Assessment of Köle Analysis (Tuinzing Modification) in Mosul City (A Cephalometric Study)

ABSTRACT

Aims: The aim of this study is to assess Köle analysis (Tuinzing modification) for determining the possible positions of chin (soft and hard tissue) in skeletal Cl.I, Cl.II and Cl. III type of malocclusion of adult age group and for both genders. **Materials and Methods:** The study was carried out on the lateral cephalometric radiograph of (118) subjects of adult age group (18-25) years old; Cl I type (28 male and 19 female), Cl II type (19 male and 17 female) and Cl III type (18 male and female 17). SNA, SNB and ANB were used to estimate the type of skeletal malocclusion. For the analysis, 2 lines perpendicular to SN line are drawn touching the most anterior point of the upper lip-Ls (upper lip plane) and one from the infra orbital point-Or (orbital plane). The position of the chin points (hard and soft tissue) were assessed via determining the position of (Pog and Pg) respectively in relation to these two vertical planes using five scores: Score 1: give to the chin point that situated posterior to orbital plane. Score 2: give to the chin point that situated in a touch with orbital plane. Score 3: give to the chin point that situated in between orbital plane and upper lip plane. Score 4: give to the chin point that situated in a touch with upper lip plane. Score 5: give to the chin point that situated anterior to the upper lip plane. **Results:** The positions of Pog and Pg: Cl I mainly at score (2 and 3) respectively, Cl II mainly at score (1and 2) respectively and Cl III type Pog gave rise to slight increase of score (3 than 2) while Pg gave rise to slight increase of score (3 than 5) with no significant difference between genders for all classes. **Conclusions:** Köle analysis (Tuinzing modification) may be valuable for determining chin (soft and hard tissues) of Cl I, Cl II and Cl III types of malocclusion of adult age group and for both genders.

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The protrusive chin is a uniquely human trait, lacking in all other primates and in hominid ancestors.[1] A harmonious soft tissue profile, an important treatment goal in orthodontics, is sometimes difficult to achieve, partly because the soft tissue overlying the teeth and bones is highly variable in its thickness.[2]

Orthodontic treatment improves lip form and increases the soft tissue chin thickness. However, the contribution of variation in hard tissues to the soft tissue profile is not fully understood.[3, 4] Ssoft–tissue changes associated with orthognathic surgery have been studied primarily in mandibular procedures. The influence of maxillary procedures on the relationship of hard–tissue to soft–tissue is less well documented.[5] Clearly, there is an increased interest in

soft–tissue changes made possible by the combined efforts of maxillofacial surgery and orthodontics.[6]

In 1959, Köle presented a technique that combined orthodontics with ‘‘corticotomy’’ surgery to increase the rate of tooth movement.[7, 8, 9, 10]

The aim of this study is to assess Köle analysis (Tuinzing modification) for determining the possible positions of chin (soft and hard tissue) in relation to surrounding structures of skeletal Cl I, Cl II and Cl III types of malocclusion of adult age group and for both genders.

MATERIALS AND METHODS

A total of 509 Iraqi patients attended from various regions of Mosul City, the study was carried out on the cephalometric of (118) subjects were selected from computer of digital radiography system (Planmeca dimaxis version 3) including adult age group ranging from (18–25) years old for both genders distributed over the three classes of malocclusion (Cl I, Cl II and Cl III) as the followings; 47 subjects had Cl I type (28 subjects were males and the females were 19), 36 subjects had Cl II type of malocclusion (19 subjects were males and the females were 17) and the remaining were (35) subjects had Cl III type of malocclusion (18 subjects were males and the females were 17). The inclusive criteria of selection for those subject were: Class I "molars and canines" relations, Class II "molars and canines" relations and Class III "molars and canines" relations for Cl I, Cl II and Cl III types of skeletal malocclusion respectively, no orthodontic treatment; full set of permanent dentition in both jaws excluding third molars; normal over jet and over bite about (2–4mm, more than 4mm and reverse over jet for Cl I, Cl II and Cl III types of skeletal malocclusion respectively) and finally no massive proximal caries or fractured anterior teeth.

The identifications of cephalometric points and corresponding lines of this study were made directly on computer of Central system for each subject, then angular measurements were made via special program (Dimaxis Planmeca Pro) which were supplied in this computer.

These points including: 4 hard tissues points; Sella (S): the center of sella tursica,[11,12] Nasion (N)–the most anterior point of the frontonasal suture.[13] Bony pogonion (Pog)–the most anterior point of the bony chin in the median plane (unilateral)[14] and finally orbitale (Or)–the lowest point in the inferior margin of the orbit[11] and two soft tissue points; Soft tissue pogonion (Pg)– Most prominent point on the soft tissue contour of the chin,[15,16] labrale superius (Ls) – the median point in the upper margin of the upper membranous lip.[11] Three lines are used one horizontal; Sella–Nasion (SN) Represents the anteroposterior extent of the anterior cranial base ([11] according to Steiner analysis (a three angles were used (SNA, SNB and ANB) to estimate the type of skeletal malocclusion, where the difference between SNA and SNB–the ANB angle– indicates the magnitude of the skeletal jaw discrepancy[17], whether Cl I, Cl II or Cl III, where (SNA: 82±2º, SNB : 78±2 º and ANB: 2–4º for Cl I group), (SNA:> 82º, SNB:<76 and/or ANB: >4º for Cl II group) and (SNA: < 80º, SNB: >80 º and/or ANB: <2º for Cl III group).[17, ,18,19, 20] For the analysis of soft tissue profile a modification of the köle analysis can be used where lines perpendicular to SN line are drawn touching the most anterior point of the upper lip–Ls (upper lip plane) and one from the infra orbital point–Or (orbital plane).[21] The position of the chin points (hard and soft tissue) may be determined via locating the position of (Pog and Pg) respectively in relation to these two vertical planes by using five scores:

Score 1: give to the chin point that situated posterior to orbital plane.
Score 2: give to the chin point that situated in a touch with orbital plane.
Score 3: give to the chin point that situated in between orbital plane and upper lip plane.
Score 4: give to the chin point that situated in a touch with upper lip plane.

Score 5: give to the chin point that situated anterior to the upper lip plane.

Statistical package for the social science (SPSS) program was used to analyze the data to obtain descriptive analysis for SNA, SNB and ANB in addition to the resultant scores of chin positions. Comparison regarding positions of Pog and Pg of males versus females or within each gender for Cl I, II and III types of Malocclusions using Mann–Whitney test and Kruskal–Wallis Test respectively, in addition between Pog and Pg within each gender using Wilcoxon Signed Ranks Test. Finally regression analysis to test the relation between SNA, SNB and ANB angles (which represent relation of mandible and maxilla with each other and with cranial base respectively) and the position of Pog and Pg at $p \leq 0.05$ level of significance.

RESULTS

Descriptive analysis of SNA, SNB and ANB angles for Cl I, Cl II and Cl III types of malocclusion of male and female samples were shown in Table (1). While the descriptive analysis involved means, percentage and standard deviations for the scores of bony Pog point and soft tissue Pg point for each gender and type of malocclusion were shown in Table (2) where bony Pog point of male and female samples shown higher percentage of score 2 and lower one at score 1, while score(3,4 and 5) didn't record in Cl I group , but the opposite in Cl II group, were shown a higher percentage of score 1 and lower one at score 2, also score (3,4 and 5) didn't record in Cl II group, on other side in Cl III group, were shown a slightly higher percentage (of score 3for male and score 2 for female sample) and the opposite for lower one. Also in the last Table the soft tissue Pg point of male and female samples were shown a highest percentage of score 3 and lowest one at score 2 in Cl I group, but exactly the opposite in Cl II group, on other side in Cl III group, were shown a slightly higher percentage of score 3 and a lower percentage of score 5.

Table (1): Descriptive analysis of SNA, SNB and ANB angles for Cl I, Cl II and Cl III type Of malocclusion of male and female samples.

CLASS	SEX	N	angle	Min.	Max.	Mean ± SD
CL.I	M	28	SNA	80	82	80.93±0.86
			SNB	76	80	78.04±1.37
			ANB	2	4	2.89±0.69
	F	19	SNA	80	84	81.53±1.12
			SNB	77	80	78.68±1.11
			ANB	2	4	2.84±0.69
Cl.II	M	19	SNA	79	88	83.42±2.59
			SNB	73	80	76.84±2.22
			ANB	5	10	6.58±1.50
	F	17	SNA	78	88	83±3.35
			SNB	73	81	77.06±2.51
			ANB	5	9	6.09±1.52
Cl.III	M	18	SNA	74	85	79.78±3.37
			SNB	76	88	81.83±3.87
			ANB	–10	0.0	–2.06±2.31
	F	11	SNA	74	84	79.45±3.08
			SNB	77	96	83.73±4.69
			ANB	–18	–1	–4.29±4.92

Table (2): Descriptive analysis involved means, percentage and standard deviations for the scores of bony Pog point and soft tissue Pg point for each gender and type of malocclusion.

CLASS	SEX	N	Mean ± SD	Scores (percentage of frequency) 1	2	3	4	5
Bony Pog point								
CL.I	**M**	28	1.96±0.19	4%	96%	—	—	—
	F	19	1.95±0.23	5%	95%	—	—	—
Cl.II	**M**	19	1.16±0. 37	84%	16%	—	—	—
	F	17	1.23±0.43	76%	24%	—	—	—
Cl.III	**M**	18	2.61±0.50	—	39%	61%	—	—
	F	11	3.45±0.52	—	55%	45%	—	—
Soft tissue Pg point								
CL.I	**M**	28	2.96±0.19	—	4%	96%	—	—
	F	19	2.95±0.23	—	5%	95%	—	—
Cl.II	**M**	19	2.32±0.48	—	68%	32%	—	—
	F	17	2.23±0.43	—	76%	24%	—	—
Cl.III	**M**	18	3.89±1.02	—	—	56%	—	44%
	F	11	3.91±1.04	—	—	55%	—	45%

In Table (3) comparison regarding the means of scores of bony Pog points and soft tissue Pg points of males versus females for each type of malocclusions using Mann–Whitney test were shown a non significant difference at $p \leq 0.05$. In Table (4) the results of the comparison of the means of scores of bony Pog points and soft tissue Pg points of each gender regarding different type of malocclusions using Kruskal–Wallis test were shown significant difference at $p \leq 0.05$.

Table (3): Comparison regarding the means of scores of bony Pog points and soft tissue Pg points of males versus females for each type of malocclusions.

Variables	SEX	N	CLASS	Z–value
Bony Pog point	**M vs.F**	47	**Cl I**	–0.28 NS
		36	**Cl II**	–0.58NS
		29	**Cl III**	–0.80 NS
Soft tissue Pg point	**M vs.F**	47	**Cl I**	–0.28 NS
		36	**Cl.II**	–0.83 NS
		29	**Cl.III**	–0.05 NS

NS: not significant.

Table (4): Comparison of the means of scores of bony Pog points and soft tissue Pg points of each gender regarding malocclusions difference.

Variables	SEX	N	CLASS	Chi–Square
Bony Pog points	M	28	Cl I	46.33*
		19	Cl II	
		18	Cl III	
	F	19	Cl I	28.47*
		17	Cl II	
		11	Cl III	
Soft tissue Pg points	M	28	Cl I	43.72*
		19	Cl II	
		18	Cl III	
	F	19	Cl I	28.48*
		17	Cl II	
		11	Cl III	

*Significant Difference at $p \leq 0.05$.

In Table (5) the results of the Comparison between the means of scores of Bony Pog points and Soft tissue Pg points of each gender at each type of Malocclusions using Wilcoxon Signed Ranks Test were shown significant difference at $p \leq 0.05$. In Table (6) the results of the Regression Analysis that test the effect of SNA, SNB, and ANB angles on the means of scores of Bony Pog points were shown different level of significances with different level of R2 (R Square) where Cl I group of male and female samples were shown the lowest R2 but the Cl III group of male and female samples were shown the highest one and Cl II group were in between them.

Table (5): Comparison between the means of scores of bony Pog points and Soft tissue Pg points of each gender at each type of Malocclusions.

CLASS	N	Sex	Z–Value
Cl.I	56	M	–5.29*
Cl.I	38	F	–4.36*
Cl.II	38	M	–3.64*
Cl.II	34	F	–4.12*
Cl.III	36	M	–3.51*
Cl.III	22	F	–3.02*

*Significant difference at $p \leq 0.05$

Table (6): Regression Analysis between the means of scores of Bony Pog points and (SNA, SNB and ANB angles) at corresponding gender and type of Malocclusions.

	Variables	FEMALE Coefficient	F–Value	R2	MALE Coefficient	F–Value	R2
Cl I	**Bony Pog point**	–4.4	1.28	14%	1.44	1.41 NS	10%
	SNA	—**			0.01		
	SNB	0.08			—**		
	ANB	0.02			–0.08		
Cl II	**Bony Pog point**	–3.05	1.04NS	19%	–5.10	3.71 NS	32%
	SNA	0.04			0.09		
	SNB	0.02			0.07		
	ANB	–0.18			—**		
Cl III	**Bony Pog point**	–8.67*	5.22*	57%	–6.70*	12.37*	62%
	SNA	0.14*			0.12*		
	SNB	—**			—**		
	ANB	–0.04 NS			–0.06 NS		

*Significant Difference at $p \leq 0.05$.
** Excluded Variable.

In Table (7) the results of the regression analysis that test the effect of SNA, SNB, and ANB angles on the means of scores of soft tissue Pg points were also shown different level of significances with different level of R2 where female samples of Cl I group were shown the lower R2 but the Cl III group were shown the higher one and Cl.II group were also in between them. On other side male samples of Cl I group were shown the lower R2 but the Cl II group were shown the higher one and Cl III group were also in between them.

Table (7): Regression analysis between the means of scores of soft tissue Pg points and (SNA, SNB, and ANB angles) at corresponding gender and type of malocclusions.

	Variables	FEMALE Coefficient	F–value	R2	MALE Coefficient	F–value	R2
Cl I	**Soft tissue Pg point**	–3.36	1.28 NS	14%	2.44	1.41 NS	10%
	SNA	—**			0.01		
	SNB	0.08			—**		
	ANB	0.02			–0.08		
Cl II	**Soft tissue Pg point**	–2.05	1.04 NS	19%	0.84	0.35	42%
	SNA	0.05			—**		
	SNB	0.02			0.01		
	ANB	–0.19			0.06		
Cl III	**Soft tissue Pg point**	–18.34*	5.22*	57%	–8.26	2.57 NS	26%
	SNA	0.28*			0.15*		
	SNB	—**			—**		
	ANB	–0.08			0.007		

*Significant Difference at $p \leq 0.05$.
** Excluded Variable.

DISCUSSIONS

The findings were indicated that samples means of (SNA, SNB and ANB) for selecting Cl I, Cl II and Cl III type of Malocclusion of male and female samples were in agreement with criteria of many studies.[17, ,18,19, 20)]

The male and female samples findings (percentage of frequency) of Scores were shown at Cl I group the Soft tissue Pg point gave rise to the highest percentage of frequency at score 3 and bony Pog at score 2 and this is in agreement with Tuinzing *et al*.[21] who reported that the chin specially (soft tissue) should be situated approximately in the middle of these two vertical lines. At Cl II group, the Soft tissue Pg and bony Pog gave rise to score 2 and score 1 respectively, while at Cl III group, soft tissue Pg point gave rise to (score 3to score 5) and bony Pog gave rise to (score 2 to score 3), these may be an indication of the changes in the anterior–posterior position of the most anterior point of the mandible (Pogonion) among different type of skeletal malocclusion.[22]

The findings of Comparison for means of scores of males versus females for the latter points regarding each type of Malocclusions were shown a non significant difference and this is in agreement with study of Graber,[19] Bishara and Jakobsen[23]. A Comparison of each gender regarding the three classes of skeletal malocclusions were shown significant difference, this may be due to the change in position of pogonion where posterior movement of pogonion because of the backward mandibular rotation as in Cl II group.[15]

The results of the Comparison between the means of scores of Bony Pog points and Soft tissue Pg points of each gender at each type of Malocclusions gave rise to significant difference of variable scores, where Radney and Jacobs[5] reported that soft–tissue changes were related to bony changes. These variations result not only from imbalance of the dental and skeletal structures but from individual variations in the thickness and tension of the soft tissues at different type of skeletal malocclusion.[2]

The result of the regression analysis that test the effect of ANB, SNA and SNB angles (which represent maxillomandibular relation in between and with cranial base structure respectively) on the means of scores of Bony Pog points and soft tissue Pg points were shown different levels of significance with different levels of R2 (R Square) at each type of malocclusions, such variations of R2 may be related to many rather than single factors influencing chin (soft and hard tissues) positions in relation to surrounding craniofacial structures where the skeletal unit of the chin may be an expression of the functional forces exerted by the lateral pterygoid muscles that, in pulling the mandible forward. The reduction in thickness at the soft tissue chin may have been due to the increase in the anterior face height and a small increase in the mandibular plane angle, causing slight stretching of the soft tissue over the chin.[24]

CONCLUSIONS

It can be concluded from this study that Köle analysis (Tuinzing modification) may be valuable for determining chin (soft and hard tissues) for Cl I, Cl II and Cl III type of malocclusion of adult age group and for both genders, these via locating the chin positions in relation to two vertical lines were drawn on tracing paper of lateral cephalometric radiograph at level of orbital point and the prominent point of upper lip.

REFERENCES

1. Sperber GH. Craniofacial development. BC Decker Inc. 2001; Pp: 133.
2. Kasai K. Soft tissue adaptability to hard tissues in facial profiles.*Am J Orthod Dentofacial Orthop*.1998: 674– 684.
3. Lo FD, Hunter WS. Changes in nasolabial angle related to maxillary incisor retraction. *Am J Orthod*. 1982; 82: 384–91 .
4. Singh RN. Changes in the soft tissue chin after orthodontic treatment. *Am J Orthod Dentofacial Orthop*. 1990; 98: 41–6 .
5. Radney, Jacobs. Soft–tissue changes and maxillary intrusion. *Am J Orthod Dentofacial Orthop.* 1981: 191–212.
6. Mansour, Burstone, and Legan. Soft–tissue changes resulting from Le Fort I maxillary surgery. *Am J Orthod Dentofacial Orthop*. 1983: 37–47.
7. Linoa S, Sakodab S, Miyawakic S. An adult bimaxillary protrusion treated with corticotomy–facilitated orthodontics and titanium miniplates. *Angle Orthod*. 2006; 76(6): 1074–1082.
8. Moon C, Wee J, Lee H. Intrusion of overerupted molars by corticotomy and orthodontic skeletal anchorage. *Angle Orthod.* 2007; 77(6): 1119–1125.
9. Tuncer C, Ataç M, Tuncer B, Kaan E. Osteotomy assisted maxillary posterior impaction with miniplate anchorage. *Angle Orthod.* 2008; 78(4): 737–744.
10. Kurt G, Iseri H, Kisnisci R. Rapid tooth movement and orthodontic treatment using dentoalveolar distraction (DAD) long–term (5 years) follow–up of a Class II case. *Angle Orthod*. 2010; 80: 597–606.
11. Athanasiou AE. Orthodontic cephalometry. Mosby–Wolfe. 1995; Pp: 47.
12. White MC, Pharoah MJ. Oral rdiography, principles and interpretation. 4th ed. Mosby. 2000; P:197.
13. Yokoo S, Komori T, Furudoi S. Orthognathic surgery for occlusal reconstruction of old malunited jaw fracture *Kobe J Med Sci.* 2006; 52(3): 37–47.
14. Swennen GR, Schutyser F, Hausamen J. Three–dimensional cephalometry. A color atlas and manual. Springer–Verlag. Berlin. 2006; P:165.
15. Bishara SE. Textbook of orthodontics. WB.Saunders Co. 2001; Pp:43–53 .
16. Meneghini F. Clinical facial analysis, elements, principles and techniques. Springer. 2002; P: 141.
17. Proffit WR, Fields HW, Sarver DM. Contemporary orthodontics. 4th ed. CV Mosby Company. 2007; P: 208.
18. Mitchell L. An introduction to orthodontics. 3rd ed. Oxford. 2007; P: 64.
19. Graber TM, Vanarsdall BF. Orthodontics current principles and techniques. 3rd ed. CV Mosby Co. 2000; Pp: 37, 957.
20. Daskalogiannakis J. Glossory of orthodontics terms. Co Inc. 2000; P: 165.
21. Tuinzing DB, Greebe RB, Dorenbos J, Becking AG. Surgical orthodontics, classification, diagnosis and treatment. Elsevier. 2005; Pp: 25–26
22. RMO. Diagnostic Services on CD–ROM. P: 42.
23. Bishara SE, Jacobson JR. A longitudinal changes in three normal facial types. *Am J Orthod.* 1985; 88: 466–502.
24. Nanda, Currier. Longitudinal changes in the adult facial profile. 1994: 464 – 476.