ORIGINAL RESEARCH ARTICLE

Jurnal Radiologi Dentomaksilofasial Indonesia December 2024, Vol. 8, No. 3: 103-12
P-ISSN.2685-0249 | E-ISSN.2686-1321

http://jurnal.pdgi.or.id/index.php/jrdi/index

# Unraveling the hidden connection: Impacted third molar classification and mandibular canal proximity on panoramic radiographs

Novi Kurniati[1*], Sabrina Tiara Hani[2]



## ABSTRACT

**Objectives:** This research is aimed to determine the relation between impacted mandibular third molar's classification and mandibular canal proximity with panoramic radiograph at RSKGM-P FKG UPDM (B).

**Materials and Methods:** This research used an analytical cross-sectional study. The number of samples in this study was 387 lower third molars from 206 digital panoramic radiographs. The samples were then analyzed based on their classification and their relation to the mandibular canal.

**Results:** The result showed in Pell & Gregory classification, the most related to the mandibular canal is class III (65.8%) with p = 0,000 and position B (58.1%) with p = 0,000. Based on the Winter classification, mesioangular angulation is the most related to the mandibular canal (52.9%) with p = 0,015. Based on the Rood & Shehab classification, it was found that the dominant relation A was 65% in class III with p = 0,000, in position B (58.3%) with p = 0,001, and in mesioangular angulation (61.1%) with p = 0,000.

**Conclusion:** This study shows that the less space available in the mandible, the deeper the position of the impacted tooth in the jaw and their angle affects the proximity of the impacted tooth to the mandibular canal and the radiographic sign of the proximity of the impacted mandibular third molar root to the mandibular canal. This illustrates the need to perform a panoramic radiographic examination prior to performing any intervention on the mandibular third molar.

***Keywords:*** *Impaction, lower third molar, radiographic image, mandibular canal, panoramic radiograph*
**Cite this article:** Kurniati N, Hani ST. *Unraveling the hidden connection: Impacted third molar classification and mandibular canal proximity on panoramic radiographs*. Jurnal Radiologi Dentomaksilofasial Indonesia 2024;8(3)103-12. https://doi.org/10.32793/jrdi.v8i3.1281

## INTRODUCTION

An impacted tooth is a pathological condition characterized by tooth failure to errupt, fully or partialy into the dental arch within the expected timeframe, resulting in a lack of normal functional positioning.[1,2] Third molars are the most frequently affected by impaction, with an incidence ranging from 9.5% to 68% across different populations.[3,4] This phenomenon can be attributed to the eruption of the third molar occurring as the final stage of tooth development, typically between the ages of 16 and 25. Insufficient space for the tooth to erupt properly is a common consequence of this timing.[3,5]

Contributing factors to the occurrence of impacted lower third molars include, but are not limited to, the smaller size of the alveolar bone arch in comparison to the total length of the dental arch.[1,6] The dental arch is subject to variation between individuals as a consequence of environmental, nutritional, genetic, racial and gender-related influences.[7] Furthermore, changes in dietary patterns towards softer foods have been identified as a potential trigger for impaction. This is due to the fact that such foods do not require the exertion of significant muscular force from the chewing muscles, which can lead to a reduction in jaw growth stimulation and an increased likelihood of dental impaction.[5,6,8]

An impacted tooth can cause food to become trapped around the affected teeth, which can make it more difficult for patients to clean them effectively. This can increase the risk of developing cavities, which can cause pain and potentially affect the distal aspect of the second molar.[1,9,10] Pericoronitis can also occur as a result of repeated trauma to the soft tissue covering the occlusal surface of an impacted mandibular third molar, which is known as the operculum. The accumulation of food beneath the operculum, which is challenging to clean, can also result in the colonization of bacteria and the subsequent development of pericoronitis. Furthermore, impacted teeth can also result in additional complications, including periodontal disease in adjacent teeth, root resorption of nearby teeth,

[1]Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Prof. Dr.Moestopo (Beragama) University, Jakarta, Indonesia 12330

[2]Faculty of Dentistry, Prof. Dr.Moestopo (Beragama) University, Jakarta, Indonesia 12330

*Correspondence to:
Novi Kurniati
drg.novi@dsn.moestopo.ac.id

Received on: September 2024
Revised on: November 2024
Accepted on: November 2024

odontogenic cysts and tumours, and even fractures in the jaw. [1] The surgical procedure employed to extract impacted lower third molars is known as odontectomy.[11] Complications following odontectomy for lower third molars have been reported with a prevalence ranging from 2.6% to 30.9%. These include bleeding, swelling (edema), pain, trismus, and nerve injury.[12]

To minimise the occurrence of neurological complications during and after surgery, good anatomical knowledge and radiographic examination are required to identify risk factors and determine the appropriate surgical procedure.[13,14] One of the examination methods that can be used to diagnose impacted teeth is panoramic radiograph.[15] Panoramic radiography is commonly used for clinical purposes, including evaluation of trauma such as jaw fractures, third molar positioning, extensive dental or bone disease, known or suspected large lesions, tooth development and eruption (especially in mixed dentition), impacted or unerupted teeth and root remains (in edentulous patients), temporomandibular joint (TMJ) pain, and developmental abnormalities.[16] Panoramic radiograph is an effective method for the preoperative evaluation of mandibular third molars, as it can be used to identify the position of the third molars and their proximity to the mandibular canal.[6]

The mandibular canal is a bilateral bony structure that begins at the mandibular foramen on the medial side of the mandibular ramus, extending downward and forward, and ends at the mental foramen.[17–21] This channel is connected to the roots of the lower jaw teeth through branches along the mandibular canal.[19,20] The depth of the third molar in the mandibular arch, the angulation of the tooth, and the position of the tooth roots in relation to the mandibular canal can influence the risk of neurosensory injury to the inferior alveolar nerve.[6]

At present, the relation between impacted mandibular third molars according to the Pell-Gregory and Winter classifications to the mandibular canal has not been studied much in Indonesia. There are several studies that examined the apical proximity of impacted mandibular third molars according to the Winter and Pell & Gregory classifications to the mandibular canal. However, these studies have not explained the relation between the classification of impacted mandibular third molars and their proximity to the mandibular canal. Therefore, the researcher wanted to investigate the relation between the impacted mandibular third molar's classification and their proximity to the mandibular canal from panoramic radiograph.

## MATERIALS AND METHODS

This study used an analytical approach with a cross-sectional study design. The data employed in this study were secondary data, comprising digital panoramic radiographic results pertaining to patients at RSKGM-P UPDM(B). The population under investigation comprised all digital panoramic radiography data pertaining to patients with impacted mandibular third molars within the radiology installation of RSKGM-P UPDM(B) between July 2023 and January 2024. A total of 206 samples were utilized in this study through the application of the total sampling technique. The inclusion criteria for this study were as follows: Panoramic radiographs of RSKGM-P UPDM(B) patients aged between 17 and 45 years, panoramic radiographs of impacted mandibular third molars with perfectly formed roots, panoramic radiographs with good quality and clarity, as well as a clear image of the ramus and angle of the mandibular inferior border. The exclusion criteria for this study included panoramic radiographs with missing mandibular second molars and those of impacted third molar patients with pathological abnormalities in the mandibular root and canal, as well as artifacts on panoramic radiographs. All panoramic radiographs were obtained using the Acteon X-Mind Prime 3D Digital Panoramic X-ray unit and subsequently evaluated with the Ais 2D App software 5.0 version.

The impacted mandibular third molar teeth were classified using the Pell and Gregory system (based on the available space and position) and the Quek et al. system, which was adapted from Winter's system based on the angulation of the teeth, as well as their relation to the mandibular canal and the radiographic appearance that was observed. Subsequently, the images of the roots of the impacted mandibular third molar teeth in relation to the mandibular canal were categorized according to seven radiographic criteria as outlined by Rood & Shehab. For the purposes of statistical analysis, univariate and bivariate analysis with the Chi-square test was employed in order to facilitate comparison of ratios according to age and gender. The statistical analysis was conducted using IBM SPSS Statistics Version 25 software. The level of statistical significance was set at $p < 0.05$.

Pell & Gregory's classification was based on the relation between the mesiodistal diameter of the impacted tooth and the available space between the distal surface of the second molar and the mandibular ramus ascendens. The classification was as follows: class I (when there was sufficient space between the distal surface of the second molar and the mandibular ramus for the mesiodistal width of the third molar to fit), class II (when the space between the distal surface of the second molar and the mandibular ramus was smaller than the mesiodistal width of the third molar), class III (when there was no space between the distal surface of the second molar and the mandibular ramus and the third molar was completely inside the mandibular ramus).[3,6,13,15] The Pell & Gregory classification is based on the relation between the depth and the occlusal plane and cervical line of the second molar tooth, which can be categorised into three positions as follows: Position A is characterised by a third molar that is positioned higher than or at the same level as the occlusal

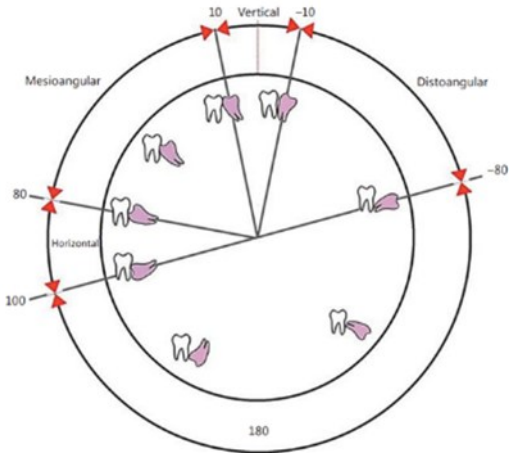


**Figure 1.** Quek et al.'s classification adapted from Winter's classification[22]

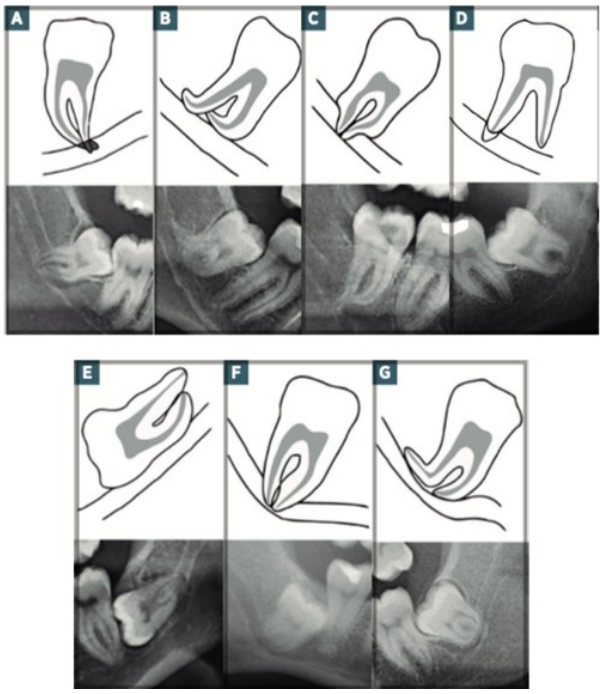


**Figure 2.** Radiographic signs of the proximity of the roots of impacted mandibular third molars to the mandibular canal by Rood & Shehab. (A) root darkening, (B) root deflection, (C) root narrowing, (D) dark and bifid apex, (E) mandibular canal discontinuity, (F) mandibular canal deflection, and (G) narrowing of the mandibular canal[6]

plane of the second molar. Position B is defined by a third molar that is situated between the occlusal plane and the cervical line of the second molar. Position C is identified by a third molar that is positioned below the cervical line of the second molar. [3,6,13,15] Quek et al.'s classification, which was adapted from Winter's classification, is based on angulation. It includes the following categories: vertical (10° to -10°, whereby the long axis of the third molar is parallel to the long axis of the second molar), mesioangular (11° to 79°, whereby the long axis of the third molar is inclined mesially), distoangular (-11° to -79°, whereby the long axis of the third molar is inclined distally), horizontal (80° to 100°, whereby the long axis of the third molar is perpendicular to the long axis of the second molar), and other (101° to -80°).[3,15,22]

The proximity between the impacted mandibular third molar and the mandibular canal could be described in three ways, namely: close (if the root of the mandibular third molar contacted the superior edge of the mandibular canal), related (if the root of the mandibular third molar passed the superior edge of the mandibular canal and was impacted radiographically), and not close (if there was a distance between the root of the mandibular third molar and the superior edge of the mandibular canal). The study observed seven radiographic signs of the proximity of the roots of impacted mandibular third molars to the mandibular canal, as described by Rood & Shehab. These signs included root darkening, root deflection, root narrowing, dark and bifid apex, mandibular canal discontinuity, mandibular canal deflection, and narrowing of the mandibular canal.[23,24]

## RESULTS

The study sample comprised of 157 female and 49 male participants, representing a gender ratio of 76.2% to 23.6%, respectively. The age group most frequently affected by impaction of the mandibular third molar teeth is 20-25 years old, as evidenced by 159 samples (77.2%). A total of 387 mandibular third molar impaction teeth were obtained from the 206 samples used in this study. The most prevalent classifications identified in this study were Class III, position B, and mesioangular angulation. Of the 387 impacted mandibular third molar teeth, 310 were related to the mandibular canal (80.1%), with the most dominant A-relation being 180 teeth (46.5%).

This study revealed a significant correlation between the classification of mandibular third molar impaction teeth according to Pell & Gregory, based on their class and their proximity to the mandibular canal. Table 2 illustrates that maxillary third molar impaction teeth of class III are more prevalent in relation to the mandibular canal (65.8%).

Table 3 indicates that position B is the dominant position in relation to the mandibular canal (58.1%). Furthermore, the Pell & Gregory classification based on position demonstrates a significant relation with the proximity between the teeth and the mandibular canal.

The results of the analysis presented in Table 4 indicate that the impacted tooth of the mandibular third molar with mesioangular angulation is predominantly associated with the mandibular canal (52.9%), with a p-value of 0.015. This suggests a significant relation between the impacted tooth of the mandibular third molar according to Winter's classification and the radiographic image of proximity to the mandibular canal based on proximity.

Table 5 indicates that class III mandibular third molar impaction teeth exhibited the highest degree of relation A (65%). Furthermore, there was a statistically significant correlation between the classification of mandibular third molar impaction teeth according to Pell & Gregory by class and the Rood & Shehab classification. The results of the data analysis indicated that the relation had a p-value of 0.000.

Table 6 illustrates that the majority of impacted mandibular third molars in position B with relation A were observed, accounting for a significant

**Table 1.** The distribution of research sample based on age and gender

| Age | Gender | | | | Total | |
|---|---|---|---|---|---|---|
| | Male | | Female | | | |
| | N | % | N | % | N | % |
| 18 | 0 | 0% | 3 | 1,5% | 3 | 1,5% |
| 19 | 1 | 0,5% | 13 | 6,3% | 14 | 6,8% |
| 20 | 7 | 3,4% | 19 | 9,2% | 26 | 12,6% |
| 21 | 3 | 1,5% | 18 | 8,7% | 21 | 10,2% |
| 22 | 5 | 2,4% | 18 | 8,7% | 23 | 11,2% |
| 23 | 8 | 3,9% | 20 | 9,7% | 28 | 13,6% |
| 24 | 9 | 4,4% | 29 | 14,1% | 38 | 18,4% |
| 25 | 4 | 1,9% | 19 | 9,2% | 23 | 11,2% |
| 26 | 4 | 1,9% | 1 | 0,5% | 5 | 2,4% |
| 27 | 2 | 1% | 5 | 2,4% | 7 | 3,4% |
| 28 | 1 | 0,5% | 2 | 1% | 3 | 1,5% |
| 29 | 0 | 0% | 2 | 1% | 2 | 1% |
| 31 | 1 | 0,5% | 2 | 1% | 3 | 1,5% |
| 32 | 0 | 0% | 3 | 1,5% | 3 | 1,5% |
| 33 | 0 | 0% | 1 | 0,5% | 1 | 0,5% |
| 34 | 1 | 0,5% | 0 | 0% | 1 | 0,5% |
| 35 | 1 | 0,5% | 0 | 0% | 1 | 0,5% |
| 40 | 2 | 1% | 2 | 1% | 4 | 1,9% |
| **Total** | **49** | **23,8%** | **157** | **76,2%** | **206** | **100%** |

**Table 2.** The relation between the classification of impacted mandibular third molars according to Pell & Gregory and their proximity to the mandibular canal

| Variable | Pell & Gregory's classification is based on Class | | | | | | Total | | *p-value* |
|---|---|---|---|---|---|---|---|---|---|
| Proximity | Class I | | Class II | | Class III | | | | |
| | N | % | N | % | N | % | N | % | |
| **Close** | 5 | 8,8% | 25 | 43,9% | 27 | 47,4% | 57 | 100% | 0,000 |
| **Related** | 3 | 1% | 103 | 33,2% | 204 | 65,8% | 310 | 100% | |
| **Not Close** | 0 | 0% | 15 | 75% | 5 | 25% | 20 | 100% | |
| **Total** | 8 | 2,1% | 143 | 37% | 236 | 61% | 387 | 100% | |

**Table 3.** The relation between the Pell & Gregory classification of impacted mandibular third molars based on their position and proximity to the mandibular canal

| Variable | Pell & Gregory's classification is based on Position | | | | | | Total | | *p-value* |
|---|---|---|---|---|---|---|---|---|---|
| Proximity | Position A | | Position B | | Position C | | | | |
| | N | % | N | % | N | % | N | % | |
| Close | 39 | 68,4% | 18 | 31,6% | 0 | 0% | 57 | 100% | 0,000 |
| Related | 127 | 41% | 180 | 58,1% | 3 | 1% | 310 | 100% | |
| Not Close | 13 | 65% | 6 | 30% | 1 | 5% | 20 | 100% | |
| Total | 179 | 46,3% | 204 | 52,7% | 4 | 1% | 387 | 100% | |

**Table 4.** The relation between the classification of impacted mandibular third molars according to Winter based on their angulation and proximity to the mandibular canal

| Variable | Winter's classification based on Angulation | | | | | | | | | | Total | | *p-value* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proximity | Vertical | | Mesioangular | | Horizontal | | Distoangular | | Others | | | | |
| | N | % | N | % | N | % | N | % | N | % | N | % | |
| Close | 21 | 36,8% | 23 | 40,4% | 4 | 7% | 9 | 15,8% | 0 | 0% | 57 | 100% | 0,015 |
| Related | 83 | 26,8% | 164 | 52,9% | 23 | 7,4% | 32 | 10,3% | 8 | 2,6% | 310 | 100% | |
| Not Close | 5 | 25% | 7 | 35% | 1 | 5% | 4 | 20% | 3 | 15% | 20 | 100% | |
| Total | 109 | 28,2% | 194 | 50,1% | 28 | 7,2% | 45 | 11,6% | 11 | 2,8% | 387 | 100% | |

**Table 5.** Relation between impacted lower third molars according to Pell & Gregory classification based on class and radiographic proximity to the mandibular canal according to Rood & Shehab classification

| Variable | Pell & Gregory's classification is based on Class | | | | | | Total | | *p-value* |
|---|---|---|---|---|---|---|---|---|---|
| Rood &Shehab's Classification | Class I | | Class II | | Class III | | | | |
| | N | % | N | % | N | % | N | % | |
| Relation A | 3 | 1,7% | 60 | 33,3% | 117 | 65% | 180 | 100% | 0,000 |
| Relation B | 0 | 0% | 8 | 36,4% | 14 | 63,6% | 22 | 100% | |
| Relation C | 0 | 0% | 20 | 51,3% | 19 | 48,7% | 39 | 100% | |
| Relation D | 0 | 0% | 1 | 11,1% | 8 | 88,9% | 9 | 100% | |
| Relation E | 0 | 0% | 1 | 4,8% | 20 | 95,2% | 21 | 100% | |
| Relation F | 0 | 0% | 7 | 24,1% | 22 | 75,9% | 29 | 100% | |
| Relation G | 0 | 0% | 6 | 60% | 4 | 40% | 10 | 100% | |
| Others | 5 | 6,5% | 40 | 51,9% | 32 | 41,6% | 77 | 100% | |
| Total | 8 | 2,1% | 143 | 37% | 236 | 61% | 387 | 100% | |

**Table 6.** Relation between impacted lower third molars according to Pell & Gregory classification based on position and radiographic proximity to the mandibular canal according to Rood & Shehab classification

| Variable | Pell & Gregory's classification is based on Position | | | | | | Total | | *p-value* |
|---|---|---|---|---|---|---|---|---|---|
| Rood &Shehab's Classification | Position A | | Position B | | Position C | | | | |
| | N | % | N | % | N | % | N | % | |
| Relation A | 74 | 41,1% | 105 | 58,3% | 1 | 0,6% | 180 | 100% | 0,001 |
| Relation B | 9 | 40,9% | 13 | 59,1% | 0 | 0% | 22 | 100% | |
| Relation C | 21 | 53,8% | 18 | 46,2% | 0 | 0% | 39 | 100% | |
| Relation D | 4 | 44,4% | 4 | 44,4% | 1 | 11,1% | 9 | 100% | |
| Relation E | 5 | 23,8% | 15 | 71,4% | 1 | 4,8% | 21 | 100% | |
| Relation F | 10 | 34,5% | 19 | 65,5% | 0 | 0% | 29 | 100% | |
| Relation G | 4 | 40% | 6 | 60% | 0 | 0% | 10 | 100% | |
| Others | 52 | 67,5% | 24 | 31,2% | 1 | 1,3% | 77 | 100% | |
| Total | 179 | 46,3% | 204 | 52,7% | 4 | 1% | 387 | 100% | |

proportion (58.3%). Furthermore, a notable relation was identified between the Pell & Gregory classification based on position and the Rood & Shehab classification, with a p-value of 0.001.

Table 7 demonstrates that the lower portion of the teeth exhibiting mesioangular angulation is predominantly associated with A (61.1%). The data analysis of the correlation between the Winter classification and the Rood & Shehab classification yielded a p-value of 0.000, indicating a statistically significant relation between the two.

## DISCUSSION

The findings of this study indicate that the majority of samples exhibiting impaction on the


Jurnal Radiologi Dentomaksilofasial Indonesia 2024; 8(3); 103-12 | DOI: 10.32793/jrdi.v8i3.1281

**Table 7.** Relation between impacted lower third molars according to Winter classification based on angulation and radiographic proximity to the mandibular canal according to Rood & Shehab classification

| Variable | Winter's classification based on Angulation | | | | | | | | | | Total | | *p-value* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rood &Shehab's Classification | Vertical | | Mesioangular | | Horizontal | | Distoangular | | Others | | | | |
| | N | % | N | % | N | % | N | % | N | % | N | % | |
| **Relation A** | 44 | 24,4% | 110 | 61,1% | 8 | 4,4% | 14 | 7,8% | 4 | 2,2% | 180 | 100% | 0,000 |
| **Relation B** | 5 | 22,7% | 9 | 40,9% | 1 | 4,5% | 4 | 18,2% | 3 | 13,6% | 22 | 100% | |
| **Relation C** | 16 | 41% | 18 | 46,2% | 0 | 0% | 5 | 12,8% | 0 | 0% | 39 | 100% | |
| **Relation D** | 2 | 22,2% | 5 | 55,6% | 1 | 11,1% | 1 | 11,1% | 0 | 0% | 9 | 100% | |
| **Relation E** | 3 | 14,3% | 5 | 23,8% | 10 | 47,6% | 2 | 9,5% | 1 | 4,8% | 21 | 100% | |
| **Relation F** | 10 | 34,5% | 12 | 41,4% | 1 | 3,4% | 6 | 20,7% | 0 | 0% | 29 | 100% | |
| **Relation G** | 3 | 30% | 5 | 50% | 2 | 20% | 0 | 0% | 0 | 0% | 10 | 100% | |
| **Others** | 26 | 33,8% | 30 | 39% | 5 | 6,5% | 13 | 16,9% | 3 | 3,9% | 77 | 100% | |
| **Total** | 109 | 28,2% | 194 | 50,1% | 28 | 7,2% | 45 | 11,6% | 11 | 2,8% | 387 | 100% | |

mandibular third molar teeth were female, with 157 samples (76.2%) out of 206 samples (Table 1). Similarly, research conducted by Lacerda-Santos et al, reported a similar prevalence of female subjects, with 711 female samples (65.2%) out of a total of 1090 samples.[6] This finding was also conveyed in research conducted by Yasin et al, Akbar et al, and Tenrilili et al.[15,23,25] The aforementioned statement can be attributed to the existence of discrepancies in the duration of the growth period between males and females, particularly during the period of maximum growth.[15,26] The average age at which the growth spurt occurs in females is 12 years, while in males it occurs at 14 years. [26] This growth spurt exerts influence beyond that of impaction, affecting height and weight. [15,27] A study conducted by Adeyemo and colleagues demonstrated a correlation between height and impaction status in mandibular third molar teeth. Subjects who experienced impaction of mandibular third molar teeth exhibited significantly lower height compared to subjects whose mandibular third molar teeth were fully erupted.[27] Similarly, in the growth In terms of growth patterns, women typically exhibit a shorter skeletal growth pattern and a relatively faster growth rate compared to men.[15] This results in the cessation of jaw growth in women coinciding with the eruption of the third molar tooth. This assertion is supported by research conducted by Azhari et al., which suggests that in women, jaw growth remains relatively constant from the age of 16 years, while in men, it reaches its peak at the age of 17 years.[28] However, the rate of jaw growth is inversely proportional to the eruption of the third molar tooth. Women experience a slowdown in jaw growth earlier than men, while in men the lower jaw third molar tooth erupts about three to six months earlier than women[15,28]

Furthermore, in Table 1 we can see that the most prevalent age range identified in this study was between 20 and 25 years. Similarly, Tenrilili et al. and Muhamad et al. reported comparable findings, indicating that the age range of 21 to 30 years was the most prevalent in their research samples. [15,29] These results may be influenced by the eruption time, which is typically around 17 to 21 years of age [25] Some sources suggest that third molars typically erupt between the ages of 16 and 25.[5] Conversely, Muhamad et al. and Akbar et al. observed a low prevalence of tooth impaction in older age groups, which they attributed to the possibility that previous tooth extractions may have been performed in individuals of advanced age.[25,29]

The results of the study indicated that the majority of maxillary third molar impaction teeth were observed in class III, representing 236 teeth (61%) out of 387 teeth (Table 2). This result is not aligned with the findings of Haddad et al. and Akbar et al., who reported that the impaction of mandibular third molar teeth in class II was the most prevalent.[25,30] As previously discussed, this classification describes whether there is sufficient space for the mandibular third molar teeth to erupt. In class III, it can be interpreted that there is insufficient space for the mandibular third molar teeth to erupt, resulting in the majority of teeth residing within the mandibular ramus.[13,15,31] This can be attributed to one of the etiologies of impaction, namely the alveolar bone arch being smaller than the total length of the dental arch.[1] The lack of jaw arch is influenced by several factors, one of which is gender.[7] As previously noted, the majority of samples in this study were female. Some studies have indicated that the growth of the jaw in women ceases when the third molar tooth erupts.[15,23] The maturation of the female jawbone can also be influenced by the menstrual cycle and physical activity, resulting in accelerated and more robust bone growth.[9] Dietary factors also play a role in bone growth, with a diet rich in fibre increasing muscle activity and promoting jaw growth.[15]

The data analysis in Table 3 revealed that position B is the most prevalent impacted tooth position of mandibular third molars in this study, affecting 204 teeth (52.7%) out of 387 teeth. This finding is in accordance with the results of previous research conducted by Primo et al. and Haddad et

al., which indicates that position B is the most dominant position in comparison to positions A and C. [30,32] Additionally, a previous study has suggested that the occurrence of impaction on mandibular third molar teeth may be influenced by factors such as mandibular ramus height and mandibular ramus angle. In the case of mandibular third molar impaction teeth, position A was found to exhibit the highest ramus and the lowest ramus height in position C. [33] Based on the size of the mandibular ramus angle, no significant difference was observed between the impacted teeth of the mandibular third molar in positions A and C. However, in position B, a smaller ramus angle was noted.[33] It can therefore be concluded that the probability of impaction is higher in cases where the mandibular ramus is of a shorter height and the angle of the mandibular ramus is smaller. [25,33] This is supported by the findings of a study which demonstrated that the ramus in males is of a greater height than in females.[34]

In this study, the classification of maxillary third molar impaction teeth according to Winter revealed that the most frequently observed angulation was mesioangular, which was identified in 194 teeth (50.1%) of 387 teeth (Table 4). These findings align with those of Passi et al., who reported a significantly higher prevalence of mesioangular angulation compared to other angulations, with 123 teeth (49.2%) exhibiting this feature out of 250 teeth.[4] Additionally, the findings of Dusak et al. further support the assertion that mesioangular angulation is more prevalent. Of the 342 teeth examined, 67.54% exhibited mesioangular angulation.[5] The results of these studies may be attributed to the fact that the average growth and eruption direction of the mandibular third molar teeth is antero-superior, and the numerous findings of the location of the third molar tooth seed, which is tilted mesially based on the lateral aspect.[8,35]

Based on Table 2, 3 and 4, the most prevalent teeth observed in this study were teeth related to the mandibular canal, comprising 310 teeth (80.1%) out of the 387 total teeth analysed. The results of this study are in accordance with the findings of Haddad et al., who examined 1,060 impacted mandibular third molar teeth and observed that 872 (54.5%) were associated with the mandibular canal.[30] . However, these results are not aligned with the conclusions of Yasin et al. In their study, it was stated that among 1,090 impacted teeth of the mandibular third molar, there were 723 teeth located far from the mandibular canal (66.33%). [23] This discrepancy could be attributed to the fact that the majority of the teeth in this study were classified as class III according to the Pell & Gregory classification, which is based on the availability of space (Table 1). In contrast, the most impacted teeth of the mandibular third molar in the study conducted by Yasin et al. were found to be in class I.[23] This assertion is supported by the findings of the Yasin et al. study, which indicate that the proximity between mandibular third molar teeth in class III and the mandibular canal is six times higher than in class I.[23] Furthermore, other studies have suggested that women have a high prevalence of tooth root entry into the mandibular canal, with a reported rate of 62.1%.[36] Additionally, the results of this study may be attributed to one of the inclusion criteria employed, namely the formation of complete mandibular third molar tooth roots. In their study, Kamadjaja et al. asserted that fully formed roots tend to make contact with the mandibular canal.[24]

The findings of this study indicate that relation A is the most prevalent in this study, with a total of 180 teeth (46.5%) from a total of 387 teeth (Tabel 5,6 and 7). This result is in accordance with the findings of Lacerda-Santos et al, who reported that 767 teeth exhibited the A relation (45.7%) out of 1677 teeth. [6] Similarly, Kamadjaja and colleagues observed that the A relation was the most prevalent in comparison to other relations.[24] several studies have attributed the darkening image at the root of the impacted mandibular third molar (Relation A) to the loss of tooth substance [37] Following an evaluation using CBCT, it was determined that the image was not caused by a loss of tooth substance, but rather by a thinning of the buccal and/or lingual cortical plates.[37] This can be attributed to a study that indicated a significant correlation between age and lingual cortical plate thickness. Specifically, the lingual cortical plate was observed to be markedly thinner in the apical one-third and middle one-third of the roots of mandibular third molar teeth in individuals aged 21-30 years.[38]

The findings of the relation analysis between the classification of mandibular third molar impaction teeth in accordance with the Pell & Gregory system (based on the availability of space in the dental arch) and the position of the mandibular canal with respect to the midline demonstrate a statistically significant relation ($p = 0.000$) (Table 2). The results indicate a positive correlation between the proximity of the mandibular third molar impaction to the mandibular ramus and the proximity to the mandibular canal. As can be seen in Table 2, the data substantiates this assertion. The results reveal a notable rise in the number of teeth situated in close proximity to the mandibular canal, as well as a significant proportion of teeth related to the canal. In particular, teeth in this vicinity can be categorised as follows: 5 teeth belonging to the mandibular third molars of Class I (8.8%), 25 teeth belonging to Class II (43.9%) and 27 teeth belonging to Class III (47.4%). Additionally, among the teeth related to the mandibular canal, there are three class I teeth (1%), 103 class II teeth (33.2%), and 204 class III teeth (65.8%). These findings are corroborated by the research of Haddad et al., which indicates that impacted mandibular third molar class III teeth are more likely to be in proximity to the mandibular canal than classes I and II.[30] The presence of mandibular third molar teeth that are largely or entirely within the mandibular ramus can be attributed to the lack

of space between the distal surface of the second molar tooth and the anterior edge of the mandibular ramus.[6,13] One study has indicated that there is a high probability of mandibular third molars being situated on the lingual side of the mandible. This can be attributed to the findings of other studies which have suggested that the position of the mandibular canal crosses lingually on the roots of mandibular second and third molars, which were previously located on the buccal side of the roots of first molars and premolars.[19,39,40] Researchers suspect that the lack of space may result in potential contact between the mandibular canal and the roots of the mandibular third molars, both on the lingual side of the mandibular canal and between the roots of other teeth.

The results of the analysis of the relation between the classification of impacted teeth of the mandibular third molar according to Pell & Gregory based on position (depth) and the mandibular canal according to proximity demonstrate a significant correlation (p=0.000) (Table 3). It can therefore be concluded that the deeper the position of the impacted tooth of the mandibular third molar, the greater the likelihood of contact or relation to the mandibular canal. This finding is further supported by the research conducted by Khojastepour et al., which states that the deeper the position of the impaction tooth of the mandibular third molar, the position of the tooth is dominantly towards the lingual side of the mandible[39] This statement remains related to the position of the mandibular canal, which is inclined to be located on the lingual side of the mandible at the root of the third molar. [19] Both statements reinforce the researcher's assertion that an increase in depth of the impacted third molar tooth may elevate the probability of contact with the mandibular canal

As evidenced in Table 4, there was a statistically significant correlation between the classification of mandibular third molar impaction teeth by angulation and the proximity of the mandibular canals (p=0.015). These findings demonstrate the high prevalence of mesioangular and vertical angulations in contact with the mandibular canal, either merely touching the outer edge of the canal (i.e., in close proximity) or in direct contact with it. These findings align with those of previous research conducted by Lacerda-Santos et al. dan Haddad et al., ., which demonstrated that both angulations have a higher frequency of contact with the mandibular canal compared to other angulations.[6,30] A study has demonstrated a correlation between the angulation of mandibular third molar teeth and their depth. Afridi et al. have asserted that as the angulation of the teeth increases, the depth of the teeth also increases, as does the proximity to the mandibular canal. [41] As stated by Haddad et al., an increase in the depth of an impacted mandibular third molar tooth accompanied by a change in angle from vertical to either mesioangular or horizontal will result in an elevated risk of interference between the roots of the mandibular third molar and the mandibular canal.[30]

Table 5 illustrates a notable correlation between the classification of impacted mandibular third molars according to Pell & Gregory's classification system, based on based on the availability of space in the dental arch and its relation with the mandibular canal according to Rood & Shehab (P=0.000). The results of the analysis on the relation between the classification of mandibular third molar impaction teeth according to Pell & Gregory based on position (depth) and its relation with the mandibular canal according to Rood & Shehab (Table 6) also demonstrated a significant relation (P=0.001). This is consistent with the findings of Lacerda-Santos et al. who observed that the deeper the impacted third molar is situated within the ramus, the more prevalent the associated signs become.[6] These results can also be attributed to previous findings indicating a tendency for the impacted mandibular third molar to be on the lingual side of the mandible. This positioning allows for contact with the lingual-side mandibular canal when crossing the roots of the mandibular third molar. [19,39,40] This statement can be related to the cause of relation A (darkening of the mandibular third molar root), which is the most dominant relation found in this study. This is due to the thinning of the buccal and/ or lingual cortical plate [37] This is clarified by research which states that the mandibular bone around teeth located on the lingual side of the mandible tends to be thinned or even perforated more than teeth located on the buccal side of the mandible [39] It can be concluded from the aforementioned statements that the lack of space and the deep position of impacted mandibular third molars can increase the frequency of radiographic signs of proximity to the mandibular canal.

Table 7 illustrates the significant relation between the classification of impacted teeth of mandibular third molars according to Winter and their relation with the mandibular canal according to Rood & Shehab (P = 0.000). The study conducted by Lacerda-Santos et al, also indicated a significant correlation between the two variables (P=0.02).[6] This implies that the angulation of the impacted mandibular third molar tooth may influence the perceived proximity to the mandibular canal. The researcher hypothesises that the angulation of the mandibular third molar impaction tooth continues to exert an influence on its depth. This is thought to be related to the presence of the mandibular third molar impaction tooth, which is known to be more prevalent on the lingual side of the mandible.

The results of the precent study indicate that the most prevalent classification system for mandibular third molar impaction is that proposed by Pell and Gregory. This system is based on the classification of teeth according to class and position, with class indicating the available space within the jawbone and position indicating depth. This finding aligns with the additional assertion by Afridi and colleagues that the correlation between Winter's classification of teeth based on angulation

and their proximity to the mandibular canal is significant but less pronounced.[41]

## CONCLUSION

The results of this study indicate a significant correlation between the Pell & Gregory classification (class and position) and proximity to the mandibular canal. A significant relation was found between the Winter classification and its proximity to the mandibular canal. A significant relation was found between the Pell & Gregory classification (class and position) and the Rood & Shehab classification. The less space available in the mandible, the deeper the position of the impacted tooth in the jaw and its angulation affects the proximity of the impacted tooth to the mandibular canal and radiographic signs of the proximity of the roots of impacted mandibular third molars to the mandibular canal. This highlights the need for a panoramic radiograph prior to any intervention on the mandibular third molar. The results of this study can be used to guide surgical planning and avoid complications due to inferior alveolar nerve injury. Further research could be conducted using the same number of samples based on each classification, as well as based on gender and age. This would enable a comparison of the results and greater accuracy in determining the relation between the classification of impacted mandibular third molar teeth and the radiographic image of their proximity to the mandibular canal.

## ACKNOWLEDGMENTS

None.

## FOOTNOTES

All authors have no potential conflict of interest to declare for this article. This research has received ethical approval from the Research Ethics Commission of the Faculty of Dentistry, Prof. Dr. Moestopo (Beragama) University with number 141/KEPK/FKGUPDMB/VII/2024. All procedures conducted were in accordance with the ethical standards.

## REFERENCES

1. HUPP JR. Management of patients with orofacial clefts. In: Craniofacial and Dental Developmental Defects: Diagnosis and Management. 2015:113-24.
2. Santosh P. Impacted mandibular third molars: Review of literature and a proposal of a combined clinical and radiological classification. Ann Med Health Sci Res. 2015;5(4):229.
3. Septina F, Atika Apriliani W, Baga I. Prevalensi Impaksi Molar Ke Tiga Rahang Bawah Di Rumah Sakit Pendidikan Universitas Brawijaya Tahun 2018. E-Prodenta J Dent. 2021;5(2):450-60.
4. Passi D, Singh G, Dutta S, et al. Study of pattern and prevalence of mandibular impacted third molar among Delhi□National Capital Region population with newer proposed classification of mandibular impacted third molar: A retrospective study. Natl J Maxillofac Surg. 2019;10(1):3-7.
5. Dusak PK, Dewi KK. DIISRIBUSI FREKUENSI TEKNIK ODONTEKTOMI BERDASARKAN KLASIFIKASI IMPAKSI MOLAR KETIGA RAHANG BAWAH YANG DILAKUKAN MAHASISWA KEPANITERAAN KLINIK BEDAH MULUT RSGM FKG UPDM (B). MANUJU MALAHAYATI Nurs J. 2022;4(10):2520-6.
6. Lacerda-Santos JT, Granja G lica L, De Vasconcelos Cat o MHC, et al. Signs of the proximity of third molar roots to the mandibular canal: an observational study in panoramic radiographs. Gen Dent. 2020;68(2):30-5.
7. Saputra YG, Anindita PS, Pangemanan DHC. Ukuran dan bentuk lengkung gigi rahang bawah pada orang Papua. e-GIGI. 2016;4(2):253-8.
8. Fitri AM, Kasim A, Yuza AT. Impaksi gigi molar tiga rahang bawah dan sefalgia Amalia. J Kedokt Gigi Univ Padjadjaran. 2016;28(3):148-54.
9. Sahetapy DT, Anindita PS, Hutagalung BSP. Prevalensi Gigi Impaksi Molar Tiga Partial Erupted Pada Masyarakat Desa Totabuan. e-GIGI. 2015;3(2):2-7.
10. Faridha DS, Wardhana ES, Agustin ED. Gambaran Kasus Gigi Impaksi Dan Tingkat Pengetahuan Pasien Penderita Gigi Impaksi Di Rumah Sakit Islam Sultan Agung Semarang. Konf Ilm Mhs Unissula 2. 2019;7:40-6.
11. Fakhrurrazi F, Hakim R fanani, Rifani R. Hubungan Tingkat Kesulitan Dengan KomplikasiPost Odontektomi Gigi Impaksi Molar Ketiga Rahang BawahPada Pasien Di Instalasi Gigi Dan Mulut Rsudza Banda Ac. Cakradonya Dent J. 2015;7(1):745-806.
12. Rizqiawan A, Lesmaya YD, Rasyida AZ, Amir MS, Ono S, Kamadjaja DB. Postoperative Complications of Impacted Mandibular Third Molar Extraction Related to Patient's Age and Surgical Difficulty Level: A Cross-Sectional Retrospective Study. Int J Dent. 2022;2022.
13. Lita YA, Hadikrishna I. Klasifikasi impaksi gigi molar ketiga melalui pemeriksaan radiografi sebagai penunjang odontektomi. J Radiol Dentomaksilofasial Indones. 2020;4(1):1-5.
14. Monaca G La, Vozza I, Giardino R, Annibali S, Pranno N, Cristalli MP. Prevention of neurological injuries during mandibular third molar surgery: technical notes. Ann Stomatol (Roma). 2017;8(2):45-52.
15. Tenrilili ANA, Yunus B, Rahman FUA. Third molar impaction prevalence and pattern: a panoramic radiography investigation. J Radiol Dentomaksilofasial Indones. 2023;7(1):9-14.
16. Kaffe I, Fishel D, Gorsky M. Panoramic radiography in dentistry. Clin Dent Rev. 2021;5(26):25-30, 19.-22
17. Boel T, Kumar SB. Gambaran Kanalis Mandibularis Kiri Secara Radiografi Panoramik Pada Warga Medan Selayang. Dentika Dent J. 2014;18(2):174-6.
18. Mortazavi H, Baharvand M, Safi Y, Dalaie K, Behnaz M, Safari F. Common conditions associated with mandibular canal widening: A literature review. Imaging Sci Dent. 2019;49(2):87-95.
19. Muñoz G, Dias FJ, Weber B, Betancourt P, Borie E. Anatomic Relationships of Mandibular Canal. A Cone Beam CT Study. Int J Morphol. 2017;35(4):1243-8.
20. Abdallah Edrees M, Moustafa Attia A, Abd Elsattar M, Fahmy Gobran H, Ismail Ahmed A. Course and Topographic Relationships of Mandibular Canal: A Cone Beam Computed Tomography Study. Int J Dent Oral Sci. 2017;4(March):444-9.
21. Pandithurai N, Gunasekar P, Saravanan T, Shakila K. Evaluation of Mandibular Canal Anatomy, Variations, and its Classification in Panoramic Radiographs: A Retrospective Study. J Sci Dent. 2023;13(1):7-10.
22. KalaiSelvan S, Ganesh SKN, Natesh P, Moorthy MS, Niazi TM, Babu SS. Prevalence and Pattern of Impacted Mandibular Third Molar: An Institution-based Retrospective Study Sundarrajan. Asian J Pharm Clin Res. 2017;7(10):1-5.
23. Yasin Ertem S, Anlar H. Evaluation of the Relation Between Impacted Mandibular Third Molar Classification and Inferior Alveolar Canal. J Dent Indones. 2020;27(1):17-22.
24. Kamadjaja DB, Asmara D, Khairana G. The correlation between Rood and Shehab's radiographic features and the incidence of inferior alveolar nerve paraesthesia following odontectomy of lower third molars. Dent J (Majalah Kedokt Gigi). 2017;49(2):59-62.
25. Akbar MF, Hadikrishna I, Riawan L, Lita YA. Impacted Lower Third Molar Profile at Dental Hospital of Padjadjaran University. J Indones Dent Assoc. 2023;5(2):91-8.
26. Pradopo S, Nelwan SC, Dewi AM, et al. Duration of Growth Spurt based on Cervical Vertebrae Maturation In Indonesia Population. Indian J Forensic Med Toxicol. 2021;15(3):4088-

94.
27. Adeyemo WL, James O, Oladega AA, et al. Correlation Between Height and Impacted Third Molars and Genetics Role in Third Molar Impaction. J Maxillofac Oral Surg. 2021;20(1):149-53.
28. Azhari A, Pramatika B, Epsilawati L. Differences between male and female mandibular length growth according to panoramic radiograph. Maj Kedokt Gigi Indones. 2019;1(1):43-9.
29. Muhamad AH, Nezar W. Prevalence of Impacted Mandibular Third Molars in Population of Arab Israeli: A Retrospective Study. IOSR J Dent Med Sci e-ISSN. 2016;15(1).
30. Haddad Z, Khorasani M, Bakhshi M, Tofangchiha M, Shalli Z. Radiographic position of impacted mandibular third molars and their association with pathological conditions. Int J Dent. 2021;2021(March).
31. Porgel M, K-E K, L A. Essentials of Oral and Maxillofacial Surgery. 1st ed. Wiley Blackwell; 2014.
32. Primo FT, Primo BT, Scheffer MAR, Hernández PAG, Rivaldo EG. Evaluation of 1211 Third Molars Positions According to the Classification of Winter, Pell & Gregory. Int J Odontostomatol. 2017;11(1):61-5.
33. Gümrükçü Z, Balaban E, Karabağ M. Is there a relationship between third-molar impaction types and the dimensional/ angular measurement values of posterior mandible according to Pell & Gregory/Winter Classification? Oral Radiol. 2021;37 (1):29-35.
34. Leversha J, McKeough G, Myrteza A, Skjellrup-Wakefiled H, Welsh J, Sholapurkar A. Age and gender correlation of gonial angle, ramus height and bigonial width in dentate subjects in a dental school in Far North Queensland. J Clin Exp Dent. 2016;8 (1):e49-e54.
35. Sukma Suntana M, Lenggogeni Nasroen S, Fadhilah I. Classification of Winter Impaction of Mandible Third Molar on the Distance of the Mandibular Canals on Panoramic Radiographs At Rsgmp Unjani. J Heal Dent Sci. 2023;2(Volume 2 No 3):455-66.
36. Utama MD, Abdi MJ, Makmur ZZ. HUBUNGAN KLASIFIKASI IMPAKSI MOLAR KETIGA MANDIBULA DENGAN JARAK KANAL MANDIBULAR PADA RADIOGRAFI PANORAMIK DI KLINIK MEDICAL CENTER. Indones J Public Heal. 2024;2(2):286-94.
37. Savani CM, Panicker K, Kiran BSR, Uppada UK. Does Darkening of Roots or Loss of White Line on Panoramic Radiographs Pose a Risk for Inferior Alveolar Nerve Damage? A CBCT Evaluation. J Orofac Sci. 2018;10(2):101-7.
38. Halder M, Chhaparwal Y, Pentapati KC, Patil V, Smriti K, Chhaparwal S. Quantitative and Qualitative Correlation of Mandibular Lingual Bone with Risk Factors for Third Molar Using Cone Beam Computed Tomography. Clin Cosmet Investig Dent. 2023;15(September):267-77.
39. Khojastepour L, Khaghaninejad MS, Hasanshahi R, Forghani M, Ahrari F. Does the Winter or Pell and Gregory Classification System Indicate the Apical Position of Impacted Mandibular Third Molars? J Oral Maxillofac Surg. 2019;77(11):2222.e1-2222.e9.
40. Gu L, Zhu C, Chen K, Liu X, Tang Z. Anatomic study of the position of the mandibular canal and corresponding mandibular third molar on cone-beam computed tomography images. Surg Radiol Anat. 2018;40(6):609-14.
41. Afridi SU, Baseer N, Durrani Z, Afridi MI, Jehan S. Association Between Angulation of MAndibular Third Molar Impaction with facial skeletal types and cephalometric landmarks. Khyber Med Univ J. 2022;14(1):47-55.