Research Article

The Journal of Clinical Medicine (ISSN 2995-6315)

Mandibular asymmetries in brazilian adolescents: prevalence and associated factors

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Received Date : April 24, 2024
Accepted Date : April 25, 2024
Published Date : May 25, 2024

ABSTRACT

Objectives : Estimate the prevalence of mandibular asymmetries in Brazilian adolescents and investigate the demographic and skeletal factors associated to the asymmetries.
Methods : Cone beam computed tomography (CBCT) images from 376 individuals aged from 10 to 19 were analysed to investigate mandibular asymmetry categorized as relative mandibular symmetry, moderate asymmetry, and severe asymmetry. Exposure variables included sex, age, side of mandibular deviation, sagittal and vertical skeletal pattern of the individuals, and cranial base angulation. The chi-square test was used to evaluate the association among asymmetry and the exposure variables. Gross prevalence rations were estimated and adjusted by Poisson regression with robust variance. Significance level was established at 5%.
Results : Prevalence values were of 78.2% for relative mandibular symmetry, 14.4% for moderate asymmetry, and 7.4% for severe asymmetry. Bivariate analysis revealed that mandibular asymmetry was associated to age, sex, and side of the mandibular deviation (p=0.021, p=0.038 e p=0.000, respectively).
Conclusions : The prevalence of mandibular asymmetry in Brazilian adolescents was of 21.8%, being more associated to patients of the male sex aged between 17-19 years who present mandibular deviation to the left side.

Keywords : Facial Asymmetry, Prevalence, Cone-Beam Computed Tomography, Adolescent

INTRODUCTION

Although an individual may present good facial aesthetics, the front view of the face is not completely symmetric, being absolute bilateral symmetry unusual in nature [1-3].
In general the facial asymmetry is a consequence of a disorganized growing pattern of the cranial structures which may be triggered by genetic factors, congenital malformations, environmental factors, habits and/or traumas, and functional deviations that may compromise maxillary and mandibular growth [2], or due to pathological factors, such as hyperplasia, osteosarcoma, paralysis, and others [4-6].
Facial asymmetry may also happen during the growth, being defined as idiopathic and non-syndromic, and occurring in the general population. This asymmetry is not observed at birth or during the childhood, and it gradually manifests itself over the growth [1,2,7] being capable of negatively influencing the psychosocial characteristics of the individuals and their quality of life [8-10].
When determining facial asymmetry, mandibular deviation is usually the main characteristic influencing the disharmony, being the displacement of the chin in relation to the median sagittal plane of the face the most striking one [4,11-13]. It is also common for the individual to present a subclinical mild degree of facial asymmetry. Such characteristic may be related to skeletal disharmony, hidden by the soft tissue that covers it, and, although there are discrepancies between the right and left sides, it is considered normal [1,2,14].
Asymmetries may also pose a challenge to orthodontic treatments [15-18], mainly in adults. The most of the studies and data presented in the literature are related to this age group and have showed a prevalence from 11% to 37% [13,19,22]. However, when the diagnostic method is more

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accurate, the asymmetry prevalence may be higher than 50% [2,4,23,24], which indicates that a precise diagnosis is paramount to locate the asymmetry and determine the best strategy for the treatment [15-18].

On the prevalence of asymmetries in adolescents, there are few studies in the literature. In one of the few not so recent study, Ramirez-Yañez et al [2] found that about 25% of the patients evaluated presented craniofacial asymmetry.

Therefore, considering the absence of studies with young individuals from Brazil mainly using cone beam computed tomography (CBCT), the objective of this cross-sectional retrospective study was to estimate the prevalence of mandibular asymmetry among Brazilian adolescents, and its association with demographic and skeletal factors.

MATERIALS AND METHODS

Sample

Institutional ethical committee approval from Lutheran University of Brazil (Canoas - RS) was obtained prior to conducting the study (reference number: 4.310.478).

The sample was comprised by cone beam computed tomography (CBCT) of 376 individuals extracted from the database of a dental diagnosis and planning center (Compass3D®, Belo Horizonte, MG, Brazil). Images were randomly chosen in relation to sex and race of the individuals. StatCalc from Epi Info version 7 was used to sample calculation. The calculation was based on a cross-sectional study with an expected prevalence of 25% of individuals ranging from moderate to severe asymmetry, confidence interval of 95% and power of 80%. The proportion of exposed and no-exposed ones was of 1:1, and the minimum sample should be comprised by 288 individuals.

The inclusion criteria were: tomographic images should have been asked either with clinical justification, or if it was impossible to answer to the clinical needs using conventional radiographic techniques (guidelines from Sedentexct project) 25, individuals should be between 10 and 19 years old, images should have been generated in tomographic devices of the same brand (i-CAT®, Imaging Sciences International, Hatfield, Pa). Exclusion criteria: individuals who had undergone trauma and/or surgeries on the face, craniofacial syndromes and anomalies.

Tomography

The same equipment (i-CAT - Imaging Sciences International, Hatfield, Pa), adjusted for 120KvP, 3-8mA and exposition time of 20 seconds, was used.

Patients were instructed to seat, occlude in maximum habitual intercuspation, and leave lips at rest. The head was positioned keeping the Frankfurt plane parallel to the ground and the median sagittal plane perpendicular to the ground.

Data collecting

DICOM files were imported to SimPlant Ortho Pro 2.0® (Materialise Dental, Lueven, Belgium), which provides the exact values of the measurements chosen. Aiming at a higher precision of the measurements, the location of the anatomic points were done by multi-planar reconstruction cuts, measurement scale of 0.01mm and 0.01°.

Table 1 presents the used points and planes of reference, and Table 2 shows the measures evaluated (Fig 1).

Table 1. Description of the anatomical points and reference planes used in this study.

Point/Plane	Abbreviation	Definition
Anatomical porion	Po	The highest point of the external auditory meatus
Orbital	Or	The lowest point of the infra-orbital margin
Basion	Ba	Midpoint on the anterior margin of the occipital foramen
Sella	S	Central point of the sella turcica
Nasion	N	The most anterior and medium point of the nasofrontal suture
Subspinal	A	The deepest anterior point in the concavity of the anterior maxilla
Supramandibular	B	Point located in the deepest concavity of the anterior portion of the mandibular symphisis
Gnathion	Gn	The lowest point of the anterior margin of the lower jaw
Pterygoid	Pt	The highest and posterior point of the superior margin of the pterygomaxillary fissure
Gonion	Go	The lowest and most posterior point of the gonia angle outline
Frankfurt plane	Frankfurt	The plane passes through the right and left anatomical porion and the left orbital point (PoR, PoL – OrL)
Median Sagittal Plane	MSP	It refers to the intersection of Nasion and Basion points, perpendicular to the Frankfurt Plane. Used to evaluate transverse changes

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Table 2. Tomographic measure.

Measurement	Definition	Variable
Gn-MSP	Distance between gnathion and the median sagittal plane	Mandibular Asymmetry
ANB angle	Angle formed by the intersection of the lines N-A and N-B	Sagittal skeletal pattern
N-Ba.PtE-Gn	Angle of the intersection of the lines N-Ba.PtE-Gn	Vertical skeletal pattern
S-N.S-Ba	Angle of the intersection of the lines S-N.S-Ba	Angle of the cranial base

Figure 1

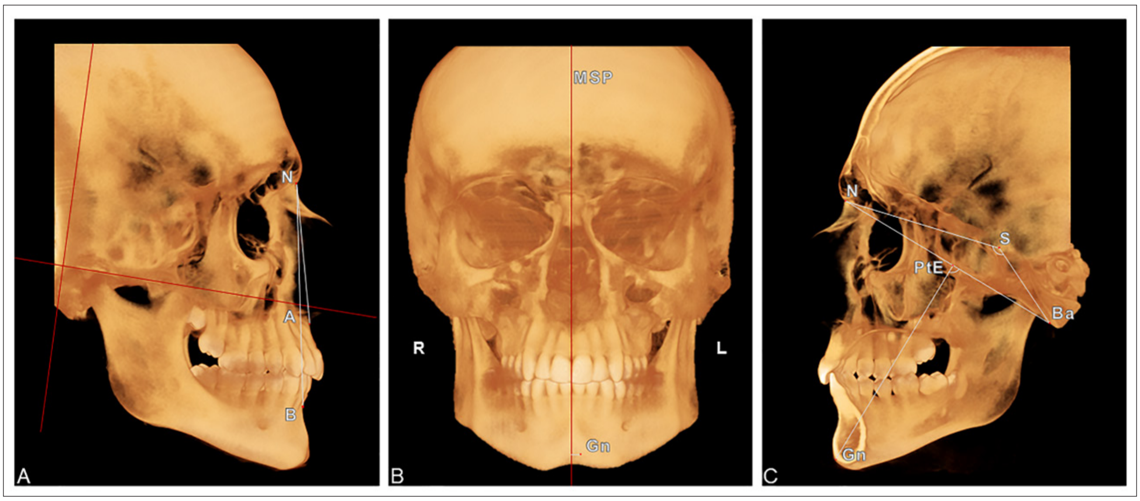

Figure 1. Measurements used in the study for skeletal variables: (A) ANB Angle (sagittal jaw relationship); (B) Gn-MSP (mandibular asymmetry); (C) N-Ba.PtE-Gn Angle (vertical skeletal relationship) and N-S-Ba angle (cranial base angle).

The primary outcome was the presence of mandibular asymmetry among Brazilian adolescents. Such asymmetry was determined by the displacement of the gnathion in relation to the median sagittal plane of the patient, because the chin has been responsible for having the greatest influence on the perception of facial symmetry [4,12,13]. Patients presenting up to 2mm gnathion deviation in relation to the median sagittal plane were considered as having relative symmetry [2,4,26-28]. The ones within more than 2mm up to 4mm gnathion deviation were classified as having moderate asymmetry, and the ones with a gnathion deviation greater than 4mm were classified as having severe asymmetry [4,12,29,30].
The exposure variables and the way they were analysed are described as follow:
Demographic variables: sex (male and female); Age (from 10 to 19), divided into three groups of age (10-13/14-16/17-19).
Skeletal variables: Side of the mandibular deviation (right or left), determined by the distance of the gnathion in relation to the median sagittal plane. Positive values indicate mandibular asymmetry to the left side and negative values to the right side. Sagittal skeletal pattern was determined by ANB angle, being considered Class I (between 0° and 4.5°), II (>4.5°), and III (<0°) [31,32]. Vertical skeletal pattern determined by N-Ba.PtE-Gn angle, it was considered as balanced (between 87° and 93°), vertical (<87°), and horizontal (93°) [33]. Cranial base angulation was determined by N-S-Ba angle, being considered normal (between 127° and 136°), acute (<127°) and obtuse (>136°) [34].

Error of the method

Three dental professionals performed the tomographic measurements, being the error determined by the intraclass correlation coefficient (ICC), intraobserver and interobserver. The three professionals evaluated 10% of the tomographic measurements in two different moments, with an interval of two weeks between evaluations. ICC, intraobserver and interobserver, was of > 0.90 for both measurements, showing that the method was highly reliable.

Statistical Analysis

SPSS® version 20.0 (IBM, Chicago, IL, USA) was used to the Statistical Analysis. Bivariate analysis, the qui-square (X^2) test, was used to evaluate the association among asymmetry and the exposure variables, significance level of $p<0.05$. Crude prevalence

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rations were estimated and adjusted for the individuals with asymmetry, in the exposure variables, by the Poisson regression (p<0.20).

RESULTS

Table 3 shows the characteristics of the sample, with absolute and relative frequencies of the dependent (outcome) and independent variables.

Table 3. Characteristics of sample individuals (n=376).

Variables/Category	N (%)
Sex	
Male	160 (42.6)
Female	216 (57.4)
Age	
10-13	190 (50.5)
14-16	116 (30.9)
17-19	70 (18.6)
Mandibular Asymmetry	
Relative symmetry	294 (78.2)
Moderate asymmetry	54 (14.4)
Severe asymmetry	28 (7.4)
Side of mandibular deviation	
Left	250 (66.5)
Right	126 (33.5)
Sagittal skeletal pattern	
Class I	193 (51.3)
Class II	113 (30.1)
Class III	70 (18.6)
Vertical skeletal pattern	
Vertical	99 (26.3)
Balanced	232 (61.7)
Horizontal	45 (12.0)
Cranial base angulation	
Acute	2 (0.5)
Balanced	370 (98.4)
Obtuse	4 (1.1)

The average age of the patients was of 13.7 years, and there was a prevalence of 21.8%, being 14.4% (54/356) of moderate asymmetry, and 7.4% (28/376) of severe asymmetry. The frequency of mandibular deviation to the left side (66.5%) was almost twice higher than to the right side (33.5%), and it was associated both with moderate and severe asymmetry.
Results about the prevalence of sagittal skeletal pattern showed that Class I was 51.3%, while Classes II and III represented 20.1% and 18.6% respectively. Regarding the vertical skeletal pattern, the balanced type (61.7%) was the most observed, followed by the vertical (26.3%) and horizontal (12%).
Data from cranial base angulation showed that the normal pattern (98.4%) was the most frequent, being followed by the obtuse angle (1.1%) and acute angle (0.5%).
Table 4 shows the results of the association tests between mandibular asymmetries and exposure variables. There was a

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significant association with the demographic variables of sex and age. Moderate asymmetry was associated to male adolescents, and to the older ones (17-19 years old).
Regarding the skeletal exposure variables, only the side of the mandibular deviation showed association with the principal outcome. It was observed that the deviation to the left side was associated with the presence of both moderate and severe asymmetries.
During the statistical analyses, it was observed that there was no need to use Poisson regression, as the only association with a p<0.02 was the variable regarding the side of the deviation, which showed a frequency of 100%, both for moderate and severe mandibular asymmetries.

Table 4. Bivariate analysis of the association between mandibular asymmetries and the exposure variables (n=376).

Mandibular Asymmetry								
		Relative Symmetry		**Moderate**		**Severe**		**p**
Variable	Answer	n	%	n	%	n	%	
Sex	Female Male	179 115	60.9% 39.1%	22 32	40.7% 59.3%	15 13	53.6% 46.4%	0.021*
Age	10-13 14-16 17-19	155 92 47	52.7% 31.3% 16.0%	26 12 16	48.1% 22.2% 29.6%	9 12 7	32.1% 42.9% 25.0%	0.038*
Side of mandibular deviation	Left Right	168 126	57.1% 42.9%	54 -	100.0% -	28 -	100.0% -	0.000*
Sagittal skeletal pattern	Class I Class II Class III	149 93 52	50.7% 31.6% 17.7%	24 16 14	44.4% 29.6% 25.9%	20 4 4	71.4% 14.3% 14.3%	0.122NS
Vertical skeletal pattern	Vertical Balanced Horizon-tal	77 183 34	26.2% 62.2% 11.6%	14 34 6	25.9% 63.0% 11.1%	8 15 5	28.6% 53.6% 17.9%	0.872NS
Cranial base angulation	Acute Balanced Obtuse	1 291 2	0.3% 99.0% 0.7%	1 53 -	1.9% 98.1% -	- 26 2	- 92.9% 7.1%	0.094NS

Chi-Square test (X^2).
NS: not-significant; *significant p≤0.05; **significant p≤0.01

DISCUSSION

One of the causes of mandibular asymmetry is the disorderly growth of facial structures. Departing from the diagnosis, professionals define the clinical approach considering both the age of the patient and the degree of asymmetry, which shows how relevant it is an early diagnosis. Therefore, this study evaluated a representative sample of CBCT from adolescents, three age groups, which allowed the estimate of the prevalence of different degrees of mandibular asymmetry and its association with demographic and skeletal factors. The prevalence was of 21.8% of mandibular asymmetry, being 14.4% moderate and 7.4% severe. The mandibular asymmetry was associated with age, sex, and side of the mandibular deviation.
Although some authors agree that to be considered an asymmetry the skeletal deviation should be of at least 4mm [4], others suggest that the asymmetry depends on the thickness of the soft tissue in the area, agreeing that in some cases present the asymmetry is present when the skeletal deviation is greater than 2mm [2]. As there has been no agreement on how to define asymmetry, in this study asymmetry was divided into categories [35], measuring the distance between the gnathion and the median sagittal plane, being individuals classified as presenting relative symmetry and moderate or severe mandibular asymmetry.
The prevalence of mandibular asymmetry was of 21.8% but the scarce number of studies in the literature regarding this age group makes the discussion more difficult. Among the few studies found, Ramirez-Yañez et al [2] found a prevalence

of 25%, a bit superior to the one found in this study, and such difference may be related to the methodology used to evaluate the asymmetry.

Regarding the variable age, the literature is controversial. Although some studies show a significant association between mandibular asymmetry and age, as found in this study [2,36-38], others say otherwise [39-42]. A possibility to explain why only the patients between 17-19 years old presented a significant correlation with mandibular asymmetry would be that these individuals experience alternating periods of growth, suggesting that asymmetry might be an adaptive response to the functional needs of the jaw and the temporomandibular joint. However, this sample did not present an association with sagittal or vertical skeletal patterns of the patients.

Mandibular asymmetry was also associated to sex in this study, and male adolescents to moderate asymmetry. Liukkonen et al [38] and Melnik [43] have also found such correlation, but most studies do not identified such significant association [2,4,22,23,41,42,44,45].

There was a statistically significant association between the left side and moderate and severe asymmetries. Such findings are also controversial, as some studies reported the same results [2,13,23,44,46], while others said the correlation was higher with the right side of the face [1,23,36,37,47].

However, there has been two possible explanations to justify the high frequency of gnathion deviation to the left side. One of them says it may be explained by the dominant growing of the right side when the dimensions of the skull and brain are evaluated [4,48].

The other possibility would be the development of an asymmetric muscle habit, unilateral chewing, which transmits the masticatory force of the teeth to the bones of the face [49]. Kim et al [27] observed a higher volume of the cranial base on the contralateral side of the mandibular deviation in adults, while Kwon et al [50] did not find morphological differences. In this study, there was no association between this variable and mandibular asymmetry.

The discussion above, the low number of studies and the limitations imposed by a cross-sectional study show the relevance of future studies regarding mandibular asymmetry in adolescents, focusing on mandibular functional changes to understand the postural component and their impact on the facial growth as a whole.

CONCLUSION

The prevalence of mandibular asymmetry in adolescents was of 21.8%, being 14.4% classified as moderate and 7.4% as severe.

Mandibular asymmetry was associated to sex and the side of the mandibular deviation, being more prevalent in male adolescents between 17 and 19 years old who presented the deviation to the left side of the face.

Acknowledgments

This work was supported by Coordenação de Aperfeiçoamento de Pessoal Nível Superior (CAPES), Brazil.

Conflicts of Interest

The authors declare no conflicts of interest.

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