Shade Determination in Anterior Teeth with Spectrophotometer and Digital Camera in The Making of Fixed Partial Dentures

(Systematic Literature Review)

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Abstract

Introduction: Fixed partial denture is a prosthesis that is permanently attached to one or more damaged teeth, or to replace missing teeth. Shade determination was one of the first step in restoration procedures or making dentures. Restoration could be a failure due to the selection of an inappropriate tooth shade, especially in the replacement of anterior teeth that have high requirements to support appearance and aesthetics. The use of a spectrophotometer and digital camera could help dentists in choosing tooth shades. **Purpose:** The purpose of this study was to determine and analyze differences in the color accuracy of anterior teeth using a spectrophotometer and digital camera in the manufacture of fixed partial denture. **Method:** This study used a systematic literature review with fifteen journals.The type of research was a survey and cross-sectional so that the bias analysis will use the Critical Appraisal Skills Program (CASP) and the data extraction in this study also uses a form according to CASP. The data obtained will be synthesized qualitatively. **Result:** This study showed that seven out of fifteen journals reported that the use of a spectrophotometer in the tooth shade determination provided an accurate result in the selection of anterior tooth shade, while eight other journals stated that the use of a digital camera could be an alternative in choosing tooth shade because digital cameras are easy to get and could combine color features to produce accurate colors. **Conclusion:** Spectrophotometers and digital cameras could provide good results in terms of shade accuracy and precision.

Keywords: digital camera; fixed partial dentures; spectrophotometer

Introduction

Age substantially affects human susceptibility to tooth loss because teeth have an essential role in human life. Tooth loss results in anatomical, physiological, functional, and psychological changes. This situation caused an increase in the need for dentures. The function of dentures was to restore the ability to chew, speak, improve facial appearance, and smile.[1] Denture could improve aesthetics and increase patient confidence in appearance.[2]

Fixed partial dentures are dentures that are restored and permanently attached to damaged or deformed teeth to replace missing teeth. Fixed dentures are made in a complex way, the prosthesis is attached to the supporting teeth and cannot be removed by the patient.[3] Fixed partial dentures treatment was designed to restore the patient's dental health and aesthetics. Fixed partial dentures indicated for one or more teeth that are missing, in which

case the teeth are replaced by pontics designed to meet the functional and aesthetic requirements of the missing teeth.[4]

Tooth shade selection was the first step before making dentures. Restorations could be failed due to improper tooth shade selection, especially in the replacement of anterior teeth using composite or ceramic materials, because anterior teeth had an important role in appearance and aesthetics.[5,6] Razooki et al said that about 75% of the colors were incorrectly selected with errors in chroma and hue assessment due to using the human eye, which can experience brightness sensitivity.[4] A the stage of matching tooth shade, experience, visual intelligence, surrounding work area, dentist's physical condition, lighting, clothing color, and patient's lip color affect the choice of tooth shade selection. These problems may cause the dentists to be unsure of the suitability between the sample tooth shade and the patient's tooth shade in the manufacture of dentures.[7]

A shade guide was used to determine tooth shade. Shade guides commonly used in dentistry were prepared with Munsell and Commission Internationale de l'Eclairage (CIE) three-dimensional color system. Munsell's system demonstrates hue, chroma, and value. The CIE color system uses an L* value for lightness and value, a* for the red-green axis, and b* for the yellow-blue axis.[7–9] Shade guides had two methods, namely conventional and digital, digital shade guides were proven to be more accurate and could minimize operator errors in color assessment. There were many types of digital shade guides, the ones that were often used in dentistry were spectrophotometers and digital cameras.

The efficient usage of spectrophotometers and digital cameras would make it easier for dentists to choose tooth shades.[10] Spectrophotometers have been developed to eliminate and minimize uncontrollable variables during the color matching process. Chu et al compared and observed with visual techniques, and it was found that the use of a spectrophotometer resulted in an increase in accuracy of 33% and there were many objective matches in 93.3% of cases.[11] Digital cameras were the most frequently used tools for taking pictures and are available in everyday dental practice, this tool uses the RGB color model, namely red, green, and blue which were added together in various ways to be able to produce various colors.[10] Digital cameras can provide the precise color determination and minimize image errors. Determination of shade using a digital camera could be assisted with graphic software in determining the results of tooth shade matching. The use of digital cameras has

disadvantages, including unstable lighting, which causes problems in intensity during color analysis, but it also requires good skills in operating and positioning the device correctly.[12]

The purpose of this study was to carry out a further systematic review of the literature review regarding the determination of anterior tooth shade using a spectrophotometer and digital camera in the making of fixed partial dentures.

Methods

In this systematic literature review, the type of research chosen was a survey and cross-sectional so that the bias analysis will use the Critical Appraisal Skills Program (CASP) and the data extraction in this study also uses a form according to CASP. The data obtained will be synthesized qualitatively.

The selected population was patients aged over 18 years who had lost their teeth and wanted to have anterior teeth shaded according to aesthetics and function with various genders, races, and economic backgrounds. This population was intervened by comparing the use of a spectrophotometer and digital camera in determining the shade of anterior teeth in the making of fixed partial dentures. The journal database search strategy used was PubMed, DOAJ, Google Scholar, Science Direct, and Elsevier. Keywords and controlled vocabulary (Table 1). The selected literature is journals published in English and Bahasa in the last 15 years.

Table 1. Data Search Strategy

Inclusion Criteria	Population and setting	Intervention/Exposure	Comparison	Outcome
Keywords	>18 years[1,2] Abutment teeth[3]	Spectrophotometer[1] Digital camera[2] Spectroradiometer[3] Shade guide conventional[4]	-	Fixed partial denture[1]
Original words	1: Adolescent, teenage, juvenile, youngster, youth 2: Person, men, man, woman, women, human 3: Abutment teeth, tooth	1: Dental color matching, shade guide digital, vita easy shade 2: Intraoral camera, digital image, shade guide digital 3: Color measurement, shade guide digital, colorimeters 4: Visual, shade guide conventional, vita classical shade guide, vita lumina guide, bleaching	- - - -	1: Crown and bridges, implant, dowel retainer, jacket crown, veneers

Controlled vocabulary	-	-	-	-
Exclusion Criteria				
Keyword	<18 years	-	-	Removable partial denture
Original word	-	-	-	-
Controlled vocabulary	-	-	-	-

Results

Based on the study, fifteen journals were published in 2010-2021 discussing the determination of anterior tooth shade using digital methods, especially spectrophotometers and digital cameras. A total of seven journals discussing the spectrophotometer in tooth shade measurement showed that a good color selection instrument in color accuracy and precision, and eight other journals discussed the use of digital cameras as an alternative to spectrophotometers because these tools produce good and significant color compatibility measurements and are easy to find.

Discussions

Color determination of anterior teeth was one of the challenges for dentists to provide good aesthetic results for patients.[13] Errors in tooth color determination in the visual method can be influenced by several factors, namely color blindness, age, fatigue, and the influence of the surrounding environment.[14] Spectrophotometer and digital camera were highly recommended to minimize operator errors and facilitate communication between dentists and laboratories to produce aesthetic dentures.[6,13,15]

All journals discussed in this systematic literature review have the result that using spectrophotometers and digital cameras is better and more reliable in the selection of tooth color, especially in anterior teeth. Borse et al and Suganya et al. recommended that clinicians with difficulty in shade determination use the digital tooth shade selection method, especially the spectrophotometer because it was accurate, repeatable, reliable.There was no subjective error in measuring L* a* and b* values.[6,13] A spectrophotometer was able to provide excellent tooth color measurement. This was supported by the research of Tabatabaian et al and Stephen et al., who stated that using a spectrophotometer showed excellent color accuracy and precision, reaching 92.6 - 99% in 93.3% of cases.[10,16,17] The shade selection using a spectrophotometer matched the hue and chroma values in the Munsell Color System.[18] The

research of Ferroukhi et al. found the disadvantages of spectrophotometers which have limitations in measuring one tooth at a time, high cost, and are a relatively low-performance instrument.[17]

Digital cameras were one of the most widely used color interpretation tools in everyday life and can be found in every dental clinic. In several studies, digital cameras have been introduced as an alternative to spectrophotometers because they could obtain accurate L* b* values, and the cost was efficient.[16] Ferroukhi et al and Kelkar et al stated that tooth shade selection using a digital camera could help replicate the color of the restoration accurately and analyze the color morphology and texture of the teeth to make accurate dentures.[17,18] Color determination procedure using a digital camera showed an increase of 13% compared to visual selection.[18,19] Digital cameras could obtain L* and b* values with the help of Software, but the results for a* values were not the same as using a spectrophotometer. Miyajiwala et al stated that using digital cameras in shade selection had not been proven valid, so you must use neutral-colored objects such as gray to assist the tool in calibrating colors.[20] Dental images obtained from digital cameras were viewed computerized with a digital shade guide. The shade tab can be moved to the computer screen for optimal results (Figure 1).[18,21] Software was used as an aid to get the RGB average value converted to CIELAB color coordinates.[22]
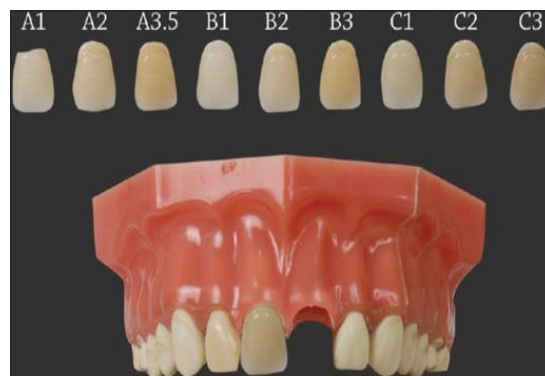

Figure 1. Digital photographic shade selection[18]

Based on the description, it is stated that spectrophotometers and digital cameras were methods for selecting appropriate and reliable digital colors to measure tooth shades. However, spectrophotometers are rarely found in everyday life, and these devices have a high price, so many clinicians use digital cameras with additional software as an alternative. The

measurement results from a digital camera with additional software were converted into CIELAB color coordinates using L* values for lightness and value, a* for the red-green axis, and b* for the yellow-blue axis so that clinicians could produce dentures according to the pleasing aesthetics required.

Conclusion

This study concludes that spectrophotometers and digital cameras have good, precise, and reliable results in terms of measuring the color of anterior teeth in the manufacture of fixed partial dentures, and spectrophotometers as a color selection tool that is superior in terms of color accuracy and precision so that dentists could easily communicate with the laboratory in determining tooth color. However, the lack of a spectrophotometer has limitations in measuring one tooth at a time, the price is high, and the tool's performance is relatively low. Digital cameras could be an alternative to spectrophotometers because of their accuracy in determining color and analyzing color morphology and texture of teeth.

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