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Prevalence and pattern of third molars impaction in a large Yemeni sample: a retrospective study

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The prevalence of teeth impaction varies substantially between different populations, and the impaction of third molars is the most commonly recorded. This study aimed to explore the prevalence and pattern of the third molars impactions among Yemeni population. This was a retrospective radiographic study conducted in Yemen between 2022 and 2023. The digital panoramic radiographs were collected from two major X-ray centers in Yemen. The angular position and depth of the impacted third molars were assessed according to the classifications of Winter and of Pell and Gregory, respectively. All radiographs were evaluated twice by one investigator in a two-week interval, and Kappa test was used for intra-rater reliability. Gender-wise differences, differences between both sides, and differences between maxilla and mandible were analyzed using Chi-squared tes with odds ratio (OR) for the risk of impaction. A P-value < 0.05 was considered significant. Panoramic radiographs of 6338 individuals were included. Their mean age was 35.1 ± 13.3 years andand 63.9% were females. A total of 25,352 sites (quadrants) were screened for the presence of thirds molars. Among which, 14,003 third molars (55.3%) were present in one or more sites. There were 1440 individuals (23%) with a total of 2828 impacted third molars (20% of the existing third molars). Females were less likely to have third molar impaction (OR = 0.46, $CI_{95\%}$ = 0.4–0.52). Impaction of the mandibular third molars was significantly more frequent than the maxillary ones (OR = 1.15, $CI_{95\%}$ = 1.04–1.26; *P* = 0.005). Horizontal and mesioangular impactions were statistically more frequent in the lower molars compared to the upper ones (*P* < 0.001 each). Contrastingly, vertical (*P* = 0.015), distoangular, and other impactions (*P* < 0.001 each)were statistically more frequent in the maxilla. Levels A and B were more frequent in the lower third molars, while level C was predominating in the upper molars (*P* < 0.001 each). The prevalence of third molars impaction is more frequent in males and mandibular arch. The angulation and level of impaction seem to be more complicated in the maxillary arch.

Keywords Impacted teeth, Prevalence, Maxilla, Mandible, Third molar

Tooth/teeth impaction is defined as a pathological condition in which one or more fully developed teeth fail to erupt or reach the normal functional position in the dental arch within the known physiologic time[1]. The prevalence of impacted teeth varies substantially between different populations, ranging from as low as 18% to as high as 70%[1–5]. Besides being the most common missing teeth, third molars are the most common teeth recorded with impaction, accounting for more than 95% of all impacted teeth, followed by the canines, central incisors, and premolars[6–8]. Many factors, individually or together, may predispose to tooth/teeth impaction. Among these are lack of space in the dental arch which may result from discrepancy in teeth and/or jaw dimensions, abnormal position of the impacted teeth, the density of the overlying gingival and bony tissue, ankylosis of the deciduous

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tooth/teeth, and presence of (a) supernumerary tooth/teeth which may obstruct the eruption of normal teeth resulting in impaction[9].

In fact, most of the impacted teeth remain asymptomatic. However, complications may arise such as pericoronitis, odontogenic cysts or tumors, pain, swelling, bone loss, and resorption of root of adjacent tooth/teeth[10]. In case of partial impactions, accumulation of the food debris along with difficulty of cleaning eventually result in developing of dental caries with its subsequent sequalae[11]. In case the impaction of the anterior tooth/teeth, esthetic will be definitely compromised[12]. Given the above mentioned complications, dental health care providers should have a prior estimation of tooth/teeth impaction in the society they are working in order to convey their health mission regarding patients' education and proper treatment. Hence, the availability of such statistics is vital and essential. Therefore, this study sought to explore the prevalence as well as the pattern of impacted third molars among Yemeni population utilizing a large sample size.

Result

Panoramic radiographs of 10,668 individuals were retrieved and screened for eligibility. Of them, 4330 radiographs were excluded for the following reasons: no complete data (e.g., gender or age), no clear details (e.g., blurred image), and the individual's age was below 17 years old. Finally, the panoramic radiographs of 6338 individuals were included in the analysis. There were 2285 (36.1%) males and 4053 (63.9%) females with a mean age of 35.1 ± 13.3 years old.

The overall prevalence of the impacted third molars among the two centers was tested, and the result revealed insignificant difference ($P > 0.05$), indicating the homogeneity of the sample. The results of the Kappa test revealed excellent agreement between the first and second readings for the angle and depth assessments (Kappa = 0.87 and 0.88, respectively, and $P < 0.001$ each).

A total of 25352 sites (quadrants) were screened for the presence or absence of the thirds molars. Among which, 14003 third molars (55.3%) were present in one or more sites; the third molars were missing in 11349 (44.7%) of the screened quadrants (Fig. 1). There were 1440 individuals (out of 6338 individuals, accounting for 22.7%) with a total of 2828 impacted third molars (20.2% of the present third molars). There were 170 individuals (11.8% of the individuals with impaction, and 2.7% of the whole sample) with 4 impacted molars, 212 individuals 14.7% of the individuals with impaction, and 3.3% of the whole sample) with 3 impacted third molars, 454 individuals (31.5% of the individuals with impaction, and 7.2% of the whole sample) with 2 impacted third molars, and 604 individuals (41.9% of the individuals with impaction, and 9.5% of the whole sample) with one impacted third molars.

Of the evaluated quadrants, the third molars were missing in around 48.2% of the upper right, 48.6% upper left, 41.1% lower right, and 41.2% lower left. Contrastingly, among those whose third molars were present, the third molars were impacted in around 20%, 20.55%, 19.2%, and 21% of the said quadrants, respectively (Table 1).

The prevalence of impaction of at least one third molar was 20.2%. Gender-wise, males had significantly higher prevalence (23.4%) than females (12.3%, $P < 0.001$); i.e., the females were less likely to have third molar

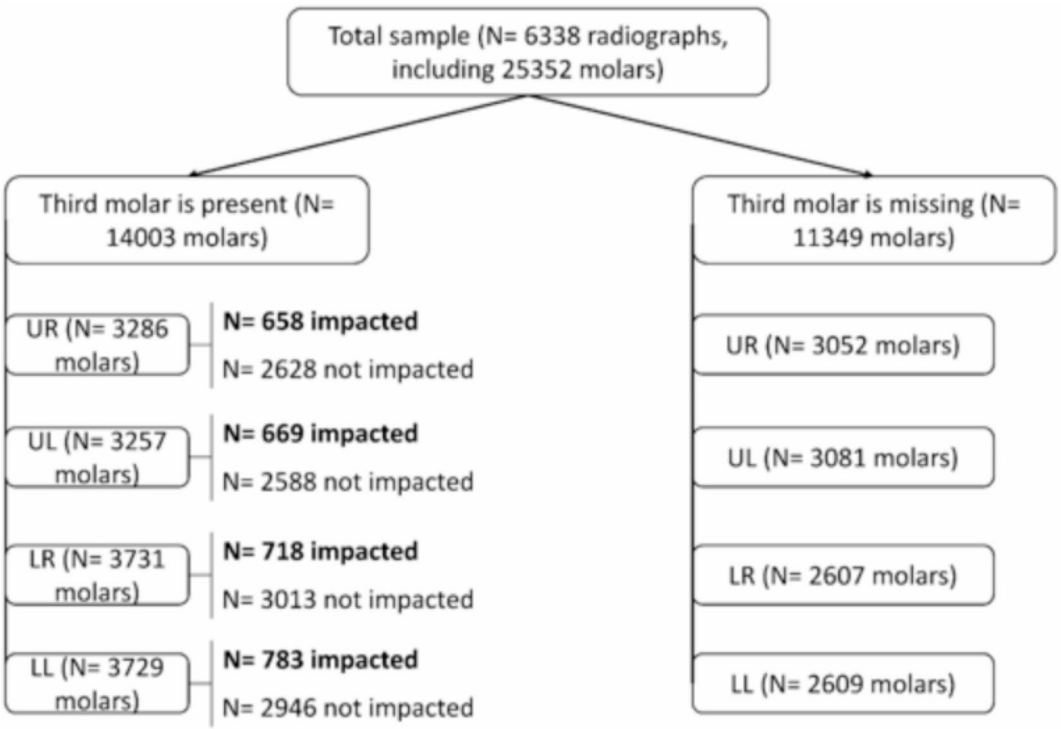

Fig. 1. Distribution of the third molars by quadrants (present versus missing and impacted versus not-impacted).

			Frequency	%
Gender ($N=6338$)		Male	2285	36.1
		Female	4053	63.9
Age ($N=6338$)		(Mean ± SD)	35.1 ± 13.3	
Presence of third molar ($N=25332$ sites)	URTM ($N=6338$)	Not present	3052	48.2
		Present	3286	51.8
	ULTM ($N=6338$)	Not present	3081	48.6
		Present	3257	51.4
	LRTM ($N=6338$)	Not present	2607	41.1
		Present	3731	58.9
	LLTM ($N=6338$)	Not present	2609	41.2
		Present	3729	58.8
Impaction of third molar ($N=14003$ molars)	URTM ($n=3286$)	Not impacted	2628	80
		Impacted	658	20
	ULTM ($n=3257$)	Not impacted	2588	79.5
		Impacted	669	20.5
	LRTM ($n=3731$)	Not impacted	3013	80
		Impacted	718	19.2
	LLTM ($n=3729$)	Not impacted	2946	79
		Impacted	783	21

Table 1. Characteristics of the study sample. URTM: Upper right third molar; ULTM: Upper left third molar; LRTM: Lower right third molar; LLTM: Lower left third molar.

	Not impacted	Impacted	*P*-value*	OR (95%CI)
Maxilla ($N=6338$)	5420 (85.5)	918 (14.5)	0.005	1.15 (1.04, 1.26)
Mandible ($N=6338$)	5307 (83.7)	1031 (16.3)		
Right ($N=6338$)	5264 (83.1)	1074 (16.9)	0.241	1.06 (0.95, 1.16)
Left ($N=6338$)	5214 (82.3)	1124 (17.7)		
Male ($n=2285$)	1751 (76.6)	534 (23.4)	< 0.001	0.46 (0.40, 0.52)
Female ($n=4053$)	3556 (87.7)	497 (12.3)		

Table 2. Gender, arch, and side distribution of the third molar impaction (at least one tooth). * Chi-Square test; OR: Odds ratio.

		URTM	ULTM	LRTM	LLTM	P-value*
Angular	Vertical	205 (27.1)	217 (28.7)	166 (21.9)	169 (22.3)	0.015
	Mesioangular	149 (12.6)	125 (10.6)	430 (36.5)	475 (40.3)	< 0.001
	Horizontal	0 (0.0)	2 (1.2)	86 (50.0)	84 (48.8)	< 0.001
	Distoangular	276 (43.4)	288 (45.3)	29 (4.6)	43 (6.8)	< 0.001
	Other	28 (33.3)	37 (44.1)	7 (8.3)	12 (14.3)	< 0.001
Depth	level A	4 (1.7)	8 (3.5)	138 (59.7)	81 (35.1)	< 0.001
	level B	266 (17.2)	271 (17.5)	465 (30.0)	546 (35.3)	< 0.001
	level C	388 (37.0)	390 (37.2)	115 (10.9)	156 (14.9)	< 0.001

Table 3. Distribution of the patterns of the third molars impaction, *n* (%). *One-sample Chi-square test.

impaction (OR = 0.46, $CI_{95\%}$ = 0.4–0.52). Similarly, the impaction of third molars in the mandible was more likely than in the maxilla (16.3% versus 14.5, OR = 1.15, $CI_{95\%}$ = 1.04–1.26; $P=0.005$). Side-wise, however, no significant difference was found regarding the prevalence rate of impaction between the right and left sides (16.9% versus 17.7%, OR = 1.06, $CI_{95\%}$ =; 0.95–1.16; $P=0.241$, ; Table 2).

Table 3 shows the distribution of the impacted third molars by angulation and depth (level) of impaction. Horizontal and mesioangular impaction patterns were statistically more frequent in the lower molars compared to the upper third molars ($P<0.001$ each). Contrastingly, vertical, distoangular, and other impaction patterns were statistically more frequent in the upper compared to the lower third molars ($P=0.015$, <0.001 and <0.001, respectively). Regarding the depth of impaction, levels A and B were more frequent in the lower third molars

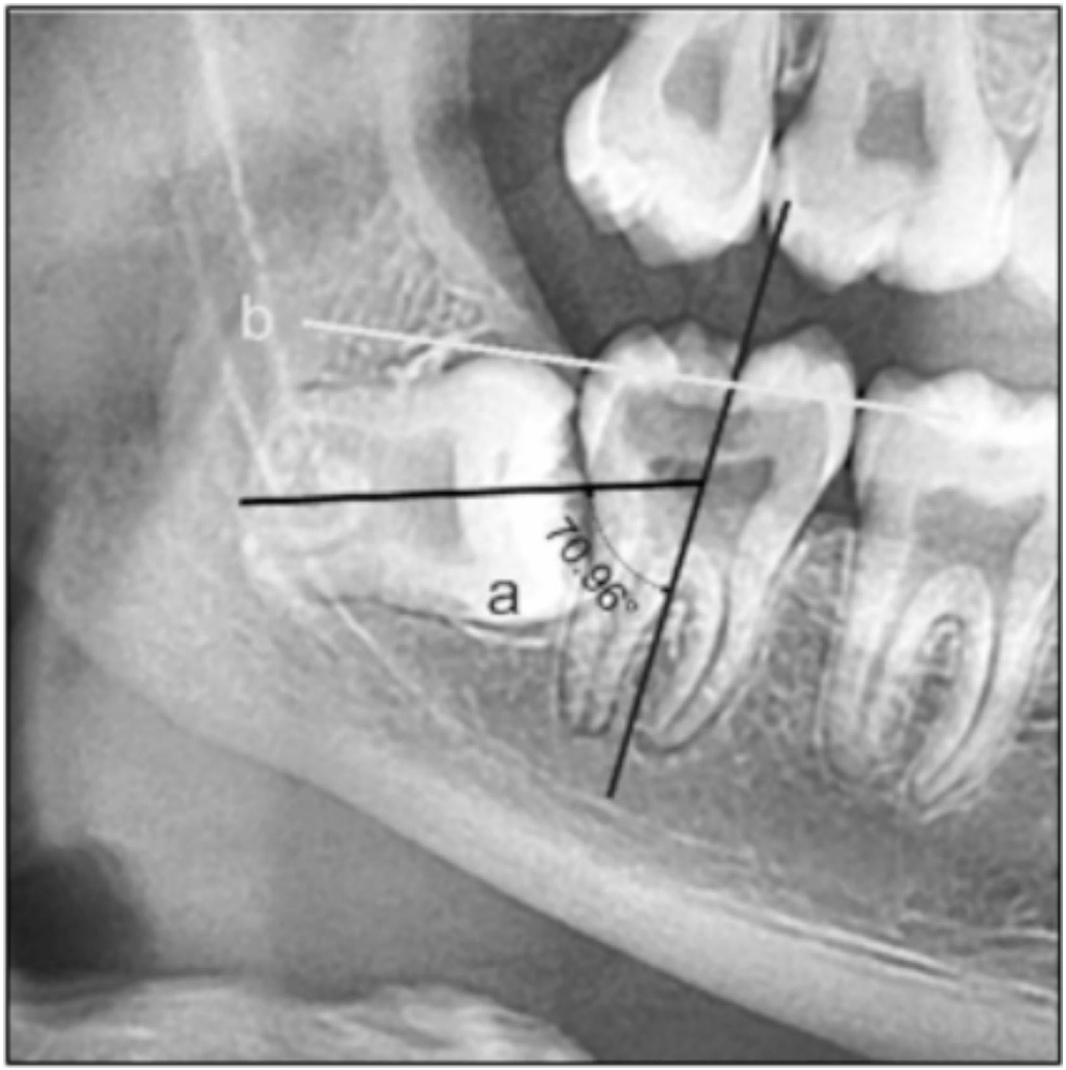

Fig. 2. Angular position (**a**) and depth of impaction (**b**) of a mandibular impacted third molar.

		Impacted URTM ($N=658$)			Impacted ULTM ($N=669$)		
		Male	**Female**	***P*-value***	**Male**	**Female**	***P*-value***
Angular	Vertical	67 (37.2)	138 (28.9)	0.198	62 (35.8)	155 (31.3)	0.638
	Mesioangular	40 (22.2)	109 (22.8)		34 (19.7)	91 (18.3)	
	Horizontal	0 (0.0)	0 (0.0)		0 (0.0)	2 (0.4)	
	Distoangular	66 (36.7)	210 (43.9)		69 (39.9)	219 (44.2)	
	Other	7 (3.9)	21 (4.4)		8 (4.6)	29 (5.8)	
Depth	level A	0 (0.0)	4 (0.8)	0.414	3 (1.7)	5 (1.0)	0.745
	level B	76 (42.2)	190 (39.7)		69 (39.9)	202 (40.7)	
	level C	104 (57.8)	284 (59.4)		101 (58.4)	289 (58.3)	

Table 4. Gender differences in the patterns of the mandibular third molars impaction, n (%). *Chi-Square test.

($P<0.001$ each), while level C was predominating in the upper molars ($P<0.001$). Figure 2 depicts the angular position (a) and depth of impaction (b).

Neither the angulation nor the depth of impaction of the upper third molars were statistically different by gender (Table 4). Contrastingly, the vertical angulation of the impacted lower right mandibular molar was statistically more frequent, while the mesioangular was less frequent in females than in males ($P=0.012$). In line with that, level B depth of the impacted lower right and left mandibular molars was statistically more frequent, while level C was less frequent in females than in males ($P=0.009$ and $P=0.008$, respectively; Table 5).

		Impacted LRTM (*N* = 718)			Impacted LLTM (*N* = 783)		
		Male	Female	*P*-value*	Male	Female	*P*-value*
Angular	Vertical	41 (16.9)	125 (26.3)	0.012	49 (18.6)	120 (23.1)	0.427
	Mesioangular	157 (64.9)	273 (57.4)		169 (64.3)	306 (58.8)	
	Horizontal	34 (14.0)	52 (10.9)		30 (11.4)	54 (10.4)	
	Distoangular	6 (2.5)	23 (4.8)		11 (4.2)	32 (6.2)	
	Other	4 (1.7)	3 (0.6)		4 (1.5)	8 (1.5)	
Depth	level A	49 (20.2)	89 (18.7)	0.009	31 (11.8)	50 (9.6)	0.008
	level B	141 (58.3)	324 (68.1)		165 (62.7)	381 (73.3)	
	level C	52 (21.5)	63 (13.2)		67 (25.5)	89 (17.1)	

Table 5. Gender differences in the patterns of the mandibular third molars impaction, n (%).*Chi-Square test.

Discussion

To the best of our knowledge, this is the first study that assessed the prevalence of missing and impacted third molars among large sample that can considered representative of at least one large city there: Thamar, if not the whole Yemeni population. The results indicate that up to 22.7% of Yemeni adults have at least one impacted third molar. That means nearly 23% of Yemeni might complain one or more of the sequelae of third molar impaction in their lives, and hence will seek treatment which mostly involves extraction of the offending third molar, that in turn is associated with postoperative pain, edema and functional difficulties, and even serious complications. Comparable to our finding, other studies reported the prevalence of impaction of the third molar ranges from 16.7 to 68.6%[13–17]. The variability may be attributed to genetic and racial differences, which are the two important factors in tooth impaction.

Indeed, one of the most frequent managment modality in oral and maxillofacial surgery is the surgical removal of impacted third molars. Hence, availability of estimates on such issues will be valuable for both: the patients and the health care providers (dental professionals in this scenario), and even for the available health care system. In light of a high prevalence rate of third molar impaction in a given community (20.2% in our study), health strategies must be initiated and tailored to deal with it timely and properly. This must include patient education on caring their teeth with especial emphasis on third molars, in addition to raising their awareness regarding the early signs and symptoms of third molars complications. Doing so primarily aims to diagnose these signs and symptoms and complications early, and thus avoid more sever course of the disease and less extensive treatment with less postoperative complications.

The prevalence, pattern, and depth of impacted third molars vary in different ethnic and racial groups. These may be due to consanguineous marriage, racial genetic characteristics, and epigenetic factors (environmental) such as food habits[18]. In fact, the change in human lifestyles has contributed to the development of smaller jaws, leaving no or not adequate space for the third molar's, the last teeth erupt into the arch[19,20]. Furthermore, early physical maturation of the third molar and delayed mineralization is claimed as a possible etiology of the high rate of third molar impactions[21]. Basically, the differences in race can affect jaw size, and maturation and time of eruption of teeth, a matter that explains the different prevalence rates of dental anomalies, missing, and/or impaction observed in different countries[21–29].

The study showed that the prevalence of impacted third molars was slightly higher in males than in females. This is in accordance with the study of Murtomaa He et al.[30], who studied the impaction of third molars in the Finnish university population and reported a prevalence rate of 29% in females and 35% in males. In contrast, this result is discordance with studies among different populations from Saudi Arabian[31] and Turkish populations[32]. The differences might be attributed to the differences in the sample size and ethnic groups.

In support with many studies conducted in Saudi Arabia, Yemen, Turkey, Pakistan, KSA, India, Iran, China, Bosnia and Herzegovina[21,29,31–37], our results showed that impaction of the third molars was significantly higher in the mandible compared with the maxilla. The most common etiological factors of the mandibular third molar impactions are the supernumerary tooth, ankylosis of the permanent or deciduous tooth, non-bone resorption due to local or systemic causes, lack of space in the dental arch, and abnormal tooth bud positioning[38,39]. It is mainly caused by a bony obstruction in the pathway of eruption, or the adjacent local tooth causes obstruction[40].

The prevalence of impacted third molars was not found in the current study to be statistically different side-wise, and this is in accordance with many previous publications[21,33,36,41]. In the current study, the horizontal and mesioangular impaction was the commonest type of angulation of mandibular impacted third molars. This result again agrees with the previous findings[18,20,21,23–25,29]. Such angulations may be due to the lack of space in the mandible at a later age, the path of eruption, and late development and maturation[21]. In contrast, Yilmaz et al.[32], Al-Dajani et al.[42], and Abulohom et al.[43] found that vertical impaction in lower third molars is the most common impaction pattern. As for the maxillary third molars, Pillai et al.[18] reported that the vertical and distoangular impaction patterns were the most frequent. Similarly, Hashemipour et al.[44] found that vertical angulation is the most common pattern in maxillary impacted third molars. Our result support these findings.

On the basis of many previous reports conducted among Canadian[26], Iranian[45], and Spanish populations[46], the most frequent depth of the mandibular third molar was level B. This is consistent with our findings. Similarly, our result augments the results of previous publications that found level A as the most frequent position of the mandibular third molar[21,27,28]. However, our results conflict with that of Yilmaz et al.[32] who found that level C

was the most frequent in the mandible. As for the maxillary third molars, our findings showed that level C was the most common, which is consistent with the result reported by pillia et al.[18], while disagree with the finding observed by Yilmaz et al.[32] who found that level B was the most common position of maxillary impacted third molar. These differences in angulation and level of impaction may be due to the difference in selection criteria of the patient, study population, and race.

The study has its strengths and limitations. The large sample size is one of the strengths. Screening the included panoramic radiographs (6338) from a larger pool of 10,668 radiographs is another strength indicating application of and adherence to strict criteria. Further strength was the evaluation process of these radiograph which was done by an expert, along with application of intra-rater reliability test on 50 radiographs evaluated twice in a 2-week interval. Among the limitations however, is the study design (retrospective, cross-sectional), the design with an inherent low level of evidence. Including more females than males was another limitation, although happened by chance: the inclusion was not gender selective. Relying on the radiographs without seeing the patients was another limitation; there might have been mismatching with the records or overalapping of the sample, although the probability of these to happen is very low. Further limitation was that the sample was taken from only two radiographic centers in Yemen. Although they are large centers in Yemen, but of course they don't represent all centers. Hence the sample might not represent the whole Yemen, a matter which jeopardizes the generalizability of the results. However, the sample was large enogh to give a picture on the third molar impaction in Yemen. The sampling process might have caused bias: the samples were collected from radiographic centers to which many dental patients attend or are referred. Accordingly, the assessed parameter (prevalence of third molar impaction) might have been overestimated, and this is another limitation.

Cconclusion

The prevalence of impaction of the third molar among Yemeni population is not uncommon, with a slight predilection toward males and mandibular arch. The horizontal and mesial angulation and level B of impaction were more frequent in the mandible, while the distal and vertical angulation and level C of impaction is more frequent in the maxilla.

Materials and methods

This was a retrospective radiographic study conducted in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards[47]. Ethical approval was obtained from the Ethics Committee at Faculty of Dentistry, Thamar University (Ref#: 2022009). In compliance with institutional regulations and based on the nature of this retrospective study, the Ethics Committee at Faculty of Dentistry, Thamar University has waived the requirement for informed consent. All data concerning patient identification were kept confidential. The data were obtained from digital panoramic radiographs collected from two major X-ray centers in Yemen (Kenan and Al-Waleed Digital X-ray Centers). In order to be included, the digital radiograph with the associated records should meet the following criteria: age of ≥ 17 years old, good quality of the radiograph, absence of any bone pathology which compromises the alignment of the teeth in the occlusal plane, absence of any syndrome, and complete patient record.

All radiographs were evaluated by one investigator who was an orthodontic specialist with very good experience in reading radiographs, and was well-trained in using the software program (Digimizer Image Analysis software program version 5.4.1) on how to assess the panoramas for the purposes of the study. In order to minimize the risk of false assessments caused by fatigue, no more than 500 radiographs were evaluated in 1 week (~70 radiographs a day). The assessment was performed on a computer monitor using the said program. A total of 50 panoramic radiographs were examined with a 2-weeks interval to evaluate the intra-rater reliability according to Cohen's Kappa test. For the study, an impacted tooth was defined as "a tooth that is partially or completely unerupted and is positioned against another tooth or bone or soft tissue so that its further eruption is unlikely"[48]. The angular position and depth of impaction were assessed for each impacted third molar according to the classifications of Winter and of Pell and Gregory, respectively[32,44]. Figure 3 presents how the angular position was assessed. Briefly, two lines were drawn along the long axes of the second and third molars. The angle formed by the intersection of these lines was measured. The angulation was classified as follows: (a) Vertical impaction: 10° to -10°, (b) Mesioangular impaction: 11° to 79°, (c) Horizontal impaction: 80° to 100°, (d) Distoangular impaction: -11° to -79°, and (e) Other: 101° to -80°. Figure 4 presents how the depth (level) of impaction was recorded. Breifly, the relationship between the occlusal surface of the evaluated impacted third molar and the cemento-enamel junction (cervical line) of the adjacent second molar was considered and classified as follows: Level A: the highest position of impacted third molar was on the same level or above the occlusal plane of the adjacent second molar, Level B: the highest position of the impacted third molar was located below the occlusal plane but above the cervical line of the adjacent second molar, and Level C: the highest position of the impacted third molar was below the cervical line of the adjacent second molar.

Data were presented in terms of descriptive statistics (frequencies and percentages). Gender-wise differences, differences between both sides, and differences between maxilla and mandible were analyzed using Chi-squared tes with odds ratio (OR) for the risk of impaction. The data was inputted and analyzed using the Statistical Package for the Social Sciences (SPSS) for Windows, Version 25.0 (Armonk, NY: IBM Corp). A P-value of < 0.05 was considered significant.

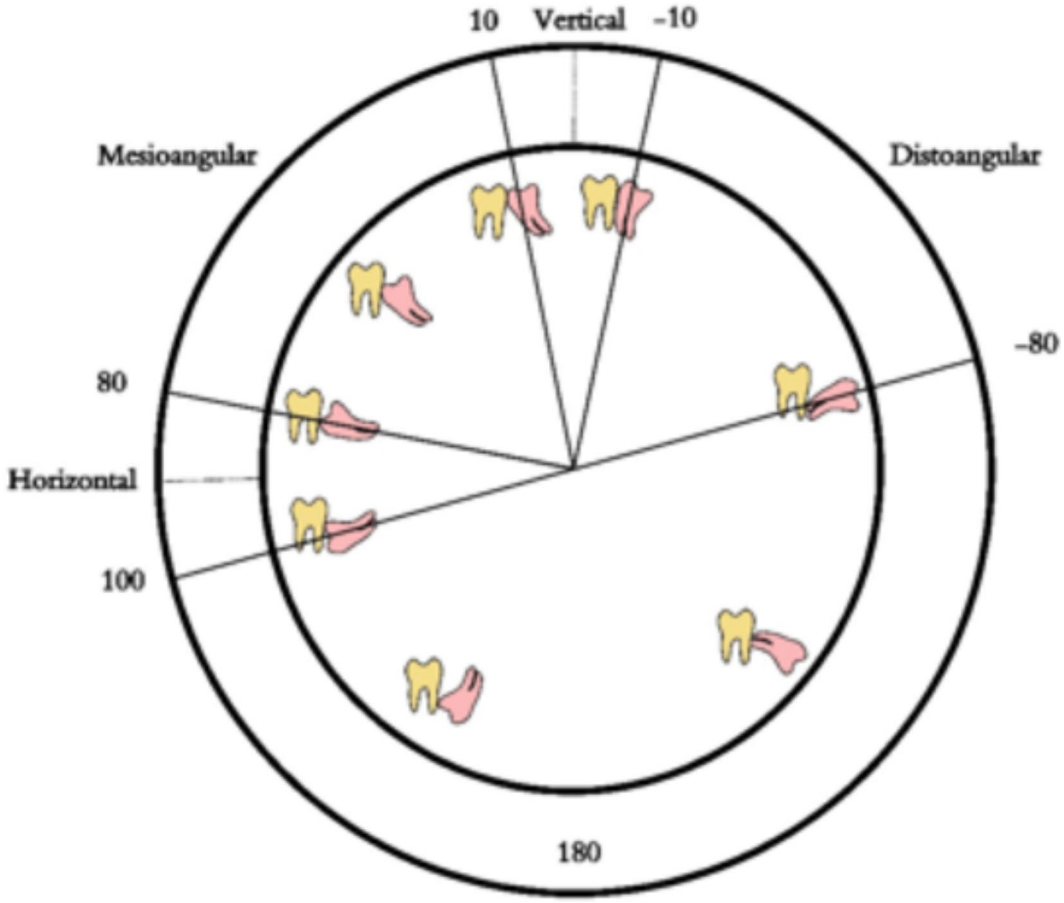

Fig. 3. Winter's c; assification for the angulation of impacted third molars.

Fig. 4. Pell and Gregory classification for the level of impaction of impacted third molars.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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M.N.A, A.G.A, and E.H. developed the concept, oversaw the data collection, and contributed to the formal analysis alongside A.A.A.; S.A. and A.N.A contributed to data collection and measurements; M.N.A, A.A.A., E.A.A., and E.H. were responsible for drafting, reviewing, and editing the manuscript, which was subsequently approved by all authors.

Declarations

Competing interests
The authors declare no competing interests.

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