ORIGINAL ARTICLE Open Access

Establishing cephalometric norms of upper and lower lips to Rickett's E-line in the Malay female population of Kuantan city: A pilot study

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Abstract

The purpose of the study was to determine the cephalometric norms of upper and lower lips to the Rickett's E-line in the Malay female population of Kuantan city, and to compare it with the Caucasian norms. This was a retrospective study involving 40 pre-existing lateral cephalometric radiographs taken from October 2017 to October 2021 of skeletal Class I females of pure Malay ethnic group aged 20 to 40 retrieved from two private dental clinics in Kuantan city of Pahang state, Malaysia (Dr Fatain's Dental Clinic Taman Tas; Dr Fatain's Dental Clinic Indera Mahkota 3). These radiographs were hand traced using acetate paper and 0.3 mm leaded propelling pencil on a light view box in a darkened room. The soft tissue outlines and the Rickett's E-line (from the tip of the nose to the soft tissue chin) were drawn and the distance of the upper and lower lips to this line was measured in mm with a metal ruler. The values were compared with the Caucasian norms [upper lip to E-line: -4 mm; lower lip to E-line: -2 mm (± 2)]. The cephalometric norms of upper and lower lips to the E-line among the Malay females of Kuantan city were -1.3 mm (± 2.0) and 0.19 mm (± 1.9) respectively. This value was significantly different than the norms of the Caucasian population ($p < 0.001$). In conclusion, the cephalometric norms of upper and lower lips to Rickett's E-line in the Malay female population of Kuantan city were established: upper lip -1.3 mm (± 2.0) and lower lip 0.19 mm (± 1.9), which were found to be more protrusive than the Caucasian norms.

Keywords: *Malay female norm, lower lip, upper lip, Rickett's E- line*

Received:
30 May 2022
Revised:
1 August 2022
Accepted:
6 December 2022
Published Online:
28 February 2023
How to cite this article:
Sivagnanam, M., & Cheong, J. M. (2023). Establishing cephalometric norms of upper and lower lips to Rickett's E-line in the Malay female population of Kuantan city: a pilot study. *IIUM Journal of Orofacial and Health Sciences*, *4*(1), 26–32. https://doi.org/10.31436/ijohs.v4i1.164
Article DOI:
https://doi.org/10.31436/ijohs.v4i1.164

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Introduction

In the early 20th century, Sir Edward H. Angle, the father of modern orthodontics, postulated that achieving an ideal dental occlusion together with ideal jaw relationships were the orthodontic treatment goal (Profitt *et al*., 2019). This was known as the Angle paradigm which dictated that the soft tissues would follow the hard tissue configurations, once the dentoskeletal relationships were established (Shetty *et al*., 2021).

However, towards the mid-20th century, researchers realized that not only soft tissues play a major role in facial appearance, but they are also independent of the underlying dentoskeletal base (Subtelny, 1959; Ricketts, 1968). Eventually, the Angle paradigm slowly shifted towards the soft tissue paradigm which emphasized on clinical examination of facial soft tissues, apart from the hard tissue counterparts. (Ackerman *et al*., 1999). Normal soft tissue proportions and adaptations were included as the new primary orthodontic treatment goal. The treatment approach was reversed as well, as the ideal soft tissue relationships

were planned prior to the hard tissues. It was believed that the relationship of the dentition to the lips and face is a key factor of facial aesthetics (Proffit *et al*., 2019). Ultimately, the orthodontic treatment aims were to achieve a harmonious dentofacial complex that consisted of balanced hard and soft tissue proportions (Soh *et al*., 2005; Lersinghanart *et a*l., 2020; Shetty *et al*., 2021).

The lateral cephalometric radiograph (LCR) which is routinely used as a baseline record for orthodontic patients is an important diagnostic and treatment planning tool in orthodontic practice. It can be used to assess the skeletal, dental as well as the soft tissue parameters. Following the hard and soft tissue landmarks identification, along with reference planes construction, numerous cephalometric analyses can be performed on this radiograph. One such soft tissue analysis pertaining to the relationship of the lips to the nose and chin is the E-line (Ricketts, 1957). The Rickett's aesthetic line or Rickett's E-line is constructed by joining the soft tissue pogonion (soft tissue chin) to the pronasale (soft tissue at the tip of the nose). The distance of the upper and lower lips to this line indicates the protrusiveness of the lips. Ricketts observed that the lower lip lay 2 mm posterior to this line (-2 mm ±2), whilst the upper lip lay further behind (-4 mm). Lips which protruded beyond this aesthetic plane were deemed as undesirable, especially in adults (Ricketts, 1968), albeit lip fullness were associated with a more youthful look (Trookman *et al*., 2009; Wollina & Goldman, 2017). However, these norms were based on Caucasian samples which cannot be generalised to the other ethnic groups due to the diversified anthropometric differences (Kumari & Das, 2017).

A few studies on the soft tissue profile of the Malaysian population have been conducted (Mohammad *et al*., 2011; Purmal *et al*., 2013; Purmal & Alam, 2013; Ab Talib *et al*., 2014; Noor *et al*., 2020). E-line of the Malaysian Chinese (upper lip: -0.04 mm ± 1.00; lower lip: +1.66 mm ± 0.91) and Malaysian Indian (upper lip: -2 mm ± 1.02; lower lip: 0.13 mm ± 0.99) populations revealed that both races have more protrusive upper lips compared to the Caucasians. In addition, the Chinese race also has a far more protrusive lower lip compared to the Indians and the Caucasians (Purmal *et al*., 2013). Previous research investigated the lips profile of the Malaysian Malay population using Ricketts analysis lacked sample size calculation (Mohammad *et al*., 2011; Ab Talib *et al*., 2014) and did not reveal the actual linear measurements of the lips to the E-line (Mohammad *et al*., 2011). A recent study that compared the soft tissue cephalometric measurements among Malaysian Malays and Chinese, used the Holdaway analysis instead that merely measured the thickness of the lips (Noor *et al*., 2020). Though lip thickness is one of the major elements of facial aesthetics, it fails to portray the protrusiveness of the face as opposed to comparing the position of the lips to the nose and chin using the E-line (Prabu *et al*., 2012; Bozdag *et al*., 2017).

Thus, this study aims to determine the cephalometric norms of upper and lower lips of the Malay female population of Kuantan city of Pahang state, Malaysia to Rickett's E-line, and to compare it with the Caucasian norms.

Materials and Methods

Ethical approval

The ethical approval for this study was obtained from the IIUM Research Ethics Committee (ID NO: IREC 2021-324).

Study design and setting

This was a retrospective study involving 40 pre-existing LCR of non-growing Malay female population aged 20 to 40 years, retrieved from October 2017 to October 2021. The priory consented radiographs were collected from the clinical records of two private dental clinics in Kuantan city (Dr Fatain's Dental Clinic Taman Tas; Dr Fatain's Dental Clinic Indera Mahkota 3).

Inclusion criteria

1. Skeletal Class I (ANB =1° to 5°) (Hassan, 1998).
2. All subjects with LCR that have adequate resolution and good quality pre-treatment cephalometric radiograph (Grade 1: Excellent, and 2: Diagnostically acceptable, according to National Radiological Protection Board (NRPB) guidance of UK).
3. All radiographs were taken from the same orthopantomograph machine (72kV, 10.0 milliampere and 40 milliseconds).
4. Subjects are pure Malay - Both parents of each subject are of Malay ethnic origin without any inter racial marriage for at least two generations.
5. Subjects with complete number of permanent teeth irrespective of presence of third molars.
6. Subjects with normal growth and development (no craniofacial or congenital disorders).
7. Subjects with no temporomandibular disorders.
8. Subjects with no prosthesis, orthodontic or major conservative work.
9. Subjects who have not undergone any surgery pertaining to the face (orthognathic or facial plastic surgery).

Exclusion criteria

1. Subjects whose radiographs are distorted or not sufficiently clear for landmark identifications (Grade 3: Unacceptable, according to NRPB).
2. Subjects' cephalometric radiographs are not in natural head position.
3. Bilateral anatomical landmarks which are too far apart.
4. Subjects with cleft lip and palate or other craniofacial deformity.
5. Subjects with any severe systemic medical conditions that might affect their physical growth.

Written consent from the patient was obtained by the on-site orthodontist at the respective clinics prior to taking their radiographs. The radiographs were taken by the same operator; a trained dental nurse who was experienced in taking LCR; using the same orthopantomograph machine and cephalometric setup in order to maintain standardisation of the radiographs. The subjects were positioned at natural head posture with the Frankfort horizontal plane parallel to the floor and the teeth in maximum intercuspation.

These radiographs were hand traced by a single investigator (M.S) on an acetate paper using 0.3mm leaded propelling pencil and metal ruler. Calibration was done to achieve agreement with supervisor (C.J.M.) in terms of landmark identifications. Any names or labels that could identify the patient on the films were replaced with identification numbers. The tracings were done on a light viewing box. Any light apart from the area being traced will be blocked out. These tracings were then repeated two weeks apart for intra-reliability assessments using intraclass correlation coefficient (ICC). Four hard tissue and four soft tissue landmarks were identified from the tracings. The landmarks and definitions were displayed in Table 1.

The reference plane used was Rickett's E-line that was drawn from the pronasale to the soft tissue pogonion (Figure 1). The distance of the upper and lower lips to this line was measured in mm using a metal ruler. The values obtained were then compared with the Caucasian norms; upper lip to E-line: -4 mm, lower lip to E line: -2 mm ± 2.

Sample size

Power analysis for mean difference from constant one sample *t*-test was conducted in G*Power (version 3.1.9.7) to determine the sufficient sample size, with a power of study = 0.80, alpha= 0.05 and effect size = 0.5. The minimum sample size calculated was 34.

Table 1. Definition of cephalometric landmarks.

Skeletal Landmark		
No	**Points**	**Definition**
1.	Sella (S)	The midpoint of the sella turcica.
2.	Nasion (N)	Junction of the nasal and frontal bones at the frontonasal suture.
3.	A point (A)	The point of deepest concavity on the anterior profile of the maxilla (maxillary alveolar process).
4.	B point (B)	The point of deepest concavity on the anterior surface of the mandibular symphysis.
Soft Tissue Landmark		
No	**Points**	**Definition**
5.	Pronasale (Pn)	The most prominent point on the apex of the nose (tip of nose).
6.	Labrale superius (Ls)	The most anterior point on the margin of the upper membranous lip.
7.	Labrale inferius (Li)	The most anterior point on the margin of the lower membranous lip.
8.	Soft tissue pogonion (Pg')	The most anterior point on the soft tissue outline of the chin.

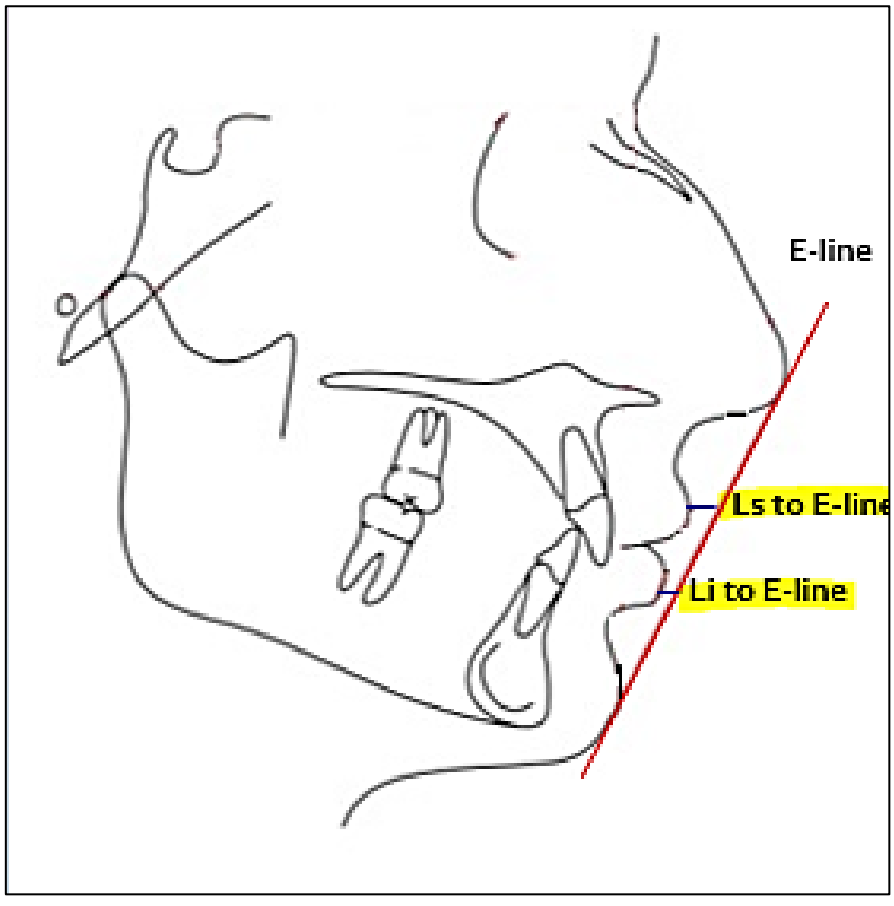

Figure 1. Rickett's E-line.

Statistical data analysis

Data analysis was performed using IBM Statistical Package for the Social Sciences (SPSS) software version 25.0 (Chicago, IL, United States of America). The significance level was set at $p < 0.05$.

Data was checked for normality distribution. Descriptive statistics was performed to obtain the mean and standard deviation for the distance of the upper and lower lips to the E-line. The intra-rater reliability was assessed using a two-way mixed, absolute agreement and single measure intraclass correlation coefficient (ICC). The means obtained for both the upper and lower lips of the Malay female population were compared with the Caucasian mean using one sample *t*-test.

Results

The ICC score was 0.944 with a *p* value of less than 0.001 indicative of excellent intra-examiner reliability.

Table 2 displayed the mean and standard deviation of the upper and lower lips to Rickett's E-line. The measurement for the upper lip was -1.3 mm (± 2.0) whereas the lower lip was 0.19 mm (± 1.9). One sample *t*-test revealed significant differences between the Malay female and Caucasian population for both upper and lower lips ($p<0.001$).

Table 2. Mean and standard deviation.

	N	Mean	Standard deviation
Upper lip	40	-1.3	2.0
Lower lip	40	0.19	1.9

Discussion

This study was based specifically on the Malay ethnic group despite Malaysia consisting of three major races. This is due to the fact that the relationship of the lips using the E-line for the Malaysian Chinese and Malaysian Indians were already conducted previously (Purmal *et al*., 2013). However, the evidence of this relationship for the Malay population was still lacking. It is known from various studies that majority of adult patients seeking orthodontic treatment were females as they were more concerned of their facial appearance (Harris & Glassell, 2011; Lam *et al*., 2020). In addition, laypeople were more sensitive to females' profile changes compared to males (Burcal *et al*., 1987; Kalin *et al*., 2021). Therefore, this pilot study focused on the Malay female population of Kuantan city.

The results revealed that both the upper and lower lips of the Malay female population in this city were more protrusive when compared to the Caucasian norms. This finding is in accordance with previous studies that found the Malaysian Malay population, when compared to Caucasians, had more proclined upper and lower incisors as well as more protrusive maxilla and mandible (Hasan, 1998; Norman *et al*., 2020). Hence, it is agreeable that the lips of this ethnic group would be more forwardly placed following the incisor and jaw positions. In addition, the study by Hasan (1998) also concluded that the Malay population have less prominent chin, which could also contribute to protrusive lips, thus supporting the result of this study.

This study thus implies that the protrusiveness of the upper and lower lips of this population is not an anomaly, but a variation of the soft tissue spectrum. It emphasizes the need to educate the patients that it is a normal facial feature of this race, and ergo need not be treated to follow the Caucasian norms. This could help in the decision of the clinician to avoid extractions in order to retract the maxillary incisors especially in Class II division 1 and bimaxillary protrusion cases (Kalin *et al*., 2021). Therefore, establishing the

cephalometric norms of the upper and lower lips to Rickett's E-line in the Malay female population aids in treatment planning and facilitating the overall treatment process, help meet the patients' expectations as well as enhancing quality orthodontic care.

Nevertheless, a few limitations of this study need to be acknowledged. As this is a retrospective study, record keeping is crucial as the study depends on the quality of the pre-existing radiographs. Apart from that, LCR provides a two dimensional view of a three dimensional object, and thus may fail to accurately represent the actual anatomic landmarks (Adams *et al*., 2004). Moreover, cephalometric tracings are subjected to errors due to measuring errors or difficulty in locating certain landmarks (Durão *et al*., 2014). However, these errors were rectified by calibration and intra-examiner reliability test. In addition, as this study was based entirely on the Malay female population of Kuantan city only, the results should be interpretated with caution. Perhaps, more sample size could be recruited in future studies to evaluate the cephalometric norms of different ethnic groups in Malaysia.

Conclusion

The cephalometric norms for the Malay female population of Kuantan city are: upper lip -1.3 mm (± 2.0) and lower lip 0.19 mm (± 1.9). This value was found to be significantly different than the Caucasian population ($p < 0.001$). Hence, the Malay female population of this city have more protrusive upper and lower lips when compared to the Caucasian norms.

Acknowledgement

This research was funded by Kulliyyah of Dentistry Postgraduate CHAIN grant from International Islamic University Malaysia (CHAIN 22-003-0003). The authors would like to thank the statistician Dr Mohamad Shafiq B Mohd Ibrahim for his contribution regarding the statistical data analysis. The authors also report no conflicts of interest. No personal gain was sought by either researchers or participants.

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