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ORIGINAL ARTICALE

RETROSPECTIVE MORPHOMETRIC EVALUATION OF MANDIBULAR ADAPTATIONS IN RELATION TO THIRD MOLAR DYNAMICS

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ABSTRACT

This retrospective radiographic study aimed to evaluate morphometric changes in the mandible associated with impacted third molars using panoramic radiographs. Sixty digital orthopantomograms (OPGs) were selected from a total of 330 cases recorded at Saveetha Dental College between January and June 2024. Bone level distal to the mandibular second molar, gonial angle, and third molar root angulation were measured using ImageJ software. Mesioangular impaction was the most common type (35%), and bilateral impactions were present in 55% of the cases. The mean bone level was 1.22 ± 0.10 mm, with slightly higher bone loss in males compared to females, although the difference was not statistically significant. A significant variation in gonial angle was observed across impaction types ($p = 0.026$), suggesting a potential association between mandibular growth pattern and impaction type. Patients who had undergone third molar extraction showed improved bone levels distal to the second molar, while those who retained their impacted third molars exhibited progressive bone loss. These findings support the diagnostic utility of panoramic radiographs in identifying key morphometric parameters relevant to clinical decision-making. The study highlights the importance of gonial angle assessment as a possible predictor of impaction pattern and emphasizes the need for early radiographic evaluation in

Keywords: Third molar impaction, mandibular morphology, panoramic radiography, bone level changes, dental imaging

INTRODUCTION

The journey of a tooth begins from a bud stage within the jaw to its fully grown position, where it is anatomically and clinically functioning. The process is defined as an eruption. The word eruption is derived from the Latin "erumpere, " meaning "to erupt". The term "eruption" aptly captures the dynamic nature of this dental phenomenon, as the tooth seemingly "breaks through" or "bursts forth" into its proper place within the mouth. [1] The tooth fails to erupt for various reasons when referred to as impacted. The reasons for an impaction are lack of space in the arch, abnormal positioning of the tooth in the arch, abnormal eruption process, early loss and ankylosis of the primary tooth, and presence of pathology.[2] The presence of an impaction would lead to dental problems, which might require the removal of the impacted tooth.[1]

An impacted tooth is defined as one that remains embedded within the jawbone, is covered by gingival tissue, and may be partially or entirely covered by bone. [3]. A partially erupted tooth is defined as one that does not fully erupt into its occlusal position but can still be seen in the oral cavity.[3] The most common teeth to be impacted are the mandibular and maxillary third molars, followed by the maxillary canines and premolars. The frequency of mandibular third molar impaction is influenced by facial skeleton, gender, age, and ethnic group. Breik and Grupor reported a higher incidence of mandibular third molar Impaction in individuals with a dolichofacial pattern (vertical growth; facial axis angle, <87) and in females

(43%) compared to males (45%).[4] In contrast, Padhye et al. [5] found that third molar impaction was more common in males (51.77%) compared to females (48.33%). Prajapati et al. [6] noted a greater incidence of impacted mandibular third molars (IMTMs) among females in the 21–30 age group. The global prevalence of impacted third molars is around 24% .[8]

When it comes to removing an impacted tooth, a prior radiological assessment is essential. A conventional intraoral periapical Radiograph (IOPA) may not capture the full extent of the position of the root development. An orthopantomogram (OPG) offers the advantage of capturing a comprehensive view of the mandible, maxilla, and facial bones in a single wide image, making it useful for diagnosing various pathological conditions, evaluating carious and fractured teeth, detecting dental anomalies, and identifying Morphometric changes refer to alterations in the size, shape, and structure of anatomical features of a bone. The various morphometric changes studied in the mandible include the mandibular angle, the ramus's width, and the mandible's overall length. Selene Barone et al. [7] found a significant correlation between the Gonial angle and the position of the mandibular third molar, noting that a decrease in the Gonial angle was associated with a higher incidence of IMTMs ($p < 0.05$). Apart from this, the impaction of mandibular third molars is also associated with a decrease in the mandibular angle, an increase in the Gonial angle, and changes in the width of the mandibular ramus. Analysing the morphometric changes may help us predict the probability of impaction. More studies are needed to analyse the morphometric changes associated with impaction. Furthermore, age, gender, ethnicity, and individual anatomical variations can influence morphometric changes. The primary aim of this retrospective was to investigate the morphometric changes in the mandible about the presence of impacted third molars.

The objectives were to determine the prevalence of third molar impaction, analyse morphometric changes in the mandible, compare morphometric differences between patients with impacted third molars, investigate the impact of demographic factors, utilise the OPG imaging technique, and identify clinical implications.

METHODS AND MATERIALS

This retrospective case–control study was conducted with archived panoramic radiographic images of patients who visited the Saveetha dental college and hospital from Jan 2024 to June 2024. Due to the practice of electronic case sheets, the data was retrieved from Dental Information Archiving Software (DIAS). For a power of 80m the sample size calculated was 60 based on the study of Krausz et al. [12]

The study received the approval of the Institutional Ethics Committee with the reference no: IHEC/SDC/OMED-2305/23/15. The inclusion and exclusion criteria are mentioned in table 1.

monitoring, using either inhalational or oral anesthesia, with the sedation protocol tailored to the

The study included 112 patients (60 females and 52 males) diagnosed clinically and by ECHO as having CHD and referred preoperatively to the MDCT unit. The mean age of the patients was 9.2±7.1 months. The patients were classified into three groups: the first group included patients with intra-cardiac malformations, the second group included patients with heart great vessel connection malformations, and the third group included patients with congenital vascular anomalies.

The common clinical presentations among the studied patients were dyspnea and cyanosis among 70% and 71.3%, respectively.

Regarding the cardiac malformations, they were represented in the following manner (Table 1): VSD (n=87;77,6%), RVOTO (n=52;46.4%), ASD (n=33;29.5%), PFO (n=13,6.25%), both single ventricle and dextrocardia each one represents (n=3; 2.6%), followed by a common atrium, juxtaposition of the atrial appendage, TV malformation, and double inlet ventricle each one of them represents (n=2; 1.7%), last one is MV malformation which is seen in one case; (0.9%).

There was no significant difference between MDCT and ECHO in diagnosing cardiac structural malformations, except for the detection of PFO, where ECHO demonstrated greater accuracy ($p<0.05$) with a moderate Kappa agreement.

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Table 1. The inclusion and exclusion criteria of the samples

Inclusion Criteria	Exclusion Criteria
Patients above the age of 18 years	Impacted third molars with incomplete root formation
OPG's free of distortion as judged by comparing the width of the ramus bilaterally and the presence of distortion in the lower anterior region.	History of steroid use, radiotherapy
Impacted third molars	Impacted third molars with second molar missing

Measurement Method:

The panoramic images were captured using Sidexis X-ray software (Dentsply Sirona, York, PA, USA) with a Schick sensor. Image analysis was conducted using ImageJ software (NIH, Bethesda, MD, USA). The X-ray parameters were set at 64–70 kV and 7–14 mA, following manufacturer recommendations for different patient demographics and body build. The OPG's were analyzed by a single observer who had developed a method based on the calibration between two observers. The gonial angle was measured in degrees by drawing two imaginary lines along the posterior border of the ramus and along the inferior border of the mandible. The type of impaction was assessed by comparing the long axis of the impacted third molar with the adjacent second molar.

The bone level was measured from the cementoenamel junction of the second molar downward until the alveolar bone. The third molar root angle was measured by taking the long axis of the root to the expected position in the arch. All the markings are shown in Figure 1.

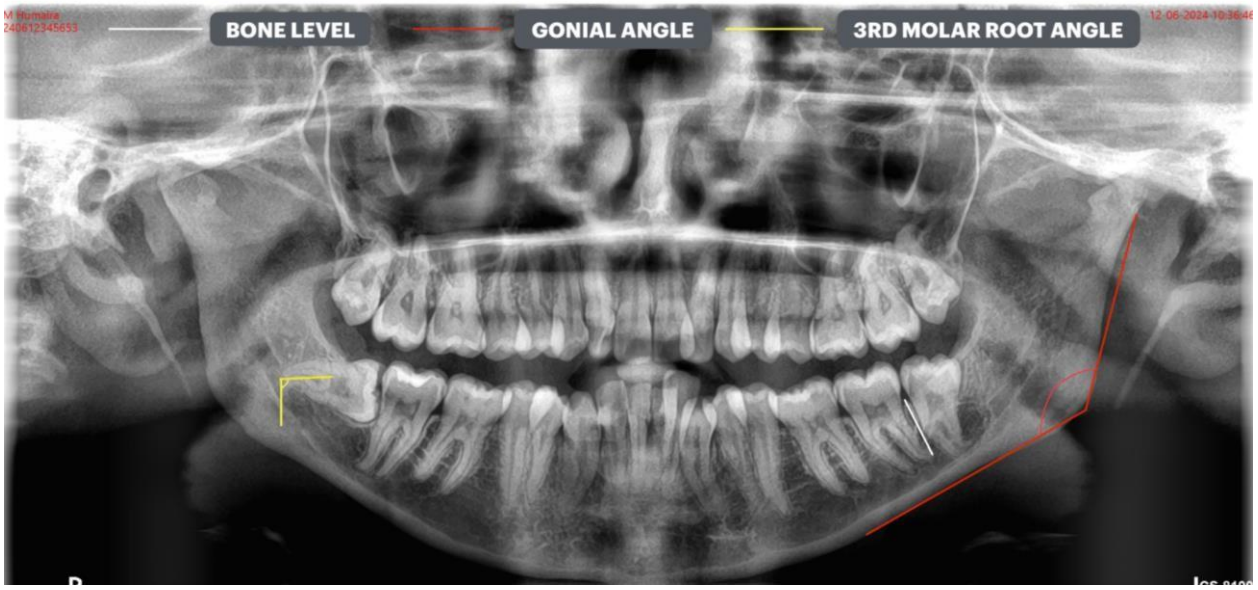

Figure 1. OPG showing the sample measurements.

Statistical Analysis:

The data was imported into an Excel sheet (Microsoft® Excel® for Microsoft 365 MSO, Version 2307, Microsoft corporation, Washington, DC, USA). The collated data was imported into IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, NY, USA). The statistical software was used for the descriptive statistical analysis. Following which the normality of the data was checked. Subsequent to which the inferential statistics was carried out.

RESULTS

The normality of the data was assessed based on the age of the individuals using bell curve fit method (Figure 2) and Shapiro Wilk's test. As the data was not following normal distribution it was decided to use non parametric tests for inferential statistics.

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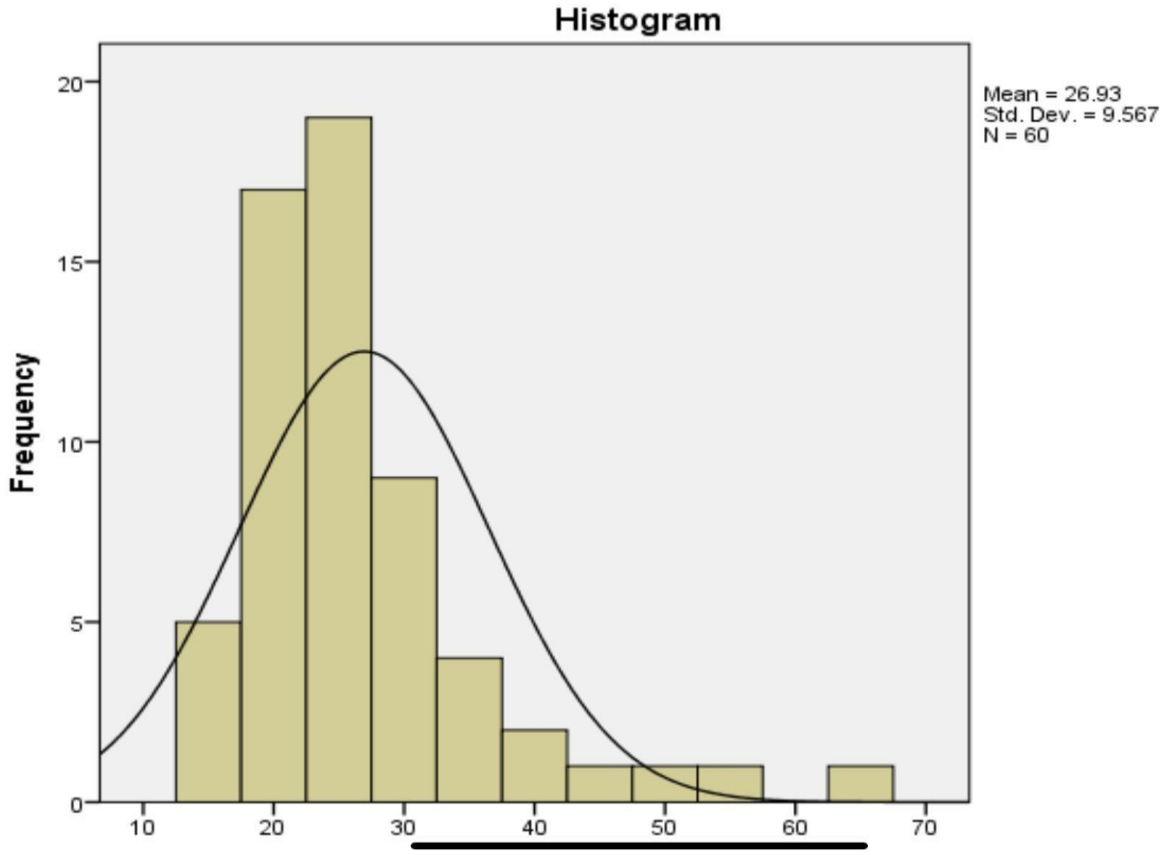

Figure 2. Histogram with bell curve super imposed.

Descriptive statistics

The total samples in the study were 60 of which 35 (58.3%) were males and 25(41.7%) were females. The mean age of the samples was 26.93 ± 9.57 and the median age was 28.65. As the sample was found to have non symmetric distribution the median was also reported. The first parameter assessed was the bone level. From the 60 patients a total of 83 impactions were reported, which means that 33 out of 60 patients had bilateral impactions. Out of the 60 samples there 21(35%) of cases had Mesioangular impaction, 20 (33.3%) had horizontal impaction. (Figure 3)

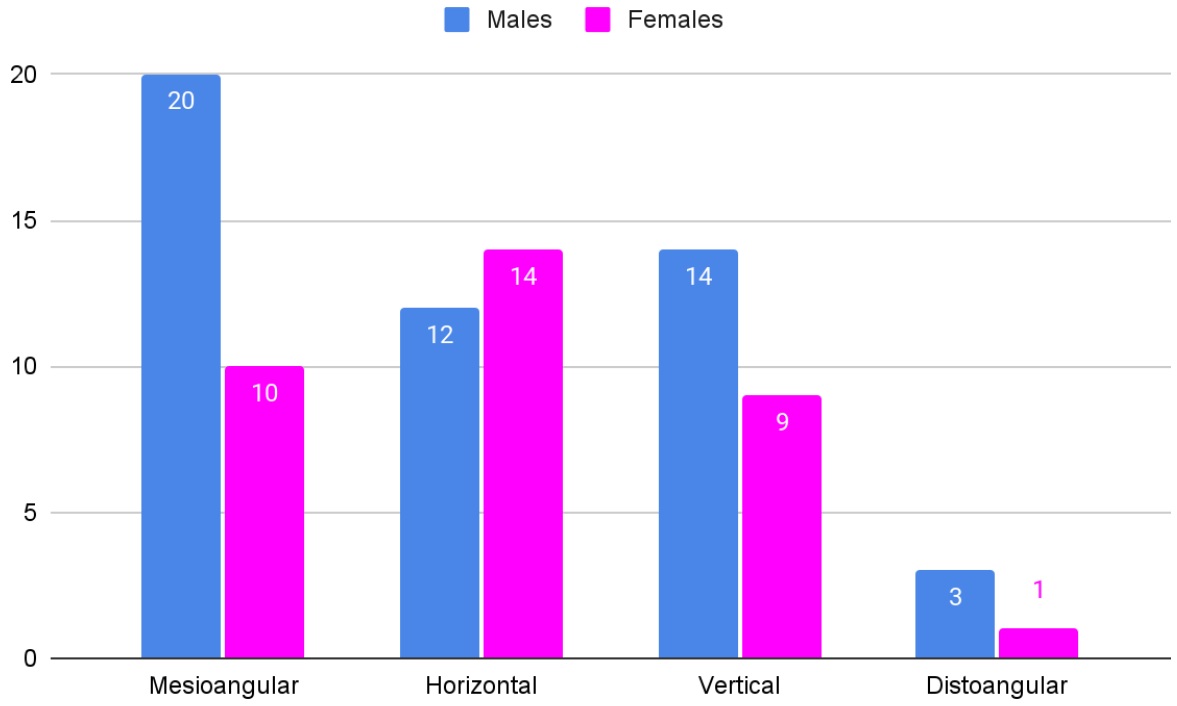

Figure 3. Distribution of gender according to the type of impactions

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The bone level was 1.24 ± 0.10 in males while in females it was 1.20 ± 0.09. The median of the bone level was 1.26 ± 0.10 and 1.19 ± 0.09. The mean gonial angle was 123.02 ± 4.93 and 122.74 ± 5.13 in males and females respectively, while the median was 122.40 ± 4.93 and 123.20 ± 5.13 in males and females respectively. The mean and median of the third molar root angle in males was 113.71 ± 18.44 and 117.20 ± 18.44 respectively. The mean and median third molar root angle in females was 111.89 ± 18.34 and 112.3 ± 18.34 respectively. (Table 2)

Table 2. The comparison of the bone level, gonial angle and third molar root angle across the genders.

Gender		Bone Level	Gonial Angle	Third Molar Root Angle
Males	Mean ± SD	1.24 ± 0.10	133.02 ± 4.93	40.81 ± 5.7
	Median ± SD	1.26 ± 0.10	132.40 ± 4.93	41.30 ± 5.7
Females	Mean ± SD	1.20 ± 0.09	132.74 ± 5.13	41.14 ± 5.9
	Median ± SD	1.19 ± 0.09	133.20 ± 5.13	40.70 ± 5.9
Overall Mean of both Genders	Mean ± SD	1.22 ± 0.10	132.90 ± 4.97	40.98 ± 5.7
	Median ± SD	1.24 ± 0.10	132. 90 ± 4.97	41.15 ± 5.7

When the above-mentioned measurements were compared across the different types of impactions, the bone levels were around the same level. The gonial angle had differences across the different types of impactions.

Inferential statistics

As the data followed non normal distribution, non-parametric tests were used to assess the levels of significance. As a first step the data was compared across the genders and it was found that the difference between the genders was not statistically significant for a significance level of 0.05. Table 3

Table 3. The comparison of the bone level, gonial angle and third molar root angle across the Impaction types.

Gender		Bone Level	Gonial Angle	Third Molar Root Angle
Mesioangular	Mean ± SD	1.22 ± 0.09	134.03 ± 5.19	40.01 ± 7.09
	Median ± SD	1.22 ± 0.09	134.30 ± 5.19	37.10 ± 7.09
Horizontal	Mean ± SD	1.22 ± 0.10	130.31 ± 3.90	41.28 ± 5.68
	Median ± SD	1.23 ± 0.10	129.95 ± 3.90	41.15 ± 5.68
Vertical	Mean ± SD	1.24 ± 0.11	133.40 ± 5.07	42.04 ± 4.95
	Median ± SD	1.26 ± 0.11	133.40 ± 5.07	43.80 ± 4.95
Distoangular	Mean ± SD	1.32 ± 0.38	136.25 ± 4.03	40.40 ± 1.41
	Median ± SD	1.32 ± 0.38	136.25 ± 4.03	40.40 ± 1.41

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Table 4. The statistical tests for the bone level, gonial angle and third molar root angle across the genders.

Sr.No	Null Hypothesis	Statistical test	P value
1	The distribution of bone level is same across both genders	Independent Sample Mann - Whitney U Test	0.128
2	The distribution of gonial angle is same across both genders		0.738
3	The distribution of third molar root angle is same across both genders		0.708

Table 5. The statistical tests for the bone level, gonial angle and third molar root angle across the type of impaction

Sr.No	Null Hypothesis	Statistical test	P value
1	The distribution of bone level is same across the type of impaction.	Independent Sample - Kruskaal Wallis Test	0.303
2	The distribution of gonial angle is same across the type of impaction.		0.026
3	The distribution of third molar root angle is same across the type of impaction.		0.534

DISCUSSION

Impaction of the lower wisdom teeth is a frequent issue that dentists regularly encounter in their practice. The frequency of impaction in the South Indian ethnic group has been around 45.85% according to a study by Kalaiselvan et al [9] The failure to extract the impacted teeth can cause wide ranging problems such as an association of cysts and other pathologies. The surgical extraction of these impacted teeth is also associated with complications like swelling, trismus, alveolar osteitis (dry socket) and nerve paresthesia. [10] Hence a careful prior surgical planning is needed to avoid the complications .[11]

Since there are prior studies showing that the bone growth patterns do influence the frequency of impaction we decided to implore further into the area .[4] So as a first step we had looked into three variables of bone level or height distal to second molar, gonial angle and third molar root angle to know the variations in the impaction pattern. The bone level was measured from the cementoenamel junction to the bone crest, as described by Faria et al .[11] Although OPGs have some limitations, clinicians still commonly use them to guide interventional decisions.[12] It is essential to assess the distal bone levels as it is an indicator of the development of sensitivity post extraction of the third molar. There have been prior studies which have compared the bone levels between pre and post extraction. [13-15] There has been no study that has reported on the bone level and the type of impaction. Our study shows that the mean pre operative bone levels were almost the same across the different types of impactions with no statistical difference. There is also no significant difference between the genders. This is in line with the observational study that there has been no difference in the association of sensitivity in patients who have different types of impactions.

The gonial angle is a measure of the facial growth pattern which in turn is an indicator of the jaw size. It has been clearly established that one of the commonest reasons for impaction of the teeth is the lack of space in the retromolar area. An increased gonial angle is associated with dolichofacial growth pattern and reduced retromolar space area.[16] In a study by Demiriel et al, the average gonial angle for cases with impaction in was 121.38 ± 7.64. However, these values were significantly higher than the gonial angle observed in patients without impaction.

On a subgroup analysis in their study they had reported that the gonial angles were significantly higher in the distoangular and vertical impaction groups.

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However, the differences were not statistically significant. [17]

In our study also the values were the highest in distoangular group and the values were significantly different. However, the overall average gonial angle was higher which could probably be due to the changes in the ethnic nature of the people. In a similar study by

Barone et al also showed higher gonial angles in patients with distoangular impaction. [7]

In a morphometric study from India on the gonial angle it was noted that the average gonial angle in the Indian population was in the range of 117-120`.[18] However there have been no similar studies of studying the gonial angle with the pattern of impactions.

Ours has been the only study to analyze the third molar root angulation to the imaginary occlusal plane. The whole plan of studying the morphometrics is that it helps us to study the patterns which could be predictors of the impactions.

Additionally, our findings corroborated those of Fernandes et al.'s study[13], which showed a correlation between aging and a shift in the alveolar crest's status. In the present investigation, males showed a greater degree of bone loss than females, although the difference was not statistically significant. Similar results were found in the study by Dias et al. [14], which used panoramic radiography to determine whether there was a significant difference between males and females in the degree of bone loss distal to the MSM. It is important to note that a number of variables, including smoking patterns, impactions, and neglecting to maintain good oral hygiene, have the potential to exacerbate periodontal disease in the mandible [15,16]. Thus, bone alterations such as bone loss could happen if an impaction is not looked after. Our results showed bone loss in individuals who did not have the IMTM extracted following an examination of their follow-up OPGs, despite differences in the type of the IMTM and other risk factors among the study participants. The study group showed bone growth and improvement distal to the MSM following IMTM extraction. These results were consistent with those of Passarelli et al. [17], who noted that once an IMTM was surgically removed, their patients' periodontal health generally improved. An impacted tooth can be removed to enhance access for cleaning and consequently, overall health.

Conversely, after removing an IMTM, Kan et al. [18] noted the development of periodontal defects on the distal end of the MSM. Various patterns of IMTMs have been found in various demographic samples by several researches. [19, 20]

The Mesioangular type of impaction was found to be more common than the horizontal type in the current study. In the Arab Emirati community, Mesioangular impaction was shown to be more common than other forms, according to Alsaegh et al. [21] In a similar vein, Eshghpour et al.[22] discovered that Mesioangular impaction was more common in Iranians. In an investigation of the Indian population, Prajapati et al.[6] too found that Mesioangular inclination was more prevalent than the other patterns, which included distoangular, vertical, and horizontal inclinations. The present study identified a greater incidence of bilateral impaction, contrasting with Alsaegh et al.'s findings [21], which showed a similar distribution between unilateral and bilateral impactions. Nevertheless, a number studies have documented significant differences in the prevalence of bilateral versus unilateral impactions across diverse populations, including those from Saudi Arabia, Singapore, China, and Libya [23,24], with bilateral impaction being more recurrent in these groups.

The limitations of our study were that no clinical parameters were taken into consideration and also the three-dimensional imaging modalities were not taken into account for the bone level comparison. Though we chose the sample choice according to the power of the study it is still a smaller number considering that this is a retrospective study. A notable strength of this study is that it provides clear evidence of bone level changes in individuals with an impacted mandibular third molar compared to those without. This highlights the effectiveness of OPG in assessing these changes, which can help clinicians develop an appropriate management strategy. [29]

CONCLUSION

Impacted third molars continue to be a common finding in dental practice, and their presence can influence mandibular structure in subtle yet clinically important ways. In this study, variations in gonial angle were found to differ significantly across types of impactions, suggesting a possible link between mandibular growth patterns and impaction risk. Although bone level differences between genders were not statistically significant, a slight trend toward greater bone loss in males was noted. Importantly, patients who had their third molars extracted showed better bone levels distal to the second molar, underscoring the value of early intervention when indicated. The use of panoramic radiographs proved effective in capturing these changes, making them a practical tool for routine evaluation. These findings may help clinicians better anticipate complications associated with third molar impactions and plan treatment more effectively. Further studies using larger samples and three-dimensional imaging are encouraged to build on these observations.

DECLARATION

ACKNOWLEDGMENTS

None.

CONFLICT OF INTEREST

None declared.

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ETHICS_ STATEMENT

This study was approved by the Institutional Ethics Committee (Ref No: IHEC/SDC/OMED-2305/23/15). Patient consent was waived due to anonymized radiographic review and no direct human intervention.

INFORMED CONSENT STATEMENT

Patient consent was waived because we only reviewed the radiographic images of the patients anonymously, and there was no intervention or investigation on humans directly.

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