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Original Article

# Effect of high temperature on various indirect restorations in forensic identification - An *in vitro* study

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## ABSTRACT

The forensic odontologist utilizes the human dentition throughout each stage of dental evaluation, and restorations are as unique as fingerprints, and their radiographic morphology, as well as the types of filling materials, are often the main feature for identification. The detection of residual restorative material and composition of unrecovered adjacent restoration is a valuable toolmark in the presumptive identification of the dentition of a burned victim. Zirconia, composite, lithium disilicate, and so on have a different resistance to prolonged high temperature. Therefore, the identification of burned bodies can be correlated with adequate qualities and quantities of the traces. Most of the odontogenic examination relies heavily on the existence of the restoration as well as the relationship of one dental structure to another. This greatly narrows the research for the final identification that is based on postmortem data. The purpose of this study is to examine the resistance of teeth and different indirect restorative materials, to variable temperature and duration, for identification. The crowns were fabricated ($n = 10$) with one of the following materials Group 1: Lithium disilicate (Emax ivoclar, vivadent), Group 2: Zirconia (BruxZir-Glidwell laboratories, USA), and Group 3: Indirect composite resin (Adoro ivoclar, vivadent). Crowns were heated in the furnace to 400°C and 1100°C during different time intervals (400°C for 5 min, 400°C for 15 min, 400°C for 30 min, and 1100°C for 15 min) and assess for surface characteristics based on visual image analysis by Patidar *et al.*, 2010. The zirconia used in this study proved to be more resistible to heat, and it proves to be the better material of choice as a forensic tool since it did not show much of a change in the morphology even at the higher temperature compared to composite and lithium disilicate.

**Keywords:** Composite resin matrix, lithium disilicate, zirconia

## Introduction

In forensic medicine, although there is various method playing an important role in personal identification, the forensic odontology is one of the reliable methods for identifying an individual.

Fire disasters are one of the major disasters where identification of an individual is very difficult compared to other disasters. The dental remains can be observed with our naked eyes, and few minor details can be observed using microscope for better identification of the victim.

Identification of burned bodies starts with the objects that have remained with the body. Teeth are considered to be the most indestructible components of the human body. Teeth have the superior resistance to most environmental effects such as fire, desiccation, and decomposition of the victim. Teeth survive most natural disasters and provide a positive, personal identification. It begins with the correlation of dental records to observed restorations.[1] As the destruction of the burned victims of the third, fourth, and fifth categories is extensive, such remains cannot be identified visually and odontologists are called to assist in the identification.[2]

In recent years, dentistry has been benefited from a marked increase in the development of esthetic materials. However, the usefulness of traditional materials has not been eliminated. Forensic odontology is concerned with the identification of different restorative materials subjected to variable temperatures, which provide important postmortem clues with the availability of premortem records.[3] In cases of mass disasters associated with fire, identification of the burned victims can be a real challenge to the forensic team.[4] By evaluating the previously restored teeth and fractured bone after the burn can ensure maximum data and help in identification of the burned body.

In forensic odontology, there are several things such as restorations, root canal filling that we can analyze for identification

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of the victim. As a postendodontic restoration, we give crowns which are made of various materials available in the market. In our study, we examined the effect on different materials used for the fabrication of crowns. With this study, we would be able to find the temperature that the material could withstand at various time intervals.

## Materials and Methods

The crowns were fabricated ($n$ = 10) with one of the following materials

- Group 1: Lithium disilicate (Emax ivoclar, vivadent)
- Group 2: Zirconia (BruxZir-Glidwell laboratories, USA)
- Group 3: Indirect composite resin (Adoro ivoclar, vivadent).

The fabricated crowns were kept separately in three different plates. Crowns were heated in the furnace to 400°C and 1100°C during different time intervals (400°C for 5 min, 400°C for 15 min, 400°C for 30 min, and 1100°C for 15 min) and assess for surface characteristics based on visual image analysis by Patidar *et al.*,2010.[5] Three plates containing crowns of different groups were prepared by an investment material of approximately equal dimension and numbered as - Plate 1, Plate 2, and Plate 3: The crowns which were fabricated under each group were kept totally immersed in the investment material, with the aim of simulating the clinical scenario. When the furnace reaches the temperature to the level which we are going to analyze the crowns were kept in the furnace at various time intervals which were mentioned above.

## Results

The effect of varying temperatures on the fabricated crowns was observed mainly in the form of colour change, surface characteristics, cracks and disintegration. The result of the study have been computed in the tables (Tables 1-3).

**Table 1: Effect of different temperature and time on E-max (lithium disilicate)**

| Temp | Time (min) | Effect |
|---|---|---|
| 400°C | 5 | No significant changes seen |
| 400°C | 15 | No significant changes seen |
| 400°C | 30 | Loss of glaze |
| 1100 | 15 | The crown melted and underwent fracture |

**Table 2: Effect of different temperature and time on BruxZir (Zirconia)**

| Temp | Time (min) | Effect |
|---|---|---|
| 400°C | 5 | No significant changes seen |
| 400°C | 15 | No significant changes seen |
| 400°C | 30 | No significant changes seen |
| 1100°C | 15 | Showed slight changes in the morphology. No major alteration noted |

**Table 3: Effect of different temperature and time on Adoro (indirect composite resin)**

| Temp | Time (min) | Effect |
|---|---|---|
| 400°C | 5 | The crown shows blackish discoloration and turned to ashes |
| 400°C | 15 | - |
| 400°C | 30 | - |
| 1100° | 15 | - |

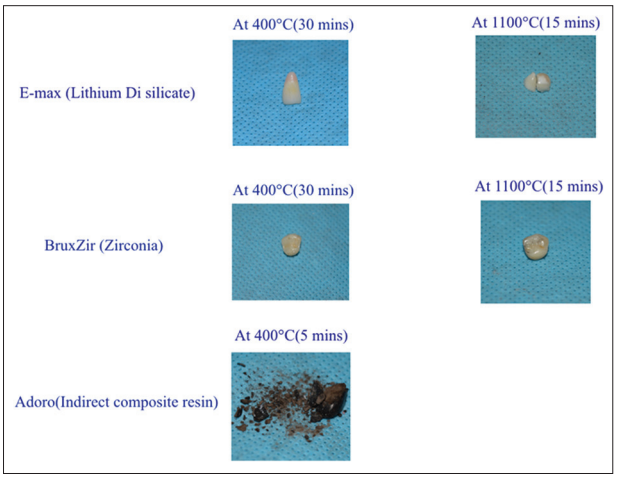


**Figure 1:** Visual images of indirect restorations with different time interval and at various temperatures

## Discussion

Forensic medicine works for forensic identification. It is a multidisciplinary effort which relies on positive identification methodologies. In forensic odontology, the importance of effort goes into identifying the victim. One method of identification in forensic odontology is to examine the burned victims and their fine traces as well as to examine the resistance of teeth and restorative material that was used to high temperature.[6]

However, there are various ways to find an individual in forensic medicine; in few mass fire disasters, the identification is being questionable. In natural fire disasters, the identification of the victim is impossible at times. In recent days, there is a great advancement in dentistry toward the restoration material. Even though there are different materials used in the field of dentistry, there are few materials which have the characteristics of having resistance toward fire. The resistance of fire depends on the physicochemical properties of the materials.[7] There are various restorative materials showing color changes and surface characteristics in many studies.[3,8-10] Hence, the dental remains could be helpful for identifying an individual.

Since teeth could only be able to withstand to a particular amount of temperature, the prosthesis we use could provide better evidence to find an individual in forensic science.

In our research, the zirconia crowns (Bruxzir) could withstand higher temperature of 1100°C for 15 min with slight change in morphology (Table 2 and Figure 1) which was similarly shown by Patidar *et al.*,2010.[5] Which could be because of the

superior mechanical properties[11-14] and also by the increased micromechanical properties.[15-17] The lithium disilicate (E-max) showed loss of glaze when kept at 400°C for 30 min and the crown melted and underwent fracture at 1100°C for 15 min (Table 1 and Figure 1), whereas Adoro (indirect composite resin) crown shows blackish discoloration and turned to ashes at 400°C for 5 min (Table 3 and Figure 1).

The material was incinerated directly and not along with the tooth, surrounding tissues, and bone which might show some variations with the analysis. There could be some difference in evaluation of the material since the heat produced is artificial and not a natural heat as the temperature produced during natural disasters and fire accidents are not specific. However, this method was done to simulate the clinical scenario to an extent.

The lithium disilicate used in this study was able to withstand for an extent of heat, and then, it leads to fracture which in turn proves to be resistible when compared to the composite resin matrix which could be because of the improved characteristics[18-20] than composite. Moreover, since the composite resin matrix is used these days conventionally for esthetic purpose which in this study, it proved to be irresistible to heat. Zirconia which was already proven to have the superior characteristics again proved to be more resistible to heat when compared to other materials used in this study. No data exist about the effects of high temperature on this material. Our findings showed that ceramic crowns did not show cracks and fragmentation at temperatures as high as 1000°C. Zirconia crown showed highest resistance to fire with no cracks and unchanged morphology, possibly due to its composition and mechanical properties of low thermal conductivity, high hardness, and chemical inertness. Even though there is several material of choice for indirect restorations, the identity of choosing the material should fulfill all the needs in a better way. Hence, zirconia as the best material of choice is used as a forensic tool and also in dentistry as a better material of choice.

By visualizing the color, cracks, and the way, it gets disintegrate will help in comparison of materials and helps to investigate in the forensic science. In future, incorporation and modification of materials in indirect restorations that withstand heat could serve as a valuable.

## Conclusion

Evaluating the effect of temperature on dental prosthesis will serve as a good tool for patient identification in forensic medicine. Further studies can be done and compared with other materials of prosthesis to ensure the best material resistant to heat which can be served as the good tool for forensic investigations.

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