Comparison of Gravoply plate barcode embedding in Complete Denture Prosthesis (CDP) to lamination barcode embedding for forensic identification purposes

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(RESEARCH ARTICLE)

Comparison of Gravoply plate barcode embedding in Complete Denture Prosthesis (CDP) to lamination barcode embedding for forensic identification purposes

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Abstract

Background: Mass disasters often occur in Indonesia, thus require the rapid identification of victims. Teeth can be one of the primary identifiers besides fingerprints and DNA. It includes dentures worn by the victim. The Denture Marking System is a technique for labeling dentures to prevent it being swapped to another. Labeling usually uses embedded barcode, made from laminated paper or gravoply plate.

Purpose: To compare Gravoply plate barcode to lamination barcode embedded in prothese for forensic identification.

Methods: The type of research is a true experimental study with a posttest-only control group design. The sample size used in this study is 20 CDP samples divided into two test groups, one is Gravoply plate barcode and another one is laminated photo paper barcode.

Results: 10 sampels of gravoply plate barcode can be read correctly, meanwhile 6 of laminated photo paper barcode showed incorrect reading and only 4 of total samples had correct result. Chi-Square test obtained p value (p<0,05) means there is significant difference between two embedding techniques.

Conclusion: Embedding barcode in denture protheses for forensic identification is better using Gravoply plate rather than laminated photo paper.

Keywords: Forensic odontology; Denture Marking System; Complete Dentures; Barcode; Gravoply.

1. Introduction

Indonesia is the 4th most populous country in the world at 275.36 million people[1], has 17,504 islands covering 1,913,578.68 km2 and has approximately 129 volcanoes. Indonesia is located between 3 major platonic regions (Indo-Australian, Eurasian, and Mediterranean). It consists of 300 ethnic groups, 1,300 tribes, and 6 religions with various socio-cultural backgrounds[2]. These demographic, geographic, sociological and historical conditions make Indonesia a disaster-prone region.

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Mass disasters that occur suddenly will cause many casualties who have no identity and cannot be recognized. Thus, the identification of victims of mass disasters (Disaster Victim Identification) is a very important activity. Disaster Victim Identification (DVI) is a procedure to identify victims who died due to mass disasters and the results can be accounted for because it refers to Interpol standards. Interpol has determined the existence of primary identifiers (PI) consisting of fingerprints, odontology (teeth), and DNA and secondary identifiers (SI) consisting of medical, accessories, and photography. According to Interpol standards, an identity identification is considered valid and correct if it has been successfully tested by at least one primary identifier or two secondary identifiers[3].

The Forensic Odontology Agency and the International Dental Association recommend a procedure of labeling denture prostheses called denture marking system to facilitate the need for identification of a person's identity. There are two methods of making denture marking systems, namely the surface method and the inclusion method. The surface method consists of the engraving method, which engraves letters and numbers on the denture base, and the embossing method, which creates embossed letters on the denture base. While the second method is the inclusion method which consists of the ID band method, which uses stainless steel which is embedded in the denture base and the barcode method where data will be stored in the form of a barcode and embedded in the denture base[4,5]. From these methods there are advantages and disadvantages of each, and in this study the inclusion method using barcodes with different materials, namely gravoply, is used.

Previous research conducted by Pathak et al[6], showed that labeling on a complete denture with the inclusion method using photo paper material was successfully carried out. Research conducted by Prakosa & Amiatun[7] also showed positive results, where the barcode using laminated paper material could survive and then be read after the denture was soaked for 4 weeks, but there was a slight drawback that lamination and also imperfect ortho resin application could cause ortho resin liquid and soaking water to enter and hit the paper which caused the barcode to be unreadable. Alzamzami[4] has also conducted other research, namely comparing the effectiveness of labeling on eye prostheses with the inclusion method using ordinary photographic paper material with laminated photographic paper which also shows that the labeling technique can also be done on eye prostheses, but has almost the same shortcomings as the research conducted by Prakosa and Amiatun. Labeling using barcodes here not only acts as a label, but the barcode will also be filled in by an online-based victim's medical status card, in accordance with research conducted by Khanizah [8] who successfully created a website containing an online-based patient status card.

Due to the above problems, the author wants to compare gravoply plate barcode embedding on complete denture prostheses with laminated barcode embedding for forensic identification. The reason researchers want to compare the two materials is because researchers want to know whether gravoply plate barcodes can be stronger, more stable, and easier to read when compared to laminated barcodes. Indeed, the gravoply plate material used by the researcher was the first time it was used, but after preliminary research, the gravoply plate material could adapt well to the denture base, so the researcher wanted to investigate further.

2. Material and methods

2.1. Material

The tools used are micromotors, straight handpieces, bur freezers (fissure and round), markers, pulasers, work mats, scissors, sow bottles (tools for sprinkling ortho resin powder), injection syringes, chi blowers, tissue paper, bowls, and smartphones that have barcode scanning applications installed (for example Google Lens). The materials used include complete denture, barcode (gravoply plate and laminated photo paper), ortho resin (powder/polymer and liquid/monomer, pumice and kryt powder).

2.2. Methods

The research design used was a true experimental design with posttest only control group design. This research was conducted at the Laboratory of Materials and Technology of Dentistry, Faculty of Dentistry, IIK Bhakta Kediri on March 2, 2023. The population of this study is a complete denture made by dentistry class 2019 of the Bhakti Wiyata Institute of Health Sciences Kediri who have completed carrying out rehabilitation skillab 2 and the complete dentures has been collected or assessed, totaling 87 prostheses. Research sampling was carried out using the Lemeshow formula (20 samples) and the sampling technique used simple random sampling technique.

The study procedure began by:

- Entering status card data into the website https://nrlkhzh.website/.

- Copying the status card link that has been created and shortening the link using the tinyurl.com website.
- Creating a barcode by entering the status card link into the qrcode.tec-it.com website then selecting the QR Code form.
- Printing 20 barcodes with details of 10 barcodes on gravoply plate and 10 barcodes on laminated photo paper. Gravoply plate barcodes are printed in laser cutting printing with a size of 13x13 mm with a thickness of 2 mm, while for photo paper barcodes are printed with a size of 13x13 mm and a thickness of 0.1 mm and after laminating the size becomes 14x14 mm with a thickness of ± 0.3 mm.
- Reducing the thickness of the gravoply plate barcode using a bur freezer until the thickness is 0.5 mm.
- Make a reduction also on the laminated barcode which is at the end of the laminated result.
- Preparing the complete denture by making a reduction boundary pattern on the posterior lingual wing of the mandible.
- Reduction was performed using a freezer bur (fissure and round). The depth of reduction was ± 1.5mm with a width of 14x14 mm for gravoply plate and 15x15 mm for laminated photo paper.
- After the reduction, the part is cleaned using a chi blower and tissue paper soaked in water.
- Then the laminated barcode was planted on the base facing the surface then covered with ortho resin powder sprinkled using a sprinkling bottle.
- Dripping ortho resin liquid using a syringe over the ortho resin powder in a 1:1 ratio.
- After the ortho resin hardened, the excess resin was removed by finishing and polishing.
- These steps were also carried out on the gravoply barcode plate.
- Next, the state of the barcode was examined and recorded with the following criteria: Stable (no ink leakage and/or no pattern change/damage due to the finishing polishing process) or unstable (ink leakage and/or pattern change/damage due to the finishing polishing process).
- Scanning the barcode that has been planted. Scanning assessment consists of scan readable or scan unreadable.
- Then the results of the comparison assessment of the barcode planting are then recorded with the following conditions: good (barcode is stable and can be read), not good (barcode is not stable but can be read), and not good (barcode is not stable and cannot be read).

3. Results and discussion

In research that has been conducted on 20 samples, the results show that there is a significant difference between the results of gravoply plate barcode embedding compared to laminated barcode with the following research results:

Table 1 Cross-tabulation of the results of post-planting barcode embedding on CDP

No.	Denture labelling	Comparison of barcode post-implantation results on CDP			Total
		Good	Less good	Not good	
1	Barcode lamination	4	6	0	10
2	Gravoply barcode plate	10	0	0	10
Total		14	6	0	20

Based on table 3.1, it can be seen the comparison of the planting results of 20 samples that have been planted with barcodes. In labeling using laminated barcode planting there are 4 good samples and 6 samples that are not good, while in labeling using gravoply plate barcode planting all 10 samples show good results.

Table 2 Chi-Square Test

	Value	Asymtotic Significance (2-sided)
Pearson Chi-Square	8.571[a]	0.03

Based on table 3.2, it can be seen that the significance value is less than 0.05 ($p < 0.05$), meaning that denture labeling using gravoply plate barcode planting is better than laminated barcode planting for forensic identification purposes.

In previous research reported by Prakosa & Amiatun[7] who planted laminated photo paper barcodes on complete dentures, that in this study there was 1 sample out of 10 samples that were not read because there was a leak in the laminated barcode due to ortho resin liquid entering the barcode. Other research results reported by Alzamzami[4] who planted barcodes on 5 samples of eye prostheses, in 2 of his samples there were also leaks caused by ortho resin liquid which caused the barcode to be unreadable.

In this study, there were also cases of ink leakage on laminated barcodes due to incoming ortho resin liquid, namely 6 pieces (table 3.1), but the barcodes were still legible. This can be influenced by several factors, first from the lamination technique on the photo paper, secondly the previous study used a heat lamination technique that was laminated by itself using an iron[4,7]. Whereas in this study using a hot lamination technique using a special machine (pressed with a certain pressure), where the machine used is more standardized than manual lamination, so even though there is ink leakage, it does not really damage the shape of the barcode (damage to the barcode pattern <30%) and as a result the barcode can still be read.

Figure 1 (1) Illustration of the iron used in the previous study (2) lamination machine used in the current study

The use of an iron in the previous study was also a contributing factor to the leakage of the laminated barcodes. The heat generated by the iron usually ranges from 60-250°C[9]. Then the pressure applied also cannot be controlled, more inclined towards weak pressure, resulting in less tight edges. Moreover, when polymerization also produces heat ranging from 30-80°C[10], this can indicate the opening of the barcode edge, so it will be easier to cause leakage of the laminated barcode. This is because the heat generated by the iron is the same as the heat during the polymerization process. While the heat generated by the lamination machine in this study is using a temperature of 110°C. In addition, excessive finishing and polishing processes can cause damage to laminated plastic. When the laminated plastic is exposed, it is possible that the photo paper can also fade, change color, or disappear due to exposure to liquid when used in the oral cavity.

The next factor is edge reduction on the laminated barcode. Too much edge reduction can cause the laminate to become less strong, which can cause ortho-resin fluid to enter through the gap. This is because during the process of meeting the monomer and ortho resin polymer, heat will be generated. The temperature generated during the ortho resin polymerization process usually ranges from 30-60°C. However, if the polymerization process is too fast or takes place in large quantities, the temperature can increase to 80°C or even higher. These high temperatures can occur when the resin liquid composition ratio is greater than the powder[10]. If the resulting adhesion of the remaining edges is too little, it is possible that the laminate becomes less strong and produces a gap due to the heat reaction during the polymerization. This causes the gap to open and the ortho-resin liquid to enter. The recommended edge reduction is to leave according to the final limit of the laminate press marks used.

While on the gravoply plate barcode material, the overall results show stable results and readable scan results which can be seen in table 3.1. This is because the gravoply plate material cannot absorb liquids and is not easily deformed or scratched during the planting, finishing and polishing process, in contrast to laminated barcodes which have the opposite properties of this gravoply plate barcode.
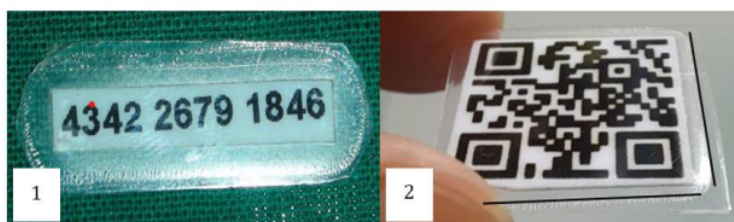
Figure 2 (1) Correct edge reduction as reported in the previous study[6] (2) Edge reduction performed in the current study.

Gravoply consists of two or more layers of plastic materials that are pasted together. The top layer is made of a wear-resistant and durable material, while the bottom layer is made of a more flexible and easy-to-cut material. The top layer is engraved to create text or images, then the bottom layer is cut to create the desired size and shape[11]. Therefore, the bottom of the gravoply barcode plate can be reduced to a thickness of ±0.5mm, because with this thickness the barcode can be easily embedded in the denture base, which has an average thickness of 2-3 mm.
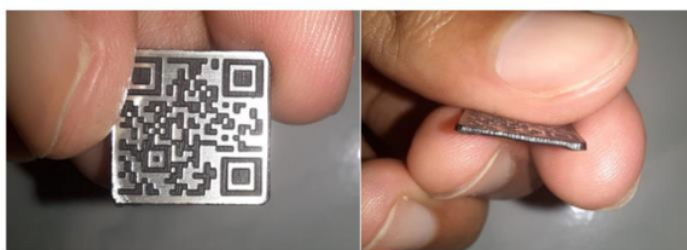

Figure 2 Barcode of the gravoply plate used in this study.

Gravoply is more wear-resistant and durable than acrylic. Gravoply is also more resistant to chemicals and heat, and is often used for making labels and signs that require high durability and durability[11]. Because of the advantages of its properties, in this study the researchers wanted to see the results of planting if the gravoply barcode plate was planted on a complete denture as a denture marking system.
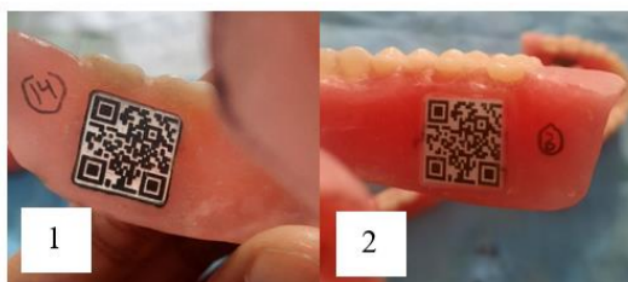

Figure 3 Overview of the results of implanting a barcode on a denture. (1) gravoply plate (2) laminated photo paper

Seeing from the description above, in order to reduce the risk of leakage and produce a readable barcode, the treatment before planting the laminated barcode can be given more attention. However, this study has also proven that there is still a risk of leakage in laminated barcodes, and this is not good for long-term use, therefore in the comparison of

implantation results, barcodes that leak but can be read are recorded as poor. This is in accordance with the results of research reported by Prakosa & Amiatun Ruth[7], that after soaking, there were leaks in 2 laminated barcode samples.

4. Conclusion

Based on the results of the study, it can be concluded that barcode embedding on complete denture prostheses for forensic identification using gravoply plates is better than laminated photo paper.

Compliance with ethical standards

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Disclosure of Conflict of interest

The authors of this manuscript do not have any financial or personal conflicts of interest.

Statement of ethical approval

The study received ethical approval by Institut Ilmu Kesehatan Bhakti Wiyata Faculty of Dentistry Health Research Ethical Clearance Commission, Kediri (160/FKG/EP/II/2023)

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