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Gender-Wise Comparison of Horizontal Position of Mental Foramen on Left Side of Mandible Using PSP

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ABSTRACT
The mental foramen is a crucial anatomical landmark in the mandible, responsible for the passage of neurovascular structures. Its position varies among individuals, impacting dental and surgical procedures. This study aims to evaluate and compare the horizontal position of the mental foramen on the left side of the mandible in both genders using PSP imaging. A cross-sectional hospital-based study was conducted on 400 adults (200 males, 200 females). Radiographic images were analyzed, and the mental foramen's location was classified into seven zones. Statistical analysis was performed using SPSS v20.0, applying Pearson's Chi-square test to determine significance. Results showed that Zone 4 (between the first and second premolars) was the most common location (60%), with no significant gender difference in its positioning. These findings aid clinicians in accurately locating the mental foramen, reducing surgical risks, and improving treatment outcomes.
KEYWORDS: Mental foramen, PSP Imaging, Gender Comparison, Radiographic Study, Mandible.

I. INTRODUCTION

The **mental foramen** is a funnel-shaped opening on the **anterolateral surface of the mandible**, marking the termination of the **mandibular canal**. It allows the passage of the **mental nerve and blood vessels**, which supply the chin, lower lip, and gingiva. Anatomical variations in its location may lead to **complications in dental and maxillofacial procedures**. Incorrect localization can result in **nerve injury, anesthesia failure, and implant placement errors**.

Several studies have assessed **the mental foramen's position** using **periapical radiography, orthopantomography, and computed tomography (CT)**. With the advancement of digital imaging, **Photostimulable Phosphor (PSP) plates** have gained prominence in dental diagnostics. This study aims to evaluate the **horizontal position of the mental foramen** in males and females using PSP imaging and provide reference data for clinicians.

II. METHODOLOGY

Study Design

A cross-sectional hospital-based study was conducted in the Radiology Wing, Department of Oral Medicine and Radiology, Sree Sai Dental College & Research Institute, Srikakulam.

Study Population

The study included 400 adults (200 males and 200 females) aged 18 and above who underwent dental radiographic imaging.

Inclusion Criteria

- High-quality images with clear visibility of anatomical structures.
- Adults aged 18 & above.

Exclusion Criteria

- Patients with malformations, bony lesions, missing teeth, orthodontic appliances, mandibular fractures, or implants.
- Radiographic artifacts or unclear mental foramen images.

Data Collection

PSP image plates were used to capture high-resolution radiographs. The left mandibular premolar region was divided into seven zones, and the position of the mental foramen was assessed accordingly.

Statistical Analysis

Data were compiled in Microsoft Excel and analyzed using SPSS v20.0. Pearson's Chi-square test was applied to examine the association between gender and mental foramen position, with statistical significance set at $p < 0.05$.

PROCEDURE OF THE STUDY

After obtaining ethical clearance, informed consent was obtained from 400 individual

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participants who were selected depending upon the eligibility criteria. All 400 radiographic images were acquired using PERFECT – 65 intra oral X-ray machine (70 KVP, 8 mA, 0.40 s) and an adult PSP image plate as a receptor. The images were interpreted using KAVO Scan Exam One Machine in which the area of interest i.e left mandibular premolar region was divided into 7 zones and the position of mental foramen was assessed.

Figure 1:PERFECT – 65 intra oral X-ray machine

Figure 2: KAVO Scan Exam One Machine

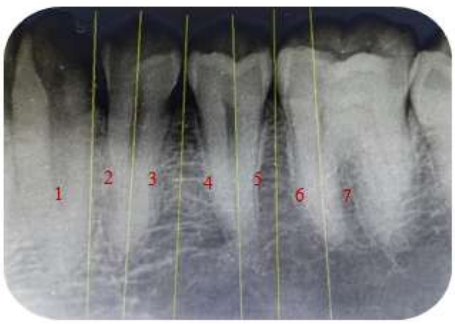

Figure 3: PSP image showing zones

Table 1:

Table 1: Description of division of zones in the image:

Zone 1	Distal to Canine
Zone 2	Mesial to 1st Premolar
Zone 3	Distal to 1st Premolar
Zone 4	Mesial to 2nd Premolar
Zone 5	Distal to 2nd Premolar
Zone 6	Mesial to 1st Molar
Zone 7	Distal to 1st Molar

STATISTICAL ANALYSIS:

Data was collected, compiled and entered in Microsoft Excel. The data was refined and coded. Data was analyzed using SPSS version 20.0. The results were summarized and displayed with appropriate usage of tables and graphical presentation in the form of pie charts and bar graphs. Descriptive statistics was applied for all data, frequency counts and percentages for qualitative variables (categorical data). Pearson chi-square test was applied for comparison of categorical data to see the association. The statistical significance level was set at p value of 5% (0.05).

III. RESULTS

Table 2: Descriptive Statistics:

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	400	18	25	21.23	1.748

Table 2 gives the descriptive statistical analysis of the age of 400 samples included in the study. It shows the youngest individual is 18 years old and the oldest individual is 25 years old.The average age is 21.23 years, suggesting that most participants are young adults.Standard Deviation (SD) of 1.748indicates that the ages are moderately spread around the mean.

Table 3: Distribution of frequency of zones:

ZONE	Frequency	Percent
1	4	1.0
2	12	3.0
3	106	26.5
4	240	60.0
5	26	6.5
6	8	2.0
7	4	1.0
Total	400	100.0

Table 3 shows the dataset including a categorical variable, Zone, representing seven zones. Their distribution is as follows:

Zone 1: 4 individuals (1.0%)
Zone 2: 12 individuals (3.0%)
Zone 3: 106 individuals (26.5%)

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Zone 4: 240 individuals (60.0%) - the largest proportion, suggesting this is the most represented zone.
Zone 5: 26 individuals (6.5%)
Zone 6: 8 individuals (2.0%)
Zone 7: 4 individuals (1.0%)

The total number of individuals across all zones is 400, confirming complete coverage.

Table 4 shows the association between Sex and Zoneby applying Chi-Square test for the assessment. The results had shown the Chi-Square Value (X^2) value of 6.893 with the Significance (p) value of 0.331. The p-value (> 0.05) indicates no significant association between gender and zone, meaning gender distribution across zones is likely random.

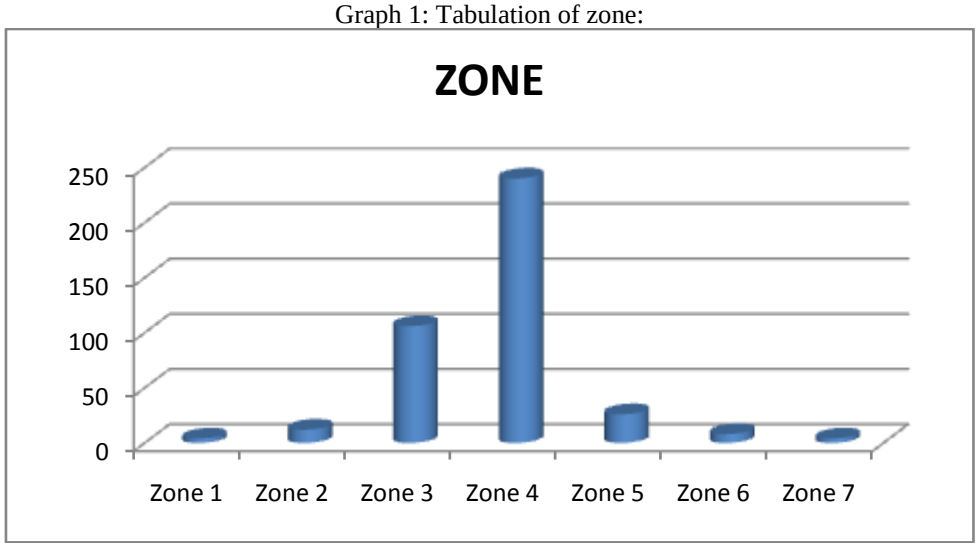
SEX	ZONE							Total	Sig.
	1	2	3	4	5	6	7		
F	4	8	56	112	14	4	2	200	X^2= 6.893 p=0.331
	2.0%	4.0%	28.0%	56.0%	7.0%	2.0%	1.0%	100.0%	
M	0	4	50	128	12	4	2	200	
	0.0%	2.0%	25.0%	64.0%	6.0%	2.0%	1.0%	100.0%	
Total	4	12	106	240	26	8	4	400	
	1.0%	3.0%	26.5%	60.0%	6.5%	2.0%	1.0%	100.0%	

Table 4: SEX * ZONE Cross tabulation:

Graph 1 & 2 shows the cross-tabulation of Sex (F: Female, M: Male) against Zone which reveals the following:
Females (200 individuals):
Zone 3: 56 (28.0%)
Zone 4: 112 (56.0%) - most prominent.
Smaller percentages in other zones (Zone 5: 7.0%, Zone 6: 2.0%, etc.).

Males (200 individuals):
Zone 4: 128 (64.0%) - higher than females.
Zone 3: 50 (25.0%).
Smaller representation in other zones.
Both genders are evenly distributed overall, each comprising 50% of the dataset.

Graph 1: Tabulation of zone:



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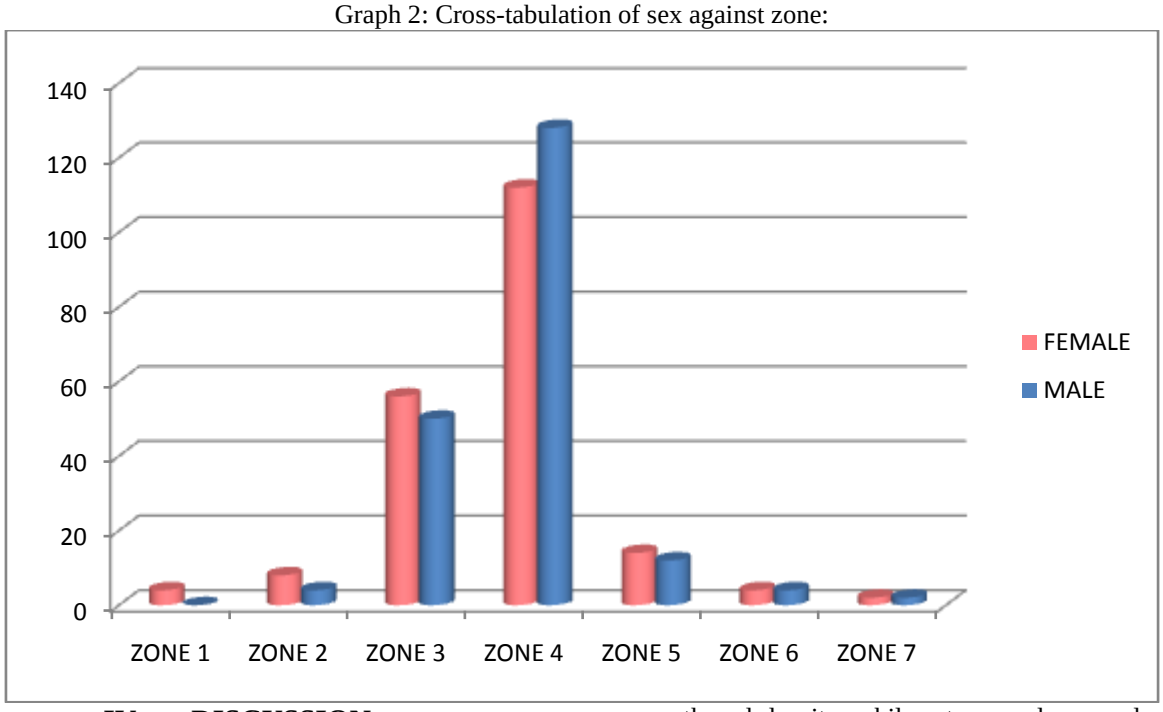
Graph 2: Cross-tabulation of sex against zone:



IV. DISCUSSION

The mental foramen, located on the anterolateral surface of the mandible, is an essential anatomical structure through which the mental nerve, artery, and vein pass. The mental nerve, a branch of the inferior alveolar nerve, provides sensory innervation to the lower lip, buccal vestibule, and gingiva anterior to the mandibular first molar. This foramen serves as a key landmark in oral and maxillofacial procedures, aiding in effective local anesthesia and reducing the risk of complications during surgeries.[17]

It is crucial to consider the possibility of an anterior loop of the mental nerve extending mesially to the foramen to prevent damage to neurovascular structures. Misinterpretation of the foramen as a radiolucent lesion near mandibular premolars further emphasizes the need for precise localization. This accuracy is particularly important in procedures like flap surgeries, apical curettage, retrograde fillings, and orthodontic surgeries.[17]

The height of the mandible, particularly in relation to the position of the mental foramen (MF), is typically greater in males compared to females. This difference is attributed to several factors, including genetic influences on bone development and metabolism. Polymorphisms in genes regulating bone remodelling, along with physical activity levels, muscle strength, diet, and hormonal variations, significantly contribute to these differences.[18]

Hormonal effects, particularly testosterone in males, promote greater mandibular growth and density, while estrogen plays a role in bone preservation in females, potentially influencing mandibular height differently across genders.This aspect is essential in gender-based studies of the mandible, particularly when identifying anatomical landmarks like the mental foramen for clinical and forensic applications.[19]

Digital radiographs utilizing photostimulable storage phosphor (PSP) plates have gained widespread acceptance in clinical settings due to their ease of use and lower radiation exposure compared to traditional radiographic methods. Recently, advancements in dual-side reading technology have been introduced to minimize image noise in PSP systems. This innovation enables radiographic image capture on both sides of the receptor, which is achieved by eliminating the opaque backing and lead foil typically found in conventional films. These design improvements enhance the efficiency and quality of PSP imaging.[20]

This study described a population of 400 individuals, mostly young adults aged 18–25 years, with an average age of 21.23 years resulting in significant mean values which is partially in accordance with the study done by Shaaban & El-Shall (2017)[21] where the females aged (8-12) years showed the statistically significant lowest mean values, followed by females aged (13-17) years while no statistically significant differences were shown between females aged (18-30), (31-50) and (51-70) years. In males aged (8-12) years showed the statistically significant lowest mean values,

followed by males aged (13-17) years and no statistically significant difference between males aged (18-30), (31-50) and (51-70) years.

This study has shown 60% of samples fall under zone 4 (in between 1st and 2nd premolar region) which was in correlation with the results of the study done by Abed et.al (2016)[10] which revealed that 57.89% of the samples showed class III division (in between 1st and 2nd premolar region).

The study had shown Zone 4 dominating the dataset (60%), followed by Zone 3 (26.5%).Both genders are evenly represented (50% each), and their distribution across zones shows no statistically significant difference. These findings were in accordance with the previous study conducted in a Turkish population by Kalender et al (2012)[22] reportedthat the MF was generally located between the first and second premolars and it was similar between males and females.

The findings of this study were different from the study done by Gungor et al (2017) which showed the MF was present at the first and second premolar teeth in females, and located at the level of the second premolar in males, and differed between males and females ($P \leq 0.01$).[23]

The study done by Gupta et.al, (2015)[8] highlighted the vertical position of the mental foramen on panoramic radiographs and the identified the position of mental foramen located between first and second premolar which was similar to the zone 4 position of the mental foramen identified in the current study.

The current study focused only on the identification of location of mental foramen on left side of the mandible because it aimed to identify the horizontal location of the mental foramen and compare the location in both genders. Various studies (Gupta et.al (2015)[8], Parnami et.al (2015)[9], Nanayakkara et.al (2018)[12], Pele et al (2021)[13], AlQahtani (2022)[14]) have done comparative analysis of mental foramen location on both left and right side of the mandible while this study used only the position of mental foramen on the left side as the previous studies did not reveal statistically significant results comparing both left and right side of the mandible.

This study used the PSP images for the identification of the mental foramen which is different from other dry mandible studies (Nanayakkara et.al (2018)[12], Bahlis et.al, 2010)[7], Panoramic studies (Ghandourah et.al (2023)[15],Gupta et.al (2015)[8], Thakare et.al (2016)[11], Parnami et.al (2015)[9]), CBCT studies ((Pele et.al, 2021)[13], AlQahtani (2022)[14]), IOPA studies (Rastegar &Motealemi (2024)[16], Bahlis et.al, (2010)[7]) as the conventional radiography has been replaced with digital imaging from the past decade and the use of PSP plates has been increased in the clinical settings.

Our study, revealed the most prominent position of mental foramen is in between the first and second premolars i.e, Zone 4 – mesial to 2nd premolar, and there is no significant difference between males and females in the aspect of position of mental foramen which is correlating with most of the studies.

Comparison of few studies to the current study with the results:

S.No	Authors	Population/country of study	Results
1	Bharathi et al (2016)[24]	20 Indians and 20 Iranians	Mental foramen below the apex of the second premolar in 52.5% of Indians, 47.5% of Iranians; 45% of it was between the first and second premolars among Indians and 47.5% of Iranians
2	Ritika et al (2015)[25]	Dried adult human skulls,Saurashtra region of Gujarat	The longitudinal axis of the second premolar for right side was 40.32% and left side 43.55% followed by the longitudinal axiswhich passed between the first and second premolars
3	Gada and Nagda (2014)[26]	Mumbai City (India)	Between the two premolars (63%), followed by position behind thesecond premolar (20.67%)
4	Moogala et al (2014)[17]	In dry dentate and edentulousmandibles in coastal Andhrapopulation of Andhra Pradesh State	In between the first and second premolars (40–50%)

5	Udhaya et al (2013)[27]	South Indian Population	At the level of the root of the second premolar, midway betweenthe inferior margin and the alveolar margin of the mandible
6	Afkhami et al (2013)[28]	Tehran, Iran	67% were below the second premolar, 24% were between the firstand second premolars

V. CONCLUSION

Mental foramen is a vital anatomical landmark in the mandible which carries the mental nerve. It plays an important role in the field of dentistry as it is located near the apices of the roots of premolars and the nerve innervates the soft tissues of the chin, lower lip, and gingiva. Variations in its position are common and can lead to complications during surgery, anaesthesia, endodontic procedures, and osteotomy.

During the dental procedures like implant surgery, osteotomy, surgical extractions, anaesthesia, endodontic procedures, it is high likely to damage the nerve if the exact position of the mental foramen is not determined. Hence this study focussed on the identification of the position of mental foramen in both males and females especially in the young adults.

The differentiation of mandibular size and dimensions might lead to minute changes in the positioning of the anatomical landmarks such as mental foramen due to sexual dimorphism of the mandible. Hence this study focussed on the gender wise comparison of the mental foramen position which resulted in no significant difference between the gender.

Differentiation of mandible into 7 zones indicates the position of the mental foramen from the mesial side of 1st premolar to distal side of 1st molar. The current study identified the highly significant results in zone 4 in both females and males but a bit more significant values in males than females followed by zone 3, zone 5, zone 6.

The study concludes that the horizontal position of mental foramen is more prominent in zone 4 in both males and females without any significant difference between the gender. Using of PSP mainly has the drawback of more radiographic noise. It is suggested that more advanced dual coated PSP plates should be used to reduce these artifacts.

LIMITATIONS

Clarity of the obtained image.
Sample size.

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