Correlating dental dimensions and malocclusion phenotypes in Brazilian population: A retrospective study

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ABSTRACT

Objective: to evaluate the association between tooth dimensions and skeletal malocclusions in a Brazilian population. **Material and methods:** This retrospective study evaluated 144 orthodontic records. Tooth dimensions were evaluated using dental casts for orthodontic diagnosis and a digital caliper. Sagittal skeletal discrepancies were used using angular measurements: the angle between sella, nasion, and subspinale point A (SNA), the angle between sella, nasion, and supramentale point B (SNB), and the angle between subspinale point A, nasion, and supramentale point B (ANB). The Mann-Whitney test was used to compare the tooth measurements between skeletal malocclusion groups. Spearman correlation was applied to evaluate the correlation between tooth measurements and ANB, SNA, and SNB values. Statistical analysis was performed with a significance level of 5%. **Results:** There was a significant differencebetween the mean tooth proportions of teeth 15, 23, 24, 34, and 44 and the retruded maxilla ($P<.05$). Teeth 12, 15, and 26 also showed statistical differences in the group in which the maxilla was protruded ($P<.05$). Teeth 12, 16, and 26 were larger in the group in which the mandible was protruded ($P<.05$). The SNB angle had a negative correlation with the mean dimensional proportion of tooth 41 ($r2=.200$; $P=.042$). **Conclusion:**There was a correlation between tooth dimensions and maxillary/mandible phenotypes in Brazilian population.

Keywords: Tooth Crown, Malocclusion Angle Class I, Malocclusion Angle Class II, Malocclusion Angle Class III.

1. INTRODUCTION

Malocclusions represent a serious public health problem highly prevalent in the world [1,2]. The malocclusion etiology is multifactorial [3-7], requiring long, complex, and costly therapeutic strategies for the orthodontist [8-10]. In this way, it is currently proposed different planning therapeutic strategies for treatment of the malocclusion leading to a more stable and functional occlusion [6,9,10].

Tooth-size measurement has been a valid diagnostic tool in the planning of therapeutic strategies by the orthodontist to treat malocclusions[11-13]. Tooth-size measurement is widely used to indicate if the available space in dental arch is sufficient to accommodate all the teeth. Patients with larger mesiodistal tooth-size are more likely to develop crowding and discrepancies [14]. Besides that, some studies also propose that tooth-size is associated with skeletal malocclusions [15-18] such as Angle Class III malocclusions [17,18] and Angle Class I malocclusions [15,16,18]. This link between tooth-size and skeletal malocclusion, despite barely explored, may improve the understanding of skeletal malocclusion etiology and to assist the orthodontist in the decision-making process for the best treatment for his patient.

Skeletal malocclusion and tooth-size are sensitive to individual and population variability. Some studies highlight the need for global and regional epidemiological recognition of malocclusion and tooth phenotypes [16,19,20]. Therefore, this study aimed to evaluate the association between mesiodistal tooth-size skeletal malocclusions in a Brazilian population. The alternative hypothesis is that there is an association/correlation between tooth dimensions and skeletal malocclusions or ANB, SNA and SNB values.

2. MATERIAL AND METHODS

2.2 SAMPLE CHARACTERIZATION

This retrospective study evaluated 144 orthodontic records (anamnesis, dental casts, and lateral cephalometric radiographs) of patients who started orthodontic treatment at the Postgraduate Orthodontics Clinic of the Ribeirão Preto Dental School, University of São Paulo, Brazil (FORP/USP) between the years 2016 to 2018. The sample was obtained by convenience. All patients who had a complete orthodontic record were initially included. Patients with tooth/teeth elements that were semi-erupted, with occlusal wear, affected by dental caries and restored on the surface mesial/distal were not evaluated and excluded from the analysis. Patients who had systemic disease or craniofacial syndromes, history of facial trauma or facial surgery, previous orthodontic treatment, records with missing radiographs and radiographs with poor quality or missing anatomical landmarks were also excluded.

2.3 DETERMINATIONS OF TOOTH DIMENSIONS PHENOTYPE

Dental dimensions were evaluated using dental casts for orthodontic diagnosis and a digital caliper (Mitutoyo 500-752-20 Compasso Digital Digimatic). The maximum mesiodistal dimension of the crown of all dental elements was individually measured in millimeters and with an accuracy of 0.1 mm. Maximum distances were defined as the most extreme points of proximal anatomical contact, mesial and distal, in a line perpendicular to the long axis of the tooth [21] All measurements were performed by only one previously calibrated operator with strict criteria to reduce variation [21].

2.4 DETERMINATION OF SKELETAL MALOCCLUSION

Pretreatment lateral cephalometric radiographs were hand traced and measured by two orthodontists previously trained (inter-observer agreement 0.95). The following landmarks were used for cephalometric analysis: point A (A), point B (B), sella (S), and nasion (N). Sagittal skeletal discrepancies were assessed using angular measurements: angle between sella, nasion and subspinale point A (SNA), angle between sella, nasion and supramentale point B (SNB), and angle between subspinale point A, nasion and supramentale point B (ANB). Then, the total sample was classified as skeletal Class I malocclusion ($0° < ANB < 4°$), skeletal Class II malocclusion ($ANB \geq 4°$), and skeletal Class III malocclusion ($ANB \leq 0°$). The evaluation was performed by a single examiner previously trained and calibrated.

2.5 STATISTICAL ANALYSIS

The normality of data was verified by Shapiro-Wilk test, which indicate non-normality of the data ($P < .05$). Mann-Whitney test was used to compare the tooth-measurements among the skeletal malocclusion groups. Spearman correlation was applied to evaluate the correlation between tooth-measurements and ANB, SNA and SNB values. The tests were performed by IBM SPSS version 25.0 (IBM Corp. Armonk, USA) and the alpha value was set at 0.05.

3. RESULTS AND DISCUSSION

One hundred eight patients were included (53 male patients, 55 female patients; mean age = 15.0 ± 7.2 years).The comparison of tooth proportion mean between skeletal malocclusion groups is presented in the Table 1. There was no significant difference between tooth proportion mean and skeletal malocclusion ($P>.05$).

The correlation between the tooth proportion means and the SNA, SNB and ANB angles were performed. There was a significant difference between the mean tooth proportions of maxillary right second premolar, maxillary left canine and first premolar and mandibular right first premolar and the retruded maxilla in relation to the skull base. The teeth had a larger mean size in the group in which the maxilla was retruded ($P< .05$). Teeth maxillary left lateral incisor, maxillary left second premolar and maxillary right first molar showed statistical difference in the group in which the maxilla was protruded in relation to the base of the skull ($P<.05$). The teeth had a larger mean size in the group in which the maxilla was protruded (Table 2). In relation to the mandible, teeth upper left lateral incisor and maxillary first molars were larger in the group in which the mandible was protruded in relation to the base of the skull ($P<.05$) (Table 3).

There was no correlation between SNA and ANB angles and the tooth proportion means. The SNB angle had a negative correlation with the mean dimensional proportion of tooth mandibular right central incisor ($r2 = .200$; $P= .04$) (Table 4).

Table 1. Mean comparison of tooth proportion among skeletal malocclusion groups

Tooth	Skeletal malocclusion Classe I		Skeletal malocclusion Classe II		p-value	Skeletal malocclusion Classe III		p-value
	Mean	Standard Deviation	Mean	Standard Deviation		Mean	Standard Deviation	
11	8.87	0.68	8.78	0.65	0.281	8.89	0.53	0.828
12	6.92	0.81	6.83	0.84	0.885	6.89	0.72	0.836
13	7.74	0.59	7.69	0.65	0.910	8.02	0.56	0.108
14	7.16	0.54	7.26	0.65	0.622	7.13	0.58	0.972
15	6.69	0.78	6.79	0.67	0.263	6.74	0.74	0.825
16	9.80	0.59	9.79	0.56	0.842	9.87	0.90	0.834
21	8.94	0.70	8.83	0.68	0.322	8.90	0.63	0.771
22	6.87	0.67	6.82	0.77	0.636	7.03	0.58	0.172
23	7.73	0.60	7.72	0.56	0.891	8.03	0.47	0.066
24	7.08	0.59	7.11	0.59	0.944	7.24	0.51	0.381
25	6.75	0.86	6.78	0.74	0.379	6.84	0.60	0.201
26.	9.74	0.71	9.80	0.57	0.655	9.81	0.74	0.888
31	5.56	0.45	5.47	0.48	0.429	5.53	0.44	0.669
32	6.06	0.50	6.04	0.46	0.844	6.04	0.47	0.908
33	6.89	0.62	6.80	0.47	0.575	7.05	0.54	0.400
34	7.29	0.55	7.17	0.70	0.218	7.34	0.44	0.665
35	7.34	0.95	7.19	1.04	0.293	7.26	0.87	0.814
36	10.96	0.65	10.98	0.76	0.846	11.12	0.94	0.942
41	5.61	0.46	5.51	0.43	0.299	5.53	0.33	0.746
42	6.11	0.51	6.09	0.43	0.879	6.03	0.45	0.747
43	6.89	0.59	6.78	0.43	0.403	6.75	0.76	0.497
44	7.27	0.65	7.17	0.64	0.404	7.28	0.43	0.758
45	7.26	1.05	7.12	1.02	0.727	7.05	0.49	0.908
46	10.91	0.67	11.01	0.72	0.558	11.05	1.14	0.827

Table 2. Mean comparison of tooth proportion among SNA classification.

Tooth	SNA = 80º to 84º		SNA < 80º		p-value	SNA > 84º		p- value
	Mean	Standard Deviation	Mean	Standard Deviation		Mean	Standard Deviation	
11	8.75	0.68	8.93	0.58	0.260	8.88	0.68	0.216
12	6.65	0.73	7.04	0.84	0.064	7.00	0.81	0.041*
13	7.61	0.64	7.92	0.65	0.134	7.78	0.53	0.394
14	7.14	0.62	7.24	0.63	0.165	7.19	0.50	0.465
15	6.55	0.84	6.82	0.56	0.008*	6.83	0.72	0.026*
16	9.73	0.64	9.76	0.59	0.923	9.91	0.63	0.503
21	8.76	0.71	9.01	0.58	0.102	8.96	0.71	0.119
22	6.75	0.68	6.94	0.61	0.383	6.94	0.75	0.296
23	7.59	0.54	7.91	0.61	0.020*	7.81	0.56	0.072
24	6.99	0.54	7.25	0.58	0.018*	7.14	0.60	0.335
25	6.70	0.91	6.68	0.47	0.244	6.89	0.85	0.127
26	9.52	0.58	9.76	0.74	0.052	10.00	0.62	0.001*
31	5.53	0.40	5.61	0.46	0.523	5.48	0.50	0.735
32	6.03	0.46	6.00	0.49	0.897	6.09	0.49	0.495
33	6.79	0.54	7.01	0.54	0.126	6.89	0.61	0.398
34	7.15	0.59	7.45	0.45	0.018*	7.24	0.64	0.449
35	7.15	1.03	7.40	0.96	0.109	7.32	0.92	0.122
36	10.80	0.65	11.03	0.65	0.254	11.13	0.79	0.052
41	5.52	0.43	5.58	0.45	0.589	5.61	0.44	0.388
42	6.04	0.46	6.03	0.52	0.961	6.19	0.46	0.130
43	6.81	0.58	6.77	0.59	0.881	6.91	0.56	0.531
44	7.06	0.62	7.35	0.46	0.022*	7.33	0.69	0.092
45	7.11	1.10	7.24	0.92	0.232	7.22	0.91	0.408
46	10.75	0.72	11.02	0.84	0.256	11.11	0.68	0.120

Table 3. Mean comparison of tooth proportion among SNB classification.

Tooth	SNB = 78º to 82º		SNB < 78º		p-value	SNB > 82º		p- value
	Mean	Standard Deviation	Mean	Standard Deviation		Mean	Standard Deviation	
11	8.79	0.67	8.80	0.61	0.909	8.94	0.69	0.386
12	6.68	0.82	6.94	0.78	0.175	7.02	0.79	0.043*
13	7.70	0.56	7.71	0.71	0.896	7.85	0.54	0.279
14	7.16	0.52	7.22	0.68	0.737	7.17	0.53	0.945
15	6.64	0.80	6.72	0.66	0.206	6.80	0.76	0.197
16	9.60	0.61	9.85	0.58	0.073	9.94	0.64	0.049*
21	8.91	0.67	8.85	0.63	0.526	8.94	0.75	0.871
22	6.79	0.78	6.81	0.52	0.873	7.00	0.75	0.266
23	7.65	0.55	7.69	0.63	0.822	7.91	0.52	0.077
24	7.10	0.55	7.08	0.60	0.777	7.15	0.58	0.955
25	6.71	0.73	6.69	0.74	0.832	6.89	0.88	0.362
26	9.65	0.52	9.66	0.76	0.449	9.96	0.65	0.028*
31	5.59	0.41	5.49	0.40	0.283	5.53	0.53	0.849
32	6.02	0.48	5.97	0.45	0.700	6.14	0.50	0.453
33	6.79	0.48	6.86	0.58	0.514	6.98	0.62	0.113
34	7.19	0.59	7.32	0.58	0.909	7.27	0.59	0.895
35	7.21	0.72	7.32	1.16	0.973	7.30	0.97	0.545
36	10.82	0.72	10.97	0.60	0.257	11.16	0.78	0.051
41	5.52	0.33	5.48	0.47	0.499	5.69	0.46	0.069
42	6.08	0.51	6.00	0.45	0.486	6.20	0.46	0.436
43	6.70	0.61	6.81	0.52	0.439	6.98	0.57	0.076
44	7.10	0.49	7.25	0.62	0.363	7.34	0.70	0.256
45	7.16	0.72	7.20	1.20	0.857	7.21	0.96	0.905
46	10.75	0.67	10.93	0.79	0.261	11.17	0.74	0.035*

Table 4. Spearman correlation among tooth-measurements and ANB, SNA and SNB values.

Tooth		SNA	SNB	ANB
11	r^2	0.049	0.146	-0.110
	p-value	0.614	0.131	0.256
12	r^2	0.047	0.104	-0.067
	p-value	0.632	0.288	0.493
13	r^2	-0.031	0.110	-0.164
	p-value	0.762	0.283	0.108
14	r^2	-0.010	0.033	0.028
	p-value	0.919	0.742	0.780
15	r^2	0.081	0.082	0.098
	p-value	0.405	0.403	0.315
16	r^2	0.119	0.100	0.031
	p-value	0.226	0.312	0.756
21	r^2	0.042	0.121	-0.103
	p-value	0.670	0.215	0.294
22	r^2	0.038	0.164	-0.188
	p-value	0.695	0.091	0.053
23	r^2	-0.002	0.143	-0.151
	p-value	0.984	0.149	0.127
24	r^2	-0.092	0.030	-0.085
	p-value	0.357	0.764	0.398
25	r^2	0.086	0.135	0.012
	p-value	0.386	0.173	0.904
26	r^2	0.186	0.181	0.040
	p-value	0.060	0.067	0.688
31	r^2	-0.014	0.099	-0.083
	p-value	0.888	0.314	0.400
32	r^2	0.088	0.155	-0.059
	p-value	0.373	0.114	0.548
33	r^2	-0.013	0.108	-0.140
	p-value	0.896	0.272	0.154
34	r^2	-0.088	0.029	-0.147
	p-value	0.381	0.773	0.143
35	r^2	0.069	0.152	-0.092
	p-value	0.493	0.132	0.365
36	r^2	0.116	0.108	0.053
	p-value	0.258	0.294	0.608
41	r^2	0.069	.200*	-0.149
	p-value	0.490	0.042	0.130
42	r^2	0.129	0.181	-0.056
	p-value	0.193	0.067	0.577
43	r^2	0.107	0.167	-0.050
	p-value	0.278	0.089	0.613
44	r^2	-0.012	0.073	-0.117
	p-value	0.902	0.468	0.246
45	r^2	0.047	0.098	0.006
	p-value	0.642	0.329	0.949
46	r^2	0.079	0.110	0.046
	p-value	0.435	0.274	0.650

The harmonic development of the stomatognathic system is essential for the general homeostasis of the human organism. The presence of all teeth within normal limits and with an adequate mesiodistal width ratio is essentially important for a balanced, aesthetical, and functional dental occlusion [11-13]. Our results showed that the mesiodistal dimension of some teeth were associated with maxillary retrognathism and maxillary and mandibular prognathism. A negative correlation was also observed in the lower left incisor and the increase in the ANB angle.The alternative hypothesis was partially confirmed.

Our results demonstrate that the mesiodistal dimensions of the maxillary right second premolar, maxillary left canine and first premolar, and mandibular right first premolars were larger in patients with maxillary retrognathism compared to patients with well-positioned maxilla. It is assumed that there was a lack of symmetry in the upper hemiarches, since it is estimated to find an arch perimeter parallel to the dental dimensions [22,23]. Regarding the mandibular first premolars, it is assumed that a compensatory mechanism acted on these teeth to compensate for the lack of maxillary development aiming at a balanced/ideal functional occlusion [20,24].

In individuals with maxillary protrusion, the mesiodistal dimensions of maxillary left lateral incisor, maxillary left second premolar, and maxillary right first molar were larger when compared to individuals with maxilla well-positioned. This finding is justified given the development fields proposed by Kjaer [24]. Limits between the frontonasal, maxillary, and palatine regions in the maxillary and mandibular allow a better understanding of regional differences in the dental arch; alveolar bone growth also depends on innervation [25]. Thus, just as lateral incisors and second premolars are more prone to agenesis, it is proposed that crown dimensions can also be altered.

An increase in the mesiodistal dimension of the maxillary and mandibular first molars has been described in association with mandibular protrusion [15,17,22,23]. Our results agree with these studies. We demonstrated an increase of the mesiodistal dimensions in the maxillary right lateral incisor, maxillary first molars, and mandibulary right first molar in patients with mandibular protrusion compared with patients with well-positioned mandible. It is worth mentioning that contrary results have already been proposed when related to sexual dimorphism [26]. Furthermore, the study by Malkoç et al. [26] emphasizes the reduced dimension of mandibulary central incisors in patients classified as Angle Class III, such a result agrees with our findings that suggest the trend of smaller mandibulary right incisor as the SNB angle is increased.

One of the limitations of our study was the use of plaster dental casts and manual tooth-size measurement. Tooth-size measurements could be obtained from digital models by 3D scanner or by cone bean computed tomography (CBCT). Despite the evidence showing the diagnostic advantages of digital study models, their clinical use has not been widespread in developing countries yet. This can be attributed to the high cost of scanning technology and reliance on the software involved in acquiring digital data.

In summary, given that achieving a stable, functional, and esthetic occlusion also requires a complete assessment of tooth dimensions, knowledge about trends in tooth size variations in patients with different types of malocclusions can help orthodontic and surgical planning in relation to need for space and relationship between dental arches.The importance of the present study is highlighted for be carried out with a Brazilian sample and for the citation of the SNA, SNB, and ANB angles together with the malocclusion phenotypes.

5. CONCLUSION

Although we did not observe an association between dental dimensions and skeletal malocclusion, there are correlations between dental dimensions and maxillary and mandible phenotypes. It is estimated that further studies will be carried out in different populations to optimize orthodontic practice.

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COMPETING INTERESTS

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTIONS

E.C.K. and J.C.Z conceived the idea; M.R.K., M.N.M. and M.B.S.S. designed the study; M.R.K., I.R.M. and C.L.B.R. collected the data; C.L.B.R. analyzed the data; I.R.M., C.P.L., M.A.H.M.O. and F.B.F. writing—original draft preparation; M.R.K., I.R.M., E.C.K. and J.C.Z. writing—review and editing; I.R.M and C. L. B. R. funding support. All authors interpreted the data and revised the final version of the manuscript.

ETHICAL APPROVAL AND CONSENT

This study was approved by the Ethics Committee of the School of Dentistry of Ribeirão Preto, University of São Paulo, Brazil (CAAE: 01451418.3.0000.5419/3.150.551) and follow the Helsinki declaration. All the patients who agreed to participate in this study signed the consent form.

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