 EÜ Dişhek Fak Derg 2011; 32: 91-95

Association between Clinical Crown Length and Vertical Growth Pattern

Gökhan ÖNÇAĞ **Arzu KARDEŞLER** **Servet DOĞAN**

Ege University Dentistry Faculty Department of Orthodontics, İZMİR

Abstract

To evaluate the association between the clinical crown length and the vertical growth pattern. Subjects (n=174), aged between 14 and 17, were divided into 3 groups. Patients' cephalometric graphies were taken with Digora Optime (Sorodex corp., Finland) and Dolphin Imaging V.10 software (Dolphin Imaging and Management Solutions, Chatsworth, USA) was used for analysis. To evaluate the vertical growth; SNGoGn, sum of posterior angles and jarabak ratio were measured. Groups were defined as normal, hypodivergent and hyperdivergent according to their vertical growth measurements. Stone models scanned and 3D digital images saved with Orthomodel digital orthodontic model software (Orthomodel, Istanbul, Turkey). Clinical crown lengths of 12 teeth were measured on both upper and lower jaws with orthomodel software program. When compared with the normal group, the clinical crown lengths of teeth numbered 16,23,26,32 were statistically higher in hyperdivergent group (p=0.004, p=0.001, p=0.001, p=0.0036, respectively). The mean ratio of upper anterior segment in hyperdivergent group was significantly higher than normal (p=0.021) group and the mean ratio of upper anterior segment, lower anterior segment and upper posterior segment in hyperdivergent group were significantly higher than the hypodivergent group (p=0.008, p=0.006, p=0.007 respectively). Results showed that the growth pattern appears to effect the clinical crown lengths. Therefore, while planning the treatment, clinical crown length evaluation should be taken into account with the other factors.

Keywords: *Vertical growth pattern, clinical crown length, 3d imaging*

Introduction

During the growth and development, there is a balance between the regions that are related with tooth-jaw-face system. However, changes in vertical dimensions generally lead to orthodontic problems.[1]

Alterations in vertical growth pattern are more effective in morphological face type formation than the antero-posterior directional changes.[2]

It is generally accepted by the orthodontists that there is a relationship between vertical growth pattern and vertical facial morphology. According to Leon Williams' "geometric theory" (which correlates tooth form and the shape of the face) the tooth form is in accordance with the shape of the face.[3]

Both condylar growth and sutural and alveolar development play crucial roles in the formation of the facial skeleton. Differentiated growth in those structures is particularly effective in vertical development of the facial charecteristics.[4] The anterior facial height is increased or decreased by the compensatory growth pattern of the nasoalveolar bone and the dental eruption. The divergent growth pattern of the facial bones allows the vertical growth of the dentoalveolar components.[5]

Extreme vertical facial types are often accompanied by an abnormal vertical development of the posterior dentoalveolar region. Excessive posterior dentoalveolar heights are frequent in long-face syndrome.[6,7,8] Anterior lower facial height length has a positive influence on molar dentoalveolar height measures and this result supports the positive correlation between dentoalveolar and craniofacial heights.[6]

Alveolar structure plays a compensatory role in establishing vertical maxillomandibular relationships.[4] In a longitudinal implant study,

Kabul Tarihi: 13.07.2011

Bjork and Skieller[7,9] found that posterior rotational growth pattern is accompanied by a reduction in eruption of molar teeth, which has been concluded as a compensatory mechanism. Betzenberger et al.[10] reported reductions in maxillary and mandibular posterior dentoalveolar heights in permanent dentition in high-angle malocclusions. The relationship between the jaws is maintained through the eruption and positioning of the teeth along their own basal arches.[4] This process is referred as the "dentoalveolar compensatory mechanism."[9] When this compensation is restrained for any reason, a skeletodental malocclusion occurs.[9,11,12] Thus, the relationship between vertical facial development and posterior dentoalveolar heights is still a matter of debate.[6]

In addition, it has been suggested that vertical growth induces active eruption of posterior teeth, which continues after completion of eruption and root formation.[13]

This study was designed to determine the relationship between the clinical crown lengths and vertical growth pattern. The null hypothesis that there is no difference in clinical crown lengths between various growth patterns.

Materials and Methods

Study Population

The cases were chosen from the patient population, visited the Department of Orthodontics, Ege University, Izmir, Turkey. A total of 174 subjects, whom accomplished their growth and development (aged between 14 and 17), were recruited for this single-centred cross sectional study.

Patients' cephalometric graphies were taken with Digora Optime (Sorodex corp., Finland) and Dolphin Imaging V.10 software (Dolphin Imaging and Management Solutions, Chatsworth, USA) was used for analysis. To evaluate the vertical growth; SNGoGn, sum of posterior angles (sella, articulare, gonial) and jarabak ratio were measured. Groups were formed according to their vertical growth measurements: normal group (n:59), hyperdivergent group (n:62) and hypodivergent group (n:53) (Table 1).

Table 1. Characteristics of study population

	Hypodivergent Group	Hyperdivergent Group	Normal Group
n	53	62	59
Gender (male/female)	26/27	31/31	30/29
Age	14-17	14-17	14-17

No statistical difference between groups ($p>0.05$)

Measurements

Alginate impressions were taken and stone models of all patients were scanned. 3D digital images were saved with Orthomodel digital orthodontic model software (Orthomodel, Istanbul, Turkey). Teeth with periodontal diseases (gingival hyperplazia, periodontitis, localized gingival recession); broken margins, restorations, size and shape malformations which can effect clinical crown length were excluded. Also patients with congenital tooth loss were excluded from the study.

Clinical crown lengths of 12 teeth were measured on both upper and lower jaws by using orthomodel software program (Orthomodel, Istanbul, Turkey). Both upper and lower jaws were also divided into 3 segments as upper/lower anterior (between canines) and upper/lower posterior (premolars and molars). Mean ratios of these segments were also compared between the 3 study groups. The distance between the most apical concavity of the gingival margin and incisal edge/occlusal surface was measured and the measurements of all teeth were recorded.

Statistical analysis

Group comparison data were analyzed with UNIANOVA, Student t-test and Bonferroni corrections.

Results

Study group

Study groups showed no significant differences for the age and gender proportion factors ($p>0.05$) (Table 1).

Clinical measurements

According to statistical analysis, the mean ratios of the teeth numbered 16, 23, 26 and 32 in hyperdivergent group were significantly higher than the normal group (p= 0.04, p=0.01, p=0.01, p=0.036 respectively). Mean ratio of 14 and 43 numbered teeth were significantly higher in normal group than hypodivergent group (p=0.016, p=0.019 respectively). In hyperdivergent group teeth with numbers 13, 14, 23, 41 and 42 had significantly higher mean clinical crown ratios than hypodivergent group (p=0.008, p=0.001, p=0.005, p=0.018, p=0.001 respectively) (Table 2, Table 3).

When the jaw segments were compared, the mean ratio of upper anterior segment in hyperdivergent group was significantly higher than normal (p=0.021) and hypodivergent groups' (p=0.008) ratios. The mean ratio of lower anterior segment and upper posterior segment of hyperdivergent group were significantly higher than the hypodivergent group (p=0.006, p=0.007 respectively). There was no significant difference in lower posterior segment mean ratio between groups (p>0.05) (Table 4).

Table 2. Clinical crown lengths of upper teeth (mm)

	16	15	14	13	12	11	21	22	23	24	25	26
Hypodivergent	4.79	5.46	6.23	7.94	7.03	8.90	8.81	7.04	8.13	6.56	5.46	4.69
Std Deviation (±)	0.64	0.74	0.82	1.10	0.83	0.85	0.83	0.82	1.19	0.86	0.75	0.91
Hyperdivergent	5.08*	5.78	6.74***	8.55***	7.33	9.11	9.22	7.27	8.84**	6.92	5.77	5.02*
Std Deviation (±)	0.92	0.76	0.72	1.01	0.86	0.99	0.81	0.83	1.15	0.80	0.82	1.03
Normal	4.74	5.59	6.64***	8.20	7.06	8.88	8.84	7.10	8.20	6.64	5.60	4.79
Std Deviation (±)	0.68	0.68	0.70	1.06	0.65	0.88	1.13	0.84	1.21	0.82	0.96	0.90

* Significantly higher than normal group (p<0.05)
** Significantly higher than normal and hypodivergent groups (p<0.05)
*** Significantly higher than hypodivergent group (p<0.05)

Table 3. Clinical crown lengths of lower teeth (mm)

	36	35	34	33	32	31	41	42	43	44	45	46
Hypodivergent	5.57	6.13	6.94	8.10	7.14	7.13	7.03	6.81	7.83	6.75	6.08	5.11
Std Deviation (±)	1.11	1.04	0.90	1.08	0.82	0.84	0.89	0.73	1.13	0.88	0.96	0.56
Hyperdivergent	5.50	6.07	7.25	8.31	7.50*	7.47	7.44***	7.39***	8.32	6.85	5.91	5.26
Std Deviation (±)	0.96	0.79	0.84	1.00	0.84	0.79	0.76	0.91	0.99	0.87	0.65	0.56
Normal	5.31	6.00	7.00	8.39	7.13	7.28	7.34	7.09	8.40***	7.10	6.02	5.17
Std Deviation (±)	0.99	0.68	0.74	1.08	0.76	0.80	0.68	0.77	1.01	0.69	0.62	0.51

* Significantly higher than normal group (p<0.05)
** Significantly higher than normal and hypodivergent groups (p<0.05)
*** Significantly higher than hypodivergent group (p<0.05)

Table 4. Mean clinical crown lengths between segments (mm)

	Upper Anterior Group	Lower Anterior Group	Upper Posterior Group	Lower Posterior Group
Hypodivergent Std Deviation (±)	7.98 ± 0.72	7.35 ± 0.67**	5.53 ± 0.58**	6.12 ± 0.61
Hyperdivergent Std Deviation (±)	8.40 ± 0.68*	7.74 ± 0.61	5.88 ± 0.56	6.12 ± 0.50
Normal Std Deviation (±)	8.05 ± 0.73	7.60 ± 0.65	5.67 ± 0.58	6.10 ± 0.45

* Significantly higher than normal and hypodivergent groups (p<0.05) **Significantly lower than hyperdivergent group (p<0.05)

Discussion

To investigate the relationship between the clinical crown length and vertical growth pattern in adolescents, we planned to recruit subjects with full permanent dentition. According to the literature, age of full eruption of the teeth is 15.4±0.5 years,[13] and the true forward mandibular rotation has higher rates in childhood than adolescence.[14] Therefore the hand-wrist radiographs were taken and epiphysis-diaphysis junction was analyzed. Our study groups included patients aged between 14 and 17.

According to the results of our study, there is a correlation between the vertical growth patterns and the changes (increase-decrease) in clinical crown lengths of the hyperdivergent and hypodivergent groups with differentiated vertical growth patterns. These results showed that the increased or decreased vertical growth can be due to the absence of compensation mechanisms. Our results are correlated with the results of Bjork and Skieller[7], Betzenberger et al[9]., Solow et al.[10]. These studies show that if compensation is restrained for any reason, a skeletodental malocclusion occurs.

We found that in hyperdivergent patients with excessive backward rotation of the mandible, the increase in clinical crown lengths of posterior and anterior maxillary teeth and anterior mandibular teeth were statistically significant, but not significant between the posterior mandibular teeth. But we also found that in hyperdivergent group there was a slight increase tendency. This may due to the small sample size or the effect of regional dentoalveolar compensation mechanism could not compensate the muscle tone and the other factors which lead to malocclusions.

In contrast to the cases with weak bite forces that tend to have dolichofacial patterns, the human subjects with strong bite forces tend to have brachiofacial patterns. This difference in bite forces have led to many speculations about the etiology of vertical facial patterns. According to Proffit and Fields,[13] it is possible that the weaker bite force in dolichofacial people might allow greater eruption of the posterior teeth than might otherwise occur and so are directly related to the excessive tooth eruption and backward rotation of the mandible often seen in such subjects. It has been reported that masseter muscle thickness is correlated to vertical facial pattern, showing that individuals with thicker masseter have a vertically shorter face.[9,16,17] Our results are correlated with these studies showing that the muscle tone is weaker in hyperdivergent subjects.

Normal and abnormal facial growth and tooth eruption are topics of great importance for several dental disciplines, such as pedodontics, orthodontics, and oral and maxillofacial surgery.[12] Many authors[20.21,15] report that upper and lower anterior teeth have already overerupted in skeletal open bite cases. Therefore extruding the overerupted anterior teeth by using anterior vertical elastics to achieve an overbite has been criticized as an invalid approach for stable results.[22,23]

Among various etiologic factors, the most frequently discussed factor is the overeruption of the upper molars.[14] Björk[7] reported that there is a tendency of the distal inclination of the posterior teeth in the backward rotation pattern with adequate dentoalveolar compensation. In the treatment of open bite cases, the treatment outcomes are the alteration of occlusal planes accompanied by uprighting of the posterior teeth. Those outcomes are similar to natural dentoalveolar compensation.[14]

In our study with the individuals who didn't have adequate compensation, the clinical crown lengths were higher in the hyperdivergent group. The distal inclination of the molar teeth could have affected the increased measurement of clinical crown length. Molar inclination is a criterion for growth and development predictions.

Conclusion

To conclude, our results showed that there is a positive relationship between vertical growth pattern and clinical crown lengths, especially in hyperdivergent group. Therefore; while planning the treatment,

- Clinical crown length evaluation should be taken into account with the other factors.
- Measurement of clinical crown length can be used because of its simplicity.

Kaynaklar

1. Schudy FF. Cant of the occlusal plane and axial inclinations of teeth. *Angle Orthod* 1963; 33: 69-82.
2. Schudy FF. Vertical growth versus anteroposterior growth as related to function and treatment. *Angle Orthod* 1964; 34: 75–93.
3. L İbrahimagic V, Jerolimov A celebic, V Carec, I Baucic and DK Zlataric. Relationship between the face and the tooth form. Col. Antropol 2001; 2: 619-626.
4. Arat Z Mirzen, Meliha Rübenduz -. Changes in Dentoalveolar and Facial Heights during Early and Late Growth Periods: A Longitudinal Study. *Angle Orthod* 2004; 75: 69–74.
5. Canonn J. Craniofacial height and depth increments in normal children. *Angle Orthod* 1970; 40: 202-218.
6. Roberto Martinaa, Mauro Farellab, Renato Tagliaferric, Ambrosina Michelottid, Giuseppe Quarembab, Theo MGJ van Eijden. The Relationship between Molar Dentoalveolar and Craniofacial Heights. *Angle Orthod* 2005; 75: 974–979.
7. Björk A, Skieller V. Facial development and tooth eruption. (an implant study at the age of puberty). *Am J Orthod* 1972; 62: 339-83.
8. Bishara SE, Augspurger EF. The role of the mandibularplane inclination in orthodontic diagnosis. *Angle Orthod* 1975; 45: 273–281.
9. Solow B. The dentoalveolar compensatory mechanism: background and clinical implications. *Br J Orthod* 1980; 7: 145–161.
10. Betzenberger DO, Ruf SA, Pancherz HA. The compensatorymechanism in high-angle malocclusion: a comparison of subjects in mixed and permanent dentition. *Angle Orthod* 1999; 69: 27–32.
11. Proffit WR. Equilibrium theory revisited: factors influencing position of the teeth. *Angle Orthod* 1978; 48: 175–186.
12. Frankel R, Frankel C. A functional approach to treatment of skeletal open bite. *Am J Orthod* 1983; 84: 54–68.
13. Proffit WR, Fields HW, Ackerman JL, Bailey LJ, Tulloch JFC. Contemporary Orthodontics.3 rd Ed. Chapter 15. St. Louis, Toronto, London: The C.V. Mosby Comp. 2000.
14. Laurel R, Leslie Thomas E, Southard Karin A, Southard John S, Casko Jane R, Jakobsen Elizabeth A, Tolley Stephen L, Hillis Chris Carolan and Mark Logue. Prediction of mandibular growth rotation: Assessment of the Skieller, Björk, and Linde-Hansen method. *Am J Orthod Dentofacial Orthop* 1998; 114: 659-67.
15. Malanie K Wanga, Peter H Buschangb, Rolf Behrents. Mandibular Rotation and Remodeling Changes during Early Childhood. *Angle Orthod* 2009; 79; 10.
16. Satiroglu F, Arun T, Isik F: Comparative data on facial morphology and muscle thickness using ultrasonography. *Eur J Ortho* 2005; 27: 562-567.
17. Farella M, Bakke M, Michelotti A, Rapuano A, Martina R: Masseter thickness, endurance and exercise-induced pain in subjects with different vertical craniofacial morphology. *Eur J Oral Sci* 2003 111:183-188.
18. S. Krarup T A, Darvann P, Larsen,2 J. L. Marsh and S. Kreiborg1,2,3,5Three-dimensional analysis of mandibular growth and tooth eruption. *J Anat* 2005; 207: 669–682.
19. Schudy FF. The rotation of the mandible resulting from growth: its implications in orthodontic treatment. *Angle Orthod* 1965; 35: 36–50.
20. Nahoum HI. Vertical proportions: a guide for prognosis and treatment in anterior openbite. *Am J Orthod* 1977; 72: 128-146.
21. Wylie WL. The relationship between ramus height, dental height, and overbite. *Am J Orthod* 1946; 32: 57-67.
22. Subtelny JD, Sakuda M. Open bite; diagnosis and treatment. Am J Orthod. 1964; 50: 337-358.
23. Epker BN, Fish LC. Surgical-orthodontic correction of open-bite deformity. *Am J Orthod* 1977; 71: 278-299.

Yazışma Adresi:

Doç. Dr. Gökhan ÖNÇAĞ
Ege Üniversitesi Dişhekimliği Fakültesi,
Ortodonti AD,
35100 Bornova, İZMİR
Tel : 0 232 388 03 26
Faks : 0 232 388 03 25
E-posta : gokhanoncag@yahoo.com