Original article

Evaluation of Digital Panoramic Imaging for Incidental Findings in Completely Edentulous Patients in a Libyan Subpopulation (LIMU Dental Center)

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Abstract
Reduction in the rate of tooth loss and the need for complete dentures has a powerful effect on dental education and treatment modalities. Data regarding the levels of tooth loss and prosthetic treatment patterns of the population for all countries must be obtained, and the changes that occur over time need to be determined. The prevalence of complete edentulism varies from country to country and from one region to another. According to the current English literature, there is no available data for Libya in this regard. This study was conducted to evaluate the prevalence of complete edentulism retrospectively and to evaluate the frequency and location of significant incidental findings concerning age, gender, type of arch (maxilla/mandible), on digital panoramic images of edentulous patients attending the Clinical Dental Center in the Faculty of Dentistry at the Libyan International Medical University (LIMU), Benghazi- Libya. It is a cross-sectional, retrospective study; digital panoramic images of patients attending the Clinical Dental Center at LIMU from April 2021 to February 2023 will be retrieved and evaluated. The prevalence of complete edentulism will be determined among 1553 digital panoramic radiographs (original sample), which will be subjected first to inclusion and exclusion criteria. Radiographic incidental findings are identified as: impacted teeth, retained roots, radiopaque and radiolucent areas, atrophic crest, foreign bodies, styloid process elongation, soft tissue calcification, maxillary sinus findings, and any other findings specific to this Libyan subpopulation. A total of 1553 panoramic images were analyzed in this study, out of which 126 (8.1%) were completely edentulous, and out of these 83 (65.8%) were associated with positive incidental findings, as of the images belonged to 82 (65.1%) males and 44 (34.9%) belonged to females, and atrophic maxilla being the most frequently observed finding 51 (35.7%), atrophic mandible found in 31 (21.7%) and styloid ligament calcification presented in 24 (16.8%) of total completely edentulous panoramic images. The result of this study showed that the rate of positive incidental findings detected in digital panoramic images of completely edentulous patients was high. Accordingly, taking panoramic images of completely edentulous patients before prosthetic replacement is important to avoid dental and medical conditions that could affect these patients.
Keywords: Completely Edentulous, Incidental Findings, Prevalence, Panoramic Radiographic Images, Libyan International Medical University LIMU.

Introduction
Complete edentulism can be defined as the issue of total loss of all natural teeth. In cooperation, general health issues and oral health issues can directly affect the quality of life, especially that of older adults. Although the prevalence of complete edentulism has declined in the last decade, tooth loss remains an important disease worldwide. Moreover, the prevalence of complete edentulism differs from region to region and from one country to another. It also differs in terms of age, gender, systemic health conditions, socioeconomic status, and other health-related factors [1-8].

Several previous studies have reported a high prevalence of significant radiographic incidental findings in edentulous patients. Therefore, panoramic radiography is the imaging modality used for producing a single image of facial structures that involves the maxillary and mandibular arches by using a relatively quick and simple procedure. This technique is used frequently as a screening tool for the pre-treatment assessment of Completely Edentulous Patients (CEP), and it is important to highlight that even though the cumulative effect of the ionizing radiation exposure raise the concerns, the radiographic selection criteria and guidelines reviewed by the American Dental Association, and the Food and Drug Administration states that routine radiographic examination of CEP is critical and recommended before complete denture construction [1,2,3,9-13].

Reduction in the rate of tooth loss and the need for complete dentures has a powerful effect on dental education and treatment modalities. Data regarding the levels of tooth loss and prosthetic treatment patterns of the population for all countries must be obtained, and the changes that occur over time need to be determined. Although some studies revealed a small number of incidental radiographic findings that influenced the treatment of CEP, others stated the significance of those findings that required surgical interventions prior to denture construction, or even to refer CEP for further investigations. Furthermore, a study suggested panoramic radiography to improve the efficacy of national oral examination and public health promotion [2,3,5,11,14-18].

In view of this, the study aims to retrospectively determine the prevalence of complete edentulism and the frequency and Location of significant radiographic incidental findings detected in panoramic radiographic images of CEP attending the LIMU Dental Center, a Libyan subpopulation.

Materials and Methods
Study design
This study is an observational, retrospective, cross-sectional study that will use the panoramic images, obtained previously in the LIMU Dental Center in the Faculty of Dentistry at LIMU, for several clinical reasons. All patients would provide their consent in advance to use their radiological images in scientific research conducted at the Faculty of Dentistry at LIMU. Ethical Clearance Certificate Reference No: DEN-2023-00094.

Study Population
1553 panoramic images were retrieved from the Radiology Unit archives in the LIMU Dental Center within the period from May 2021 to February 2023. The original sample will be subjected to both inclusion and exclusion criteria set for this specific study: The inclusion criteria are: digital panoramic images of totally edentulous Libyan patients. Whereas the exclusion criteria are: images of low quality, or with errors, of mixed dentition, or dentated patients, or images with disagreement issues between evaluators.

Methods
The investigator evaluated the images for radiographic incidental findings, which are identified as: impacted teeth, retained roots, radiopaque, and radiolucent areas, atrophic crest, foreign bodies, styloid process elongation, maxillary sinus findings, and finally, any other findings specific to this Libyan population.

Data collection
Demographic information regarding the age and gender of patients was collected in a coded checklist for confidentiality. Panoramic images of patients were observed and evaluated under standard conditions: a dimly lit room, the same workstation computer unit, and the same display monitor.

Materials
The images were evaluated by a trained dentist (first observer), and then were evaluated by a Dentomaxillofacial Radiologist (second observer) for reliability. All panoramic images were taken by the same Digital Panoramic System: (Vatech · Rayence · Vatech MCIS · Ewoosoft · Woorien · Vatech eng. Address 13, Samsung 1-ro 2-gil, Hwaseong-si, Gyeonggi-do, 18449, Korea. VATECH); and the Software (EasyDent V4 Viewer – English Copyright © 2002-2012 by VATECH Version 4.1.5.10). Selected exposure settings 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.

Reliability and Repeatability
For the selected sample, the "inter-observer" repeatability and the "intra-observer" reliability between the first and second observers will be calculated for 15% of the randomly selected images.

Statistical analysis
The prevalence of incidental findings about age, gender, and type of arch will be evaluated and expressed as frequency and percentage. All measurements will be presented as mean (M) and standard deviation (SD) values; the "Chi-Square Test" will be performed using the available version of the statistical package for social sciences software (SPSS). The threshold for statistical significance will be set at (P < 0.05).

Results
The inter-observer repeatability and intra-observer reliability between the first and second observers were calculated for 15% of the randomly selected images. The Cronbach's Alpha scored 0.645, suggesting that the observations have moderate internal consistency. An Alpha value of 0.645 is considered good, indicating that the observations are moderately correlated and measure the same underlying concept. This value indicates that the scale is reliable and can be trusted for further analysis.

The study included a total of panoramic images of 1553 patients, consisting of 126 edentulous images, contributing 8.1%, out of these 82 (65.1%) were males and 44 (34.9%) females (Table 1).

Table 1: The gender distribution of frequency and percentage of completely edentulous panoramic images.

Gender	Frequency	Percent
Female	44	34.9%
Male	82	65.1%
Total	126	100%

From the total number of the completely edentulous panoramic images, 83 (65.8%) were observed with positive incidental findings. The minimum and maximum age groups were distributed between 28 and 87 years old. The mean age of the participants was 61.3±11.6 years in females, while the mean age in males was 60.8±10.3 years old (Table 2).

Table 2: The age group distribution of completely edentulous images.

Age	Frequency	Percent
28-55	45	35.7%
56-65	39	31.0%
66-75	29	23.0%
76-95	13	10.3%
Total	126	100%

As regarding the radiographic incidental findings, the most frequent incidental finding was atrophic maxilla 51 (35.7%), then atrophic mandible 31 (21.7%), styloid ligament calcification 24 (16.8%), while the detected radiopacities in maxilla and mandible were 8 (5.6%) and 6 (4.2%) respectively, the remaining roots in maxilla 7 (4.9%) and mandible 3 (2.1%), mental nerve near crest of the ridge 5 (3.5%), impacted teeth in maxilla 3 (2.1%), impacted tooth in mandible 1 (0.7%), soft tissue calcification 2 (1.4%), radiolucency in the maxilla 1 (0.7%), and radiolucency in the mandible 1 (0.7%), (Table 3).

Table 3: The distribution of incidental findings detected in the completely edentulous panoramic images.

Incidental findings	Frequency	Percentage
Impacted tooth in the maxilla	3	2.10%
Impacted tooth in the mandible	1	0.70%
The remaining root in the maxilla	7	4.90%
The remaining root in the mandible	3	2.10%
Radiolucency in the maxilla	1	0.70%
Radiolucency in the mandible	1	0.70%
Radiopacity in the maxilla	8	5.60%
Radiopacity in the mandible	6	4.20%
Atrophic maxilla	51	35.70%
Atrophic mandible	31	21.70%
Soft tissue calcifications	2	1.40%
Styloid ligament calcification	24	16.80%
Mental nerve near the crest of the ridge	5	3.50%
Total	**143**	**100%**

However, the other incidental findings: maxillary sinus opacity, Stafne's bone defect, laryngeal cartilage calcification, and foreign body were not detected in the evaluated panoramic images.

With age and the most frequent incidental findings observed in this sample, the Chi-Square test was employed to assess the association between categorical variables. With a significance level P value set at 5%, which is aimed at identifying meaningful relationships within the data. Age was divided into two groups: adults <65 and elderly >65. The atrophic maxilla 51 (40.2%) found in the adult group and 18 (40.9%) in the elderly group, and this was statistically insignificant. At the same time the atrophic mandible was observed in 31 panoramic images, 15 (18.3%) found in the adult group and 16 (36.4%) in the elderly group, with the P-value 0.025, which indicates it is statistically significant. Also, the styloid

ligament calcification was present in 24 images: 11 (13.4%) in the adult group and 13 (29.5%) in the elderly age group, with a P-value obtained as 0.028 (Table 4).

Table 4: The distribution of the atrophic maxilla, atrophic mandible, and styloid ligament calcification by age, with the Chi-Square test and the P-value set at 0.05 as statistically significant.

Incidental findings	Age		X²	P-value
	Adult 28-64	Elderly > 65		
Atrophic maxilla	33 (40.2%)	18 (40.9%)	0.005	0.942
Atrophic mandible	15 (18.3%)	16 (36.4%)	5.041	0.025
Styloid ligament calcification	11 (13.4%)	13(29.5%)	4.832	0.028

Regarding to gender and incidental findings from statistical point of view the most frequent findings were analyzed where atrophic maxilla found in 51 patients 35 males (42.7%) and 16 females (36.4%) in which (x^2) chi-square test was used for independence of gender and atrophic maxilla that give P value of 0.491 indicating that there is no statistical significant as P value is more than 0.05 while the second most frequent finding was atrophic mandible found in 31 completely edentulous patients 19 females (42.2%) and 12 males (14.6%) P value 0.00, also the styloid ligament calcification the third most frequent incidental finding which is presented in 17 male (20.7%) and 7 females (15.9%) and P value 0.511 indicating no statistical significance in association between gender and these incidental findings of collected population in this study, (Table 5).

Table 5: The distribution of the atrophic maxilla, atrophic mandible, and styloid ligament calcification about gender, with Chi-Square test and the P-value set at 0.05 as statistically significant. **Mandible and styloid ligament calcification in relation to gender with Chi-Square test and the P-value set at 0.05 as statistically significant.**

Incidental findings	Gender		X²	P-value
	Females	Males		
Atrophic maxilla	16 (36.4%)	35 (42.7%)	0.475	0.491
Atrophic mandible	19 (43.2%)	12 (14.6%)	12.58	0.000
Styloid ligament calcification	7 (15.9%)	17 (20.7%)	0.432	0.511

Discussion

One of the most crucial indications of panoramic radiography is to examine the jaws and surrounding tissues and structures before prosthetic replacement [1]. The high frequency of positive incidental findings obtained in this sample of panoramic images indicates the importance of examination of completely edentulous patients with panoramic radiography before prosthetic procedures in completely edentulous patients [1,2,3].

According to the World Health Organization (WHO) and other independent studies in 42 countries, the prevalence of total edentulism is the lowest in Nigeria (1.3%) and the highest in Bosnia-Herzegovina (78%) patients older than 65 years old [5,19,20,21]. The prevalence of complete edentulism in the current study was low (8.1%), yet in the age group under 65 years old.

In a previous study by Sadik et al. (2020) reported that the most frequent incidental findings detected were the remaining roots (18.9%), impacted teeth (7.9%), radiopacities (2.7%), and radiolucencies (1.5%) [2]. another study by Kose et al. (2015) reported that the most detected findings were atrophic maxilla (10%), remaining roots (9.5%), soft tissue calcifications (6%), impacted teeth (4.8%), atrophic maxilla (10%), remaining roots (9.5%), soft tissue calcifications (6%), impacted teeth (4.8%), radiolucencies (1.6%) and radiopacities (1.5%) [4], while Sahin and Ozdede (2020) reported atrophic maxilla (50.7%), atrophic mandible (28.4%), radiopacities (14.2%), remaining roots (13.7%), impacted teeth (5.8%) and radiolucencies (3.1%) [1]. A recent study by Yuksel et al. (2023) reported atrophic maxilla (38.7%), atrophic mandible (36.9%), remaining roots (18.3%) and styloid ligament calcifications (13.1%) these results are relatively similar to the present study in which atrophic jaws and styloid ligament calcifications were the most frequent findings [3].

However, the results obtained from this study indicate that the most frequent incidental finding is atrophic maxilla 51 (35.7%), the second most common incidental finding was atrophic mandible 31 (21.7%), the third one is styloid ligament calcification detected in 24 (16.8%) of total sample, while the

other incidental findings less observed in this sample were radiopacities in the maxilla and mandible 8 (5.6%) and 6 (4.2%) respectively, the remaining roots in maxilla 7 (4.9%) and mandible 3 (2.1%), mental nerve near crest of the ridge 5 (3.5%), impacted teeth in maxilla 3 (2.1%), impacted tooth in mandible 1 (0.7%), soft tissue calcifications 2 (1.4%), radiolucencent lesions in the maxilla 1 (0.7%), and in the mandible 1 (0.7%). Furthermore, other findings that were absent in this study were maxillary sinus opacity, stafne bone defect, laryngeal cartilage calcification, and foreign body, as all of these were not detected in the evaluated panoramic images. It is important to highlight that the presence of these incidental findings can affect the prosthetic replacement of these patients, as atrophic ridges can influence the retention and stability of conventional complete dentures or even limit the placement of an implant that may lead to encroachment of vital structures such as maxillary sinus in the maxilla or inferior alveolar nerve in the mandible. However, the presence of other incidental findings, as calcifications, does not usually affect prosthetic treatment, but may require medical treatment or surgical intervention, and should be taken into consideration for further consultation [1,2]. According to John D. Jones et al (1985) if radiolucency findings are detected they should be further evaluated clinically and radiographically and biopsies should be taken if the lesion appears suspicious or it may need to be observed periodically to detect possible changes in location or size that could endanger the patient health or affect the fitness of dentures [25].

Regarding to remaining roots observed in clinically edentulous jaws, the decision whether these remaining roots should be removed is debatable; as Ennis and Berry (1949) stated that every retained root is a threat and recommended that all remaining roots should be removed [26]. In contrast, Guyer (1975) stated that the decision to surgically remove retained roots has been provided by the submerged root concept [27]. In this context, previous studies reported different positive incidental radiographic findings among completely edentulous patients, with the most common finding being retained root fragments. However, in the current study, panoramic images examination revealed that remaining root fragments represent the fifth most frequent incidental finding [2,4].

Regarding the limitations in this study, firstly the sample size is small when compared to other previous studies, secondly the evaluation of only two dimensional images of three dimensional objects, without clinical examination, that may lead to some difficulty in distinguishing of some lesions with panoramic images and the inability to make exact diagnosis of the lesions, which may require more clinical confirmation, or using more advanced imaging modalities, such as Cone Beam Computed Tomography (CBCT) and computed tomography (CT) [1,2,4].

Conclusion

Even though the prevalence of edentulism in the panoramic images was fairly low in the adult age group, the frequency of incidental findings was almost high in the elderly age group in both male and female. Some of these findings may affect the dental and medical condition of the patients, and surgical intervention or medical consultation may be required in some conditions before prosthetic replacement by conventional dentures or implant-retained prostheses. This makes pre-operative evaluation using panoramic images very important for completely edentulous patients. However, in some edentulous cases, 2 Dimensional (2D) panoramic imaging might not be adequate. Certain incidental findings, such as large radiolucent lesions, may require careful evaluation via advanced 3D imaging modalities, such as CBCT and CT, for optimal management.

Conflict of interest. Nil

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