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Effect of temperature on extracted teeth of different age groups.

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Abstract

Introduction: Type of dentition and age-related changes may affect morphologic and radiologic behaviour of dental hard tissues under different temperatures.

Aim: To analyze the effects of varying temperatures on extracted teeth of different age groups in a simulated laboratory set up.

Material and methods: Each group consisted of 25 teeth, the first set of specimens of each group were (A1–A8, B1–B9, and C1–C8) exposed to a temperature of 400°C, second set (A9–A16, B10–B17, and C9–C16) to 700°C, and the third set (A17–A25, B18–B25, and C17–C25) to 1000°C.

Result: Various degrees of changes in relation to temperature were observed mor phologically and radio graphically at 400°C, 700°C and 1000°C.

Conclusion: It can be concluded that dental evidence may provide clues to solve the mystery in fire investi gations as dental structures are the last to be destroyed under extreme conditions.

Keywords: Forensic odontology, Age, Teeth, Effect of temperature.

Introduction

The establishment of forensic odontology is a unique discip line that has been attributed to Dr. Oscar Amoedo (Father of Forensic Odonto logy) who identified the

victims of fire accident in Paris, France in 1897. Fire remains one of the major causes of morbidity and mor tality throughout the world and identification of a body from the fatal fire remains a daunting task.

Identification of human remains in mass disasters is a difficult task. Identification of burned bodies starts with the objects that have remained with the body.

Teeth are the most indestructible components of the human body. Teeth have the highest resistance to most environ mental effects like fire, desiccation, and decomposition.[1] The extent of damage to the teeth caused by thermal insult depends on the temperature range and duration of exposure.[2]

Aim and Objectives

To analyze the effects of varying temperatures on extracted teeth of different age groups in a simulated laboratory set up. To record physical and radiographic features of teeth before and after exposure to varying temperature (400°C, 700°C, 1000° C). To evaluate the color change, trans lucency, surface texture and mor phology after heating to access the resistance of teeth at varying temperature (400°C, 700°C, 1000°C) for Forensic purposes.

Material and Method

Each group consisted of 25 teeth and was tagged with a unique identification number which denotes the age group and temperature to which they were exposed. The first set of specimens of each group were (A1–A8, B1–B9, and C1–C8) exposed to a temperature of 400°C, second set (A9–A16, B10–B17, and C9–C16) to 700°C, and the third set (A17–A25, B18–B25, and C17–C25) to 1000°C.

All the teeth were photographed and were then placed on a digital occlusal film (SIRONA ©) and radiographed (GENORAY ©) under fixed parameters.

The specimens from each age group which were exposed to different temperatures (400°C, 700°C, and 1000°C) were assessed visually for changes in color, trans lucency, surface texture, and morphology.

Changes such as separation of enamel from dentin, fracture lines, and dimensional changes were radio graphically assessed.

Observations and Result

Table 1:

Table: 1- Morphological changes of Deciduous Teeth (GROUP A) at different temperature levels

STRUCTURE	PARAMETER	400°C	700°C	1000°C
Crown	Color	Greyish color with dark brown to black patches	Dark grey with patches of bluish-gray	Enamel color is grey-whitish with patches of light bluish-grey
	Translucency	Translucency observed	Loss of Translucency	Loss of Translucency
	Surface texture	Shiny appearance	Loss of glossiness	Enamel has a light shiny appearance.Coronal dentin is has dull chalky appearance
	Morphology	Fracture lines seen in enamel	Fracture lines seen in enamel	Fragmentation of enamel exposing coronal dentin. Fracture line are also seen in coronal dentin.
Root	Color	Color range from black to brown with dark black patches	Color range from white to light bluish-gray	Bluish-grey with patches of dark grey are present on root surface.
	Translucency	Loss of translucency	Loss of translucency	Loss of translucency
	Surface texture	Dull Black appearance	Dull white-greyish appearance	Dull, black to bluish-grey appearance
	Morphology	No morphological changes observed	No morphological changes observed	Fracture lines seen on root surface

Table 2:

Table: 2- Morphological changes of Young Permanent Teeth (GROUP B) at different temperature levels

STRUCTURE	PARAMETER	400°C	700°C	1000°C
Crown	Color	Greyish color with dark brown to black patches	Enamel color is dark gray with patches of bluish-gray. Exposed coronal dentin is bluish-white color.	Color of enamel was determined from fragments found attached to some samples.Enamel is grey with patches of light bluish-grey. Dentin color is light grey to chalky white
	Translucency	Translucency observed	Loss of translucency	Loss of translucency
	Surface texture	Shiny appearance	Loss of glossiness. Coronal dentin has a dull, chalky surface texture.	Traces of enamel remain on crown. Enamel fragments are shiny in appearance. Dentin has a dull,chalky appearance.
	Morphology	Fracture lines seen in enamel	Fragmentation of enamel layer is found, exposing the coronal dentin. Some sample showed fragmentation of coronal dentin too	Complete fragmentation of enamel and coronal dentin.
Root	Color	Color range from black to brown with dark black patches	Color ranges from white to bluish-white	Bluish-grey with patches of dark grey-white present on root surface.
	Translucency	Loss of translucency	Loss of translucency	Loss of translucency
	Surface texture	Dull black to greyish appearance	Root surface has dull chalky appreance	Dull, grey to chalky appearance
	Morphology	No morphological changes observed	Fracture lines are seen on the root surface	Fracture lines are seen on the root surface

Table 3:

Table: 3 - Morphological changes of Adult Permanent Teeth (GROUP C) at different temperature levels				
STRUCTURE	PARAMETER	400°C	700°C	1000°C
Crown	Color	Greyish color with dark brown to black patches	Enamel appear white with patches of bluish-grey. Dentin is bluish-grey color.	Enamel color is white to bluish grey patches.Dentin color is bluish-grey.
	Translucency	Translucency observed	Loss of translucency	Loss of translucency
	Surface texture	Loss of glossiness	Enamel has shiny appearance Dentin has dull,chalky appearance.	Enamel has shiny appearance Dentin has dull,chalky appearance.
	Morphology	Fracture lines seen in enamel	Enamel is separated from coronal dentin. Small fragment of dentin are also detached with enamel layer	Enamel layer is lost in some samples.Fracture lines present in coronal dentin.
Root	Color	Black to brownish-black	Bluish grey to white	Bluish grey to dark grey
	Translucency	Loss of translucency	Loss of translucency	Loss of translucency
	Surface texture	Dull black to greyish appearance	Dull, Chalky appearance	Dull, Chalky appearance
	Morphology	No morphological changes observed	Fracture lines present	Fracture lines present

Table 4:

Table: 4 - Radiological changes of Deciduous Teeth (GROUP A) at different temperature levels				
STRUCTURE	PARAMETER	400°C	700°C	1000°C
Crown & Root	Fracture Lines	Present.1-2 lines of fine thickness appear to involve in dentin and enamel	Present. Increased in no. and thickness compared to those seen in 400°C	Present.Fracture Lines are more in no. and thickness then seen in 700°C
	Enamel Separation	Not observed	Present. Radiolucent area separating the enamel and dentin extends entirely of the DEJ	Present. Radiolucent area separating the enamel and dentin extends entirely of the DEJ is wider
	Morphology	No morphological changes observed	No morphological changes observed	No morphological changes observed

Table 5:

Table: 5 - Radiological changes of Young Permanent Teeth (GROUP B) at different temperature levels				
STRUCTURE	PARAMETER	400°C	700°C	1000°C
Crown & Root	Fracture Lines	Present. 2-3 lines of fine thickness appear to involve on both radicular and coronal portion of tooth.	Radiolucent lines are present with increased in no. and width then 400°C.	Fracture lines present with increased in no. and width then 700°C
	Enamel Separation	Enamel separation present but not too appreciable.	Radiolucent line separating enamel and dentin extends along the DEJ	Enamel layer is completely lost
	Morphology	No morphological changes observed	No morphological changes observed	Crown portion is not appreciable at all.

Table 6:

Table: 6 - Radiological changes of Adult Permanent Teeth (GROUP C) at different temperature levels				
STRUCTURE	PARAMETER	400°C	700°C	1000°C
Crown & Root	Fracture Lines	Present. 2-3 lines of fine thickness seen in radicular & coronal portion of tooth. Lines appear to be confined to dentin only.	Radiolucent lines are present with increased in no. and width then 400°C. involving both enamel and dentin.	Radiolucent lines are present with increased in no. and width then 700°C. involving both enamel and dentin.
	Enamel Separation	Enamel separation present but not too appreciable. Some sample shows beginning of separation	Radiolucent lines separating enamel and dentin extend entirely the DEJ	Enamel layer is completely lost
	Morphology	Radiolucent area seperating enamel and dentin is present at the DEJ.	Enamel layer is lost in some samples,but with largely intact coronal layer.	Enamel layer is lost in some samples.Coronal dentin has fracture lines.

Figure 1: Morphological and radio graphical changes in sample specimen from GROUP A at 400°C. (A) Pre heating photo graph (B) Preheating radiograph (C) Post heating - crown surface appear shiny and root shows black color (D) Post heating radiograph showing mini mal fracture lines

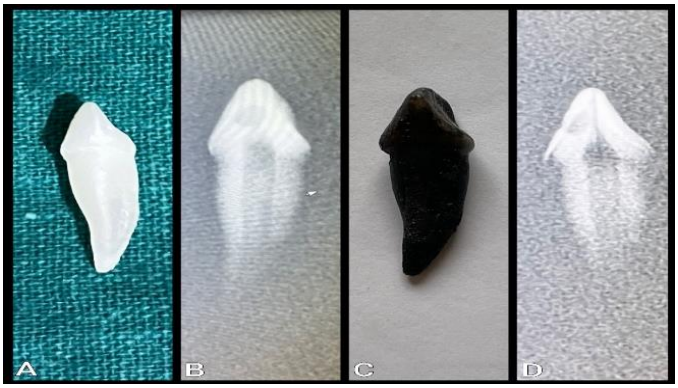


Figure 2: Morphological and radiographical changes in sample specimen from GROUP B at 700°C.(A) Preheating photograph (B) Preheating radio graph (C) Post heating – loss of glossiness and dull chalky appear ance with white to greyish color seen on root surface (D) Post heating radiograph shows increase in no. of fracture lines.

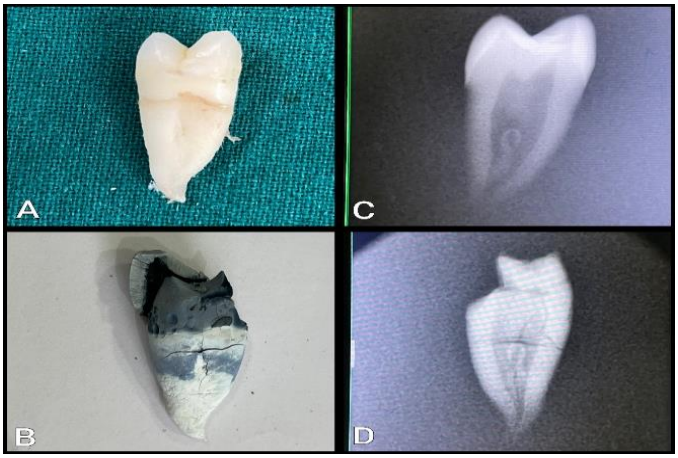
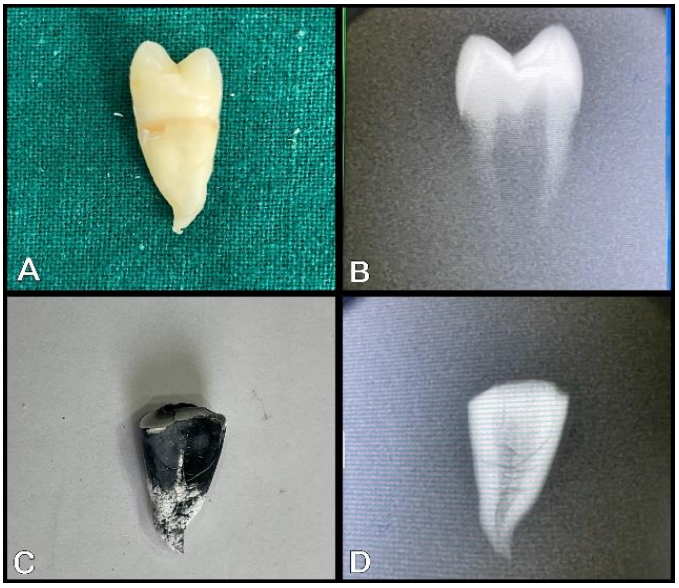


Figure 3: Mor pho logical and radiographical changes in sample specimen from GROUP C at 1000°C.(A) Pre heating photograph (B) Preheating radiograph (C) Post heating – loss of crown portion (D) Post heating radio graph shows increase in no. of fracture lines with loss of coronal surface.



Discussion

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 and restorative material to high temperature [3]. At times, victim identification in fire disasters becomes nearly impossible owing to complete destruction of soft tissues.

In such circumstances dental remains may prove to be of value since they are extremely hard and resist temperatures to a certain extent. According to the results obtained in the present study, we found that teeth irrespective of any age group, which remained exposed to gradual increments of temperature, experienced less structural damage than teeth exposed to a sudden higher temperature, similar observation was reported by Fereira et al. in 2008. [4]

The color changes of crown after thermal exposure are similar for a particular temperature regardless of age group.[2] The enamel surface showed greyish discoloration with dark brown-black patches at 400°C, dark grey with bluish grey white patches at 700°C, and grey with light bluish grey patches at 1000°C. Similar observations were reported by Shekhawat KA et al in 2016 where the crown of teeth exhibited a change in color ranging from whitish (200°C) to blackish discoloration (400°C) to greyish white (600°C), when exposed to high temperatures.[4]

On the contrary, a study conducted by George et al in 2017 reported a change in color to yellowish-grey at 400°C. [2] The change of color was the most common characteristic for each range of temperature, and this was directly related with the level of carbonization and incineration of teeth.[5]

In present study, mild fracture lines on enamel surface were observed on teeth from any age group at 400°C.

This observation contrasted with the study of George R et al in 2017 where no morphologic changes were reported on specimens of Group B and C at 400°C. [2] At 700°C, the Group A (deciduous teeth) showed fractured line at enamel surface were as Group B and C exhibited fragmentation, exposing the coronal dentin.

Similar observations were reported by Karkhanis S et al in 2009, shown that at lower experimental temperatures the teeth fragmented into large particles, and as the temperature increased there was associated disintegration into numerous smaller fragments. [6]

At 1000°C, the Group A also showed fragmentation but still retained most of their crown structure. The Group B show complete loss of enamel layer and fragmentation including the coronal dentin. Complete loss of crown was observed in a few specimens.

At 1000°C, the teeth from Group C showed complete loss of enamel layer. In contrast to the Group B, coronal dentin in Group C was intact. Similar observations were reported by George R et al in 2017 where it was observed that the coronal dentin of the Group C was more resilient even at 1000°C as compared to the coronal dentin of Group B. [2]

The radiographic changes in teeth from all the three age groups exhibited increasing degree of fracture as the temperature increases. This was represented as radiolucent lines increasing in number as well as width from lower to higher temperature.[2]

In present study at 1000°C, teeth from the Group A showed more pronounced enamel separation than at lower temperatures. At 1000°C, teeth from the Group B showed

complete loss of their enamel layer and loss of most of the underlying coronal dentin.

Teeth from the Group C also showed a complete loss of their enamel layer at 1000°C. However, in Group B, the teeth retained most of their coronal dentin in Group C. Similar observations were reported by Savio C et al in 2006 where, all the teeth presented the detachment of the crown, and four crowns were reduced in fragments at 1000°C. [7] Similarly, Shekhawat KA et al in 2016 also reported same observations, where complete disintegration of crown occurred only root remained at 1000°C. [4]

The age factor and type of the dentition may influence the heat-induced changes in teeth. Comparative dental identification methods should be applied with caution while the dental tissues are exposed to high temperatures.[2]

Conclusion

Forensic odontology is of great importance in medicolegal identification procedures. Dental hard tissues (enamel and dentin) show a series of specific changes when subjected to heat directly and gradually. Their morphological and radiographical features reveal information on the temperature ranges to which they might have been subjected.

The teeth, although resistant to most physical trauma, can become brittle and fragile when subjected to increased temperature. Disintegrated teeth are difficult to reconstruct for the purpose of post-mortem radiography and dental charting.

Understanding thermally induced changes in teeth can, therefore, assist forensic investigators to appropriately handle fragile dental tissues and then study the thermal record of the teeth.[6]

Thus, it can be concluded that dental evidence may provide clues to solve the mystery in fire investigations as dental structures are the last to be destroyed under extreme conditions.[4]

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