Dentoskeletal changes in Class II malocclusion patients after treatment with the Twin Block functional appliance

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Abstract

Objective: This prospective clinical study evaluated dentoskeletal changes in Class II malocclusion patients after treatment with the Twin Block functional appliance (TB). **Method:** The sample was divided into two groups with 19 subjects in each: Group TB, with mean age of 9 years and 6 months (sd = 10 months); and a control group, with mean age of 9 years and 9 months (sd =13 months), both situated before the pubertal growth spurt. Unpaired Student's t test showed the sample homogeneity at the beginning of the study. Initial (T1) and one year follow-up (T2) cephalometric radiographs were obtained for all subjects. Wilcoxon test and Mann-Whitney test were used to evaluate changes intra and intergroups from T1 to T2. **Results:** A Class I molar relationship was achieved in 15 subjects of the TB group, while no modification occurred in the control group. No significant effect was observed either in the maxilla or in the vertical pattern. A significant increase in total mandibular length and an anterior displacement of the mandibular position occurred in the treated group (p<0.05) as well as an overjet reduction, influenced by significant upper incisor retroclination and lower incisor proclination (p<0.05). **Conclusions:** Class II treatment with the Twin Block appliance in Brazilian patients showed skeletal and dental effects, including increase in mandibular length and incisors compensation, respectively.

Keywords: Class II malocclusion. Functional appliance. Growth.

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INTRODUCTION

Class II patients show specific clinical characteristics, such as a large overjet resulting in a soft tissue profile imbalance. This is closely related to patients' and parents' complaints concerning self-image and self-confidence.[1,2] In order to reestablish their self-esteem, an early approach into correction of the dentoskeletal disharmony and improvement of facial esthetics may be indicated in the pre-pubertal stage, sometimes leading to two-phase orthodontic treatment.[3] Although, the controversy regarding the best time of Class II skeletal malocclusion correction still remains.[4]

Interceptive correction of mandibular retrognathism in growing patients requires knowledge concerning the mechanism of functional orthopedic appliances. These appliances may be effective based on the possibility of inducing bone growth. The occurrence of additional mandibular growth during the active phase of treatment and stability of the results are important questions to be addressed.[5]

The Twin Block (TB) appliance is used to promote correction of Class II mandibular deficiency malocclusions. A number of authors[6-11] have already discussed its effectiveness on mandibular changes, overjet and Class II correction in European and American sample, but different populations may have different results using the same appliance.

The aim of this study was to assess the maxillomandibular skeletal and dentoalveolar changes produced by the Twin Block appliance treatment in a Brazilian sample.

MATERIAL AND METHODS

This study was a prospective randomized clinical trial, submitted and approved by the Institutional Ethics Committee, comprised of 38 subjects selected from those attending the Department of Orthodontics (State University of Rio de Janeiro). Screening was based on the following inclusion criteria: Skeletal Class II (ANB > 4°); molar Class II relationship; overjet > 6 mm (Fig 1A) and no previous orthodontic treatment. Subjects had to be included on pre-pubertal growth spurt phase characterized by: Fishman[12] indicators "1 and 2" of skeletal maturity estimated from 100 to 85% of individual's relative growth rate on the hand and wrist radiograph and confirmed by the "initiation phase" of the vertebral maturation described by Hassel and Farman[13] on the cephalometric radiograph.

The sample was randomly divided in two groups: the TB group (TBG) included 12 boys and 7 girls (mean age = 9 years and 6 months; sd = 10 months) and the Control group (CG) also included 12 boys and 7 girls (mean age = 9 years and 9 months; sd = 13 months).

Cephalometric radiographs were obtained at the beginning of the study (T1) and after 12 months of observation (T2). They were scanned and digitized using Radiocef 2.0 Memory Studio computer software (Floresta, Belo Horizonte/MG, Brazil). The customized cephalometric analysis used in the study is shown in Figures 2 and 3. A vertical reference line (VL) was constructed perpendicular to sella-nasion through sella to measure anteroposterior position of the first molars.[14]

To evaluate the error of the method, 10 pairs of radiographs were randomly selected and digitized by the same operator four times each. An intraclass correlation coefficient (ICC) was calculated to test intra-operator error. Unpaired Student's t test was used to check for homogeneity between groups for cephalometric values at T1.

The subjects in the CG did not undergo any orthodontic intervention during the study, but right after this time they were submitted to comprehensive orthodontic treatment at the pubertal growth spurt. The TBG patients used the removable appliance (Fig 1B) in a modified design of the one described by Clark[2] (Fig 4),

FIGURE 1 - Lateral views of a mandibular retrognathism Class II malocclusion subject.
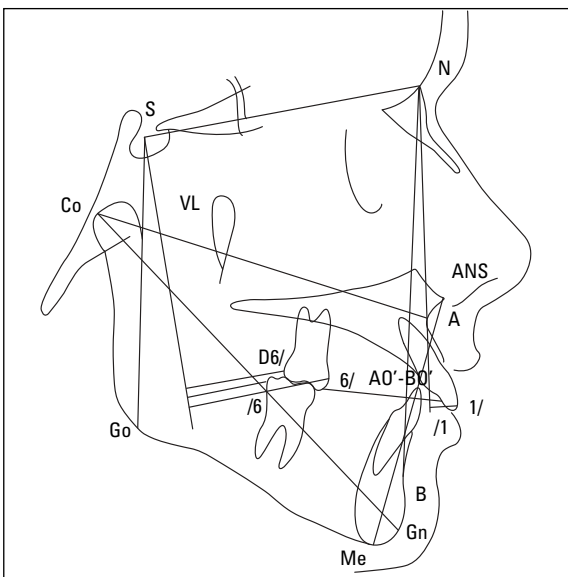

FIGURE 2 - Customized cephalometric analysis: Linear measurements. Co-A: Maxillary length; Co-Gn: Mandibular length; AO'-BO': Wits appraisal; LAFH: Distance from anterior nasion spine (ANS) to menton (Me), anterior facial height; S-Go: Distance from sella to gonion, posterior facial height; 1/NA (mm): Upper incisor-nasion/point A line; 1/NB (mm): Lower incisor-nasion/point B line; U6/VL: Distance from the most anterior point of the upper first molar to vertical line; DU6/VL: Distance from the most posterior point of the upper first molar to vertical line; L6/VL: Distance from the most posterior point of the lower first molar to vertical line.
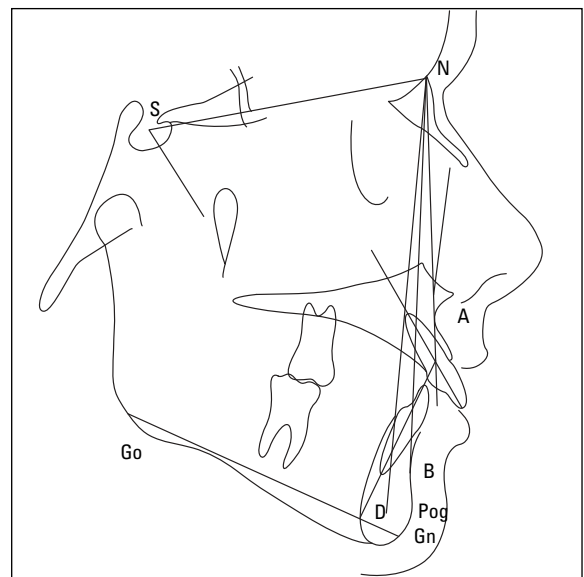

FIGURE 3 - Customized cephalometric analysis: Angular measurements. SNA: Sella-nasion-point A angle; SNB: Sella-nasion-point B angle; SND: Sella-nasion-point D angle; ANB: Point A-nasion-point B angle; NA/APog: Angle formed by nasion-point A and pogonion-point A; GoGn/SN: Angle formed by gonion-gnathion and sella-nasion; SNGn: Sella-nasion-gnation angle; 1/NA (degree): Upper incisor-nasion/point A line; 1/NB (degree): Lower incisor-nasion/point B line; 1/GoGn: Angle formed by lower incisor and gonion-gnathion; 1/1: Interincisor angle.
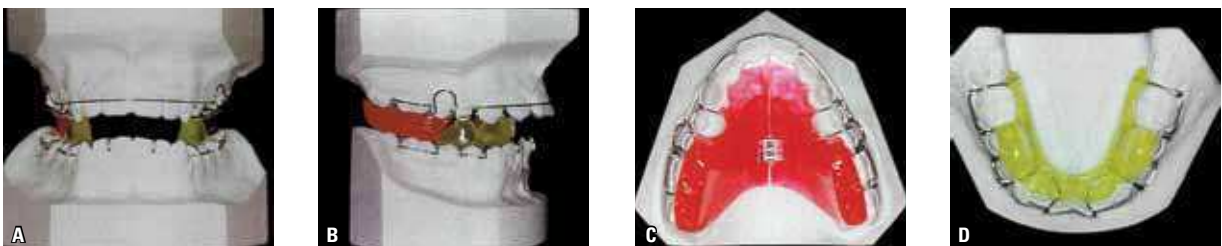

FIGURE 4 - Twin Block appliance used in this study.

and were instructed to wear it continuously except during sports, eating and oral hygiene. The initial construction bite was taken with approximately 4 mm mandible protrusion. A time grid was filled in by the parents, and showed that the appliance had been worn on average for 18 hours and 50 minutes per day.

Descriptive statistics were used to determine the mean and standard deviation of the linear and angular cephalometric values at T1 and T2 for both groups. Wilcoxon test was used to check for statistical differences between T1 and T2 in each group and Mann-Whitney test to evaluate changes resulting from treatment at the end of the observation period (T2) between groups. The confidence level of p<0.05 was used as reference for all statistical tests.

RESULTS

The error of the method demonstrated excellent operator reproducibility, showing ICC values higher than 0.773 for a confidence interval of 95%.

Means, standard deviations and results of the unpaired Student's t test of the cephalometric measurements at T1 are shown in Table 1. No statistically significant differences between groups were observed, thus confirming the sample homogeneity at T1.

The molar relationship correction was attained in 15 of the 19 treated patients (80%), while the CG did not show any modification in Class II relationship.

Table 2 shows initial and final cephalometric values of the CG and TBG as well as the results of the Wilcoxon test comparing each group from T1 to T2. Significant increases in mandibular length (Co-Gn= +2.82 mm) and in maxillary length (Co-A= +2.37 mm) occurred in the CG, reflecting the maintenance of the Class II pattern with growth, confirmed by the unaltered ANB. The linear measurements for upper incisor (1/NA: p<0.30) and for upper and lower

TABLE 1 - Cephalometric measurements of CG and TBG at T1 and the p values of the results of the unpaired Student's test.

GROUPS Measurements	Control (n = 19)		Twin Block (n = 19)		p
	Mean	SD	Mean	SD	
SNA	80.30	4.78	80.96	3.64	0.636
SNB	74.07	3.42	74.39	3.68	0.780
SND	72.40	3.30	71.59	3.23	0.502
ANB	6.24	2.00	6.51	1.66	0.645
1/NA (mm)	4.95	2.90	6.23	2.72	0.170
1/NA (degrees)	26.07	7.70	28.83	6.52	0.241
1/NB (mm)	6.29	2.42	6.31	2.62	0.978
1/NB (degrees)	30.18	5.79	29.62	5.27	0.760
1/1	117.51	10.41	114.92	7.97	0.396
GoGn-SN	35.27	5.13	34.78	5.38	0.773
NA-Pog	11.99	4.93	12.15	3.96	0.913
Co-Gn	107.05	6.29	110.94	4.29	0.089
Co-A	89.22	5.49	92.08	3.46	0.062
1/GoGn	100.83	7.08	100.43	5.43	0.845
LAFH	63.76	4.54	65.61	4.99	0.239
AO-BO	5.77	2.93	6.66	2.99	0.360
SNGn	70.33	3.32	69.78	4.14	0.658
S-Go	69.32	3.62	71.08	3.97	0.164
U6/VL	29.72	5.39	31.47	5.22	0.317
L6/VL	27.12	5.29	28.97	5.51	0.300
DU6/VL	19.04	4.49	20.87	5.21	0.255

TABLE 2 - Cephalometric measurements of the groups at T1 and T2 (n=38) (Wilcoxon test).

| | Control Group (CG) | | | | | | | Twin Block Group (TBG) | | | | | | |
| | T1 | | T2 | | (T2-T1) | SD | p | T1 | | T2 | | (T2-T1) | SD | p |
	Mean	SD	Mean	SD				Mean	SD	Mean	SD			
SNA	80.30	4.78	81.46	4.66	1.16	3.05	ns	80.86	3.75	81.57	4.21	0.71	1.54	ns
Co-A	89.38	5.37	91.74	4.91	2.37	3.18	*	92.08	3.46	95.41	5.47	2.27	3.22	*
SNB	74.06	3.42	75.20	4.26	1.15	2.71	ns	74.39	3.68	76.22	3.57	1.83	1.32	*
SND	72.40	3.30	72.78	3.34	0.38	1.26	ns	73.10	3.09	71.60	3.23	1.42	1.31	*
Co-Gn	10.05	7.52	110.72	6.97	2.82	2.80	*	110.94	4.29	115.81	3.59	5.22	3.26	*
ANB	6.24	2.00	6.25	1.59	0.02	1.53	ns	6.51	1.66	4.78	2.32	-1.16	0.94	*
Na/APog	11.99	4.93	12.12	4.62	0.13	3.03	ns	12.15	3.96	9.89	4.31	-2.25	1.98	*
AO-BO	5.77	2.93	6.71	3.43	0.95	2.79	ns	6.66	2.99	3.57	3.32	-3.09	2.66	*
GoGn/SN	35.27	5.13	34.94	5.74	-0.32	2.32	ns	34.78	5.38	34.28	4.66	-0.50	2.38	ns
LAFH	63.76	4.54	64.58	4.57	0.82	2.26	ns	65.61	4.99	69.31	8.79	2.06	2.10	*
SNGn	70.33	3.32	69.74	4.45	-0.59	2.15	ns	69.78	4.14	68.61	3.58	-0.99	1.52	*
S-Go	69.32	3.62	70.56	4.59	1.24	2.53	ns	71.08	3.97	73.38	4.68	2.46	3.05	*
1/NA (mm)	4.95	2.90	5.64	2.44	0.70	1.38	*	6.23	2.72	3.64	2.37	-2.59	2.43	*
1/NA (degrees)	26.07	7.70	27.42	7.29	1.35	3.30	ns	28.83	6.52	20.47	4.92	-8.36	5.14	*
1/NB (mm)	6.29	2.42	6.62	2.51	0.34	1.37	ns	6.28	2.63	7.52	2.43	1.25	1.35	*
1/NB (degrees)	30.18	5.79	31.15	6.86	0.98	3.29	ns	29.62	5.27	33.41	5.00	3.80	3.72	*
1/GoGn	100.83	7.08	101.00	7.65	0.17	3.40	ns	100.43	5.43	7.52	2.43	2.48	3.67	*
1/1	117.51	10.41	115.16	11.40	-2.35	5.40	ns	114.92	7.97	33.41	5.00	5.40	5.62	*
U6/VL	29.72	5.39	32.32	5.72	2.60	4.64	*	31.47	5.22	35.36	10.41	1.45	1.96	*
DU6/VL	19.04	4.49	21.11	5.56	2.08	4.36	ns	20.87	5.21	22.35	4.65	1.01	1.86	*
L6/VL	27.12	5.29	29.67	6.26	2.55	4.85	*	28.97	5.51	32.55	5.52	3.51	2.82	*

first molars (U6/VL and DU6/VL: $p<0.014$ and L6/VL: $p<0.04$) also increased statistically. The treatment group showed significant changes in all the cephalometric measurements, except for SNA and GoGn/SN.

In the comparison between the TBG and CG at T2 (Table 3), the most important skeletal findings in the treated group were a statistically significant increase in mandibular length (Co-Gn) and in the spatial position of the mandible related to the anterior cranial base (SND), and a significant reduction in the measurements related to maxillomandibular sagittal position (ANB, NA/APog = $p<0.05$, AO-BO = $p<0.01$). The treated group also showed statistical changes on upper incisors position (1/NA mm and 1/NA degree) and on lower incisors tipping (1/NB degree), which resulted in significant reduction of interincisor angle ($p<0.01$).

TABLE 3 - Comparison of CG and TBG mean changes between T1-T2 (Mann Whitney test).

Measurements		Control Group (n=19)		Twin Block Group (n=19)		p
		T2-T1	SD	T2 - T1	SD	
Skeletal	SNA	1.16	3.05	0.71	1.54	0.418
	Co-A	2.37	3.18	2.27	3.22	0.708
	SNB	1.15	2.71	1.83	1.32	0.057
	SND	0.38	1.20	1.42	1.31	0.027*
	Co-Gn	2.82	2.80	5.22	3.26	0.020*
	ANB	0.02	1.53	-1.16	0.94	0.008*
	NA/Apog	0.13	3.03	-2.25	1.98	0.002*
	AO-BO	0.95	2.79	-3.09	2.66	0.000*
	GoGn/SN	-0.32	2.32	-0.50	2.38	0.885
	LAFH	0.82	2.26	2.06	2.10	0.091
	SN-SGn	-0.59	2.15	-0.99	1.52	0.418
	S-Go	1.24	2.53	2.46	3.05	0.234
Dental	1/NA (mm)	0.70	1.38	-2.59	2.43	0.000*
	1/NA (degrees)	1.35	3.30	-8.36	5.14	0.000*
	1/NB (mm)	0.34	1.37	1.25	1.35	0.075
	1/NB (degrees)	0.98	3.29	3.80	3.72	0.034*
	1/GoGn	0.17	3.40	2.48	3.67	0.109
	1/1	-2.35	5.40	5.40	5.62	0.000*
	U6/VL	2.60	4.64	1.45	1.96	0.885
	DU6/VL	2.08	4.36	1.01	1.86	0.840
	L6/VL	2.55	4.85	3.51	2.82	0.212

DISCUSSION

Clinically, 80% of the treated group have benefited from the correction of the Class II molar relationship, while no improvement was observed in the control group. As the children were treated before the pre-pubertal spurt, the stability of the correction needs to be checked later on.

The TB treatment did not result in inhibition of maxillary forward growth since no statistical difference was observed in the TBG (Table 3). These results are in agreement with Lund and Sandler,[7] while some authors[8,9,10] have reported slight maxillary restraint suggesting a headgear effect. Change in the position of point A due to upper incisor retroclination may have hidden the effect upon maxilla in this study, affecting SNA and CO-A changes.

The TB appliance was found to have influenced mandibular anterior development when SND was used as reference (p<0.05). In contrast, SNB angle changes did not reflect the same pattern, probably because point B was influenced by proclination of the lower incisors. Previous studies have reported an anterior mandibular displacement related to the anterior cranial base as a result of TB treatment, which means that the mandible was spatially altered in the anteroposterior plane resulting in a correction of Class II malocclusion (Table 3).[7,8,10,11,16]

A significant increase in mandibular length (Co-Gn=2.4 mm) was observed as well as a significant reduction in intermaxillary sagittal discrepancy (ANB = -1.18°; NA/APog = -2.38°; AO-BO= -4.04 mm), which probably contributed to the Class II correction (Table 3). An increase in total mandibular length was also found by Morris et al[6] (3.7 mm in 9 months), Lund and Sandler[7] (2.4 mm/year), Mills and McCulloch[8] (4.2 mm/year), Toth and McNamara[10] (3.0 mm in 16 months) and Trenouth[11] (3.2 mm/year). These results suggest a response of mandibular growth increments, which may be in part justified by a reported good compliance, as the appliance is considered comfortable and esthetic.

No significant changes were observed in the vertical measurements (Table 3), which were expected as a result of the capping effect of the appliance blocks controlling vertical eruption of the molars.[2] Clinically, it has been demonstrated that the TB maintains the facial pattern.[2,6,8,9] In some studies,[7,10] the increase in

facial height has been attributed to a different appliance design that allows molar eruption.[17] Although, molar disocclusion has been mentioned by Clark[2] as an advantage of the appliance (Figs 1B and 4C) which could be also observed in this sample at the end of the treatment and was considered important in influencing mandibular anterior growth.

The first molars did not show significant linear changes when measured to VL (p>0.05) (Table 3). The upper incisors showed significant retroclination (1/NA= 3.29 mm, 9.71°); the lower incisors, proclination (1/NB= 2.82°) and the interincisal angle, an increase (1/1= 7.75°) and these results are in accordance with other authors[7,8,10,11] who have reported similar findings. The effect on the upper incisors can be mainly attributed to the Hawley arch (Fig 4B) which transmitted a reaction force to the upper incisors. Koroluk et al[18] verified that overjet reduction is favorable in early treatment, considering the high trauma incidence in preadolescents with a Class II Division 1 malocclusion.[3] The lower incisor movement may have been due to anchorage loss in response to keeping the mandible in a protrusive position. This effect may be unfavorable in patients where the incisors are proclined before treatment. Therefore, this approach may not be indicated in such cases or an additional stage of treatment may be required to upright the lower incisors.[3]

CONCLUSION

The present study assessed changes after a 12-month treatment with the Twin Block appliance, compared to a control group. The analysis of the results leads to the following conclusions:

1) Eighty percent of the patients treated with the Twin Block appliance attained Class I relationship.
2) A significant improvement occurred in the total mandibular length and anteroposterior relationship.
3) Significant retroclination and proclination was observed in the upper and lower incisors, respectively, leading to a decrease in the overjet.
4) No statistically significant change was found in molar position in the treated group.
5) No effect was observed in the position of the maxilla.

ACKNOWLEDGEMENTS

REFERENCES

1. Shaw WC. The influence of children's dentofacial appearance on their social attractiveness as judged by peers and lay adults. Am J Orthod. 1981;79(4):399-415.
2. Clark WJ. The twin block technique. A functional orthopedic appliance system. Am J Orthod Dentofacial Orthop. 1988;93(1):1-18.
3. Tulloch JF, Phillips C, Proffit WR. Benefit of early Class II treatment: progress report of a two-phase randomized clinical trial. Am J Orthod Dentofacial Orthop. 1998;113(1):62-72, quiz 73-4.
4. Dolce C, McGorray SP, Brazeau L, King GJ, Wheeler TT. Timing of Class II treatment: skeletal changes comparing 1-phase and 2-phase treatment. Am J Orthod Dentofacial Orthop. 2007;132(4):481-9.
5. Voudouris JC, Kuftinec MM. Improved clinical use of Twin-block and Herbst as a result of radiating viscoelastic tissue forces on the condyle and fossa in treatment and long-term retention: growth relativity. Am J Orthod Dentofacial Orthop. 2000;117(3):247-66.
6. Morris DO, Illing HM, Lee RT. A prospective evaluation of Bass, Bionator and Twin Block appliances. Part II: The soft tissues. Eur J Orthod. 1998;20(6):663-84.
7. Lund DI, Sandler PJ. The effects of Twin Blocks: a prospective controlled study. Am J Orthod Dentofacial Orthop. 1998;113(1):104-10.
8. Mills CM, McCulloch KJ. Treatment effects of the Twin Block appliance: a cephalometric study. Am J Orthod Dentofacial Orthop. 1998;114(1):15-24.
9. Parkin NA, McKeown HF, Sandler PJ. Comparison of 2 modifications of the Twin-Block appliance in matched Class II samples. Am J Orthod Dentofacial Orthop. 2001;119(6):572-7.
10. Toth LR, McNamara JA Jr. Treatment effects produced by the Twin-Block appliance and the FR-2 appliance of Fränkel compared with an untreated Class II sample. Am J Orthod Dentofacial Orthop. 1999 Dec;116(6):597-609.
11. Trenouth MJ. Cephalometric evaluation of the Twin-Block appliance in the treatment of Class II division 1 malocclusion with matched normative growth data. Am J Orthod Dentofacial Orthop. 2000;117(1):54-9.
12. Fishman LS Radiographic evaluation of skeletal maturation. A clinically oriented method based on hand-wrist films. Angle Orthod. 1982;52(2):88-112.
13. Hassel B, Farman AG. Skeletal maturation evaluation using cervical vertebrae. Am J Orthod Dentofacial Orthop. 1995;107(1):58-66.
14. Brunharo IP, Quintão CA. O aparelho Twin Block: técnica de confecção e aplicação clínica. Rev Bras Odontol. 2001;58(6):373-7.
15. Quintão C, Helena I, Brunharo VP, Menezes RC, Almeida MA. Soft tissue facial profile changes following functional appliance therapy. Eur J Orthod. 2006 Feb;28(1):35-41. Epub 2005 Aug 19.
16. Caldwell S, Cook P. Predicting the outcome of Twin Block functional appliance treatment: a prospective study. Eur J Orthod. 1999;21(5):533-9.
17. Vig PS, Vig KW. Hybrid appliances: a component approach to dentofacial orthopedics. Am J Orthod Dentofacial Orthop. 1986;90(4):273-85.
18. Koroluk LD, Tulloch JF, Phillips C. Incisor trauma and early treatment for Class II division 1 malocclusion. Am J Orthod Dentofacial Orthop. 2003;123(2):117-25; discussion 125-6.

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