Comparing the prevalence of impacted teeth through radiographic evidence among orthodontic and general populations: A secondary data analysis

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ABSTRACT

Introduction: There is noticeable variability in reporting the prevalence of impacted teeth, which can be attributed to the variability in the age, gender, and type of populations investigated.
Materials and Methods: Panoramic radiographs were examined retrospectively for patients who attended dental clinics at King Abdulaziz Medical City and the College of Dentistry at King Saud bin Abdulaziz University for Health Sciences (KSAU-HS) Riyadh, Saudi Arabia. The sampling frame for the orthodontic population included digital records of 2998 patients randomly selected from an original 8000 patients treated from 2016 to 2022 in the orthodontic clinic. For the general population, 3002 patients were randomly selected from an original 15000 patients treated at the dental college from 2016 to 2022. A tooth was considered impacted if it failed to erupt after two years of the expected complete root formation.
Results: The prevalence of at least a single impacted tooth was higher in the orthodontic population (13.2 %) than in the general population (11.2 %). However, this difference was not statistically significant, p = 0.103. The orthodontic population had a significantly higher prevalence of impacted #13, #11,#23,#25. In contrast, the general population had a significantly higher prevalence of all third molars impaction (p < 0.005).
Conclusion: Although the prevalence of at least a single tooth impaction between the orthodontic and general populations was not significantly different, the type of teeth differs. Hence, understanding the type of population investigated while reporting the prevalence of impacted teeth is critical in understanding the variability between different reports.

1. Introduction

A tooth is considered impacted when it fails to erupt into its normal anatomical position beyond its expected chronological time (Archer, 1975). Several etiological factors have been attributed to cause impaction of the teeth, such as, retained deciduous teeth, an abnormal eruptive path, supernumerary tooth blocking the eruption path, dental crowding, or any form of soft or hard tissue pathologies (Becker, 2022). Early detection and management of impacted teeth is often suggested to avoid the impending complications like root resorption, gingival infection and dentigerous cysts (Hupp, 2014). Additionally, impactions are often associated with malocclusions, affecting both the normal functions and aesthetics (Richardson and Russell, 2000).

Several factors, including age, gender, eruption timing, available space, and ethnicity, influence tooth impaction, with numerous studies exploring the prevalence of impacted teeth across various ethnicities, cultures, and regions (Fardi et al., 2011; Topkara and Sari, 2012; Patil and Maheshwari, 2014; Arabion et al., 2017). The reporting of impacted

teeth fluctuates, with reports ranging from 6.9 % to as high as 37.8 % (Shah et al., 1978; Hugoson and Kugelberg, 1988). Notably, in studies excluding the third molars, canines were the most commonly impacted teeth, while molars were the least in North Indian and Greek populations (Fardi et al., 2011; Patil and Maheshwari, 2014).

Previous studies in Saudi Arabia reporting the prevalence of impaction have mainly focused on third molars and canines (Khawaja et al., 2015; Melha et al., 2017; Alhammadi et al., 2018). Wide variability exists in reporting the prevalence of an impacted tooth; for example, the maxillary canines have been said to be impacted in a range of 1.3–10.1 % (Mustafa, 2014; Alkadhi et al., 2017). Also, the mandibular third molars have been reported to be impacted in a range of 10.6–64.8 % (Alsehimy, 2014; Alfergani et al., 2017). Such a wide range and variability require careful interpretation, which can be attributed to different populations investigated or different diagnostic criteria applied.

Considering the noted limitation within the literature, no earlier research in Saudi Arabia has assessed the differences in the prevalence of impaction between the population with general dental issues and orthodontic patients. Therefore, this study aims to compare the prevalence of impacted teeth between orthodontic patients and people with common dental problems attending two dental centers in Riyadh, Saudi Arabia.

2. Material and methods

IRB approval from King Abdullah International Medical Research Centre (SP21R/358/06) was granted. Based on evidence from previously published data (Alamri et al., 2020), the sample size was estimated by applying the formula n = 4pq/L2 and assuming a statistical power of 80 % with 95 % confidence level, as 6000 patients. The sampling frame for the orthodontic population included digital records of 2998 patients were randomly selected from an original 8000 patients who were treated from 2016 to 2022 in the orthodontic clinic at King Abdulaziz Medical City, Riyadh, Saudi Arabia. But for the general population, 3002 patients were randomly selected from an original 15000 patients treated at the College of Dentistry at King Saud bin Abdulaziz University for Health Sciences (KSAU-HS) Riyadh, Saudi Arabia from 2016 to 2022. In both groups, the representation of each gender was intentionally equal to allow the comparison between the males and females. Radiographs of Saudi patients more than 9 years of age were included. Patients with medical conditions or craniofacial abnormalities that could affect teeth eruption were excluded. Patients with a history of previous orthodontic treatment were also included and their initial pretreatment radiographs were examined. Patient records and radiographs identified using the inclusion criteria were reviewed retrospectively. A tooth was considered impacted if it fails to erupt into its anatomical position after 2 years of the complete root formation (Proffit et al., 2018).

To assure examiner reliability, the same investigator examined samples of 100 randomly selected radiographs two weeks apart. To ascertain the test–retest reliability, Cohen's kappa test was used to assess inter-rater and intra-rater reliability for diagnosing the impaction of teeth. The mean values of the variables obtained during the two sessions were compared using paired t-tests. The intra-rater reliability for the overall impaction evaluation showed almost perfect agreement for both investigators (0.924 & 1.00). While the inter-rater reliability also showed almost perfect agreement (Kappa = 0.936).

2.1. Statistical analysis

The data tabulated were analyzed using the SPSS version 23 for Windows, (IBM SPSS Statistics, Armonk, NY, USA). Descriptive statistics (mean and standard deviation) were calculated for all the quantitative outcome variables. Pearson's correlation was used to quantify the correlation and compare the categorical data between the two groups. The

statistical significance of the results was fixed at a p-value < 5 % (α = 0.05) and at 95 % confidence interval. Descriptive analysis and statistical comparisons assuming a 95 % level of significance (p < 0.05) were performed using statistical package software (IBM SPSS Statistics Version 20, IBM, Armonk, NY, USA).

3. Results

On reviewing the patient records, 2998 radiographs belonged to the orthodontic group and 3002 of them to the general population. The representation of each gender in the two groups was intentionally equal (50 %). The general population group (31.5 years old) was older than the orthodontic group (18.1 years). [Table 1].

The prevalence of impacted teeth was more in the orthodontic population (13.2 %) than in the general population (11.2 %). However, this difference was not statistically significant, p = 0.103 [Table 2]. Among the general population, impacted teeth were nearly equal (4.3 %) on the right and left sides of the jaw. In addition, bilateral teeth impaction in this group was recorded in 6.9 % of the reviewed radiographic records. On the other hand, in the orthodontic group the prevalence of impacted teeth was more on the right side (4.2 %) than on the left side (3.5 %). However, only 5 % of the radiographs in this group showed bilateral impacted teeth.

In the general population, the most prevalent impacted teeth in the maxilla were the right maxillary third molar tooth, #18 (4.4 %) followed by the left maxillary third molar tooth, #28 (4.1 %). Followed by the maxillary canines #13 (1.5 %) and tooth #23 (1.3 %). A similar pattern was also recorded in mandibular teeth where the most prevalent impacted teeth were third molars, #38 (7.0 %) and, #48 (6.8 %). The canines (0.2 %) on both sides of the mandible were the most prevalent impacted teeth among mandibular anterior teeth [Table 3] and [Fig. 1]. In the orthodontic population, the most frequently impacted teeth in the maxilla were the canines #13 (4.3 %) and #23 (3.9 %). Followed by the third molars, #28 (2.4 %) and #18 (2.2 %). In contrary, among the mandibular teeth, #38 and #48 (3.1 %) were the two most common impacted teeth. Followed by the mandibular canines #43 (0.5 %) and #33 (0.3 %). In comparison to the maxilla, the mandible had a higher rate of impacted third molars. [Table 3]

In the maxilla, the occurrence of impactions among third molars and canines on both side of the jaw showed a statistically significant difference (p = 0.001) when compared between the two study populations. The prevalence of impacted third molars (#18 and #28) was significantly (p = 0.001) more in the general than orthodontic population. However, the canine impaction occurrences was more in the orthodontic population. In addition, the prevalence of impacted #11 and #25 teeth was more in the orthodontic population than the general population. [Table 3] In the mandible, only the impaction of third molars showed statistically significant difference (p = 0.001) between the two populations. The impactions of both third molars (#38 and #48 teeth) was more in orthodontic than the general population. In contrast to the maxilla, the mandibular canine impactions didn't show statistically significant difference between the two study populations. [Table 3]

In the general population, males (17.7 %) had a higher proportion of impacted teeth than females (13.2 %). This difference was statistically significant (p = 0.004). While in the orthodontic population, the prevalence was slightly greater among males (13.8 %) than female (12.6 %).

Table 1
Descriptive characteristics of study participants.

		General Population	Orthodontic Population
		N (%)	N (%)
Gender	Female	1502 (50)	1498 (50)
	Male	1500 (50)	1500 (50)
	Total	3002	2998
Age (Mean ± SD)		31.5 ± 15.4	18.1 ± 8.5

Table 2
The overall prevalence of impaction among General and Orthodontic Population.

		N (%)	P value
General Population	No impaction	2666 (88.8)	
	Impaction	336 (11.2)	0.103
Orthodontic Population	No impaction	2600 (86.8)	
	Impaction	394 (13.2)	

Chi-square test, *Statistical significance at p ≤ 0.05.

Table 3
Comparison of Prevalence of Impaction for Individual teeth between the two populations.

Tooth #	General Population (3002 total)		Orthodontic Population (2998 total)		P-value
	N	(%)	N	(%)	
18	134	4.46	67	2.23	**0.001***
17	4	0.13	3	0.10	0.707
16	0	0.00	0	0.00	NA
15	5	0.17	7	0.23	0.562
14	2	0.07	6	0.20	0.156
13	45	1.50	130	4.34	**0.001***
12	1	0.03	3	0.10	0.317
11	0	0.00	7	0.23	**0.008***
21	2	0.07	8	0.27	0.057
22	1	0.03	2	0.07	0.563
23	40	1.33	117	3.90	**0.001***
24	2	0.07	4	0.13	0.413
25	1	0.03	14	0.47	**0.001***
26	0	0.00	1	0.03	0.317
27	6	0.20	1	0.03	0.059
28	124	4.13	72	2.40	**0.001***
38	210	7.00	93	3.10	**0.001***
37	3	0.10	4	0.13	0.704
36	0	0.00	0	0.00	NA
35	2	0.07	5	0.17	0.256
34	3	0.10	3	0.10	0.999
33	5	0.17	10	0.33	0.195
32	0	0.00	0	0.00	NA
31	2	0.07	0	0.00	0.158
41	0	0.00	1	0.03	0.317
42	0	0.00	1	0.03	0.317
43	6	0.20	14	0.47	0.073
44	2	0.07	2	0.07	0.999
45	2	0.07	7	0.23	0.095
46	0	0.00	1	0.03	0.317
47	2	0.07	4	0.13	0.413
48	203	6.76	94	3.14	**0.01***

Chi-square test, *Statistical significance at p ≤ 0.05.

This difference between the gender groups had no statistical significance (p = 0.338).

4. Discussion

This study represents a new effort in examining the prevalence of permanent tooth impactions within two distinct populations: the general population and the orthodontic population. The general population represents patients who underwent any dental treatment other than orthodontic treatment, whereas the orthodontic population represents patients who seek only orthodontic treatment. A total of 6000 radiographs of Saudi patients with age above 9 years were included in the study. The general population had a significantly higher prevalence of impacted third molars, while the orthodontic population had a significantly higher prevalence of impacted maxillary canines, maxillary right central incisor and maxillary left second premolar.

One of the main findings in the retrospective study is the difference in the most commonly impacted tooth in each population. In the general population, it was the third molars, while in the orthodontic population,

it was the maxillary canines. This significant difference can be attributed to the younger nature of the orthodontic population in our study, and according to our inclusion criteria, a tooth is considered impacted only if it does not erupt two years after its normal chronological time of root development completion, which can eliminate the eligibility to assess third molar impaction in many of the orthodontic population in our study, and matching for age can misrepresent the true nature of each population.

The overall prevalence of teeth impaction was higher in the orthodontic population (13.2 %) than in the general population (11.2 %). However, the prevalence of impacted teeth in the general population in the present study was similar to a previous report conducted in the eastern province of Saudi Arabia, which examined impactions of all the teeth except the third molars, and reported a prevalence rate of 13.2 % (Alamri et al., 2020). In another retrospective analysis of 878 digital orthopantomograms of patients from Jeddah, the reported prevalence of impacted teeth was 21.1 % (Afify and Zawawi,2012). These differences in the prevalence of impacted teeth between studies could be attributed to differences in the sample sizes, age of study groups, diagnostic criteria, and geographic locations.

The current study illustrated that out of the 3002 patients from the general population, 22.3 % had at least one impacted third molar, which is lower than the prevalence estimated in the central region 37 years earlier, which was reported to be 31.8 %. (Haidar and Shalhoub, 1986) It is important to note that the mentioned study reported the prevalence based on the number of wisdom teeth examined rather than the number of patients, which can present completely different readings. However, the reported prevalence in this study remains comparatively higher than those reported by Afify et al. (15.9 %) and Jan et al. (19.2 %) (Afify and Zawawi, 2012; Alsehimy, 2014). In accordance with the present study, the impaction prevalence evaluated in Jeddah and Al-Madinah showed that the third molar impaction was higher in the mandible than the maxilla (Alsehimy, 2014; El-Khateeb et al., 2015). In addition, Zaman et al. studied 17,760 Saudi patients and found 12.3 % had at least one impacted mandibular third molar (Zaman et al., 2021), a comparable finding in our general population 13.8 %. Alfregani et al. showed 64.87 % had impacted mandibular third molar (Alfergani et al., 2017). This extreme variation could be explained by the selected population in that study, which only investigated records of patients attending the Oral and Maxillofacial Surgery clinic.

Among the general population, canines are the second most commonly impacted tooth after the third molars. The reported percentage of canine impactions is 2.8 % out of 3002 cases. Similar studies have investigated canine impactions among different regions in Saudi Arabia, with reports ranging from 1.3 to 4.9 % (Mustafa, 2014; Alyami et al., 2020). On the other hand, among the orthodontic population in this study, the most commonly impacted tooth is the maxillary canine (6.2 %). However in the mandible, the canine is the second most common after third molars, 2.3 %. A similar study on orthodontic patients in Riyadh region showed that 10.1 % have maxillary canine impactions (Alkadhi et al., 2017).

Our data showed the prevalence of premolar impaction was 0.63 % in the general population and 1.6 % in the orthodontic population, which shows us that the orthodontic population is almost three times more likely to have an impacted premolar. In our general population, the maxillary and mandibular premolars were almost similar, with 0.34 % and 0.31 % respectively. A different pattern was seen in the orthodontic population, where the impaction of maxillary premolars was more prevalent (1 %) than the mandibular premolars (0.6 %). This was in contrast to a report where mandibular premolars were more frequently (0.9 %) impacted than maxillary premolars (0.3 %) (Mustafa, 2015).

Certain teeth have rarely been reported on in terms of prevalence of impaction. In particular, the impaction of first molars, second molars, central and lateral incisors. Amongst the general population, there were only four impacted central incisors (0.1 %) and only two impacted
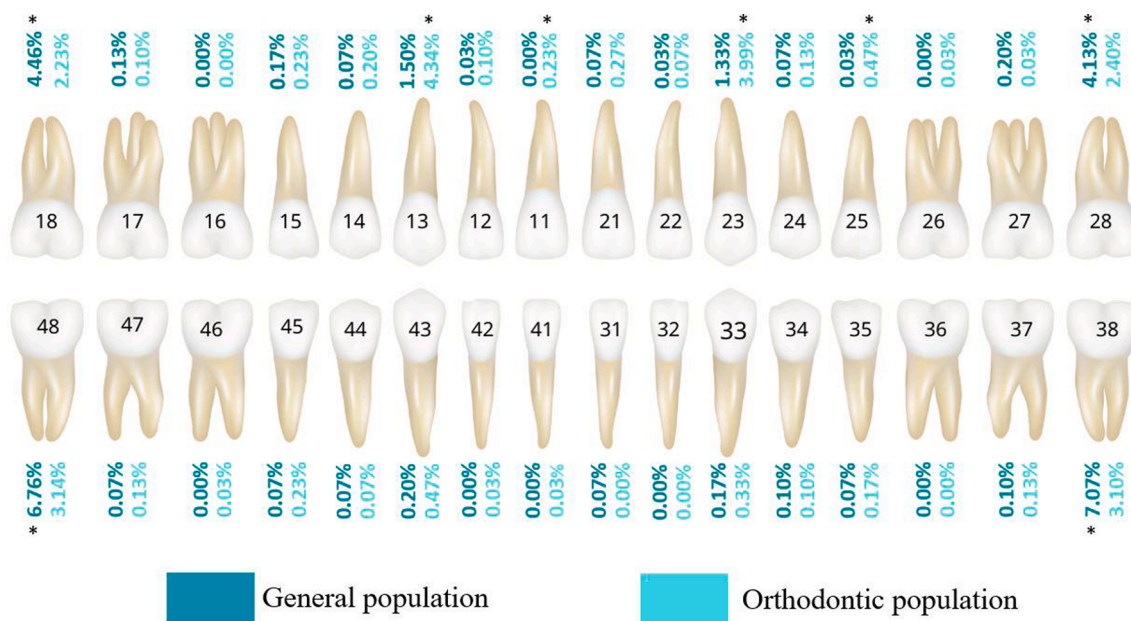
Fig. 1. Prevalence of impactions for individual teeth in the orthodontic and general populations.

lateral incisors (0.06 %). For the second molars, fifteen teeth were impacted (0.5 %), while for the first molars, no teeth were impacted in both arches, and making them the least commonly impacted teeth in our findings. In comparison to the orthodontic population, there were sixteen impacted central incisors (0.53 %), mainly in the upper arch. Five upper lateral incisors were impacted (0.2 %) and only one was in the lower arch (0.03). Finally, twelve second molars (0.4 %) and only two impacted first molar (0.1 %) were detected.

It is essential to apply both clinical and radiographic evaluations to accurately diagnose impacted teeth. Thus, it is important to note this retrospective investigation was limited to radiographic examinations and chart review alone. In addition, given that our study sample was drawn exclusively from only two centers in a single region, it is advisable to broaden the scope by including samples from various regions across Saudi Arabia to ensure our findings' generalizability.

5. Conclusion

The prevalence of at least a single tooth impaction between the orthodontic and general population was not statistically different. However, the type of teeth impacted in each population differed. The most prevalent impacted teeth in the general population were the third molars, followed by the maxillary canines. Conversely, in the Orthodontic population, the most prevalent impacted teeth were the maxillary canines, followed by the third molars. Hence, understanding the type of population investigated while reporting the prevalence of impacted teeth is critical in understanding the variability between different reports.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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