Original Article

Dental Arch Dimensions in the Mixed Dentition: A Study of Italian Children Born in the 1950s and the 1990s

Efisio Defraia[a]; Giulia Baroni[b]; Andrea Marinelli[c]

Abstract: The objective of this study was to compare the dental arch dimensions in the mixed dentition in two modern samples living in the same geographic area and separated by almost 35 years. A group of 83 subjects (39 boys and 44 girls) born between 1953 and 1959 (mean age: eight years and three months ±15 months for the boys and seven years and 11 months ±12 months for the girls) were compared with a group of 84 subjects (38 boys and 46 girls) born between 1990 and 1998 (mean age: eight years and eight months ±12 months for the boys and eight years and four months ±11 months for the girls). Measurements were taken on dental casts for posterior and anterior arch segments, intermolar and intercanine width, and mesiodistal size of incisors. The available anterior space in both arches and the posterior and anterior transverse dimensions were calculated. Groups were compared using a nonparametric test (Mann-Whitney *U*-test) for independent samples ($P < .05$). Results show that both boys and girls of 1990s showed significantly smaller maxillary intermolar width when compared with 1950s. Posterior transverse interarch discrepancy was significantly minor in girls of 1990s. The present population has a greater probability of developing a malocclusion as a consequence of the secular trend toward the reduction of the width of the upper arch. (*Angle Orthod* 2006;76:446–451.)

Key Words: Arch dimensions; Posterior intermolar transversal discrepancy

INTRODUCTION

Modern population are affected by characteristic diseases such as malocclusions, caries, diabetes, hypertension, and heart disease that are uncommon in underdeveloped societies.[1] The changes in environment, habits, and the greater diffusion of respiratory pathologies were considered to be responsible for a progressive increase in the prevalence of malocclusions.[2] Occlusal patterns follow secular trends that were described in the literature in several populations; this tendency was found not only between ancient and modern subjects but also in the comparison among cohorts of the same century separated by almost 30 years.[3–8] Transverse dental arch dimensions, in particular, appear to be progressively reduced. A secular trend toward a reduction of the anterior space and an increased prevalence of crowding was also described by Lavelle[9] and Brin et al,[10] whereas Lindsten et al[5] did not find similar results. The dimensions of posterior segment in the mixed dentition show instead a trend through an increase in contemporary people when compared with ancient populations (showing interproximal attrition) and subjects of the half of the last century (showing an higher prevalence of interproximal caries).[4] The aim of this study is to compare the dental arch dimensions in the mixed dentition in two modern samples living in the same geographic area and separated by almost 35 years: a group of subjects born in 1950s and another group born in 1990s.

[a] Assistant Professor, Department of Orthodontics, University of Florence, Florence, Italy.

[b] Graduate PhD student, Department of Orthodontics, University of Florence, Florence, Italy.

[c] Research Associate, Department of Orthodontics, University of Florence, Florence, Italy.

Corresponding author: Dr. Andrea Marinelli, Research Associate, Department of Orthodontics, University of Florence, Via del Ponte di Mezzo 46-48, 50127 Florence, Italy (e-mail: a_marinelli@yahoo.com)

Accepted: June 2005. Submitted: April 2005.

MATERIALS AND METHODS

Subjects

The 1950s group (50sG) of 83 subjects (39 boys and 44 girls) was derived from the files of patients, who were first observed at the Department of Orthodontics of the University of Florence, Italy, in the 1960s. All subjects were born between 1953 and 1959. The mean age of the 50sG was eight years and three months ±15 months for boys and seven years and 11 months ±12 months for girls. The boys presented 19 subjects with Class I, 17 subjects with Class II division 1, and three subjects with Class III malocclusions. The girls presented 21 subjects with Class I, 18 subjects with Class II division 1, two subjects with Class II division 2, and three subjects with Class III malocclusions.

The 1990s group (90sG) of 84 subjects (38 boys and 46 girls) was derived from patients observed at the same Department in the years between 1996 and 2003. These subjects were born between 1990 and 1998. The mean age of the 90sG was eight years and eight months ±12 months for boys and eight years and four months ±11 months for girls. The males presented 20 subjects with Class I, 16 subjects with Class II, and two subjects with Class III malocclusions. The females presented 21 subjects with Class I, 20 subjects with Class II division 1, two subjects with Class II division 2, and three subjects with Class III malocclusions.

The following inclusionary criteria were adopted for both groups: (1) availability of detailed clinical files; (2) absence of any previous orthodontic treatment; (3) absence of bruxism; (4) absence of unilateral posterior crossbite; (5) availability of dental casts of good quality; (6) absence of missing teeth, dental traumas, dental anomalies, deep caries, restorations; and (7) availability of panoramic radiographs.

All subjects were Caucasians belonging to the same geographic area (Tuscany). They all presented in early mixed dentition (presence of first permanent molars and upper and lower central and lateral incisors erupted or in phase of eruption). To reduce the range of variables affecting arch measurements, the two groups were matched for sex distribution and prevalence of sagittal malocclusions. Unilateral posterior crossbites (as assessed from the dental records and confirmed by the dental casts) were excluded because of the expected asymmetries between the sides with and without a crossbite. Panoramic radiographs were examined to control the absence of dental anomalies, deep caries, and restorations.

METHODS

Measurements were made on dental casts by one of us (Dr. Baroni) using a sliding caliper.

The following measurements were taken (1) posterior segment (right and left): the distance between the mesial surface of the first permanent molar and the mesial surface of the deciduous canine; (2) anterior segment (right and left): the distance between the mesial surface of the deciduous canine and the mesial surface of the permanent central incisor; and (3) mesiodistal size of each permanent incisors.

These measurements were taken for upper and lower arch and for left and right sides. (1) Interincisal midline diastema (upper and lower); (2) available space was calculated as the sum of anterior segments and interincisal midline diastema minus the sum of the mesiodistal sizes of the teeth; (3) maxillary intermolar width: distance between the central fossae of right and left first maxillary molars; (4) mandibular intermolar width: distance between the tips of the distobuccal cusps of right and left first mandibular molars; (5) posterior transverse interarch discrepancy (PTID): difference between maxillary and mandibular intermolar widths; (6) maxillary intercanine width: distance between the mesial margin of right and left maxillary deciduous canine; (7) mandibular intercanine width: distance between the tips of the cusps of right and left deciduous canine. If the cusp tips were abraded, the assumed center of the abraded area was used; and (8) anterior transverse interarch discrepancy: difference between maxillary and mandibular intercanine widths.

Method error

Fifteen randomly selected models were remeasured to calculate method errors for all the variables, as described by Dahlberg.[11] Any systematic error was determined by calculating the coefficients of reliability for all the variables, as suggested by Houston.[12] Method errors ranged from 0.00 to 0.66 mm. Corresponding coefficients of reliability ranged from 0.81 to 1.00.

Statistical analysis

The data from cast measurements of the two groups were compared separately for boys and girls, using a nonparametric test (Mann-Whitney *U*-test) for independent samples ($P < .05$). All statistical computations were performed with a Social Science Statistical Package Software (SPSS, Version 12.0, SPSS Inc, Chicago, Ill).

RESULTS

Descriptive statistics and statistical comparison for the examined groups are reported in Tables 1 and 2. Both boys and girls of 90sG showed significantly smaller maxillary intermolar width when compared with 50sG. PTID was significantly minor in girls of 90sG. A reduction of the anterior segments of the upper arch in girls of 90sG on the left side was found, but the difference is clinically not relevant. No differences were found for all other examined values.

TABLE 1. Descriptive Statistics and Statistical Comparison for Females

	Females											
	1950s					1990s						
	N	Minimum	Maximum	Mean	SD	N	Minimum	Maximum	Mean	SD	Z	Significance
Posterior superior right segment	44	21.0	24.5	22.54	0.74	46	20.0	25.0	22.66	1.06	−0.920	NS[c]
Anterior superior right segment	44	11.5	17.0	14.28	1.26	45	9.5	17.5	14.86	1.68	−2.114	*
Upper interincisal diastema	44	0.0	4.0	1.27	1.07	45	0.0	4.5	1.07	1.14	−1.053	NS
Anterior superior left segment	44	11.0	17.0	14.34	1.59	45	10.0	17.5	14.94	1.39	−1.684	NS
Posterior superior left segment	44	21.0	27.5	22.65	1.10	46	20.0	25.0	22.58	1.04	−0.119	NS
Maxillary intercanine width	44	21.5	30.0	25.99	2.05	46	20.0	30.0	25.95	2.39	−0.174	NS
Maxillary intermolar width	44	41.0	48.5	44.51	2.03	46	38.5	48.5	43.42	2.46	−2.309	*
Mesiodistal size 12	24	5.5	9.0	7.06	0.76	37	5.5	8.0	6.86	0.67	−0.762	NS
Mesiodistal size 11	44	6.5	10.0	8.73	0.61	45	6.0	10.0	8.57	0.74	−1.342	NS
Mesiodistal size 21	44	6.5	10.0	8.73	0.61	45	6.0	10.0	8.57	0.74	−1.342	NS
Mesiodistal size 22	26	5.5	9.0	7.06	0.71	37	5.5	8.0	6.86	0.67	−0.722	NS
Superior available space	24	−6.5	4.5	−0.83	3.24	38	−6.0	6.0	0.60	2.86	−1.631	NS
Posterior inferior left segment	44	21.5	26.0	23.10	1.08	46	21.0	26.5	23.11	1.13	−0.294	NS
Anterior inferior left segment	44	7.0	13.0	10.89	1.10	46	8.5	13.5	10.90	1.13	−0.250	NS
Lower interincisal diastema	44	0.0	2.0	0.14	0.41	46	0.0	1.5	0.17	0.35	−1.142	NS
Anterior inferior right segment	44	7.5	13.0	10.92	0.97	46	8.0	13.5	11.17	0.97	−1.290	NS
Posterior inferior right segment	44	21.5	25.5	23.15	1.15	46	21.0	25.5	23.09	1.07	−0.212	NS
Mandibular intercanine width	44	22.0	32.0	25.31	2.03	46	21.5	30.5	25.38	2.24	−0.437	NS
Mandibular intermolar width	44	41.0	50.0	45.77	2.24	46	39.5	54.5	45.62	2.63	−0.828	NS
Mesiodistal size 32	38	5.5	7.0	6.05	0.40	41	5.0	7.0	6.08	0.50	−0.521	NS
Mesiodistal size 31	44	4.5	6.5	5.62	0.40	46	5.0	7.0	5.67	0.56	−0.094	NS
Mesiodistal size 41	44	4.5	6.5	5.64	0.39	46	5.0	7.0	5.67	0.56	−0.017	NS
Mesiodistal size 42	37	5.5	7.0	6.04	0.41	41	5.0	7.0	6.08	0.50	−0.619	NS
Inferior available space	37	−6.0	4.0	−1.34	2.39	43	0.0	17.0	4.63	4.52	−0.890	NS
ATID[a]	44	−3.5	5.0	0.68	1.89	46	−4.5	4.0	0.56	2.17	−0.049	NS
PTID[b]	44	−4.0	1.0	−1.26	1.16	46	−8.0	−0.5	−2.2	1.61	−2.747	***

[a] ATID indicates anterior transverse interarch discrepancy.
[b] PTID indicates posterior transverse interarch discrepancy.
[c] NS indicates not significant.
* $P = .05$; *** $P = .001$.

DISCUSSION

Dental conditions of many different ''primitive'' populations have been studied since the beginning of the last century. Price[13] studied Gaelic communities in the Outer Hebrides, Eskimos and Indians of North America, Melanesian and Polynesian South Sea Islanders, African tribes, Australian Aborigines, New Zealand Maori, and the Indians of South America and observed a very low incidence of dental diseases and malocclusions. In Eskimos, he observed perfect occlusions until the contact with industrialized societies,[14] and later the incidence of malocclusion increased to 50%.[15]

Price[13] related dental problems with the introduction of a diet based on processed foods. Begg[16] in 1954 studied living and dead Australian aboriginals and noted a very low prevalence of malocclusions. He suggested that the loss of interproximal hard tissues because of attrition could be able to provide enough space for permanent teeth to achieve an adequate alignment. Corruccini and Whitley,[17] extending Price's hypotheses, supported the ''disuse theory,'' in contrast to Begg and gave a great importance to decreased function of the masticatory system, which should be responsible of inadequate development of the jaws.

The findings of this study indicate that untreated subjects in the mixed dentition observed in the last 10 years show a significantly smaller width of the upper arch when compared with subjects observed 40 years ago in accordance with the findings of Lindsten et al.[3–4,6] This can be interpreted as a sign of lack of function in modern subjects as a consequence of processed food, on the basis of the positive association between masticatory function and development of the jaws. This association has been experimentally demonstrated on animal samples by numerous studies. Beecher and Corruccini[18] found association between moderate differences in the hardness of the diet and narrowing of the maxillary arch in the rats. They suggested that mediolateral maxillary growth depends on the stimulation of the muscles provided by rough elements in the diet. The same authors found the equivalent results with a population of rhesus macaques.[19] Bouvier and Hylander[20] microscopically examined the same sample and found fewer secondary Haversian

TABLE 2. Descriptive Statistics and Statistical Comparison for Males

	Males											
	1950s					1990s						
	N	Minimum	Maximum	Mean	SD	N	Minimum	Maximum	Mean	SD	*Z*	Significance
Posterior superior right segment	39	21.0	25.0	23.269	1.025	38	21.5	25.0	22.974	0.877	−1.512	NS[c]
Anterior superior right segment	37	11.0	18.5	14.959	1.643	37	10.5	17.5	15.081	1.588	−0.538	NS
Upper interincisal diastema	37	0.0	5.0	1.405	1.246	36	0.0	4.0	1.153	1.088	−0.855	NS
Anterior superior left segment	38	11.0	18.5	15.118	1.840	37	12.0	17.5	15.041	1.411	−0.261	NS
Posterior superior left segment	39	16.5	25.0	22.885	1.471	38	21.0	25.0	22.868	0.984	−0.717	NS
Maxillary intercanine width	39	22.5	34.5	27.090	2.476	38	22.0	31.0	26.605	1.846	−0.553	NS
Maxillary intermolar width	39	40.5	51.0	45.667	1.981	38	38.0	50.5	44.382	2.372	−2.623	***
Mesiodistal size 12	23	6.0	8.0	6.957	0.673	29	5.5	9.0	7.103	0.699	−0.807	NS
Mesiodistal size 11	32	8.0	10.0	8.984	0.466	35	7.0	9.5	8.714	0.546	−1.951	NS
Mesiodistal size 21	32	8.0	10.0	8.984	0.466	35	7.0	9.5	8.714	0.546	−1.951	NS
Mesiodistal size 22	23	6.0	8.0	7.000	0.640	29	5.5	9.0	7.086	0.695	−0.506	NS
Superior available space	22	−6.5	8.0	0.295	3.966	29	−5.0	7.5	0.517	3.247	−0.124	NS
Posterior inferior left segment	39	22.0	26.0	23.769	1.135	38	22.0	25.0	23.684	0.926	−0.098	NS
Anterior inferior left segment	39	9.0	14.0	11.333	1.034	38	10.0	16.0	11.447	1.155	−0.171	NS
Lower interincisal diastema	39	0.0	1.0	0.128	0.249	38	0.0	1.5	0.250	0.431	−0.929	NS
Anterior inferior right segment	39	8.5	13.0	11.179	1.073	38	9.0	16.0	11.355	1.289	−0.316	NS
Posterior inferior right segment	39	22.0	26.0	23.859	1.088	38	22.0	26.0	23.763	0.998	−0.422	NS
Mandibular intercanine width	39	23.0	31.0	26.282	1.860	38	22.0	30.0	25.789	1.926	−0.959	NS
Mandibular intermolar width	38	44.0	53.5	46.921	2.075	38	42.0	50.0	46.197	2.107	−1.153	NS
Mesiodistal size 32	35	5.5	7.0	6.386	0.422	34	5.5	7.0	6.294	0.479	−0.900	NS
Mesiodistal size 31	39	5.0	6.5	5.897	0.416	37	5.0	6.5	5.743	0.435	−1.606	NS
Mesiodistal size 41	39	5.0	6.5	5.897	0.416	37	5.0	6.5	5.743	0.435	−1.606	NS
Mesiodistal size 42	36	5.5	7.0	6.375	0.420	34	5.5	7.0	6.294	0.479	−0.807	NS
Inferior available space	35	−5.0	4.0	−1.943	2.268	34	−5.5	5.0	−0.897	2.296	−1.995	NS
ATID[a]	34	0.0	21.0	6.765	5.065	34	0.0	13.5	4.309	4.445	−0.292	NS
PTID[b]	39	−4.5	5.5	0.808	2.235	38	−2.5	3.5	0.816	1.426	−1.162	NS

[a] ATID indicates anterior transverse interarch discrepancy.
[b] PTID indicates posterior transverse interarch discrepancy.
[c] NS indicates not significant.
*** $P = .001$.

systems in the mandibular corpus. Ciochon et al[21] found a 25% greater size of the deep masseter and superficial masseter and temporalis weight in minipigs fed hard food in comparison with minipigs supplied with soft food.

Another important cause of narrowing of the upper arch in modern populations is the amplified prevalence of mouth breathing[22] as a consequence of an increase in respiratory diseases such as allergy and asthma.[23–27] Lindsten et al[28] suggested that many contemporary children chew gum frequently, and so a change in dietary consistency cannot be ruled out as a causative factor of narrowing of the maxilla. Consequently, mouth breathing has to be considered a major cause of the narrowing of maxillary arch in the modern populations.

A tendency toward a reduction of the posterior transverse intermolar dimension was found in children born in the 1990s with respect to their coetaneous born in 1950s: PTID is an underlying sign of various malocclusions. Tollaro et al[29] have shown that a negative PTID exists in dental arches with Class II malocclusion (3.4 mm on average) and seemingly normal buccal relationships. Baccetti et al[30] demonstrated that a negative PTID is recorded consistently in Class II subjects with deciduous dentitions and that the negative PTID is maintained or worsened during the transition into the mixed dentition. Varrela[31] confirmed that children with distal occlusions have narrower intermolar distances with respect to normal subjects since the age of three years, and this dissimilarity amplifies with age. In a previous study[8] performed on the same cohort, differences between the 50sG and the 90sG were found for all deciduous teeth, which appeared to be significantly more abraded in the 50sG.

The simultaneous presence of underdeveloped jaws and unworn teeth may be a cause of dental interferences and forced guidance of the mandible in an incorrect position in the sagittal or transverse plane, with a consequential malocclusion.[32,33] The stimulation of the muscular structures due to hard and fibrous foods allows a major development of the dental arches, resulting in a greater functional stimulation of the masticatory muscles and increased occlusal wear.

There was no difference between the two groups for the dimensions of the posterior segments, which contrasts with the results of Lindsten et al.[34] Lindsten's group found larger spaces in the posterior segment in children born in the 1980s when compared with subjects born in the 1950s. They hypothesized that there was a change in the lateral arch space conditions during the last decades because of the decline in caries prevalence occurring in the same period. The different findings of our study may be due to a different selection of the samples because the absence of caries was an inclusionary criterion for subjects involved in this study. The other causes of loss of proximal tooth material of posterior teeth, such as interproximal wear, are lacking in modern populations and are not able to cause a reduction of the length of the posterior segments of the arch in the mixed dentition.

CONCLUSIONS

- Italian children born in the 1990s show a significantly reduced transverse intermolar maxillary width and a tendency to a reduction of the posterior transverse intermolar discrepancy, in comparison with a sample of children born in 1950s.
- Contemporary children have a greater probability for developing a malocclusion compared with the children living 35 years before.

REFERENCES

1. Trowell HC, Burkitt DP, Eds. *Western Diseases: Their Emergence and Prevention.* Cambridge, Mass: Harvard University Press; 1981.
2. Corruccini RS. An epidemiologic transition in dental occlusion in world populations. *Am J Orthod.* 1984;86(5):419–426.
3. Lindsten R. Secular changes in tooth size and dental arch dimensions in the mixed dentition. *Swed Dent J Suppl.* 2003;(157):1–89.
4. Lindsten R, Ogaard B, Larsson E, Bjerklin K. Transverse dental and dental arch depth dimensions in the mixed dentition in a skeletal sample from the 14th to the 19th century and Norwegian children and Norwegian Sami children of today. *Angle Orthod.* 2002;72(5):439–448.
5. Lindsten R, Ogaard B, Larsson E. Dental arch space and permanent tooth size in the mixed dentition of a skeletal sample from the 14th to the 19th centuries and 3 contemporary samples. *Am J Orthod Dentofacial Orthop.* 2002; 122(1):48–58.
6. Lindsten R, Ogaard B, Larsson E. Transversal dental arch dimensions in 9-year-old children born in the 1960s and the 1980s. *Am J Orthod Dentofacial Orthop.* 2001;120(6):576–584.
7. Lindsten R, Ogaard B, Larsson E. Difference in dental lateral arch length between 9-year-olds born in the 1960s and the 1980s. *Am J Orthod Dentofacial Orthop.* 2000;117(6): 663–668.
8. Marinelli A, Alarashi M, Defraia E, Antonini A, Tollaro I. Tooth wear in the mixed dentition: a comparative study between children born in the 1950s and the 1990s. *Angle Orthod.* 2005;75(3):318–321.
9. Lavelle CL. Variation in the secular changes in the teeth and dental arches. *Angle Orthod.* 1973;43(4):412–421.
10. Brin I, Zwilling-Sellam O, Harari D, Koyoumdjisky-Kaye E, Ben-Bassat Y. Does a secular trend exist in the distribution of occlusal patterns? *Angle Orthod.* 1998;68(1):81–84.
11. Dahlberg G. *Statistical Methods for Medical and Biological Students.* New York, NY: Interscience Publications; 1940.
12. Houston WJ. The analysis of errors in orthodontic measurements. *Am J Orthod.* 1983;83(5):382–390.
13. Price, WA. *Nutrition and Physical Degeneration.* New Canaan, Conn: Keats Publishing, Inc; 1943.
14. Price, WA. Eskimo and Indian field studies in Alaska and Canada. *J Am Dent Assoc.* 1936;23:417–437.
15. Wood BF. Malocclusion in the modern Alaska Eskimo. *Am J Orthod.* 1971;60:344–354.
16. Begg P. *Begg Orthodontic Theory and Technique.* Philadelphia, Pa: WB Saunders Company; 1965.
17. Corruccini RS, Whitley LD. Occlusal variation in a rural Kentucky community. *Am J Orthod.* 1981;79:250–262.
18. Beecher RM, Corruccini RS. Effects of Dietary Consistency on Craniofacial and Occlusal Development in the Rat. *Angle Orthod.* 1981;51(1):61–69.
19. Beecher RM, Corruccini RS. Effects of dietary consistency on maxillary arch breadth in macaques. *J Dent Res.* 1981; 60(1):68.
20. Bouvier M, Hylander WL. Effect of bone strain on cortical bone structure in macaques (Macaca mulatta). *J Morphol.* 1981;167(1):1–12.
21. Ciochon RL, Nisbett RA, Corruccini RS. Dietary consistency and craniofacial development related to masticatory function in minipigs. *J Craniofac Genet Dev Biol.* 1997; 17(2):96–102.
22. Sly RM. Changing prevalence of allergic rhinitis and asthma. *Ann Allergy Asthma Immunol.* 1999;82(3):233–248.
23. Gross AM, Kellum GD, Franz D, Michas K, Walker M, Foster M, Bishop FW. A longitudinal evaluation of open mouth posture and maxillary arch width in children. *Angle Orthod.* 1994;64(6):419–424.
24. Gross AM, Kellum GD, Michas C, Franz D, Foster M, Walker M, Bishop FW. Open-mouth posture and maxillary arch width in young children: a three-year evaluation. *Am J Orthod Dentofacial Orthop.* 1994;106(6):635–640.
25. Corruccini RS, Flander LB, Kaul SS. Mouth breathing, occlusion and modernization in a North Indian population. *Angle Orthod.* 1985;55(3):190–196.
26. Corruccini RS, Kaul SS. The epidemiological transition and anthropology of minor chronic not-infectious diseases. *Med Anthrop.* 1984;7:36–50.
27. Marks MB. Allergy in relation to orofacial dental deformities in children: a review. *J Allergy Clin Immunol.* 1965;36:293–302.
28. Lindsten R, Ogaard B, Larsson E. Transversal dental arch dimensions in 9-year-old children born in the 1960s and the 1980s. *Am J Orthod Dentofacial Orthop.* 2001;120(6):576–584.
29. Tollaro I, Baccetti T, Franchi L, Tanasescu CD. Role of posterior transverse interarch discrepancy in Class II division 1 malocclusion during the mixed dentition phase. *Am J Orthod Dentofacial Orthop.* 1996;110:417–422.
30. Baccetti T, Franchi L, McNamara JA Jr, Tollaro I. Early dentofacial features of Class II malocclusion: a longitudinal study from the deciduous through the mixed dentition. *Am J Orthod Dentofacial Orthop.* 1997;111:502–509.
31. Varrela J. Early developmental traits in Class II malocclusion. *Acta Odontol Scand.* 1998;56:375–377.

32. Moyers RE, Wainright R. Skeletal contributions to occlusal development. In: McNamara JA Jr, ed. *The Biology of Occlusal Development,* Monograph 7. Craniofacial Growth Series. Ann Arbor, Mich: Center for Human Growth and Development, University of Michigan; 1977:89–111.
33. Tollaro I, Defraia E, Marinelli A, Alarashi M. Tooth abrasion in unilateral posterior crossbite in the deciduous dentition. *Angle Orthod.* 2002;72:426–430.
34. Lindsten R, Ogaard B, Larsson E. Difference in dental lateral arch length between 9-year-olds born in the 1960s and the 1980s. *Am J Orthod Dentofacial Orthop.* 2000;117(6):663–668.