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RESEARCH ARTICLE

A CROSS-SECTIONAL STUDY OF ARTIFACTS IN CONE BEAM COMPUTED TOMOGRAPHY IMAGES OF PATIENTS IN A HOSPITAL

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Abstract

Introduction: In the field of dentistry, cone beam computed tomography is frequently used as a method of research. Although it provides a three-dimensional image of the head and neck structures, there are drawbacks in the form of artifacts that reduce image clarity and force the patient to undergo another radiograph, increasing their exposure to radiation. The purpose of this research was to determine the prevalence of artifacts in cone beam computed tomography images of patients who were visiting a hospital.

Methods: All cone beam computed tomography radiographs of patients between June 2020 and January 2023 were included in a descriptive cross-sectional study on patient cone beam CT images in the dental radiology archives at the Department of Dentistry. There were 780 patient images in the research. When present, the artifacts were recorded and classified as inherent, procedure-related, introduced, and patient motion artifacts. Calculations included a point estimate and a 95% Confidence Interval.

Results: There were artifacts in 665 (85.25%) (82.76-87.74, 95% Confidence Interval) of the 780-cone beam computed tomography image subjects.

Conclusions: Patients' cone beam computed tomography images typically contain artifacts, which is consistent with research conducted in related environments.

Introduction:-

The investigation of the oral and maxillofacial area now includes cone beam computed tomography (CBCT). Their use in dentistry has grown significantly due to their reduced radiation exposure compared to conventional computed tomography (CT)[1] and the superiority of 3-Dimensional data over 2-Dimensional extra-oral radiographs. However, can severely impair the quality of CBCT images, occasionally to the point where they become useless for diagnostic purposes. An artifact is any distortion or error in the image that is unrelated to the topic being examined, according to White and Pharoah.[2]

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Understanding these can help patients avoid repetitive exposure. We did our best to locate studies on the artifact in CBCT from Nepal, but to the best of our knowledge, we were unable to do so. Therefore, the purpose of this research was to determine the prevalence of in patients who visited a hospital using cone beam computed tomography images.

Methods:-

The Department of Dentistry, Government Medical College Doda, dental radiology archives were the subject of a descriptive cross-sectional study that included all CBCT radiographs of patients obtained between June 2020 and January 2023.

The dental radiology archives' CBCT pictures served as the inclusion criterion. Blank or unrecorded scans with no visible images meet the exclusion requirements. As a result, 780 CBCT pictures were used in the research. Dentium Rainbow CBCT machine with specifications including scan time of 20 seconds, peak voltage of 100 kVp, tube current of 12 mA, field of view of 16 x 18 cm2, and voxel size of 300 m was used to capture the images. Data for a volume CT was obtained. To get axial and coronal images, multi-planar reconstruction was done on a viewing machine. In Rainbow TM Image Viewer Version 1.0.0.0, the acquired images were examined. The images were viewed by an oral radiologist with more than three years of expertise in CBCT reporting on the same computer screen using the same image viewer, in ambient light, with all curtains closed. The artifact was noticed and classified as inherent, procedure-related, introduced, and patient motion when it was discovered.[3]

The process-related artifact known as aliasing appears as minute striations in the scanned pictures. The remaining two procedure-related patterns are double contours and ring or circular stripes.

- Cupping, which is a distortion of metallic structures caused by the occurrence of beam hardening, was introduced.
- Dark lines and streaks

Patient motion artifact causes the image's double outlines. The data were entered into Microsoft Excel 2014, and IBM SPSS Statistics version 20.0 was used for analysis. Calculations included a point estimate and a 95% CI.

Results:-

There were detected in 665 (85.25%) of the 780-cone beam computed tomography images of individuals. More than one artifact was evident in every radiograph. 665 (38.08%) were procedural-related, such as the Aliasing effect, and 665 (38.08%) were inherent in the shape of noise and scattering. There were metal objects in all 373 (56.09%) of the patients' CBCT images that were presented. 43 (2.46%) of the outlines had doubled as a result of patient movement. Compared to maxillofacial or craniofacial pictures, they were more obvious in segmental images. The CBCT's likelihood of occurrence (Table 1).

Table 1:- Classification and occurrence of in CBCT images.

Type of artifacts (n=665)	n (%)
Inherent artifact Step appearance Cone-beam effect	665 (100)
Procedure-related artifact (n=665) Aliasing Ring or circular streaks	 665 (100)
Introduced (n=373 (56.09)) Dark bands Streaks and dark bands Cupping, streaks and dark bands	 4 (1.07) 40 (10.72) 329 (56.09)
Patient motion (n=43)	43 (6.47)

Discussion:-

Due to superimposition and distortions, two-dimensional images only offer a limited amount of information. Since its debut in 1998 in Italy, cone beam CT (CBCT) has been extensively used in the diagnosis and treatment of oro-maxillofacial anomalies.[3] Even so, CBCT has its drawbacks, like artifact. Retakes of radiography that expose patients to radiation needlessly are caused by artifact. According to the Health Protection Agency's

recommendations for oral CBCT scans, a minimum of 95% of the images must be diagnostically appropriate to prevent the need for repeat scans.[4] The operator and clinician must be aware of the causes of radiation production as well as strategies to avoid and reduce it, keeping in mind the Alara principle, which states that radiation doses to patients and staff should be as low as realistically achievable[5].
In our research, the majority of the images had, which was comparable to the study carried out in Turkey in 2019 where 600 CBCT images were examined, and only 15 images were discovered to be lacking any.[6] However, an Indian study published in 2019 revealed that, due to artifacts, only 42 of the 900 CBCT images were repeated.[7] The most frequent artifact identified in the current research was aliasing, which is procedure-related and inherent in the form of noise and scatter. Research conducted in 2018 in Germany found that 9% of radiographs had to be repeated due to bad calibration or issues with scanner detection.[8] Ten (23.81%) of the total 42 images examined in India in 2019 had noise, but none of the images had aliasing or scatters.[7]

When photons engage with matter, they diffract from their original path, which is what causes scatter. On the one hand, flat panel detector (FPD) technology, used in CBCT, offers excellent spatial resolution with a patient radiation exposure that is relatively low, but on the other, contrast resolution is negatively impacted by increased X-ray scatter and decreased temporal resolution. Low density tissues and their boundary become more difficult to distinguish in the resulting image due to a decrease in low contrast resolution. In contrast to CBCT machines where the noise is greater due to the use of lower mA and soaring scattered radiation from the lack of post-patient collimation, conventional CT machines use high mA and pre and post-patient collimation to reduce the scattered radiation to a negligible amount.[9]

All the images in the current research that included metal objects displayed beam hardening in the shape of streaks, bands, and cupping. Beam hardening or streak made up 7.14 % of the total in research conducted in Chennai, India.[7] In 2015 Italian research using 500 CBCT images, metal revealed a statistically significant relationship with the field of view (FOV) and acquisition time. They found that wide FOVs, which include areas far from the locations of metal objects like jaws, prevent the detection of artifact.[10] Beam hardening (dark band or streaks) was the most prevalent artifact in research conducted in Turkey, but the correlation between metal and FOV or acquisition durations was not statistically significant (585 out of 600 images).[6]

In order to determine whether CBCT images could jeopardise the accuracy of such measurements, Brazil contrasted the dental plaster model and cone-beam computed tomography image in 2014. They observed that the existence of an image had a negative impact on CBCT images.[11] Therefore, it is crucial for diagnosis and treatment planning to reduce in order to keep image quality.

The current study's limitation was that it did not examine whether the type of metal density impacted the final beam hardening artifact. The relevance of the metal object's proximity to the Region of Interest (ROI) was not taken into consideration. The authors advise additional research comparing CBCT machines of various makes and using a bigger sample size.

Conclusions:-

Cone beam computed tomography images of patients show comparable prevalence to studies conducted in related environments. The most frequent artifacts, according to our research, were aliasing and scatter, followed by beam hardening. can result from a number of factors that eventually lead to varying degrees of CBCT image quality degradation. Therefore, reducing them involves using technology, such as artifact-reducing software and cutting acquisition time, in addition to operator and patient awareness. The goal is still to give patients the greatest possible chance for treatment.

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