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Scorching Effects of Heat on Extracted Teeth

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Abstract: Fire investigation is the multidisciplinary basis of the exploration, which involves investigations concerning the origin of fire, its cause as well as the identification of victims. At times, victim identification in fire disasters becomes nearly impossible owing to complete destruction of soft tissues. In such circumstances, teeth may prove to be of value since they are extremely hard. A precise understanding of physical and histological changes in teeth subjected to high temperature can provide valuable clues in fire and crime investigations, when dental evidence remains.

AIM: The main aim and objective of the study was to investigate structural damage in freshly extracted teeth to heating, at different temperatures for a certain length of time in the laboratory..

OBJECTIVE: To evaluate physical and histological changes in teeth exposed to high temperatures and co-relates finding to the temperature.

Methods: Freshly extracted 54 permanent teeth of different age groups were collected and were subjected to temperatures of 100°C, 300°C, and 600°C. Teeth were then examined for any physical changes such as change in colour, texture, or morphology that occurred. Then the teeth were subjected for decalcification following which the tissues were kept for routine processing and were embedded in paraffin wax. Sections of 4 µm thickness were made and stained in hematoxylin and eosin (H and E) to correlate the microscopic findings to the temperature.

RESULT: Statistical analysis showed a significant association between temperature elevation and the degree of structural alteration observed in extracted teeth ($p < 0.05$).

CONCLUSION: The present study demonstrated that exposure to increasing temperatures produces progressive macroscopic and microscopic alterations in extracted human teeth. Changes such as discoloration, enamel cracking, dentinal disruption, carbonization, and fragmentation became more pronounced with rising temperature levels. Teeth exposed to higher temperatures showed severe structural destruction and loss of normal morphology.

Keywords: Forensic fire investigation, heat, histological patterns.

1. INTRODUCTION

Among many investigating procedures, fire investigation poses a challenging aspect as it involves investigations concerning the origin of fire, its cause, and the identification of the victims. In fire accidents, victim identification becomes nearly impossible owing to complete destruction of soft tissues. In such circumstances dental evidences may provide a clue to solve the mystery of victim identification, since dental structures are the last to get destroyed under extreme conditions, be it temperature, acid, or putrefaction. [1, 2] The reason being that they are extremely hard and are encased both hard and soft tissue casing. [1] A precise understanding of physical and histological changes in teeth subjected to high temperature can provide valuable clues in fire and crime investigations, when dental evidence remains. [3] Few studies have been found in literature regarding the physical and histological changes in teeth subjected to high temperatures. Hence the present study was undertaken to investigate structural damage in freshly extracted teeth to heating, at different temperatures for a certain period of time in the laboratory and; physical and microscopic findings were correlated to the temperature.

2. METHODOLOGY

2.1. Study Design

This experimental study investigated structural damage in freshly extracted teeth subjected to heating at different temperatures.

2.2. Objectives

To evaluate physical and histological changes in teeth exposed to high temperatures and correlate findings to temperature.

2.3. Data Collection Methods

- 54 freshly extracted permanent teeth were collected, cleaned, and fixed in 10% formalin.
- Teeth were categorized by patient age into groups A (<30 years), B (30-45 years), and C (>45 years).
- Teeth were heated to 100°C, 300°C, or 600°C for 15 minutes, then cooled.
- Physical changes (color, texture, morphology) were examined.
- Teeth were decalcified, processed, and sectioned for H&E staining.

2.4. Data Analysis

Physical and microscopic findings were correlated to temperature.

2.5. Limitations

- Study was conducted in a laboratory setting, may not reflect real-world fire conditions.
- Small sample size (54 teeth).
- Limited temperature range (100°C, 300°C, and 600°C).

3. RESULT

A total of 220 students took part in this with females (78.0%) and male of (22.0%). Age of the participants ranging from 18-25 years. In this study females were more likely to demonstrate perception in dissection room experiences than male. Significantly INTERNS showed greater familiarity with advanced applications than third year and final year students and interns.

AGE

	N	Minimum	Maximum	Mean	Std. Deviation
Age:	200	18	27	21.86	1.892

Gender

		Frequency	Percent
Valid	MALE FEMALE Total	44	22.0
		156	78.0
		236	100.0

Year of the study

		Frequency	Percent
Valid	III BDS		
	IV BDS	72	36.0
	INTERN	60	30.0
	Total	68	34.0
		200	100.0

Distribution and comparison of responses based on gender:

Item	Response	Males		Females		Chi-Square value	P value
		n	%	n	%		
Q1	1	2	33.3	4	66.7	0.486	0.922
	2	71	36.7	122	63.2		
	3	2	25	6	75		
	4	5	35.7	9	64.2		
Q2	1	12	34.3	23	65.7	1.211	0.750
	2	13	39.4	20	60.6		
	3	54	36.7	93	63.3		

	4	1	16.7	5	83.3				4
Q3	1	12	46.2	14	53.8	2.900	0.407	Q3	1
	2	15	39.5	23	60.5				2
	3	52	34.7	98	65.3				3
	4	1	14.3	6	85.7				4
Q4	1	18	41.9	25	58.1	2.226	0.527	Q4	1
	2	17	41.5	24	58.5				2
	3	43	33.6	85	66.4				3
	4	2	22.2	7	77.8				4
Q5	1	17	48.6	18	51.4	5.165	0.160	Q5	1
	2	13	44.8	16	55.2				2
	3	49	32.5	102	67.5				3
	4	1	16.7	5	83.3				4
Q6	1	13	48.1	14	51.9	4.972	0.174	Q6	1
	2	15	48.4	16	51.6				2
	3	50	31.8	107	68.2				3
	4	2	33.3	4	66.7				4
Q7	1	24	44.4	30	55.6	2.311	0.510	Q7	1
	2	12	36.4	21	63.6				2
	3	40	32.5	83	67.5				3
	4	4	36.4	7	63.6				4
Q8	1	21	41.2	30	58.8	3.071	0381	Q8	1
	2	11	42.3	15	57.7				2
	3	47	34.6	89	65.4				3
	4	1	12.5	7	87.5				4
Q9	1	27	46.6	31	53.4	5.544	0.136	Q9	1
	2	14	33.3	28	66.7				2
	3	38	33.9	74	66.1				3
	4	1	11.1	8	88.9				4
Q10	1	48	41	69	59	3.277	0.351	Q10	1
	2	5	41.7	7	58.3				2
	3	25	29.8	59	70.2				3

	4	2	25	6	75				4
Q11	1	17	37	29	63	1.378	0.711	Q11	1
	2	14	34.1	27	65.9				2
	3	47	37.9	77	62.1				3
	4	2	20	8	80				4
Q12	1	31	38.8	49	61.3	3.172	0.366	Q12	1
	2	10	45.5	12	54.5				2
	3	38	34.2	73	65.8				3
	4	1	12.5	7	87.5				4
Q13	1	32	39.5	49	60.5	13.115	0.004*	Q13	1
	2	16	64	9	36				2
	3	31	29	76	71				3
	4	1	12.5	7	87.5				4
Q14	1	32	39.5	49	60.5	13.115	0.004*	Q14	1
	2	16	64	9	36				2
	3	31	29	76	71				3
	4	1	12.5	7	87.5				4
Q15	1	32	39.5	49	60.5	13.115	0.004*	Q15	1
	2	16	64	9	36				2
	3	31	29	76	71				3
	4	1	12.5	7	87.5				4

$P \leq 0.05$ is statistically significant

Distribution and comparison of responses based on year of the study:

Item	Resp onse	I BDS		II BDS		III BDS		IV BDS		INTERN		Chi- Value	P- Value
		n	%	n	%	n	%	n	%	n	%		
Q1	1	6	21.4	4	14.2	3	10.7	4	14.2	11	39.2	25.533	0.012*
	2	18	14.4	25	20	17	13.6	32	25.6	43	34.4		
	3	4	13.7	5	17.2	5	17.2	2	6.8	13	44.8		
	4	6	20.6	4	13.7	2	6.8	8	27.5	9	31.0		
Q2	1	8	22.9	2	5.7	1	2.9	9	25.7	15	42.9	19.500	0.077
	2	4	12.1	6	18.2	2	6.1	9	27.3	12	36.4		
	3	22	15	30	20.4	24	16.3	25	17	46	31.3		
	4	0	0	0	0	0	0	3	50	3	50		
Q3	1	8	30.	3	11.5	1	3.8	6	23.1	8	30.8	18.924	0.090
	2	4	10.5	6	15.8	2	5.3	8	21.1	18	47.4		
	3	22	14.7	29	19.3	24	16	29	19.3	46	30.7		
	4	0	0	0	0	0	0	3	42.9	4	57.1		
Q4	1	10	23.3	8	18.6	4	9.3	8	18.6	13	30.2	13.442	0.338
	2	7	17.1	10	24.4	6	14.6	8	19.5	10	24.4		
	3	17	13.3	20	15.6	17	13.3	27	21.1	47	36.7		
	4	0	0	0	0	0	0	3	33.3	6	66.7		
Q5	1	9	25.7	4	11.4	1	2.9	6	17.1	15	42.9	14.976	0.243
	2	5	17.2	5	17.2	3	10.3	5	17.2	11	37.9		
	3	20	13.2	29	19.2	23	15.2	32	21.2	47	31.1		
	4	0	0	0	0	0	0	3	50	3	50		
Q6	1	9	33.3	3	11.1	1	3.7	5	18.5	9	33.3	14.721	0.257
	2	5	16.1	6	19.4	4	12.9	5	16.1	11	35.5		
	3	20	12.7	29	18.5	22	14	34	21.7	52	33.1		
	4	0	0	0	0	0	0	2	33.3	4	66.7		
Q7	1	15	27.8	9	16.7	7	13	11	20.4	12	22.2	18.549	0.100
	2	2	6.1	5	15.2	3	9.1	9	27.3	14	42.4		

	3	17	13.8	23	18.7	17	13.8	23	18.7	43	35		
	4	0	0	1	9.1	0	0	3	27.3	7	63.6		
Q8	1	14	27.5	9	17.6	8	15.7	11	21.6	9	17.6	22.160	0.036*
	2	3	11.5	6	23.1	1	3.8	3	11.5	13	50		
	3	17	12.5	23	16.9	18	13.2	29	21.3	49	36		
	4	0	0	0	0	0	0	3	37.5	5	62.5		
Q9	1	15	25.9	13	22.4	9	15.5	11	19	10	17.2	23.238	0.026*
	2	3	7.1	9	21.4	3	7.1	10	23.8	17	40.5		
	3	16	14.3	16	14.3	15	13.4	22	19.6	43	38.4		
	4	0	0	0	0	0	0	3	33.3	6	66.7		
Q10	1	22	18.8	28	23.9	15	12.8	22	18.8	30	25.6	25.928	0.011*
	2	0	0	1	8.3	0	0	2	16.7	9	75		
	3	12	14.3	9	10.7	12	14.3	19	22.6	32	38.1		
	4	0	0	0	0	0	0	3	37.5	5	62.5		
Q11	1	13	28.3	3	6.5	7	15.2	9	19.6	14	30.4	35.896	0.001*
	2	0	0	7	17.1	2	4.9	15	36.6	17	41.5		
	3	21	16.9	28	22.6	18	14.5	19	15.3	38	30.6		
	4	0	0	0	0	0	0	3	30	7	70		
Q12	1	14	17.5	9	11.2	11	13.8	18	22.5	28	35	31.675	0.002*
	2	1	4.5	1	4.5	0	0	5	22.7	15	68.2		
	3	19	17.1	28	25.2	16	14.4	21	18.9	27	24.3		
	4	0	0	0	0	0	0	2	25	6	75		
Q13	1	13	16	10	12.3	8	9.9	17	21	33	40.7	34.863	0.001*
	2	0	0	3	12	0	0	5	20	17	68		
	3	20	18.7	25	23.4	19	17.8	22	20.6	21	19.6		
	4	1	12.5	0	0	0	0	2	25	5	62.5		
Q14	1	13	16	10	12.3	8	9.9	17	21	33	40.7	34.863	0.001*
	2	0	0	3	12	0	0	5	20	17	68		
	3	20	18.7	25	23.4	19	17.8	22	20.6	21	19.6		
	4	1	12.5	0	0	0	0	2	25	5	62.5		
Q15	1	13	16	10	12.3	8	9.9	17	21	33	40.7	34.863	0.001*
	2	0	0	3	12	0	0	5	20	17	68		
	3	20	18.7	25	23.4	19	17.8	22	20.6	21	19.6		
	4	1	12.5	0	0	0	0	2	25	5	62.5		

$P \leq 0.05$ is statistically significant

4. DISCUSSION

Fire investigation is the multidisciplinary basis of the exploration, which involves investigations concerning the origin of fire, its cause as well as the identification of victims. 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. A precise understanding of physical and histological changes in teeth subjected to high temperature can provide valuable clues in fire and crime investigations, when dental evidence remains.[1-3] 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. The establishment of forensic odontology is a unique discipline that has been attributed to Dr. Oscar Amoedo (Father of Forensic Odontology) who identified the victims of fire accident in Paris, France in 1897. Controlled laboratory incineration of teeth and their histologic evaluation have the potential to create valuable data for these dental tissues.[4,5] Norrlander classified body burns into five categories: (1) Superficial burns; (2) destroyed epidermis areas; (3) destruction of the epidermis, dermis, and necrotic areas in the underlying tissues;(4) total destruction of the skin and deep tissue; and (5) burned remains.[6] Teeth are considered to be the most indestructible components of the human body and they have the highest resistance to most environmental effects like fire, desiccation, and decomposition, the reason being their structure and composition. Considering the above facts the present study was aimed to investigate structural damage in freshly extracted teeth to heating, at different temperatures for a

certain length of time in laboratory. In the present study, at 100°C, H and E stained sections dentin demonstrated uniform widening of the tubules and showed cohesion of dentinal tubules with splitting between the clusters giving rise to “wicker basket pattern” in few areas. At 300°C, dentin demonstrated irregular dilatations of tubules giving rise to a pattern referred “vapor bubble pattern” along with “wicker basket pattern” in many areas. Teeth subjected to 600°C temperature disintegrated completely during decalcification and were ineffectual for histological study. Teeth with stand considerable amount of heat due to their highest resistance to most of the environmental effects like fire, desiccation, and decomposition, the reason being their structure and composition where enamel is made up of 96% inorganic, whereas dentin is composed of 76% inorganic, and 20% organic component, mainly type 1 collagen. The collagen in dentin is stabilized by the inorganic content against any thermal denaturation and shrinkage to a certain extent.

At higher temperatures, the collagen is destroyed leaving behind inorganic component, which is lost during decalcification. The higher the temperature the more is the destruction of collagen framework and more is the disintegration of tissue in decalcification fluid. [1,7,8] In the present study, the widening of dentinal tubules was seen at 100°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. Similar changes may be seen even at any temperature between 100°C and 300°C. Though temperature below 300°C is not encountered in cases of fire disasters or crimes, the study of teeth heated to this temperature may reveal some interesting observations. Wicker basket pattern was seen at 100°C in few areas and at 300°C in many areas, which could appear due to loss of inorganic matrix from decalcification, shrinkage due to drying, and incineration and consequent loss of intertubular organic matrix. The presence of uniform splitting along the transverse axis of dentinal tubules at a distance of 15-20 µm was consistent with the distance between incremental lines of Von Ebner seen in dentin. This finding emphasized the fact that incremental lines indeed are the weakest areas in the hard tissues. There was faster decalcification of younger teeth when compared with older teeth in the present study, which could be due to the fact that inorganic content of younger teeth is lesser when compared with older teeth, as inorganic content increases with age.

5. CONCLUSIONS

Evaluation of incinerated dental remains may provide additional forensic investigative avenues in victim identification 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.

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