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Variation in mandibular canal position in different sagittal skeletal patterns: a CBCT study

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ABSTRACT

The mandible presents morphological variations, even in individuals without syndromes. This variability will determine different skeletal sagittal patterns, generally classified as Class I, II or III. The anatomical position of the mandibular canal has been investigated in different skeletal patterns, often using cone-beam computed tomography (CBCT) images, for diagnostic or surgical planning purposes. ***Aim:*** *The aim of this study is to perform a three-dimensional analysis of the position of the mandibular canal (MC) in adults with Class I, II and III skeletal patterns, by means of segmentation and 3D measurements on CBCT images.* ***Materials and Method:*** *75 CBCT images were obtained from a secondary database, and 3D analysis was performed using ITK-SNAP and 3D Slicer software. The 3D evaluation consisted of determining the orientation of the position of the mandible, segmentation of the mandible and the MC, creating 3D models, and establishing anatomical landmarks. Vertical (supero-inferior, SI), transverse (mediolateral, RL,) and 3D measurements were performed.* ***Results:*** *The position of the MC is modified according to the skeletal pattern and by morphological factors of the mandible such as sex and gonial angle. The proximity of the MC to the oblique line is smaller in the SI direction in Class III, and the position of the MC is associated with variation in the gonial angle. It may be closer to the cortical lingual in the central region.* ***Conclusion:*** *The mandibular canal position should be considered in tomographic evaluation during diagnosis and therapeutic planning of mandible surgeries, especially in cases of sagittal ramus osteotomy.*

Keywords: *mandible - malocclusion - cone beam computed tomography - mandibular nerve.*

Variação na posição do canal da mandíbula em diferentes padrões esqueléticos sagitais: um estudo de CBCT

RESUMO

A mandíbula apresenta variações morfológicas, mesmo em indivíduos sem síndromes. Essa variabilidade determinará diferentes padrões sagitais esqueléticos, comumente classificados em Classe I, II ou III. A posição anatômica do canal da mandíbula tem sido investigada em diferentes padrões esqueléticos, frequentemente em imagens de tomografia computadorizada de feixe cônico (TCFC), para fins de diagnóstico ou planejamento cirúrgico. ***Objetivo:*** *Este estudo visa analisar tridimensionalmente a posição do canal mandibular (CM) em adultos com padrões esqueléticos de Classe I, II e III por meio de segmentação e medições tridimensionais em TCFC.* ***Material e métodos:*** *75 imagens de TCFC foram obtidas de um banco de dados secundário e a análise 3D foi realizada nos softwares ITK-SNAP e 3D Slicer. As etapas da avaliação 3D consistiram na orientação da posição da mandíbula, segmentação da mandíbula e do MC, criação de modelos 3D e marcação de pontos anatômicos de referência. Foram realizadas medidas verticais (súpero-inferior, SI), transversais (mediolateral, RL) e 3D.* ***Resultados:*** *A posição do MC é modificada de acordo com o padrão esquelético e por fatores morfológicos da mandíbula, como sexo e ângulo goníaco. A proximidade do MC à linha oblíqua é menor na direção SI na Classe III e a posição do MC está associada à variação do ângulo goníaco, podendo estar mais próxima da cortical lingual na região central.* ***Conclusão:*** *A posição do MC deve ser considerada na avaliação tomográfica durante o diagnóstico e planejamento terapêutico em cirurgias de mandíbula, principalmente nos casos de osteotomia do ramo sagital.*

Palavras-chave: *mandíbula - má oclusão - tomografia computadorizada de feixe cônico - nervo mandibular.*

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INTRODUCTION

The mandible presents morphological variations, even in individuals without syndromes[1]. This variability will determine different skeletal sagittal patterns, generally classified as Class I, II or III. While skeletal Class I represents proximity to mandibular balance in size, shape and position, Class II and III relationships are disharmonious. The reestablishment of facial harmonic balance requires planning and may include surgical procedures such as bilateral sagittal split osteotomy (BSSO)[2,3].

Because of its high potential for injury to the inferior alveolar nerve (IAN), mandibular osteotomy to correct facial disharmonies, particularly BSSO[4], requires attention to noble anatomical structures such as the mandibular canal (MC)[2,3]. The incidence of postoperative sensory disturbances, including paresthesia, dysesthesia, hyperesthesia and hypoesthesia, ranges from 11.5 to 77%, according to subjective or objective evaluation[5-7] important Such surgical procedures therefore require prior knowledge of the region, individually and within characteristics of subtypes of skeletal disharmonies. Cone-beam computed tomography (CBCT) images have often been used to investigate the anatomical position of the MC in different skeletal patterns[8-10] for diagnostic or surgical planning purposes. Sekerci and Sahman[11] studied the position of the MC for surgical purposes, but the patients were not classified according to skeletal discrepancy. Identifying the different MC positions in patients with different skeletal patterns can help diagnose and plan oral and maxillofacial surgery, with influence on the treatment plan, choice of fixation type, and postoperative prognosis. Three-dimensional (3D) segmentation in CBCT can be used to isolate and delimit a specific region, focusing on the anatomical structure of interest with quantitative and qualitative analyses[12].

The aim of this study is to conduct a three-dimensional analysis of the position of the MC in adults with Class I, II and III skeletal patterns by means of segmentation and 3D measurements on CBCT images.

MATERIALS AND METHOD

This cross-sectional observational study was approved by the Research Ethics Committee (42632921.6.0000.5083), following STROBE guidelines[13]. A sample was randomly obtained from a CBCT database from dental radiology clinics. The sample included orthodontic and surgical patients. Images were acquired by I-CAT scans (Imaging Sciences International, Hatfield, PA) with voxel size 0.4mm^3 and PaX-Zenith3D (Vatech, Yongin, Korea) with voxel size 0.12mm^3.

Inclusion criteria were 1) CBCT of patients with Class I, II or III skeletal malocclusions; 2) age ≥ 18 years for males and ≥ 16 years for females; and 3) field of view of 23cm × 17cm, with patients at maximum intercuspation. Exclusion criteria were 1) images suggestive of facial trauma or bone surgeries involving the oral and maxillofacial region; 2) absence of any permanent lower teeth, except third molars; 3) third molars in contact with IAN; 4) intraosseous lesions; 5) poor quality CBCT due to artifacts; and 6) mandibular asymmetry.

An orthodontist selected the sample, and the ANB angle was confirmed by CBCT for assignment to skeletal Class I, II or III[14]. Demographic characteristics were recorded. Cephalometric data, such as ANB angle, SNB angle, mandible length, mandible ramus height and gonial angle[15] were recorded and analyzed (supplementary material S1).

Sample size was calculated in G*Power from a pilot study with ten images, using a power of 80% and alpha of 0.05, with a standard deviation estimate equal to 0.1. A 3D analysis was performed by a single examiner who had been previously trained. Data collection began after achieving excellent intra-examiner agreement (ICC). The analysis was carried out in eight stages, similar to those described by Evangelista et al[16].

1. Conversion of DICOM to GIPL by ITK-SNAP (version 2.4.0).
2. Standardization to 0.5 mm^3 voxel size in the original scan with the 3D Slicer (version 4.10.2) to reduce the computational power and time for image analysis[17].
3. Orientation of the mandible using the 3D Slicer for standardizing the position of the mandible and the MC.
4. Semi-automatic segmentation of the mandible and MC
5. Creating a volumetric color map with ITK-SNAP. The landmarks, all perpendicular to the mandibular plane, showed three regions in the MC, as specified in Fig. 1. Navigation in sagittal, axial and coronal sections and

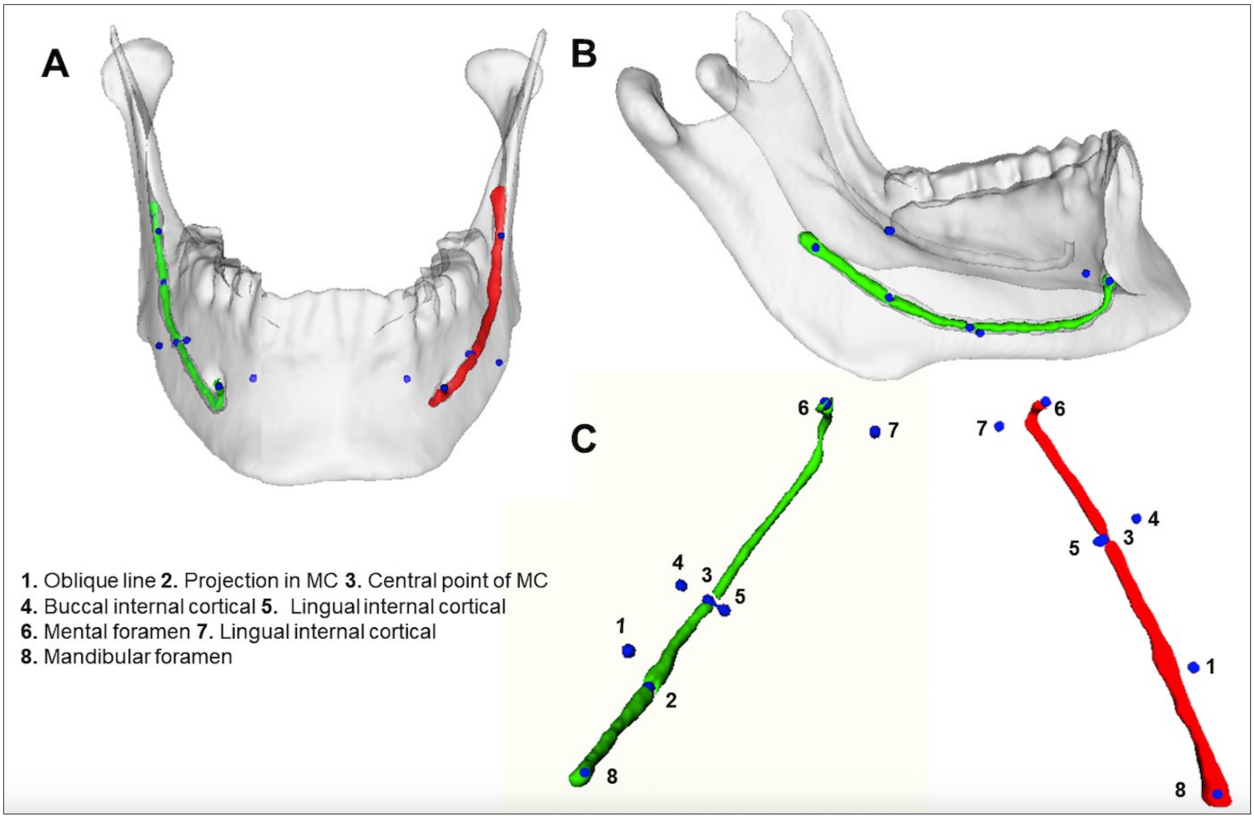

Fig. 1: 3D mandible model, including the right and left MC of a patient with skeletal class III (A) malocclusion. Side view of MC 3D model and landmarks (B). Top view of the MC 3D model and landmarks: oblique line, projection of the line on the MC, the central point of the MC (point projected perpendicularly from the center of the line between the mental foramen and mandible foramen), buccal internal cortical bone of the mandible in the region of the center of the MC, lingual internal cortical of the mandible in the region of the center of the MC, mental foramen, lingual internal cortical of the mandible in the region of the mental foramen and mandible foramen (C).

3D reconstruction were used to position the eight points. The landmarks were identified in ITK-SNAP as follows: mental foramen, mandible foramen, oblique line, projection of the landmark of the oblique line on the MC, landmark in the center of the MC, landmark in the buccal internal cortical of the central region of the MC, landmark on the internal lingual cortical of the central region of the MC, and landmark on the internal lingual cortical of mental foramen region (supplementary material S2).

6. A virtual 3D surface model was generated in 3D Slicer.
7. Landmarks were detected in the original surface models, oriented in a standardized manner, using the Q3DC of the 3D Slicer.
8. Quantitative linear distances and directional changes in the mediolateral (RL), supero-inferior (SI), and 3D axes were generated automatically by the Q3DC. The same points and measurements were performed in the pilot study.

Statistical analysis was performed with SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Variables were tested by the Shapiro-Wilk test, and found to be normal. Differences in the demographic and cephalometric characteristics were calculated using one-way ANOVA (continuous variables) and chi-square (nominal variables). The paired t-test was used to identify the symmetry of measurements between the right and left sides. One-way-ANOVA, together with Levene's test to confirm the homogeneity of variances, was used to compare the mean values obtained by adding the right and left sides of each measurement of the MC between groups, followed by Tukey's post hoc test to indicate the groups that differed from each other. Pearson's correlation was used to verify the association between the MC variables and mandibular position and morphology. A multivariate regression analysis was performed. ICC detected a systematic error with a 95% confidence level to verify reliability after repeating the placement of all pre-marked landmarks and measurements in one-third of the sample recruited by drawing lots, with a seven-day interval. The level of significance was 0.05.

RESULTS

From a database of 770 CBCT images, 75 were randomly selected and distributed equally according to skeletal Class I, II and III patterns. Table 1 presents the demographic data and morphological and cephalometric characteristics.

All measurements showed good to excellent ICC. No statistically significant difference in linear distances was found between the right and left sides, as shown in Table 2, demonstrating symmetry for all measurements. Standard deviation ranged from 0.7 to 2.7mm. We therefore worked with the means. Table 3 presents the quantitative measurements of the means on the right and left sides for each

Table 1. Demographic data and morphological and cephalometric characteristics

Measurements	Class I (n=25)		Class II (n=25)		Class III (n=25)		*p*
	$\bar{X}$ (SD)	Min/Max	$\bar{X}$ (SD)	Min/Max	$\bar{X}$ (SD)	Min/Max	
Sex (F/M) [b]	13/12		15/10	16/9			0.681
Age (years) [a]	29.6 (7.6) ^{A}	19.0/45.0	32.2 (9.1) ^{A}	20.0/54.0	26.6 (4.9) ^{A}	18.0/38.0	**0.034**
ANB(°) [a]	2.4(1.0) ^{A}	0.3/3.7	6.2 (2.3) ^{B}	4.0/12.8	-2.0 (1.7) ^{C}	-5.5/-0.2	**<0.001**
SNB(°) [a]	80.2 (4.0) ^{A}	72.6/88.5	77.7 (4.0) ^{B}	69.2/84.9	85.3 (2.9) ^{C}	79.3/92.1	**<0.001**
Mandibular length(mm) [a] **(Co-Gn)**	116.0 (7.2) ^{A}	100.2/127.8	109.1 (9.3) ^{B}	81.8/121.7	120.1 (7.2) ^{A}	104.1/134.9	**<0.001**
Mandibular ramus height (mm) [a] **(Co-Go)**	60.0 (4.1) ^{AB}	54.1/66.6	57.7 (5.8) ^{A}	51.2/70.0	62.3 (5.1) ^{B}	52.0/72.9	**0.007**
Gonial angle (°) [a] **(Co-Go.Go-Gn)**	118.4 (6.5) ^{A}	101.5/130.1	119.0 (9.0) ^{A}	99.5/134.3	122.6 (8.4) ^{A}	110.7/140.8	0.141

[a]One-way ANOVA test; [b]Chi-square test; p <0.05; Co: condyle; Gn: gnathion; Go: gonium; Equal letters represent statistically similar results and different letters represent statistically different results; Levene Test p>0.05

Table 2. Linear distance and difference between the right and left sides of the MC in skeletal Class I, II and III malocclusions

Variables	Class I				Class II				Class III			
	Right Side (SD)	Left Side (R-L)	Diff. (R-L)	*p*	Right Side (SD)	Left Side (R-L)	Diff. (R-L)	*p*	Right Side (SD)	Left Side (R-L)	Diff. (R-L)	*p*
Oblique line - MC (mm)												
RL	1.9 (1.4)	2.0 (1.6)	-0.1	0.715	2.6 (1.6)	2.9 (1.8)	-0.28	0.262	1.9 (1.1)	2.0 (1.7)	-0.13	0.666
SI	-14.5 (2.4)	-14.6 (2.6)	-0.14	0.438	-14.5 (2.7)	-14.4 (2.5)	-0.14	0.559	-12.3 (1.4)	-12.1 (1.6)	-0.37	0.371
3D	14.7 (2.5)	14.7 (2.5)	0.08	0.784	14.8 (2.6)	14.8 (2.6)	0.05	0.857	12.5 (1.4)	12.2 (2.5)	0.25	0.514
Central of MC - Buccal Internal Cortical (mm)												
RL	4.1 (1.4)	4.1 (1.4)	-0.04	0.840	4.6 (1.3)	4.5 (1.4)	0.03	0.832	3.6 (1.8)	4.1 (1.7)	-0.49	0.185
3D	4.5 (1.5)	4.5 (1.5)	-0.15	0.180	5.2 (1.5)	5.2 (1.6)	-0.07	0.612	4.2 (1.3)	4.6 (1.8)	-0.36	0.113
Central of MC - Lingual Internal Cortical (mm)												
RL	2.3 (1.0)	2.2 (1.0)	0.05	0.762	2.1 (0.7)	2.2 (1.2)	-0.12	0.560	3.3 (1.3)	2.9 (1.1)	0.45	0.091
3D	2.5 (1.1)	2.4 (1.2)	0.07	0.751	2.3 (0.8)	2.5 (1.2)	-0.21	0.344	3.6 (1.5)	3.2 (1.2)	0.44	0.156
Mental Foramen- Lingual Internal Cortical (mm)												
RL	6.7 (1.6)	6.5 (1.8)	0.23	0.390	6.2 (1.2)	6.0 (1.4)	0.16	0.329	5.5 (1.2)	5.4 (1.4)	0.14	0.487
3D	7.5 (1.7)	7.3 (1.8)	0.18	0.421	6.9 (1.3)	6.9 (1.6)	0.01	0.935	6.1 (1.3)	6.1 (1.5)	0.05	0.792

Paired t-test; p <0.05; : medium; Diff: difference.

Table 3. Linear distance and difference between the right and left sides of the MC in skeletal Class I, II and III malocclusions

	Class I (n=25)			Class II (n=25)			Class III (n=25)			*p*
	X̄	SD	CI	X̄	SD	CI	X̄	SD	CI	
Oblique line- MC (mm)										
RL	2.0 ᴬ	1.4	1.4;2.5	2.8ᴬ	1.6	2.1;3.4	2.0ᴬ	1.2	1.5;2.4	0.079
SI	-14.4ᴬ	1.7	-15.6;-13.7	-14.5 ᴬ	1.9	-15.3;-13.7	-12.1ᴮ	1.6	-12.7;-11.4	**<0.001**
3D	14.7 ᴬ	2.5	13.7;15.7	14.8ᴬ	2.6	13.7;15.9	12.3ᴮ	1.8	11.6;13.1	**<0.001**
Central of MC- Buccal Internal Cortical (mm)										
RL	4.1ᴬ	1.3	3.5;4.6	4.6 ᴬ	1.3	4.0;5.1	3.6ᴬ	1.8	2.9;4.4	0.241
3D	4.5ᴬ	1.4	3.9;5.1	5.2 ᴬ	1.5	4.;5.8	4.5 ᴬ	1.4	3.9;5.1	0.138
Central of MC- Lingual Internal Cortical (mm)										
RL	2.2 ᴬ	0.9	1.9;2.6	2.2 ᴬ	0.8	1.8;2.5	3.1ᴮ	1.0	2.7;3.5	**0.001**
3D	2.4 ᴬ	1.0	2.0;2.9	2.4 ᴬ	0.9	2.0;2.7	3.4 ᴮ	1.1	2.9;3.9	**0.001**
Mental Foramen- Lingual Internal Cortical (mm)										
RL	6.6ᴬ	1.6	6.0;7.3	6.1 ᴬᴮ	1.2	5.6;6.6	5.4 ᴮ	1.2	4.9;6.0	**0.012**
3D	7.4 ᴬ	1.6	6.7;8.1	6.9 ᴬᴮ	1.4	6.3;7.5	6.1 ᴮ	1.3	5.6;6.7	**0.008**

One-way ANOVA test; $p<0.05$; Equal letters represent statistically similar results, and different letters represent statistically different results. Statistically significant results are highlighted in bold. Levene Test $p>0.05$

skeletal pattern. In Class III, the MC was closer to the oblique line, in the SI direction (12.1 ± 1.6mm) (p<0.001).

In the central region of the MC, the position of the MC in Class III was further from the internal lingual cortical of the mandible and according to the RL (3.1 ± 1.0mm) and 3D (3.4 ± 1.1 mm) distances (p=0.001). In the mental foramen region, the position of the MC in Class III was closer to the lingual cortical of the mandible, expressed in the RL (5.4 ± 1.2mm) (p=0.012) and 3D (6.1 ± 1.3mm) measurements (p=0.008).

Pearson's correlation showed that the greater the ANB angle, the greater the SI and 3D distances from the MC to the oblique line, and the smaller the RL and 3D distances to the lingual internal cortical. The greater the gonial angle, the smaller the SI and 3D distances, with the MC closer to the surface distance in the region of the oblique line, and the smaller the RL and 3D distances from the mental foramen to the lingual internal cortical of the mandible. Same distances from the mental foramen showed a positive correlation with sex, with 0.322 (p=0.005) for the RL dimension and 0.313 (p=0.006) for the 3D dimensions (Table 4). The adjusted R^2 value decreased, demonstrating that the MC distances improved the regression model less than expected by chance (supplementary material S3).

DISCUSSION

It is essential to know the MC position in planning orthognathic surgery because BSSO design begins in the vestibular cortical of the ramus and body of the mandible, passing through the distal region of the molars, close to the oblique line. Postoperative complication of this technique is mainly injury to the IAN at the time of osteotomy[18,19]. Previous studies on the MC position for BSSO purposes used CBCT and evaluated the vestibular and lingual cortices and the MC[11,20]. However, as these studies neither considered the classification of the patients regarding skeletal malocclusion nor assessed the course of the MC, it is difficult for surgeons to apply the results clinically.

The current study used a methodology based on segmentation of 3D models of the mandible and MC, evaluating the course of the MC, with measurements from the mandibular foramen to the mental foramen, adding information about the correspondence of the MC between the right and left sides of each patient, grouped according to skeletal malocclusion.

Our results showed differences in MC position in skeletal Classes I, II and III. Nonetheless, in a study by Huang and Liao[9], CBCT evaluation of the position of the MC in skeletal Classes I, II and III with measurements from the buccal and lingual cortical to the root of the first molar found no difference among

Table 4. Correlation between predictor variables and MC distances

Predictor Variables	Posterior Region				Central Region						Anterior Region (Mental Foramen)					
	Oblique line (SI)		Oblique line (3D)		Buccal cortical (RL)		Cortical vestibular (3D)		Lingual cortical (RL)		Lingual cortical (3D)		Lingual cortical (RL)		Lingual cortical (3D)	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
ANB	**-0.366**	**<0.001**	**0.304**	**0.008**	**0.253**	**0.028**	**0.253**	**0.028**	**-0.437**	**<0.001**	**-0.431**	**<0.001**	0.125	0.286	0.149	0.201
Mandibular length (Co-Gn)	0.134	0.252	-0.093	0.429	-0.033	0.389	-0.032	0.394	0.181	0.119	0.178	0.127	0.048	0.684	0.143	0.975
Mandibular ramus height (Co-Go)	0.045	0.660	0.143	0.220	0.036	0.380	0.087	0.280	0.162	0.166	0.085	0.471	0.189	0.105	0.155	0.183
Gonial angle (Co-Go. Go-Gn)	**-0.524**	**<0.001**	**-0.536**	**<0.001**	-0.138	0.119	-0.123	0.147	0.077	0.511	0.067	0.565	**-0.285**	**0.013**	**-0.299**	**0.009**
Age	-0.104	0.376	-0.124	0.288	-0.092	0.217	-0.109	0.175	-0.036	0.759	-0,045	0.700	0.063	0.589	0.066	0.574
Sex	0.022	0.851	0.183	0.117	**0.290**	**0.012**	**0.303**	**0.008**	-0.149	0.203	-0.139	0.234	**0.322**	**0.005**	**0.313**	**0.006**

Pearson Correlation test. $p<0.05$. Bold numbers indicate statistically significant values.

groups. A study by Lee and Han[10] reported that upon CBCT evaluation of the anatomical position of the MC concerning the vestibular cortical in skeletal Class III, the participants were divided according to whether or not the MC and cortical made contact. However, due to the divergence of methodologies, it is not possible to make a direct comparison between studies.

Several landmarks have been used in the literature, such as measurements at the mandible foramen, mandible angle, mandible body, and midpoint[8], measurements from the third to first molar, including the distance between the outer surface and the buccal and lingual cortical[11], ramus thickness, MC internal diameter, width from the bone marrow to the buccal cortical and lingual[20], length between the outer margin of the MC and the buccal and inferior cortical, as well as mandible thickness[10]. For our study, we chose to use parameters observed in surgical planning, such as the SI depth of the MC concerning the oblique line. Another important aspect of the BSSO is that it is directed from the lingual region of the ramus to the region of the buccal cortical of the molars. This aspect was evaluated by the distances from the center of the MC to the buccal and lingual internal cortical.

The stability of the anatomical landmarks utilized in Bilateral Sagittal Split Osteotomy (BSSO) is frequently the subject of research. Gaitan-Romero et al.[21] found that both extrinsic and intrinsic factors influence long-term stability, with the amount and orientation of displacement of cephalometric points in the vertical and sagittal planes exhibiting significant angular increases in the ANB angle and backward relapse of SNB, although not exceeding four degrees. Analysis of linear measurements showed that the mean differences in cephalometric landmarks were clinically acceptable, with a value of 2 mm, except for the gonion. Other stable regions have been reported in the literature, such as the posterior region of the ramus of the mandible, located between the gonial angle and the neck of the condyle, and the subcoronoid space, situated inferior to the coronoid process[22].

The stability of landmarks in cases involving different fixation techniques has also been analyzed, yielding satisfactory and comparable results across various fixation groups[23]. Further clinical and prospective studies with medium- and long-term follow-up are needed to assess the stability of the new anatomical landmarks proposed in the current study.

The anatomy of the mandibular canal pathway varies significantly. In the study by Vieira et al.[24], the most common courses of the mandibular canal were identified as straight (74.7%), catenary (19.4%), and progressively descending (6.2%). Nevertheless, the selection and delineation of anatomical landmarks for orthognathic surgery also vary considerably, and the classification of the mandibular canal reflects this variability[25-27].

Further research incorporating this information and focusing on orthognathic surgery is essential to more accurately evaluate the incidence of neural injuries, particularly in patients undergoing BSSO. The anterior loop of the mandibular canal is frequently observed in the anterior region of the mandible, with prevalence ranging from 0% to 94%. This variation can be attributed to differing definitions, geographic regions, and assessment methodologies[28-30]. Furthermore, understanding the anatomical variations in the mentonian region is crucial for cases involving mentoplasty, as noted by Hui et al[31].

New information from the current study includes the correlation between the distance from the mental foramen to the lingual internal cortical and sex, with smaller size in females, corroborating the findings in the literature, which report dimorphism of the symphysis[32]. It was also observed that Class III has the most superficial MC in the oblique line region, with a correlation to gonial angle. These results reinforce previous findings from a study that demonstrates an association between MC position and gonial angle[33], as well as a method of cephalometric analysis reporting that Class III patients have a greater gonial angle[34].

Another finding was the correlation between ANB angle and RL and 3D distances from the center of the MC to the lingual internal cortical. One study evaluated the same distance in a similar region, reporting greater values in the area distal to the third molar, but did not analyze skeletal classification[11], so data cannot be matched. Our study found a greater RL and 3D distance from the center of the MC to the lingual internal cortical in Class III patients. Thus, MC and neurovascular bundles may be closer to cortical lingual in these patients, indicating an increased risk of injury to the IAN.

Other findings include the correlation of ANB angle and SI and 3D distances from the oblique line to the MC. This finding was analyzed in a recent study using the RL distance, in which the shortest distance from the vestibular bone marrow in the oblique line region was measured. Patients were divided according to ANB angle, with inferences for BSSO. A shorter distance was found in Class III, implying a higher risk of injury to the IAN[35].

The current study is of considerable interest from both surgical and anatomical perspectives. Studying the trajectory of the MC using cone beam computed tomography is regarded as standard for anatomical description of vital structures and their variations, and enables extrapolation to clinical-surgical practices with the aim of preventing irreparable damage[36-37].

It is essential to consider that, although the current trend is to perform orthognathic surgery on increasingly younger patients, observation by CBCT of patients aged 18 in males and 16 in females or younger should not influence the conclusions regarding the anatomical position of the MC in older adult individuals who are candidates for such surgical procedures[38]. Furthermore, from a strictly descriptive anatomical standpoint, the presence of positional or recurring anomalies, which occur in 26% of cases and may be expected in this context, is not emphasized[24].

The clinical applicability of this study is linked to the evaluation and planning of surgical treatment to correct skeletal malocclusions. In our sample, Class III patients had an MC distance closer to the oblique line. This suggests that surgeons should pay careful attention to changes in position and consider the positions of the MC within the different skeletal patterns. A comprehensive evaluation of CBCT images and measurements is essential for preoperative design in orthognathic surgeries using BSSO. Direct injuries to the IAN can be avoided or minimized, thereby reducing discomfort and postoperative complications[39].

The limitations of this study include the use of retrospective data, the absence of complete clinical information, and a sample with skeletal disharmonies of different degrees of severity. Further studies including these parameters, especially the degree of severity, could better clarify the association of MC position in different vertical facial patterns, as well as in patients with facial asymmetry, to enable quantitative and qualitative assessment of intrinsic issues regarding differences in morphological characteristics between mandibular hemiarches.

CONCLUSION

Considering the population studied, the present study suggests that mandibular canal position differs according to the skeletal pattern and morphological aspects of the mandible. The MC is closer to the oblique line in Class III patients, with a greater gonial angle, and may be positioned closer to the cortical lingual in the central region. Further research including the degree of severity of skeletal disharmonies and anatomical accidents may better elucidate MC position both in vertical facial patterns and in patients with facial asymmetry.

CONFLICT INTERESTS

The authors declare no potential conflicts of interest regarding the research, authorship, and/or publication of this article.

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