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Original Article

Stereomicroscopic Analysis of Extracted Teeth Exposed to Higher Temperature for Forensic Odontological Research

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ABSTRACT:

Background: Dental restorations and endodontic material display a substantial degree of resistance to high temperatures. The location, shape and unique characteristics of each restoration can hence serve as an excellent tool for positive affirmative identification. Hence; we planned the present study to assess the effect of heat on the teeth and the different restorations and their resistance to this extreme state. Apart from gross examination of the teeth, a stereomicroscopic study will carried out to study the finer details post exposure to heat. **Materials & methods:** The present study was conducted in the department of Oral pathology of MGS Dental College, SriGanganagar. 72 extracted teeth were collected from the Department of Oral and Maxillofacial Surgery. All the tooth specimens were randomly divided into four study groups, with 25 samples in each group, as follows: Group I: Unrestored teeth, Group II: Teeth restored with Glass Ionomer, Group III: Teeth restored with Composite, and Group IV: Root canal treated teeth. All the teeth samples were exposed to the elevated temperatures for a short, standardized period of time. Each tooth sample was examined macroscopically and then under a stereomicroscope at 15 × magnification. The effects of varying temperatures on the unrestored and restored teeth were observed mainly in the form of color changes, cracks, fragmentation, and marginal seal of restorative materials. At the specified temperatures, observations of all samples of each group were recorded and assessed. **Results:** At 200 degrees, cracks appeared only in group III specimens, whereas specimens of other groups remained unchanged. At 400 degrees, cracks appeared in all the study groups except for study group IV. At 400 and 800 degrees, specimens of study group IV remained unchanged. **Conclusion:** The heat-induced dehydration and loss of organic constituents led to a fragile nature of the teeth that required careful handling.

Key words: Extracted teeth, Forensic odontology, Stereomicroscope.

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INTRODUCTION

Forensic odontology or forensic dentistry is the application of dental knowledge to those criminal and civil laws that are enforced by police agencies in the criminal justice system.[1] Keiser-Neilson defined forensic dentistry as "that branch of forensic dentistry that in the interest of justice deals with the proper handling and examination of dental evidence and the proper evaluation and presentation of dental findings".[2- 4] In recent years, resin composites have become more useful as posterior restorative materials. Composite restorative materials represent one of the many successes of modern biomaterials research, since they replace biological tissue in both appearance and function. At least half of posterior direct restoration placements now rely on composite materials.[5- 7] Unfortunately, demands on these restorations with regard to mechanical properties, placement, and need for in situ curing leave significant room for advancements, particularly with respect to their mechanical properties, polymerization shrinkage and polymerization-induced stress, thermal expansion mismatch, fracture, abrasion and wear resistance, marginal leakage, and toxicity. Ultimately, these shortcomings reduce a restoration's lifetime and represent the driving force for improvement in dental composites. Clinical evaluations and laboratory-based studies focused on composite durability also continue to highlight this need for new materials.[8]

Dental restorations and endodontic material display a substantial degree of resistance to high temperatures. The location, shape and unique characteristics of each restoration can hence serve as an excellent tool for positive affirmative identification. Therefore, precise understanding of macroscopic changes in teeth subjected to high temperatures is of great importance in forensic medicine.[9] Hence; we planned the present study to assess the effect of heat on the teeth and the different restorations and their resistance to this extreme state. Apart from gross examination of the teeth, a stereomicroscopic study will carried out to study the finer details post exposure to heat.

MATERIALS & METHODS

The present study was conducted in the department of Oral pathology of MGS Dental College, SriGanganagar. 72 extracted teeth were collected from the Department of Oral and Maxillofacial Surgery. All the tooth specimens were randomly divided into four study groups, with 25 samples in each group, as follows:

Group I: Unrestored teeth
Group II: Teeth restored with Glass ionomer
Group III: Teeth restored with Composite
Group IV: Root canal treated teeth

For avoiding experimental or measurement bias, restorative materials were filled in determined dimensional class I cavities in premolars (5 × 3 × 3 mm) and molars (3 × 2 × 2 mm). The approximate dimensions of the restoration were measured using "William's Probe." After restoration, all samples including healthy teeth were stored in 0.9% sodium chloride solution at room temperature for 1 month to simulate oral cavity conditions before further tests were done. Each sample was placed in a custom-made tray of phosphate-bonded investment material and exposed to burnout furnace at five different predetermined temperatures –200°C, 400°C, 600°C and 800°C – reached at an increment rate of 30°C/min. Once the desired temperature was reached, the teeth samples were maintained inside the furnace for 15 min, after which they were removed and left to cool to room temperature. Thus, all the teeth samples were exposed to the elevated temperatures for a short, standardized period of time. Each tooth sample was examined macroscopically and then under a stereomicroscope (Zeiss Stemi DV4 Stereo Zoom Microscope) at 15 × magnification. The effects of varying temperatures on the unrestored and restored teeth were observed mainly in the form of color changes, cracks, fragmentation, and marginal seal of restorative materials. At the specified temperatures, observations of all samples of each group were recorded and assessed.

RESULTS

At 200 degrees, cracks appeared only in group III specimens, whereas specimens of other groups remained unchanged. At 400 degrees, cracks appeared in all the study groups except for study group IV. At 400 and 800 degrees, specimens of study group IV remained unchanged.

Table 1: Showing distribution of teeth into various study groups

Group	Number of teeth	Material
I	25	Unrestored teeth (Control)
II	25	Glass ionomer restored teeth
III	25	Composite restored teeth
IV	25	Root canal treated and obturated teeth

Table 2: Showing changes in the specimens at 200O V

Group	Cracks	Macroscopic changes
I	No cracks	Yellow to light brown colour
II	No cracks	Chalky white
III	Cracks	No change in color
IV	No cracks	No color change

Table 3: Showing changes in the specimens at 400O V

Group	Cracks	Macroscopic changes
I	Cracks on crown and root	Gray to brown
II	Cracks	Dark brown
III	Cracks	Black
IV	No cracks	Fine black spots

Table 4: Showing changes in the specimens at 600O V

Group	Cracks	Macroscopic changes
I	Cracks on crown and root	Grey colour
II	Cracks	Black
III	Cracks	Chalky white
IV	No cracks	Dull & darker

Table 5: Showing changes in the specimens at 800O V

Group	Cracks	Macroscopic changes
I	Fragmentation of crown and cracks on root	Greyish brown
II	Cracks	Black
III	Fragmentation of restoration	Chalky white
IV	No cracks	Dull & darker

DISCUSSION

In forensic odontology, a great deal of effort goes into identifying the victim. 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 exposed to high temperature. One of the first studies on identification of human remains by dental examination goes back to 1897 and was carried out following the fire at the Bazar de la Charite, France.[11, 12] Under the light of above evidence; we planned the present study to assess the effect of temperature on various dental restorative materials. Thus, in this study, the teeth were subjected to four different predetermined temperatures of 200°C, 400°C, 600°C and 800°C, simulating temperatures in various fire accidents. At 200°C, the teeth did not show any signs of fracture. As the temperature increased, cracks were seen in crown and root at 400°C and fragmentation of crown was observed at 800°C. Thus, root was found to be more resistant as compared to crown. This was in accordance with the report by Merlati *et al*., which highlighted the important point that calcinated teeth, being completely dehydrated, are very delicate.[13]

Ceramic restorations are being increasingly used worldwide. There is paucity of data about the effects of high temperature on this material. Our findings showed that ceramic fillings did not show cracks and fragmentation at temperatures as high as 800°C. Ceramic fillings 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. As the ceramic restorations could still be identified at high temperatures, it is a boon to restorative as well as forensic dentistry.[14] GIC restoration cracked at a low temperature of 200°C and fragmented at 800°C. Composite material showed cracks at lower temperatures (400°C). The most resistant of all the materials tested was all-ceramic, which did not crack until 800°C, and GIC was the least resistant to fire.

The present study also showed restored teeth having cracks and crown shattering at lower temperatures compared with unrestored teeth. This may be the result of alterations in structural integrity of the hard tissue due to cavity preparation, which may have resulted in its early damage. This was in accordance with the results of other similar studies that were performed.[15]

The color, cracks, fragmentation, and marginal seal scale obtained in our study for each temperature offer a practical comparative method for use in forensic investigations. Thus, bodies exposed to high temperatures can be subjected to microscopic analytical methods. In one of the past studies, the authors compared the effect of different temperatures (400 C, 800 C and 1000 C) on Composite as post endodontic restoration using Naked eye, Digital camera and Radiovisiography (RVG) in forensic analysis. An in vitro study was conducted on 42 human teeth with composite as post endodontic restoration exposed to three temperature ranges: 400°C, 800°C and 1,000°C. Composite material studied in the present research offered great resistance to high temperatures, without exhibiting considerable macrostructure variation, in such a way that physical changes (dimensional stability, fissures, cracks, fractures, texture, color, carbonization and incineration) can be identified and associated to each specific temperature range. Dental tissues and materials offer great resistance to the effect of high temperatures. Moreover, they present specific changes (color, texture, fissures, cracks fractures, fragmentation) which might contribute to the process of identifying a corpse, or burned, incinerated or carbonized human remain.[16] Thus, when there is severe damage to teeth and associated structures as a result of fire, along with conventional means of dental identification, evidence may be salvageable through the use of stereomicroscope.

CONCLUSION

The results of the present work also gave important implications for the daily forensic practice of fire victim identification. The heat-induced dehydration and loss of organic constituents led to a fragile nature of the teeth that required careful handling.

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