

CHAPTER FIVE

DISCUSSION

5.1 INTRODUCTION

Obtaining an appropriate shade for the prosthesis that matches the shade of the adjacent skin remains problematic. This is mainly due to the fact that no standard shade guides are available for maxillofacial defect prosthetic materials. Thus, shade matching is accomplished often at chairside by trial and error, by mixing dry earth pigments with translucent medical-grade elastomers (Ma et al., 1988; Abdulhadi, 2008). Shade matching is assessed visually, even though it may be plagued by unreliable and inconsistent results (Okubo et al., 1998).

5.2 MATERIALS AND METHODS

5.2.1 Devices assessed in the study

The spectrophotometer was selected for this study due to its reproducibility and consistency in measuring colour tones (Cowerd et al., 2008). However, its usefulness was contested according to the results of this study. The results showed that the colour reproduction of this device was widely different from the other recording devices, i.e. the digital camera and scanner (Table 4.2). This may be due to different design principles of these devices, and every device has its own range of colours it can reproduce.

The CIE L*a*b* mode was used in the study to analyse the skin colour data because it is considered by many as the best mode that represents the colour gamut of human skin and nature, and is a universally agreed numeric description of how we see

colour. In this research the CIE L*a*b* colour units were used to approximate human vision perception as the L* component closely matches human perception of lightness. It can thus be used to make accurate colour balance corrections by modifying output curves in the a* and b* components, or to adjust the lightness contrast using the L* component (Jarad et al., 2005; Margulis, 2006).

Whatever the device assumed to be accurate in reproduction of colours, the final judgment should be left to the human visual perception. Therefore, visual assessment was included in this research to reveal the best device as the main objective of this research was to find the device that fulfils the criteria for selection of the best shade matching device, i.e. safe, repeatability, reliability in reproducing the full spectrum of the human skin colours, simplicity of operation, cost-effective, amenable and handy to use.

The digital camera could be considered as a standardized and repeatable device when the camera is set accordingly. It can cover the wide skin colour spectrum. However, advanced setting requires special skill and knowledge in photography. It is safe and has no harmful effects on the human body. The main disadvantage of the digital camera is the cost when compared to the scanner. However, its cost is lower than that of the spectrophotometer. The scanner is a simple, standardized device. It can be used safely with no harmful effects on the human body. It can be operated by anyone with no specialised skills or knowledge of its working mechanism. The only disadvantage of the scanner is the limited coverage of the skin colour spectrum. Therefore, it needs some modification in order to enhance its accuracy of colour readings.

A study comparing the use of 4 types of spectrophotometer and digital camera in colour matching showed good results with the camera (Bicchierini et al., 2005).

However, due to the intrinsic factors of the materials and the complexity of the skin, automatic colour detection for prosthesis production was difficult. Therefore, any system that is used for colour matching of prosthetic materials will require further development for full satisfaction of the needs of prostheses manufacturers.

5.3 RESULTS

5.3.1 Subject in the study

The subjects who participated in the study were staff and students in the Faculty of Dentistry, University of Malaya. An equal number of subjects from the 3 main ethnic groups in Malaysia were recruited to participate in the study as convenient sample because of the availability of subjects in the Faculty of Dentistry and for reducing statistical bias (Table 4.1). However, this does not reflect the ethnic components of Malaysia's multi-racial society, where Malays are 53.3%, Chinese 24.8%, indigenous 11.8%, Indians 7.7%, others 1.2% (<http://www.state.gov/r/pa/ei/bgn/2777.htm>).

The Chinese skin shade is yellow, while Malays and Indians are darker skinned, with the Malays fairer than the Indians. The skin colour in five different groups (French and American Caucasian, Japanese, African-American, and Hispanic-American) was studied and data compared with women's self-perception of skin colour. Three types of complexion - dark, medium, or light - were distinguished in each group. The skin colour of Japanese women, however, was not be compatible with the lightness scale distinguished and therefore the lighter skin colour was considered difficult to match (Caisey et al., 2006). In contrast, it was easier to match darker skin shades as samples of dark skin tones were easier to match for maxillofacial prosthetic replacement materials (Aina et al., 1978; Guttal et al., 2008). Therefore it was appropriate that the skin shades of the subjects in the study were classified as dark, medium, fair and light (Figure 4.6).

5.3.2 The L*a*b* values of the different devices

The L* value of the spectrophotometer range is greater than the L* values in the digital camera and the scanner (Figure 4.2). This may be due to different devices not producing the same visual colour, as the spectrophotometer, digital cameras, scanners and printers handle output and input data differently. All these devices produce colour in different ways, although advances in colour measurement techniques have included the ability to convert various measurements of spectrophotometric values into different colour parameters and colour mode values comparable (Johnston, 2009).

The spectrophotometer reproduces colour that was lighter than the other devices. The reason for this is because of the difference in the way the spectrophotometer sends and receives reflected light. The mean a* value of the scanner range of colours is more than the mean a* value in the digital camera and the spectrophotometer. This means that the scanner reproduces colour towards the reddish region. The mean b* value of the spectrophotometer is near the zero position of the B axis, this means very light yellow colour, while the mean b* value of the scanner is more toward the saturated yellow region.

The mean L* value range of the three devices in recording the different ethnic groups showed that the Chinese had greater mean L* value, which means the Chinese ethnic group had lighter (more reflective) skin, then the Malay ethnic group, and finally the Indians. While the mean a* and b* value range are nearly the same in the three ethnic groups (Table 4.3).

The mean L* value range of the three devices showed that the females had greater mean L* value, that means their skin colour is lighter than males. While the mean a* and b* value range are nearly the same in males and females (Table 4.4).

5.4 THE METHOD OF COMPARING THE RESULTS OF THE COLOUR MATCHING

5.4.1 Ethnic groups

The results showed that L*a*b* values of the three devices were significantly different (Table 4.2a). The L*a*b* values of Malay and Chinese showed significant difference for spectrophotometer and digital camera. However, the scanner showed different results only for L* and b* values (Table 4.3a). This might be due to the limitation in the design of the scanner in recording this range of skin colour spectrum.

The results of spectrophotometer and the scanner for Malays and Indians showed that the L* and a* values only were different. On the other hand, the result of L* value was different only for the colours captured using a digital camera. An explanation for this result may be due to the fact that L* value demonstrates the lightness difference between the two ethnic groups due to different reflection of the skin. while, the a* and b* values signify the yellow and red colour range which was not different (Table 4.3b).

The Indians and Chinese L*a*b* values were different when recorded by spectrophotometer and digital camera, while, the scanner results were significant only for L* and b* values. Again the difference is related to the skin shade features in the two ethnic groups (Table 4.3c).

No other study was found in the literature that determined the usefulness of the devices used in this study to assess skin colour. It would be useful if CIELAB values of the skin shades of people of different ethnic groups are available, so that similar studies could be compared. It was stated that most Caucasian skin tones lie within the range of CIELAB values of (L*:62-72, a*:2-10, and b*:11-22) (http://www.swpp.co.uk/professional_imagemaker/accurate_reproduction_skin_tones.ht

ml). However, no reference to the study conducted or how the values were obtained could be found in the literature.

Comparing these values of the Caucasian group to the mean CIE L*a*b* values from the spectrophotometer of the 3 ethnic groups in the study, where it was seen that for the Indians (L*:57, a*:8.37, b*:10.5), Malays (L*:61.03, a*:9.13, b*:11.07) and Chinese (L*:66.63, a*:7.37, b*:9.00) (Table 4.3). It may be seen that the results of the spectrophotometer values were appropriate for the groups studied. Their skin shades had lower L* values than the L* values of the Caucasian group, indicating darker skin shades of the group studied, compared to the Caucasian skin shades.

5.4.2 Gender

Males and females skin colours were different for spectrophotometer and scanner in L* and a* values, while, the digital camera results were not significant for L*a*b* values (Tables 4.4 and 4.4a). This signifies that values from the spectrophotometer and scanner may be used to identify the differences of colours in males and females.

In a study determining the colour of maxillary central incisors using a spectrophotometer, it was found that age and gender were statistical predictors of the natural colour of central incisors (L* values of central incisors changed with age and were 2 CIE L*a*b* units higher in females (Gozalo-Diaz et al., 2008). However, the results of this study may not be conclusive as the subjects were not balanced for gender in all ethnic groups (Tables 4.5 to 4.7). Hence, in these tables, values of L*a* and b* values were reported but not analysed statistically.

5.5 THE RESULTS OF THE VISUAL PERCEPTION METHOD AND ITS LIMITATIONS

Generally, the observer results signified that the spectrophotometer produced the least successful results of skin matching when compared visually to the original skin colour. The scanner results were fair compared visually to the skin colour. On the other hand the digital camera produced the best matching of the skin colour among the other devices (Figure 4.1).

The results showed significant differences for the ability of the three tested devices to reproduce skin colour as assessed by the 4 different assessors (Table 4.8). This significance means that there was a big difference between these three devices results and also in the evaluation of the observers. The observer judgements on the ability of the three tested devices to reproduce the skin colour is important as visual assessment of colour matching results will continue to be used as the final step of evaluation, even though some controversy may arise for its use as an evaluation method due to the limitations such as the subjective assessment of the observers and the evaluation scale used.

5.6 CLASSIFICATION OF THE SKIN SHADES

5.6.1 Method used to classify the skin shades

As no standard method for classification of skin shades was found, the method using the normal distribution curve was used with the L^* values obtained from the digital camera. One reason for the use of the normal distribution curve is that it is easy to use and easy to be understood. It is simply arranging the L^* values from the minimum to the maximum values, and grouping the values using the mean and standard deviation values (Bulman and Osborne, 2002).

This facilitated grouping the L^* values into groups with the lowest L^* values to the highest L^* values, and distributing them by percentages in the various allotted groups, i.e. the 4 groups obtained. In this study, using the normal distribution curve, it should follow that 16% of the subjects had dark colour skin, 34% had medium colour skin, 34% had fair colour skin, and 16% had light colour skin (Bulman and Osborne, 2002).

In the dark colour group, 86.6% of the subjects in this group were Indians (Table 4.9). In the medium colour group, almost half of the subjects were either Indians or Malays (Table 4.10). On the other hand, the fair colour group was composed mainly of Chinese subjects followed by Malays and a small number of Indians (Table 4.11). Finally, the light colour group consisted of almost two thirds of Chinese subjects with Malays making up the rest one third (Table 4.12).

Taking the whole of the sample studied, it was found that 17% of the subjects had dark skin, 59% had medium to fair skin and 24% had light skin (Tables 4.9-4.12). This approximates the skin colour of the ethnic composition of Malaysia.

It has to be said that although the final shades may be the average skin shades of the sample of the population studied, they may not give truly accurate matches of any skin shade in the sample (Figure 4.6). Printed versions of colours may not show the true colours of the skin shades studied, as some of the colours that can be captured by a scanner or camera, and measured by the spectrophotometer may not be reproduced precisely on printer or a printed paper. Most colour pictures need to be corrected using colour editing software like Photoshop for exposure and processing errors.

5.7 CLINICAL SIGNIFICANCE OF THE STUDY

This study emphasised an approach to investigate the best device that satisfies the maxillofacial requirements in skin colour reproduction of the Malaysian population. A lot of work has to be done regarding the application of the findings of this research to enhance the maxillofacial prostheses tinting procedures, which are until now done according to trial and error. This means material wasting, time consuming, and improper colouring of the maxillofacial prosthesis. Using the camera to produce a record of the skin colour may exempt the patient from being present in the clinic during the initial processes of matching the colour i.e. when tint mixing before silicone processing procedures with more satisfying results.

CHAPTER SIX

CONCLUSIONS AND SUGGESTIONS FOR FURTHER STUDY

6.1 CONCLUSIONS

Within the limitations of this study, the following conclusions were drawn:

- 1 The digital camera was the best device compared to the spectrophotometer and the scanner in reproducing facial skin colour.
- 2 The skin shades of a sample of the Malaysian population may be classified into 4 main groups; dark, medium, fair, and light.

6.2 LIMITATIONS OF THE STUDY AND SUGGESTIONS FOR FURTHER STUDY

1. The number of the subjects involved in this study was not representative of the Malaysian skin colour gamut. The composition of the sample regarding the gender was insufficient to make a complete data base for the classification of the skin colours in Malaysians. In addition, it was difficult to involve more individuals from mixed ethnic groups so that the results will be more global for the Malaysian people.
2. Future studies should also include different areas of the skin, for example other areas of the facial skin like the cheek and tip of the nose, and other areas like the back of the hand. However, the use of these areas may be limited by the presence of facial hair and more variation due to pigmentation from the sun.

3. The flatbed scanner was limited in use because its size made the recording more difficult. A hand-held scanner would be more convenient to use, if available.
4. The transformation of RGB to L*a*b CIE values was extra time consuming and some variations might occur during the transformation, although this might have been negligible.
5. Illumination for the digital camera was fixed to a certain degree; however different illuminations may be used to confirm the obtained results. It would be more interesting to see if compact digital cameras would have produced the same result as the camera used in the study. Compact digital cameras are more practical and convenient to be used in a normal dental practice.
6. A shade guide for maxillofacial prosthetic silicone materials should be the final product of this type of research so as to facilitate colour matching of prosthesis to the adjoining skin colour.