Original Article

The Effect of Frankel II and Modified Twin Block Appliances on the 'C'-axis: The Growth Vector of the Dentomaxillary Complex

Stanley Braun, DDS, MME, PE[a]; Nelson R. Diers, DDS[b]; Gabriel Engel, BDS, LDS, MDSc[c]; Peter Wojtkiewicz, DMD[d]; Sabin K. Ewing, DDS[d]

Abstract: The recently determined 'C'-axis, the growth vector of the dentomaxillary complex, permits an evaluation of any meaningful growth changes thereto by the Frankel II and modified Twin Block functional appliances. Retardation of the velocity of change (mm/year) in length of the 'C'-axis did not occur. The angular relationship of the 'C'-axis to Sella-Nasion (θ) and to the palatal plane (α) were not altered in a clinically significant way. Favorable changes observed in the correction of Class II malocclusions are likely because of dentoalveolar alterations buttressed by favorable mandibular growth. (*Angle Orthod* 2004;74:749–753.)

Key Words: 'C'-axis; Dentomaxillary growth vector; Frankel II appliance; Modified Twin Block appliance; Growth modification

INTRODUCTION

The primary use of functional appliances is to influence dentofacial growth by altering mandibular posture.[1] When a Class II malocclusion results from mandibular retrognathia, positioning the mandible forward is believed to enhance its growth. However, this belief remains somewhat controversial.[2–11] Investigators have also proposed that the Class II correction observed with functional appliances was the result of a ''headgear effect'' on dentomaxillary growth.[12,13]

The recently determined 'C'-axis, the growth vector of the dentomaxillary complex, suggested this retrospective study to evaluate any meaningful changes of the dentomaxillary complex's growth vector related to the Frankel II and the modified Twin Block functional appliances.[14–16]

MATERIALS AND METHODS

Two groups of patients had been treated in two separate private practices. One group consisted of 23 females and 23 males and was treated with the Frankel II appliance. The ages of females at the onset of treatment ranged from 7.4 to 14.0 years (mean, 9.7 years). The ages of males at the onset of treatment ranged from 7.8 to 15.6 years (mean, 10.9 years). The length of Frankel II therapy extended from a minimum of 0.5 to a maximum of 2.2 years (mean, 1.4 years) in females and 0.7 to 2.8 years in males (mean, 1.4 years).

The second group, treated with the modified Twin Block appliance, comprised six females and 10 males. The ages of females at the onset of treatment ranged from 11.0 to 14.3 years (mean, 12.4 years). The ages of males at the onset of treatment ranged from 11.5 to 16.3 years (mean, 13.5 years). The length of modified Twin Block therapy extended from 0.5 to 1.6 years (mean, 0.9 years) in females and 0.7 to 1.3 years in males (mean, 0.9 years).

Lateral cephalograms (T1) were taken of all patients at the onset and at the completion (T2) of each functional-appliance treatment regimen. No other appliances were used during functional therapy. The cephalometric measurements descriptive of the growth axis of the dentomaxillary complex, shown in Figure 1, were recorded at T1 and T2.[14] One investigator made all the T1 and T2 cephalometric measurements of the Frankel-treated group, and another investigator made all the T1 and T2 cephalometric measurements of the patients treated with the modified Twin Block appliance.

Twenty T1 and T2 cephalograms (10 female, 10 male) were selected randomly from the entire Frankel II sample of 92 radiographs, and the pertinent points and planes re-

[a] Clinical Professor of Orthodontics, Vanderbilt University Medical Center, Nashville, TN.

[b] Clinical Instructor, Department of Orthodontics, Indiana University, Indianapolis, IN.

[c] Private practice, Jerusalem, Israel.

[d] Orthodontic Resident, Vanderbilt University Medical Center, Nashville, TN.

Corresponding author: Stanley Braun, DDS, MME, PE, 7940 Dean Road, Indianapolis, IN 46240
(e-mail: ortho.braun@juno.com).

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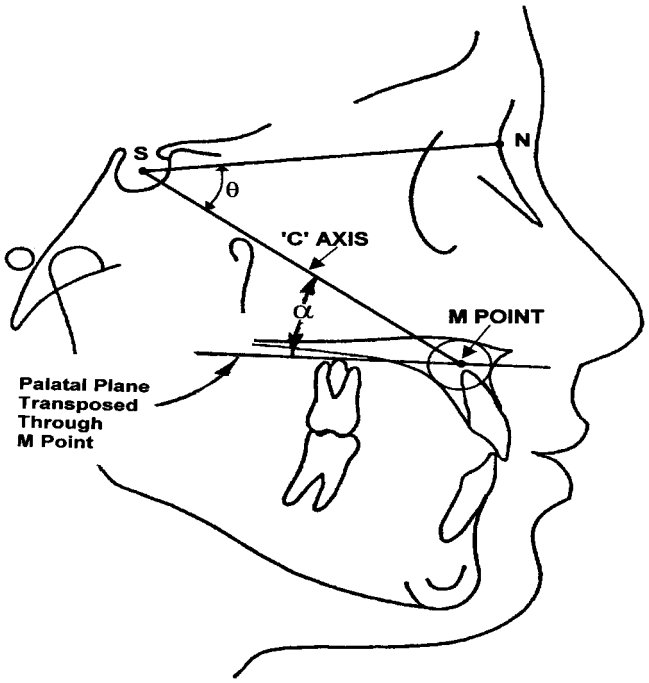

FIGURE 1. 'C'-axis cephalometric measurements.

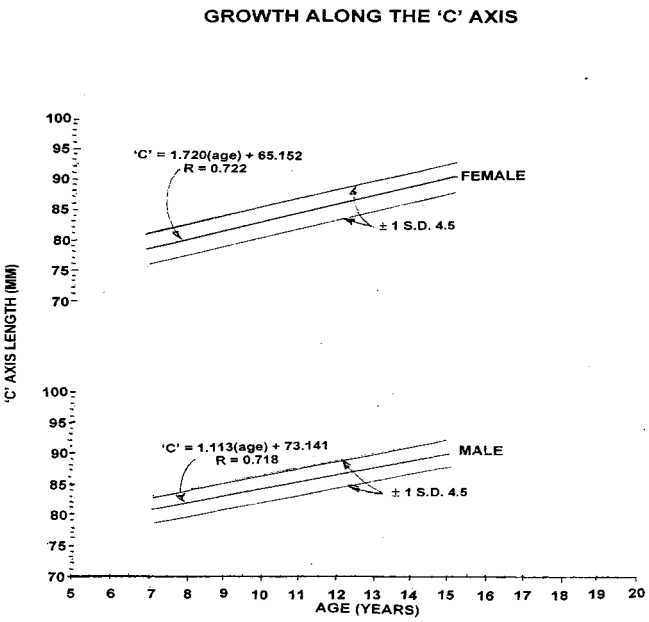

FIGURE 2. 'C'-axis length changes in patients treated with the Frankel II appliance.

measured to evaluate examiner error. Eight T1 and T2 cephalograms (three female, five male) were also selected randomly from the entire modified Twin Block sample of 32 radiographs, and the appropriate points and planes remeasured to evaluate examiner error. The variations in cephalometric measurements were determined to be 0.260% in the Frankel II sample and 0.153% in the modified Twin Block sample. All linear cephalometric measurements were

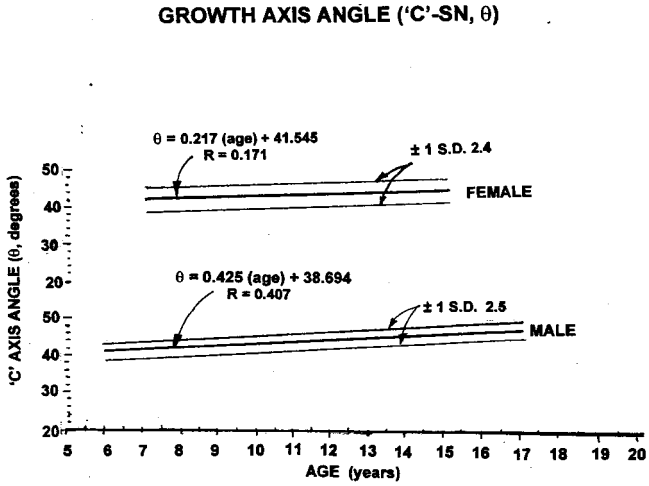

FIGURE 3. 'C'-axis angle θ ([Sella-Nasion]–[Sella-M point]) changes in patients treated with the Frankel II appliance.

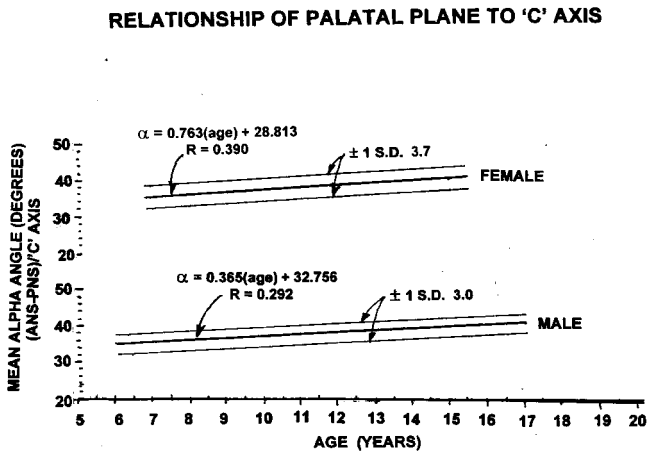

FIGURE 4. 'C'-axis angle α ([ANS-PNS]–'C'-axis) changes in patients treated with the Frankel II appliance.

normalized to a 90-mm midsagittal plane–film distance using the formula:

$$\text{corrected measurement value} = 0.065(90 - [\text{midsagittal plane–film distance}]) + \text{measurement value}.$$

RESULTS

Changes in the 'C'-axis (growth vector) linear measurements (Sella-M point), and in the angular measurements ([Sella-Nasion]–[Sella-M point]), and palatal plane–(Sella-M point) vs age for each gender in each of the participants treated with the Frankel II appliance and the modified Twin Block appliance are shown in Figures 2 through 7.

DISCUSSION

To facilitate a comparison between individuals of each gender treated in this study with normally occurring 'C'-

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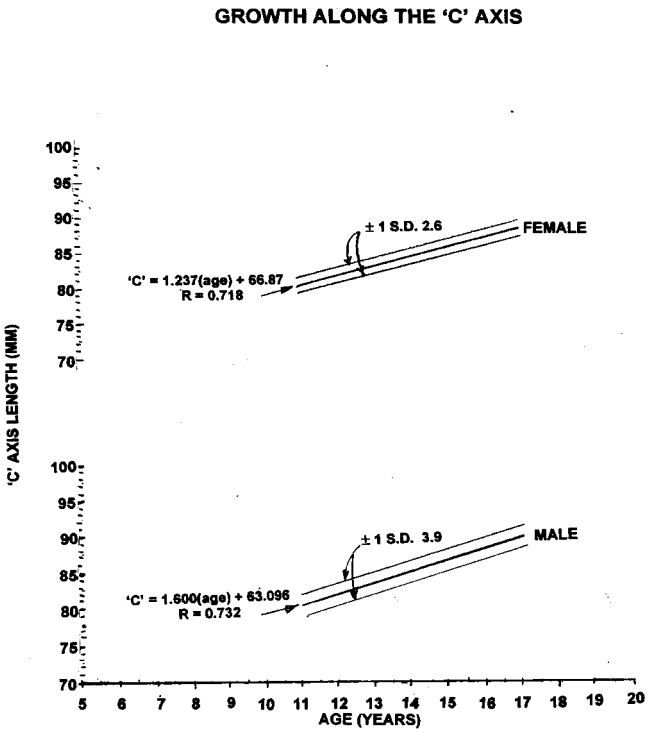

FIGURE 5. 'C'-axis length changes in patients treated with the modified Twin Block appliance.

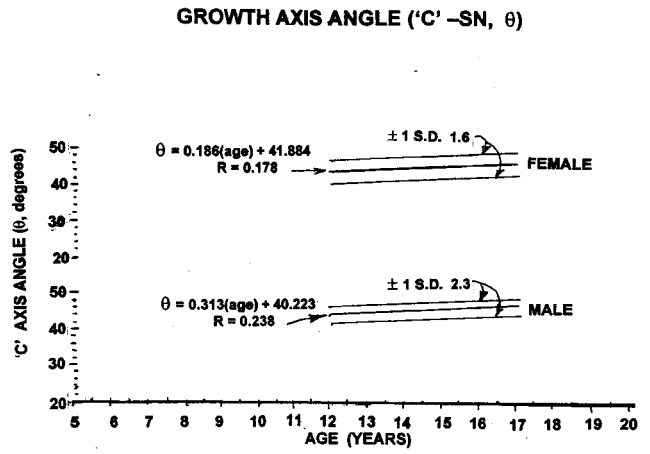

FIGURE 6. 'C'-axis angle θ ([Sella-Nasion]–[Sella-M point]) changes in patients treated with the modified Twin Block appliance.

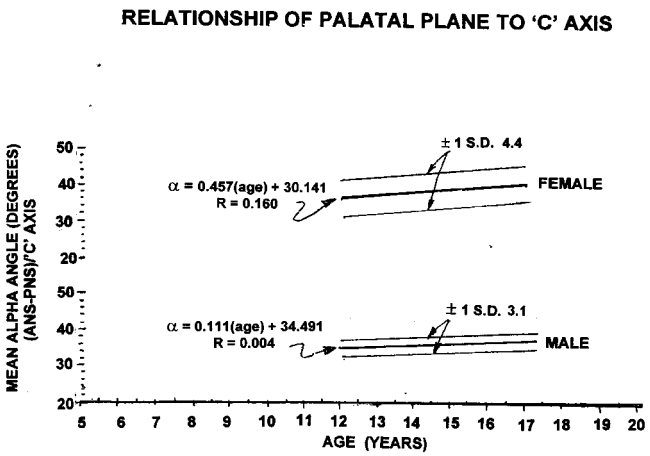

FIGURE 7. 'C'-axis angle α ([ANS-PNS]–'C'-axis) changes in patients treated with the modified Twin Block appliance.

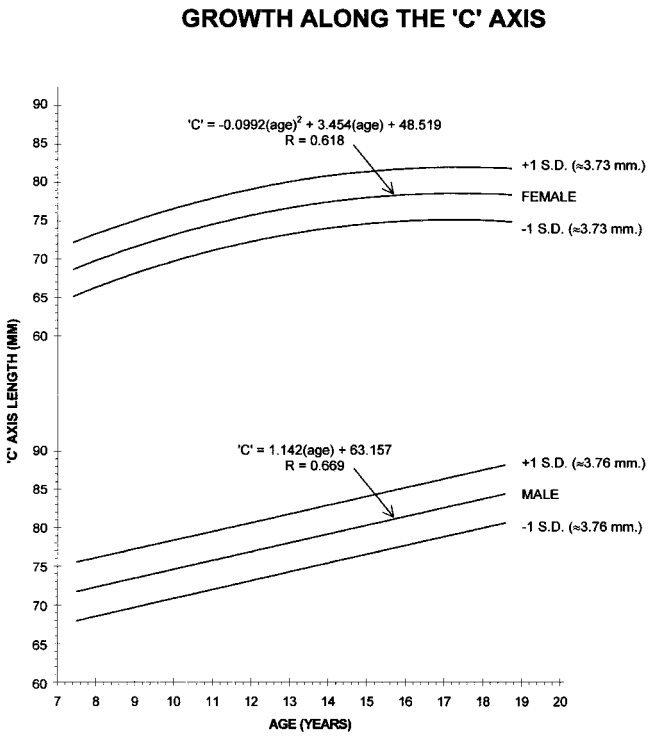

FIGURE 8. 'C'-axis length changes in nontreated males and females.

axis longitudinal growth changes in nontreated individuals, the reader is referred to Figures 8 through 10.[14]

In nontreated growing males, the 'C'-axis length increased at a mean rate of 1.14 mm/year from ages 7.4 to 18.8 years. This is determined by the slope of the linear regression formula seen in Figure 8, with a correlation coefficient (*R*) of 0.669. In nontreated growing females, the 'C'-axis length increase with age is characterized by the second-order regression formula seen in Figure 8, having an *R* of 0.618. The rate of change (velocity) of 'C'-axis length increase is given by the first derivative of this second-order equation[17]; it is velocity (mm/year) at any given age = −0.198 (age) + 3.45. Thus, the velocity of growth of the 'C'-axis may be easily computed for females at any given age.

In nontreated growing males and females, the growth-axis angle θ ([Sella-Nasion]–[Sella-M point]) increased at a velocity of 0.35°/year and 0.20°/year, respectively, from ages 7.4 to 18.8 years (Figure 9). The palatal plane angle α ([ANS-PNS]–['C'-axis]) increased 0.23°/year and 0.20°/year in nontreated growing males and females, respectively, for the same age range (Figure 10). It should be noted that

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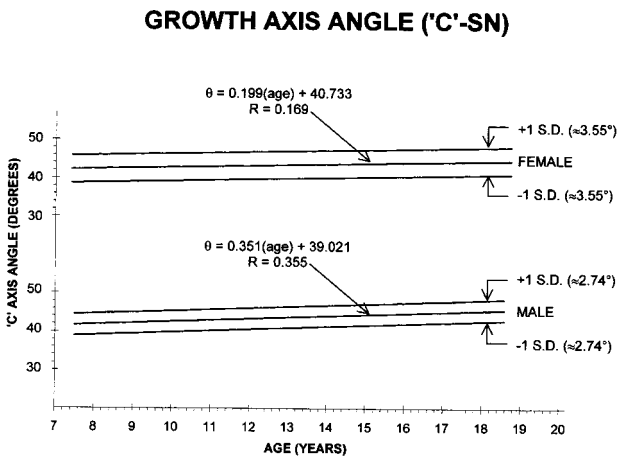

FIGURE 9. 'C'-axis angle θ changes in nontreated males and females.

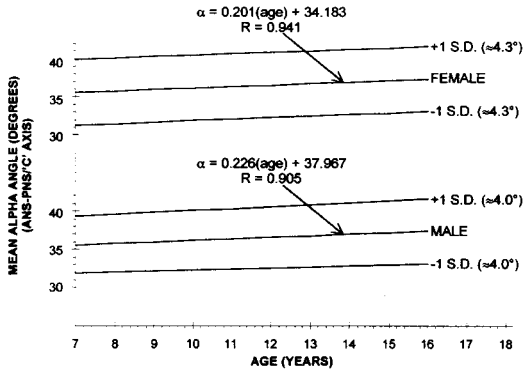

FIGURE 10. 'C'-axis angle α changes in nontreated males and females.

the correlation coefficients are relatively low for these two angular measurements (θ,α) because the slopes (velocity of change) of each of the regression formulas approach a horizontal line. (The changes are minimal).

In the female and male groups treated with the Frankel II appliance, the velocity of growth along the 'C'-axis was 1.72 and 1.11 mm/year, respectively (Figure 2). In the female and male groups treated with the modified Twin Block appliance, the velocity of growth along the 'C'-axis was 1.24 and 1.60 mm/year, respectively (Figure 5). In nontreated females, the velocity of growth along the 'C'-axis was variable with a high of 2.02 mm/year during the seventh year of life and steadily decreasing to 0 mm/year during the 17th year of life (mean velocity, 1.06 mm/year). This is the age range of females treated with the Frankel II and with the modified Twin Block appliance. One can conclude that neither functional appliance had a meaningful effect in reducing the velocity of growth along the 'C'-axis in females. The slightly greater mean velocities found in some treated with the functional appliances may be because of two possibilities: (1) the functional-appliance groups' data is cross-sectional vs serial data in the nontreated growing female group and (2) the groups treated with the functional appliances were relatively small.

The growth-axis angle θ change in nontreated growing females and males was 0.20°/year and 0.35°/year, respectively. In the group treated with the Frankel II appliance, the growth angle θ change was 0.22°/year and 0.43°/year in females and males, respectively. In the group treated with the modified Twin Block appliance, the growth angle (θ) change was 0.19°/year and 0.31°/year, respectively. One may conclude that these alterations in the growth-axis angle when compared with nontreated individuals of the same gender are clinically insignificant and easily fall within tracing error (ie, 0.01°/year minimum, 0.08°/year maximum).

The alterations in velocity of change in the palatal plane angle (α) related to Sella-M point seen in the groups treated with the Frankel II and the modified Twin Block appliances vary from a maximum of 0.6°/year (0.763°/year − 0.201°/year) in the female group treated with the Frankel II appliance to a minimum of 0.12°/year (0.111°/year − 0.226°/year) in the male group treated with the modified Twin Block appliance. Both these alterations in velocity of change in θ and in α are clinically insignificant. For example, a two-year treatment regimen with the Frankel II appliance would produce a mean change in θ of 0.16°([0.43°/year − 0.35°/year] 2 years) in the male groups and a maximum velocity change in α of 1.2°(0.6°/year × 2 years) in the female groups.

CONCLUSIONS

The growth axis ('C'-axis), which describes the growth vector of the dentomaxillary complex is not altered in any clinically meaningful manner through the use of either the Frankel II or the modified Twin Block appliances. Investigators have reported recently that any positive changes found in the correction of Class II malocclusions are due to dentoalveolar changes fortified by relatively favorable mandibular growth.[18]

REFERENCES

1. Proffit WR, Fields HW Jr. *Contemporary Orthodontics,* 2nd ed. St Louis, Mo: Mosby; 1993.
2. Mills JRE. The effect of functional appliances on the skeletal pattern. *Br J Orthod.* 1991;18:267–275.
3. Wieslander L, Lagerström L. The effect of activated treatment on Class II malocclusions. *Am J Orthod.* 1979;75:20–26.
4. Creekmore TD, Rodney LJ. Frankel appliance therapy: orthopedic or orthodontic? *Am J Orthod.* 1983;83:89–108.
5. Pancherz H. A cephalometric analysis of skeletal and dental changes contributing to Class II correction in activator treatment. *Am J Orthod.* 1984;85:125–134.
6. McNamara JA, Bookstein FL, Shaughnessy TG. Skeletal and dental changes following functional regulator therapy on Class II patients. *Am J Orthod.* 1985;88:91–110.
7. Vargervik K, Harvold EP. Response to activated treatment in Class II malocclusions. *Am J Orthod.* 1985;88:242–251.
8. Pancherz H, Malmgren O, Hägg U, Omblas J, Hansen K. Class

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II correction in Herbst and Bass therapy. *Eur J Orthod.* 1989;11: 17–30.
9. McNamara JA, Howe RP, Dischinger TJ. A comparison of the Herbst and Frankel appliances in the treatment of Class II malocclusion. *Am J Orthod Dentofacial Orthop.* 1990;98:134–144.
10. Chen JY, Will LA, Niederman R. Analysis of efficiency of functional appliances on mandibular growth. *Am J Orthod Dentofacial Orthop.* 2002;122:470–476.
11. Pangrazio-Kulbersh V, Berger JL, Chermak DS, et al. Treatment effects of mandibular anterior repositioning appliances on patients with Class II malocclusion. *Am J Orthod Dentofacial Orthop.* 2003;123:286–295.
12. Hotz R. Application and appliance manipulation of functional forces. *Am J Orthod.* 1970;58:459–478.
13. Mills JRE. Clinical control of craniofacial growth: A skeptic's viewpoint. In: McNamara JA, ed. *Clinical Alteration of the Growing Face.* Ann Arbor, Mich: Center of Human Growth and Development, University of Michigan; 1983;17–31.
14. Braun S, Rudman RT, Murdock HJ, et al. 'C'-Axis: A growth vector for the maxilla. *Angle Orthod.* 1999;69(6):539–542.
15. Frankel R. The artificial traction of the mandible by functional regulators. In: Cook JT, ed. *Transactions of the Third International Orthodontic Congress.* St Louis, Mo: Mosby; 1975.
16. Dyer FMJ, McKeown HF, Sandler PJ. The modified Twin Block appliance in the treatment of Class II div. 2 malocclusions. *Br J Orthod.* 2001;28:271–280.
17. Person RV. *Calculus with Analytic Geometry*. San Francisco, Calif: Rinehart Press; 1970:92–107.
18. O'Brien K, Wright J, Conboy F, et al. Effectiveness of early orthodontic treatment with the Twin Block appliance: a multi-center, randomized, controlled trial. Part I: dental and skeletal effects. *Am J Orthod Dentofacial Orthop.* 2003;124:234–243.

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