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Analysis of Holdaway soft-tissue measurements in children between 9 and 12 years of age

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SUMMARY In this study, 43 lateral cephalometric radiographs from 20 boys and 23 girls subjects were used to determine the Holdaway soft tissue growth changes. Subjects with Class I occlusions, balanced skeletal profiles, normal growth and development, and no orthodontic treatment history were included in the investigation. The cephalometric measurements were carried out on the first and second radiographs of each subject, with an average interval of 5 years. The growth changes in both sexes were analysed separately. The changes resulting from growth and development were determined by a paired *t*-test.

The results showed that all measurements were significant at various levels except for upper lip sulcus depth, subnasal-H line distance, and lower lip H distance in girls, and upper lip sulcus depth, subnasal-H line distance, H angle and lower lip H line distance in boys. The measurement differences were observed with a Student's *t*-test. No significant difference was found for any measurement except upper lip base thickness ($P < 0.001$) and upper lip thickness ($P < 0.01$). The following measurements during the observation period were statistically different: soft-tissue facial angle ($P < 0.01$ in girls, $P < 0.05$ boys), nose prominence ($P < 0.001$ in girls and boys), skeletal profile convexity ($P < 0.001$ in girls, $P < 0.01$ in boys), basic upper lip thickness ($P < 0.001$ in girls and boys), upper lip thickness ($P < 0.05$ in girls, $P < 0.001$ in boys), H angle ($P < 0.001$ in girls), lower lip sulcus depth ($P < 0.001$ in girls and boys), and soft-tissue chin thickness ($P < 0.001$ in girls, $P < 0.001$ in boys).

Introduction

Diagnosis and treatment planning play an important part in orthodontic considerations. Treatment-planning procedures are based on hard-tissue measurements, and some attempts have been made to find a standard value for the hard and soft tissues (Neger, 1959; Ricketts, 1960; Steiner, 1960; Merrifield, 1966; Peck and Peck, 1970).

The changes in the soft tissues following orthodontic treatment are still unclear (Burstone, 1958; Merrifield, 1966; Iwasawa *et al*., 1977). Some researchers have studied the thickness of the soft-tissues to determine the relationship between the hard and soft tissues, and to determine the effect of hard-tissues on facial aesthetics (Riedel, 1950; Ricketts, 1960; Wisth, 1972; Mauchamp and Sassouni, 1973). Others have highlighted the necessity for the hard and soft tissues to be evaluated together, and that peri-oral function, facial aesthetics, and stability are important factors in orthodontic treatment (Riedel, l950; Burstone, 1958; Ricketts, 1960; Subtelny, 1961; Merrifield, 1966; Mauchamp and Sassouni, 1973).

Holdaway (1983) stated that 'Usually, as we correct malocclusions, we bring about changes in appearance that are pleasing to all concerned. However, most orthodontists who have practiced for even a few years have had the unpleasant experience of finding that some patients' faces looked better before the orthodontic corrections were made.' Holdaway (1984) stated that 'Systems based on hard-tissue measurements or reference lines alone may produce disappointing results.'

Table 1 Number of individuals, age and sex distribution.

	Girls (n = 23)		Boys (n = 20)		Total (n = 43)	
Age (month)	Beginning	In the 5th year	Beginning	In the 5th year	Beginning	In the 5th year
Mean	121.04	180.04	123.65	183.35	122.26	181.58
SD	5.79	5.51	7.69	8.01	6.79	6.90
Min.	110.00	169.00	108.00	167.00	108.00	167.00
Max.	131.00	189.00	132.00	192.00	132.00	192.00

Hard- and soft-tissues change with growth (Angle, 1899; Burstone, 1958; Subtelny and Rochester, l959; Subtelny, 1961). It is possible to follow the development of the face and chin by means of longitudinal investigations (Subtelny and Rochester, 1959; Ricketts, 1960).

The purpose of this study was to examine the 5-year changes in Holdaway measurements due to growth and development in boys and girls between 9 and 11 years of age.

Materials and methods

The material comprised the longitudinal lateral cephalometric radiographs of 43 patients, 20 boys and 23 girls, selected from subjects who attended the Department of Orthodontics, School of Dentistry, Atatürk University. Distribution by sex and age is shown in Table 1. The following criteria were used for selection of the sample:

1. Class I occlusion with normal overbite and overjet.
2. Normal growth and development.
3. Balanced facial skeletal profile.
4. All lateral cephalometric radiographs taken with the lips in light contact and the teeth in occlusion.
5. None of the subjects had undergone orthodontic therapy.

The radiographs were traced by one investigator (AMŞS). The landmarks were located according to the definition provided by Holdaway (1983, 1984). The following measurements were used (Figures 1 and 2).

A—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.

B—Nose prominence. The dimension between the tip of the nose and a perpendicular line drawn to the Frankfort plane from the vermillion.

C—Upper lip sulcus depth. The measurement between the upper lip sulcus and a perpendicular line drawn from the vermillion to the Frankfort plane.

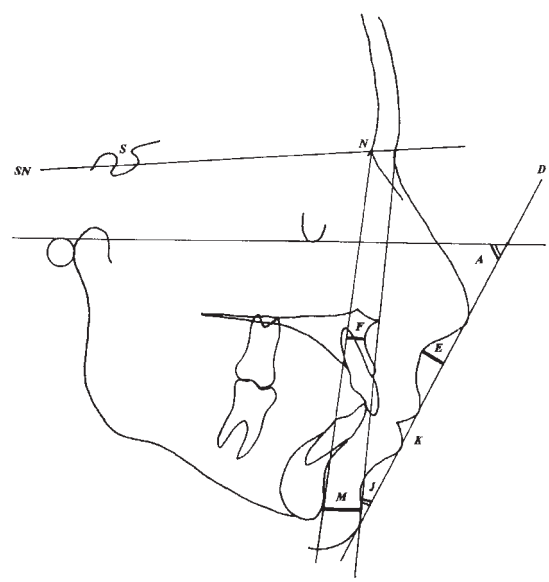

Figure 1 Cephalometric measurements. A—soft-tissue facial angle; D—H line; E—measurement of soft-tissue subnasale to H-line; F—skeletal profile convexity; J—H angle; K—lower lip to H line; M—soft-tissue chin thickness.

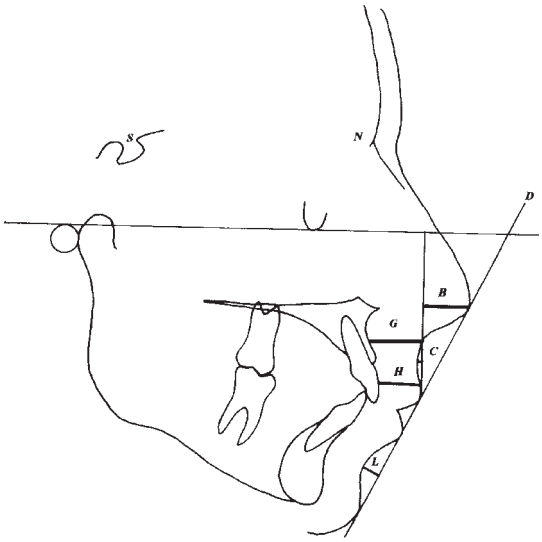

Figure 2 Cephalometric measurements. B—Nose prominence; C—Upper lip sulcus depth; D—Basic upper lip thickness; H—Upper lip thickness; I—Upper lip strain measurement (G–H); L—Inferior sulcus to the H line.

D—H line. Tangent drawn from the tip of the chin to the upper lip.

E—Measurement of soft-tissue subnasale to H line. Measurement from subnasale to the H line.

F—Skeletal profile convexity. The dimension between point A and facial line.

G—Basic upper lip thickness. The dimension measured approximately 3 mm below point A and the drape of the upper lip.

H—Upper lip thickness. The dimension between the vermillion point and the labial surface of upper incisor.

I—Upper lip strain measurement. The difference between the basic upper lip thickness and the upper lip thickness (G–H).

J—H angle. The angle formed between the soft-tissue facial plane line and the H line.

K—Lower lip to H line. The measurement of the lower lip to the H line.

L—Inferior sulcus to the H line (lower lip sulcus depth). The measurement at the point of greatest convexity between the vermillion border of the lower lip and the H line.

M—Soft-tissue chin thickness. The distance between the hard- and soft-tissue facial planes at the level of suprapogonion.

Two weeks after the first measurements, 15 radiographs were selected at random, and remeasured and a paired *t*-test applied to the first and second measurements. It was found that the difference between the first and second measurements of the 15 radiographs was insignificant. Correlation analysis applied to the same measurements showed the highest *r* value 0.993 to be for the soft-tissue facial angle, and the lowest *r* value 0.836 for the skeletal profile convexity (Table 2).

The arithmetic mean, minimum, maximum, and standard deviation were calculated for each measurement. The significance levels of the changes resulting from growth and development were determined by a paired *t*-test. The measurement differences observed for 5 years in both sexes were compared using a Student' *t*-test.

Results

The results of the paired *t*-test used to determine the separate changes in Holdaway measurements in girls and boys over 5 years are shown in Tables 3 and 4.

The change in upper lip thickness in girls was significant ($P < 0.05$), whereas the soft-tissue facial angle and the H angle showed a change of $P < 0.01$ (Table 3). There was also a significant change in nose prominence, skeletal profile convexity, basic upper lip thickness, inferior

Table 2 Error measurement for the differences between the first and second measurements.

Measurements	*r*
Soft-tissue facial angle	0.993
H angle	0.988
Nose-prominence	0.979
Measurement of soft-tissue subnasale to H line	0.976
Inferior sulcus to H line	0.958
Lower lip to H line	0.957
Soft-tissue chin thickness	0.949
Upper lip thickness	0.936
Basic upper lip thickness	0.882
Upper lip sulcus depth	0.837
Skeletal profile convexity	0.836

Table 3 Mean, minimum, maximum, and standard deviations of cephalometric measurements at the beginning and after 5 years, and change between the beginning and after 5 years of measurements in girls.

	1. Measurements (n = 23)				2. Measurements (n = 23)				Difference in measurements (n = 23)					
Measurements	Min.	Max.	x	SD	Min.	Max.	x	SD	Min.	Max.	x	SD	t	P
Soft-tissue facial angle	72.00	94.00	86.17	4.63	77.00	96.50	88.65	4.82	–3.00	12.00	2.48	3.57	3.33	**
Nose-prominence	8.00	22.50	13.11	3.23	11.00	22.50	16.09	3.05	–4.00	8.50	2.98	2.66	5.38	***
Upper lip sulcus depth	0.50	5.00	2.41	1.28	1.00	5.00	2.96	1.21	–1.00	4.50	0.55	1.27	2.05	_
Measurement of soft-tissue subnasale to H line	1.00	11.50	5.63	2.52	2.00	14.00	5.48	2.31	–3.00	3.50	–0.15	1.89	–0.39	_
Skeletal profile convexity	–0.50	5.50	2.35	1.61	–4.00	5.00	0.98	2.45	–4.00	1.00	–1.37	1.55	–4.25	***
Basic upper lip thickness	11.00	16.50	13.54	1.38	12.00	19.50	14.89	1.86	–1.00	4.50	1.35	1.61	4.03	***
Upper lip thickness	11.00	15.00	12.98	1.27	11.00	17.00	13.89	1.51	–2.00	4.50	0.91	1.84	2.38	*
Upper lip strain measurement	–2.00	3.00	0.57	1.14	–3.00	5.50	1.00	1.75	–3.00	3.00	0.43	1.64	1.27	_
H angle	8.00	20.50	14.63	3.79	6.50	22.00	12.67	4.11	–7.00	2.50	–1.96	2.92	–3.21	**
Lower lip to H line	–2.00	3.50	0.54	1.45	–2.00	3.00	0.72	1.64	–1.50	2.00	0.18	1.11	0.75	_
Inferior sulcus to H line	3.00	6.00	4.59	0.90	3.50	8.00	5.72	1.17	–0.50	4.00	1.13	0.92	5.89	***
Soft-tissue chin thickness	8.50	16.00	11.46	1.84	10.00	15.50	12.52	1.65	–1.00	3.00	1.06	1.09	4.69	***

*P < 0.05; **P < 0.01; ***P < 0.001.

Table 4 Mean, minimum, maximum and standard deviations of cephalometric measurements at the beginning and after 5 years, and change between the beginning and after 5 years of measurements in boys.

	1. Measurements (n = 20)				2. Measurements (n = 20)				Difference in measurements (n = 20)					
Measurements	Min.	Max.	x	SD	Min.	Max.	x	SD	Min.	Max.	x	SD	t	P
Soft-tissue facial angle	72.50	94.00	85.42	5.65	80.50	94.50	87.55	3.99	–4.00	9.50	2.13	3.33	2.85	*
Nose-prominence	8.00	18.00	12.27	2.94	11.50	22.00	16.00	2.64	0.00	6.50	3.73	1.76	9.47	***
Upper lip sulcus depth	–2.50	4.50	2.47	2.01	1.00	6.00	2.77	1.59	–3.50	3.50	0.30	1.53	0.88	_
Measurement of soft-tissue subnasale to H line	3.00	11.00	6.70	2.34	2.50	11.50	6.62	2.22	–3.50	2.50	–0.08	1.76	–0.19	_
Skeletal profile convexity	–1.00	8.00	4.00	1.99	–3.00	6.50	2.70	3.21	–5.00	1.00	–1.30	1.83	–3.18	**
Basic upper lip thickness	11.00	16.00	13.65	1.33	14.00	20.00	16.90	1.83	0.50	6.50	3.25	1.69	8.60	***
Upper lip thickness	10.50	17.50	13.75	1.80	13.00	21.50	16.15	2.12	0.50	5.00	2.40	1.39	7.71	***
Upper lip strain measurement	–2.50	2.50	–0.10	1.38	–3.00	4.50	0.75	2.04	–1.00	4.50	0.85	1.38	2.76	*
H angle	5.00	22.50	16.10	4.20	5.50	21.00	15.67	4.75	–7.00	4.50	–0.43	2.89	–0.66	_
Lower lip to H line	–2.00	3.00	0.90	1.30	–3.00	4.00	1.00	1.80	–3.00	3.50	0.10	1.67	0.27	_
Inferior sulcus to H line	0.50	8.50	4.75	1.91	3.00	10.00	6.52	2.23	–0.50	5.00	1.77	1.25	6.35	***
Soft-tissue chin thickness	9.00	16.50	11.97	2.16	10.00	17.50	13.22	1.87	–2.00	4.50	1.25	1.52	3.68	**

*P < 0.05; **P < 0.01; ***P < 0.001.

lip sulcus to the H line, and soft-tissue chin thickness (P < 0.001).

On the other hand, in boys, the soft-tissue facial angle was found to be significant at the 0.05 level, and the skeletal profile convexity, the soft-tissue chin thickness at a level of 0.01. The measurements of nose prominence, basic upper lip thickness, upper lip thickness, and inferior lip sulcus to the H line showed a change at a level of 0.001 significance (Table 4).

The following results were obtained through the Student's *t*-test applied to compare the measurement differences of girls and boys. The upper lip thickness was significant ($P < 0.01$), but that for the basic upper lip thickness was not (Table 5).

Whilst the soft-tissue facial angle, nose prominence, basic upper lip thickness, lower lip sulcus depth and soft-tissue Pogonion thickness measurements increased in boys and girls due to age, skeletal profile convexity and H angle measurements showed a decrease. However, the decrease in H angle in girls was significant ($P < 0.01$; Tables 3 and 4).

The increase in basic upper lip thickness and upper lip thickness measurements was more significant in boys than girls (Tables 3 and 4).

Discussion

In this study, it was found that the majority of Holdaway measurement in boys and girls between 9 and 11 years old increased over a 5-year period.

Regardless of the significance levels of the soft-tissue facial angle, this angle increased both in girls and boys. This supports the results of Schugg (1985) and Zylinski *et al.* (1992) who found that the soft-tissue facial angle in pre-adolescents and adult males increased with respect to age.

Nose prominence in this investigation increased with age, which is in agreement with the findings of Subtelny and Rochester (1959), Giray and Altuğ (1985), and Schugg (1985). Furthermore, the finding that the increase in males is more than in females is also supported by Anderson *et al.* (1973), Giray and Altuğ (1985), and Nanda *et al.* (1990). Göyenç *et al.* (1992), however, found an increase in nose prominence measurement only in girls with a skeletal Class II malocclusion in their research, which was performed on adult individuals of different skeletal Classes.

It was also determined in this study that the skeletal profile convexity measurement was greater in boys than in girls and that this measurement decreased with age. Mauchamp and Sassouni (1973) also found the facial profile to be flatter in females than in males.

The increase in upper lip base and upper lip thickness due to age is supported by various researchers (Wisth, 1972; Mauchamp and Sassouni, 1973; Giray and Altuğ, 1985; Schugg, 1985; Nanda *et al.*, 1990). Furthermore, Mink (1963) and Forsberg and Odenrick (1979)

Table 5 Mean, minimum, maximum and standard deviation differences of cephalometric measurements at the beginning and after 5 years, and changes between measurement difference for girls and boys.

	Girls $n = 23$				Boys $n = 20$					
Measurements	Min.	Max.	$\bar{X}$	SD	Min.	Max.	$\bar{X}$	SD	t	P
Soft-tissue facial angle	–3.00	12.00	2.48	3.57	–4.00	9.50	2.13	3.33	–0.34	–
Nose-prominence	–4.00	8.50	2.98	2.66	0.00	6.50	3.73	1.76	1.10	–
Upper lip sulcus depth	–1.00	4.50	0.55	1.27	–3.50	3.50	0.30	1.53	–0.56	_
Measurement of soft-tissue subnasale to H line	–3.00	3.50	–0.15	1.89	–3.50	2.50	–0.08	1.76	0.14	–
Skeletal profile convexity	–4.00	1.00	–1.37	1.55	–5.00	1.00	–1.30	1.83	0.13	–
Basic upper lip thickness	–1.00	4.50	1.35	1.61	0.50	6.50	3.25	1.69	3.77	***
Upper lip thickness	–2.00	4.50	0.91	1.84	0.50	5.00	2.40	1.39	3.01	**
Upper lip strain measurement	–3.00	3.00	0.43	1.64	–1.00	4.50	0.85	1.38	0.90	–
H angle	–7.00	2.50	–1.96	2.92	–7.00	4.50	–0.43	2.89	1.72	–
Lower lip to H line	–1.50	2.00	0.18	1.11	–3.00	3.50	0.10	1.67	–0.17	–
Inferior sulcus to H line	–0.50	4.00	1.13	0.92	–0.50	5.00	1.77	1.25	1.90	–
Soft-tissue chin thickness	–1.00	3.00	1.06	1.09	–2.00	4.50	1.25	1.52	0.45	–

**$P < 0.01$; ***$P < 0.001$.

reported that the lips draw back due to age. Park and Burstone (1986), and Genecow *et al*. (1990) determined that the positions of incisor teeth have a great influence on lip position.

Mamandras (1988) in his study performed on individuals between 8 and 18 years of age, indicated that the upper lip base depth measurement was greater in 18-year-old males, and that the total increase between 8 and 18 years was 46.33 per cent in males, whereas it was only 14.68 per cent in girls. He also reported that the greatest increase in males occurred between 8 and 16 years of age and for females between 10 and 14. The results of the present study are supported by the findings of others who considered the same age range.

The findings of the H angle being larger in males is in agreement with the results of most researchers (Jenatschke, 1977; Gazilerli and İşcan, 1980; Bishara *et al*., 1984; Giray, 1985), except for Hasund *et al*. (1980). The possible reasons for the difference in these findings from those of Hasund *et al*. (1980) is that their study was carried out on adults, and/or the bony points N and B were used for evaluation of the H angle.

Bishara *et al*. (1984) reported that the H angle decreased significantly in girls between 10 and 15 years of age and in males between 15 and 25.5 years of age. As the subjects in the present study were between 10 and 15 years of age, the fact that the H angle decreased significantly in girls is supported by Bishara *et al*. (1984).

The finding that the lower lip sulcus depth increases with age is in agreement with the results of Lew *et al*. (1992) who reported a similar measurement of 4 mm.

Another measurement found to be greater in males is the soft-tissue chin thickness. The findings are in agreement with those of Göyenç *et al*. (1992), Mauchamp and Sassouni (1973), Flynn *et al*. (1989), Seren (1990), and Yücel-Eroğlu (1991). However, the measurements of Giray and Altug (1985) are different as their research group comprised children between 8 and 11 years of age. There are other researchers supporting that the soft-tissue thickness in the jaw prominence region increases due to age (Mauchamp and Sassouni, 1973; Genecow *et al*., 1990; Nanda *et al*., 1990). Nanda *et al*. (1990) in their study performed on 40 subjects between 7 and 18 years found a total increase in boys of 2.7 mm and in girls of 2.0 mm.

The increase of the upper lip sulcus depth and the decrease of the subnasal-H line distance with age was not found to be statistically significant either in girls or boys. Genecow *et al*. (1990) also reported an increase with age in the measurement of upper lip sulcus depth. On photographic studies performed on North American adult Negroes (Sushner, 1977), subnasal-H line distance was found to be 6.2 ± 2.0 mm in girls and 7.8 ± 2.8 mm in boys. However Sushner (1977) reported that the soft-tissue profiles in Negroes are more protrusive, and that Caucasian standards indicated by Ricketts (1960), Steiner (1960, 1962), and Holdaway (1983) could not be applied to non Caucasian.

There are many studies reporting that the lower lip H line distance is greater in males (Sushner, 1977; Hsu, 1993).

Conclusions

The following measurements during the observation period of both sexes were statistically significant: soft-tissue facial angle ($P < 0.01$ in girls, $P < 0.05$ in boys); nose prominence ($P < 0.001$ in girls and boys); skeletal profile convexity ($P < 0.001$ in girls, $P < 0.01$ in boys); basic upper lip thickness ($P < 0.001$ in girls and boys); upper lip thickness ($P < 0.05$ in girls, $P < 0.001$ in boys); H angle ($P < 0.001$ in girls); lower lip sulcus depth ($P < 0.001$ in girls and boys); soft-tissue chin thickness ($P < 0.001$ in girls, $P < 0.001$ in boys).

The change in Holdaway measurements in girls and boys showed similarities except for the H angle. These findings suggest that the face tends to become less convex with growth. On the other hand, upper lip base thickness and upper lip thickness showed an increase due to age in both sexes, but this increase was greater in boys than girls. The measurements of lip thickness showed that, as the child grows, the facial structures as well as other body structures enlarge.

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References

Anderson J P, Joondeph D R, Turpin D L 1973 A cephalometric study of profile changes in orthodontically treated cases ten years out of retention. Angle Orthodontist 43: 324–336

Angle E H 1899 Classification of malocclusion. Dental Cosmos 41: 350–357

Bishara S E, Peterson L C, Bishara E C 1984 Changes in facial dimensions and relationships between the ages of 5 and 25 years. American Journal of Orthodontics 85: 232–252

Burstone C J 1958 The integumental profile. American Journal of Orthodontics 44: 1–25

Flynn T R, Ambrogio R I, Zeichner S J 1989 Cephalometric norms for orthognathic surgery in black American adults. Journal of Oral and Maxillofacial Surgery 47: 30–38

Forsberg C M, Odenrick L 1979 Changes in the relationship between the lips and the aesthetic line from eight years of age to adulthood. European Journal of Orthodontics 1: 265–270

Gazılerlı Ü, İşcan H N 1980 Değişik cins ve iskeletsel sınıflamalarda Holdaway yumuşak doku ölçümlerinin değişimi. Ankara Üniversitesi, Diş Hekimliği Fakültesi Dergisi 7: 167–174

Genecow J S, Sinclair P M, Dechow P C 1990 Development of the nose and soft tissue profile. Angle Orthodontist 60: 191–198

Giray B 1985 Büyüme ile Holdaway yumuşak doku ölçümünün değişimi. Ankara Üniversitesi, Diş Hekimliği Fakültesi Dergisi 12: 27–37

Giray B, Altuğ Z 1985 Yüz estetiği ve iskelet doku. Marmara Üniversitesi, Diş Hekimliği Fakültesi Dergisi. 1: 32–43

Göyenç Y, Karadede M I, Şener E, Baran S 1992 Dişsel Cl I, iskeletsel Cl I, Cl II, Cl III ilişkili bireylerde yumuşak doku değişimleri. Türk Ortodonti Dergisi 5: 117–125

Hasund A, Wisth P J, Böe O E 1980 Der-H Winkel in der Kieferorthopädischen Diagnostik. Fortschritte der Kieferorthopädie 41: 40–46

Holdaway R A 1983 A soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Part I. American Journal of Orthodontics 84: 1–28

Holdaway R A 1984 A soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Part II. American Journal of Orthodontics 85: 279–293

Hsu B S 1993 Comparisons of the five analytic reference lines of the horizontal lip position: their consistency and sensitivity. American Journal of Orthodontics and Dentofacial Orthopedics 104: 355–360

Iwasawa T, Moro T, Nakamura K 1977 Tweed triangle and soft-tissue consideration of Japanese with normal occlusion and facial profile. American Journal of Orthodontics 72: 119–127

Jenatschke V F 1977 Wachstumsprognose-retrospektiv. Fortschritte der Kieferorthopädie 38: 17–29

Lew K K K, Ho K K, Keng S B, Ho K H 1992 Soft-tissue cephalometric norms in Chinese adults with aesthetic facial profiles. Journal of Oral and Maxillofacial Surgery 50: 1184–1189

Mamandras A H 1988 Linear changes of the maxillary and mandibular lips. American Journal of Orthodontics and Dentofacial Orthopedics 94: 405–410

Mauchamp O, Sassouni V 1973 Growth and prediction of the skeletal and soft tissue profiles. American Journal of Orthodontics 64: 83–94

Merrifield L L 1966 The profile line as an aid in critically evaluating facial aesthetics. American Journal of Orthodontics 52: 804–822

Mink J R 1963 A soft-tissue analysis of the face in the mixed dentition. Journal of Dentistry for Children 30: 263–271

Nanda R S, Meng H, Kapilla S, Goorhuis J 1990 Growth changes in the soft tissue facial profile. Angle Orthodontist 60: 177–190

Neger M 1959 A quantitative method for the evaluation of the soft-tissue facial profile. American Journal of Orthodontics 45: 738–751

Park Y C, Burstone C J 1986 Soft tissue profile fallacies of hard tissue standards in treatment planning. American Journal of Orthodontics 90: 52–62

Peck H, Peck S 1970 A concept of facial esthetics. Angle Orthodontist 40: 284–318

Ricketts R M 1960 A foundation for cephalometric communication. American Journal of Orthodontics 46: 330–357

Riedel R A 1950 Esthetic and its relation to orthodontic therapy. Angle Orthodontist 20: 168–178

Schugg R 1985 Die neue Holdaway-Analyse bei anatomisch korrekter Okklusion. Fortschritte der Kieferorthopädie 46: 288–298

Seren E 1990 Normal okluzyonlu bireylerde iskeletsel profil ile yumuşak doku profilinin sefalometrik olarak karşılaştırılması. Türk Ortodonti Dergisi 3: 78–84

Steiner C C 1960 The use of cephalometrics as an aid to planning and assessing orthodontic treatment. American Journal of Orthodontics 46: 721–735

Steiner C C 1962 Cephalometric as a clinical tool. In: Kraus B S, Riedel R A (eds) Vistas in orthodontics. Lea and Febiger, Philadelphia, pp. 131–161

Subtelny J D 1961 The soft-tissue profile, growth and treatment changes. Angle Orthodontist 51: 105–122

Subtelny J D, Rochester N Y 1959 A longitudinal study of soft tissue facial structures and their profile characteristics,

defined in relation to underlying skeletal structures. American Journal of Orthodontics 45: 481–507

Sushner N I 1977 A photographic study of the soft tissue profile of the Negro population. American Journal of Orthodontics 72: 373–385

Wisth P J 1972 Changes of the soft tissue profile during growth. Transactions of the European Orthodontic Society, pp. 123–131

Yücel-Eroğlu E 1991 Normal ve anomalili erişkin bireylerde yumuşak doku profilinin değerlendirilmesi. Doktora tezi. Gazi Üniversitesi Sağlık Bilimleri Enstitisü Ortodonti Anabilim Dalı, Ankara

Zylinski C G, Nanda R S, Kapila S 1992 Analysis of soft tissue facial profile in white males. American Journal of Orthodontics and Dentofacial Orthopedics 101: 514–518