

# Morphological Assessment of the Anterior Loop in the Region of Mental Foramen Using Cone Beam Computed Tomography

Evaluación Morfológica del Asa Anterior en la Región del Foramen  
Mentoniano Mediante Tomografía Computarizada de Haz Cónico

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SOMAN, C.; ALOTAIBI, W. M.; ALOTAIBI, S. M.; ALAHMADI, G. K. & ALQHTANI, N. R. R. Morphological assessment of the anterior loop in the region of mental foramen using cone beam computed tomography. *Int. J. Morphol.*, 42(3):766-772, 2024.

**SUMMARY:** Anterior loop in the mental foramen region is a critical region in the mandible. The non detection of anterior loop leads to inadvertent complications during the surgical procedures in this region. This study aimed to evaluate the morphological assessment of the mental foramen's anterior loop (AL) using (CBCT) cone-beam computed tomography. CBCT data was retrieved from January 2018 to December 2022 and screened for eligibility. Images were viewed using panoramic reconstructed views for initial screening. Further multiplanar reformatted view in axial, coronal and sagittal planes were examined. When anterior loop was detected, the path of inferior alveolar canal was traced and the anterior loop was analyzed. Statistical analysis was carried out on the data. Cross-tabulation was done to associate gender and age with the achieved findings (heights and diameters) using the Chi-square test. In this analysis 519 cases were included and examined for presence of anterior loop. 22 cases were included in the study, out of which 10(45.5%) males and 12(54.5%) females. The prevalence of AL is high among females. AL was found higher on the right side in 14 (68.2%) cases compared to the left side with 7 (31.8%) cases. The mean diameter of AL on the right side was 2.5 mm, and on the left side diameter was 1.96 mm. The prevalence of anterior loop in the region of mental foramen in Saudi Population was found to be 4.24%. Careful evaluation for the anterior loop can prevent hemorrhagic episodes during surgical intervention or implant procedures in the mandibular premolar region.

**KEY WORDS:** Anterior loop; Mental loop; Morphology; Mental foramen; Mandible; Cone beam computed tomography.

## INTRODUCTION

The mandibular canal consists of an inferior alveolar neurovascular bundle. It is a site within the medial side of the mandible, starting from the lingual side of the ramus and ending at the mental foramen. Where the mental nerve emerges, mental foramen (MF) is found on the anterolateral side of the mandible at roughly the same distance (13-15 mm) from the superior and inferior margins of the mandible (Khojastepour *et al.*, 2015).

The most common site of the mental foramen (MF) exists between the first and second premolars (Sing & Srivastav, 2010; Kqiku *et al.*, 2011) In Saudi population the site of mental foramen opening was found to be at the apex of second molar (Al-Mahalawy *et al.*, 2017). The portion of the inferior alveolar nerve that curves up anteriorly to the mental foramen is called the anterior loop (AL) of the inferior alveolar nerve before leaving the canal (Apostolakis &

Brown, 2012) The mandibular canal usually follows an anterior and inferior course and turns backwards at the premolar to exit the canal through the mental foramen. This deflection from its route backwards creating the anterior loop might be ascribed to the shift in the position of the MF during the morphological development of the mandible from the primary canine to the primary molar region (Alyami *et al.*, 2021).

It is crucial to determine the anterior loop region of the mandibular canal before any surgical procedure to avoid any nerve damage that may occur. At intervals throughout the operation, there is a risk of injury. The chance of injury to the neurovascular bundles exiting the MF is exceptionally high throughout endodontic/orthogenetic surgery and fixation of bone fractures or surgical removal of roots, teeth, cysts, and tumors (Greenstein & Tarnow, 2006; von Arx *et al.*, 2013).

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To detect the anterior loop, the most commonly employed investigation with low radiation dose is the advanced three-dimensional imaging using Cone Beam computed tomography (CBCT). (Vujanovic-Eskenazi *et al.*, 2015). Multiple studies have been conducted to understand the patterns, classify the types and analyze the anterior loop in different populations. A recent systematic review denoted the mean prevalence of AL to be 43.18% (Barbosa *et al.*, 2021). Due to the structural variation which may exist in different population, it is inevitable to assess anterior loop in Saudi population. Prevalence of anterior loop was studied using CBCT in Saudi Arabia. However, this study focused on morphometric assessment of MF and only the presence of AL was studied (Al-Mahalawy *et al.*, 2017). A study in Saudi Arabia analyzed 149 samples and classified the types of anterior loop (Alyami *et al.*, 2021). Another recent study in Saudi Arabia analyzed the presence and length of the anterior loop along with mental foramen measurements. However, these studies were not focused on the assessment of the anterior loop. There is a gap noted in the morphological evaluation of anterior loop among Saudi population which is the rationale of the study.

This retrospective cross-sectional study thus aimed to assess the prevalence of the AL of the mental nerve and identify and analyze the variation in length, diameter, and height of the AL in males and females within the Saudi population.

## MATERIAL AND METHOD

This retrospective study was performed with the approval of the Research Ethics Committee at a private university in Riyadh, Saudi Arabia (Approval number FIRP/2020/74/247/244). The research was conducted following the deceleration of Helsinki 2013 guidelines.

A random sample of 519 CBCT scans was obtained at the Center for Radiology Diagnostic Jaws in the university's hospital from 2018 to 2021. The images were procured using a CBCT scanner (Galileos Comfort Plus with the following specifications: Tube potential 98 KV, Tube current 3-6 mA, Effective dose 28-154  $\mu$ SV, Voxel size 0.25-0.125 mm and FOV 15 $\times$ 15 $\times$ 15) CS Software was used to analyze the image in 3-dimensions (axial, coronal, and sagittal). The images of the participants who had undergone a CBCT examination of the premolar and molar regions of the mandible were retrieved from the archival records and interpreted for the assessment of AL of the mandibular canal. Patients were selected based on the eligibility criteria as listed

### Inclusion criteria

- healthy patients
- 18-75

- There is no history of any mandibular surgery.
- At least one premolar in the quadrant.

### Exclusion criteria

- Medically compromised patients.
- Overlapping of the hyoid bone.
- Metabolic or bone disorder.
- Edentulous patients.
- Orthodontic treatment.

The measurements of the anterior loop were calculated as diameter of the canal less than 3 mm was interpreted as Incisive canal. A diameter more than 3 mm was considered as anterior loop and was evaluated further. When more than one canal was located in the cross section, the diameter of the upper canal was considered as diameter of anterior loop (Figs. 1 to 3) (Apostolakis & Brown, 2012). Leveraging the coronal reconstruction image, the study team proceeded to locate the most mesially situated point of the mental foramen, aiming to determine the presence or absence of an anterior loop. Examination of the coronal sections yielded two principal categories: the first exhibiting a single, rounded hypodense image indicative of an anterior extension, and the second characterized by two discrete hypodense areas. All measurements were taken in mm. The height and length of the anterior loop was also assessed (Fig. 4).

Di= Diameter of the incisive canal, measured as diameter less than (<) 3 mm

DAL= Diameter of the incise canal, measured as diameter more than (>) or equal to (=) 3 mm

H1= Vertical dimension from the superior mental foramen cortex to the mandibular inferior margin, visualized in both reconstructed panoramic and sagittal imaging modalities.

H2= Vertical dimension from the anterior-most point of the anterior loop to the inferior margin of the mandible in panoramic images and sagittal sections

H3= The vertical distance between the lowest point of the IAN canal and the inferior margin of the mandible, visualized in both reconstructed panoramic and sagittal images (mental foramen was the reference point in the sagittal view).

L= length from H<sub>2</sub> to H<sub>3</sub>

The length of the anterior loop was determined by multiplying the number of consecutive coronal slices needed to traverse from the mental foramen's front edge to the loop's front edge by the slice thickness (Apostolakis & Brown, 2012; do Nascimento *et al.*, 2016).

**Statistical Analysis:** The collected data was analyzed using Statistical Package for Social Sciences (SPSS) version 22,

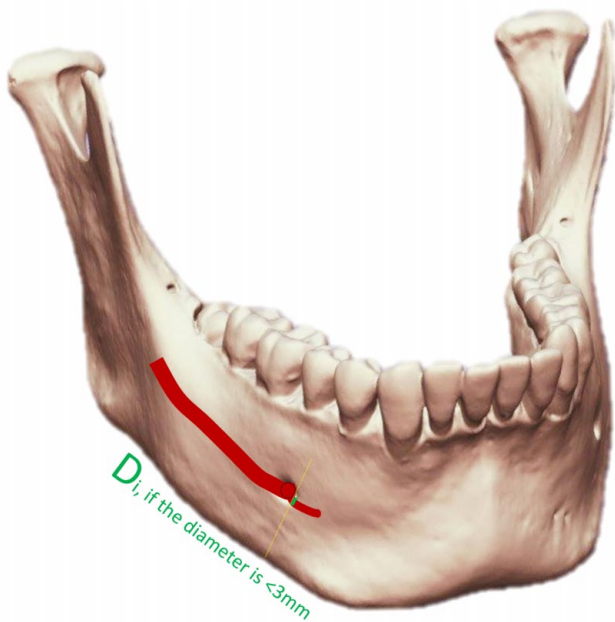


Fig. 1. Diameter (Di) of the incisive canal.

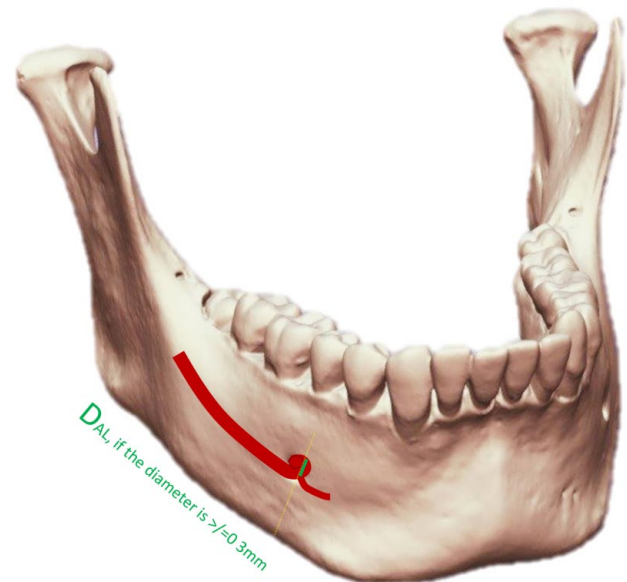


Fig. 2. Diameter (DAL) of the Anterior Loop.

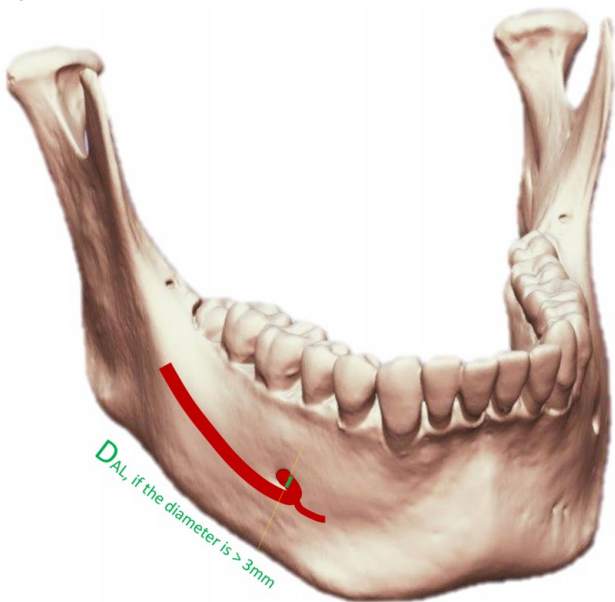


Fig. 3. Diameter (DAL) of the Anterior Loop in case of 2 foramens in the cross-sectional image.

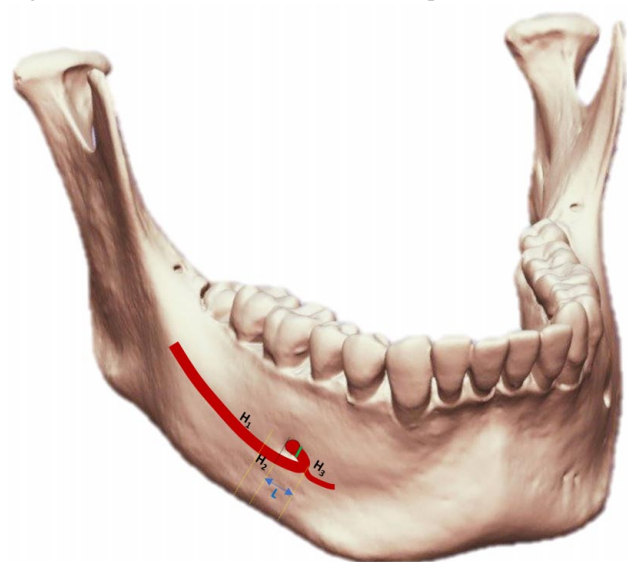


Fig. 4. Measurement of the height and length of the anterior loop. L=Length of the anterior loop, H1=Height of the from the superior mental foramen cortex to the mandibular inferior margin, H2=Height from the superior mental foramen cortex to the mandibular inferior margin and H3=Height distance between the lowest point of the IAN canal and the inferior margin of the mandible

for descriptive and inferential statistics. Frequencies were measured and stated in the results section, and a comparison between groups was done using the Chi-square test with the value of significance kept under 0.05. Cross-tabulation was done to associate sex and age with the achieved findings (heights and diameters) using the Chi-square test.

## RESULTS

CBCT data were screened using inclusion and exclusion criteria. Out of 703 scans, a total of 519 cases were collected for this study. The reasons for exclusions were edentulous, osteoporosis, incomplete data, and single arch

images. Anterior loop was detected in 22 remaining cases in this study.

Table I. Age groups distribution based on sex.

Age groups (years)	Male (%)	Female (%)	Total (%)
18-28	1(10 %)	2(16 %)	3(13 %)
29- 40	3(30 %)	5(42 %)	8(36 %)
41- 55	2(20 %)	5(42 %)	7(32 %)
Above 55	4(40 %)	0(0 %)	4(18 %)
Total	10(45 %)	12(55 %)	22(100 %)

Table II. Comparison of males and females relating to different variables.

Variable	Sex	Mean	SD	SE	P-Value
H1 Right	Male	8.0975	.63227	.22354	.913
	Female	6.6243	.71183	.26904	
H1 Left	Male	7.9650	1.02530	.72500	.729
	Female	6.8960	.96365	.43096	
H2 Right	Male	11.0050	1.14543	.40497	.017
	Female	9.9957	.52826	.19966	
H2 Left	Male	10.3900	1.17380	.83000	.789
	Female	10.1160	1.00286	.44849	
H3 Right	Male	5.9325	.63096	.22308	.016
	Female	4.7957	.34491	.13036	
H3 Left	Male	5.8550	.91217	.64500	.492
	Female	5.1180	.62990	.28170	
H2-H3	Male	5.1322	.52268	.17423	.602
	Female	5.1342	.44265	.12778	
Diameter R	Male	2.0500	.19603	.06931	.035
	Female	3.0243	2.77782	1.04992	
Diameter L	Male	1.9900	.16971	.12000	.549
	Female	1.9460	.11824	.05288	
Mean R	Male	7.3930	.63619	.24046	.243
	Female	8.1225	.91445	.32331	
Mean L	Male	7.5967	.23483	.13558	.003
	Female	7.5583	1.21997	.60999	

The male sex comprised of 45.5% (10) cases and 54.5% (12) were females. Regarding their age, 13.6% were of 18-28 years, 36.4% were 29-40, 31.8% were 41-55, and 18.2% were 55 or older (Table I). The occurrence of AL on the right side contributed to 68.2% (15) whereas 31.8% (7) were observed on the left. The mean height of RH1 was 7.41 mm, LH1 was 7.2 mm, RH2 was 10.53 mm, L2 was 10.19 mm, RH3 was 5.4 mm, LH3 was 5.32, H2 to H3 was 5.13 mm. There was no significant correlation among variables of height with the sex (Table II). When the age groups were compared to the mean of H1, H2, and H3 (mm) of the anterior loop on the left and right side, it did not yield any statistically significant results (Table III). The mean diameter of anterior loop analyzed on the right side (R-DAL) was 2.5 mm, and left side diameter (L-DAL) was 1.96 mm which showed no association between the groups (Table IV).

As far as sex was concerned, no statistically significant association were observed with AL sides, RH1 height, LH1 height, RH2 height, LH2 height, RH3 height, LH3 height, Right diameter(R-DAL), Left diameter and length H2 to H3(L-DAL) (p-values >0.05). Similar results were observed when comparing age groups with all the variables, and no statistically significant difference was achieved (p-values >0.05).

Table III. Comparison of age groups with regard to the mean of H1, H2, and H3 (mm) of the anterior loop on the left and right side.

		Sum of Squares	df	Mean Square	F	Sig.
MeanR	Between Groups	3.565	3	1.188	1.950	.180
	Within Groups	6.704	11	.609		
	Total	10.269	14			
MeanL	Between Groups	1.063	2	.531	.605	.590
	Within Groups	3.515	4	.879		
	Total	4.578	6			

Table IV. Comparison of L and Right diameter of anterior loop between groups.

		Sum of Squares	df	Mean Square	F	Sig.
RDiameter	Between Groups	10.062	3	3.354	.921	.462
	Within Groups	40.048	11	3.641		
	Total	50.110	14			
LDiameter	Between Groups	.011	2	.005	.275	.773
	Within Groups	.077	4	.019		
	Total	.087	6			

## DISCUSSION

**Age Category and Prevalence:** A study done from China reported 32 out of 113 (28.3 %) study participants aged 19-30 had AL, 23 % 31-40 years, 30 % 41-50 years, and 18.5 % 50+ years had the prevalence of AL. When compared to males and females, 59 out of 113 (52.2 %) males and 47.8 % females had a prevalence of AL. When comparing these findings with the present study results, 18-28 years had 13.6 % prevalence, which is low; 29-40 years had 36.6 %, which is high; 41-55 years had 31.8 %, which is high; and 55+ had 18 % prevalence, which is lower than the Chinese study findings (Li *et al.*, 2013). In a study from India, 57.5 % out of 200 scans presented with the anterior loop (Rodricks *et al.*, 2018).

**Laterality:** Regarding laterality, 55 out of 113 (48.6 %) had preponderance to the right side, and 51.4 % had AL on the left side in a study from China (Li *et al.*, 2013). In an Indian study, males, 52.3 % had prevalence on the right side, 39.6 % on the left side, and 58.6 % on both sides (Rodricks *et al.*, 2018). A similar study in Indian population revealed that the AL was more commonly seen on the mandible's left side than the right side. (Chappidi *et al.*, 2019). A study in Saudi population found the prevalence of AL was higher on the right side as compared to the left (Alyami *et al.*, 2021; Othman & Zahid, 2022). The current study also in Saudi population found AL had a higher prevalence on the right side similar to the previous studies (Rodricks *et al.*, 2018; Chappidi *et al.*, 2019; Alyami *et al.*, 2021; Othman & Zahid, 2022).

**Association with Age/Sex:** The present study did not show any statistically significant association while comparing sex and age with the characteristics of AL. This was in contrast to previous studies that reported prevalence of AL had statistically significant association with age but not sex (Rodricks *et al.*, 2018; Raju *et al.*, 2019). In Indian population males showed a higher prevalence of AL as compared to females (Rodricks *et al.*, 2018; Chappidi *et al.*, 2019). The study by Rodricks *et al.* (2018) reported the prevalence of the anterior loop was found in 55 % of males and 45 % of females. In contrast, a study from China found males had a 45.5 % prevalence as compared to 52.2 % females (Li *et al.*, 2013). The results of the present study were in concurrence with the Chinese study, and showed that males had a lower prevalence than females. A recent study in Saudi population revealed that the highest prevalence of AL was found among males compared to females (Alyami *et al.*, 2021). However, this study was conducted in a smaller sample size compared to the present study.

**Diameter of AL:** This study aimed to determine the prevalence of anterior loops of the mental nerve and their characteristics and features, such as height, length, and

diameter. The mean size of the anterior loop was evaluated to be 3.54 mm $\pm$  1.41 (Vujanovic-Eskenazi *et al.*, 2015); 1 to 4 mm (Rodricks *et al.*, 2018). A similar study conducted by Sinha *et al.* (2019) reported that the mean diameter of AL on the left side in their study was calculated to be 2.22 mm in males and 2.32 mm in females. On the right side, it was 4.83 mm in males and 2.64 mm in females (Sinha *et al.*, 2019). Thus, the mean diameter of AL on the left side was 2.23 mm (average of male and female measurements) and on the right side, it was 3.73 mm (Sinha *et al.*, 2019). In this present study, the mean diameter of anterior loop both on the right side (2.5 mm), and on the left side (1.96 mm) was lower which may be attributed to ethnic variation in the morphology.

**Height of AL:** The height of the AL ranged from 7.8 to 15.1 mm. (Rodricks *et al.*, 2018). In the previous study by Sinha *et al.* (2019), for H1 was 12.58 mm; mean value of H2 was 12.72 mm (average right and left side values in males and females); the mean values of H3 were 10.97 mm (average right and left side values in males and females). The current study results were lower than the previous study (Sinha *et al.*, 2019)

**Length of AL:** The length of anterior loop ranges from a mean value of 0.15 mm to 11 mm, with a mean length of 4.13  $\pm$  2.04 mm (Neiva *et al.*, 2004). The mean length of the anterior loop on the right side was 0.46 mm and 0.54 mm among males and females, respectively, which was greater than the left side (0.38 mm and 0.35 mm). The mean length of the caudal loop on the right side was 3.59 mm and 3.46 mm and left side was 3.54 mm and 3.54 mm among males and females, respectively (Rodricks *et al.*, 2018).

The mental nerve anterior loop average length was assessed to be 1.8  $\pm$  0.35 mm (Othman & Zahid, 2022); 1.14 to 1.61 mm (Gupta *et al.*, 2021); 1.59 mm (Vujanovic-Eskenazi *et al.*, 2015); 0 to 5.1 mm (Kumar *et al.*, 2021); average of the mean length of AL among male and females were 3.25 mm (Sinha *et al.*, 2019); 0.89 mm (0–5.7) (Apostolakis & Brown, 2012) and 1.8 to 4.8 mm (Rodricks *et al.*, 2018).

The mean length of AL in the present study was 5.13 mm. The results were in contrast to previous studies. The difference can be attributed from the method of analyzing the length in the previous studies. However, the present study employed systemic evaluation of the length as described in previous studies.

The limitation of the study was that it was a single center study. The sample size of the study was large. Hence the results can be generalizable.

## CONCLUSION

The anterior loop of the mental foramen was determined in 22 of the 519 patients in this study which accounts to 4.24 %. The study noted higher prevalence in females and on the right side of the mandible. No statistically significant differences were identified between both age and sexes. However, the 29-40 age group had a considerably larger AL than the ages 18-28 years and 51 years and above. Future studies should evaluate the length, height and diameter of the anterior loop using multicenter data.

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**SOMAN, C.; ALOTAIBI, W. M.; ALOTAIBI, S. M.; ALAHMADI, G. K. & ALQHTANI, N. R. R.** Evaluación morfológica del asa anterior en la región del foramen mentoniano mediante tomografía computarizada de haz cónico. *Int. J. Morphol.*, 42(3):766-772, 2024.

**RESUMEN:** El asa anterior en la región del foramen mentoniano es una región crítica en la mandíbula. La no detección del asa anterior conduce a complicaciones inadvertidas durante los procedimientos quirúrgicos en esta región. Este estudio tuvo como objetivo evaluar la evaluación morfológica del asa anterior (AL) del foramen mental mediante tomografía computarizada de haz cónico (CBCT). Los datos CBCT se recuperaron desde enero de 2018 hasta diciembre de 2022 y se examinaron para determinar su elegibilidad. Las imágenes se visualizaron utilizando vistas panorámicas reconstruidas para la evaluación inicial. Se examinaron además, vistas reformateadas multiplanares en los planos axial, coronal y sagital. Cuando se detectó el asa anterior, se trazó el trayecto del canal mandibular y se analizó el asa anterior. Se realizó un análisis estadístico de los datos. Mediante la prueba de Chi-cuadrado se realizó una tabulación cruzada para asociar el sexo y la edad con los hallazgos obtenidos (alturas y diámetros). En este análisis se incluyeron y examinaron 519 casos para detectar la presencia de asa anterior. Se incluyeron en el estudio 22 casos, de los cuales 10 (45,5 %) eran hombres y 12 (54,5 %) mujeres. La prevalencia de AL es alta entre las mujeres. Se observó que AL fue mayor en el lado derecho en 14 (68,2 %) de los casos en comparación con el lado izquierdo con 7 (31,8 %) casos. El diámetro medio de AL en el lado derecho fue de 2,5 mm y en el lado izquierdo fue de 1,96 mm. La prevalencia del asa anterior en la región del foramen mental en la población saudí fue de 4,24 %. Una evaluación rigurosa del asa anterior puede prevenir episodios hemorrágicos durante una intervención quirúrgica o procedimientos de implante en la región de los premolares mandibulares.

**PALABRAS CLAVE:** Asa anterior; Bucle mental; Morfología; Foramen mental; Mandíbula; Tomografía computarizada de haz cónico.

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