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Macroscopic and microscopic effects of elevated temperatures on unrestored and restored teeth: An in-vitro forensic study

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ABSTRACT

Background: The present "in vitro" study was done to observe the effects of high temperatures on teeth restored with different restorative materials and unrestored teeth. **Aim and Objective:** This study aims to investigate the nature of damage to unrestored and restored teeth subjected to high temperatures. The main objective of the study is to assess whether it could serve as an aid in identification of human dental remains in forensic odontology for cases of incineration by means of comparison between ante-mortem and post-mortem records. **Materials and Methods:** The present study was conducted on 125 extracted premolar teeth which were later on divided into five groups (25 premolar teeth each) as control group, group of teeth restored with class I amalgam restorations, group of teeth restored with class I composite/adhesive system restorations, group of teeth restored with Class I glass ionomer restoration and group of teeth restored with metal ceramic crown restored teeth. The restored teeth were placed in a furnace and heated at a rate of 10°C/min. The effects of the predetermined 200°C, 400°C, 600°C, 800°C, 1000°C and 1200°C temperatures were examined macroscopically and then microscopically by means of a stereomicroscope.Data obtained in the present study was subjected to the statistical analysis using SPSS 18 software for one-way ANOVA and independent t-test (paired). **Result:** The class I restorations made of amalgam could be identified till 1200°C because they maintain their shape despite the disintegration of the crowns along with PFM restoration with disintegration of remaining restorations along with tooth. Systematic approach toward the preservation of charred dentition, as at times could prove to be the best evidence for identification of those who are extensively burned. **Conclusion:** Pre-planned and systematic approach toward the preservation of charred dentition is important as at times it could act as a potential evidence for the identification of those who are severely burnt.

Key words: Dental identification; Forensic sciences; Temperatures

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INTRODUCTION

The science of dentistry as related to the law is known as forensic dentistry or forensic odontology. Forensic dentistry involves dentist's participation in assisting legal and criminal issues focussing mainly on identification of human beings, in cases of mass disaster where the dead body is usually badly mutilated.[1]

Comparative Dental identification involve use of both ante-mortem and post mortem records to assist in identifying the victims of violence, disaster or other mass tragedies.[1] In many cases the tentative identification of the individual is unknown the correlation of dental records to observed restorative treatment provides the best evidence for investigation of unknown remains.[1]

Teeth are the indestructible components of the human body and have unique highest resistance to most of the environmental effects like fire, desiccation, decomposition.[1] Norlander classified body burns in five categories: (1) superficial burns, (2) destroyed epidermis areas,

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(3) destruction of the epidermis and dermis and necrosis areas in underlying tissues, (4) total destruction of the skin and deep tissues and (5) burned remains. Since the destruction of burned victims of the third, fourth and fifth category, is extensive, such remains cannot be identified by conventional methods like visual recognition or fingerprints.

Therefore, in cases of natural as well as man-made disasters, teeth help in positive personal identification for victims in an otherwise unrecognizable body.[2] The present study was conducted to observe the effects of high temperatures on teeth restored with different restorative materials and unrestored teeth.

Aims

1. To evaluate and compare the macroscopic & microscopic features of unrestored, restored and endodontically treated extracted teeth, before and after exposure to an experimental range of high temperatures.
2. To investigate the nature of damage to unrestored and restored teeth subjected to high temperatures.

Objectives

1. To assess whether the study can serve as an aid in identification of human dental remains in forensic odontology for cases of incineration by means of comparison between ante-mortem and post-mortem records
2. To evaluate whether the study can highlight the significance of microscopic study of dental tissues as a determinant of tooth and thereby using structural damage to dental tissues as a valuable clue to the nature and severity of fire for criminal investigations.

MATERIALS AND METHODS

This study was conducted at Department of Pathology, College of Medical Sciences-Teaching Hospital, Bharatpur, Chitwan, Nepal. Ethical clearance (IRC-Ref No.:2019-037) was obtained from the institutional review committee. One hundred twenty-five non-carious teeth, extracted for orthodontic reasons were selected for this study. Teeth were then disinfected in a 5% sodium hypochlorite solution for 1 hour and then stored in sodium chloride 0.9% solution at 37°C for up to 15 days. These were then divided into two groups Group I (control group=25 teeth) and Group II (restored teeth=100 teeth). Class I Cavities (faciolingual width 1 - 1.5mm and a depth of 1.5 - 2mm) were prepared in group II teeth and these were restored and further subdivided into four sub groups based on restoration present in them as –

Sub group A: Amalgam (DPI) restored teeth (25 extracted teeth).

Subgroup B: Composite (Dentsply) restored teeth (25 extracted teeth).

Subgroup C: Glass Ionomer Cement (Type 2 Restorative material --GC Corporation) restored teeth (25 extracted teeth).

Subgroup D: Metal Ceramic Crown restored teeth (25extracted teeth).

After restoration were done all the teeth of Group I and Group II were then again immersed in 0.9% NaCl solution at 37°C for 15 days. After 15 days these teeth were then taken out from NaCl solution. Then mesio-distal dimension of the teeth of both groups were then recoded with the help of digital Vernier calliper (Yamayo japan).All these teeth were then mounted on blocks made by phosphate bonded investment material**.** Then all these teeth were then exposed to different temperatures 200°C, 400°C, 600°C, 800°C, 1000°C, and 1200°C in muffle ceramic furnace (TEMP 1400°C Unident). The temperature of the furnace was changed at the constant rate of 10 degrees centigrade/minute. As soon as each target temperature (200°C, 400°C, 600°C, 800°C, 1000°C, and 1200°C) was reached, the corresponding set were removed and allowed to cool at room temperature. Before exposing the teeth to higher range of temperature the furnace was preheated to previous temperature and then when that temperature was reached the teeth were placed for next cycle of higher temperature.

The teeth and restorations were then analyzed macroscopically by direct vision of the samples and finally by stereomicroscope using the following parameters–:

For teeth

1. Size of the crown (Mesiodistal width of the crown)
2. Color of the crown (from yellowish white or whitish yellow → brown → black → greyish blue → chalky white)
3. Cracks and fissures in the crown (Present or Absent)
4. Fragmentation and fractures in the crown. (Present or Absent).

For restorations

1. Shape of the restoration
2. Presence of cracks or fissures (Absent or Present)
3. Shattering or detachment of the filling from the tooth. (Present or Absent).

RESULTS

After exposing the extracted teeth of both the Group I (unrestored) & Group II (restored) to 200°C-1200°C temperatures the macroscopic variations (Tables 1-5) were recorded by visual examination. Along with the macroscopic examination, stereomicroscopic assessment

(Table 6 and 7) was also done at different temperatures to analyse the microscopic changes (Figures 1-8).

Estimation of mesiodistal diameter of teeth was done to analyse the loss of tooth material when being exposed to different graded high temperatures which indicated that for all the groups and subgroups there was decrease in mesio-distal dimension at increased temperatures except for Sub group D (metal ceramic restored teeth) where after 600°C there was increase in the mesio-distal dimension. Shrinkage was observed in the tooth material as the temperature was increased. In all the groups and sub groups positive shrinkage was observed but in case of Sub group D (metal ceramic restored teeth) negative shrinkage was seen which meant increase in the dimensions of the concerned tooth. Change in the colour of the crown was observed on exposure to increased temperature from yellowish white or whitish yellow →brown → black → greyish blue → chalky white. There was observable change in the color of the root also. Fragmentation of the crown of the extracted teeth was seen in all groups and sub groups except Sub group D (metal ceramic restored teeth) at temperature above 400°C. In case of Sub Group D (metal ceramic restored teeth) surface of crown showed mere crackling. Cracks were observed on the surface of the crown and root of teeth of all the groups and sub groups from and after 400°C except for Sub group D (metal ceramic restored teeth) where cracks were observed from and after 600°C.

Data obtained in the present study was subjected to the statistical analysis using SPSS 18 software for one-way ANOVA and independent t-test (paired) and was subsequently done to ascertain the mean and standard error of mean of experimental groups.

Estimation of Mesiodistal dimension of the teeth was also done using a Vernier caliper. The results were interpreted on the basis of comparison between different groups in terms of loss of tooth material by comparing the Mesiodistal dimensions with those obtained after exposure to higher temperature.

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.[2] At times, victim identification in fire disasters becomes nearly impossible owing to complete destruction.[3] The teeth used in the experiments described should were of the same type in order to enable comparison between observations at different temperatures. For our study premolar teeth were chosen. These premolar teeth were those which have been

Table 1: Macroscopic changes in Group I (unrestored teeth) when exposed to 200°C-1200°C

Temperature → / Group/Subgroup →	200°C	400°C	600°C	800°C	1000°C	1200°C
Group I (Control Group) Unrestored Teeth						
Crown	Color of the crown remained unchanged as whitish yellow	Color of the crown changes from whitish yellow to yellowish brown with blackened fissures.	Crown is fragmented and color of the crown changes to greyish white.	Crown of the tooth samples are fragmented & color of the crown changes to whitish black	Color of the Crown are fragments appears to be whitish grey and it is nearly converted to ash	Color of the ashified crown changes from whitish grey to chalky white.
Root	Color of the root is yellowish brown.	Color of the root of the teeth changes from yellowish brown to brownish black.	Root is intact and appears blackish white.	Color of the root changes from blackish white to whitish black	Color of fragmented root appears to be whitish grey and root fragments are nearly converted to ash.	Color of the fragmented root of the tooth samples changes from whitish grey to chalky white with entire tooth structure converted to white solid ash
Cracks	Cracks were absent	Cracks appear on the crown and root surface	Cracks appear on the crown and root surface	Cracks appear on the fragmented crown and root surface	Cracks are present on the fragmented crown and root surface	Teeth are converted to solid ash

Table 2: Macroscopic changes in Sub Group A-Amalgam restored teeth (Group II) when exposed to 200°C - 1200°C

Temperature → Group/Subgroup ↓	200°C	400°C	600°C	800°C	1000°C	1200°C
Group II Sub Group A (Amalgam Restored Teeth)						
Restoration	Loss of smoothness and brightness at the surface of the restoration.	Loss of surface shine and lustre of the restoration.	Restoration surface is blackened and evidence of amalgam restorative material attached to the broken tooth fragments.	Amalgam restoration seen attached to the fragmented crown pieces	Globules of amalgam are seen	Clusters of remaining amalgam restoration care seen.
Crown	Color of tooth crown is yellowish white	Color of the crown of the tooth changes to yellowish brown or black Occlusal surface of the tooth along with restoration are blackened.	Color of the broken crown pieces of the teeth appears to be black.	Color of the fragmented crown appears bluish white.	Color of the fragmented crown segments changes from bluish white to greyish white or white.	Color of the fragmented crown color of the crown changes from greyish white to Chalky white with slight pinkish hue.
Root	Color of the root of the tooth appears to be yellowish white	Root appears to yellowish brown to brownish black.	Roots color changes to yellowish black from yellowish brown. white color of the root	Root color appears bluish white	Color of the fragmented root is greyish white root	Color of the roots changes from greyish white to Chalky white Both crown and root are converted to white ash.
Cracks	Cracks are absent	Crown surface shows few horizontal cracks.	Cracks are evident on the crown and root surface	Cracks are evident on the crown and root surface	Cracks are evident on the crown and root surface	Large number of cracks are present on remaining tooth samples
Marginal Seal	Altered marginal seal was seen	Marginal seal alteration increased	Restoration seems to be detached from the tooth	Restoration is detached from fragmented tooth	Restoration is detached from tooth samples	Restoration is detached & scattered in sample

Table 3: Macroscopic changes in Sub Group B‑Composite restored teeth (Group II) when exposed to 200°C ‑ 1200°C

Temperature → / Group/Subgroup ↓	200°C	400°C	600°C	800°C	1000°C	1200°C
Sub Group B (Composite restored teeth)						
Crown	Color of tooth crown is yellowish white.	Color changes to yellowish brown. In 7 samples the crown surface showed brown coloured patches	Colour of crown fragments turns to brownish black/ black.	Color of the fragments of crown changed from black	Color of the crown fragments changed to white color.	Color of the broken crown turns white coloured
Root	Root color is yellowish white.	Color turns yellowish brown	Color turns blackish coloured.	Coloured to white/ bluish white.	Color of the root fragments changes to white color	Color changes to white. Root fragments are converted to solid ash.
Restoration	Restoration exhibited bluish hue on the surface.	Colour of the filling material changed to light brown. The filling material shows marginal shrink.	Color of filling material surface changed from light brown to brownish black.	Color change to white/bluish white. No traces of filling material found	No traces of filling material found	No traces of restoration were found
Cracks	Fine cracks were present in 5 samples on crown surface	2 samples showed presence of cracks in the filling material	In 8 samples cracks were observed on the tooth crown.	Fragmented tooth	Fragmented tooth	Fragmented tooth

extracted as part of orthodontic treatment and also because they were free from decay. The choice of premolar teeth was considered to be appropriate as premolars belong to the pluri-radicular group and also these are better preserved in a fire than incisor teeth, which are rapidly destroyed.[4]

Merlati et al (2002)[5] in their study found that unrestored teeth when exposed to 200°C, showed alteration in the colour from yellowish white to light yellowish brown. In our study at 400°C the colour of root was brownish black. Our study showed that at 600°C the crown was fragmented and the root was intact with dark brown colour with black stains which was in accordance with study done by Bagdey et al (2014).[6] Stereomicroscopy (20X) at 400°C revealed micro-fractures and cracks on the crown and root surface which was similar to the findings of Merlati et al (2002).[5] At 600°C the colour of crown fragments in our study was found to be dark brown with black pigmentation which was in accordance with study done by Moreno et al (2009).[3] Stereomicroscopy (20x) at 600°C revealed numerous minute fractures on the root which was similar to findings of study by Bagdey et al (2014).[6] In our study at 800 ˚C the colour of crown and root of the unrestored teeth was greyish which was contrary to findings of Merlati et al (2002).[5] Stereomicroscopy (20X) at 800°C in our study showed presence of vertical cracks on the root surface. Stereomicroscopy (20X) at 1000°C in our study showed numerous micro- fractures which was in accordance with findings of Merlati et al (2002).[5]

The results of study done by Moreno et al (2009)[3] revealed that composite fillings could be identified till 800°C and amalgam fillings till 1000°C but it was contrary to our study findings where the composite restoration could be identified till 600°C only and the amalgam restoration was identifiable till 1200°C. The amalgam in our study showed loss brightness, marginal seal and bubbles on the surface at 200°C which was in accordance with study done by Merlati et al; (2004),[7] Moreno et al; (2009),[3] Vazquez L et al (2012).[8] The loss of the marginal seal was due to the evaporation of mercury and loss of organic matrix. Bubble formation on the restoration surface indicated the evaporation of mercury on exposure to high temperature.[9]

In our study at 400°C the colour of the crown was light brown or black which was simulated findings of the study by Merlati et al (2004).[7] The black appearance of the crown was due to the carbonization process.[10] Stereomicroscopy (20x) at 400°C showed loss of marginal seal which was similar to findings of Bagdey et al; (2014).[6] At 600°C amalgam showed opaque blackened appearance which matched findings of study by Moreno et al (2009).[3]

Moreno et al (2009)[3] in their study found that at 800°C amalgam restoration shows corrugated surface with fissures

Table 4: Macroscopic changes in Sub Group C-GIC restored teeth (Group II) when exposed to 200°C - 1200°C

Temperature → Group/Subgroup ↓	200°C	400°C	600°C	800°C	1000°C	1200°C
Sub Group C (GIC restored tooth)						
Restoration	Loss of surface lustre of restoration. The restoration extruding from the tooth in 3 samples. Color of the restorative surface was off-white.	Restoration color changes to yellowish brown with presence of surface cracks	No evidence of restoration	Absent	Absent	Absent
Crown	Color unchanged with yellowish white appearance.	Color changes to light yellowish brown in few samples and dark yellowish brown in 18 samples.	Colour of the crown segments changes to grey. 4 samples showed dark brown color of broken crown.	Color of the fragmented crown changes from grey to bluish white.	Color of fragmented crown changes from bluish white to greyish white.	Color of crown turns to chalky white colour.
Root	Colour appears to be light yellowish brown.	Colour changes to black	Color of the root fragments appeared grey	Color of the root changes from grey to bluish white with off-white color in few.	Color changes to white coloured with both crown and root fragments converted to solid ash.	Color of the root changes to chalky white Both crown and root are converted to solid ash.
Cracks	Absent	Presence of cracks on the surface of the tooth on few samples	Present on crown and root surface	Present on crown and root fragments	Present on remaining crown & root fragments	Complete fragmentation of the tooth
Marginal integrity	Present	Loss of marginal seal	Absent	Absent	Absent	Absent

Table 5: Macroscopic changes in Sub Group D-metal ceramic crown restored teeth (Group II) when exposed to 200°C - 1200°C

Temperature → Group/Subgroup ↓	200°C	400°C	600°C	800°C	1000°C	1200°C
Sub Group D (metal Ceramic crown restored tooth)						
Surface Glaze	Present	Present	Slight loss of surface shine.	Decreased surface shine.	Increased gloss on the surface	Gloss is increased
Crown	Color of the crown remained unchanged as Creamish White	Color of the tooth crown remains Creamish white.	Color of the crown changed to dark Creamish white.	Crown color changes to light Creamish brown	Color of the crown changes to dark Creamish brown.	Color of the crown changes to light brown with absence of fissures and grooves. Separated ceramic coating with white patches and bubbly globular shape of crown.
Root	Color changes to yellowish white	Color changes to yellowish brown.	Color changes to dark yellowish brown with few samples exhibiting metal exposure	Color changes to bluish white with few samples exhibiting metal exposure.	Color changes to white. In 9 samples color was greyish white.	Color changes to chalky white.
Cracks	Absent	Root surface in 6 samples exhibited cracks	Root surface exhibited numerous cracks	Present on the crown and root interface	Present on the crown, and root interface	Present on both the crown and root.

Table 6: Stereomicroscopic changes in Group I (unrestored teeth) and Sub Group A-Amalgam restored teeth (Group II) when exposedto 200 ˚C- 1200 ˚C

Temperature → Group/Subgroup ↓	200°C	400°C	600°C	800°C	1000°C	1200°C
Group I						
Unrestored teeth (Control Group)	The root surface showed micro cracks or fractures.	Fine cracks are evident on the crown surface and extended cracks on the root surface.	Numerous minute micro fractures on the root Surface.	Vertical cracks chalky white root.	Micro-fractures were evident on the crown surface.	The crown surface of the tooth shows numerous fissures and root surface also shows cracks. Irregularities present on the broken tooth. 6 samples show widened cracks with yellowish discoloration.
Group II				**Restored teeth**		
Subgroup A (Amalgam restored teeth)	Evidence of bubbles on the surface of the filling.	Evidence of loss of marginal seal	Appearance of fractures on the surface of the filling which maintained its shape. Grooves were seen in the residual cavity walls.	Cracks were evident on the restoration with increased loss of marginal seal. Remnants of cavity that contained filling could be identified.	Irregular remaining tooth surface beneath the restoration	Crown surface shows pinkish appearance with deposits of metal near root surface.

Table 7: Stereomicroscopic changes in Sub Group B-Composite restored teeth (Group II), Sub Group C-GIC restored teeth (Group II), Sub Group D-metal ceramic crown (Group II) when exposed to 200°C- 1200°C

Temperature → Group/Subgroup	200°C	400°C	600°C	800°C	1000°C	1200°C
Subgroup B (Composite restored teeth)	Loss of marginal seal was evident.	Evidence of surface marking on the cavity surface containing the filling.	Characteristic grooves of milling were seen.	Remnants of the cavity that contained the filling could be identified but no evidence of restoration.	Numerous cracks and micro fractures were evident.	The crown surface is greyish white internally cracks present on crown and root surface.
Subgroup C (GIC restored teeth)	Loss of marginal seal was seen.	Numerous cracks are evident on the surface of root surface.	Presence of deep fracture lines along the length.	Loss of distinction between the anatomical crown and the root.	The root surface shows cracks and micro fractures.	The surface shows numerous cracks. Surface appears irregular.
Subgroup D (PFM) restored teeth)	Numerous areas of minute depressions can also be seen on the surface of the crown	Granular surface appearance was seen. Crack lines are evident on the surface of the crown. The point of attachment of crown to root appears to have developed numerous cracks.	Appearance of bubble-like structures on the surface of the crown.	There is presence of crack lines on the crown surface. Root surface shows numerous cracks	The crown surface shows well evident crack lines and white patches	The crown develops increased granular appearance and numerous bubbles. Cracks can be seen on the ceramic surface

but this finding was absent in our study. In study by Merlati et al (2002)[5] the crown was fragmented and restoration was recovered at some distance from shattered tooth and this was in accordance with the findings or our study. In our study at 800°C globules of amalgam restoration termed as "silver bullets" were absent which were seen in studies by Vazquez L et al (2012)[8], Moreno et al (2009).[3] In our study Stereomicroscopy (20X) at 400°C revealed loss of marginal seal which was in accordance with study by Bagdey et al (2014).[6] Study by Moreno et al (2009) presented with one finding of presence of golden thread that surrounds the occlusal surface and cusps between 800°C -1200°C.[3] This feature was absent in our study.

In our study at 200°C the stereomicroscopy (20X) showed loss of marginal seal which was similar to findings of study done by Merlati et al (2002).[5] When the composite resin restored tooth was heated further to 400°C the colour of restoration changed to light brown and this finding was in accordance with study done by Vazquez L et al (2012).[8] In our study marginal retraction and cracks were observed in composite resin at 400°C which was in accordance with study done by Vazquez L et al; (2012).[8] Stereomicroscopy (20X) at 400°C showed cavity surfaces containing the composite with numerous surface markings which was in accordance with findings of Merlati et al (2002).[5] In our study composite restoration was non identifiable after 600°C which was in accordance with study by Merlati et al (2002)[5] but was contrary to results of studies by Vazquez L et al (2012).[8] Stereomicroscopy (20X) at 600°C showed characteristic grooves created due to instrumentation and this findings was similar to findings of Merlati et al (2002).[5] Stereomicroscopy (20X) at 800°C showed the outlines of cavity remnants and this was similar to findings of Merlati et al (2002).[5] Stereomicroscopy (20X) at 1000°C in our study showed numerous cracks and micro-fractures on the root surface which was similar to findings of study by Merlati et al(2002).[5]

In our study at 200°C loss of marginal seal was seen with a stereomicroscope (20X) and this finding was in accordance with study done by Bagdey et al(2014).[6] In our study at 400°C the colour of the crown and Glass Ionomer Cement restoration changed to yellowish brown and colour of the root changed to black. These findings were in accordance with study done by Bagdey et al (2014).[6]

Metal Ceramic crowns in our study at 600°C showed slight discolouration with pitted surface with exposure of underneath metal. These findings were in accordance with findings of study done by Patidar et al (2010).[11] In our study at 1200°C the ceramic overflowed with loss of morphology of the crown. There was change of glaze along with separation of ceramic small flakes along with discolouration. There crown was complete displaced from root. The crown showed

Figure 1: Macroscopically fragmented chalky white crown and chalky white root observed in unrestored teeth at 1200°C

Figure 2: Macroscopically chalky white crown and root with small clusters of restoration observed in amalgam restored teeth at 1200°C

Figure 3: Macroscopically globular shaped crown with loss of surface morphology and white coloured root surface in metal ceramic crown restored teeth observed at 1200°C

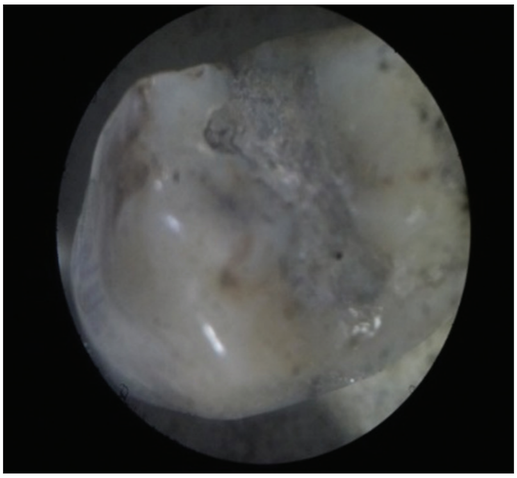

Figure 4: Steromicroscopically loss of marginal seal of the restoration in amalgam restored tooth observed at 400°C

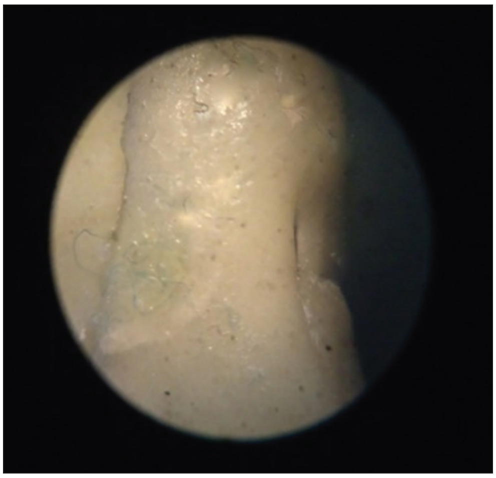

Figure 5: Steromicroscopically crown surface with pinkish appearance and clusters of restoration observed in amalgam restored tooth at 1200°C

Figure 6: Steromicroscopically loss of marginal seal of the restoration in GIC restored tooth observed at 200°C

patchy pattern.[12] These findings were similar to findings of study by Patidar et al (2010).[11] The metal ceramic crowns due to their high strength and resistance to wear resisted exposure to high temperature without undergoing many changes.

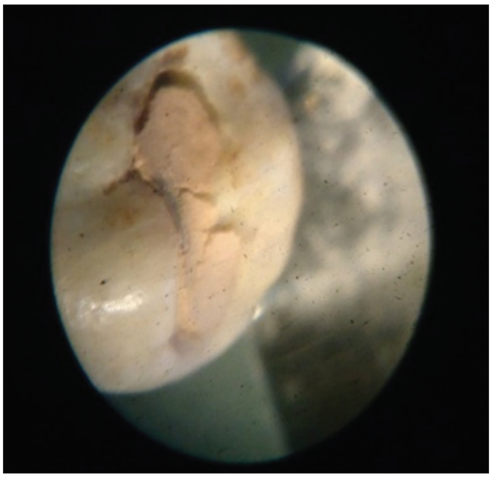

Figure 7: Steromicroscopically granular appearance on the surface of the crown of metal ceramic crown restored tooth observed at 400°C

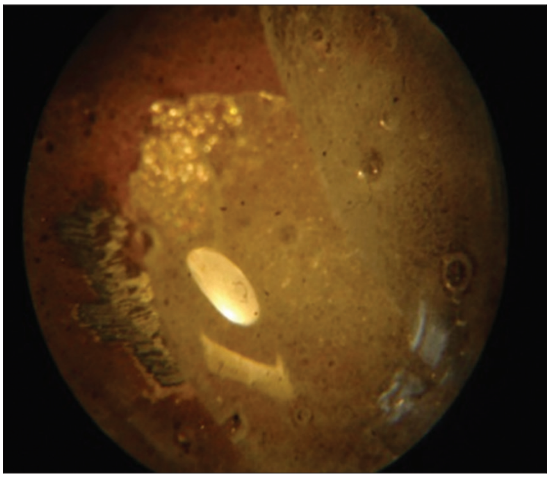

Figure 8: Steromicroscopically globular shaped crown with presence of granularity, numerous bubbles and cracks on the surface of metal ceramic crown restored tooth observed at 1200°C

When the teeth whether unrestored or restored were heated there occurs reduction in the mesio-distal dimension of tooth or in other words there occurs shrinkage of tooth material.[13] The average volumetric shrinkage when observed radiographically between 400°C-1000 °C ranged from 4.78% to 32.53%.[14]

In our study also the assessment of the mesio-distal diameter of the tooth was done with the help of digital Vernier calliper and on the basis of the mesio-distal dimension obtained percentage shrinkage was calculated using the formula:[14]

% Shrinkage= [(Original dimension- Altered dimension)/ original dimension] x 100[14]

Abnormal behaviour was seen in case of metal ceramic crown restored teeth it was seen that the % shrinkage showed fluctuating pattern with a decrease from preheating -600°C and after that there was increase in the dimension of crown when the temperature was increased from 600°C -1200°C. The increase in the dimension after are due to the expansion of metal underneath followed by overflowing of overlying ceramic.

In our study, once the pre-determined temperatures were reached, the samples were removed from the oven and allowed to cool at room temperature. The materials were therefore subjected to only one controlled and limited thermal shock.[14]

The teeth are known to survive higher temperatures and the effect of heat on teeth in reality is further complicated by the duration of exposure to high temperatures. As the teeth show resistance to the higher temperatures they could be efficiently used as a tool for forensic investigations.[7]

CONCLUSION

The progressive colour alterations and the values of average shrinkage it might be possible to predict the ante- mortem size of the teeth, thereby supporting the odontological identification process in cases where only isolated teeth are present. Of the all dental filling restorative materials amalgam has the potential to resist up to 1200°C temperature. Other restorative filling materials like Composite, GIC were not able to show enough resistance against high temperature. Metal ceramic crown start showing change after 800°C by development of crack lines and exposure of underneath metal and at 1200°C it starts cracking.

This study highlighted the importance of the pre-planned and systematic approach toward the preservation of charred dentition, as at times it could act as a potential evidence for the identification of those who are severely burnt.

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