Abstract: Aim: the aim of the study was to assess the prevalence of impacted teeth and its association with sex and age among a sample of the Yemeni population. Materials and Methods: A cross sectional study design was employed. The study included 999 radiographical records of patients who had panoramic X-rays previously done. All radiographs were assessed for the number and type of impacted teeth, pathology-associated impaction, sex, age and location (mandible and/or maxilla). The collected data was analyzed using SPSS® version 21 software. Results: The study sample comprised digital panoramic radiographs of Yemeni patients aged 17 to 54 years (mean 26.6 years). The present study found 542 patients (54.3%) presented with at least one impacted tooth. The 17 to 25 years age group of the study sample had the highest prevalence of tooth impaction (28.6%). Only 10 (1.0%) case presented pathologies associated with the impacted teeth. There was a significant difference in the number of male 203 (20.3%) and female 339 (33.9%) patients with impacted teeth ($p=0.031$). Impacted teeth occurred slightly more often in the mandible (42.8%) compared to the maxilla (42.4%). Conclusion: The prevalence of impacted teeth among a sample of Yemeni population was high. Third molars and canines were the most common impacted teeth. The prevalence of impacted teeth in females was higher than in males and it was higher in the mandible than in the maxilla, with the younger patients with a higher prevalence of impaction.

Keywords: Impacted tooth; third molar; panoramic radiography; prevalence; cross-sectional studies; Yemen.
INTRODUCTION.

Tooth eruption is a complex, localized, and programmed sequence involving bone remodeling at a specific timing. Dental anomalies including impaction, supernumerary teeth, and alterations in size and structure of teeth are of great concern and it is a major challenge for both dental practitioners and patients. This is because of the potential complications and possible risks to function and desired esthetics and may be even associated with psychological effects.

Tooth impaction is its failing to erupt in order to reach the occlusal plan even after completion of two-thirds of its root, so it is covered by mucoperiosteum and bone because of abnormalities such as malposition, lack of space, odontoma, excessive soft tissue, endocrine diseases, or due to obstruction by another tooth.

Furthermore, impacted teeth are often associated with pericoronitis, periodontitis, cysts, neoplasms, root resorption of the adjacent tooth and can cause detrimental effects on adjacent teeth. Also, it weakens the body of the mandible at an angle increasing the susceptibility to fracture and vague orofacial pain and neuralgias.

Many patients are not aware about the presence of impacted teeth and it is usually detected during routine examinations. Therefore, early detection and proper management is important to avoid possible complications.

The prevalence of impacted teeth has been studied in different communities, and it can provide important pathologic and genetic profile information. Many factors affect its prevalence including the age of the sample, dental eruption sequence, and the radiographic criteria for eruption and impaction.

Third molar impactions are classified according to the angulation of the impacted teeth. Winter’s classification is used to categorize the type of impacted teeth angulation with the reference to the angle formed between the intersected longitudinal axes of the second and third molars.

According to the American Association of Oral and Maxillofacial Surgeons, since the majority of the impacted teeth are at the risk of these complications their removal should be considered as early as possible.

Although orthopantomograms (OPG) and periapical radiographs are utilized to determine the presence of tooth impaction, previous studies reported that periapical radiographs are only better than OPG in determining the number of roots. However, the OPG is the radiograph of choice when the patient has associated trismus.

So the aim of the study was to assess the prevalence of impacted teeth and their association with sex and age among a sample of Yemeni population.

MATERIALS AND METHODS.

The study utilized a cross-sectional design. Because of the difficulty of achieving a rational sample size by primary data from patients and the availability and accessibility of the radiographic records, the data of the study was collected from the radiographical records of the patients who had a panoramic X-ray previously taken during the period from 1st November 2016 to 1st of August 2018.

Records from three private radiographic centers in Sana’a city were gathered. A case sheet was designed for data recording and radiograph interpretation. All panoramic radiographs were included in the study sample irrespective of patients age or sex. After assessment of the patients records, patients who displayed a pathological situation, any conditions that may affect normal growth of permanent dentition as diseases or trauma of the jaw, and any syndromes or hereditary diseases, such as craniosynostosis, were excluded from the study.

The sample of this study included 999 subjects. Teeth were considered as impacted when they remained below the jaw for a minimum of two years after the respective expected mean age of tooth eruption. All radiographs were determined for the number and type of impacted teeth, pathology associated impaction, sex, age and location (mandible and/or maxilla). The third molar impaction angulation was scored based on Winter’s classification.

The data from the examination sheet was collected and scored. The collected data was analyzed using SPSS* version 21 software (SPSS Inc. Chicago, IL). Descriptive, bivariate, and multivariate analysis was the performed. A p-value less than 0.05 was considered as significant.

The Ethics Committee of the Faculty of Medicine, University of Science and Technology, Sana’a, Yemen, has approved the study (MECA NO. EAC/UST133).
Table 1. The prevalence of impacted teeth according to sex and age among the study sample.

| Variable                      | Male | Female | p-value |
|-------------------------------|------|--------|---------|
| Impacted teeth                |      |        |         |
| Yes                           | 542  | 54.3   |         |
| No                            | 457  | 45.7   |         |
| Sex                           |      |        |         |
| Male                          | 405  | 40.5   |         |
| Female                        | 594  | 59.5   |         |
| Age Group (years)             |      |        |         |
| 17-25                         | 462  | 46.2   |         |
| 26-35                         | 387  | 38.7   |         |
| 36-54                         | 150  | 15.0   |         |

Table 2. The prevalence of impacted teeth regarding age among the study sample.

| Age group (years) | Impacted teeth | p-value |
|-------------------|----------------|---------|
|                   | Yes% | No%    |         |
| 17 - 25           | 286  | 176    | 0.001   |
| 26 - 35           | 191  | 196    |         |
| 36 - 54           | 65   | 85     |         |
| Mean and SD±      | 26.6±6.8 |         |         |

Table 3. The prevalence of impacted third molar according to location and sex among the sample study.

| Variable                      | Male | Female | p-value |
|-------------------------------|------|--------|---------|
| Impacted Lower Third Molar    |      |        |         |
| Yes                           | 148  | 14.8   | 0.708   |
| No                            | 257  | 25.7   |         |
| Impacted Upper Third Molar    |      |        |         |
| Yes                           | 109  | 10.9   | 0.052   |
| No                            | 296  | 29.6   |         |

Table 3. The prevalence of impacted third molar according to location and sex among the sample study.
RESULTS.

The study sample comprised 999 digital panoramic radiographs of Yemeni patients aged 17 to 54 years (mean, 26.6 years) were examined. They were assessed for the presence of impaction and the location of impacted teeth. Out of all patients, 40.5% were male and 59.5% were female. The majority of the patients were in the age group 17-25 years, followed by 26-35 years. The present study found that, 542 patients (54.3%) presented with at least one impacted tooth with a 1.2:1 ratio of patients having impaction to those who did not; 594 of patients (59.5%) was female with a ratio of male to female patient of 1:1.4. The prevalence of impacted teeth, gender and age groups. (Table 1).

The 17 to 25 years age group had the highest prevalence of tooth impaction (28.6%), but this prevalence decreased with increasing age. (Table 2)

Impacted third molars were found in 453 patients (45.3%), with only 33 patients with impacted premolars. Out of the 999 examined cases, there were only 10 (1.0%) with pathologies associated to the impacted teeth. There was a significant difference in the number of male 203 (20.3%) and female 339 (33.9%) patients with impacted teeth ($p=0.031$). Impacted teeth occurred
slightly more often in the mandible (42.8%) compared to the maxilla (42.4%).

The present study showed that there were significant age differences among the age groups of the study sample (26.6±6.8) and its significant association with impaction of teeth \((p=0.001)\). Binomial regression analysis showed that the odds of having impaction in females was 1.32 compared to males [CI; (1.021.70), \(p=0.031\)]. The highest percentage of impaction was lower third molar followed by upper third molar, whereas the lowest prevalence was for upper central incisor. There were no cases of impacted first and second molars nor of impacted lateral incisors. However, there were two cases of impacted upper central incisors (0.2%). (Figure 1)

There was a non-significant association between impaction of the lower third molar and sex, and the percentage of impaction of lower third molars was higher among female compared to male patients. Upper third molar impaction was significantly associated with the sex of patient with the prevalence of impaction of upper third molar among female patients was higher than that of their male counterparts. From all the teeth included in this study, other than third molars, the only significant association with sex was the impaction of upper canines, other teeth were not significantly associated with sex. (Table 3)

Mesio-angular impaction was the most common angulation (38.3%), whereas the disto-angular angulation of impacted third molars was the least common (5.6%). Impacted lower third molars was most commonly mesio-angular (52.9 %) followed by horizontal impaction (30.7 %). Vertical impaction was the most common among the maxillary third molar impactions ( 55.5%). (Figure 2)

**DISCUSSION.**

To the best of our knowledge, this study is the first attempt of investigating the prevalence of the impacted teeth in a sample of population living in Sana’a city, the capital of Yemen. Furthermore, despite one study for impaction of canines, and to the extent of the researchers’ knowledge, no studies have been conducted nor published conducted by other institutions in our country, aiming to assess the prevalence of any impacted teeth in a single study.

As expected, the selection method for radiograph employed in this study was similar to that employed in other studies. However, the sample size chosen in this study was considerably larger than that of most other studies mentioned in the medical literature.\(^\text{12}\)

Orthopantomograms are one of the most important diagnostic tool for most of dental specialties. Traumatic dental and jaw injuries, presence of cysts and tumors in facial, maxillary, and mandibular areas, and dental anomalies of number, size and shape, are examples of alterations that can be conveniently observed on a panoramic radiograph.

Although this study may not represent the Sana’a population as a whole, the results are useful for primary health workers because the patients studied represent the range of dental patients referred from most of dental centers and hospitals to the radiographic center.

The prevalence of impacted teeth in the study population was 54.3%, a relatively high prevalence compared with studies involving a wider age range of patients, including patients younger than 17 years.\(^\text{12,13}\)

The present investigation found impaction to be significantly more prevalent among females (54.4%) compared to males (30.9%), this finding is in disagreement with El-Khateeb \textit{et al.},\(^\text{14}\) who found that the incidence of impacted teeth did not differ significantly between males and females among Saudi subjects.

The prevalence rate of third molar impaction in the present study was high (45.3%) 453/999 when compared to the previous studies conducted in Saudi Arabia and other countries.\(^\text{15,16}\) Where as other studies reported a relatively higher prevalence rate (77.1%) of impacted third molars compared to our study.\(^\text{17}\) These studies reported frequencies of 65.6% in the United States of America, 68.6% in Singapore, and 77.1% in Saudi Arabia.

This difference may be due to the fact that genetic and racial differences are two important factors in tooth impaction. Although a study conducted in Nigeria\(^\text{18}\) found that the prevalence of third molar impaction in countries with high standards of living ranges from 9.5 to 25%; the prevalence rate in this study is close to what was reported in a study that examined 999 OPG of a Singapore Chinese population (68.6%).\(^\text{19}\)

In the present study, it was found that out of 999 cases investigated there were only ten cases (1.0%) of impacted teeth with associated pathologies. This finding was much lower than that found by El-Khateeb \textit{et al.},\(^\text{14}\)
who reported that the associated pathologies were found in 18.2% of impacted maxillary third molars, and 31.5% impacted mandibular third molars. The age group 17 to 25 years had the highest prevalence of third molar tooth impaction (28.6%) and this decreased with increasing age. Similar to the results of other studies and as widely stated in the literature, this difference was statistically significant \((p=0.031)\), the results of the present study showed a difference in the prevalence of impaction of third molars between male and female patients, but this difference was non-significant. This finding of our study was similar to the studies reporting gender predilection in terms of the third molar impactions. Whereas this finding disagreed with Syed et al., regarding a Saudi population in which males had a higher incidence of third molar impaction compared to females.

Different developmental growth profile patterns in males and females might explain the higher prevalence of third molar impaction in females. Besides, the growth of the jaw in females usually stops at the time when the third molars just start to erupt. However, in males, the growth of the jaw continues during the period of third molar eruption, which provides adequate space for the eruption of the third molar. Third molar impaction was more prevalent in the lower arch more than in the upper arch irrespective of the age group, in the present study the ratio of third molar impaction was 1:1.22 for the upper arch to the lower arch. This tooth might be the most common tooth to need to be extracted since it is commonly associated with pathology and diseases. McArdle et al investigating lower third molars with 10.11 panoramic radiographs reported that from the examined teeth 49%, 27%, 14%, 5%, and 2% was associated with pericoronitis, caries and related diseases, mandibular second molar decay, periodontal disease, and dentigerous odontogenic cysts, respectively. The most common angulation in the mandible was mesioangular (52.9%), which is in agreement with findings of Quek et al., and Hashemipour et al.

However another study conducted by Bataineh et al., reported that vertical impaction was the most common angulation impaction in the mandible. Different methods to classify the angulation were used in these studies, hence this could be the reason behind the differences found. The current study showed that the most common angulation in the maxilla was vertical (55.5%) which is in agreement with other authors, but Kruger et al., observed that mesioangular impaction was the most common among maxillary third molar impactions.

Very few studies have been carried out regarding impacted premolars. It has been concluded from the results of another study, that premolar impaction is rare, with the prevalence ranging from 2.1-2.7%.

The results of the present study were higher with a prevalence of 3.3%. The present study indicated that the mandibular premolars were more frequently impacted than maxillary premolars. This is in agreement with the findings of another study regarding that mandibular premolars remained impacted more frequently.

This results may emphasize that, during the follow up of the patients with impacted teeth, not to rush to surgical removal, with their putative related complications and harmful effects of the patients, unless there is a treatment need from an aesthetic or functional perspective.

In the present study, canine impaction represented 14.2% of the overall investigated sample. When comparing lower jaw with upper jaw canine impaction, lower jaw canine impaction was present in 2.8% of the sample whereas the upper jaw impacted canines comprised 11.4% of the sample. These findings are in the line with the results of a previous report, which also showed that canine impaction is more prevalent in the maxilla than the mandible. According to the literature, the prevalence of maxillary canine impaction ranges between 0.8 and 2.8% among different populations. On the other hand, mandibular canine impaction is relatively rare.

The ratio of maxillary to mandibular impaction was about 1:1.10. The maxillary impacted canines was 8.4% in females and 3.0% was in males showing a significant sex predilection. Sex distribution of impacted canines in the present study was relatively in agreement with that of two studies, one of which is a recent study among a Saudi population.

In a previous study among Sana’a population regarding canine impaction; 3.55% of subjects were determined to
have canine impactions, this percentage is much lower than that we found in this study (14.2%).\textsuperscript{30} Furthermore in the present study maxillary impacted canines was very much higher than mandibular (11.4% compared to 2.8%), these results are much higher that of previous study in which 3.18% subjects presented maxillary canine impactions, and 0.15% subjects presented mandibular canine impactions. As in the present investigation, the same authors also found that the prevalence of impacted maxillary canine was significantly higher in females than in males. This difference in the results of the same population might be due to the difference in sample size and sampling methods and the source of the OPG records, since Al-Motareb et al.,\textsuperscript{30} study data was from records of 453 patients who attended their outpatient orthodontic clinic for evaluation of malocclusions.

Whereas our study data source was a radiographic center to which the cases were referred from multiple and different dental practitioners and different specialties. The maxillary central incisor is rarely reported as an impacted tooth and there are very few studies assessed their prevalence. The present study found that the prevalence of impacted central incisors among the study sample was 0.2%.

Compared to Nepalese and Malaysian patients, in which the prevalence was 1.8% and 2.4% respectively, it was lower in our study, which may be due to selecting the sample from orthodontic and the current study emphasizes the rarity of its occurrence. There were various etiological factors for the impaction of maxillary central incisors. One of the most common reasons was the presence of supernumerary teeth in the midline causing obstruction on the path of eruption.\textsuperscript{31}

The study of a Nepalian population also further compared the occurrence of impacted maxillary central incisors between males and females, which was 1.9% and 1.6% respectively in their population. Whereas the current study found that there was no male cases of impacted central incisors (0.0%) compared to 0.2% in females, gender differences of maxillary central incisor impaction was not statistically significant in this study and other studies.

According to a recent review, prophylactic extraction of asymptomatic third molars occurs in a disorderly manner without clearly defined criteria. Although the American Association of Oral and Maxillofacial Surgeons recommends extraction of all four third molars in adolescence to minimize complications such as severe pain, hypoglossal nerve palsy and infection, there are no randomized controlled studies to compare the long-term outcome of early removal versus retention of pathology-free third molars.\textsuperscript{32}

Future studies are required to evaluate the etiology behind this relatively high frequency of third molar impaction especially in the nationwide. The present study, like most of the similar previous works about third molar impaction, used a hospital based sample, which lacks randomization.

More precise studies are necessary to evaluate the impaction of third molars in a randomized sample representative of Yemeni population. The present study has several limitations such as difficulty in tracing all the dental records notes and OPG. There were also incomplete data in some dental records. Also, more studies are required to evaluate the pattern of third molars in other regions of Yemen.

**CONCLUSION.**

The prevalence of impacted teeth among a sample of Yemeni population was high. Third molars and canines were the most commonly impacted teeth. The prevalence of impacted teeth in females was higher than males and in was higher in the mandible than the maxilla, with younger patients with a higher prevalence of impaction. Occurrence of associated pathologies with impacted teeth were very rare.

**Conflict of interests:** The authors declare no conflicts of interest.

**Ethics approval:** This work was approved by Ethical Committee of the Faculty of Medicine at UST, Yemen (MECA NO EAC/UST133), approved the study protocol.

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**Authors’ contributions:** The present work was carried out, and the manuscript was written and approved in collaboration among all authors.

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