

Effect of high temperature on crowns as post-endodontic restoration in forensic analysis: An *in vitro* study

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ABSTRACT

Fire is one of the most common causes of morbidity and mortality throughout the world. When physical or finger print identification is not possible in cases of massive disasters, forensic odontology comes into play. Teeth restored with crowns serve as a valuable tool in such situations. The aim of this study was to assess the effects of high temperature on endodontically treated teeth restored with all ceramic (zirconia) and metal ceramic crowns. This study was conducted on 9 extracted molars and premolars, which were divided into two groups. Group 1: Endodontically treated molars and premolars restored with all-ceramic crown and Group 2: Endodontically treated molars and premolars restored with metal ceramic crowns. In this study, at 400 and 800°C, there were color changes in both the crowns placed and also disintegration of the teeth. Beyond 1100°C, the tooth completely disintegrated leaving behind both the crowns suggestive of its remarkable aid in forensic analysis. This study can, therefore, imprint the importance of pre-planned and systematic approach toward preservation of dental records as it proves to be a good evidence of identification.

Keywords: Forensic odontology, human identification, endodontically treated teeth, crowns, all ceramic, metal ceramic, high temperature

Introduction

Human identification by forensic odontological analysis is considered to be the most challenging and reliable method over the decades.^[1,2] When the damage is caused due to heat, forensic odontology has been of vital use.^[3-5]

Fire remains as one of the major causes of morbidity and mortality worldwide.^[6,7] Norrlander has classified body burns into five categories: (1) Superficial burns (2) destruction of epidermis region (3) destruction of epidermis, dermis and presence of necrotic areas in the underlying tissues (4) complete destruction of the skin and deep tissue, and (5) burnt remains.^[8,9]

Identification of burnt remains of bodies starts with the objects that have been left with body. Teeth have been considered as the most indestructible component in the human body and are said to have the highest resistance to fire, acids, desiccation, and decomposition because of their composition and a protective layer of soft tissues covering them. Teeth tend to survive at most natural disasters and act as a vital identification in situations where bodies become unrecognizable.^[10,11] Burnt victims are usually unrecognizable and the conventional methods such as face and fingerprint recognition fail to play a role identification that is when odontologists are called for assistance.^[12]

Over the past few decades, restoration of endodontically treated teeth has become a vital part of dentistry.^[13] Crowns are being placed in both anterior as well posterior teeth and have become a trend of replacing metal-based alloys with materials such as ceramics since these reproduce the closest appearance to natural teeth. Therefore, the chances of individuals who are treated in contemporary dental practice will tend to have these materials in their mouth.^[8] Previous studies have compared the effects of heat on various dental materials used in the oral cavity up to about 100–1000°C.^[9,14] Therefore, the aim of this study was to determine the effects of high temperature on endodontically treated teeth restored with all-ceramic and metal ceramic crowns.

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Materials and Methods

In this study, 9 extracted molars and premolars, disinfected with 5% sodium hypochlorite solution for 1 h, were divided into two groups. The two most commonly used crowns include all ceramic and metal ceramic crowns.

Group I: Nine molar or premolar teeth are endodontically treated and restored with all ceramic (zirconia) crowns.

Group II: Nine molar or premolar teeth are endodontically treated and restored with metal ceramic crowns [Figure 1].

Erosive, grossly decayed, fractured, and/or previously treated extracted teeth were excluded.

To avoid experimental bias, access opening was done, working length was determined using K-files (Mani, Tochigi, Japan) and cleaning and shaping was done ProTaper Universal rotary files (Dentsply Maillefer, Ballaigues, Switzerland) followed by obturation (Figure 4) and restored with composite resin restoration, [Figures 2-4] followed by the respective crowns.



Figure 1: Nine molars and premolars used in the study

After restoration, all samples were immersed in 0.9% sodium chloride solution at room temperature for 1 week to stimulate oral environmental conditions before further tests.

All teeth were then placed in a burnout furnace at different predetermined temperatures –400, 800, and 1200°C- reached an incremental rate of 30°C every minute.

Once the desired temperature was reached, the samples were maintained inside the furnace for about 15 min, after which they were removed and left to cool at room temperature. Therefore, all the teeth were exposed to high temperatures for a standardized period of time.

Results

The teeth samples were subjected to incineration at three different temperatures at various durations of time.

- At 400°C: The teeth samples were placed in the burnout furnace and heated up to 400°C, after which the temperature was maintained at the same and changes in the teeth were observed. The crown of the samples seemed to remain intact, although

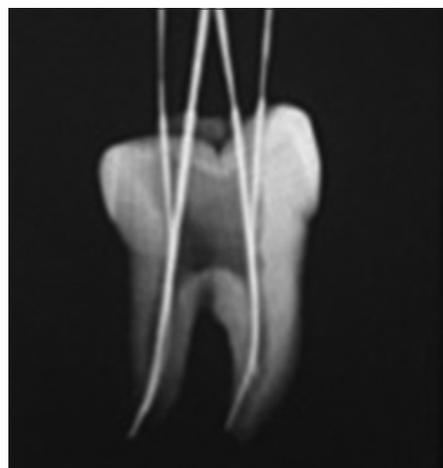


Figure 3: Working length was determined radiographically



Figure 2: Access opening was done



Figure 4: Obturation radiograph

there was an evident color change to dark brown was observed in all the samples [Figure 5].

- At 800°C: The temperature was again maintained for about 5 min, after which teeth were again examined. The teeth seemed to have disintegrated with the presence of cracks in the roots with crowns being displaced. The displaced crowns were found to have distinct margins which are attributed to melting of the ceramic material [Figure 6].
- At 1200°C: The temperature was maintained for 15 min this time and teeth were examined. Presence of ceramic overflow with loss of glaze, texture was seen. The surface of the crowns appeared to be uneven and porous was observed [Figure 7 and Table 1].

Discussion

Forensic odontology is a unique discipline which is attributed to Dr. Oscar Amoedo, who is considered the father of forensic odontology, identified victims of fire accident in Paris, France in 1897.^[10]

Dental identification is considered one of the most reliable and frequently applied methods in the field of forensics.^[15] Human identification requires a great deal of effort, requiring the coordinated efforts of a multidisciplinary team.^[16] One of the methods of identification is to look into fine traces of burnt bodies, and also examine teeth and the restorative materials exposed to high temperatures.^[6,17]

Human body is subjected to various temperatures during a fire accident. Incidents such as petrol combustion occur at around 800–1100°C,^[18] cremation of dead occurs at 871–983°C,^[5] and house fires up to 649°C.^[19] The temperature reached in fires depends on various factors which includes the site of the accident (open/closed space), duration of the combustion, nature of the oxidant and the substances used to stop the fire.^[19]

Due to the above reasons, this study was carried at about temperatures between 400 and 1200°C. At 400°C, the crowns of the samples were intact with an evident color change in teeth to dark brown. As the temperature increased to 800°C, teeth disintegrated with cracks in the root and crowns got displaced, although their margins were intact. At 1200°C, there was overflow of ceramic with loss of glaze; texture and uneven porous surface of the crowns were observed. These changes in teeth samples at different temperatures contribute toward identification of the victim.

Since this is an *in vitro* study, it cannot completely mimic the *in vivo* conditions that occur in real life incidents due to protection from adjacent tissues and bone covering the tooth structure. Since the tooth samples were removed and cooled to room temperature; the materials were exposed to controlled thermal conditions.

Due to fire, there is the presence of damage to teeth and the associated structures, such that only parts or the fragments of them are available for analysis. Since these remnants are discolored and fragile, they are often not noticed in the huge fire debris.^[20] This study showed teeth



Figure 5: At 400°C



Figure 6: At 800°C



Figure 7: At 1200°C

Table 1: Sequential effects of high temperature on endodontically treated teeth restored with all-ceramic and metal ceramic crowns

Temperature	Time (min)	Effects
400°C	5	Crown of the samples was intact with an evident color change in teeth to dark brown
800°C	5	Disintegrated teeth with cracks in the root and displaced crowns in intact margins
1200°C	15	Overflowing ceramic with loss of glaze, texture and uneven porous surface

can act as an evidence to determine the chain of happenings that have occurred during fire accidents and contributes as a vital remnant in mass disasters of fire.

Conclusion

This study can, therefore, imprint the importance of pre-planned and systematic approach toward preservation of dental records as it proves to be a good evidence of identification.

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