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Innovative Approach by Modifying the Fitting Surface of Prosthesis Used for Individual Identification Post Heat Treatment- SEM Analysis

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Abstract

Aims: To visualize the surface irregularities and changes after heat treatment on the prosthesis. This was done by Scanning Electron Microscopy. **Material and Methods:** Eight prosthesis were prepared with modification on the fitting surfaces. The occlusal surface of the tooth to receive the prosthesis was modified and engraved with the initials in the form of identification features. These were heat treated under furnace at temperatures of 500°C, 1000°C and 1500°C after which the scanning was done under Electron Microscope. **Results:** After heat treatment it was observed that the inner surface of the prosthesis was merely distorted and the details were intact. Analysis of the surface irregularities shows that there are slit surface changes on the occlusal surface at 1000°C and the fitting surface details are well protected. **Conclusion**: It was identified that after heat treatment at temperatures 1000°C and above some changes started occurring on the fitting surface and the identification features. At these temperatures the whole human body is charred and even the bones start to get destroyed. SEM images give the detailed pictures of the same and that if this method is incorporated in day today dentistry it will be a boom in the forensic identification.

Keywords: All Metal Prosthesis, Heat Treatment, Porcelain Fused to Metal, SEM Evaluation

Introduction

Identification of such individuals has been tried on all levels amongst which DNA identification is supposed to be one of the most reliable[1]. It has long been talked about the need of new innovative methods to re-establish the links of the individuals who have been charred under high temperatures[2]. This method can be a supportive measure for the identification of the same. While investigating cases whose bodies have been decomposed or destroyed due to any of the reasons the biggest hurdle is to verify the details of the individuals like finger print analysis, eye scan or DNA retrieval from the body parts[3]. There is high probability of these methods to take long time of identification and requires high investment costs. Using the methods mentioned in this article can aid in the faster method of cross verification of the individuals and that it can be one of the sure and short methods before the final proof can be gathered. Diagnostic cast was taken as the Model. The tooth supposed to receive a full prosthesis was modified on the occlusal surface and the details were placed on the same. The details can be in the form of carvings if the patients or the clinicians' details. Used in this research is the method of engraving the occlusal surface with the initials of the patient. The same were reproduced as negative replica in the impressions made. Wax patterns were made carefully to reproduce the details. The final prosthesis were made of All Metal and Porcelain fused to metal. Total eight prosthesis were fabricated. Depending upon the temperatures these were divided into three each.

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Material and Methods

Occlusal Grooving

Diagnostic cast which was to be used as a model was visualised in detail to check for any irregularities if present. Cylinder Flat End Bur(Prima Dental, Number 835, International Reference number SF-41,) was used to carve the occlusal surface of the mandibular molar. Minimal depth of the engraving the fitting surface was kept at 2 mm, to provide the details as required[4]. Occlusal engraving has long been practiced before as an aid in providing extra retention after prosthetic placement[4]. This method aides in the extra retention and can also help in locking the prosthesis. This method, if incorporated in the form of some detail in context of the patient's or the clinician's detail will hasten the investigation procedures.

Wax up and Detailing

Wax pattern fabrication in cases like this where there are certain features are to be replicated is a task of challenge. As there are certain grooves and details which are to be evident in the final casting, wax patterns carry an important role. Wax pattern was fabricated using drop by drop method using Crown Wax of Bego Company[5]. After the pattern was complete it was removed carefully and the investment was done.

Burnout and Casting

Wax elimination was done after the investment material had set using Burnout furnace named Multimat NTX Press (Dentsply, India). Followed by this casting was done. The metal was made to cool down gradually at room temperature to avoid shrinkage.

Temperature Treatment

Thermal treatment to each group was given separately.

Group one (n=6) received no thermal treatment and was taken as the control group. This group provided the reference of the surface changes which occurred after thermal treatment.

Group two (n=6) received thermal treatment at 500°C.

Group three (n=6) was treated at 1000°C,

Group four (n=6) had the thermal treatment of 1500°C.

SEM Evaluation

The large depth of field achievable can produce an image of great visual depth with a three-dimensional appearance. The operating environment of a standard scanning electron microscope dictates that specialist preparation techniques are used. Typically, a biological specimen is chemically fixed, dehydrated through an acetone or ethanol series and then dried at the critical point - a method used to minimize specimen distortion due to drying tensions. For dry samples, this process is not necessary. SEM can also be used to investigate smooth surfaces of industrial samples. The samples are mounted on a stub of metal with adhesive, coated with 40 - 60 nm of metal such as Gold/Palladium and then observed in the microscope.

SC 7620 is composed of three components –

- The cabinet assembly.
- The vacuum chamber.
- The sputter head.

Since the SEM is operated under high vacuum, so the specimens must be compatible with high vacuum (~ 10-5 mbar). This means that liquids and materials containing water and other volatile components cannot be studied directly.

The electron column of the SEM consists of an electron gun and two or more electromagnetic lenses operating in vacuum. The electron gun generates free electrons and accelerates these electrons to energies in the range 1-40 keV in the SEM. The purpose of the electron lenses is to create a small, focused electron probe on the specimen. Most SEMs can generate an electron beam at the specimen surface with spot size less than 10 nm in diameter while still carrying sufficient current to form acceptable image. Typically, the electron beam is defined by probe diameter (d) in the range of 1 nm to 1 μm, probe current (ib) – pA to μA; and probe convergence (α) – 10-4 to 10-2 radians.

Discussion

All the prosthesis were evaluated under normal vision and under the SEM. The images were put under the grids of even sizes. The irregularities were measured under four major types with grades 0 and 1, where 0 is for no abnormality seen and 1 if present

Irregularity type 1 - Surface Irregularity,

Irregularity type 2 - Cracks,

Irregularity type 3 - Melting,

Irregularity type 4- Bubbling.

The defects of the occlusal surfaces were counted in each grid. These grids were of 2.7 mm in size and each image was superimposed with 70 grids, 10 horizontal and 7 vertical. Surface irregularities were counted by two different evaluators and the mean of which was taken. The readings are mentioned in the following tables.

Table 1. Shows impact of temperature on Metal Prosthesis results evaluated by evaluator number 1

Type of surface treatment	Type of Irregularity	Grades in 70 squares
No treatment	Surface Irregularity	70
	Cracks	0
	Melting	39
	Bubbling	0
Heat treated at 500°C	Surface Irregularity	66
	Cracks	0
	Melting	44
	Bubbling	10
Heat treated at 1000°C	Surface Irregularity	67
	Cracks	25
	Melting	70
	Bubbling	57
Heat treated at 1500°C	Surface Irregularity	70
	Cracks	49
	Melting	70
	Bubbling	70

Table 2. Shows impact of temperature on Metal Prosthesis results evaluated by evaluator number 2

Type of surface treatment	Type of Irregularity	Grades in 70 squares
No treatment	Surface Irregularity	70
	Cracks	0
	Melting	23
	Bubbling	0
Heat treated at 500°C	Surface Irregularity	70
	Cracks	19
	Melting	49
	Bubbling	0
Heat treated at 1000°C	Surface Irregularity	70
	Cracks	65
	Melting	68
	Bubbling	70
Heat treated at 1500°C	Surface Irregularity	70
	Cracks	70
	Melting	70
	Bubbling	70

Table 3. Shows impact of temperature on PFM Prosthesis evaluated by evaluator number 1

Type of surface treatment	Type of Irregularity	Grades in 70 squares
No treatment	Surface Irregularity	54
	Cracks	0
	Melting	6
	Bubbling	0
Heat treated at 500°C	Surface Irregularity	63
	Cracks	6
	Melting	12
	Bubbling	18
Heat treated at 1000°C	Surface Irregularity	67
	Cracks	8
	Melting	70
	Bubbling	70
Heat treated at 1500°C	Surface Irregularity	70
	Cracks	42
	Melting	57
	Bubbling	70

Table 4. Shows impact of temperature on PFM Prosthesis evaluated by evaluator number 2

Type of surface treatment	Type of Irregularity	Grades in 70 squares
No treatment	Surface Irregularity	46
	Cracks	0
	Melting	8
	Bubbling	0
Heat treated at 500°C	Surface Irregularity	53
	Cracks	6
	Melting	42
	Bubbling	23
Heat treated at 1000°C	Surface Irregularity	70
	Cracks	12
	Melting	65
	Bubbling	56
Heat treated at 1500°C	Surface Irregularity	70
	Cracks	70
	Melting	70
	Bubbling	70

There are severe deformities seen with both the prosthesis at temperatures of 1000°c and above. What is important here is the changes that occurred on the surfaces towards the tooth. Even at temperatures of 1500°c there were some details evident. Table 1 and 2 shows the impact of temperature on metal prosthesis and how the surface details are kept intact even at temperatures above 800°c. the readings were taken by two different evaluators. This can be seen in figure 1. Table 3 and 4 has the readings of two evaluators for the impact of temperatures on PFM

Table 5. Shows mean value of impact of temperature on Metal Prosthesis results evaluated by both evaluators

	Type of Irregularity	Grades in 70 squares
No treatment	Surface Irregularity	70
	Cracks	0
	Melting	31
	Bubbling	0
Heat treated at 500°C	Surface Irregularity	67.5
	Cracks	9.5
	Melting	46.5
	Bubbling	16.5
Heat treated at 1000°C	Surface Irregularity	68.5
	Cracks	45
	Melting	69
	Bubbling	63.5
Heat treated at 1500°C	Surface Irregularity	70
	Cracks	59.2
	Melting	70
	Bubbling	70

Table 6. Shows mean value of impact of temperature on PFM Prosthesis evaluated by both evaluators

Type of surface treatment	Type of Irregularity	Grades in 70 squares
No treatment	Surface Irregularity	50
	Cracks	0
	Melting	7
	Bubbling	0
Heat treated at 500°C	Surface Irregularity	58
	Cracks	6
	Melting	27
	Bubbling	20.5
Heat treated at 1000°C	Surface Irregularity	68.5
	Cracks	10
	Melting	67.5
	Bubbling	63
Heat treated at 1500°C	Surface Irregularity	70
	Cracks	56
	Melting	63.5
	Bubbling	70

(Porcelain Fused to Metal) prosthesis. Figure 2 has the evidence of the same. Mean value of the readings of two evaluators was computed and is seen in table 5(Metal prosthesis) and table 6(PFM prosthesis) respectively. Chart 1 and Chart 2 shows the diagrammatic presentation of the same. If an individual faces a temperature of this high degree there are very few chances left for the same to be identified. To reach to a conclusion this surface detailing can definitely help.

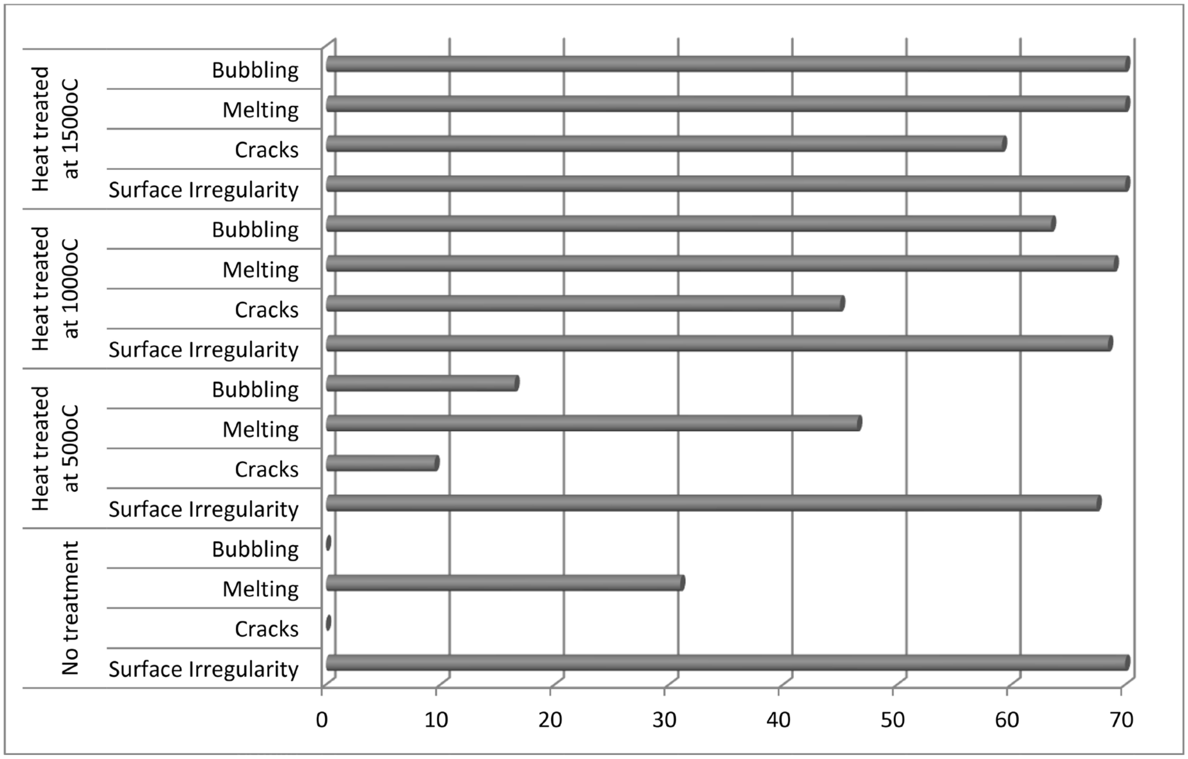

Chart 1. Shows mean value of impact of temperature on Metal Prosthesis

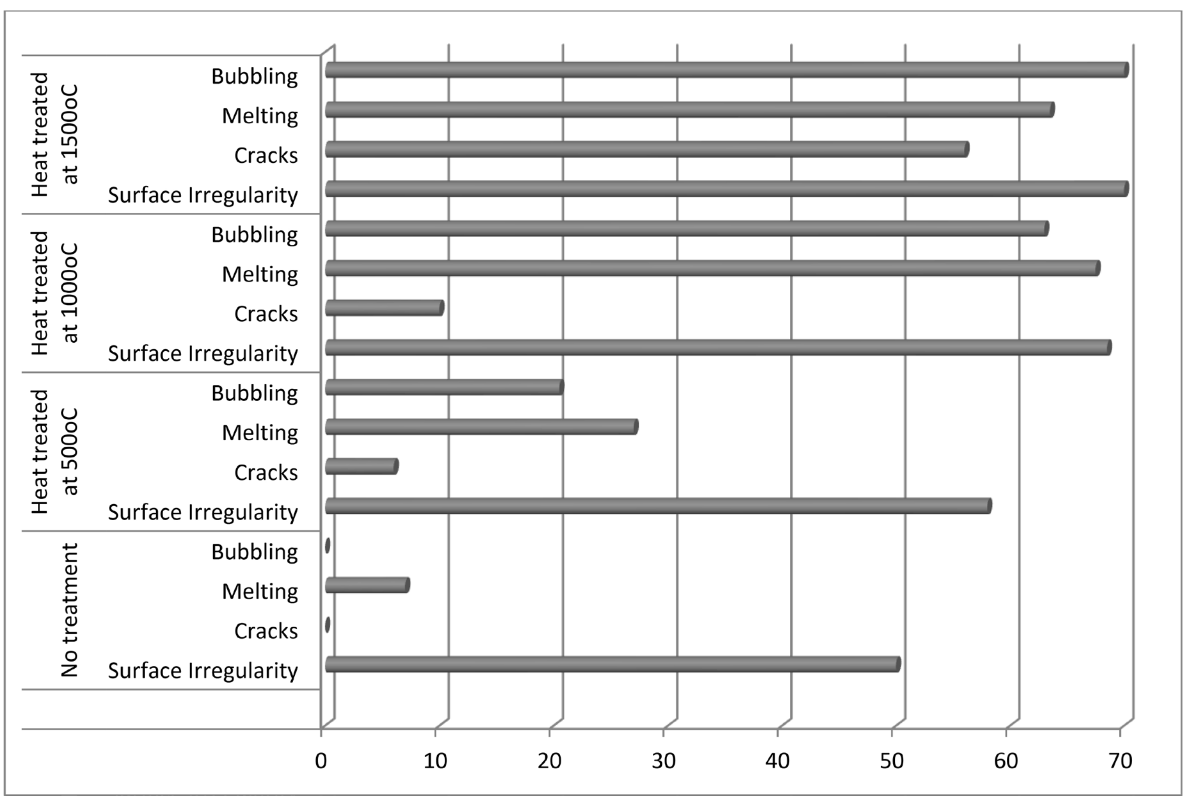

Chart 2. Shows mean value of impact of temperature on PFM Prosthesis

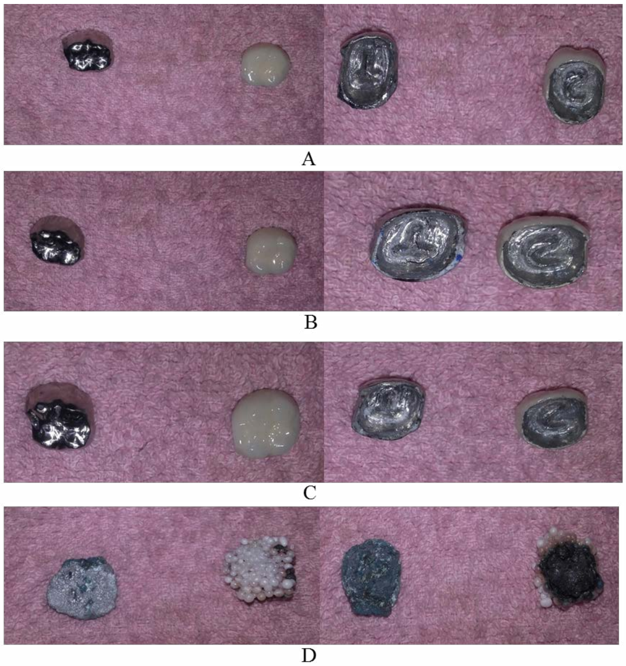

Figure 1. Surface Changes On Fitting Surface Of Metal And Occlusal Porcelain Surface After Heat Treatment At Different Temperatures A) No heat treatment, B) Heat treatment at 500°C, C) Heat treatment at 1000°C, D) Heat treatment at 1500°C.

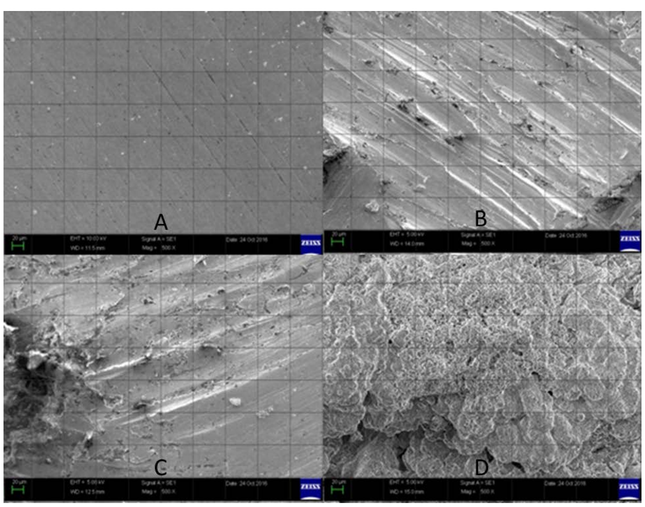

Figure 2. Surface changes on metal surface after heat treatment at different temperatures.

Results

This study has two evaluators checking for the surface changes with and without heat treatment. Where there is no heat treatment given, it is evident that in both the metal and PFM prosthesis there are no cracks and

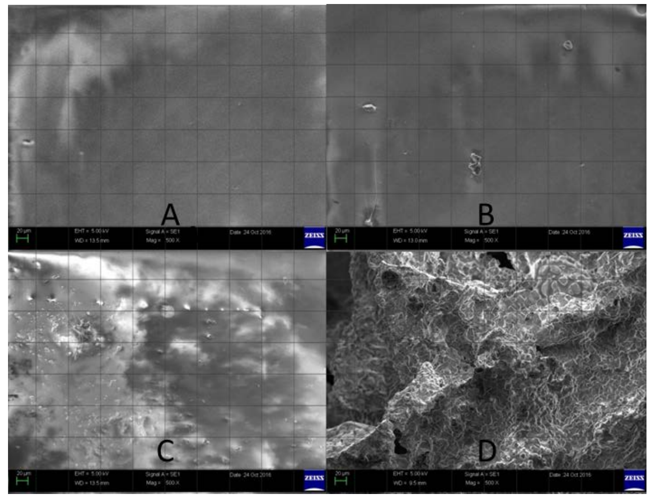

Figure 3. Surface changes on porcelain after heat treatment at different temperatures.

bubbles present. Only surface irregularities and melting could be seen. This is due to the machining with the metal prosthesis.

Porcelain is fired at temperatures above 500°c[6]. Due to this, melting is seen after glazing procedures. As seen in figure 3, it can be appreciated that till temperatures 1000°c, no frank change can be seen. At temperature 670°c and 810°c full body can be decomposed and destroyed[7]. When the temperature was increased till temperature 1500°c it could be seen that the whole surface was destroyed on the occlusal side but still the details of the fitting surface could be seen. As seen in chart 1 and 2, when heat treatment of 500°c was given, bubbling and cracks could be seen. At temperatures of 1000°c, bubbling increased enormously with rising temperatures. While reaching the temperatures of 1500°c cracks were present on all over the surface. Bubbling, Melting, Surface irregularity approximately reached 100% and was seen with all the 70 squares.

Conclusion

With the rising need to incorporate new and impeccable ideas to individual identification it is very important to keep the basic roots of dentistry viable. This method uses the basic concept and incorporates the details of the individual on the inner surface of the prosthesis. As seen, after heat treatments these details were kept intact to a large extent. This can be a boom in the forensic identification of an individual incinerated at temperatures at which no portion of the human body can be used for any diagnosis.

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