Original Article

Prevalence of Errors in Fundamentals of Patient Positioning in Digital Orthopantomogram- A Retrospective Study

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ABSTRACT

Introduction: Digital panoramic radiograph or Orthopantom-ogram (OPG) has become an indispensable equipment in oral disease diagnosis. However, it is prone for positioning errors in digital imaging systems that affect quality of dental care.

Aim: To assess the prevalence of errors in patient positioning in digital OPG.

Materials and Methods: This retrospective study including 900 digital OPG's (483 males and 417 females) which were collected from the Department or Oral Medicine and Radiology at Saveetha Dental college and hospital, Chennai, Tamil Nadu, India. Digital OPG images taken during the month of January from 1.1.2021 to 31.1.2021 were retrospectively collected and used for this study. The data was then analysed and interpreted in the consecutive months from 1.2.2021 to 31.3.2021. The images were assessed for the frequency of positioning errors by a single radiologist and its association with the patient gender. The results were statistically

analysed using Statistical Analysis of the Social Sciences (SPSS) 23.0 software. Chi-square test was used for the statistical analyses to determine the association between positioning errors and gender (p-value ≤0.05).

Results: Among the positioning errors, the most common error was "head too far forward", 19.9% in males and 23.5% in females. The least common errors seen were excessive downward angulation and upward over-angulation 27 (5.6%) and 16 (3.3%) cases in males and 19 (4.6%) and 15 (3.6%) cases in females, respectively. The association between gender and positioning errors was found to be statistically significant at p-value 0.001 (p<0.05) with a Chi-square value of 22.455.

Conclusion: This study highlights the importance of structured training in taking panoramic radiographs and quality support required for proper image outcome. This is necessary to reduce treatment cost, patient time expenditure, exposure to radiation and delay in treatment planning.

INTRODUCTION

The OPG has become an indispensable image modality in the field of dental sciences and is vital in the dentist's armamentarium for proper diagnosis. All digital radiographs consist of an integration of narrow tomograms consecutively examined onto the digital finder or detector which is present underneath a secondary slit [1]. But, in any case, the encompassing picture is a complicated geometrical projection of the jaws with various superimpositions and contortions which might be exacerbated by technical errors in picture procurement [2].

Panoramic imaging includes equipment preparation, patient preparation, and patient positioning. The equipment preparation varies based on the recommendations given by the manufacturer. Patient preparation includes removing all metallic objects from the head and neck area that might interfere with the procedure. Positioning of the patient is crucial in taking OPG as the duration of time increases if not done in proper manner. Therefore, it is important that the patient be as comfortable as possible during the procedure [3]. The correct positioning requires the patient's upright position with an elongated neck, shoulders down, straight back, and feet together; Frankfort plane parallel and the median sagittal plane perpendicular to the ground with chin support and the tongue resting against the palate [4].

The study on errors in patient positioning is vital as the output image generated will be diagnostically poor and hence additional radiographic exposure is required to obtain satisfactory image with diagnostic merit [5]. In case of repeating orthopantomogram when the quality is poor for enabling diagnosis, the risk of inducing cancer is associated which have been calculated as 0.21 or 1.9 cases/ million examinations [4,6,7]. Therefore, understanding the nature of existence is crucial in determination of prevention.

There have been previous studies that had determined patient positioning errors in conventional panoramic radiographs [7,8]. Many studies have also been done using digital OPGs in various populations regarding image quality [4,9-11]. But no study has been done that assessed the influence of gender of the patient with the positioning errors. The aim of this study was to assess the prevalence of errors in fundamentals of patient positioning in digital OPG in the Chennai population and to evaluate the most common patient positioning errors in OPG and if there existed any significant association with the patient gender.

MATERIALS AND METHODS

The retrospective study was conducted in the Department of Oral and Maxillofacial Radiology, Saveetha Dental college and Hospital, Chennai during February 2021 to March 2021. The study proposal was reviewed by the Institutional Human Ethical Committee Review Board and approval was obtained [Ref. No: IHEC/SDC/OMED-2002/21/53]. Digital OPG images taken during the month of January from 1.1.2021 to 31.1.2021 were retrospectively collected and used for this study. The data was then analysed and interpreted in the consecutive months from 1.2.2021 to 31.3.2021. All those images were taken using the same OPG machine [Genoray papaya digital system, Unicorn Denmart] with three laser positioning guides [antero-posterior, vertical and mid-sagittal alignment lights] and in pre-set settings of scan time one minute 20 seconds, exposure time 3 seconds/ projection, 30 seconds totally and exposure values 66-85 kV/6-10 mA. The stored Image data was in Digital Imaging and Communications in Medicine (DICOM) format and was viewed in DlCOM 3.0 software for this study.

Inclusion criteria: The images of dentulous patients of age range 15-65 years of both genders were included in this study.

Exclusion criteria: The images of patients who were completely edentulous, with fractured jaw bones and of age below 14 years were excluded from the study.

The final selected OPG samples (n=900) consisted of 483 males and 417 females. The images were assessed by a single experienced senior maxillofacial radiologist.

Study Procedure

The OPG was divided into six areas to determine diagnostic quality based on Lannucci and Howerton guidelines [3].

Area 1: Dentition- Teeth arranged in a smile like curvature, dental crowns and root apices of all teeth visible;

Area 2: Ramus and cervical spine- Mandibular ramus should be the same width on both sides, cervical spine may be visible along edges of the image, but should not overlap the mandibular ramus;

Area 3: Nasal cavity and maxillary sinus- The double image of hard palate appears above the root apices of the maxillary teeth;

Area 4: Body of mandible- Smooth appearance and continuity of the Inferior border of mandible;

Area 5: Condyle- Condyle is centrally positioned, is of similar size on both sides, and is on the same orientation in horizontal plane;

Area 6: Hyoid- Hyoid bone double image appears. Hyoid may slightly overlap the mandible.

The common patient positioning errors considered in this OPG study were anterior teeth positioning errors, mid-sagittal plane positioning errors and occlusal plane positioning errors [3,12]. The appearance of these faults used for image assessment were as follows:

Anterior teeth positioning errors: In Anterior teeth positioning errors the head was too far forward, i.e. dental arch positioned anterior to focal trough [Table/Fig-1a] where the narrow unsharp image of anterior teeth is present, anterior teeth appear "skinny" or "lean" and out of focus on the OPG image, spine overlaps the rami, prominent overlapping of the premolars might be seen or head was too far back, i.e. dental arch positioned posterior to focal trough where wide unsharp image of anterior teeth present, teeth appear fat or broad and out of focus on the OPG image, Temporomandibular joint (TMJ) region not evident [Table/Fig-1a,b].
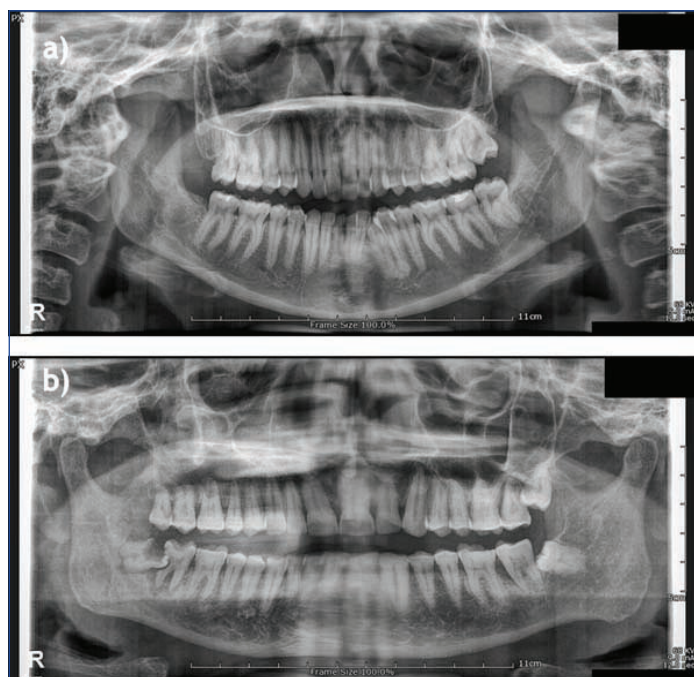
[Table/Fig-1]: a) Anterior teeth positioning error head too far forward, i.e., dental arch positioned anterior to focal trough; b) Anterior teeth positioning error head too far back, i.e., dental arch positioned posterior to focal trough.

Mid-saggital plane positioning errors: In mid-sagittal plane positioning errors it was tilting of the head, where condyle of one side higher than the other side and inferior border of the mandible slopes to one side or twisted position of patient, where condyle asymmetry might be seen, as the ramus and posterior teeth on one side of the image appear larger than those on the other side of the image because the side farthest from the receptor appears magnified, and the side closer to the vicinity to the digital receptor appears tiny and smaller [Table/Fig-2a,b].
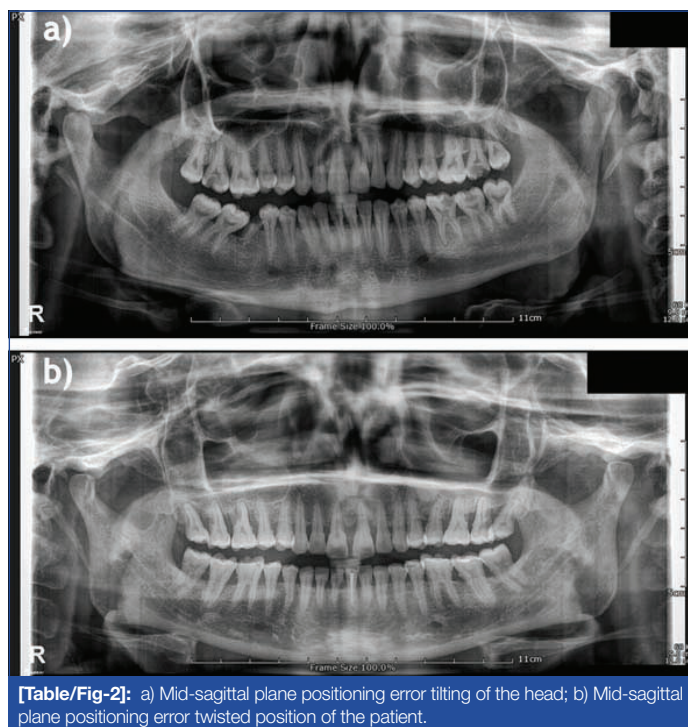
[Table/Fig-2]: a) Mid-sagittal plane positioning error tilting of the head; b) Mid-sagittal plane positioning error twisted position of the patient.
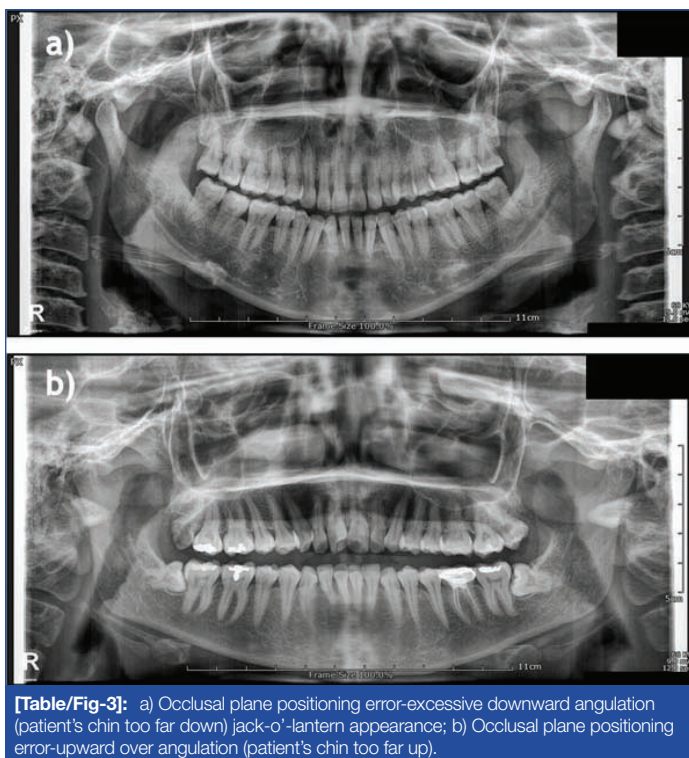
Occlusal plane positioning errors: In occlusal plane positioning errors, it comprised of excessive downward angulation (patient's chin too far down) in which lack of definition of the lower incisors seen, roots may appear short, Condyles are positioned higher on the image, hyoid bone forms a single widened line an exaggerated smile line or jack-o'-lantern appearance (curved upward) was seen on the image or upward over angulation (patient's chin too far up) in which flattening of occlusal plane or reverse smile line (curved downward) was seen, hard palate and floor of the nasal cavity appears superimposed over the apices of the roots of maxillary teeth, maxillary incisors appear blurred and magnified, mandibular condyles may not be visualised or may appear closer to the lateral edge of the OPG image [Table/Fig-3a,b].

STATISTICAL ANALYSIS

The data was tabulated in an excel sheet and formatted. The data analysis was performed using IBM SPSS 23.0 software (SPSS Inc., Chicago, IL., USA). Chi-square test was used for the statistical analyses to determine the association between positioning errors and gender (p-value ≤0.05 is significant).

RESULTS

The frequency distribution of positioning errors in 900 OPGs of 483 males (53.6%) and 417 females (46.3%) of age range 15-65 years with mean age of 40 years [Table/Fig-4]. No positioning errors were seen in the majority of OPGs, 365 (40.56%) and the prevalence of positioning errors in the present study was 59.44%. The most common positioning error was head too far forward seen in 194 (21.56%). It was followed by tilting of the head in 120 (13.33%). About 78 (8.67%) of the cases had head too far back positioning error. It was followed by twisted position of patient seen in 66 (7.33%). Excessive downward angulation (patient's chin too far down) was seen in 46 (5.11%) and the least common positioning error was upward over angulation (patient's chin too far up) seen in 31 (3.44%).

Parameters	χ² value	p-value
Positioning errors * Gender	22.455	0.001

[Table/Fig-5]: Association between positioning errors and gender calculated by Chi-square test.
χ² value and p-value obtained from Chi square test; p-value ≤0.05 is significant

[Table/Fig-3]: a) Occlusal plane positioning error-excessive downward angulation (patient's chin too far down) jack-o'-lantern appearance; b) Occlusal plane positioning error-upward over angulation (patient's chin too far up).

Positioning errors	Male n (%)	Female n (%)	Total n (%)	p-value
Correct positioning	172 (35.6)	193 (46.3)	365 (40.55)	0.0011
Excessive downward angulation (patient's chin too far down)	27 (5.60)	19 (4.60)	46 (5.1)	0.4982
Head too far back	49 (10.1)	29 (35.6)	78 (8.7)	0.0994
Head too far forward	96 (19.9)	98 (23.5)	194 (21.5)	0.1906
Tilting of the head	80 (16.6)	40 (9.6)	120 (13.3)	0.0021*
Twisted position of patient	43 (8.90)	23 (5.50)	66 (7.7)	0.0510
Upward over angulation (patient's chin too far up)	16 (3.30)	15 (3.60)	31 (3.4)	0.8056

[Table/Fig-4]: The association between the two genders for each individual positioning error.
*p ≤0.05 is statistically significant; Chi-square test

The distribution of positioning errors according to gender is depicted in [Table/Fig-4]. Among the 417 females, the majority of 193 (46.3%) had no positioning errors. The most common error was Head too far forward seen in 98 (23.5%). The next common error was tilting of the head seen in 40 (9.6%). Head too far back and twisted position of the patient were seen in 29 (7%) and 23 (5.5%) cases respectively. The least common positioning errors seen were excessive downward angulation (patient's chin too far down) and upward overangulation (patient's chin too far up)" seen in 19 (4.6%) and 15 (3.6%) cases, respectively respectively. Among the 483 males, the majority of 172 (35.6%) had no positioning errors. The most common error was head too far forward seen in 96 (19.9%). The next common error was tilting of the head seen in 80 (16.6%). Head too far back and twisted position of the patient were seen in 49 (10.1%) and 43 (8.9%) cases, respectively. The least common positioning errors seen were excessive downward angulation (patient's chin too far down) and upward over angulation (patient's chin too far up) seen in 27 (5.6%) and 16 (3.3%) cases, respectively.

The association between positioning errors and gender was performed using Chi square test [Table/Fig-5]. The association was found to be statistically significant at p-value=0.001 (p-value ≤0.05 is significant) with a chi square value of 22.455. The association between the two genders for each positioning error individually are tabulated in [Table/Fig-4].

DISCUSSION

In the present study, the association between gender and positioning errors was found to be statistically significant at p-value=0.001 (p<0.05) with a chi square value of 22.455. However, image samples of males were higher than females and statistical association was significant, it cannot be concluded that errors were more in males than females. It can be understood as slight male predilection in positioning error. Further studies, with equal samples from males and females are needed to be conducted to validate this result.

Panoramic imaging or pantomography is a radiographic technique for creating a single image of the orofacial structures that includes both the maxillary and the mandibular arches, their dental components and their supporting surrounding structures [13]. Currently, panoramic radiography is not only available in the broader arena but also vital for diagnosing morphological variations in the oral condition. They provide evidence that can be used with clinical examination to improve the diagnostic process [14].

The diagnostic merit of properly recorded excellent panoramic radiograph will be far superior when compared to the one exposed under less careful quality control [15]. In obtaining panoramic images, improper performance by the professional and/or patient results in a radiographic image of unsatisfactory quality that can also lead to a misdiagnosis and the development of an inadequate treatment plan. Hence, proper patient positioning in the device is the most important factor in prohibiting a volley of errors in diagnosis and in designing treatment strategies.

The understanding of the errors happening in these radiographs and the information to rectify them would go a farther way in constructive utilisation by being cost effective when sensible radiographic technique is followed [16]. There are no established guidelines in existence that avoids production of Images of poor quality by the OPG equipment [9].

The result of this study was not in concordance with previous studies [Table/Fig-6] on prevalence of most common positioning errors in panoramic radiography [Table/Fig-6] [5,8,17-21]. Chin tipping and improper tongue position in palate were the most common positioning errors in those studies. This was not observed in the present study as chin tipping could be found easier when laser positioning guide is used and properly verified. Also, improper tongue position would result in superimposition of tongue shadow over anterior teeth creating blurring of image which would have been corrected by the technician by repeating the radiograph [3].

It is difficult to take panoramic radiographs without positioning errors [22,23]. Repeating a radiograph, without first establishing the cause of the error, may result in the error simply being perpetuated [24]. Nevertheless, with the preparation of panoramic radiographs, a failure rate of about 10% must be tolerated. Panoramic radiography may be unsuitable for some patients because their physical stature, facial asymmetry, or inability to follow directions make it difficult to position them properly at the machine. A higher frequency of errors was observed on the radiographs made of patients who have short or thick necks, are extremely overweight, or are unusually tall [24]. Possible technical issues that cause errors might be due to factors like technician shortage, support staff inexperience, improper equipment, limited reporting time, excess work load, poor lighting leading to eye fatigue, missed attention to detail due to frequent repeating of same task [25].

The reason for this study's finding's might also be attributed to the overzealous nature of patients in positioning themselves beyond

S. No.	Author's name and year	Place of study	Number of subjects	Parameters assessed	Conclusion
1	Kaviani F et al., 2008 [8]	Iran	250	Five types of errors: Patient positioning errors Darkroom errors Failure to remove metallic accessories Equipment setup errors Patient movement during exposure	Patient positioning error is the most frequent error (78%)
2	Dhillon M et al., 2012 [17]	Ghaziabad, India	1782	Nine types of errors: Chin tipped high Chin tipped low Slumped position Patient positioned forward Patient positioned backward Failure to position the tongue against the palate Patient movement during exposure Head tilted Head turned to one side.	Patient positioning error is the most frequent error (89%). Among them, the most common error was the failure to position the tongue against the palate (55.7%)
3	Ekströmer K et al., 2014 [18]	Sweden	1904	10 types of common errors	Patient positioning error is the most frequent error (79%)
4	Granlund CM et al., 2012 [19]	Sweden	1287	10 types of errors: Chin and occlusal plane rotated upwards Chin and occlusal plane rotated downwards Widening of anterior teeth Blurring of anterior teeth Rotation of the head to the right Rotation of the head to the left Lower border of mandible not visible on the image Tongue not in contact with hard palate TMJ off the image Foreign objects and/or other errors	Tongue not in contact with hard palate is the most frequent patient positioning error (79%)
5	Nileema AJSP 2016 [20]	Sri Lanka	250	Frequency of errors in patient preparation, patient positioning, patient motion, exposure, handling and processing	Patient positioning error the most common error (88%)
6	Subbulakshmi A C et al., 2016 [16]	Tamil Nadu, India	200	Most common positioning error among 10 types	Failure to place the tongue close to the palate (66%)
7	Khator AM et al., 2017 [5]	Nagpur, India	500	Most common positioning error	Head turned to one side (33.8%)
8	Newadkar UR et al., 2016 [21]	Maharashtra, India	2000	Most common positioning error	Failure to place the tongue on the palate (48.7%)
9.	Present study	Chennai, India	900	six common positioning errors: Head too far forward Head too far back Tilting of the head Twisted position of the head Chin too far down Chin too far up	Head too far forward is the most common positioning error (19.9% in males and 23.5% in females)

[Table/Fig-6]: Comparison of results of previous positioning error studies done in digital OPG with present study [5,8,17-21].

instructed resting position on the bite block. Since this does not get flagged due to lack of intraoral positioning guide and the laser positioning guides doesn't get altered when head placed too far forward, it fails to catch the attention of the technician [22]. Hence, it was advocated that after patient positioning, the operator has to retract the lip with gloved fingers and confirm its placement in the groove of the bite block and not further forward. In future, a new design of bite block with deeper incisal edge seat and broader coverage till lateral incisors could be fabricated so that the patient finds easy in locking the positioning [25].

Limitation(s)

This study had been conducted only within this dental institute in Chennai population, by only one observer. In future, further studies could be expanded as multicentric study in a larger population of variant demographics with equal distribution of gender samples.

CONCLUSION(S)

The significance of this study was that among the positioning errors, the most common positioning error was head positioned too far forward and the least common positioning error seen was upward over-angulation. The association between gender and positioning errors was found to be statistically significant (p<0.05) and males had more positioning error than females. This study concludes with emphasis on the need for quality training and assistance in taking panoramic radiographs with established error scoring guidelines for

quality control. This understanding will prohibit the cost of taking repeated OPGs and also reduce the extended examination duration with limited radiation exposure.

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