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Retrospective Cross-sectional Radiographic Assessment of Permanent First Molars in a Libyan Sub-population

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ABSTRACT

Objectives: This study aims to radiographically determine the prevalence of missing and decayed first permanent molars (FPMs) in a Libyan sub-population, as well as to investigate any distinctive patterns related to age and gender.

Materials and Methods: Retrospective, cross-sectional assessment evaluated a total of 931 panoramic radiographs. The radiographs were divided into two groups according to age: group A 9-39 years old, group B: >40 years old. Study groups were further divided into two sub-groups: males and females. The radiographs were evaluated by two observer groups: 1-Two trained intern dentists and one 5th-year dental student 2-Oral and maxillofacial radiologist. Appropriate statistical tests were utilized for the statistical.

Results: The percentages of missing and decayed FPMs were 32% and 17%, respectively. There was a statistically significant difference in the odds of missing upper and lower FPMs with age; (P = 0.0001), (OR = 0.1136), (95% CI 0.0788, 0.1636) and (P = 0.0001), (OR= 0.1165), (95% CI 0.0754, 0.1806), respectively. The difference in the odds with gender was only statistically significant for the upper missing FPMs; (P = 0.01), (OR = 0.7), (95% CI 0.647, 0.942).

Conclusion: High prevalence of missing and decayed FPMs in this Libyan sub-population was highlighted with significant age and gender associations. The findings suggest the importance of preventive practices to reduce extractions, raise awareness and promote restorative dentistry, in order to maintain proper health and the functions of the stomatognathic system.

Keywords: First permanent molars, Libyan sub-population, Oral radiology, OPG.

1. Introduction

First permanent molars (FPMs) are the first teeth to erupt, usually when a child is six years old (1,2). Regarding both functional and developmental aspects, FPMs are considered an important unit of mastication (3). Furthermore, Andrew described FPMs as a key of occlusion (4). Accordingly, FPMs are an integral part in the dental development of functionally desirable occlusion and its subsequent effects on dental and dentofacial development (1). Tooth loss is mainly attributed to dental caries and periodontal disease (5). Moreover, it was found that caries is the main reason for permanent teeth extraction (6). Dental caries is a multi-factorial infectious disease, attributed to 4 main detrimental factors: Tooth surface, bacteria, sugar and time (7). In addition, there are risk factors including: oral hygiene, saliva, teeth morphology and dental caries (5). Also, modifying factors as: age, gender, eating habits, genetics, and socio-economic factors (education, occupation and access to professional care) (8,9).

Although in the developed parts of the world the prevalence of dental caries among children is in decline,

there has been an increase in some developing countries (9). For instance, in Saudi Arabia, it has been found that caries prevalence among children is 83% (5). FPM loss would have devastating effects on dental and dento-facial development. As stated in the literature, the loss of this key of occlusion may lead to malocclusion, malalignment, super-eruption of opposing teeth, shifted central line, shifted distribution of growth stimulatory masticatory forces (unilateral chewing), horizontal mandibular displacement, continuous displacement of the condyles during growth and development, asymmetrical growth of the mandible, and mesialization and rotation (after the loss of the maxillary first permanent molar) due to posterior cross-bite (3,10). Moreover, there has been evidence supporting the association between FPM loss and anterior open bite (AOB) (11). It has also been reported that FPM loss causes periodontal disease, due to tipping of adjacent teeth crowns (second molar and second premolar) towards the extraction site (3).

FPMs are utilized in orthodontic treatment as an anchoring unit, thus they play an important role in orthodontic treatment and their loss would result in a more complicated orthodontic treatment (5). In the process to comprehend the characteristics, trends and severity of malocclusion and the complexity of orthodontic treatment needs, thereafter, the initial step can be the quantification of missing FPMs in a population (12).

Due to the aforementioned crucial role of FPMs and the stated complications associated with their loss, it is conclusively apparent that FPM preservation is of utmost importance, as it impacts normal dental and dento-facial development. This can be achieved by early dental screening and preventive dental measures for FPM protection (1). Moreover, in cases of FPM premature loss, interceptive orthodontic and/or prosthetic treatment is necessary to prevent or reduce the undesirable consequences of premature extraction (13).

Panoramic images (PANs), also known as Orthopantomography (OPG), is a type of radiography that is utilized for diagnosis and treatment planning (14). It is also known to be the most frequently prescribed screening examination in dentistry (14). Moreover, PANs are majorly used by orthodontists, as they have an integral role as a diagnostic tool, diagnostic record, orthodontic treatment planning, monitoring and assessment of treatment progress and outcomes (12). This imaging technique has several advantages, particularly relative low cost, and low radiation exposure while obtaining a comprehensive overview of dental arches, maxillary and mandibular bones, and anatomic structures of relevance, such as inferior alveolar nerves and maxillary sinuses that are to be conserved during surgery (14).

However, PANs also have disadvantages and limitations, as they only present two-dimensional images of a three-dimensional structure, where different structure superimposition negatively affects accurate interpretation (vertebral column obscuring anterior teeth). The lack of fine details of PANs, compared to volumetric imaging, especially for accurate diagnosis of carious lesions (Computed Beam Cone Tomography "CBCT"). in addition to patient positioning errors are examples of such effects (14).

The present study retrospectively evaluated panoramic images in a Libyan sub-population to determine the prevalence of missing and decayed FPMs, as well as to investigate any patterns related to age and gender.

2. Materials and Methods

In this retrospective, cross-sectional study, after ethical approval attainment, 2108 digital panoramic images from the time period (from July 2021 to August 2023) were retrieved. After applying the specific inclusion and exclusion criteria, 931 images were included in the study. Ethical approval was granted by Libyan International Medical University (LIMU) ethical committee. The inclusion criteria included panoramic images of Libyan patients aged from 9 years and above attending the LIMU dental center. Exclusion criteria included images with no date of birth, low-quality images, images with errors, images with large pathological lesions and fractures obscuring the field of interest, and images with disagreement issues among observers.

An informed consent to participate in the study was obtained; in case of adult patients, the informed consent was provided by themselves and in case of participants less than 18 years old, the informed consent was provided by one of their parents or legal guardian. The images were exported and saved in a JPEG file, without any adjustments, maintaining contrast, brightness and magnification. Patients were divided into 2 age groups: Group A: 9-39 years old, and Group B: 40 years and above. Each group was further sub-divided into males

and females. Panoramic images were observed and evaluated first by two trained intern dentists and one 5th-year dental student, who have undergone a 5-day workshop specifically designed for this research by an oral and maxillofacial specialist, and second by an oral and maxillofacial radiologist.

Observation and evaluation were carried out under standard conditions; dimly lit room, the same workstation computer unit and the same display monitor. The "intra-observer" repeatability and the "inter-observer" reliability between the first and second observers were calculated for 15% randomly selected images.

All panoramic images were obtained by the same digital panoramic system: (Vatech Rayence, Korea); and the Software (EasyDent V4 Viewer, Version 4.1.5.10). Selected exposure settings were composed of two sets of combinations: (60 kVp, 4 mA, 18 s), and (66 kVp, 8 mA, 18 s). Panoramic images were processed and evaluated using a workstation computer unit (Hp LP2475W LCD TFT Monitor, China). The PC workstation used Windows® 7 Professional 32- bit with XP Mode operating system.

Codes were used for recording the evaluation of FPM status in the panoramic images: Code 0 = Missing, Code 1 = Healthy (present and sound), Code 2 = Decayed (primary decay, recurrent/secondary decay, badly decayed), Code 3 = Restored (excluding recurrent/secondary decay).

The Statistical Package for Social Sciences (IBM SPSS® Inc., version 25.0, Chicago, Illinois, USA) was utilized for all statistical analyses. No differentiations were applied based on age or gender. The results are expressed as mean (M ± SD), with a significance level marked at $p<0.05$. Continuous variables were summarized using M ± SD, while categorical variables were reported as frequencies and percentages. The chi-square test (χ^2 test) was employed to assess frequency differences across genders and between upper and lower dental arches. T-test for two independent samples was employed to assess the mean differences between genders.

3. Results

The analysis of the 931 images for reliability of both intra-observer and inter-observer agreement, was evaluated, yielding no differences of significance ($p>0.05$), confirming reliability. The first observer, intra-class correlation coefficient (ρ) indicated a reliability level extending from 0.81 to 1.00. The second observer achieved a reliability score between 0.97 and 1.00 for a randomly selected sample amounting to 140 (15%) images. For the inter-observer agreement, Fleiss's kappa test (k) was applied, demonstrating an agreement between the first and second observers regarding the same 140 (15%) images extending from 0.85 to 1.00. Values higher than 0.70 were considered reliable, and the initial readings were subsequently used for statistical data evaluation.

The sample in this study (n=931) consisted of the panoramic images of 468 females (50.3%) and 463 males (49.7%), aged 9 years and above with a median age of 39 years. In general, the prevalence percentages of the detected FPMs in these images were as follows: 32% Missing, 17% Decayed, 39% Healthy and 11% Restored.

Regarding missing FPMs and age, with a P-value of (0.00) and a confidence interval (CI) which does not include 1, it can be concluded that there is a high statistical significance in the odds of upper missing status between individuals aged 9-39 years and those aged 40 years and above. The second group (40 years and above) had much more missing FPMs, concluding increased FPM loss with the increase in age (Table 1). Almost the same results were found for the lower missing FPMs (Table 1).

Regarding decayed FPMs and age, with a P-value of 0.41 and a CI which includes 1, it can be concluded that there is no statistically significant difference in the odds of upper decayed status between individuals aged 9-39 years and those aged 40 years and above (Table 1). Nearly the same results were found for the lower decayed FPMs, with a P-value of 0.29 and CI including 1 (Table 1). Accordingly, there is no statistically significant difference in the odds of lower decayed status between individuals aged 9-39 years and those aged 40 years and above (Table 1).

Regarding missing FPMs and gender: with a P-value of 0.01 and CI not including 1, it can be concluded that there is a statistically significant difference in the odds of upper missing status between females and males, where males had much more missing FPMs (Table 2). On the contrary, there is no statistically significant difference in the odds of lower missing status between females and males, with a P-value of 0.90 and CI including 1 (Table 2).

Table 1: P-value, odds ratio (OR) and the 95% confidence interval (CI) for missing and decayed FPMs (upper and lower) with age groups

Upper	9-39 years	40 years and above		Lower	9-39 years	40 years and above	
Missing	98	451	**P-value:** 0.00 **OR:** 0.11 **95% CI:** 0.08, 0.16*	**Missing**	130	517	**P-value:** 0.00 **OR:** 0.12 **95% CI** 0.08, 0.18*
Non-missing	862	451		**Non-missing**	830	385	
Decayed	216	102	**P-value:**0.41 **OR:** .14 **95% CI**: 0.83, 1.56	**Decayed**	232	97	**P-value:** 0.28 **OR:**1.15, **95%CI:** 0.88, 1.49
Non-decayed	646	349		**Non-decayed**	598	288	

Table 2: P-value, odds ratio (OR) and the 95% confidence interval (CI) for missing and decayed FPMs (upper and lower) with gender

Upper	Female	Male		Lower	Female	Male	
Missing	252	297	**P-value:** 0.01 **OR:** 0.78 **95% CI**: 0.647, 0.94*	**Missing**	324	323	**P-value:** 0.90 **OR:** 0.98, **95% CI:** 0.82, 1.18
Non-missing	684	629		**Non-missing**	612	603	
Decayed	156	162	**P-value:** 0.15 **OR:** 0.85 **95% CI:** 0.67, 1.06	**Decayed**	159	170	**P-value:** 0.36 **OR:** 0.89 **95% CI:** 0.69, 1.14
Non-decayed	528	467		**Non-decayed**	453	433	

Regarding decayed FPMs and gender: there is no statistically significant difference in the odds of upper decayed status between females and males, with a P-value of 0.16 and CI including 1 (Table 2). Similarly, there was no statistically significant difference in the odds of lower decayed status between females and males, with a P-value of 0.37 and CI including 1 (Table 2).

4. Discussion

Tooth loss is persistently regarded as a major public health problem, affecting an individual's quality of life (12). FPM extraction has long been a subject of debate. FPMs were sometimes preserved for preventive reasons. In recent years, orthodontists have favored the extraction of FPMs and have given indications for their extraction (15-17).

FPMs have an essential role in the dental and general health of individuals and subsequently aid to identify educational and treatment needs in the community (1,3,16). For the aforementioned reasons, the health status evaluation of these teeth grants sufficient information about the oral health of a population (18). Quantifying the missing FPMs in a population can be the initial step toward apprehending the trends and characteristics of the severity of malocclusion and hence the complexity of orthodontic treatment needs (12). In addition, it emphasizes the importance of preserving FPMs, especially since their early loss causes many problems (19).

When FPM extraction is decided, it should be done in accordance with an orthodontist before the eruption of second and third permanent molars. Usually, the best time is 8-10 years and 10.5-11.5 years (15,16,21). Gill et al. claimed that FPM extraction during the time intervals of 8-10 years and 10.5-11.5 years would facilitate mesial movement of the permanent second molar into the FPM area (22). Otherwise, the extraction of FPMs at a later age would result in an unsatisfactory and/or inadequate space closure, condylar problems and orthodontic malocclusion (23).

Almugla et al., using panoramic images (PANs),

found that the prevalence of missing FPMs is 39.2% in the age group of 9-27 years, which is 27.4% less in comparison with the results of our study (12). Alshawaf et al., utilizing PANs, found that the prevalence of missing FPMs is 25.3% in the 15-34 years age group, which is 13% less than the results of our study (5).

Rezaie et al., in their study using PANs, found that there was a positive relation between the prevalence of missing FPMs and age, where the higher the age the more the missing, and gender (male predilection); missing lower FPMs were seen in 33.5% of the subjects, while upper FPMs were missing in 22.6% of the subjects, demonstrating that lower missing FPMs were more frequent than upper missing FPMs (1). In comparison with our study, a positive relation between missing FPMs and age is consistent in both upper and lower FPMs, where the higher the age the more the missing, while only upper missing FPMs had a statistically significant association with gender (male predilection). This is in agreement with the current study, as the prevalence of missing lower FPMs was higher than the prevalence of missing upper FPMs. Özmen et al. also reported that lower missing FPMs were more frequent than upper missing FPMs. However, females had more missing FPMs than males, which is inconsistent with the current findings (16).

İncebeyaz et al. used PANs to evaluate FPM status and determined that 45.7% of FPMs were healthy, while 54.3% required treatment. Missing upper FPMs amounted to 38.6% and missing lower FPMs amounted to 43.9%. They also reported that the rate of healthy FPMs decreased with age. In comparison to the current study, healthy FPMs amounted to 39%, Furthermore, a lower percentage of FPMs was indicated for treatment (17%). Missing upper FPMs and missing lower FPMs were noticeably less frequent (9%), compared to the current study in which the percentage of missing upper FPMs was 29.5%, and that of missing lower FPMs was 34.7%. Yet, it was consistent regarding the greater percentage of missing FPMs being in the lower jaw, as well as regarding that the amount of healthy FPMs decreased with age (24).

Duman et al., using PANs, determined that 45.7% of FPMs were healthy and 54.3% needed treatment, while in the current study, 39% were healthy (devoid of any decay or restorations), while only 17% required treatment. The rate of diseased FPMs in males was lower than in females, which is inconsistent with our findings. However, the difference in the percentages of diseased FPMs is very large (37%). Yet, this is not a good sign; as missing FPMs in the current study amounted to 32%, indicating an obvious trend towards more FPM extraction (25).

Both, Gjermo et al. using 2 posterior bitewing radiographs and Halıcıoğlu et al. using PANs, reported that the number of lower missing FPMs was higher, which contradicts the findings of our study. However, these discrepancies may be attributed to the various ethnic origins of samples in both studies (26,27). Generally, previous research conducted on similar age groups showed that FPMs in females were more affected, which can be attributed to the fact that females reach puberty before males, as well as to the earlier eruption of FPMs in females, which is consistent with the findings of the current study (28).

Furthermore, variations in the results of FPM rates could be attributed to the various age groups, sample size, as well as to societal differences, investigation of FPMs solely, initial caries that was not revealed by the used radiographic images and preventive measures across national boundaries. Moreover, FPM loss and decay were assessed across a broad age range and a large sample size in this investigation. The disparity between different studies could also be attributed to differences in age ranges and sample sizes (29).

The current results demonstrated an association between age and dental status regarding missing FPMs; however, only upper missing FPMs had a significant association with gender (males more than females). Previous studies have revealed that females have more caries than males, which is inconsistent with our findings, indicating that there was no statistical significance for gender association with FPM decay (30).

It has been reported in the literature that FPMs are the most frequently affected teeth with caries, mainly attributing that to the eruption timing, which aligns with the primary dentition period and the depth of the grooves in the occlusal morphology of FPMs, allowing for food entrapment and retention (31).

It is critical to gradually maintain or even increase the number of patients with healthy FPMs by raising awareness and education rather than opting for extraction and suffering the results of FPM loss and the expenses of their prosthetic replacement (32).

Patients should be recommended for prosthetic

replacement and informed about the complications associated with missing FPMs, taking into account the potential repercussions, with the goal being the prevention of FPM extraction, with more focus on preventive measures, early treatment of decay and control of periodontal diseases, so that FPMs in question will not need to be extracted, thus preventing loss of functionality and appearance (33,34).

In the current study, OPG was used for caries diagnosis; however, this type of imaging is not considered optimal for this specific purpose due to the lack of fine details and the inherent nature of OPG two-dimensional representation of a three-dimensional object. Also, data utilized was extracted from only one source. Furthermore, this study was retrospective in design and was not paired with a clinical evaluation of the sample of patients included.

5. Conclusions

Within the limitations of this retrospective study, there is an alarmingly high prevalence of missing and decayed FPMs among a Libyan sub-population with significant age and gender associations. This highlights the importance of implementing preventive practices to reduce extractions, as well as the crucial need to raise awareness and promote restorative dentistry, in order to maintain proper health and function of the stomatognathic system.

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Conflict of Interests

The authors have no conflict of interests to declare.

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