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The Differences of Enamel Rod Patterns on the Tooth before and after Burning as a Tooth Prints

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Abstract

The tooth can stand by postmortem effects such as fire because of high temperature, and tooth enamel will have to increase in crystallization of hydroxyapatite so that it can still withstand. Enamel consists of enamel rods that microscopically have a unique pattern called tooth prints. The study aims to determine the differences between enamel rod patterns before and after being burnt as a determinant of tooth prints. The study used 30 maxillary first premolar that was randomly selected. The recording of enamel rod patterns was done using the cellulose acetate peeling technique. It did the recording before burnt (antemortem) and after being boiled at 650oC for 15 minutes (postmortem). Tooth prints which are the results of recording enamel rod pattern, were analyzed using Verifinger SDK v.4.2 to obtain a minute score, and then a statistical test was performed. The development of the statistical test showed no significant difference in enamel rod pattern between before and after being burnt (paired T-test, p=0,175). This study concludes that there is no significant difference in enamel rod patterns between before and after being burnt, showing that tooth prints can be used as an alternative for forensic identification in fire victims.

Keywords
forensic odontology; tooth prints; enamel rod pattern; cellulose acetate peeling technique

I. Introduction

Forensic identification is required to identify disaster victims (Pertiwi, 2014). The victim identification process currently uses an Interpol standard known as DVI (Disaster Victim Identification) (Interpol, 2014). The identification process is not only to carry out a cause-of-death analysis but also to get information about the victim. The information, psychologicaly, can provide peace to the victim's family with certainty of the identity of the victim. Forensic identification of victims can be made in two ways, namely visually or secondary and objective or primary (Monica, 2013; Prawestiningtyas, 2009). The difficulty of primary forensic identification through fingerprints found in fire victims. This is because most of the victim's body condition is no longer intact, so the primary forensic identification that can be done is to use teeth known as forensic odontology (Prawestiningtyas, 2009; Budi, 2014). Forensic odontology is a science that has a role in identifying individuals who use teeth as an identification tool (Debnath, 2016). Forensic applications in Indonesia still have many challenges that need to be highlighted, so that Forensic odontology needs to be promoted by forensic experts who has a main role in the DVI team. Teeth are the most challenging part of the body that resistant to effects postmortem and have the highest ability to withstand environmental effects such as fire, decomposition, drought, and forensic evidences (Auerkari, 2008). The success of the teeth to reveal the identity of the victim because the condition of the teeth tends to be individual (Juneja, 2016).

The enamel on teeth can be used in forensic identification. One of the structures in enamel is the enamel rod which has a unique pattern between individuals (Dahal, 2014). The study of enamel rod pattern called ameloglyphics. Enamel rod pattern can be used as a data antemortem on a personal identity. The highest content of enamel is hydroxyapatite crystals (Berkovitz, 2011). According to Fairgrieve (2007) and Fredericks (2012), when hydroxyapatite crystals are exposed to high temperatures, there will be an increase in hydroxyapatite crystallization in the enamel, which causes the enamel not to be damaged as well as shrinkage due to dehydration, so that the pattern enamel rod does not change. Tooth print or enamel rod pattern can be used as individual identification which is effective during adverse conditions such as burning (Dahal, 2014); Imaizumi, 2015).

Based on some of the problems above, the purpose of this study was to determine the difference in the pattern of the enamel rod before and after being burned as a determinant of tooth prints. The proposed hypothesis is that there is no difference between the enamel rod patterns on the teeth before and after burning.

II. Research Methods

The research method used is quantitative with a research one-group pretest-posttest design to determine the differences of enamel rod pattern between not exposed and exposed to high temperatures.

The sample selection used a simple random sampling technique, and 30 samples were selected. The sample used was the maxillary first premolar [14] because the buccal surface of the crown was convex, indicating a solid development of the middle buccal lobe. The structure was more persistent in the buccal premolars even at an advanced age [9][15]. The premolars used were indicated for orthodontic treatment with normal crown [14]. The teeth used as sample were intact teeth (crown-root). There were no caries, fractures, restorations, abrasions, attrition, erosions, and enamel hypoplasia [16]. The teeth used as samples were obtained from several dentist and dental clinics.

2.1 Recording of the Enamel Rod Pattern

The samples were polished, cleaned with distilled water, and dried (Dahal, 2014). The buccal surface of the tooth was outlined with a size of 0.5 x 0.5 cm with an ink pen in the middle third of the occlusal area (Manjunath, 2012). The buccal third of the occlusal section was chosen because this area is more resistant to attrition, abrasion, etc. (Deshmukh, 2015) and less prone to caries development (Manjunath, 2011). First, apply etching orthophosphoric acid 37%using an applicator tip on the marked enamel area for 20 seconds, then rinse with distilled water and dry. After that, cut the cellulose acetate film, smearing a drop of acetone on the sample's surface. The purpose of applying acetone is to dissolve the cellulose acetate film to print unevenness on the enamel surface (Shirish, 2014) correctly. The cellulose acetate film was attached without pressing to the etched enamel for 20 minutes. Flatten the cellulose acetate film using a cotton pellet held using tweezers so that there are no other prints attached to the film (Dahal, 2014). After 20 minutes, the cellulose acetate film was removed and placed on a glass slide for observation. Observations were made under an Olympus light microscope BX53 with a magnification of 40x objective lens and 10x eyepiece, which were then photographed with an image resolution of 72 PPI (pixels per inch) (Juneja, 2016); Deshmukh, 2015). The results of photomicrographs are adjusted for image sharpness and image quality using the software Microsoft Office Picture and Corel sharpness and image quality using the software Microsoft Office Picture and Corel Photo-Paint 9 to 300 PPI to match the usage criteria Verifinger SDK v.4.2 (Manjunath, 2011; Ramenzoni, 2006).

2.2 Minutiae Score Reading

Photomicrograph sample before burning (pretest), uploaded to software Verifier with option enrollment. The pattern is enamel rod analyzed biometrically automatically and generates minutiae score, then saved in database. After that, upload a photomicrograph of the sample after being burned (posttest) on the software with the full option (Neurotechnology, 2004). Process identification automatically generates the minutiae score of the equation which shows the characteristics of the recognition analysis that have been done.

2.3 Sample Burning

Putting all samples on a heat-resistant porcelain crucible was then placed in a muffle furnace and exposed to a temperature of 680oC (Priyanka, 2015). The sample was heated at 680oC for 15 minutes (Prakash, 2014). The duration is calculated using a stopwatch.

2.4 Statistical

Prestest and posttest data was obtained by minutiae scores which is the result of pattern recognition using Verifier SDK software. The Statistical test used the Shapiro-will test to determine data distribution (Dahlan, 2008). Then, if the normality test result is normal distribution, it could be tested by the paired T-test (Budiarto, 2015).

III. Results and Discussion

3.1 Results

During the combustion process, inside the *muffle furnace,* there was a “pop” sound of impact between the teeth and the wall teeth to the furnace, which was exposed to pressure and fracture. From the combustion results, seven samples had crown-root fractures into several parts, and 23 other samples only had root fractures with the crown of the tooth still intact but in a fragile state or there was a fracture of the crown into two parts. Most samples experienced discoloration, i.e., the tooth roots turned black (charcoal), and the crown became silvery (shiny gray). As a result of burning, after recording the pattern *enamel rod posttest,* the brittle tooth sample was destroyed into several parts. It was not possible to repeat the recording of the pattern enamel rod. Mu'rifah in Hasibuan et al (2019) stated about personal health, namely that someone will try to maintain andincrease their own level of health in order to achieve peace of life and have the best workforce.

Minutiae score from pattern recording Hasil *enamel rods* before recording was taken as data *pretest,* and scores *minute* pattern recording *enamel rod* after being burned was taken as data *posttest*.

Table 1. Descriptive Analysis of Research Results

Variable	Number (N)	Average(Z)	Std. Deviation
pretest	30	3611.63	81.538
posttest	30	3559.73	171.790
Difference	30	51.9	204.378

Source: Data processed by SPSS (2019)

a. Shapiro-Wilk Test

The results of the Shapiro-Wilk test is p-value = 0.089 at pretest, p = 0.063 at posttest, and p-value = 0.311 for the difference between the two data. From the normality test results, the hypothesis test for the different tests can be done using a paired T-test.

b. Paired T-Test

From the paired T-test results conducted on the research data, p = 0.175. It can be concluded that Ho is accepted. There is no difference in the pattern *enamel rod* between before and after being burned.

3.2 Discussion

The enamel structure of the dental crown is surrounded by a matrix consisting of *hydroxyapatite crystals* 96% (calcium and phosphorus), 1% organic tissue content, and 3% water so that it can last longer at high temperatures (Prawestiningtyas, 2009; Berkovitz, 2011; Tandaju, 2017). At the tooth root, the cementum contains an organic matrix (type I collagen), minerals (about 45%), and a small amount of water (Neel, 2016). Fairgrieve (2007) and Fredericks (2012) stated that in teeth, there is a crystallization of hydroxyapatite at high temperatures, which causes the size of the crystals in the enamel to increase and the larger the size, the more stable the hydroxyapatite contained, so that the tooth enamel can still survive (Amin, 2017). The increase in hydroxyapatite crystallization occurs simultaneously with the dehydration process, so that the diameter of the enamel rod is not present significant changes, as well as the pattern (Juneja, 2016; Imaizumi, 2015). The dental and oral health of children in Indonesia is very concerning, so it needs serious awareness and attention (Keloay in Wardani, 2021).

Seen from this study, the combustion results showed that the crown remained intact while the tooth roots were deformed into charcoal and fractured. This is consistent with the theory that the enamel (2-2.5 mm) is thicker than the cementum (15-200 μm) so that the crowns are more resilient than the roots of the teeth (Amin, 2017; Wadhwan, 2010). In real life, the root of the tooth does not experience brittleness first, which causes the tooth's crown to detach and disappear from the oral cavity. Heating causes hardening of the periodontal ligament and bone due to dehydration and loss of organic matter in the bone. The teeth are fused with the jawbone and cannot be detached (Prawestiningtyas, 2009; Aggrawal, 2016).

The results of combustion show a change in the color of the teeth. Based on previous research, teeth burned at temperatures between 500-700oC experienced a change in the color of the crown enamel to gray. In contrast, the tooth roots turned gray or white and broke into several fragments (Priyanka, 2015). The gray color of the enamel is caused by carbonates that appear as a result of carbonation. The decrease in translucency due to the dehydration process results in the white color of the burnt teeth (Amin, 2017). There is less calcium hydroxyapatite in the root than in the enamel. At a temperature of 500-700^{o}C, the tooth's crown has not yet appeared white.

In contrast, the tooth's root has turned whiter (Priyanka, 2015). At the recording stage of the pattern *enamel rod, the* teeth resulting from combustion were brittle. Only one recording could be done on the sample *posttest.* This is consistent with the theory that the teeth are burned at a temperature of 600°C or more experienced fragility (Prakash, 2014). Crystallization of hydroxyapatite as an inorganic component plays a role in resisting mechanical forces from heat, resulting in brittle enamel and starting to break apart from the underlying dentin (Amin, 2017). This becomes a challenge for researchers in recording posttest enamel rod patterns so that there are no errors and biases during the recording process.

The equation of the enamel rod pattern was tested through automatic biometric analysis with Verifinger SDK. The result of this process was *minutiae* scores. The *minutiae* score as the data was carried out statistical tests using different tests, if p> 0.05, then there was no significant difference (Santosa, 2018). This is different from determining the identical pattern of fingerprints. Fingerprints are identical if there are 12 or more points that are the same from the two image patterns but have not been proven identification evidence if there are less than 16 points (Smith, 2014).

The automatic biometric analysis used in this research is the *Verifinger SDK v.4.2 software*. Although there is already a new version of *Verifinger software*, there is no difference in how automated biometric analysis is performed (Neurotechnology, 2006). This study showed that the *minutiae* scores *pretest* were not the same with each other. This is following the theory that each tooth has pattern *enamel rod* a unique. This uniqueness is why teeth can be used as forensic odontology tools for fire victims. The theories are also appropriate with this research which shows that the teeth can survive at a temperature of 680°C. As the hard tissue, teeth can withstand high temperatures during the firing process than soft tissues in the oral cavity (Juneja, 2016).

IV. Conclusion

From the pretest and posttest minutiae score data from this study, statistical tests were performed using paired t-test. Based on the results of the paired T test that has been carried out, the value of significance of 0.175 which is greater than 0.05. So, it can be concluded that the null hypothesis is accepted. Supported by research by Juneja et al. (2016) that there is a high similarity of enamel rod pattern between the teeth before and after exposure to high temperatures. The result this study is that there is no significant difference between enamel rod pattern on teeth before and after being burned at 680oC for 15 minutes.

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