrix from decalcification, shrinkage due to drying and, incineration and consequent loss of intertubular organic matrix.



CONCLUSION:

Histological evaluation of incinerated teeth can act as a source of forensic evidence after exposure to temperature up to 600°C, indicating that this information can be used as a means of comparison in human identification of victims in fire accidents because of the consistency of morphological changes, the histological patterns at temperatures that are commonly encountered in common domestic fires. A larger sample size, more temperatures and variables like caries, restorations, root canal-treated teeth, and implants will provide a more reliable data for practical implications.

Figure1: Electric muffle furnace

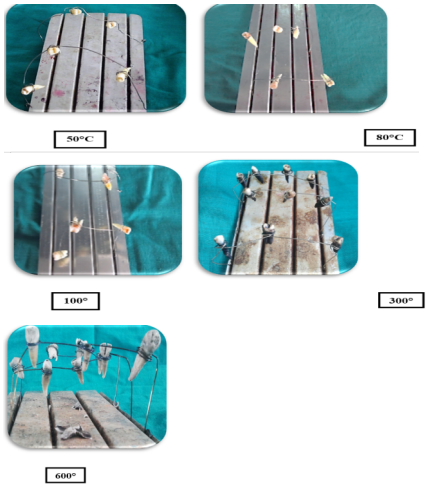


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FIGURE 2: Custom made tray with loops &teeth fitted in the loops in upright position, which were to be placed in electric muffle furnace at 50°C, 80°C,100°C, 300°C, 600°C

FIGURE3: Teeth were subjected for Strong Acid

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