PERCEPTION OF LIP AESTHETICS OF REPAIRED CLEFT LIP AMONG PROFESSIONALS, LAYPERSONS AND CLEFT PATIENTS USING THREE-DIMENSIONAL IMAGES

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PERCEPTION OF LIP AESTHETICS OF REPAIRED CLEFT LIP AMONG PROFESSIONALS, LAYPERSONS AND CLEFT PATIENTS USING THREE-DIMENSIONAL IMAGES

ABSTRACT

Introduction: Specialized treatment is necessary for cleft lip and palate patients from their early periods of life until adulthood. Often, the scars formed in the lip region are left behind. These impaired appearances can affect patients' psychosocial well-being and ultimately, their quality of life. A difference in aesthetic perception may exist among individuals with different professional backgrounds. The observed differences may be related to the level of knowledge, perception and exposure between the groups. There is more emphasis now on patients' own views or perception on what they want to achieve at the end of their treatment. This research can therefore help clinicians to better understand cleft patients' needs and expectations so that treatment provided in future can be improved upon.

Objectives of study: To determine the differences in perception on lip aesthetics by dental professionals, laypersons and cleft patients, and to investigate the influence of lip asymmetry on aesthetic perception.

Materials and method: Three-dimensional images of treated cleft lips and of controls were presented in random order to three groups of raters, i.e. cleft patients, dental professionals and laypersons. For each image, the raters had to evaluate the lip attractiveness using Visual Analog Scale (VAS), ranging from 0-10cm. Differences in mean VAS scores given by the observer groups were analyzed using one-way analysis of variance (ANOVA). Pearson correlation coefficient was used to investigate the relationship between lip asymmetry and aesthetic scores.

Results: The mean VAS score for the treated cleft images was 3.6 lower than that of non-cleft images (5.2 vs 8.8) and this difference was statistically significant. There was no significant difference in the VAS scoring by the three rater groups. Although not significant, a negative correlation was found between the amount of lip asymmetry and VAS score.

Conclusion: Treated cleft lips had significantly lower aesthetic scores than normal lips. The professional background of raters did not influence their perception of lip aesthetics. The level of asymmetry also did not affect their aesthetic scoring.

PERSEPSI KECANTIKAN BIBIR DENGAN MENGGUNAKAN GAMBAR TIGA-DIMENSI REKAHAN BIBIR YANG TELAH DIRAWAT DI KALANGAN GOLONGAN PROFESIONAL, ORANG AWAM DAN PESAKIT REKAH BIBIR

ABSTRAK

Pengenalan: Rawatan khusus diperlukan untuk pesakit rekah bibir dan lelangit dari awal kehidupan mereka sehingga dewasa. Seringkali, parut yang tertinggal di kawasan bibir boleh menjejaskan kesejahteraan psikososial pesakit dan akhirnya kualiti hidup mereka. Perbezaan persepsi kecantikan mungkin wujud di kalangan individu dengan latar belakang profesional yang berbeza. Perbezaan ini mungkin disebabkan oleh tahap pengetahuan, persepsi dan pendedahan yang berlainan. Kini, lebih banyak penekanan pada pandangan atau persepsi pesakit diberikan untuk mencapai matlamat yang terbaik pada akhir rawatan mereka. Oleh itu, penyelidikan ini boleh membantu perawat untuk lebih memahami keperluan dan harapan pesakit supaya rawatan yang diberikan pada masa depan dapat ditingkatkan.

Objektif: Untuk menentukan perbezaan persepsi kecantikan bibir oleh profesional pergigian, orang awam dan pesakit rekah bibir, dan untuk menyiasat pengaruh asimetri bibir pada persepsi kecantikan.

Kaedah: Imej tiga dimensi rekah bibir yang telah dirawat dan bibir normal dibentangkan secara rawak kepada tiga kumpulan pemerhati, iaitu pesakit rekah bibir, profesional pergigian dan orang awam. Bagi setiap imej, pemerhati harus menilai kecantikan menggunakan Visual Analog Scale (VAS), dari 0-10 cm. Perbezaan skor VAS antara kumpulan pemerhati akan dikaji menggunakan *Analysis of Variance* (ANOVA). *Pearson correlation coefficient* akan digunakan untuk mengkaji hubungan antara asimetri bibir dan skor kecantikan.

Keputusan: Skor purata VAS untuk imej rekah bibir yang dirawat adalah 3.6 lebih rendah daripada imej bibir normal, dan perbezaan ini adalah signifikan. Tiada perbezaan yang signifikan antara skor VAS yang diberikan oleh tiga kumpulan pemerhati. Walaupun tidak signifikan, korelasi negatif didapati antara tahap asimetri bibir dan skor VAS.

Kesimpulan: Rekah bibir yang dirawat mempunyai nilai estetik yang jauh lebih rendah daripada bibir normal. Latar belakang profesional para pemerhati tidak mempengaruhi persepsi kecantikan bibir. Tahap asimetri juga tidak mempengaruhi penilaian estetik mereka.

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TABLE OF CONTENTS

PAGE

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

Specialized treatment is necessary for patients with cleft lip and palate (CLP) defect from their early periods of life until adulthood to improve the facial appearance and function. However, the scars formed and the asymmetry in the lip region are often left behind. These impaired facial appearances can affect patients' psychosocial well-being and ultimately, their quality of life.

A difference in perception may exist among patients, laypersons and professionals when evaluating morphological characteristics around the dentofacial region. The observed differences may be related to the level of knowledge, perception and exposure between the groups.

As clinicians, we often focus on obtaining the best clinical results for our patients and may form our own opinion on the aesthetic values of those results. However, currently there is more emphasis on patients' own views or perception on what they want to achieve at the end of their treatment. As we play a deciding role in determining the aesthetic destiny of a patient's face, the patient's perception of his or her own appearance must be taken into account before treatment planning. For that reason orthodontists are obliged to study and consider facial beauty, balance and harmony as perceived, not just through their own eyes, but through those of the general public as well.

1.1 Importance of the Proposed Research

Cleft lip and/or palate patients were perceived to have a tendency to be more depressed, have learning disabilities and a lower self-esteem (Ramstad et al., 1995; Broder et al., 1998). Broder and Strauss (1992) reported that 33% of cleft lip patients, 49% of cleft palate only patients, and 56% of CLP patients had problems that warranted a psychosocial consult.

In a previous local study carried out by Noor and Musa in 2007, parents and patients of 60 CLP (12 to 17 years old) from Hospital Universiti Sains Malaysia were interviewed to determine the level of satisfaction with the treatment that they received. The questionnaires used were the Cleft Evaluation Profile (CEP) and the Child Interview Schedule. Nine of them reported that their self-confidence was "very much affected“, and up to 83% of the patients felt their self-confidence was affected by their cleft conditions. They also found that the lips were the second most concerned feature that the CLP patients and parents felt needed more attention. Sinko et al. (2005) reported that majority (63%) of the female patients asked for further treatment, particularly for the corrections of the upper lip and nose.

Raters with different backgrounds evaluate facial aesthetics of patients with cleft differently. Marcusson et al. (2002) reported that patients themselves tend to rate aesthetics on operated cleft lip worse compared to professionals (3.2 vs 3.6 on a 5-point Likert scale). On the other hand, Foo et al. (2013) reported that professionals gave a lower score compared to cleft patients (50 vs 72.2) on a Visual Analogue Scale of 0 to 10 cm. To date, there is no local study that investigates the differences in the aesthetic judgment of lip or facial appearance by raters of different backgrounds. This research can therefore help clinicians to better understand their cleft patients’ needs and expectations so that treatment provided in future can be improved upon.

1.2 Aim

To analyze the perception on lip aesthetics by dental professionals, laypersons and cleft lip patients, using three-dimensional facial images.

1.3 Objectives

1) To identify differences in valuation on lip aesthetics of treated cleft lip and non-cleft lip images.
2) To determine if there is a difference of perception in the outcome of cleft lip repair among patients, laypersons and dental professionals (i.e. orthodontists and oral surgeons).
3) To investigate the influence of lip symmetry on the aesthetic evaluation of repaired cleft lip.

1.4 Null Hypotheses

1) There is no significant difference exists in the evaluation of lip aesthetics of repaired cleft lip and normal lip.
2) The perception of lip attractiveness is not dependent on the professional background of the raters.
3) Lip symmetry does not influence the perception on aesthetics.

1.5 Alternative Hypotheses

1) There is a significant difference in the evaluation of lip aesthetics of repaired cleft lip and normal lip.
2) The perception of lip attractiveness was dependent on the professional background of the raters.
3) Lip symmetry does influence the perception of aesthetics.

CHAPTER 2: LITERATURE REVIEW

2.1 Lip Function and Aesthetics

Man uses his lips and facial muscles to register his emotions. A subtle movement of the lips may create friendliness, coyness, sweetness, hardness, sarcasm or hate. Extreme happiness can be shown by marked contraction of the corners of the mouth and elevators of the lips. Extreme sadness can be expressed by contraction of the triangularis and mentalis. Relaxation of all the muscles about the mouth, with a slight opening between the teeth, denote love and passion. The orbicularis oris is a major factor in these expressions. When it is associated with teeth clenching, it can show rage. Alone, it can close the lips tightly. And when added to risorius and platysma action, it can portray terror (Rubin, 1974). This myriad of complex facial muscle movements differentiates man from the lower animals. The face expresses a person's inner emotions.

Smile index (Ackerman, 2002), incisogingival display (Peck, 1992), golden proportion (Levin, 1978), smile arc (Mackley, 1993) and buccal corridor width (Sarver, 2001) all have been associated with smile aesthetics in past studies. The vertical lip thickness is found to have an influential role in smile attractiveness (McNamara et al., 2008).

During the Renaissance, renowned painters (della Francesca, da Vinci, Dürer) proposed rules for establishing ideal proportions to achieve optimum aesthetics and harmony. The golden ratio, also known as the divine proportion, is denoted by the symbol Φ (phi) and is an irrational number of the order 1.618033988. It is considered by many to be the key to the mystery of human beauty and aesthetics (Bashour, 2006). It can be observed in nature, art, architecture, and even the human body. Some of the examples include flowers, snowflakes, spiral pattern of seeds in sunflowers, spiral shape of the snails and animal horns, pentagonal shape of the seashells, number of human toes and fingers, and the relationship of phalanges in the human hand and fingers. Even the

whole human body can be sectioned into a golden proportion. Therefore, the idea is that the golden proportion is aesthetically pleasing to the eye since it occurs in many natural forms.

In 1982, Ricketts published an article discussing the significance of golden proportion in facial aesthetics and stated that facial features can be assessed mathematically using the golden proportion. The height of the face from the pupils to the chin is Φ times the height from the hairline to the pupils. The distance between the lateral canthi is Φ times the width of the mouth. The width of the mouth is Φ times the width of the nose. The volume and, therefore, the vertical height of the vermilion of the upper to the lower lips should ideally yield the value of Φ, 1:1.618. This is first seen with da Vinci's classic proportions of the lips relative to the rest of the face. These basic artistic principles, first practiced hundreds of years ago, still apply today (Sarnoff and Gotkin, 2012).

From frontal view, the lower third of the face (from subnasale to menton) can be divided into thirds, with the upper lip in the upper one-third (from subnasale to stomion) and the lower lip in the lower two-thirds (from stomion to menton) (Arnett and Bergman, 1992). The ideal upper lip: lower lip ratio is again, 1:1.618.

From lateral view, the lips should be slightly everted at their base, with several milimeters of vermillion border show at rest, although they tend to become more retrusive with age. Protrusion of the lips varies between ethnic groups, with individuals of African origin being more protrusive. Lip protrusion is also relative to the size and shape of the chin. Generally, lips are considered too protrusive when both are prominent and incompetent (Cobourne and DiBiase, 2016).

2.2 Age and Ethnic Differences in the Lips

The fundamental proportions of the lips change as a person ages, with thinning and volume loss of the upper lip vermilion, and lengthening of the cutaneous portion of the upper lip. Maxillomandibular bony resorption, dental changes, gravity, osteoporosis and further loss of soft-tissue volume at the oral commissures cause the commissures to turn downward in a perpetual frown (Kar et al, 2018).

In recent years, a surge in ethnic populations and increasing migration have made it a challenge for surgeons in distinguishing facial characteristics specific to a certain ethnicity. Over the past two decades there is an increasing interest in the consideration of ethnic differences in the evaluation of beauty. We all know that beauty lies in the eye of the beholder and is extremely subjective. It is dictated often by individual preferences and ethnic or cultural factors. On the other hand, most available anthropometric measurements have been established from Caucasian values. Treatment regimens that typically result in a good outcome in one ethnicity could yield less pleasing results in others.

Certain ethnic groups, especially Blacks, genetically have greater lip volume. The increased melanin in their skin acts as a protection and therefore, is less prone to solar elastosis. As a consequence, they rarely develop radial rhytides in the lips and their vermilion can retain its volume even subsequent to aging (Sarnoff and Gotkin, 2012). Hwang and Hwang (2005) reported that the ratio of vermilion size to mouth width was greater among the Japanese than to the Korean ideals of beauty in the late 18th and early 19th centuries. Large differences were found between Asian and Caucasian lips. Female Caucasian lips are generally thinner and have an overall smaller upper lip size. Caucasian male lips are overall thinner and demonstrated the smallest cupids bow width, as compared to Chinese and Korean males (Wong et al., 2010).

2.3 Comparison of Facial Morphology between Cleft and Non-Cleft Patients

A comparative study was done by direct facial measurements and by measuring lateral cephalometry of 75 treated cleft and 75 noncleft Malay subjects (Badrul, 2005). The upper lip height was significantly higher for non-cleft subjects and philtrum width was found to be significantly higher for the cleft subjects. The study also reported that certain facial measurements (nasal and upper anterior facial height, nasal width) and skeletal measurements (SNB, ANB, maxillo-mandibular angle, and anterior lower facial height, ALFH) were unique to the patients.

In another study done by Othman et al in 2013, three-dimensional (3D) facial measurements of repaired unilateral CLP and non-cleft patients were carried out to analyze craniofacial proportions. It was found that the craniofacial areas that were the most disproportionate were the orolabial (upper lip and height of upper vermilion) region and the nose (nasal and nasal tip) region. Both these regions were flatter or larger in the cleft patients.

Farkas et al. (2000) analyzed facial disproportion that contributed to disharmony and imbalance among young adult cleft patients who had undergone surgery. They found that shorter upper face height and narrower mandible were the common characteristics of these patients when compared to patients in the control group. Also, for upper face proportionality (nasion - stomion / nasion-gonion), more bilateral cleft subjects had a short upper face than unilateral cleft subjects. On the other hand, the reverse is true when it comes to dimensions of the lower face (subnasale - gonion / nasion - gonion). More unilateral cleft patients had a long lower face than their bilateral counterparts. However, it is unknown if these findings were due to the postoperative trauma on growth of the face, or characteristics that were already present before surgery.

Djorjevic et al. (2012) utilized laser scanning to investigate facial morphology and asymmetry in repaired cleft patients. The superimposed three-dimensional images demonstrated that these patients had more retruded forehead, midface and mandible. The amount of facial asymmetry in this group of subjects was also higher and was statistically significant.

2.4 Repair and Management of Cleft Lip

At infancy, the use of orthopaedic plates is practised in many cleft centres throughout the world, but remains controversial as there is insufficient data that clearly demonstrates if the burden of care and costs involved are of a significant long-term benefit to the patient. McNeil in 1956 first described using an intraoral appliance to reposition the maxillary segments prior to surgery, and claimed that it encouraged the development of a good dental occlusion and produced more favourable growth. The technique has evolved over the years and has collectively become known as pre-surgical orthopaedics. Latham et al. (1976) described how their pin and plate appliance aimed to approximate the bony segments and, when combined with gingivoperioplasty and early bone grafting, facilitated normal alveolar and dental development. Studies of untreated clefts and less-invasive approaches have failed to support this concept.

Although many new variants have been developed including pre-surgical nasoalveolar moulding (PNAM), the original concept has more or less remained the same. It involves usually an intraoral removable appliance to expand the palatal segments and mould the alveolus to improve arch form before surgery. The design of the appliance can incorporate active or passive components; extraoral strapping can be added to help narrow the soft tissue cleft while stents improve the nasal morphology. It is now generally accepted that speech and feeding do not improve by intraoral appliances, but the benefits of nasal development and facial growth remain contested by both sides of the pre-surgical orthopaedic debate (Papadopoulos et al., 2012, Uzel and Alparslan, 2011).

Surgical repair of cleft lip usually carried out between 3 to 6 months of age; the exact age is usually dictated by surgeon preference. Classically, the preferred age is at 10 weeks old, following surgeons Wilhelmsen and Musgrave's (1966) rule of 10s recommendation (the child must weigh at least 10 pounds, is at least 10 weeks of age;

and has at least 10g hemoglobin). Advances in neonatal care and paediatric anaesthesia have made it possible to perform cleft surgery during the neonatal period, although there is currently no clear evidence to suggest that is particularly advantageous (Schendel, 2000).

Most centres repair bilateral cleft lips at the same procedure (simultaneous correction of lip, nose and alveolus), but some still carry out two separate operations. The goals of repair are both functional and aesthetic. Recreation of the obicularis muscle to circumferentially surround the opening of the oral cavity is important for lip function and lasting cosmetic outcomes. Aesthetically the goals of repair include establishing symmetry of the nose and cupid's bow in a manner that places scars in less discernable areas, and formation of lip continuity.

There are many medieval references to the operation but it was not illustrated until Paré published his treatise in 1575 (Paré, 1634) (Figure 2.1). Paré is regarded as the founder of modern cleft-lip surgery. The straight-line repair is indicated in only minor clefts. It produces the shortest scar but once the scar contracts along the incisional line, it lifts the defective side, leaving an unsatisfactory notch on the vermillion. Historically, less attention has been directed toward the nose or muscles when optimum results actually require that these two areas also be addressed adequately. Instead, attention has been turned towards geometric skin flap techniques concentrating on the lip.

The nineteenth century saw an increase in publications on methods of repairing clefts, i.e. those of Mirault (1844) and Hagedorn (1892) (Figures 2.2 and 2.3). Hagedorn published his first work in 1884, and produced a second paper in 1892 (Heycock, 1971). It led to Le Mesurier's (1949) introduction of incision method, the Z-plasty, and suturing of the lip in complete unilateral clefts on it (Figure 2.4).

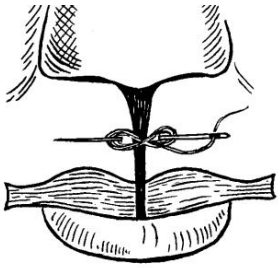


Figure 2.1. The straight line repair for minor clefts introduced by Paré (1575).

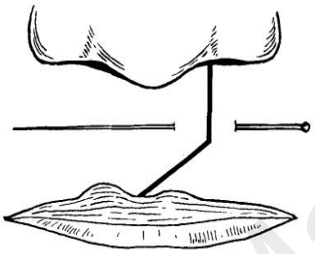


Figure 2.2. Mirault's (1844) lip repair method which was far more influential than Paré's

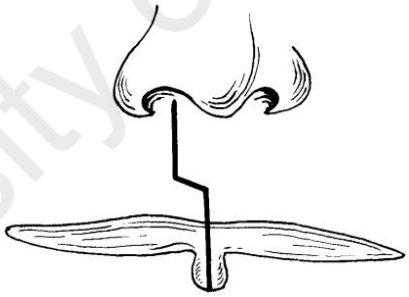


Figure 2.3. In this method, Hagedorn (1892) used an incision that resembles a dew-drop. It was originally published in 1884.

Figure 2.4. Le Mesurier (1949). The first Z-incision method.

Le Mesurier's repair was the first to create a Cupid's bow. Unfortunately, it has lost much of its popularity because this method resulted in the lip being too long on the cleft side. Tennison's (1952) repair also creates a Cupid's bow but it does not suffer the disadvantage of a long lip (Figure 2.5).

The First International Congress of Plastic Surgery in Stockholm in 1955 marked a turning point in cleft lip surgery when doctor Millard presented his rotation-advancement flap (Figure 2.6) technique. Ralph Millard developed this technique by operating cleft lip children during his military service in the Korean War. The design of rotation-advancement flap is based on a curved line (rotation) on the non-cleft side in order to balance the lip height discrepancy. This technique creates a more symmetrical nasal base and philtral column width because the horizontal arm of the zig-zag is hidden in the base of the nostril. Today the technique is used by more than 85% of cleft surgeons around the world, with or without some modifications (Knezevic et al., 2017). Although this produces an aesthetically good scar, it sometimes does not produce adequate lip length and the repaired lip is tighter in the lower third, due to vertical scar contraction.

Figure 2.5. Tennison (1952). The repair crosses the vermilion border at right-angles.

Figure 2.6. Millard (1955). The philtrum is preserved and rotated to its normal position. This results in a scar that follows the natural line of the philtral column.

The rotation advancement technique has been followed with some modifications which have been made by numerous cleft surgeons, such as extended incision in the columella, insertion of small skin triangle on the non-cleft side for the elongation of the lip on the cleft side or some other small geometric modification on the line of rotation (Knezevic et al., 2017).

Bilateral cleft lip repair shares many of the same goals with unilateral repair. Lip strapping or some form of dentofacial orthopedic manipulation helps in proper alveolar closure, philtral design, and nasal correction (Mulliken, 2009). In bilateral cleft lip, the upper lip orbicularis oris muscle must be freed from each lateral cleft element and reunited at the midline when possible, thus creating the philtrum. It is unavoidable that there will be some degree of maxillary retrusion following repair, but first priorities are speech and the labionasal appearance. Midfacial hypoplasia and reverse overjet are entirely correctable after growth has taken place (Mulliken, 2009).

In many cases, changes occur with growth that necessitate further secondary revisions. Patients may need revision when problems such as nasolabial asymmetry, distortion, and hypoplasia are encountered. These problems might be increasingly obvious prior to attending school and become magnified during adolescence. The appropriate timing for the secondary surgical correction of the cleft lip is still being debated. The repair is often performed in conjunction with rhinoplasty, when the nasal growth has completed (Lim et al, 2013). In secondary lip repairs, knowledge on lip anatomy and its muscular substructure are important, as the muscles of the region must be identified, dissected out thoroughly, and placed in their proper anatomic position. Adjunctive procedures such as collagen injection, micrografting and dermabrasion should also be included in the surgeon's treatment options (Doonquah and Ogle, 2002).

2.5 Psychosocial Effects of Cleft Lip and Palate

Research has shown that attractive children receive more positive treatment and are seen as having a more positive social behaviour and brighter than their less attractive counterparts (Dion et al., 1972). Clefting that involves the face imposes evident physical difference; therefore as a consequence, cleft related facial difference could be expected to have an impact on social interactions.

Incidence of teasing is high among children with CLP (Bernstein and Kapp, 1981; Turner et al., 1997). The general assumption that follows is these children must experience some kind of psychosocial distress as a result of their condition. Broder and Strauss (1992) reported that 56% of CLP patients, 49% of cleft palate only patients, and 33% of cleft lip patients had problems that warranted a psychosocial consult.

Cleft lip and/or palate patients were perceived to have lower self-esteem, learning disability, and a tendency to be more depressed (Broder et al., 1998). There are few differences in educational attainment and employment between adults with CLP and other people. There are reported specific learning problems among CLP children

(Millard and Richman, 2001), and mental development scores significantly decreased as infants with CLP grew older (Kapp-Simon and Krueckeberg, 2000). One in four cleft children repeated a grade at school (Broder et al., 1998). Income seemed to be lower among CLP adults as compared to the control population (Ramstad et al., 1995).

Anxiety and depression are common in adults with CLP. Dissatisfaction with appearance has been found to be a cause of depression among cleft patients. (Marcusson et al., 2002). There is significantly more avoidance and social anxiety among CLP subjects than among siblings and controls (Berk et al. 2001).

While overall psychosocial functioning appears to be good among children and adults with CLP (Heller et al., 1985; Bjornsson and Agustsdottir, 1987), two areas of social functioning have been reported that appear to differentiate those with CLP from those without CLP: marriage and friendships. Fewer people with CLP marry as compared to subjects without cleft, and when they marry they do so later in life, particularly if the CLP is bilateral (Ramstad et al., 1995). CLP children and in their young adulthood were reported to have fewer friends than non-cleft subjects (Noar, 1991; Ramstad et al., 1995).

2.6 Changes in Lip Attractiveness Standards

There has been a disagreement over the years whether the facial ideals and concepts have remained static since they have been described several thousands of years ago. Some orthodontic articles suggest that the facial ideals have remained constant, whereas other studies suggest that public perception of facial aesthetics has been changing with time.

Auger and Turley (1999) collected profile photographs of Caucasian females ages 18-35 years from fashion magazines over a 92-year period, from 1900 to 1992. Photographs were divided into five-time periods. A trend toward fuller and more anteriorly positioned lips has been observed as the sample became more recent, suggesting that the public's preference shifted toward fuller lips in the more recent years. According to the authors, one of the reasons for this trend is that fuller and more protrusive lips are considered to be a sign of youthfulness. Modern society seems to be obsessed with looking youthful and associates thin lips with older faces since the lips become thinner with age. Furthermore, fuller lips are often present in the African American models and models with the mixed ethnic background. An increase in a number of African American models in advertisements has been observed in the 1960s and 1970s thus possibly contributing to this trend.

The results of this study have been confirmed by Berneburg et al. (2010) who also found that as the lip fullness increased, the nasolabial angle decreased, and the profile became more convex in both women and man during the period from 1940 to 2008. Therefore, a conclusion can be made that facial ideals and standards have been changing along with the changes and developments in our society.

2.7 Visual Analogue Scale (VAS)

Hayes and Patterson (1921) were the first to use VAS. It has a line anchored at each end by the extremes of the variable being measured. This can represent a continuum between opposing adjectives in a bipolar scale or between complete absence and the most extreme value in a mono-polar scale.

There are many different considerations in designing a VAS, such as length of the line, labels for the ends of the line, presence or absence of scale marks on the line, presence or absence of numbers on the scale marks, vertical or horizontal placement of the line, discrete categories versus continuous scales, identification of a midpoint, and so on. In each case, the respondent has to draw a mark on the line to indicate his or her position on the scale. The distance of this mark from the origin is measured to determine the respondent's value on the scale.

According to Kerlinger (1964), VAS is probably the best of the usual forms of rating scales. It fixes a continuum in the mind of the observer and suggests equal intervals. It requires little motivation from the rater and frees the rater from direct quantitative terms. It is also clear and easy to understand and use. In health and medical research, the VAS is widely used. Many of these applications appear to be in clinical settings involving self-administration.

Despite their apparent advantages, the VAS has its drawbacks. In part this may be because two key features of such measures are that (a) they require self-administration and (b) they are visual, that is they cannot be administered using an aural medium such as the telephone. These characteristics, along with the extra effort needed to measure and record the answer provided, may limit the use of VAS in surveys.

Recent developments in graphical user interfaces such as Microsoft Windows and HTML raise the possibility of greater use of VAS in computer-assisted self-interviewing or web-based survey applications. The rich graphical nature of modern computer interfaces, along with the ability to use direct manipulation devices such as slider bars, may solve some of the drawbacks associated with paper-based VAS. Kreindler et al., (2003) developed a VAS mood questionnaire for handheld computers. The use of a stylus and the graphical user interface permitted the use of a system that replicated a paper-based VAS, that is the respondent could draw a line on the screen to mark the desired point on the scale.

The simplicity of the VAS promotes high compliance, and it has been proven to have high reliability and validity (Ahearn, 1997). It is suitable to measure changes in mood and the scores obtained can represent the patients' feelings (Zealley and Aitken, 1969). Averbuch and Katzper (2004) compared a VAS and a 5-point categorical pain scale and found equivalent sensitivity between the two for measuring changes in pain levels. Hawker et al. (2011) did a study on pain intensity of patients with arthritis and reported that the test–retest reliability of VAS has been shown to be good, but higher among literate ($r = 0.94$, $P < 0.001$) than illiterate patients ($r = 0.71$, $P < 0.001$) before and after attending a rheumatology outpatient clinic. It also showed a high correlation (0.71-0.78) with a 5-point verbal descriptive scale of "nil," "mild," "moderate," "severe," and "very severe".

In this study, the authors used VAS as it is a valid and yet simple tool to gauge raters' perception on the aesthetics of lips. Perception is a subjective feature hence to measure it the authors felt that a continuous grading scale like the VAS is highly suitable.

2.8 Three-Dimensional Imaging

The majority of the studies that evaluated facial attractiveness and beauty in the past used conventional two-dimensional (2D) imaging, such as lateral cephalometric radiographs, profile view, frontal view and three-quarter view facial photographs, and profile line drawings. However, with the introduction of three-dimensional (3D) imaging, 2D imaging might not be sufficient to evaluate 3D facial characteristics.

In the past, the main 3D records routinely used by practicing orthodontists were study models. This allows malocclusions to be examined and demonstrated from many viewpoints. Nevertheless, it does not provide any information on how that dentition relates to the soft tissues and skeletal of the face. Another disadvantage includes the pouring, trimming and storage of the diagnostic study casts.

Some applications of 3D imaging in orthodontics include pretreatment assessment of dentoskeletal relationships, facial profile, auditing orthodontic outcomes with regard to hard and soft tissues, 3D hard and soft-tissue predictions, and treatment planning. Other benefits of 3D models in orthodontics include custom-made archwires, archiving 3D facial, skeletal, and dental records for in-treatment planning, research, and other medical and legal purposes (Hajeer et al., 2004).

2D imaging comes in two axes, the horizontal(x) and the vertical(y). 3D images add one more axis and more perspective. When talking about 3D images, the three different axes often are referred in slightly different terms. The (x) axis is known as the transverse dimension, (y) axis is the vertical dimension and the (z) axis the anteroposterior dimension. These three axes make up three-dimensional space when combined (Udupa and Herman, 1991). To convert that information to a 3D computer image, three steps are involved. First, mathematics is used to describe the physical properties of the object. The object is then seen as a ‘wireframe’ or ‘polygonal mesh’ made up of triangles or

polygons to help in the visualization. Secondly, a surface layer of pixels is placed, resulting in the 'image' or 'texture mapping'. In the second step, lighting and shading will be added to make the object look more realistic. The last step is known as rendering and consists of the computer program converting the anatomical data from the object into a life-like 3D picture seen on the computer screen (Seeram, 1997).

2.9 3D-Facial Imaging

Facial 3D imaging analysis is gaining popularity and allows visualization of the face through surface area and volume analysis (Incrapera et al., 2010). 3D digital imaging is a minimally invasive, quick and accurate method and is capable of reproducing the surface geometry of the face with realistic color and texture, thus creating a lifelike facial image and allowing for the objective evaluation of the face (Heike et al., 2010).

While there are many different methods to achieve the same goal, all methods should be non-ionizing, non-invasive, and minimize the need for patient cooperation. Following are the types of 3D facial imaging:

I) Cone Beam Computed Tomography (CBCT)

With the introduction of CBCT, radiation dose has been reduced and resolution increased as compared to computed tomography (CT) scans for dental imaging. Although not a routine use in orthodontics, the CBCT proves to be a valuable tool in particularly the diagnosis of ectopic and impacted teeth. It can also be useful for imaging of temporomandibular joint morphology, assessment of alveolar bone height and volume prior to implant placement, and airway analysis (Merrett et al., 2009). Although at a reduced dose, there is still radiation involved during exposure.

II) Laser Scanning

3D images can be acquired by laser triangulation from an optical source. The device consists of a laser sent out over the patients face, which is then captured by a charged couple device (CCD) and then that is converted into a computer generated image. The surface laser scanner can detect the object's length, width and its depth as a result of triangulating the distance between the laser beam and scanned surface (Kusnoto and Evans, 2002). Kau et al. (2005) reported that this technique produces reproducible and reliable data when used to produce three-dimensional facial images.

III) Stereophotogrammetry

Stereophotogrammetry is a vision based technique that converts images taken by two or more cameras simultaneously at different angles, into a three dimensional image. Hence the surface topography of a patient's facial morphology can be obtained (Kau, 2005). Some advantages of stereophotogrammetry include rapid data capture, accurate identification of landmarks to within 0.5mm, and it generates an immediate 3D display (Ayoub et al., 1996). Also, there is no need for contact of the instruments on the cutaneous surface and shorter patient interaction time is needed because measurements can be carried out immediately after data acquisition. Because of the rapid data acquisition, it can be used on very young patients. Some disadvantages come from the software that is needed to convert the images and that each system used commercially must be validated so that the measurements of all the surfaces are accurate and reproducible. Shadows being created on the images, specifically around the nasal and paranasal areas due to the cameras flash coming from two sources, is another disadvantage (Aldridge et al., 2005). Also, the software accompanying the stereophotogrammetric cameras can be expensive, it is only available in certain research centres, and has restricted portability (Ladeira et al., 2013).

IV) Structured Light Technique

This is a vision based technique that creates a 3D image from one image using the method of triangulation. Compared to stereophotogrammetry, this uses one image while the latter uses two images or more to create the 3D image. The image is created when a projector shines a "structured" light pattern on to the object being recorded. The morphology of the surface of the object will cause the light pattern to distort and bend. The cameras at a known distance, will then capture the reflected light and that information is then translated into three-dimensional co-ordinates (Kau, 2005).

V) 3dMD Face System

It is a new system that combines both the structured light method and the stereophotogrammetry method into one system called the 3dMD Face (Kau et al., 2007). Two banks of cameras are used, with each bank consisting of one color and two infrared cameras to capture the 3D image. This system operates by projecting a random light pattern onto the patient and then the image is captured by the two banks of cameras capturing their image simultaneously and from different angulations. The manufacturer reported an accuracy of 0.5mm and a clinical accuracy of 1.5% of the total observed variance (Aldridge et al., 2005). Some other advantages of this system are that it is portable, has quick capture speed, and operates in standard clinical/office lighting conditions. It has also been shown that the 3dMD Face system detects landmarks that are highly reproducible (Aldridge et al., 2005).

It can be concluded that 3D stereophotogrammetry has many advantages. In this study, stereophotogrammetric images of the lips were used to gauge raters' aesthetic perception. The reason these three-dimensional images were used was to allow raters to manipulate (rotate, pan and zoom) them and therefore, carry out a proper aesthetic evaluation. The more detailed and lifelike these images mimic that of the real lips, the more accurate the evaluation could be carried out.

CHAPTER 3: MATERIALS AND METHOD

3.1 Study Design

This was a prospective cross-sectional quantitative study, whereby standardized 3D lip images of both cleft lip (treated) cases and controls were presented in random order to three groups of raters, i.e. cleft patients, dental professionals and laypersons.

3.2 Ethical Approval

Ethical approval was obtained from the Medical Ethics Committee, Faculty of Dentistry, University of Malaya, Kuala Lumpur. Ethics Committee/ IRB Reference number was DF CD1610/0063(P). Date of approval was on 14th June 2016 (Appendix A). All suitable patients were explained about the purpose and nature of the study that were outlined on the Patient's information Sheet (Appendix B). Verbal and written consent (Appendix C) were obtained from the patients and raters who fit the inclusion criteria and voluntarily wished to participate in the study.

3.3 Patient Selection

The patients that were selected for capturing of 3D facial images were recruited from the Combined Cleft Lip and Palate Clinic, Faculty of Dentistry, University of Malaya. Recruitment of patients took place from September 2016 to December 2016. A total of 16 images (8 treated cleft lip and 8 non-cleft lip) would be captured and used so as not to discourage or fatigue the raters by presenting too many sets of images for evaluation (Mclaughlin et al., 2009).

The following criteria were used:

1) At least 18 years of age.
2) Patients under the cleft group were operated with primary closure of the lip conducted at the age of 3-6 months.
3) The repaired cleft lip and/ or palate patients may or may not have had lip revisions at a later stage.
4) The controls (non-cleft patients) had Class I malocclusions with no severe skeletal asymmetry or discrepancy.

The following exclusion criteria were used:

1) Syndromic patients.
2) Cleft palate only patients.
3) Patients who were unwilling to give consent.

3.4 Sample Size Calculation

The samples in this study consisted of raters of different backgrounds, namely dental professionals, laypersons (school teachers) and cleft lip patients. School teachers were selected to represent the laypersons group because teachers are known to interact frequently with children due to their nature of work, and children with cleft are proven to have lower self-esteem than their normal counterparts. The school teachers' view on this could hence give a good representation on how this condition is being perceived by the public.

The power and sample size calculation was done using G*Power Software Version 3.1.9.2 (Faul et al., 2007). The sample size was calculated based on a previous study done by Sinko et al. (2005) that investigated on patients' evaluation of aesthetic outcome in cleft repair. With the possible 10% dropout rate, a power of 0.8 and significance level set at 0.05, a total of 30 samples were needed. Hence, a minimum of 10 raters were needed in each group.

3.4.1 Eligibility Criteria of Samples

The inclusion criteria for the raters were:

1) Must be 18 years and above.
2) Under the dental professionals group, the raters must have had experience of working in a cleft team for at least 5 years.

The exclusion criteria for the raters were:

1) Patients whose three-dimensional images were used in this study.

3.5 Image-Capturing

Once all 16 of the patients have agreed and consented for their images to be taken, appointments were arranged for the photography session. Their 3D facial images were captured using the VECTRA-M5 360º Imaging System (Canfield Scientific Inc. Fairfield, NJ, USA)3D for full-face imaging (Figure 3.1). The cameras were calibrated before the image was captured using the manufacturer's guidelines to ensure consistency and magnification. The images were taken at rest (not smiling) and without any lipstick or piercings on.

Figure 3.1. VECTRA-M5 360º Imaging System

All the captured images were then cropped to just the lips. To standardized the cropping, four landmarks were marked on each lips, then the image were cropped 8mm above *ls*, 8mm below *li*, 8mm to the left of *chR* and 8mm to the right of *chL* (Figure 3.2). The cropped images were then transferred to a laptop, and were ready for evaluation by the raters.

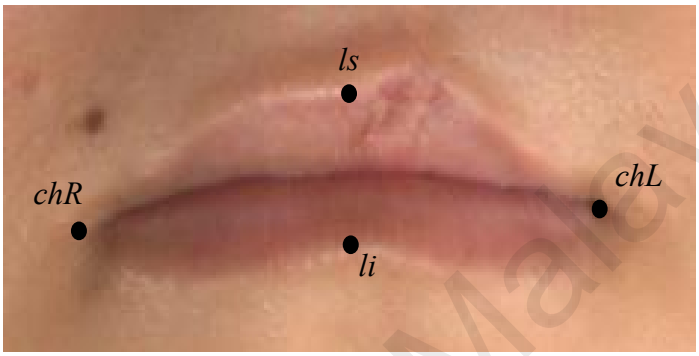


Figure 3.2. Example of a cropped 3D lip image. *ls* = laberale superiorus, *li* = laberale inferiorus, *chR* = right cheilion, *chL* = left cheilion

3.6 3D Asymmetry

To measure asymmetry of each image, the outline of the upper lip on the right side was first plotted (Figure 3.3), and then its surface area was measured using Mirror® software (Canfield Fairfield, NJ, USA). This step was repeated to measure the surface area of the upper lip on the left side. The differences in surface area between the left and right sides would give the amount of asymmetry.

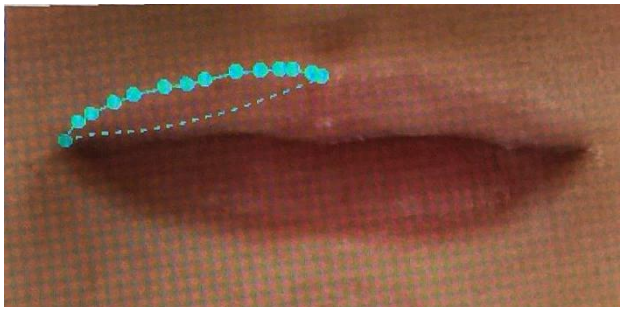


Figure 3.3. Plotting of the outline of the upper lip.

Method Error

Measurement errors could be produced as a consequence of inappropriate placement of points while measuring surface areas on the lip. To calibrate the measurer, an expert in the field of craniofacial anthropometry was invited to carry out the asymmetry measurement as well, then both sets of data (the measurer's and the expert's) were compared and analyzed. To assess the reproducibility of asymmetry measurement on the lip images, five images were selected at random. The randomization process was done by assigning each image to a number and these numbers were then kept in an opaque envelope. After a two-week interval, five numbers were drawn out from the envelope and the asymmetry measurement was carried out again on images that corresponded to these numbers. Intraclass correlation coefficient test (ICC) was conducted on the repeated measurements.

3.7 Image Evaluation

Subjects from the three rater groups (dental professionals, laypersons, and cleft lip and/or palate patients) evaluated the lip images from a laptop. Prior to the evaluation, calibration of the VAS (Visual Analogue Scale) was first carried out by the two authors, LM and SAO. Intraclass correlation coefficient was calculated from the VAS scores given by the both them.

For each image, the raters had to evaluate the lip attractiveness using VAS (Figure 3.4), by placing a mark on the horizontal line of the scale. Zero or "0" corresponded with least aesthetic and 10 corresponded with most aesthetic. During evaluation, they could manipulate the 3D pictures on the laptop in all directions, and there was no time limit for scoring.

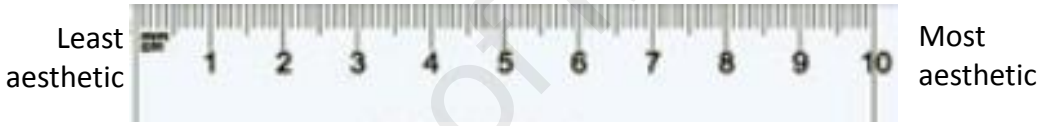


Figure 3.4. Visual Analogue Scale (VAS)

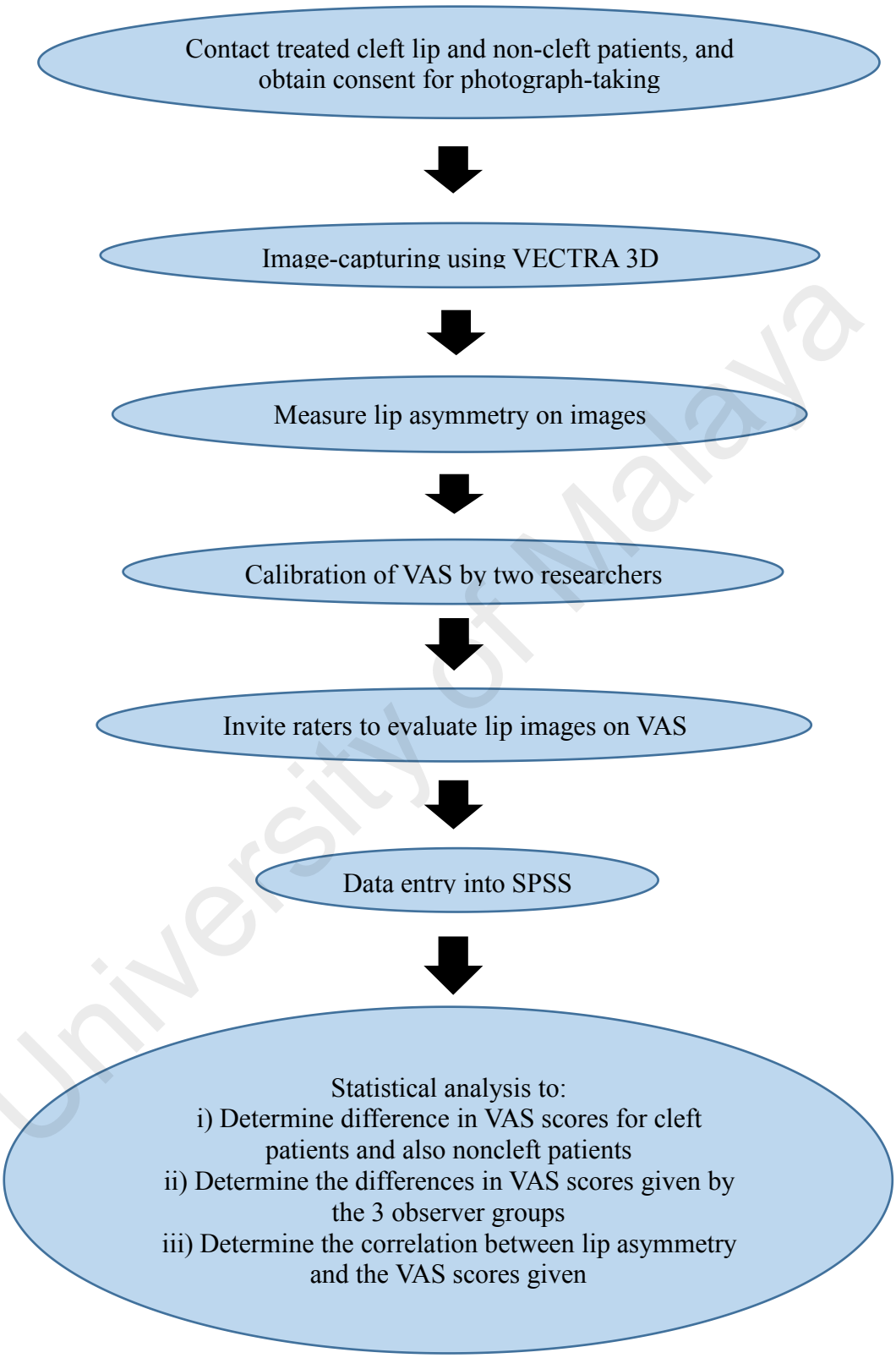
3.8 Statistical Analysis

The overall VAS scores were calculated as the mean VAS scores given by each rater group. The aesthetic score given was the dependent variable while the type of image (whether treated cleft or control), and type of rater group (whether laypersons, dental professionals or cleft patients) were the independent variables. The statistical analyses of the study objectives are tabulated in Table 3.8. All statistical analyses were carried out using Statistical Packages for Social Science (SPSS) Version 23.0 (SPSS for Window, SPSS Inc., Chicago, IL, USA). The level of significance was set at $p < 0.05$.

Table 3.8. Study objectives and their corresponding statistical analyses

Study Objectives	Analytic Procedure
1) To analyze the mean scores given by all rater groups (patients, dental professionals and laypersons)	One-way analysis of variance (ANOVA)
2) To analyze the difference in mean VAS scores of repaired cleft lip images and of non-cleft images	Independent t-test or Mann-Whitney U test
3) To find the relationship between the asymmetry of the lips and VAS scores given by the raters	Pearson correlation coefficient

Flowchart of Method



CHAPTER 4: RESULTS

4.1 Patient Recruitment

Recruitment of patients for 3D facial imaging took place from September 2016 to December 2016. They were selected at random and approached during the Combined Cleft Clinic, which took place once every month at the Faculty of Dentistry, University of Malaya, Kuala Lumpur. As for the recruitment of non-cleft patients, they were randomly approached at the Postgraduate Orthodontic Clinic of the same university. Interested patients were then given consent forms and Patient's Information Sheet prior to image-capturing.

4.2 Demographics of Patients in 3D Image Acquisition

A total of 16 patients were recruited for 3D facial imaging. Eight were non-cleft or normal patients, and the remaining eight were repaired cleft lip patients, out of which 4 patients had unilateral cleft lip and 4 patients had bilateral cleft lip. Table 4.1, 4.2 and 4.3 show the demographic data of the participants. Out of 16 patients, 10 of them (62.5%) belonged to the 18-29 years age group, while the remaining 37.5% were thirty years old and above (Table 4.1). Recruitment of male patients in this research was higher than female patients (9 for male patients and 7 for female patients) (Table 4.2). Half of the patients were Malay, while the Chinese and Indian patients consisted of 37.5% and 12.5% respectively (Table 4.3).

Table 4.1: Age distribution of patients

Age (years)	Repaired cleft lip patients		Non-cleft patients	Total
	Unilateral cleft	Bilateral cleft		
18-29	3	2	5	10
30 and above	1	2	3	6
Total	4	4	8	16

Table 4.2: Gender distribution of patients

Gender	Repaired cleft lip patients		Non-cleft patients	Total
	Unilateral cleft	Bilateral cleft		
Male	3	1	5	9
Female	1	3	3	7
Total	4	4	8	16

Table 4.3: Ethnicity distribution of patients

Ethnicity	Repaired cleft lip patients		Non-cleft patients	Total
	Unilateral cleft	Bilateral cleft		
Malay	2	3	3	8
Chinese	2	1	3	6
Indian	0	0	2	2
Total	4	4	8	16

4.3 Demographics of the Raters

Thirty raters evaluated the 3D images on the VAS. Below are their demographics. Majority of the raters were within the 21-30 years old age group, followed by 31-40 years old, 41-50 years old, above 50 years old and the least was below 21 years old (Table 4.4). In terms of gender distribution, there were equal number of male and female raters. However, there were more female raters in the dental professionals group, and vice versa in the cleft patients group (Table 4.5). Up to 67% of the raters were of Malay ethnicity, while the remaining 33% consisted of Chinese and Indian raters equally (Table 4.6).

Table 4.4: Age distribution of raters

Age (years)	Dental Professionals	Laypersons	Cleft Patients	Total (%)
Below 21	0	0	1	3
21-30	0	7	8	50
31-40	3	2	1	20
41-50	4	1	0	17
Above 50	3	0	0	10
Total	10	10	10	100

Table 4.5: Gender distribution of raters

Gender	Dental Professionals	Laypersons	Cleft Patients	Total (%)
Male	3	4	8	50
Female	7	6	2	50
Total	10	10	10	100

Table 4.6: Ethnicity distribution of raters

Ethnicity	Dental Professionals	Laypersons	Cleft Patients	Total (%)
Malay	7	8	5	67
Chinese	2	0	3	16.5
Indian	1	2	2	16.5
Total	10	10	10	100

4.4 Calibration of Lip Asymmetry Measurement

To calibrate the measurement of lip asymmetry carried out by the main investigator, an expert in the field of craniofacial anthropometry was invited to carry out lip asymmetry measurements on the 3D images, whereby the differences in surface area between the left and right side of the upper lip corresponded to the amount of asymmetry. Table 4.7 shows the asymmetry measurements that were carried out. Measurer 1 was the main investigator of this study, LM, and Measurer 2 was the expert. Intraclass correlation coefficient test (ICC) was used to assess the reliability on these measurements. The result showed an ICC of 0.777, which indicates a good reliability (Table 4.8).

Table 4.7: Measurements of lip asymmetry by the investigator and the expert.

Image no.	Asymmetry (cm^2)	
	Measurer 1	Measurer 2
1	0.097	0.062
2	0.164	0.095
3	0.303	0.312
4	0.395	0.393
5	0.179	0.382
6	0.117	0.257
7	0.003	0.184
8	0.343	0.332
9	0.132	0.176
10	0.108	0.094
11	0.137	0.027
12	0.096	0.232
13	0.033	0.138
14	0.254	0.230
15	0.193	0.138
16	0.093	0.107

Table 4.8: Reliability test on lip asymmetry measurement

Intraclass correlation	95% Confidence Interval		Significance
	Lower bound	Upper bound	
0.777	0.389	0.921	0.002

From the 16 three-dimensional images that were captured with VECTRA camera, 5 were chosen at random for the author to re-measure lip asymmetry after a two-week interval. Table 4.9 shows the asymmetry measurement of the five images carried out at two different times. ICC test was conducted to assess intraobserver reliability of the lip asymmetry measurement. The result showed an ICC of 0.906, which indicates excellent reliability (Table 4.10).

Table 4.9: Measurements of lip asymmetry by the investigator at two different intervals

Image no.	Asymmetry (cm^2)	
	1st measurement	2nd measurement
1	0.164	0.201
2	0.179	0.096
3	0.003	0.011
4	0.108	0.089
5	0.033	0.030

Table 4.10: Intraobserver reliability of lip asymmetry measurement

Intraclass correlation	95% Confidence Interval		Significance
	Lower bound	Upper bound	
0.906	0.096	0.990	0.021

4.5 Calibration of Visual Analogue Scale

Aesthetic evaluation on the 3D lip images was to be done on the VAS. The VAS was calibrated by having the two investigators of this study (LM and SAO) to evaluate the images. Table 4.11 shows the VAS scores of the images given by the two investigators. The ICC test conducted showed a good reliability of 0.826 (Table 4.12).

Table 4.11: VAS scores of the lip images given by the two investigators

Image no.	VAS score	
	By LM	By SAO
1	6	8
2	8	10
3	4	4
4	6	8
5	6	7
6	6	9
7	5	7
8	8	9
9	8	8
10	10	10
11	9	10
12	10	10
13	10	10
14	10	9
15	8	9
16	7	9

Table 4.12: Reliability test of Visual Analogue Scale

Intraclass correlation	95% Confidence Interval		Significance
	Lower bound	Upper bound	
0.826	0.211	0.949	0.000

4.6 Mean Visual Analogue Scale score of Treated Cleft Lip vs Normal Lip

To check for normality of the data, the skewness and kurtosis z-values were performed. For the treated cleft lip data, the skewness z-value was -0.943 (-0.709/ 0.752) while the kurtosis z-value was 1.219 (1.806/ 1.481). Both these values were between the range of -1.96 and +1.96 which showed that the data was normally distributed. For the normal lip data, the skewness z-value was -.0.882 (-0.663/ 0.752) while the kurtosis z-value was 0.55 (0.815/ 1.481). Both values were also between the ranges of -1.96 and +1.96 which suggested that the data was normally distributed (Table 4.13).

From the Shapiro-Wilk test, the *p*-values for both the treated cleft lip and normal lip images were above 0.05. Hence, this again indicated that the mean VAS scores were normally distributed (Table 4.14).

Overall, the images of treated cleft lip had a mean VAS score of 5.2, which is lower than that of normal lip by 3.6 (mean VAS score for normal lip images is 8.8) (Table 4.15).

Independent t-test was carried out to analyze the difference in mean VAS scores of treated and normal lip images. This difference was statistically significant, as the *p*-value is less than 0.05 (Table 4.15). Therefore, the null hypothesis can be rejected.

Table 4.13: Normality test for data of VAS scores for treated lip and normal lip.

Type of image	Mean VAS	Std deviation	Min.	Max	Skewness	Std error for skewness	Kurtosis	Std error for Kurtosis
Treated lip	5.198	0.622	4.0	6.2	-.0.709	0.752	1.806	1.481
Normal lip	8.338	0.179	8.5	9.1	-.0.663	0.752	0.815	1.481

Table 4.14: Shapiro-WIlk test for normality of data distribution of VAS scores

VAS score	Shapiro-Wilk test	
	Statistic	*p*-value
Treated lip	0.933	0.539
Normal lip	0.934	0.551

*$p < 0.05$

Table 4.15: Mean VAS scores for treated lip and normal lip images.

Type of image	N	Mean VAS score	Std. Deviation	Std. Error Mean	t	*p*-value	Std. Error Difference
Treated lip	8	5.198	0.6220	0.2199	15.903	.000*	0.2289
Normal lip	8	8.838	0.1793	0.0634		.000*	

*$p < 0.05$

4.7 Mean VAS scores from Different Groups of Raters

To check for normality, Shapiro-Wilk test was conducted. The *p*-values for both mean VAS scores for treated and normal lip images from all the rater groups were above 0.05, which indicated that the data were normally distributed (Table 4.16).

To analyze mean VAS scores given by different rater groups, one-way analysis of variance (ANOVA) was carried out. The difference in mean VAS scores was not statistically significant between rater groups, as the *p*-values are 0.096 and 0.157 for the treated lip images and normal lip images respectively (Table 4.17).

Table 4.16: Shapiro-Wilk test for data distribution of mean VAS scores by different rater groups.

Mean VAS score		Shapiro-Wilk test	
		Statistic	*p*-value
Treated lip	Dental professionals	0.965	0.846
	Laypersons	0.967	0.866
	Cleft patients	0.921	0.365
Normal lip	Dental professionals	0.880	0.131
	Laypersons	0.892	0.179
	Cleft patients	0.944	0.596

*$p < 0.05$

Table 4.17: ANOVA of mean VAS scores by different rater groups

Mean VAS score		ANOVA			
		Sum of squares	Degree of freedom	F	*p*-value
Treated lip	Between groups	7.461	2	2.557	0.096
	Within groups	39.383	27		
	Total	46.843	29		
Normal lip	Between groups	3.247	2	1.984	0.157
	Within groups	22.097	27		
	Total	25.344	29		

*$p < 0.05$

In terms of mean VAS scores for treated lip images, raters under the patient group gave the lowest scores (mean of 4.3) as compared to observers in the dental professional and laypersons group (mean of 5.5 and 5.3 respectively). The layperson group had the largest standard deviation of mean VAS score (Figure 4.1).

For the mean VAS scores for normal lip images, raters from the patient group again rated those images with the lowest scores (Figure 4.2). And again, the laypersons group had the widest standard deviation.

When oral surgeons and orthodontists from the dental professional group were separated into two different rater groups (5 to each group), the results were still not significant (Table 4.18). Both the *p*-values for mean VAS scores of treated and normal lip images were above 0.05.

Hence, we accept the null hypothesis, and can conclude that the professional background of raters does not influence their aesthetic perception on treated (repaired) lip and also normal lip.

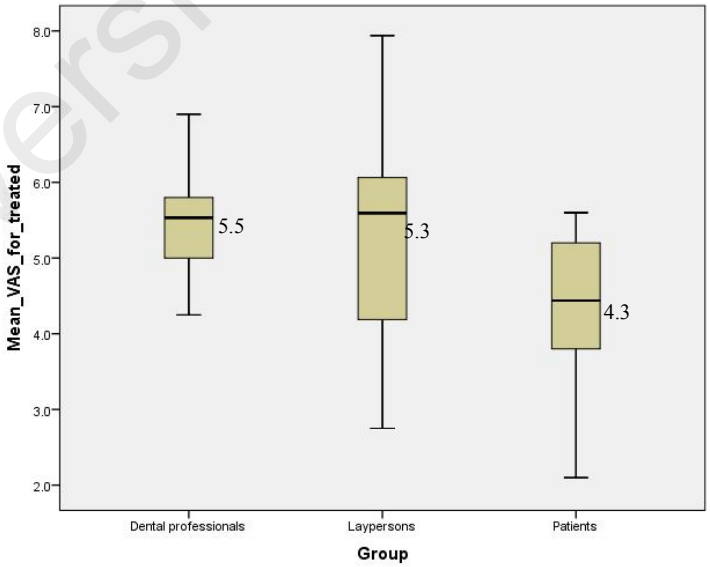


Figure 4.1. Mean VAS scores of treated lip images according to rater groups.

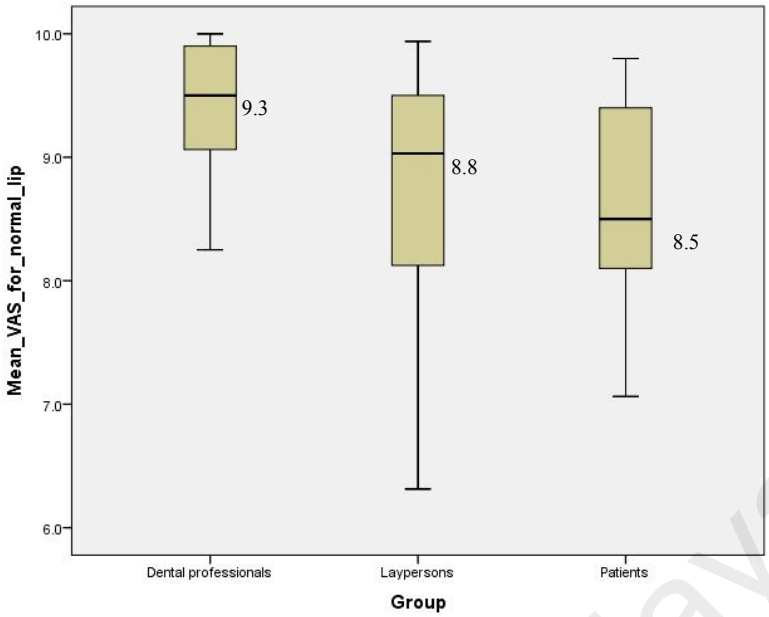


Figure 4.2. Mean VAS scores of normal lip images according to rater groups.

Table 4.18: ANOVA of mean VAS scores by different rater groups, with the dental professional group further divided into oral surgeons and orthodontists.

Mean VAS score		ANOVA			
		Sum of squares	Degree of freedom	F	*p*-value
Treated lip	Between groups	8.058	3	1.801	0.172
	Within groups	38.785	26		
	Total	46.843	29		
Normal lip	Between groups	3.281	3	1.289	0.299
	Within groups	22.063	26		
	Total	25.344	29		

*p< 0.05

4.8 Descriptive Analysis on VAS Scoring of Repaired Cleft Lip Images by Raters

When the VAS was broken down into 3 categories, i.e. 0 -4, 4.1 - 7 and 7 - 10, majority of the dental professionals had higher standards for aesthetics when evaluating the repaired cleft images. Up to 57.5% of them rated a score of 4 and below for the repaired cleft images, while most of the raters from the laypersons and cleft patients group gave a moderate score of 4.1 - 7 (Table 4.19). The least number of dental professionals, laypersons and cleft patients rated high scores for the repaired cleft images. Only 2.5% of the dental professionals and cleft patients, and 11.25% of the laypersons, rated a score of 7 - 10 (Figure 4.3).

Table 4.19. VAS scoring of repaired cleft lip images by different rater groups

Number of Raters (%)	VAS Score (cm) of Repaired Cleft Lip Images		
	0 - 4	4.1 - 7	7.1 - 10
Dental professionals	57.5 %	40 %	2.5 %
Laypersons	20 %	68.75 %	11.25 %
Cleft patients	37.5%	60 %	2.5 %

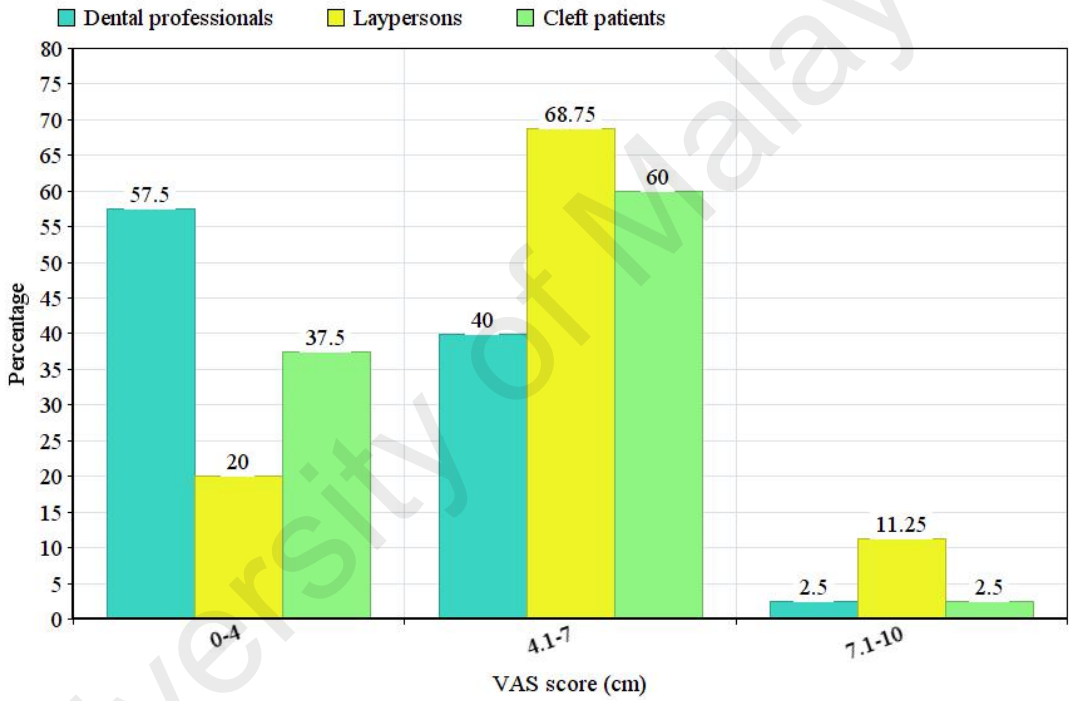


Figure 4.3. VAS scoring of repaired cleft lip images by different rater groups

4.9 Descriptive Analysis on VAS Scoring of Non-Cleft Lip Images by Raters

For the non-cleft lip images, none of the raters gave a low score of 0 - 4. A huge majority of the raters gave a high score of between 7.1 and 10, with the dental professionals making up the largest group in this category (97.5%) (Table 4.20 and Figure 4.4).

Table 4.20. VAS scoring of non-cleft lip images by different rater groups

Number of Raters (%)	VAS Score (cm) of Non-Cleft Lip Images		
	0 - 4	4.1 - 7	7.1 - 10
Dental professionals	0 %	2.5 %	97.5 %
Laypersons	0 %	11.25 %	88.75 %
Cleft patients	0 %	13.75 %	86.25 %

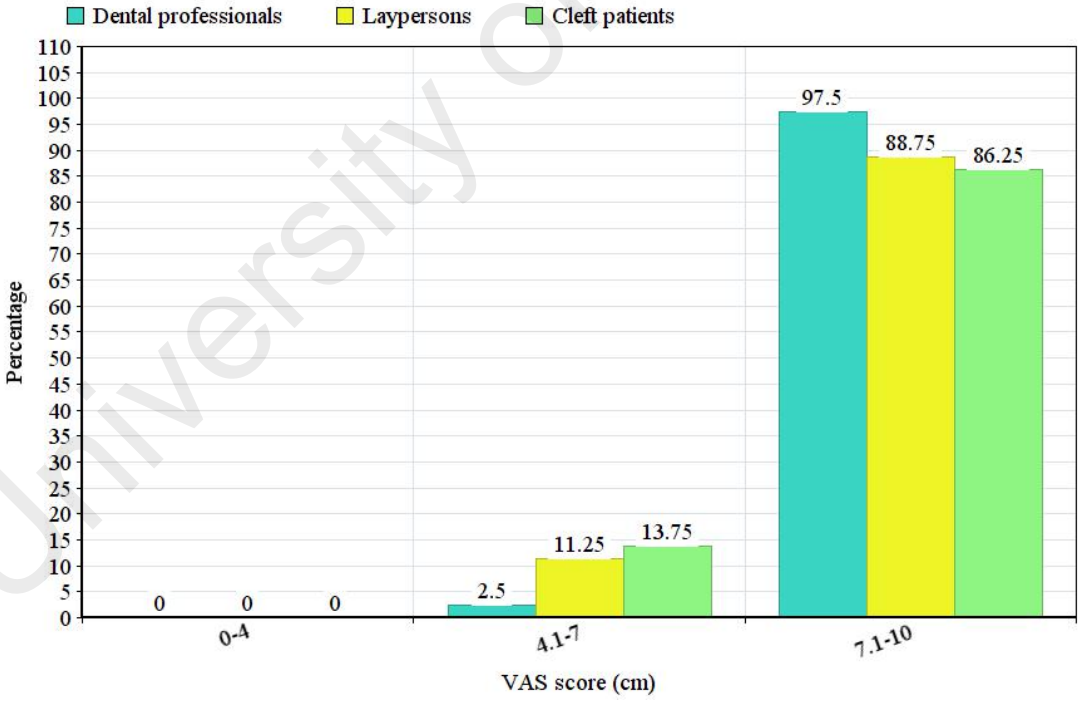


Figure 4.4. VAS scoring of non-cleft lip images by different rater groups

4.10 Correlation between Lip Asymmetry and Aesthetic Scores

Pearson correlation coefficient test was conducted to analyze the relationship between asymmetry and aesthetic perception. The mean VAS scores given by the three rater groups were the dependent variable while the lip asymmetry was the independent variable (Table 4.21). It was found that these two variables had a negative correlation, which meant that the more asymmetric a lip image, the lower its aesthetic score. However, this relationship was not statistically significant, as the *p*-values were above 0.05 (Table 4.22).

Table 4.21 Lip asymmetry and mean VAS scores of the 16 images

Image no.	Mean VAS Score			Lip Asymmetry (cm^2)
	By Dental Professionals	By Laypersons	By Cleft Patients	
1	5.3	5.5	4.6	0.097
2	5.6	5.7	4.8	0.164
3	3.5	4.1	4.5	0.303
4	4.9	4.9	4.6	0.395
5	6.6	6.7	5.2	0.179
6	5.3	5.9	5.0	0.117
7	5.5	5.4	5.2	0.003
8	6.2	5.5	4.9	0.343
9	8.5	8.1	8.8	0.132
10	9.5	9.0	8.3	0.108
11	9.2	8.6	8.6	0.137
12	9.0	9.0	8.6	0.096
13	9.1	9.0	9.1	0.033
14	9.1	8.9	9.2	0.254
15	9.3	8.9	8.3	0.193
16	9.2	8.6	8.5	0.093

Table 4.22: Pearson correlation coefficient on lip asymmetry and mean VAS score according to three rater groups

Correlation	N	Pearson Correlation	*p*-value
Asymmetry and mean VAS score by dental professionals	16	-0.377	0.150
Asymmetry and mean VAS score by laypersons	16	-0.424	0.101
Asymmetry and mean VAS score by cleft patients	16	-0,361	0.169

CHAPTER 5: DISCUSSION

5.1 Background of the Patients involved in 3D Imaging

Sixteen patients were recruited to perform the 3D facial imaging. Eight were non-cleft or normal patients, and the remaining 8 were repaired cleft lip patients. Their age and gender distribution were similar therefore, minimizing selection bias. Eight of the non-cleft patients were patients who were undergoing their orthodontic treatment at the Postgraduate Clinic, Faculty of Dentistry, University of Malaya, Kuala Lumpur. In order to exclude influencing factors, this group of patients had no major dental or skeletal discrepancies, and were only undergoing orthodontic treatment to correct Class I malocclusions.

As for the 8 cleft patients, they were recruited during the Combined Cleft Clinic that takes place on the third Friday morning of every month at the same faculty. All of them had completed their treatment and were under follow-up appointments for review annually, except for 2 patients who were still undergoing their orthodontic treatment at the Postgraduate Clinic (one patient was having his second orthodontic treatment due to relapse). Three of the 8 cleft patients had orthognathic surgery, and one was offered the surgery but the patient opted for orthodontic camouflage treatment only.

It was impossible to standardize the surgical procedure used to repair these clefts as multiple surgeons were involved in the operation. Six of the cleft patients had their lip repaired by oral and maxillofacial (OMF) surgeons of the faculty, while the remaining 2 undergone lip repair by plastic surgeons from the Surgical Department, University Malaya Medical Centre (UMMC), Kuala Lumpur. Four of the patients also had lip revision.

Cleft lip and palate (CLP) patients who need alveolar bone grafting (ABG) will be referred to the OMF Surgery Department. We found that some CLP patients had a delayed ABG procedure (after 12 years old) when their lip and palate repairs were done at the Surgical Department in UMMC. This may indicate a need for a standardized protocol for all treatment centres for proper referral and timing of treatment. Lack of timeliness in each stage of the cleft management will increase the incidence of residual deformity. Bardach et al. (1992) stressed the need for timeliness of cleft treatment to reduce the chances of residual deformity so that maximal improvement from each surgery can be achieved for the patient.

5.2 Image Acquisition

In the present study, the facial images captured were cropped up to the lips, as we were analyzing only lip aesthetics. By eliminating distracting variables such as hairstyles, facial expressions and make-up, the subjectivity that may influence raters' perception was reduced. The lip images were also plain (with no lipstick or piercings) and were in neutral position. Activities like frowning or smiling with the teeth seen may add confounding factors to the study.

The facial images were captured under standardized conditions, with calibrated 3D cameras. The only potential variation of the images could be attributed to different stages of biological development of the patients or to the presence of facial hair (one participant had a moustache). We decided not to exclude this image from the consecutive selection since this could create selection bias. In the real world, there will be individuals with facial hair. These people function and socialize normally with their present appearance and therefore, should be judged as they are.

5.3 Demographics of the Raters

The rating panels of the present study were dental professionals (namely orthodontists and maxillofacial surgeons), laypeople and cleft patients. The laypeople of this study represented the most objective group because they did not have previous experience related to clefts. The reason why we chose school teachers to represent laypeople was because of the reported literature on incidences of bullying and teasing faced by cleft children at school (Bernstein and Kapp, 1981, Turner et al., 1997). The school teachers' view on this could hence give a good representation on how this condition is being perceived by the public. On the other hand, the dental professionals group may have some degree of professional bias. Both orthodontists and maxillofacial surgeons routinely evaluate facial aesthetics in their daily practice and they had previous experience related to clefts in their careers. As for cleft patients, getting their input in this study was vital as our main purpose was to investigate any difference in esthetic perception between them and dental professionals.

The criteria of 18 years and above was set as the minimum age requirement to be a rater for this study as it was deemed that by this age, a certain level of maturity was achieved to be able to differentiate what is aesthetically acceptable or not acceptable. People who are younger may have a totally different view on aesthetic perception and this may influence the result of the study. In the study by Sinko et al. (2005), a psychologist was involved to explain the evaluation procedure to the patients but in this current study, only the main investigator was present to guide the raters during the evaluation process and the nature and outline of the study were explained and handed out in the form of a Patient's Information Sheet (Appendix B).

The average age of the raters was 33.6 years, with the range of 18 - 58 years. There was no dental professional under the age of 31 in this study as one of the inclusion criteria in order to be a rater under the dental professionals group was that he or she has to have at least 5 years of experience in cleft management. The intention of the present study was to represent the profession. Thus, the raters were randomly selected without taking the age into account.

The laypersons and cleft patients represented a similar age range. Also, there were not that many cleft patients who were above the age of 31 years being recruited in this study. It was difficult to find older cleft patients, as most of them no longer had follow-up appointments or further treatment at the faculty, and were less willing to participate in the study.

5.4 Types of Imaging on Aesthetic Evaluation

In this study, all the cropped lip images were in 3D. There has been an increased pattern in the number of publications listed in PubMed on 3D imaging in CLP patients. For example, in the year between 2000-2009, there were 76 publications with 'cleft' and various forms of '3D' in the title, whereas in the following decade, the number increased by more than two-fold. One can assume that this trend will continue, particularly due to decreasing costs of 3D imaging systems, and therefore it may be expected that the majority of cleft centres will utilize this technology to assess their treatment results, including aesthetics of nasolabial area. Nevertheless, the drawback of 3D imaging that is worth mentioning is the incomplete scanning of facial surfaces, particularly leaving out the hairline, ears and chin. This will bring about limitations in studies that involve or investigate on these landmarks. Fortunately, this disadvantage did not affect the present study as it utilized cropped lip images.

Todd et al. (2005) carried out a study to investigate whether a 2D or 3D image would influence the ranking of facial attractiveness. They used 2D and 3D images of five individuals with skeletal patterns ranging from Class I to moderate Class III, and their raters consisted of orthodontists, oral surgeons and laypersons. In summary, they did not find any great variation in evaluation of aesthetics on the 2D and 3D images. Marshall et al. (2013) studied the perception of facial attractiveness among dental students, orthodontic residents, and orthodontic faculty members using 2D and 3D images. The experienced group (residents and faculty members) had significantly higher attractiveness scores for all race/gender-specific images when compared to the inexperienced group (dental students), but there was no significant difference in ranking of facial attractiveness when viewing 2D images versus 3D images.

3D images seemed better than 2D images for rating nasolabial aesthetics in treated CLP subjects (Stebel et al., 2015). Eight lay raters were invited to assess the aesthetics on cropped 2D and 3D images using a 100-mm visual analogue scale (VAS). Intrarater agreement demonstrated a better reliability of ratings performed on 3D images than 2D images (ICC for 3D images ranged from 0.733 to 0.857; for 2D images from 0.151 to 0.611). The mean VAS scores showed, however, no differences between the 2D and 3D formats. On the contrary, Al-Omari et al. (2003) reported that 2D image scores were in greater agreement with clinical evaluation than were the 3D assessment scores when it comes to evaluation of the lip and nose of treated complete unilateral CLP (p = 0.017 and 0.011 respectively). 3D images were only more accurate when it comes to assessing the midface (p = 0.047). However, the authors highlighted that lay assessors that were involved had poor reproducibility when rating the facial images clinically (k = 0.16 - 0.58).

To the trained eye, evaluators were as confident about assessing 3D as they were about 2D facial images (Zogheib et al., 2018). Fourteen dentists from the University Clinic of Leuven were asked to identify linear and angular measurements from 30 facial images in 2D and 3D formats, and these measurement were then compared to the direct clinical measurement carried out on the 30 volunteers. The authors found that the 3D linear measurements were closer to the clinical standard compared to the 2D measurements (error rate of 1.8% vs 3.3%), especially when it came to the inner canthal distance and alar base width measurements. As for angular measurements, there were no significant differences.

Most studies on facial attractiveness have relied on attractiveness assessed from photographs rather than from video clips or live observation. Yet, attractiveness of potential partners has been judged almost exclusively during live interaction. Static photographs supply limited information on dynamic properties such as head, gaze, expressive and vocal movements, which are important in social interactions (Schmidt and Cohn, 2001). Rubenstein (2005) found no significant correlation between attractiveness judged from an image and a clip. Penton-Voak and Chang (2008), however, reported otherwise. Fifty-six undergraduate participants were presented with video and static stimuli in smiling and neutral conditions. Their results indicated that smiling and movement influenced attractiveness judgments differently for male and female images; smiling increased the attractiveness ratings of female, but not male images, whereas movement increased the attractiveness ratings of male, but not female images. In this study, the movement or dynamics of our 16 samples were not captured in video, only static 3D images were captured by the VECTRA camera. However, during the evaluation by the raters, they were allowed to manipulate and rotate (yaw, pitch and roll) the images on a laptop by moving the cursor, hence “simulating” a

dynamic imagery. Nonetheless, all the images were taken in neutral condition, not smiling.

5.5 Mean VAS Scores of Treated Lip and Normal Lip

The difference between the mean VAS score for treated and normal lip was significant in this study. The unfavorable aesthetic perception in patients with cleft might be due to the imperfections that are still present in these patients despite surgical correction, such as discrepancies in vertical lip length and symmetry, malaligned obicularis oris muscle, and scarring. Eichenberger et al. (2014) obtained a similar result, with a difference in mean VAS score of 1.97 between the treated and normal lip ($p < 0.05$). They used a total of sixty 2D photographs in frontal and profile view. This may have caused rater fatigue as the raters had to gauge a large number of images at one visit and thus, affected the mean VAS score of the images. Also, a second evaluation was not carried out by the raters to check for intrarater reliability.

When comparing aesthetics of cleft patients, severe skeletal Class III patients designated for orthognathic surgery, and skeletal Class I (control group) patients, the treated cleft images were again rated significantly less attractive (Meyer-Marcotty et al., 2011b). Standardized frontal photos of the mentioned patients were taken, and they were not cropped. The images in the current study on the other hand, were cropped to just the lips, yet the study produced a result of significant difference in aesthetic score between treated lip and noncleft lip. Hence it can be concluded that the raters were able to detect enough differences between those two types of lips without having them to visualize the whole facial appearance.

Raters tend to also observe the cleft images for a longer period during evaluation compared with the unaffected faces (Meyer-Marcotty et al., 2011a). This was proven by using an eye-tracking camera. Additionally, raters with a cleft themselves focused greater attention on the features that are anomalous on their own faces in comparison to

raters without a cleft lip and palate. The lower face, especially the nasolabial region, prevails for happy and pleasant expressions (Ross et al., 2007). Residual scars or asymmetries situated in this decoding area for normally happy and pleasant expressions, may appear more obvious for raters. This might have led to the lower scores of the clefts images.

5.6 Aesthetic Scores by Different Rater Groups

The findings of this study found differences in the perceptions of lip aesthetics amongst dental professionals, lay people and cleft patients, although they were not significant. Cleft patients gave the lowest mean VAS score (4.3) for the treated lip images, as compared to laypersons and dental professionals. This result is similar to previous studies where the patients rated the aesthetic outcome of cleft lip worse than the professionals (Sinko et al., 2005, Marcusson et al., 2002). Like this present study, Sinko et al. (2005) used VAS to gauge their raters' aesthetic perception. However, raters from the patient group had to rate their own aesthetic outcome after cleft repair and not from photographs of other patients. They rated 64.68 on a 100mm scale of the VAS, 16.76 lower than that was rated by professionals who comprised of a maxillofacial surgeon, an orthodontist, a dental assistant and a speech therapist ($p < 0.001$). Marcusson et al. (2002) used a 5-point Likert scale with the endpoints "very dissatisfied" and "very satisfied". They found that the raters under the professional group gave a mean score for the lip region that was slightly higher than the cleft group (3.4 vs 3.0). This difference was statistically significant.

On the other hand, Foo et al. (2013) reported that professionals rated the treated cleft photographs lower than cleft patients and laypersons. This difference could be due to the difference in rating groups. The rating panel in their study included general dentists and psychologists, apart from orthodontists. This difference in rating panel composition, may have influenced the aesthetic rating. Nevertheless, the authors'

justification was that they may produce a more representative aesthetic rating as the study took into account the different professionals of a cleft team whom, with their different expertise, may influence the type and course of treatment, as well as the general public's perception.

Study done by Papamanou et al. (2012) to analyze aesthetic evaluation on the repaired cleft patients had only two rater groups, i.e. dental professionals (orthodontists and maxillofacial surgeons) and laypersons. They found that laypersons were less satisfied with the treated lip than dental professionals. As for the current study, laypersons also gave a lower aesthetic score than dental professionals. Laypeople had no previous experience related to clefts. On the contrary, both surgeons and orthodontists are expected to have a type of professional bias since they are familiar with the difficulties of treating such cases and this may influence them to be more tolerant to undesirable aesthetic results.

Lo et al. (2002) also had two rater groups of dental professionals and laypersons. The professionals gave a mean score which was slightly higher than the laypersons, and the difference was not significant ($p = 0.105$). They used a rating scheme in which a score of 3 was given for a good or close-to-normal appearance, 2 for an average result that needed minor revision, and 1 for a poor result that needed major reconstruction. However, this scale of 3 may not be helpful or sensitive enough to analyze the specific details of patients' perception towards repaired lip.

The perception of the layperson in the society with which cleft patients live in can influence how successful these individuals fare in work, education and social situations. Gkantidis et al. (2013) reported that the low aesthetic scores given by laypeople were correlated with the increased self-reported influence of the cleft condition in the patients' social activity and professional life ($0.56 < rho < 0.74$, $p < 0.05$). Therefore, the authors recommended that specialists should not treat what is

considered important by definition of his/her speciality or only the patients' concerns, but also those of their social environment.

Majority of the raters in the present study that gave a low VAS score of 0-4 for the repaired lip images were dental professionals (57.5%). On the other hand, most of the laypersons and cleft patients gave a moderate score of between 4.1-7. It seemed that more dental professionals had higher aesthetic standards than cleft patients and laypersons. Individuals with a cleft are familiar with orofacial clefting, and have higher awareness on the condition and its effects on facial appearance. Cleft patients have lived through the condition and its chronological management that spans from birth to adulthood. It could be this awareness that made them more receptive and flexible towards aesthetics of the repaired lip. In contrast, dental professionals especially orthodontists and oral maxillofacial surgeons, are driven to achieve good results functionally and aesthetically for their patients daily. They are more set in reaching these objectives hence, have a higher aesthetic aim on repaired lip.

As for the non-cleft lip images, the aesthetic perception were more agreeable among the three rater groups. All the groups had majority of the raters scoring a high VAS score of 7.1-10. It can be concluded that it is easier to gauge a normal image than an image that is out of the norm.

5.7 Lip Asymmetry and Aesthetic Perception

Facial symmetry has long been accepted as the aesthetic gold standard (Perrett et al., 1999). Although the face of a patient with CLP clearly appears more symmetrical after surgery, even the most advanced interventions do not result in a completely normal facial appearance.

In the present investigation, there was no significant correlation ($p > 0.05$) between the amount of asymmetry and lip aesthetics. This finding is similar to the study done by Fudalej et al. (2012). They had a panel of 4 orthodontists familiar with the treatment of children with cleft deformities assessing the appearance of the lip according to a 5-point scale: from 1 corresponding with a very good appearance to 5 corresponding with a very poor appearance. They found a weak relationship between asymmetry and aesthetics in subjects with complete unilateral CLP. Desmedt et al. (2015) also found a poor association between nasolabial asymmetry and aesthetics in more severe cleft forms like unilateral CLP as compared to unilateral cleft lip ($r^2 = 0.04$ vs 0.56). The authors suggested this could be because in a more severe cleft type like CLP, nasolabial symmetry was less important than the shape of this region for aesthetic judgment. Their findings seemed to confirm with their impression that the more severe the cleft, the less important the symmetry is for aesthetic perception.

The non-significant correlation between asymmetry and aesthetic perception found in the current study could also be because raters needed a wider view of a facial region, such as the nasolabial region and not just the lips, in order to more accurately rate the aesthetics for the images. As we know, individuals with cleft lip are affected by asymmetry issues that pertained to not only the lip, but the nose as well. By including the nose for assessment, the amount of asymmetry for each image may inevitably increase, given that more areas were to be measured.

In the present study, the treated lip images were not further classified into types of residual deformities or asymmetry. But according to Morzycki et al. (2018), the type and severity of the deformity could influence how observers show varying degrees of attentional bias to the lip region. The authors presented a series of images of a child digitally modified to simulate different residual deformities (long lip, short lip, white roll or vermilion disjunction, and vermilion excess), a lip scar with no secondary deformity, or a normal lip, to their raters who are laypeople. Eye movements during evaluation were recorded using a table-mounted eye-tracking device. The raters spent significantly more time focused on the upper lip regions in patients with simulated lip deformities relative to those who did not ($P < 0.01$), and they spent less time focused on the eye region in the presence of a residual deformity ($P < 0.05$). Short lip deformity also resulted in the greatest duration evaluation time compared to the other types of deformity ($P < .001$).

Unfortunately, the association between type of cleft (whether unilatral or bilateral and whether complete or incomplete) and symmetry could not be investigated in the present study as this would have rendered the cleft groups yet smaller. Separate analysis for the type of surgical procedure and gender in the cleft groups could not be undertaken for the similar reason. It will be interesting to investigate these factors in a larger study with increased sample size. Facial asymmetry is deemed to be more pronounced in cleft patient, although the non-cleft faces were not perfectly symmetric (Bughaigis et al., 2014). When the left and right side of non-cleft images were superimposed, the landmarks on the mid-sagittal place of the faces did not correspond with their reflections. Farkas and Cheung (1981) have reported that 3% asymmetry is common in healthy children: the right side tends to be larger and the upper third of the face has the most asymmetry.

The unilateral cleft lip and alveolus (UCLA) patients showed significant landmark asymmetry, although less than the unilateral cleft lip and palate (UCLP faces. The asymmetry in both cleft types was mainly due to the unilateral nature of the deformity and its repair involving the lip/alveolus; therefore, a greater effect on facial symmetry was expected compared to the bilateral cleft lip and palate (BCLP) and cleft palate only (CP) faces. BCLP is a more symmetrical defect than a single-sided cleft, but still significantly more asymmetric than CP (Bughaigis et al., 2014). Wu et al. (2016) reported a similar finding, although they compared facial symmetry in normal healthy infants and infants with CLP (prior to lip repair). The authors admitted that it was difficult to keep some of the infants still during image-capturing, which may lead to inaccuracy during the measurement of symmetry.

When it comes to smile aesthetics, symmetry also plays a role. In the study by Batwa et al. (2013), dentists and cleft patients were presented lip photographs with differing degrees of asymmetry (a photograph from an individual considered to have an average smile was used and the right side of the upper lip was increased in thickness by 1, 2, 2.5 and 3 mm). They found that large degrees of lip asymmetry (2.5 mm or more) affected the aesthetic judgment of both the dentists and cleft patients, but they were tolerant to mild asymmetries (2 mm asymmetry and below). This is an interesting finding because it reflects how similar dentists were to cleft patients about any perceived deviation of the smile from the norm. It also showed that cleft patients had a reasonable tolerance of lip asymmetry, as a small degree of asymmetry (up to 2 mm) is not noticeable by cleft patients. It is therefore important to consider these findings when planning lip revision surgery and to inform patients of any significant expected lip asymmetry when obtaining informed consent.

The face is rarely static during day to day social interactions. Asymmetry of motion initiation and form could be more relevant than static resting and expression asymmetry to the perception of facial asymmetry during social interactions. It would be worthwhile to investigate on the dynamics of facial expression in future studies. Unfortunately, ‘‘four-dimensional’’ (4D) imaging systems are expensive, and dynamic analysis adds an additional layer of complexity.

5.8 Limitations of the Study

Due to incomplete information on the cleft patients' lip repair and variability in their surgical technique, we were unable to assess if these factors would have influenced the VAS scores given by the raters.

The raters in this study were not randomized, but recruited through convenience sampling. Due to limited time, we were only able to approach school teachers (that represented the laypersons) from a school in Petaling Jaya, which is considered an urbanized town. Hence, the result of this study may not be able to be generalized to the Malaysian society as a whole. Nevertheless, for the dental professionals group, we had raters from different medical centres and teaching institutions who are actively managing cleft cases, not just from the University of Malaya alone.

For the facial images used in this study, we recruited patients from a multiracial background for their 3D photographs to be captured. Given the different skin tones of the patients, we could not rule out that this discrepancy in the images did not affect the raters' judgement during evaluation. Even though the images used were cropped to the lips, the surrounding skin was still visible.

5.9 Recommendations

By recruiting specialists of cleft centres all over Malaysia, and laypersons from different social and economic backgrounds in the study, hopefully the result gained would represent the true perception of Malaysians.

Despite surgical advances and the advantage of undergoing surgical repair at a younger age, CLP patients are often affected by psychological issues due to their condition. They are perceived to have lower self-esteem and a tendency to be more depressed (Broder et al., 1998). Therefore, it would be beneficial to carry out a questionnaire to assess how the deformity affects these patients' health-related quality of life, which encompasses physical, mental and social health.

It was reported that males and females have different views in perceiving aesthetics. Girls may be more affected by stigma of the repaired cleft because of the importance given by society towards physical attractiveness (Kapp, 1979). Hence, it would be interesting to investigate whether gender has a role to play in the aesthetic perception of cleft repairs.

Growth continues to take place even in adulthood. Aging brings upon changes to the soft tissues and the surgical outcome of lip repair may vary over the years. 3D imaging can help in cohort documentation to better predict these changes in future. This can also help patients to be more aware of the surgical limitations on their treatment.

Inappropriate or incomplete record keeping of cleft patients hinders proper, high quality research from being conducted. Management of a cleft child spans over a few decades, across different specialties. In certain circumstances, patients relocate and have to continue their treatment at a different cleft centre in a different state. Vital information regarding their medical history or treatment updates may easily go missing. Therefore, it is wise to implement a national registry system that is accessible online to record information on these children from birth. A good example to follow is

The Cleft Registry and Audit Network (CRANE). It is a database run by the Cleft Development Group (CDG) in the UK to collect information on all children born with cleft lip and/or cleft palate in England, Wales and Northern Ireland. When centralization of data is in place, yearly audits can be done and further improvements to quality of care can be brought upon.

CHAPTER 6: CONCLUSION

The perception on lip aesthetics by dental professionals (orthodontists and oral surgeons), laypersons and cleft lip patients have been analyzed using 3D facial images. Within the limitations of the study, it can be concluded that:

1. The treated lip had a significantly lower aesthetic score than the non-cleft lip.
2. Professional background of the raters did not influence aesthetic perception..
3. There was no correlation between lip asymmetry and aesthetic perception.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

Presentations at scientific conferences:

1. Perception of Lip Aesthetics of Repaired Cleft Lip Among Professionals, Laypersons and Cleft Patients Using Three-Dimensional Images

   Presented at the 25th Malaysian Association of Orthodontists International Scientific Conference and Trade Exhibition

   This presentation won the prize for Best Poster Presentation for Postgraduate Malaysian Association of Orthodontists.

   Kuala Lumpur, Malaysia

   27th - 29th April 2019