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Radiographic analysis of third molar impaction pattern

Análise radiográfica do padrão de impactação de terceiros molares

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ABSTRACT

Objective: The objective of this study was to analyze the angulation, depth relative to the occlusal plane, and available space of third molars, as well as their distribution by sex, using panoramic radiographs. **Methods**: This descriptive epidemiological study was based on digital panoramic radiographs of male and female individuals over 18 years of age, obtained between 2017 and 2020. A calibrated examiner evaluated the impacted third molars, classifying them according to Winter's and Pell & Gregory's classification systems. Data were analyzed using STATA statistical software. The study was approved by the Research Ethics Committee of UESB (CEP-UESB). **Results**: Of the 2,621 radiographs assessed, 657 met the inclusion criteria, totaling 1,208 maxillary and 1,196 mandibular third molars. In the maxilla, vertical angulation was the most prevalent, followed by distoangular, mesioangular, and horizontal positions. In the

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mandible, vertical angulation also predominated, followed by mesioangular, horizontal, and distoangular. Regarding impaction depth, Level A was the most frequent in both arches, followed by Levels C and B in the maxilla, and Levels B and C in the mandible. **Conclusion**: As for available space, Class II was the most common in the mandible, followed by Classes I and III. Vertical angulation and Level A depth were the most prevalent in the maxilla. In the mandible, vertical angulation, Level A depth, and Class II space were the most frequent. Third molar impactions were more commonly observed in females.

Indexing terms: Diagnosis, oral. Radiography, panoramic. Tooth, impacted.

RESUMO

Objetivo: Analisar a angulação, a profundidade em relação ao plano oclusal e o espaço disponível para terceiros molares, bem como sua distribuição entre os sexos, utilizando radiografias panorâmicas. **Métodos**: Trata-se de um estudo epidemiológico descritivo baseado em radiografias panorâmicas digitais de indivíduos do sexo masculino e feminino com idade acima de 18 anos, obtidas entre 2017 e 2020. Um examinador calibrado avaliou os terceiros molares impactados, classificando-os segundo os sistemas de Winter e Pell & Gregory. Os dados foram analisados utilizando o software estatístico STATA. O estudo foi aprovado pelo Comitê de Ética em Pesquisa da UESB (CEP-UESB). **Resultados**: Das 2621 radiografias avaliadas, 657 foram incluídas no estudo, totalizando 1208 terceiros molares superiores e 1196 inferiores. Na maxila, a angulação vertical foi a mais prevalente, seguida pelas posições distoangular, mesioangular e horizontal. Na mandíbula, também predominou a angulação vertical, seguida das posições mesioangular, horizontal e distoangular. Em relação à profundidade de impactação, o Nível A foi o mais frequente em ambas as arcadas, seguido pelos Níveis C e B na maxila, e pelos Níveis B e C na mandíbula. **Conclusão**: Quanto ao espaço disponível, a Classe II foi a mais comum na mandíbula, seguida pelas Classes I e III. A angulação vertical e a profundidade Nível A foram mais prevalentes na maxila. Na mandíbula, predominaram a angulação vertical, a profundidade Nível A e o espaço Classe II. As impactações de terceiros molares foram mais frequentes em indivíduos do sexo feminino.

Termos de indexação: Diagnóstico bucal. Radiografia panorâmica. Dente impactado.

INTRODUCTION

The term ‘tooth impaction’ defines a tooth unable to emerge completely into the oral cavity thereby preventing normal occlusion [1], characterizing a phenomenon particularly relevant in dentistry due to its high prevalence and associated complications [2]. In decreasing order of frequency, impaction most commonly occurs in the mandibular premolars followed by the mandibular canines, maxillary premolars, maxillary central incisors, maxillary lateral incisors, and mandibular second molars [1]. Maxillary first and second molars are rarely impacted [1]. Studies worldwide consistently indicate a high prevalence of impacted third molars, especially mandibular third molars [3-6].

Tooth impaction etiology is moderately understood, but studies show that factors such as lack of mesiodistal space for eruption in the oral cavity, dental crowding, and heredity may be involved [7,8]. Although impacted teeth can remain asymptomatic, third molars are often associated with pathologies like caries, pericoronitis, cysts, tumors, and resorption of the adjacent tooth, justifying the frequent prophylactic extractions of these teeth in oral and maxillofacial surgery [9,10].

Knowing the intraosseous positioning and communication between professionals is crucial for the surgical planning of impacted teeth [11,12]. Panoramic radiography is the gold standard for the clinical evaluation of impacted third molars for it enables facial structure visualization, including the inferior alveolar canal, thus contributing to an accurate diagnosis and planning [13].

To facilitate communication between professionals and surgical planning, several systems have been proposed to classify these teeth, among which those of Winter [14] and Pell & Gregory [15] stand out. Winter's classification system groups the teeth according to the degree of impaction degree, identifying angulations such as vertical, mesioangular, distoangular, horizontal, inverted, lingual, and buccal. In turn, the Pell & Gregory classification system relates the occlusal plane of the third molar to the adjacent second molar (Levels A, B, and C) and defines Classes I, II, and III, associating the mesiodistal diameter of the third molar to the ascending mandibular ramus.

Thus, this study identified the inclination, depth in relation to occlusal plane, and available space of third molars by means of panoramic radiographs and their distribution between sexes.

METHODS

This cross-sectional study analyzed 2,621 digital panoramic radiographs from patients with a mean age of 27.9±8.42 years. Of these, 12.6% were 18 to 20, 59.5% were 21 to 30, 19.5% were 31 to 40, and 8.3% were 40 years old or older. Difference in age between sexes was not statistically significant (p=0.281).

The research was approved by the Research Ethics Committee of the Universidade Estadual do Sudoeste da Bahia (UESB) under opinion No. 3.845.829, CAAE: 28805020.7.0000.0055.

Radiographs were obtained from February 2017 to March 2020 at the teaching clinic of a Brazilian public university using the same digital panoramic X-ray machine (EAGLE, Dabi Atlante brand, 85kVp and 10 mA).

Radiographs from male and female patients aged from 18 to 70 years who had at least one third molar with complete root formation were included in the sample. Radiographs with incompletely developed roots, bone pathologies altering tooth alignment in the occlusal plane, or developmental conditions affecting the visibility of the study area (tumors, cysts, fractures, or malformations) were excluded. Patients who had undergone orthognathic surgery, had facial trauma, used orthodontic devices, had agenesis and/or absence of second or third molars with coronal destruction that prevented their classification, and low quality images (distortion or inadequate contrast) were also excluded.

All radiographs were analyzed in an environment with adequate lighting using zoom and contrast adjustment on a computer. To minimize analysis errors due to visual fatigue and stress, a single standardized examiner evaluated an average of 30 radiographs per day. Presence or absence of third molars were evaluated according to the Winter classification which considers angulation (vertical, mesioangular, distoangular, horizontal, inverted, lingual, and buccal) (table 1, figure 1). Pell & Gregory's classification evaluated the depth in relation to occlusal plane (Level A, Level B, and Level C) and the relation with the mandibular ramus in mandibular molars (Class I, Class II, Class III) (table 1, figure 2).

Third molars were considered impacted if their eruption to the functional position in the occlusal plane was interrupted, with no correlation to other pathologies. Buccal and lingual angulations were not evaluated, as they required additional occlusal radiographs.

Data were tabulated into Microsoft Excel 2019 (Microsoft Corporation, US) and statistically analyzed on Stata statistical package, version 14 (StataCorp, 2021). Variables underwent frequency distribution analysis, and significant differences between groups were determined using Student's t-test, with a p-value <0.05 considered statistically significant.

Table 1. Winter and Pell & Gregory classifications for impacted third molar teeth.

Classification	Definition
Winter	
Vertical	The long axis of the third molar is parallel to the long axis of the second molar.
Horizontal	The long axis of the third molar is horizontal.
Mesioangular	The long axis of the third molar is inclined in mesial direction to the second molar.
Distoangular	The long axis of the third molar is tilted distally or posteriorly away from the second molar.
Transversed	The third molar is completely horizontal, i.e., inclined to buccal or lingual position
Inverted	The tooth is inverted, with the tooth root facing the occlusal plane.
	Pell & Gregory
Depth (in relation to occlusal plane)	
Level A	The highest portion of the third molar is at or above the occlusal plane.
Level B	The highest portion of the third molar is below the occlusal plane, but above the level of the cementoenamel junction of the second molar.
Level C	The highest portion of the impacted third molar is below the level of the cementoenamel junction of the second molar.
Available space (in relation to ascending mandibular ramus)	
Class I	There is sufficient space between the anterior border of the ascending ramus and the distal of the second molar for eruption of the third molar.
Class II	The space available between the anterior border of the ramus and the distal of the second molar is smaller than the mesiodistal diameter of the crown of the third molar.
Class III	The third molar is totally embedded in the bone of the anterior border of the ascending ramus because of the absolute lack of space.

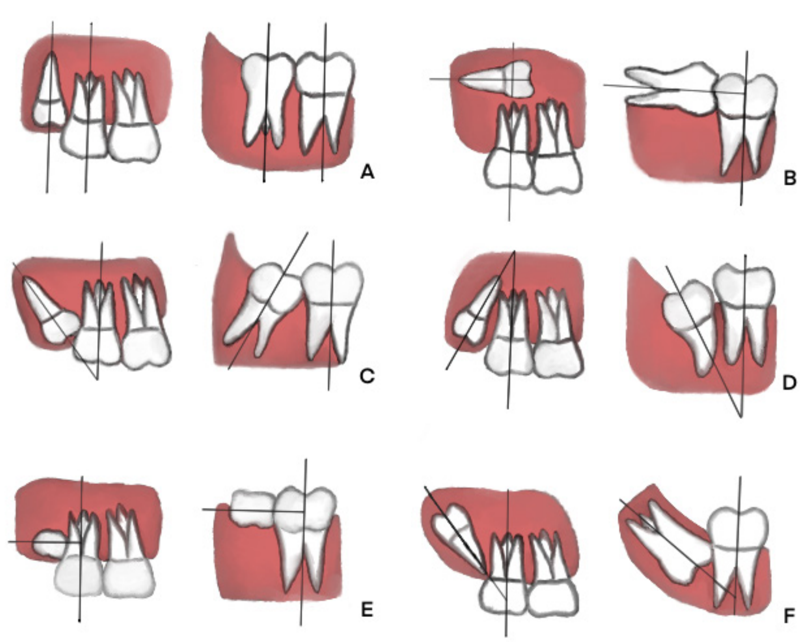

Figure 1. Illustrative diagram of the Winter Classification
Note: (A) Vertical; (B) Horizontal; (C) Mesioangular; (D) Distoangular, (E) Transversed, (F) Inverted.

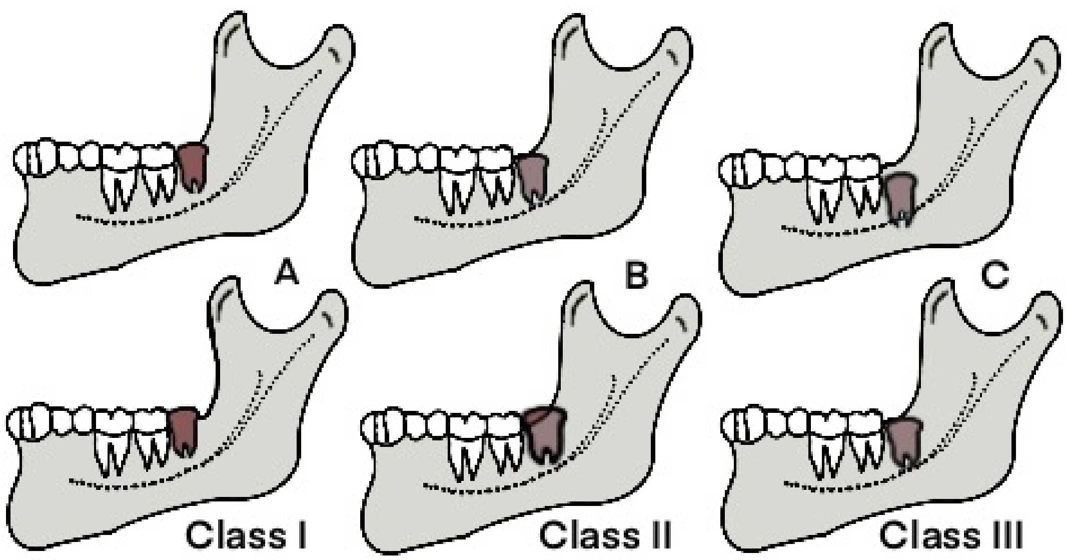

Figure 2. Illustrative diagram of the Pell & Gregory Classification.

Note: Regarding depth: (A) Level A, (B) Level B, (C) Level C; and regarding available space (in relation to ascending mandibular ramus): (D) Class I, (E) Class II, (F) Class III.

RESULTS

During the study period, 2,621 panoramic radiographs were taken. After applying the inclusion and exclusion criteria, 657 radiographs were selected of which 405 (61.6%) were of female patients. Of the 2,403 third molars found, 1,208 (50.3%) were in the maxilla and 1,195 (49.7%) in the mandible, whereas 225 (34.2%) were present outside the oral cavity.

Following Winter's classification, the most prevalent angulation found for maxillary third molars was vertical followed by distoangular, mesioangular, and horizontal. Vertical angulation followed by mesioangular, horizontal, and distoangular were predominant in the mandible (table 2).

Following the Pell & Gregory classification for inclusion depth, the most frequent position in the maxilla was Level A, followed by Levels C and B. In the mandible, Level A prevailed, followed by Levels B and C (table 3).

Regarding available space for inclusion depth of the lower third molar in the mandibular ramus, Class II was the most common, followed by Classes I and III (table 4).

DISCUSSION

We found a higher prevalence of impacted third molars in female patients, in line with studies by Al-Madani et al. [3], Je [16], and Gatti et al. [17], who also reported a higher prevalence in female patients. Hatem et al. [18] and Kalaiselvan et al. [19], however, presented discordant data, observing a higher prevalence of impaction in male patients.

These divergences can be attributed to sexual dimorphism in the mandibular bone, which stops growing in females when the third molar begins to erupt but continues to grow in males. Factors like diet

Table 2. Distribution and association between sex and the Winter [14] classification regarding the inclination of third molars.

Winter's Classification	Maxilla [n(%)]						Mandible [n(%)]					
	Tooth 18			Tooth 28			Tooth 38			Tooth 48		
	F	M	Total	F	M	Total	F	M	Total	F	M	Total
Vertical	322 (79.5)	217 (86.1)	539 (82)	307 (75.8)	196(77.8)	503(76.6)	259(64)	175 (69.4)	434(66.1)	257(66.5)	167(66.3)	424(64.5)
Mesioangular	8(2.0)	2(0.8)	10 (1.5)	13 (3.2)	8 (3.2)	21 (3.2)	71 (17.5)	33 (13.1)	104 (15.8)	70 (17.3)	40 (15.9)	110 (16.7)
Distoangular	41(10.1)	12(4.8)	53(8.1)	51(12.6)	25(9.9)	76(11.6)	3 (0.7)	1(0.4)	4 (0.6)	9(2.2)	-	9 (1.4)
Horizontal	1(0.2)	1(0.4)	2(0.3)	2 (0.5)	2 (0.8)	4(0.6)	31(7.7)	29(11.5)	60(9.1)	28(6.9)	22 (8.7)	50 (7.6)
Absent	33(8.1)	20 (7.9)	53 (8.1)	32(7.9)	21(8.3)	53(8.1)	41(10.1)	14(5.6)	55(8.4)	41(10.1)	23(9.1)	64 (9.7)
Total	405(61.6)	252(38.4)	657(100)	405(61.6)	252(38.4)	657(100)	405(61.6)	252(38.4)	657(100)	405(61.6)	252 (38.4)	636 (100)
p-value	0.095			0.861			0.053			0.146		

Table 3. Numerical and percentage distribution of the depth of the maxillary and mandibular third molars according to the Pell & Gregory [15] classification for depth.

Depth according to Pell & Gregory	Maxilla [n(%)]						Mandible [n(%)]					
	Tooth 18			Tooth 28			Tooth 38			Tooth 48		
	F	M	Total	F	M	Total	F	M	Total	F	M	Total
Level A	272(67.2)	195 (77.4)	467(71.1)	269(66.4)	172(55.8)	441(67.1)	227(56.0)	157 (62.3)	384(58.4)	228(56.3)	148(58.7)	376(57.2)
Level B	45(11.1)	13(5.2)	58(8.8)	23(9.1)	36(11.7)	59(9.0)	101(24.9)	58(23.0)	159(24.2)	90(22.2)	52 (20.6)	142 (21.6)
Level C	56(13.8)	25(9.9)	81(12.3)	39(15.5)	68(22.1)	107(16.3)	36(8.9)	25(9.9)	61(9.3)	47(11.6)	30 (11.9)	77(11.7)
Absent	32(7.9)	19(7.5)	51(7.8)	18(7.1)	32(10.4)	50(7.6)	41(10.1)	12(4.7)	53(8.0)	40(9.9)	22(8.7)	62(9.4)
Total	405(61.6)	252(38.4)	657(100)	349(53.1)	308(46.9)	657(100)	405(61.6)	252(38.4)	657(100)	405(61.6)	252(38.4)	657(100)
p-value	0.015			0.946			0.072			0.903		

Table 4. Distribution and association between sex and the Pell and Gregory [15] classification regarding the relationship with the mandibular ramus for lower Molars.

Pell and Gregory Classification	Mandible					
	38 [n(%)]			48 [n(%)]		
	F	M	Total	F	M	Total
Class I	146(36.)	104(41.3)	250(38.1)	139(34.3)	78(31)	217(33)
Class Ii	183(45.2)	108(42.9)	291(44.3)	181(44.7)	123(48.8)	304(46.3)
Class Iii	35(8.6)	27(10.7)	62(9.4)	45(11.1)	29(11.5)	74(11.3)
Absent	41(10.1)	13(5.2)	54(8.2)	40(9.9)	22(8.7)	62(9.4)
Total	405(61.6)	252(38.4)	657(100)	405(61.6)	252(38.4)	657(100)
p-value		0.083			0.719	

and genetics can also influence the difference in tooth impaction [20]. Bruce et al. [21] suggest that the higher percentage of impaction in females can be related to a greater concern with oral health.

Impacted third molars were more prevalent in the maxilla than in the mandible. Studies indicate that third molar impaction location varies between maxilla and mandible depending on the population studied, ranging from 18% to 70% [18]. However, most studies indicate a higher prevalence of mandible impaction. Specifically, a retrospective analysis revealed that 73.2% of cases showed impaction of the mandibular third molar [22]. Another study reported a higher frequency of impacted third molars in the mandible (57.3%) compared with the maxilla (42.7%) [3].

The scientific literature highlights some factors that explain third molar impaction etiology, including facial growth retardation, space limitation (anteroposterior or transverse), distal direction of eruption, early physical maturity, lack of sufficient eruption force, or a vertical direction of condylar growth. Additionally, ethnicity-related variations in growth pattern and size of the mandible and tooth are crucial determinants of the eruption pattern [18,23-25].

The recommended treatment for impaction in the oral and maxillofacial area is based on surgical procedures, which can be associated with complications such as perforation or fracture of the mandibular cortical plate, and paresthesia or dysesthesia resulting from damage to the Inferior Alveolar Nerve (IAN) or the lingual nerve [26].

To communicate with professionals and assess the difficulty level of impacted third molar surgeries, oral healthcare providers use the Winter and Pell & Gregory classifications [27].

Here, vertical angulation, as described by Winter's classification, was predominant among the impacted third molars in both sexes, in both the upper and lower arches. These findings corroborate Gupta et al. [28]. Haque et al. [29] found that the most frequent angulation in the mandible was mesioangular, followed by vertical. Je et al. identified a higher percentage of mesioangular impaction in female patients [16]. Meanwhile, Dena found distal inclinations to be more frequent in females [30].

When investigating the prevalence of third molar impaction pattern in the population of Madurai, Kalaiselvan et al. [19] observed that 60% of study participants had mesioangular impaction. These findings disagree with ours, which identified vertical angulation as the most frequent impaction [31].

According to the Pell & Gregory classification [15], the impaction level indicates how deep the tooth is on the bone. Here, Level A was the most prevalent in the maxilla, followed by Level C and, finally, Level B. Other studies reported different patterns, identifying a higher prevalence of Level A in the maxilla, followed by Level B and C [30,31]. Regarding lower third molar impaction, Level A was the most prevalent, followed by Level B and Level C, in line with Gupta et al. [28]. We highlight that these studies disregarded the population group evaluated, which may explain the differences observed in tooth angular position.

The inclusion depth of impacted third molars plays a significant role in several associated pathological conditions. Research has shown a strong correlation between impaction depth of third molars and the occurrence of external root resorption in adjacent teeth [31]. Additionally, impaction depth has been associated with an increased risk of distal caries in the second molar, root resorption of the second molar, and pathological lesions, with specific angulations and impaction depths representing higher risks for these conditions [32].

Regarding inclusion of the third molar in the mandibular ramus, these studies indicated Class II as the most prevalent, followed by Class I and Class III, as described by Pell & Gregory's classification. These results corroborate the studies by Da Silva [27], Dena [30], and Kalaiselvan et al. [19].

Our results somewhat corroborate the studies previously conducted on the topic. Investigating the prevalence and position of third molars by means of radiographs is crucial for diagnosing and planning their extraction, and for preventing complications during the procedure and pathological conditions such as caries, pericoronitis, cysts, tumors, and root resorption of adjacent teeth.

CONCLUSION

Radiographs of the evaluated population showed vertical angulation as the most prevalent for impacted third molars in the maxilla, followed by distoangular, mesioangular, and horizontal according to Winter's classification, In the mandible vertical angulation was most common, followed by mesioangular, horizontal, and distoangular. Regarding the Pell & Gregory classification, Level A depth was the most prevalent among the impacted upper third molars, followed by Levels C and B. For the lower third molars, Level A was most common, followed by Levels B and C. As for available space in relation to the ascending mandibular ramus, Class II was the most frequent, followed by Classes I and III. Maxillary and mandibular third molar impaction was more prevalent in females.

Conflict of interest: The authors declare that there are no conflicts of interest.

Collaborators

JS Pereira, MC Oliveira, GM Cairo, and CA Casotti, conceptualization. JS Pereira and GM Cairo, data curation. JS Pereira and GM Cairo, investigation. JS Pereira, MC Oliveira, and GM Cairo, methodology. JS Pereira and MC Oliveira, formal analysis. MC Oliveira and CA Casotti, supervision. CA Casotti, project administration. CA Casotti, resources. JS Pereira, writing – original draft. MC Oliveira, GM Cairo, and CA Casotti, writing – review and editing.

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