Floating norms for the assessment of craniofacial pattern in the deciduous dentition

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SUMMARY This study provides norms for the evaluation of individual skeletal patterns in subjects with full deciduous dentition. The method is based on the associations among correlated craniofacial measurements (S–N–A, S–N–B, NL–NSL, ML–NSL, N–S–Ba). The results are given in a graphical box-like form (floating norms). An easy practical procedure allows identification of either individual harmonious craniofacial features or anomalous deviations from the individual norm. The use of cephalometric floating norms in the deciduous dentition phase is strongly recommended for early diagnosis and treatment planning.

Introduction

Conventional cephalometric diagnosis is clinically based on the use of population mean and range for separated craniofacial measurements. However, significant correlations among cephalometric skeletal variables (topographical correlations) have been assessed (Solow, 1966). This finding led to the concept of craniofacial pattern, which can be described by correlated sagittal and vertical skeletal parameters. It appeared advantageous therefore to substitute the norm intended as a population mean with a new norm constructed on the variability of the associations among suitable cephalometric variables (floating norms) (Hasund and Böe, 1980; Järvinen, 1986; Segner, 1989).

Unfortunately, floating norms as a means to evaluate individual skeletal patterns have been developed only for adult subjects (Segner, 1989). An attempt to provide a cephalometric classification of facial patterns for a sample of untreated subjects aged 7–19 years using floating norms was undertaken by Lavergne and Gasson (1976, 1982). This system allowed an appraisal of individual skeletal features during the juvenile and adolescent periods (Petrovic *et al.*, 1987, 1990).

In our opinion, the use of floating norms in earlier developmental phases should also be considered. During the deciduous dentition phase some malocclusions are already evident and they show a distinctive craniofacial pattern (Bishara *et al.*, 1988; Varrela, 1993; Tollaro

et al., 1994). Additionally, early diagnosis is needed in order to start treatment immediately when appropriate (West, 1969; Stensland *et al.*, 1988; Tollaro *et al.*, 1995a,b).

The aim of the present study is to give floating norms for the assessment of individual craniofacial pattern in the deciduous dentition phase as a guidance for early diagnosis and treatment planning.

Subjects and methods

A sample of 100 untreated children (42 males, 58 females) was selected from the files of the Department of Orthodontics of the University of Florence, Italy. All the children presented full deciduous dentition (mean age 5.67 ± 0.82 years).

The subjects were chosen according to the following criteria:

1) absence of caries of deciduous teeth;
2) absence of congenitally missing deciduous teeth;
3) absence of cleft lip and/or palate and of craniofacial malformative syndromes;
4) presence of normal occlusal relationship, i.e. flush terminal plane or mesial step deciduous molar relationship, Class I deciduous canine relationship, absence of anterior crossbite and open-bite.

The investigated sample therefore consisted of a group with ideal occlusion. All the subjects
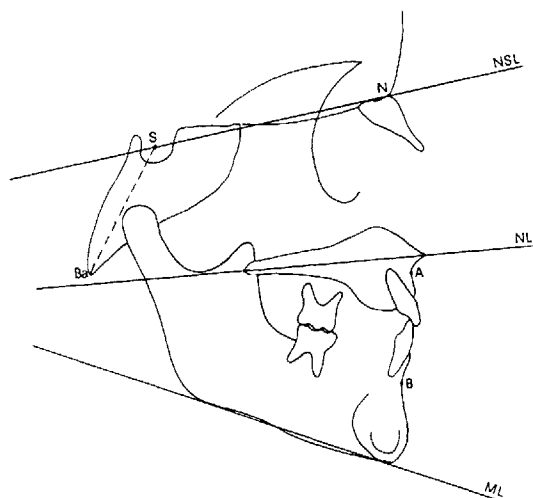
Figure 1   Cephalometric landmarks and planes.

were white Caucasian children from Tuscany, Italy.

Though not required by the nature of the cephalometric measurements (angular measurements), lateral standardized cephalograms of the 100 children were taken by using the same X-ray device and by a single technician. The focus-median plane distance was 152 cm and the film-median plane distance was 10 cm, allowing an enlargement of 7 per cent.

The following measurements were performed (Fig. 1): maxillary prognathism (S–N–A), mandibular prognathism (S–N–B), maxillary

inclination relative to the cranial base (NL–NSL), mandibular inclination relative to the cranial base (ML–NSL) and cranial base angle (N–S–Ba).

The method error for all these angles was assessed by means of Dahlberg's formula (1940) on 20 repeated measurements randomly selected from the total of the observations. The error in degrees was 0.58 for S–N–A; 0.41 for S–N–B; 0.31 for NL–NSL; 0.45 for ML–NSL; and 0.63 for N–S–Ba.

Data analysis

The statistical examination (Statgraphics®, 1987) of the recorded data comprised:

1) calculation of Pearson's correlation coefficients;

2) linear regression analysis;

3) multiple regression analysis.

Results

Descriptive statistics for all the cephalometric measurements are given in Table 1. Table 2 shows the linear correlation coefficients (r) between the cephalometric variables.

Linear regression equations with corresponding r^2 and standard error of the estimate are reported in Table 3. Table 4 shows the multiple

Table 1   Descriptive statistics.

Cephalometric variables	Mean	SD	SE	Min	Max
SNA	79.88	2.91	0.29	70.5	88.5
SNB	76.35	2.85	0.28	69.0	83.5
NL–NSL	7.94	2.75	0.27	−0.5	15.0
ML–NSL	35.23	3.27	0.32	27.5	43.0
NSBa	131.56	4.44	0.44	121.0	142.0

Table 3   Linear regression equations with corresponding r^2 and standard error (S.E.) of the estimate.

Regression equations	r^2	S.E.
SNB = 0.901SNA + 4.26	0.84	1.11
NL–NSL = −0.387SNA + 38.92	0.16	2.52
ML NSL = −0.328SNA + 61.43	0.08	3.14
NSBa = −0.741SNA + 190.93	0.23	3.89
SNA = −0.319NSBa + 121.98	0.23	2.55

Table 2   Correlation coefficients (r) between the cephalometric measurements.

Cephalometric variables	NL–NSL	N–S–Ba	ML–NSL	S–N–B
S–N–A	−0.409***	−0.488***	−0.292**	0.922***
NL–NSL		0.238*	0.282**	−0.407***
N–S–Ba			0.295**	−0.461***
ML–NSL				−0.384***

*$P<0.05$. **$P<0.01$. ***$P<0.001$.

S-N-A	NL-NSL	N-S-Ba	ML-NSL	S-N-B
58		148		56
59	16	147	42	57
60		146		58
61	15	146		59
62		145	41	60
63	14	144		61
64		143	40	62
65		142		63
66	13	141		64
67		140	39	65
68	12	139		66
69		138	38	67
70	11	137		68
71		136	37	69
72	10	135		70
73		134	36	71
74	9	133		72
75		132		73
76	8	131	35	74
77		130		75
78	7	129	34	76
79		128		77
80	6	127	33	78
81		126		79
82	5	125	32	80
83		124		81
84	4	123	31	82
85		122		83
86	3	121	30	84
87		120		85
88	2	119	29	86
89		118		87
90	1	117	28	88
91		116		89
92	0	115		90
93				91
94	-1			92
95				93
96				94
97				95
98				96
99				
100				
101				
102				
103				

Figure 2 Floating norms for the deciduous dentition in a graphical box-like form.

Table 4 Standard errors of the estimate (SE) when predicting one of the variables S–N–A, NL–NSL, N–S–Ba, ML–NSL, and S–N–B from the other four by means of multiple regression analysis ($n = 100$).

Cephalometric variables	R	R^2	SE
SNA	0.92	0.85	1.10
NL–NSL	0.40	0.16	2.52
NSBa	0.48	0.23	3.89
ML–NSL	0.42	0.18	2.94
SNB	0.92	0.85	1.07

correlation coefficients R, the adjusted R^2 and the standard error of the estimate when predicting one of the five measured variables from the remaining four by means of a multiple regression analysis.

Figure 2 illustrates the regression results in a graphical box-like form with S–N–A as the independent variable and NL–NSL, N–S–Ba, ML–NSL, and S–N–B each as the dependent variable, according to the method of Segner (1989).

Discussion

Many authors have recommended an early orthodontic/orthopaedic approach to different types of malocclusion (Thilander, 1963;

Sakamoto, 1981; Wieslander, 1984; Takada *et al.*, 1993). Moreover, the comparison between the values for some of the cephalometric variables (S–N–A, S–N–B, ML–NSL) in our primary dentition sample and in Segner's permanent dentition sample was statistically significant (Student's *t*-test, $P < 0.01$). This finding justified the investigation into craniofacial skeletal pattern in the deciduous dentition phase, in order to provide a discrete tool for early diagnosis and treatment planning. As no statistically significant differences between males and females were found for any of the cephalometric variables, the data were pooled.

The diagnostic diagram which is presented as a graphical box (Fig. 2) is the outcome of the pattern of associations among cephalometric variables. Any horizontal line connecting the values of the different variables inside the box has to be considered as a line expressing an harmonious skeletal pattern during the deciduous dentition phase. The line may correspond to the centre of the box (Fig. 3). In this case, the subject will be classified as harmonious and orthognathic. In fact, the central line of the box connects the mean values for the various measurements. When the line lies in the upper part of the box, the subject, though still harmonious,
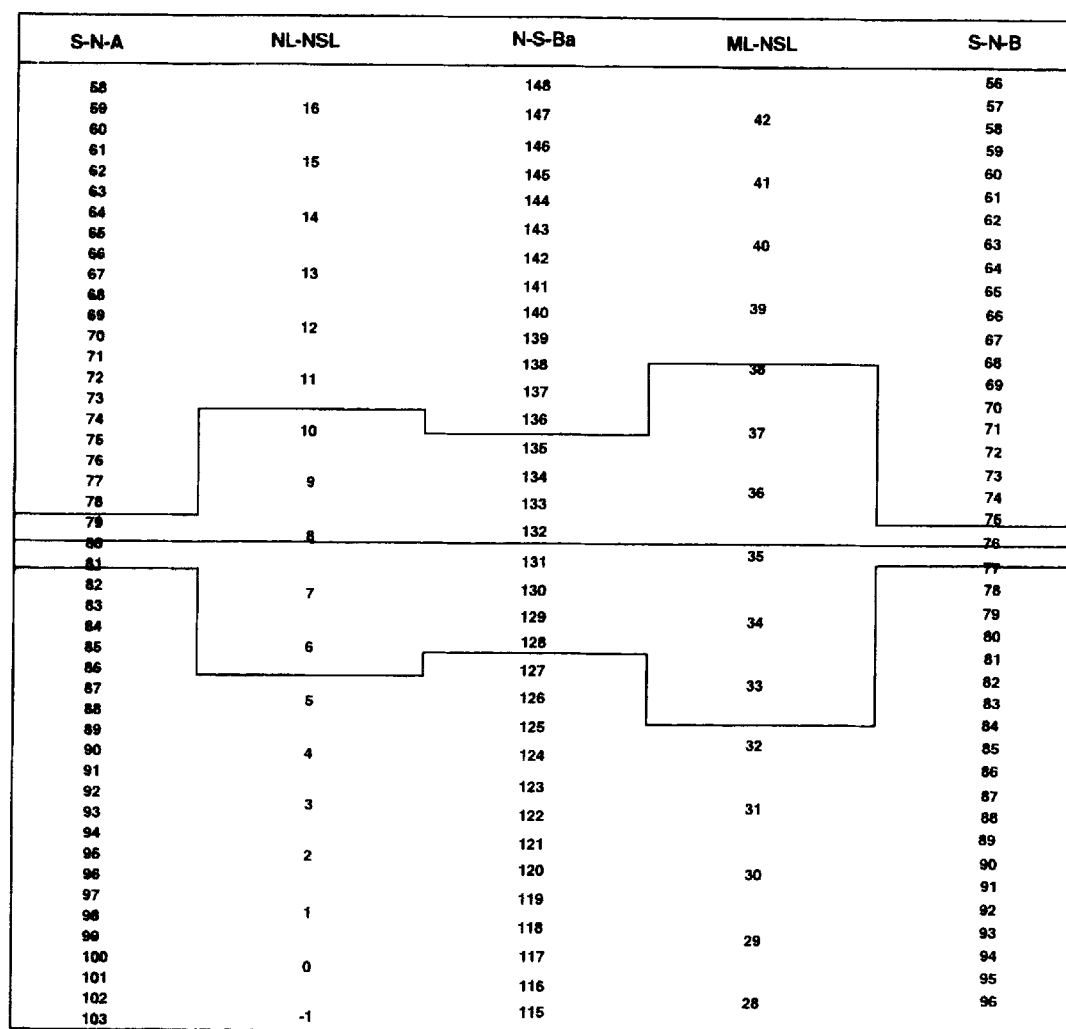
S-N-A	NL-NSL	N-S-Ba	ML-NSL	S-N-B
58		148		56
59	16	147	42	57
60		146		58
61	15	146		59
62		145	41	60
63		144		61
64	14	143		62
65		142	40	63
66		142		64
67	13	141		65
68		140	39	66
69	12	139		67
70		138		68
71		137	38	69
72	11	136		70
73		135	37	71
74	10	134		72
75		133	36	73
76	9	132		74
77		131	35	75
78	8	130		76
79		129	34	77
80	7	128		78
81		127	33	79
82	6	126		80
83		125	32	81
84	5	124		82
85		123	31	83
86	4	122		84
87		121	30	85
88	3	120		86
89		119	29	87
90	2	118		88
91		117	28	89
92	1	116		90
93		115		91
94	0			92
95				93
96	-1			94
97				95
98				96
99				
100				
101				
102				
103				

Figure 3 Graphical box with the mid-line connecting the mean values of the cephalometric variables and the range of variability represented by the standard error of the estimate of multiple regression analysis.

is classified as retrognathic. In order to maintain the ideal occlusion, the two jaws have to incline downward and backward in relation to the cranial base. When, on the other hand, the line lies in the lower part of the box, the subject, though still harmonious, is classified as prognathic and the jaws will show an upward-forward inclination in relation to the cranial base. A certain range of variability around any horizontal harmony line is actually allowed. The range of variability is represented by the standard error of the estimate of the multiple

regression analysis (Table 4). It therefore depends on the variability of the associations among cephalometric variables. The range is narrower for S–N–A and S–N–B, and wider for the remaining three variables (Fig. 3). Standard errors of the estimate for all the variables were lower than those given by Segner (1989). In particular, S–N–A, S–N–B and ML–NSL showed a narrower range, probably related to a smaller inter-subject skeletal variability in the deciduous dentition when compared with adult ages.
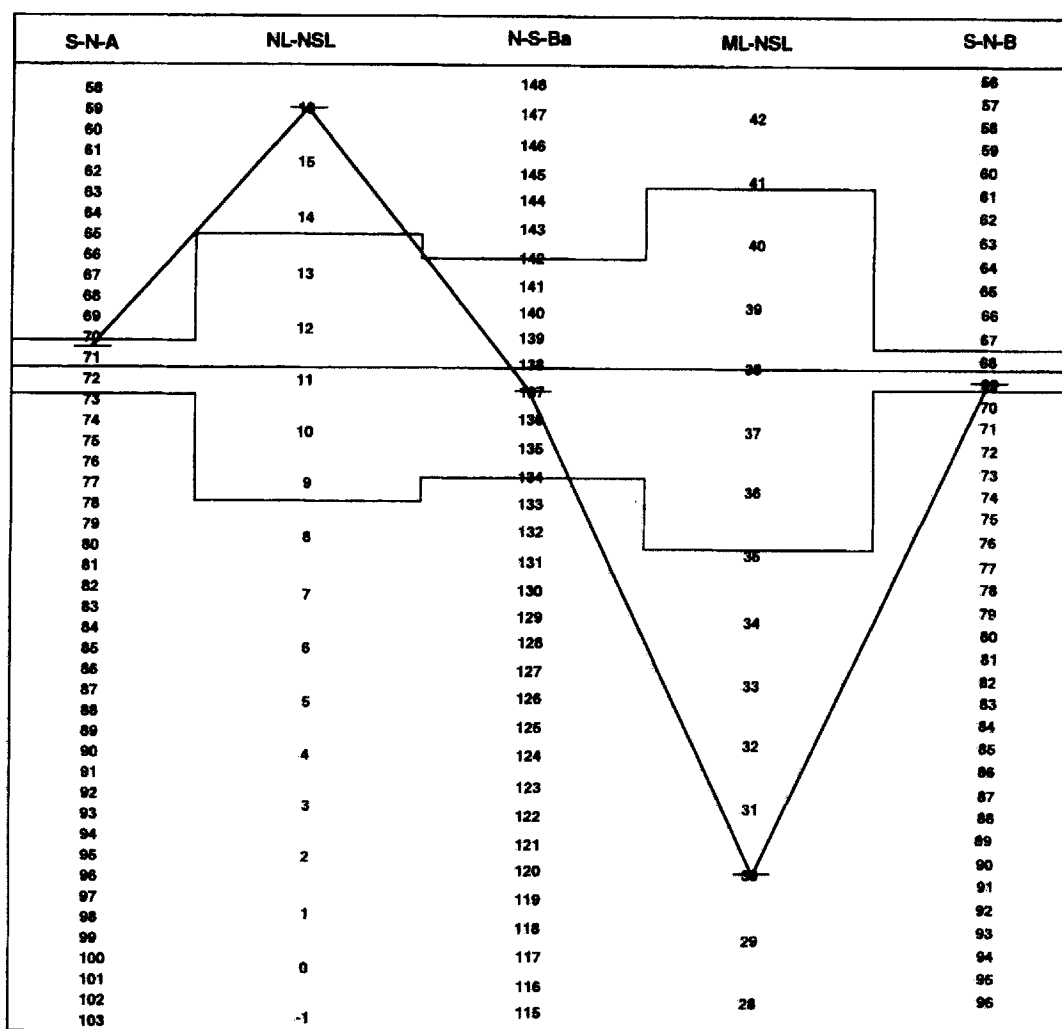

Figure 4 Values for a 5.6-year-old female reported inside the graphical box. The individual harmony line lies in the upper part of the box so that the patient can be classified as retrognathic. All the values except NL–NSL and ML–NSL fall within the range of variability. Consequently, the deviations from the harmonious craniofacial pattern are localized in the inclination of the two jaws in relation to the cranial base.

A subject whose cephalometric values fall within the range can still be considered as a subject endowed with an harmonious skeletal relationship. The same subject will be further classified as ortho-, retro- or prognathic according to the zone of the box that includes his cephalometric values. In this case, the individual horizontal harmony line is traced as a best-fit line among the individual cephalometric values. Practically, the range should be moved inside the box in a way that all the values of the patient fall within the borders of the range.

A step-by-step practical procedure can be performed as follows:

1) Localize the five cephalometric values of the patient inside the graphical box (Fig. 2).

2) Take a transparent acetate and draw on it only the borders of the range together with the mid-line as they appear in Fig. 3.

3) Superimpose the acetate on the graphical box.

4) Move the acetate along the graphical box so that the highest number of individual values fall within the range. The mid-line of the range on the acetate will automatically become the best-fit individual harmony line for the patient.

5) The value (or the values) which remain outside the range will indicate the deviation from a harmonious craniofacial pattern.

If one or more individual values lie outside of the range, they will indicate deviations from harmonious facial pattern. In this way, the cephalometric variables responsible for an unbalanced skeletal pattern will be easily detected. For example, the subject, a 5.6 year-old female, whose cephalometric values are shown in Fig. 4 presents three out of the five individual measurements within the borders of the range. The individual harmony line which is the best-fit line for the cephalometric measurements, lies in the upper part of the box. This classifies the patient as retrognathic. Further, the subject is harmonious as to sagittal skeletal relationship and to angulation of the cranial base (S–N–A, N–S–Ba, S–N–B). The deviations from harmonious craniofacial pattern are located in the inclinations of the jaws in relation to the cranial base (NL–NSL and ML–NSL). In particular the palatal plane is tilted downward and backward, whilst the mandibular plane is tilted upward and forward. Consequently, a diagnosis of skeletal deep bite can be assessed in this patient.

The early identification of such a severe skeletal deep bite during the deciduous dentition phase represents an important diagnostic finding allowing treatment to start immediately or to wait for more advanced developmental phases (after eruption of first permanent molars).

The results of the present study emphasize the importance of using a discrete cephalometric reference in the deciduous dentition. Further investigations should assess the possible need for a separate set of floating norms and of a separate box for children in the mixed dentition.

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