

# QUALITY ASSESSMENT OF LATERAL CEPHALOMETRIC RADIOGRAPHS

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## ABSTRACT

*Lateral Cephalometric radiograph is a valuable diagnostic tool for the orthodontist. Quality assurance of radiographs is important as unsatisfactory radiograph can alter patient diagnosis and treatment plan. The main objectives of this study were to assess quality of lateral cephalometric radiographs using three point quality scale and compare the results achieved with minimum targets proposed by NRPB in "Guidance Notes For Dental Practitioners On The Safe Use Of X-Ray Equipment." Radiographs were obtained from pretreatment records of patient undergoing orthodontic treatment. With exception to basic information section, each aspect of lateral cephalometric radiographic image summarized in "Standards by Faculty of Dental Surgery" was rated by using a three point quality scale proposed by National Radiological Protection Board. Minimum targets recommended in "Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment" were used to compare results. Out of all the attributes assessed on 266 radiographs, point "B" was the most clearly identifiable attribute while contrast was least clear attribute. 185 (69.5%) radiographs assessed were classified as excellent, 44 (16.5%) radiographs were diagnostically acceptable, while only 37 (14%) radiograph were rated as diagnostically unacceptable which clearly did not meet the targets recommended by NRPB. Quality of Lateral Cephalometric radiograph must be assessed regularly in order to prevent repetition and excessive exposure of radiation to patients.*

**Key Words:** Lateral Cephalometric, Radiograph, Quality Assurance, Radiation.

## INTRODUCTION

Lateral cephalometric radiographs has become one of the most important tool for growth prediction, diagnosis and treatment planning in orthodontics / orthognathic surgery.<sup>1</sup> It helps to describe relationships between skeletal, dental and soft tissue elements of the craniofacial complex, and is also used to gather information for both clinical and research based orthodontics. Standardized nature of these projections has allowed orthodontists to evaluate and compare pre treatment dental and skeletal relationships of patient with the changes during and at the end of the treatment.<sup>2</sup> With the increased awareness associated with the risk of ionizing radiations and radiography, guidelines have been published for practitioners to consult before advising or taking any radiographic image in order to avoid any unnecessary radiation exposure to patient.<sup>3-5</sup> No exposure of ionizing radiations can be considered completely free of risks, although levels of radiation experienced

by patients during dental radiographs are much lower when compared to everyday background radiation exposures or radiation exposure due to radiographs for different medical purposes.<sup>6-7</sup> Few studies have reported evidence of increased risk of salivary glands, thyroid and brain tumors form dental radiography.<sup>8-12</sup> Therefore it is important to ensure that any radiograph taken must offer net benefit to the health care of the patient.<sup>13</sup> Numerous publications have pointed out that many dental radiographs taken are of poor quality to an extent where they are of no diagnostic value.<sup>14,15</sup> Therefore it is important to ensure that radiograph taken are of good quality, avoiding the need of repeating radiographic image and exposing patient to additional ionizing radiations.<sup>4</sup> Errors of Lateral Cephalometric radiographs are divided in to three groups.<sup>16</sup>

- 1 **Identification Errors;** Unclear or difficulty in identification of landmarks on Cephalometric radiographic images.
- 2 **Projection Errors:** Errors caused by rotation of head in transverse, vertical or anteroposterior axes.
- 3 **Mechanical Errors:** Errors that occurs during tracing or measuring the angles with protector.

Cephalometric measurements may have only limited application in orthodontics unless these errors are precisely evaluated and understood. Projection errors, which can affect angular and linear measurements have been minimized to some extent by the use of head holding device in lateral Cephalometric radiog-

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raphy.<sup>16</sup> There is increasing need for precise location and identification of Cephalometric landmarks in order to improve quantitative studies of craniofacial growth and evaluation of treatment effects.<sup>17</sup>

Literature review showed that in Pakistan, no study has been done to assess quality of lateral cephalograms. The main objectives of this study were to assess quality of lateral Cephalometric radiographs using three point quality scale and compare the results achieved with minimum targets proposed by national radiological protection board in Guidance Notes For Dental Practitioners On The Safe Use Of X-Ray Equipment.<sup>4</sup>

**METHODOLOGY**

All digital lateral cephalometric radiographs of patients presenting to Orthodontic Department from January 2015 to December 2016, were included in this study. The quality of each radiograph was assessed by the single examiner under identical conditions. With the exception to basic information section, each aspect of lateral cephalometric radiographic image summarized in Standard By Faculty of Dental Surgery, The Royal College of Surgeons of England<sup>18</sup> (Table 1) was rated by using a three point quality scale proposed by National Radiological Protection Board<sup>19</sup> (Table 2). Individual ratings for all the aspects of radiographic image were then averaged and rounded up in order to obtain an overall rating of the radiographic image quality. If any aspect as mentioned in Table 1 was rated 3, then that overall rating of radiographic image was rated 3 as some of the aspect of the radiographic image were unacceptable. Intra-examiner reliability was tested by re-examining 50 radiographic images a month after initial assessment to ensure the diagnostic consistency. Minimum targets recommended in Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment<sup>4</sup> (Table 3) were used to assess the overall sample. Data tabulation and descriptive analysis was carried out using SPSS 19 software (SPSS Inc., Chicago. IL., USA).

**RESULTS**

Out of all the attributes assessed on 266 digital lateral cephalometric radiographs, point “B” was the most clearly identifiable; on 99.2% radiographs it was rated excellent and not even on single radiograph it was rated as diagnostically unacceptable (Table 4). Contrast was least clear attribute and only 69.5% radiographs assessed were rated excellent and had good contrast while 13.9% radiographs were rated as diagnostically unacceptable. Porion was found to be Diagnostically Unacceptable in 7.15% Radiographs.

Using the recommended criteria by National Radiological Protection Board of United Kingdom<sup>19</sup>, 185 (69.5%) radiographs assessed were classified as ‘excellent’ as these radiographs had clearly identifiable hard tissue landmarks, correct head position and good

contrast. 44 (16.5%) radiographs were ‘diagnostically acceptable’ as the diagnostic utility of the radiograph was not compromised, while only 37 (14%) radiograph were rated as ‘diagnostically unacceptable’ and had poor contrast or poorly identifiable landmarks. (Table 5)

**DISCUSSION**

Radiology has crucial role in field of medicine.<sup>20</sup> Besides the fact that radiographs exposes patient to

TABLE 1: ATTRIBUTES ASSESSED ON LATERAL CEPHALOMETRIC RADIOGRAPH, STANDARD SET BY FACULTY OF DENTAL SURGERY, THE ROYAL COLLEGE OF SURGEONS OF ENGLAND<sup>18</sup>

Basic information	
1	Name Recorded
2	Age Recorded
3	Hospital Number Recorded
4	Label Not Obscuring Radiograph.
Cephalometric Landmarks	
5	Soft Tissue Outline Visible.
6	Teeth In Occlusion.
7	Good Contrast.
8	‘A’ Point Identifiable..
9	‘B’ Point Identifiable..
10	Nasion Identifiable..
11	Sella Identifiable..
12	Incisors Visible & Their Angulations Measurable.

TABLE 2: SUBJECTIVE QUALITY RATING OF RADIOGRAPHS<sup>19</sup>

Rating	Quality	Basis
Rating 1	Excellent	No errors
Rating 2	Diagnostically acceptable	Some errors which do not detract from the diagnostic utility of the radiograph
Rating 3	Diagnostically Unacceptable	Errors which render the radiograph diagnostically unacceptable

TABLE 3: MINIMUM TARGETS FOR RADIOGRAPHIC QUALITY<sup>4</sup>

Ratings	Targets
Rating 1	Radiographs – Should not be less than 70%
Rating 2	Radiographs – Should not be more than 20%
Rating 3	Radiographs – Should not be more than 10%

TABLE 4: NRPB RATINGS OF EACH ATTRIBUTE FOR 266 DIGITAL LATERAL CEPHALOMETRIC RADIOGRAPH

S. No.	Attributes	Excellent	Diagnostically Acceptable	Diagnostically Unacceptable	Total
1	Soft Tissue Profile	242 (91%)	10 (3.8)	14 (5.3%)	266
2	Teeth In Occlusion	262 (98.5%)	1 (0.4%)	3 (1.1%)	
3	Contrast	185 (69.5%)	44 (16.5%)	37 (13.9%)	
4	'A' Point	230 (86.5%)	24 (9%)	12 (4.5%)	
5	'B' Point	264 (99.2%)	2 (0.8%)	0 (0 %)	
6	Nasion	239(89.8%)	15 (5.6%)	12 (4.5%)	
7	Sella	242 (91%)	19 (7.1%)	5 (1.9%)	
8	Porion	230 (86.5%)	17 (6.4%)	19 (7.1%)	
9	Incisors & Their Angulations	233 (87.6%)	16 (6%)	17 (6.4%)	

TABLE 5: OVERALL NRPB RATING COMPARED WITH RECOMMENDED MINIMUM TARGETS

NRPB Ratings	Recommended Targets	Targets Achieved (Results)
Rating 1	Should not be less than 70%	69.5%
Rating 2	Should not be more than 20%	16.5%
Rating 3	Should not be more than 10%	14%

the ionizing radiations, they have significant role in diagnosis of various diseases.<sup>20,21</sup> Along with physical examination, nowadays power of diagnostic imaging is widely acknowledged.<sup>20</sup> Radiographs play significant role in concluding diagnosis, for making accurate treatment plan, early detection of diseases, even in pre-symptomatic stage.<sup>20,21</sup>

In dentistry intra-oral radiographs are routinely used for detection of caries, bone loss, intraoral hard tissue pathology and dentoalveolar fracture. Extra oral radiographs are used in special cases for detection of underlying pathology, to monitor dentofacial growth and to assess the progress of treatment.<sup>22</sup>

In diagnostic imaging, radiographic techniques should be used to maximize the perceived information content and minimize the exposure to ionizing radiations.<sup>20,23</sup>

Quality assessment of radiographic images is important as it prevents repetition of radiographs, for cost effectiveness, to minimize the risk of exposure of radiation.<sup>23</sup> Good quality radiograph is important to detect underlying pathology<sup>20</sup>, for good visibility of anatomical landmarks<sup>24</sup>, perceive maximum information about underlying anatomical structures<sup>20</sup> and for accurate measurements of skeletal and dental problems like in lateral cephalograms to make treatment plan.<sup>24</sup>

Lateral Cephalometric Radiograph with good contrast, accurate head position and visible anatomical landmarks prevent repetition and excessive exposure radiation. National Radiological Protection Board of

United Kingdom proposed a three point quality scale.<sup>11</sup> A radiograph with no errors receives rating "1" while radiograph which has some errors, but it does not detract from the diagnostic utility of the radiograph receives rating "2". Radiograph that has major errors which render the radiograph diagnostically unacceptable receives rating "3". Results of our study showed that 69.5% radiographs were rated excellent (grade 1) while 16.5% radiographs were diagnostically acceptable (grade 2) and 14% radiographs were diagnostically unacceptable (grade 3). Minimum Targets recommended in Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment<sup>4</sup> are that grade 1 radiographs should not be less than 70%, while grade 3 radiographs should not be more than 10%. Results of current study clearly shows that these targets were not achieved in this study.

Out of all the attributes assessed on the lateral cephalogram, results of this study shows that point B received "Rating 1" in 99.2% radiographs and only 0.8% received "Rating 2". Not even single radiograph was rated as diagnostically unacceptable because of Point B.

Contrast was the least clear attribute, it was diagnostically unacceptable in 14% cases, followed by porion that received Rating 3 in 7.1% of the radiographs. Some studies have reported that contrast is one of the most important components in assessing the image quality, as it can be affected by radiation dose and exposure.<sup>23</sup> Porion is another important anatomical landmark which is required to construct Frankfurt plane. True anatomical porion is difficult to locate either due to superimposition of anatomical structures or because of Ear rod of cephalostat superimposing the anatomical porion.<sup>25</sup> A study conducted by Adenwalla<sup>24</sup> reported that there is poor correlation between anatomic and cephalometric porion.

When ionizing radiation strikes the human cell it can cause damage to DNA. Genetic mutation and cancer induction are the most common risks associated with ionizing radiation. Although the advent of digital radiography has minimized patients exposure to ion-

izing radiation dose, however quality assessment of radiographs is important as it prevents the repetition of radiographs that as a result exposes patients to unnecessary radiations.<sup>20,26,27</sup> If repetition of radiographs is mandatory or multiple radiographs are required to assess dentofacial development and to analyze the progress of treatment then proper preventive and protective measure should be taken to minimize hazards of ionizing radiations.<sup>28</sup>

In Pakistan, more work needs to be done to assess quality of radiographs, especially in dentistry. Recently, evaluation of dental panoramic radiographs for different errors was carried out by Khan SQ, Quershi BA, Mehdi H<sup>29</sup>, which clearly shows that work is being carried out, though at much slower pace.

## RECOMMENDATIONS

In Pakistan, Radiology as a subject needs to be given its due share by including it in undergraduate as well as post graduate curriculum of dental students. Dental professionals must receive proper training in dental radiography. Radiograph taken by untrained operator can be compared to a photograph taken by amateur photographer. Currently there is no legislation that makes training mandatory, one possible reason could be due to the fact that problems in field of radiology has never been stressed upon.

## CONCLUSION

Lateral Cephalometric Radiograph will deliver great value if the quality assurance of these radiographs is done on regular basis by both Orthodontists and Radiologists. All the operators must be properly trained and remain up-to-date with latest developments in the field of radiology. Spending time on patient positioning, skills of operator and better communication between patient and operator are some factors that can help in producing high quality radiographs.

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- Shakeel Qutub Khan:** Manuscript Writing, Data Collection & Proof Reading.
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- Babur Ashraf:** Manuscript Writing & Proof Reading.