

Holdaway Soft Tissue Cephalometric Standard for Malay Adults

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ABSTRACT

Objectives: The aim of this study were: 1. To report facial soft tissue measurements in Class I Malay adult, 2. To compare between gender, 3. And to check applicability of Holdaway values for Class I Malay adults. **Materials and Methods:** Lateral cephalometric of 20 men and 20 women age 20-30 years with Class I skeletal was selected from Orthodontic Clinic, Faculty of Dentistry UiTM. The subject has no orthodontic or orthognathic surgery done before the radiograph was taken. The radiograph was traced and evaluated by the authors. Cephalometric landmarks were located according to Holdaway analysis. Ten linear and two angular measurements were produced on each radiograph and measured. For each variable, the mean and standard deviation (SD) was calculated using simple t-test ($p < 0.05$). **Results:** Soft tissue measurements for Malay have significant difference as compared to Holdaway value except for three parameters which are soft tissue facial angle, superior sulcus depth, and soft tissue chin thickness. When compared between genders, male has larger value in skeletal profile convexity, upper lip strain and soft tissue thickness while females demonstrated higher value in nose prominence and superior sulcus depth. **Conclusions:** It has been concluded that Malay values for Holdaway soft tissue analysis were found to be statistically different. Hence Holdaway soft tissue values are not applicable for use in orthodontic practice for Malay population. Further research to confirm values obtained for Malay population would aid in better diagnosis and treatment planning.

Keywords: Soft tissue; Malay adult; Class Skeletal pattern; Holdaway analysis.

INTRODUCTION

Nearly every popular discussion of facial esthetics seems to begin and end with hoary aphorism that "Beauty is in the eyes of beholder". Harmonious soft tissue profile is an important treatment goal in orthodontics and is sometimes difficult to attain because of soft tissue overlying teeth and bones is highly variable in thickness (Wuerpel et al., 1937). Contemporary orthodontics includes treatment of dental and skeletal disharmonies with

careful considerations of integumental features of the face. Disharmonies and disproportions of face, as well as imbalances of lips and their surrounding musculature have been classified in various ways by many scientists (Peck et al., 1970, Burstone, 1958, Ricketts, 1968), and others.

The soft tissues covering the face play an important role in facial aesthetics, speech, and function. Angle pointed out that the soft tissues were an important factor in facial harmony (Maurya et al., 2014). Facial harmony in orthodontics is determined by the morphologic relationships and proportions of the nose, lips, and chin. Detailed soft tissue analysis is an important component of comprehensive diagnosis and treatment planning (Hameed et al., 2018). A balance between the dental and the perioral muscles must be achieved to attain stability of the treatment outcome (Maurya et al., 2014).

In reference to such practical need of soft tissue evaluation, many assessment methods of soft tissue profile were introduced including Holdaway analysis aesthetic plane, and Burstone' soft tissue analysis. Holdaway has attempted to quantify the soft tissue features that contribute to better orthodontic planning decision leading to improved treatment outcomes. Each analysis utilized specific soft tissue landmarks to describe the relationship between various facial components (Burstone, 1958 and Ricketts, 1968).

Holdaway soft tissue analysis has addressed the main profile characteristics of the lower and middle facial structures. It also relates its findings to the facial upper third. The analysis was adopted in many practices and was utilized in several studies to report the cephalometric soft tissue findings of different ethnicities in addition to the comparison of Holdaway established norms (Bascifti et al., 2003 and Alcade et al., 2000).

In orthodontic practice cephalometric radiography is most used to evaluate and analyze the soft tissue pattern. The term cephalometry means the scientific measurement of the dimensions of craniofacial complex (Ijaz et al., 1994). With knowledge of the standard facial traits and patient's soft tissue features, individualized norms can be established to optimize facial attractiveness (Bergman 1999). A cephalometric approach to facial examination is therefore of great benefit.

Most classical cephalometric standards were based on sample populations with European or American ancestries (Hwang et al., 2002) and these norms may not be appropriate for the diagnosis and treatment planning of patients from other ethnic or racial backgrounds. This has led to the introduction of cephalometric norms for different ethnic and racial groups. Such investigations have shown significant differences between the ethnic and racial groups studied compared with Europeans and Americans (Hwang et al., 2002, Bacifti et al., 2003, Manar et al., 2008 and Alcade et al 2000). Furthermore, greater ethnic differences were reported in soft tissue relationships compared with skeletal and dental relationships.

The aims of the study were: 1. To determine the soft tissue measurements in Class I Malay adult, 2. To compare between gender and 3. To check applicability of Holdaway values for Class I Malay adults. Therefore, to determine soft tissue cephalometric norms for a sample of Malay adults, the tracing was done according to the method described by Holdaway.

The following null hypotheses were tested:

1. There are no significant differences between male and female soft tissue measurement using Holdaway soft tissue analysis.
2. There are significant differences of soft tissue Malay population compared to Holdaway norms.
3. Holdaway soft tissue analysis is not applicable to measure the soft tissue of Malay population.

MATERIALS AND METHODS

Lateral cephalograms of 40 orthodontically untreated adult subjects are having Class I skeletal pattern were analyzed. It was further divided into two subgroups which are male and female.

The study design is a cross-sectional descriptive type is carried out in the Orthodontic Department of Faculty of Dentistry UiTM, Sungai Buloh. Ethics approval was sought from Research Ethics Committee Faculty of Dentistry UiTM. Informed consent was also sought by asking patients to sign a form that explained the nature and purpose of the radiographic examination.

The sample met following criteria: Malay adult with Class I skeletal pattern, Class I molar and canine relationships, normal overjet and overbite, no crowding, competent lips, no previous orthodontic or orthognathic treatment and no significant medical history, no cleft of lip and palate, no history of trauma, has complete set of permanent teeth except third molar. Patients with any kind of syndrome were also excluded.

Lateral cephalograms of the participants which were obtained during their training, were retrieved from their files. Lateral cephalograms were taken in a standardized manner, following the recommendation of the cephalostat manufacturer (Instrumentarium OC200D, Finland). Teeth were in occlusion, and lips were in relaxed position. Lateral cephalograms then traced and measured by the author, maximum of three tracing and measurement per day.

For each subject a lateral cephalogram was taken in natural head position with Frankfort horizontal plane of the patient parallel to the floor. Cephalogram were taken from the right side of the patient at 5-ft from mid-sagittal plane. Tracing had been done on the cephalograms. Data analysis procedure included tracing of the soft tissues on tracing paper, using pencil.

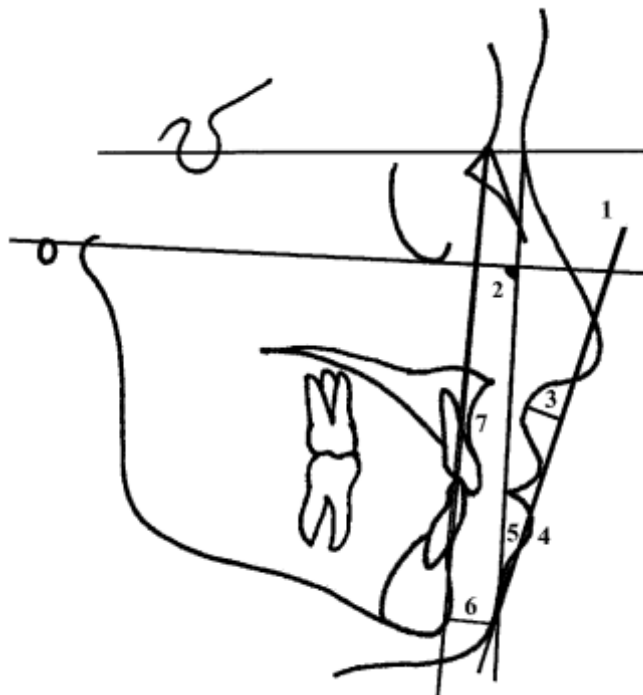


FIGURE 1. Cephalometric measurements: (1) H line; (2) Soft tissue facial angle; (3) Measurement of soft tissue subnasale to H line; (4) Lower lip to H line; (5) H angle; (6) Soft-tissue chin thickness; (7) Skeletal profile convexity.

Six reference lines were identified and traced according to definitions by Holdaway, 1983.

Reference lines and planes:

- 1) Harmony (H) line: drawn tangent to the chin and upper lip.
- 2) Sella-nasion (SN) line.
- 3) Soft tissue facial (STF) line: drawn from the point where the extension of the SN line crosses the soft tissues to a point on the soft tissue chin overlying Ricketts' suprapogonion (SPG).
- 4) Hard tissue facial plane (HTF): drawn from nasion to pogonion.
- 5) Frankfort horizontal (FH) plane.
- 6) Frankfort perpendicular (FP) line: a line perpendicular to FH and tangent to the vermilion border of the upper lip.

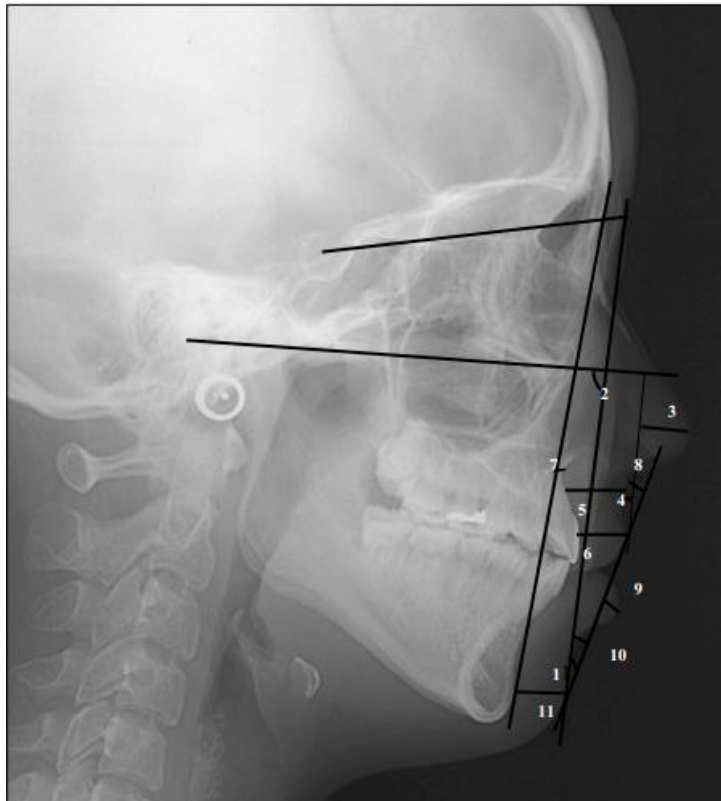


FIGURE 2: Holdaway soft tissue analysis. (1) H angle; (2) soft tissue facial angle; (3) nose prominence; (4) upper lip sulcus depth; (5) basic upper lip thickness; (6) upper lip thickness; (7) skeletal convexity; (8) soft tissue subnasale to H line; (9) lower lip to H line; (10) inferior sulcus to H line; (11) soft tissue chin thickness.

Ten linear and two angular measurements were analyzed on each radiograph. The landmarks were located according to the definition provided by Holdaway.

The following measurements were used.

Angular measurement

- 1) Soft tissue facial angle: the downward and inner angle formed at a point where the Sella-nasion line crosses the soft tissue and a line combining the suprapogonion with the Frankfort horizontal plane.
- 2) H angle: the angle formed between the soft-tissue facial plane line and the H line.

Linear measurements

- 1) Nose prominence: the dimension between the tip of the nose and a perpendicular line drawn to the Frankfort plane from the vermilion.
- 2) Superior sulcus depth: the measurement between the upper lip sulcus and a perpendicular line drawn from the vermilion to the Frankfort plane.
- 3) Measurement of soft tissue subnasale to H line: measurement from subnasale to the H line.
- 4) Skeletal profile convexity: the dimension between point A and facial line.
- 5) Basic upper-lip thickness: the dimension measured approximately three mm below point A and the drape of the upper lip.
- 6) Upper-lip thickness: the dimension between the vermilion point and the labial surface of the upper incisor; and
- 7) Upper-lip strain measurement: the difference between the basic upper-lip thickness and the upper-lip thickness.
- 8) Lower lip to H line: the measurement of the lower lip to the H line.
- 9) Inferior sulcus to the H line (lower lip sulcus depth): the measurement at the point of greatest convexity between the vermilion border of the lower lip and the H line.
- 10) Soft-tissue chin thickness: the distance between the hard and soft-tissue facial planes at the level of supra-pogonion.

Statistical Analysis

Descriptive statistics were calculated, including means and standard deviations for the whole sample, male and females. For data analysis, independent simple T-test was used to measure differences between genders. Predetermine the significance levels for statistical test at a probability value of 0.05 or less. Analyses are performed with SPSS software version 20. Power calculations indicated that a difference of one standard deviation would be detected with a power of 0.89 ($\alpha = 0.05$) for the present sample size.

Reliability

An error analysis exercise was carried out using 20 radiographs, which were traced a second time after 2 weeks. Systematic bias was examined using a paired t-test (10), and estimation of random error was done with the index of reliability by correlating repeat measurements (11) (measurements of the 20 radiographs used in the error analysis that were taken a second time after 2 weeks). Error analysis showed no significant differences when systematic bias was tested ($P < .05$), and correlations were found to be greater than 0.95, indicating no random error.

RESULTS

Table 1: Descriptive of mean age from the sample.

Gender	Mean age
Male	23
Female	22

Table 1 stated the mean age for male and female for sample size in this research. The sample size for male and female is 20 people for both groups.

Table 2: Statistical Values for Male and Female Soft Tissue Measurement

Holdaway Variables	Holdaway norms	Males (n = 20)		Female (n = 20)		Difference (Mean)	95% Confidence Interval of Difference	
		Mean	SD	Mean	SD		Lower	Upper
Soft tissue facial angle (°)	91	90.95	4.78	90.18	3.53	0.77	3.40	-1.86
H Angle (°)	10	17.2	2.93	15.53	3.58	1.67	3.73	-0.39
Nose prominence (mm)	16	12.95	2.01	14.58	2.95	-1.63*	-0.04	-3.22
Superior sulcus depth (mm)	3	1.98	1.13	3.37	2.54	-1.39*	-0.15	-2.63
Subnasale to H line (mm)	5	9.6	3.12	7.84	3.44	1.76	3.82	-0.30
Skeletal convexity (mm)	0	4.4	1.82	2.63	1.07	1.77*	2.70	0.84
Basic upper lip thickness (mm)	15	13.95	1.79	13.16	1.12	0.79	1.72	-0.14
Upper lip thickness (mm)	14	10.45	1.50	11.05	2.93	-0.6	0.87	-2.07
Upper lip strain (mm)	1	3.5	1.70	1.68	1.49	1.82*	2.82	0.82
Lower lip to H line (mm)	0	0.5	2.21	1.53	1.12	-1.03	0.06	-2.12
Inferior sulcus to H line (mm)	5	4.75	1.86	3.97	1.42	0.78	1.82	-0.26
Soft tissue chin thickness (mm)	11	12.2	2.93	11.37	4.06	0.83*	3.06	-1.40

* Significant difference at P<0.05

Table 2 shows the descriptive statistics of both genders and compares the result for all measured variables. There were significant differences between males and females in several of the measured variables. Males exhibited larger values for skeletal profile convexity, upper lip strain and soft tissue chin thickness. Females demonstrated significantly higher value for nose prominence and superior sulcus depth. The rest of the variables show no significant difference between the genders.

Table 3: Statistical Value of Malay Soft Tissue Measurement Compared to Holdaway Norms

Holdaway Variables	Holdaway Norms (Mean)	Malay Norms (Mean)	SD	Difference (Mean)	T-test $\alpha=0.05$
Soft Tissue Facial Angle ($^{\circ}$)	91	90.58	4.18	0.42	0.63
H Angle ($^{\circ}$)	10	16.38	3.33	-6.38	-11.96*
Nose Prominence (mm)	16	13.74	2.61	2.26	5.41*
Superior Sulcus Depth (mm)	3	2.65	2.05	0.35	1.07
Soft Tissue Subnasale to H Line (mm)	5	8.74	3.35	-3.74	-6.97*
Skeletal Profile Convexity (mm)	0	3.54	1.73	-3.54	-12.78*
Basic Upper Lip Thickness (mm)	15	13.56	1.54	-1.44	5.84*
Upper Lip Thickness (mm)	14	10.74	2.30	3.26	8.85*
Upper Lip Strain (mm)	1	2.61	1.83	-1.61	-5.49*
Lower Lip to H Line (mm)	0	1	1.82	-1	-3.43*
Inferior Sulcus to H Line (mm)	5	4.37	1.68	0.63	2.34*
Soft Tissue Chin Thickness (mm)	11	11.79	3.50	-0.79	-1.41

Critical value < 2.02

Table 3 shows statistical value of Malay soft tissue measurement compared to Holdaway norms. Out of the two angular and ten linear measurements, there are nine parameters that Malay population has significant difference as compared to Holdaway value. Malay soft tissue measurement has higher value compared to Holdaway norms in H angle, soft tissue subnasale to H line, skeletal convexity, upper lip strain and lower lip to H line. Otherwise, Malay soft tissue measurement is lower compared to Holdaway norms in nose prominence, basic upper lip thickness, upper lip thickness and inferior sulcus to H line.

DISCUSSIONS

To facilitate in orthodontics planning, orthodontics has the cephalometric analysis as the diagnostic aid. Holdaway analysis is one of the tools available in assessing the facial soft tissue measurement thoroughly and in detailed. It was done by Reed A. Holdaway in 1983 on Caucasian population. Many studies in different population and ethnics to measure the facial soft tissue using Holdaway analysis have been reported.

In this study, the results have shown that there are several parameters that differs Malay males from females. Male exhibits greater measurement in soft tissue chin thickness, upper lip strain and skeletal convexity compared to females. Soft tissues chin thickness in male is 12.2mm while female is 11.37mm in mean. Similar finding was reported by Bascifti et al., 2003. For upper lip strain, it is associated with the measurement of basic upper lip thickness and upper lip thickness of the person. The deductions of the two measurements indicate the straining and incompetency of the upper lip. The mean measurement for male was 3.5 while female was 1.68 showing male have significantly increase lip straining compared to female and basic Holdaway norms which has the mean value of 1. Skeletal convexity was found greater in male than female which contraindicate with the protrusion of the lip that was found more in female although it is statistically insignificant.

Malay female was found to have greater nose prominence and superior sulcus depth compared to Malay male. The result disagrees with the result reported by Manar et al., 2008. which showed that there is no sexual dimorphism in nose prominence. Female have shown to have deeper superior sulcus depth which presented with mean margin of 3.37 while male with the value of 1.98. it can be related with more protruded upper lip found in female although it is no found to be statistically different.

In this study, there are no significant differences between Malay measurement to Holdaway values for three parameters which are soft tissue facial angle, superior sulcus depth and soft tissue chin thickness with the t-test value are 0.63, 1.07 and 1.41 respectively. The Holdaway value for this parameter is 91 +/- 7 which the increase of the angle indicated prognathic of lower jaw while decrease value of the angle indicated retrognathic of lower jaw.

Superior sulcus depth can also be known as upper lip curvature. It measured from the tangent of Frankfort horizontal plane to the upper lip sulcus. Although Holdaway described its value is 3mm, but it also suggests that 1-4mm is acceptable measurement. Soft tissue chin thickness is measured form hard tissue pogonion to the soft tissue pogonion. The value suggested by Holdaway is 11 and it has no difference between Malay and Holdaway norms.

Malay showed significant different in H angle with value of the t-test is 11.96. The difference mean is 6.38. H angle as measured between two planes which are soft tissue facial plane and harmony line. It can measure the prominence of the upper lip or retrognathism of the soft tissue chin. H angle exhibit larger value for Malay sample than the recommended by Holdaway. The H angle can be affected by the position of the mandible and the chin.

Nose prominence in Malay soft tissue is lower than the suggested by the Holdaway norms. As the nose prominence influence the adjacent of circum oral and facial structure, it has become one of the important structures that may affect the treatment planning. Holdaway suggested that the nose prominence is depending on the individual facial characteristics, but the value for the Holdaway norms is 14-24 mm.

Soft tissue subnasale to H line is increase in the Malay population compared to Holdaway soft tissue analysis. The stated value in Holdaway soft tissue analysis ideally is 5mm. But 3-7 mm is acceptable value for a patient. If a patient has lower than 3 mm, then it indicated short thin lip while if the value is higher that 7mm, it indicated the long thicker lip.

Other than that, there are other variables that have increase value in number include skeletal profile convexity. It was drawn from the hard tissue facial that go through to the point A in Holdaway analysis. Thus,

they got the value of zero for the result. The increasing result for the Malay population in skeletal profile convexity indicated that the Malay population have more convex profile compared to Holdaway.

Malay population soft tissue for basic upper lip thickness is lower than Holdaway value which the mean difference is 1.44. The average value suggested by Holdaway is 15 mm. it is measured horizontally from a point 3 mm below the A point to the outer of upper lip. It indicates the straining and competency of the upper lip. The upper lip thickness of the Malay population also shows lower mean value than the Holdaway norms. It can be correlated with the higher value of upper lip strain in Malay population soft tissue that indicates the incompetency of the upper lip. It also reported to have the same result in Japanese (Alcade, Jinno, Orsini, Sasaki, Sugiyama, Matsumura, 2000) and Turkish adults (Basciftci, Uysal, Buyukerkmen, 2003).

The ideal lower lip position is 0-0.5 mm to the H line. In this study, the result show Malay population was more posteriorly positioned in relation to the H line than that reported by Holdaway. The increased in distance of lower lip to the H line may indicate prominent soft tissue chin or retruded position of lower lip. the value of inferior sulcus depth to the H line of Malay population is lower than the Holdaway norms. the average value stated by Holdaway is 5 mm which was measured from a point of deepest curvature between lower lip and chin to the H line.

CONCLUSION

This study was performed to evaluate the soft tissue measurement of Malay population according to Holdaway analysis. The result showed that there are similarities of value in parameter when compared between males and females, except for female exhibited larger soft tissue measurement in nose prominence and superior sulcus depth while skeletal profile convexity, upper lip strain, and soft tissue chin thickness reported higher value in males. For Malay population compared to Holdaway analysis value, they are different compared to each other except for soft tissue facial angle, superior sulcus depth and soft tissue chin thickness that has no significant differences found. Based on our study, Holdaway soft tissue analysis in Class 1 is not applicable for Malay Class 1 skeletal pattern. Further research can be taken into consideration to confirm values obtained from our study to aid better diagnosis and treatment planning.

REFERENCES

- Alcade RE, Jinno T, Orsini MG, Sasaki A, Sugiyama RM, Matsumura T. (2000). Soft tissue cephalometric norms in Japanese adults. *Am J Orthod Dentofacial Orthop.*,118(1), 84–89
- Arshad Hameed, Junaid Israr Khan, Abida Ijaz. *Pakistan Oral & Dental Journal: Soft Tissue Facial Profile Analysis in Patients with Class I And Class II Skeletal Pattern Visiting Children’s Hospital, Lahore*, 28(2)
- Basciftci FA, Uysal T, Buyukerkmen A. (2003). Determination of Holdaway soft tissue norms in Anatolian Turkish adults. *Am J Orthod Dentofacial Orthop*, 123(4), 395–400.
- Bergman RT. (1999). Cephalometric soft tissue facial analysis. *Am J Orthod Dentofacial Orthop*, 116, 373-89.
- Burstone C.J. (1958). The integumental profile. *Amer. J. Orthodont.*,44, 1-25.
- Houston WJB. (1983). The analysis of errors in orthodontic measurement. *Am J Orthodontics*, 83,382–390.
- Hwang H, Kim W, McNamara JA Jr. (2002). Ethnic differences in the soft tissue profile of Korean and European-American adults with normal occlusions and well-balanced faces. *Angle Orthodontics*, 72, 72–80

- Ijaz A. (1994) Diagnostic implications of cephalometric analysis of 100 patients of malocclusion. *Pak Oral Dental J*, 14, 14-31.
- Manar Y Abdul-Qadir, Alaa' D Al-Dawoody, Ne'am F Agha. (2008) Evaluation of Holdaway Soft Tissue Analysis for Iraqi Adults with Class I Normal Occlusion *Al-Rafidain Dent J.*, 8(2), 231-237
- Peck H, Peck (1970). A concept of facial esthetics *Angle Orthodontics*, 40,284-318.
- Rana Pratap Maurya, Vijay Prakash Sharma, Pradeep Tandon, Amit Nagar, Sneha Lata Verma. (2014). *Journal of Orthodontic Research: Soft-tissue characteristics of Class-II Division-1 malocclusion in North Indian adult population: A cephalometric study*, 2(2)
- Ricketts R.M. (1968). Esthetics, environment, and the law of lip relation. *Am. J. Orthodontics*, 54, 927-951.
- Stirrups DR. (1993). Guidance on presentation of cephalometry based research studies. A personal perspective. *Br J Orthodontics*, 20,359-365.
- Wuerpel E.H. (1937) On facial balance & harmony. *Angle Orthodontics*. 7,81-89