The Effect of High Temperature Heating on Indentation Resistance of Cobalt Chromium Alloy Plates as Denture Labeling for Forensic Identification

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ABSTRACT— ***The labeled denture is important to identify people who have memory loss or identify of bodies in mass disasters, mainly due to the fires. Denture labeling made of tinfoil or paper laminated, but this form can easily be damaged if exposed to high temperatures. Cobalt Chromium (CoCr) Alloy metal is resistant to high temperatures which has melting point 1150º-1500ºC, so that possibility can be used as a tool in identification. Purpose: To determine indentation resistance of CoCr alloy plates on heating with high temperatures and be expected the use of its can be alternatives as denture labeling for forensic identification. Methods: Experimental Laboratory with sample form of plates made of CoCr metal cast and measuring 30X10X2 mm, with depth of indentation is 1.5 mm. The plates were heated with temperatures 400º, 800º,1050ºC and duration 5 and 15 minutes in the preheating furnace machine. 42 samples were divided into 3 groups (temperature of heating) and each group was divided into 2 groups again (duration of heating). Results: The size of depth and width of indentation (mm) of plate for all groups, there was no significant difference between before and after heating, except in groups heating to a temperature of 1050°C for 15 minutes (P<0.05). Conclusions: Heating with high temperature is not enough to make the plate damaged and deformed, so labeling indentation can still be read clearly. The use of CoCr plate can be alternatives as denture labeling.***

Keywords— High temperature, Heating, Denture labeling and CoCr plate.

1. INTRODUCTION

Recently there have been many reports of mass accidents with many victims. One of them is a fire victim, either because of a forest fire, an aircraft fire or a fire due to a volcanic eruption. This mass casualty is often difficult when identifying bodies. The problem of identification is a long issue and requires accuracy because there are many bodies that have been scorched and must be buried as soon as possible. Basically the principle of forensic identification is comparing antemortem data and postmortem data in unknown people [1]. One of the antemortem data that can be used is the use of denture labeling.

Denture labeling is a marking system on dentures that is very helpful in identifying individually those in patients who are comatose or unconscious people; an unknown body or burned scorched bodies due to a mass accident [2,3]. Denture labeling is commonly used in dental clinics abroad, but in Indonesia its use is still rare. The form of denture labeling generally contains initial names or bar codes on tin foil [4] or on laminated paper [3] which contains data on the name, age, sex of the patient and is placed in the acrylic base of the denture.

The use of dentures in Indonesia is now known to be increasing, this is in accordance with the research conducted by Glaxo Smith Kline (GSK), which is about 14% of the denture users or 25 million people with the age limit of 15 years and over. According to GSK's Dental Detailing Manager Ariandes Veddytarro, stressing that based on data there are a number of users of good denture made of acrylic or metal in Indonesia tend to increase with increasing life expectancy [5]. With the increase in denture users in Indonesia, the use of denture labeling as a marker can also be considered.

Denture labeling made of tin foil or laminated paper is easily damaged or destroyed when exposed to high temperature heating, it is necessary to think about making denture labeling plates that are resistant to high temperatures, so that it can be used to help the identification process in case of fire. Research on this plate has been studied by Srinivasan et al (2015), who researched the success of titanium plates as denture labeling after heating with high temperatures and under pressure [6]. However, this titanium material is relatively expensive so it is necessary to look for other cheaper materials. One alternative is a metal plate made of Cobalt Chromium alloy. This material has a high melting point of 1150º 1500º C and this metal is generally used for making metal denture [7].

Much research has been done to see at the role of forensic odontology in helping to identify victims who burnt with high temperatures, one of them is what has been researched by Patidar et al (2010), in the study verified that the material

and composition in a dental restoration (gold, amalgam, silicate and metal porcelain) can resistant without damage to the heating at a temperature of 1050º C for 15 minutes [8].

This research aims to determine the indentation resistance of Cobalt Chromium metal plate as a denture labeling to heating at high temperatures, so that in the end it can be useful to be used as a tool in identifying fire victims in the field of forensic dentistry.

2. RESEARCH METHOD

This type of research is an experimental laboratory. Specimens in the form of plates made of cast metal from Cobalt Chromium alloy materials, measuring 30 x 10 x 2 mm with a depth of labeling indentation 1.5 mm. The number of research samples was 42 specimens consisting of 3 groups with each group consisting of 14 samples and heated at different temperatures (group A with a temperature of 400ºC; group B with a temperature of 800ºC; group C with a temperature of 1050ºC). Then each group was divided into 2 groups, each group consisting of 7 samples heated for 5 minutes and 15 minutes.

The CoCr alloy plate samples were fabricated using a wax pattern and made indentation from a metal stamp pad, after burning out wax then the mold was casted with molten metal using an induction casting machine. All CoCr alloy plate samples before the heating process were first collected by measuring the depth and width of the labeling indentation using a Digital caliper millimeter with a precision of 0.02 mm. Then, each sample group (A, B and C) is heated in a Preheating oven furnace according to the temperature of the treatment. After that the samples are cleaned with an Ultrasonic Cleaner "Cole-Parmer 8891" for 5 minutes, then dried with an air spray. After that, data retrieval again by measuring the depth and width of the labeling indentation of the Cobalt Chromium plates.

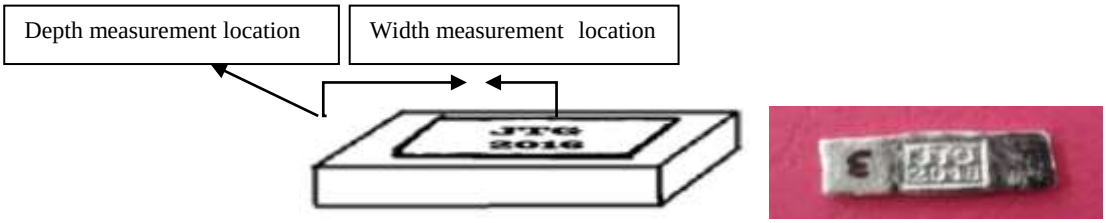
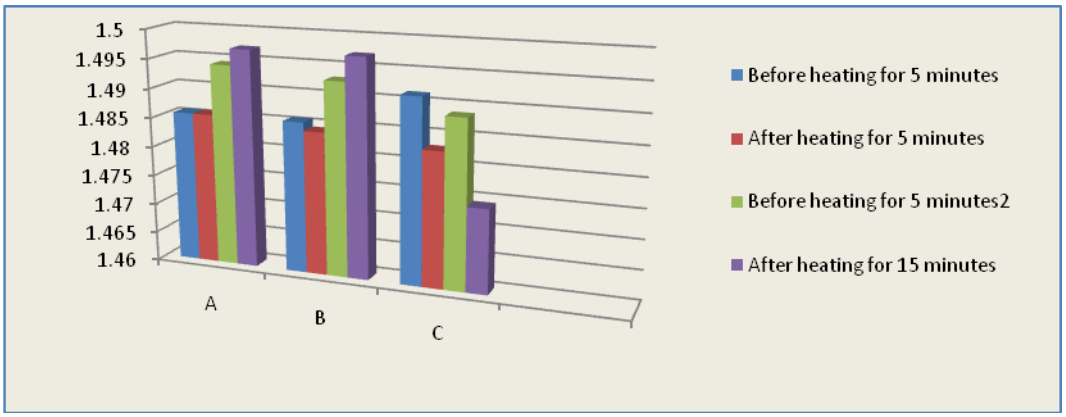


Figure 1: Schematics and Labeled Sample Plates

3. RESULT

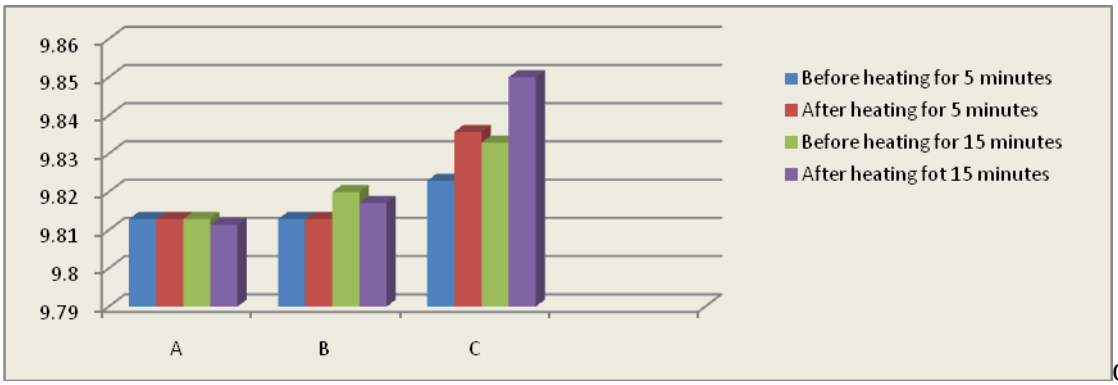
To know the average size of depth and width of the indentation (mm) of CoCr Alloy plates in all groups (A, B and C) which were heated for 5 minutes and 15 minutes, it can be seen in the graph below.



Group A = heating at 400 ° C; Group B = heating at 800 ° C; Group C = heating at 1050 ° C.

Figure graph 1: Average Depth of CoCr Alloy Plate.

The Results in the graph 1 can be seen that in group A, the average size of the depth of indentation (mm) of the CoCr Alloy plate before and after heating for 5 minutes showed no difference and at 15 minutes heating there was an increase in the size of the depth (mm) although the value was small. Group B, in the heating group for 5 minutes there was a decrease and in the heating group for 15 minutes there was an increase even though the values of both were not too large. Whereas in group C, it was seen that in the 5 minute heating group and 15 minute heating there was a decrease in the size of the depth of the indentation .



Group A = heating at 400 ° C; Group B = heating at 800 ° C; Group C = heating at 1050 ° C.

Figure graph 2: Average Width of CoCr Alloy Plate

The results in graph 2 can be seen that in group A, the average size of width of the indentation (mm) of the CoCr Alloy plates before and after heating for 5 minutes showed no difference and in the heating group for 15 minutes there was a decrease even though the difference was not large. Group B, in the heating group for 5 minutes also showed no difference size, but in the heating group for 15 minutes there was a decrease even though the difference was not too large. Whereas in group C, the heating group for 5 minutes and heating for 15 minutes there was an increase.

The results of bivariate analysis (Paired T-test with significance value p <0.05) showed that the depth and width of the indentation (mm) between before and after heating for 5 minutes in all groups (A, B and C) showed no significant difference, because p> 0.05. the analysis of the depth and width of the indentation (mm) of Co Cr Alloy plate between before and after heating for 15 minutes in groups A and B showed no significant difference, because p> 0.05. Whereas, in group C showed a significant difference, because p <0.05 (depth p= 0.008 ; width p=0.002).

The results of significance of the size in depth and width of the CoCr Alloy plate in groups A, B and C between the heating groups for 5 minutes and 15 minutes were analyzed by the T-Test with a significance value of p <0.05, and the results showed that in group A and B at both the depth and width of the indentation, between 5 and 15 minutes heating did not show a significant difference (p> 0.05), whereas in group C there was a significant difference, because p <0.05.

The results of Multivariate analysis (One way Anova-test with significance value p <0.05) showed that the significance (p) of the heating group for 15 minutes showed that between groups A and B, both at the depth and width measurements of the Co Cr Alloy plate indentation there was no significant difference, because p> 0.05. That the significance (p) of the heating group for 15 minutes showed that between groups A and B, both at the depth and width measurements of the Co Cr Alloy plate indentation there was no significant difference, because p> 0.05. Whereas, between groups B and C (depth p=0.027; width p=0.002), also between groups A and C (depth p=0.027; width p=0.000) both at the size of the depth and width of the indentation of the Co Cr Alloy plate it was found that there were significant differences, because p <0.05.

4. DISCUSSION

In this research there were significant differences in almost all temperature groups and duration of heating groups (except group C with duration for 15 minutes. this shows that high temperature heating (400 ° C, 800 ° C and 1050 ° C) in Co Cr Alloy plate samples is not enough to make the plate damaged or deformed, the surface of the plates are still intact even though the color is different. The Color changes begin to occur at 800 ° C where the plates look slightly dark, whereas at heating 1050 ° C (group C) the plate surfaces turn scorched, even though indentation can still be read clearly. There were no significant differences in all of the research groups in accordance with previous studies researched by Patidar KA et al (2010), which explained that there was no damage to some dental restorations including metal dentures with heating to a temperature of 1050 ° C for 15 minutes [8]. Other studies, such as those researched by Bagdey et al (2014) explained that teeth and tooth restorations remained intact and resistant to high temperatures [9]. Srinivasan et al(2015) also examined denture labeling made of titanium plates heated and pressure, the result was no loss of indentation when heated to 1,500 ° C overnight, but only residue remained under pressure of 200 kg / cm [6].

The results of the research for group C which was heated at 1050 ° C for 15 minutes there were significant differences between before and after heating, both depth (p = 0.008) and width of indentation (p = 0.002). This is probably due to the expansion factor caused by high temperature heating. Expansion of substances is an event of changes in the geometry of an object due to the influence of heat. This change in geometry can include increasing length, width, and volume and expansion according to the laws of physics is directly proportional to the increase in temperature [10].

At 400 ° C, 800 ° C and 1050 ° C, heating for 5 minutes showed no difference before and after heating at the depth and width measurements of the injury, although the plate has been heated with high temperatures, this is probably due to the expansion coefficient of CoCr alloy metal is quite low. The low expansion coefficient of alloy is due to the presence of Molybdenum (Mo) as an Alloy minor and serves to reduce the expansion coefficient of an alloy, so that the change in

geometry of this metal is not too large [11]. Whereas in group C with a heating of 1050 ° C for 15 minutes the difference was seen, this was due to a high temperature factor and a long time, allowing the metal to occur with a significant expansion process. Heating with this temperature (1050 ° C) is already high but this temperature is still below the melting point of Co Cr Alloy (1150-1500º C), so that it is not enough to change the shape of a metal plate, so that the labeling plate can still be read.

5. CONCLUSION

The depth and width of the labeling indentation of the Co Cr Alloy plates for all groups of temperatures and duration of heating there were no significant differences between before and after heating, except for the heating group at 1050 ° C for 15 minutes. Heating with high temperatures on Co Cr Alloy plate samples for 5 minutes and 15 minutes, is not enough to make the plate damaged and deformed. The surfaces of the plate are still intact even though the different of color, and labeling indentation can still be read clearly.

6. ACKNOWLEDGEMENT

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