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Assessment of Maxillofacial Trauma Using CBCT: A Cross-Sectional Study on Diagnostic Efficiency and Clinical Outcomes

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ABSTRACT

The study aims to evaluate the diagnostic efficiency of Cone Beam Computed Tomography (CBCT) in assessing maxillofacial trauma and its impact on clinical outcomes. A cross-sectional analysis was conducted on a cohort of patients presenting with maxillofacial injuries, comparing CBCT results with traditional diagnostic methods such as X-rays and clinical examinations. The diagnostic accuracy, sensitivity, and specificity of CBCT were assessed, and its role in identifying fractures, soft tissue injuries, and other traumatic anomalies was explored. Clinical outcomes, including treatment planning, post-operative recovery, and complication rates, were analyzed to determine the contribution of CBCT to improving patient management. The results showed that CBCT provided superior imaging clarity and diagnostic precision, particularly in complex fractures and anatomical regions difficult to assess with conventional imaging techniques. The study concluded that CBCT significantly enhances the diagnostic process, leading to more accurate treatment decisions and improved clinical outcomes in patients with maxillofacial trauma.

Keyword: *CBCT, Clinical outcomes, Diagnostic efficiency, Fractures, Imaging techniques, Maxillofacial trauma, Treatment planning*

1. INTRODUCTION

Maxillofacial trauma encompasses injuries to the facial bones, soft tissues, and structures such as the mouth, jaw, and facial skeleton. These injuries can occur due to accidents, physical violence, falls, or sports-related incidents and vary in severity

[1]. Such trauma not only causes physical distress but can also impact a person's appearance, oral function, and quality of life [2]. Timely and precise diagnosis is essential for effective treatment, as it can prevent complications and support quicker recovery [3]. However, diagnosing maxillofacial injuries is complex due to the intricate anatomy of the face and the variety of possible injuries.Historically, plain radiography (X-ray) and computed tomography (CT) have been the primary methods for diagnosing maxillofacial trauma [4]. While X-rays are widely accessible, they lack the capacity to provide detailed 3D images of facial structures. CT scans, on the other hand, provide detailed cross-sectional images that allow for a clearer understanding of bone and soft tissue involvement, though they are associated with higher radiation exposure and may not always be cost-effective in emergency situations [5].Recently, Cone Beam Computed Tomography (CBCT) has emerged as a promising alternative for diagnosing maxillofacial trauma. CBCT is a specialized form of CT that uses a cone-shaped X-ray beam to create high-resolution 3D images with relatively low radiation exposure. This technique has gained popularity due to its ability to offer superior images of facial bones and surrounding tissues with reduced radiation risks, making it especially useful for trauma patients who need detailed assessments [6]. Additionally, CBCT's lower radiation dose compared to traditional CT makes it safer, particularly when repeated imaging is necessary during treatment [7].Several studies have examined the diagnostic efficiency of CBCT in evaluating maxillofacial trauma, focusing primarily on its advantages over traditional imaging techniques [8]. While it is well-established that CBCT excels in visualizing bone fractures, its role in evaluating soft tissues, treatment planning, and clinical outcomes is still being explored [9]. A major challenge in managing maxillofacial trauma is accurately assessing the extent and nature of the injury. Injuries to the face can affect various structures, including bones, teeth, sinuses, and soft tissues. Complex fractures involving the zygomatic arch, orbital floor, or mandibular body require detailed imaging to guide surgical decisions [10]. CBCT's ability to generate high-resolution 3D images provides a comprehensive view of these fractures; making it an invaluable tool for surgeons during the planning phase [11].Another key consideration in treating maxillofacial trauma is tracking post-treatment progress and monitoring fracture healing [12]. CBCT can be used for follow-up imaging to assess fracture status, evaluate the success of surgical procedures, and detect complications such as infection or misalignment. Early detection of such issues can significantly impact treatment decisions and improve clinical outcomes [13].Furthermore, accurate imaging plays a crucial role in the management and clinical outcomes of trauma patients [14]. Research shows that precise, timely diagnoses correlate with improved treatment outcomes, fewer complications, and shorter recovery periods. For instance, when managing mandibular fractures, preoperative planning using CBCT images can help achieve better alignment of fractured segments, reducing the risk of nonunion or malunion, and improving both functional and aesthetic results [15]. Three-dimensional imaging also enables surgeons to choose the most appropriate surgical approach, minimizing unnecessary incisions and soft tissue damage.Additionally, CBCT enhances interdisciplinary collaboration in managing complex maxillofacial trauma [16]. Treatment often involves a team of specialists, including oral and maxillofacial surgeons, radiologists, and reconstructive surgeons [17]. CBCT's 3D images facilitate clear communication among team members, ensuring a comprehensive understanding of the injury and treatment plan. This collaborative approach often leads to better clinical outcomes and higher patient satisfaction [18].Despite its many advantages, several factors must be considered when incorporating CBCT into clinical practice for maxillofacial trauma. One concern is the cost of acquiring and using CBCT equipment, along with the necessary training for clinicians to interpret the images effectively [19]. The procedure's cost could be a barrier in low-resource settings or for patients with limited access to specialized care. Although CBCT provides lower radiation doses than traditional CT, it is important to weigh the benefits of detailed imaging against the need to minimize radiation exposure, especially for pediatric or elderly patients, who are more sensitive to radiation [20].This study aims to explore the diagnostic efficiency of CBCT in managing maxillofacial trauma and evaluate its impact on clinical outcomes. By analyzing CBCT's ability to detect fractures, assess soft tissue involvement, and guide treatment planning, this research seeks to offer insights into its potential as a primary imaging tool for maxillofacial trauma patients. Additionally, the study will examine whether integrating CBCT into clinical practice results in improved treatment outcomes, faster recovery, and enhanced overall patient satisfaction. Ultimately, the goal is to contribute to the growing body of knowledge on CBCT in managing maxillofacial trauma, refining treatment protocols, enhancing patient care, and improving diagnostic imaging efficacy in trauma settings.

2. METHODOLOGY

This cross-sectional study was conducted to evaluate the diagnostic efficiency of CBCT in assessing maxillofacial trauma and its subsequent influence on clinical outcomes. The study was carried out over a 12-month period at multiple tertiary care centers equipped with CBCT imaging facilities and treating patients with facial trauma.

Study Population: The study included patients presenting with maxillofacial trauma, irrespective of age and gender, who required diagnostic imaging for assessment. Patients were selected using purposive sampling based on clinical indication for radiographic evaluation. Informed consent was obtained from all participants or their legal guardians. Exclusion criteria included patients with contraindications to CBCT, prior maxillofacial surgeries altering anatomical landmarks, or incomplete clinical records.

Data Collection and Imaging Protocol: Each patient underwent a clinical examination, followed by imaging using both conventional radiographs (orthopantomogram and/or plain facial X-rays) and CBCT. CBCT scans were performed using standardized protocols (field of view: 8x8 cm to 12x15 cm; voxel size: 0.2 mm to 0.4 mm) depending on the extent of trauma. Images were assessed by two independent oral radiologists blinded to the clinical findings to minimize observer bias. Parameters evaluated included fracture location, displacement, comminution, involvement of adjacent anatomical structures (e.g., sinuses, alveolar bone), and soft tissue status where visible.

Outcome Measures: The diagnostic accuracy, sensitivity, and specificity of CBCT were compared against conventional radiographs, using intraoperative findings and clinical follow-up as the reference standard. Additionally, the influence of CBCT findings on treatment planning (surgical vs. conservative), intraoperative modifications, and postoperative outcomes (complications, healing status, and functional recovery) was documented.

Data Analysis:

Data were analyzed using SPSS version 25.0. Descriptive statistics were used to summarize demographic and clinical characteristics. Diagnostic indices (sensitivity, specificity, positive predictive value, negative predictive value, and accuracy) were calculated for both CBCT and conventional radiography. Inter-observer agreement was assessed using Cohen's kappa coefficient. Chi-square and t-tests were applied where appropriate, with a p-value of <0.05 considered statistically significant.

Ethical Considerations: The institutional ethics committees of participating centers approved the study protocol. All procedures were conducted by the ethical standards of the Declaration of Helsinki.

Prisma Flowchart

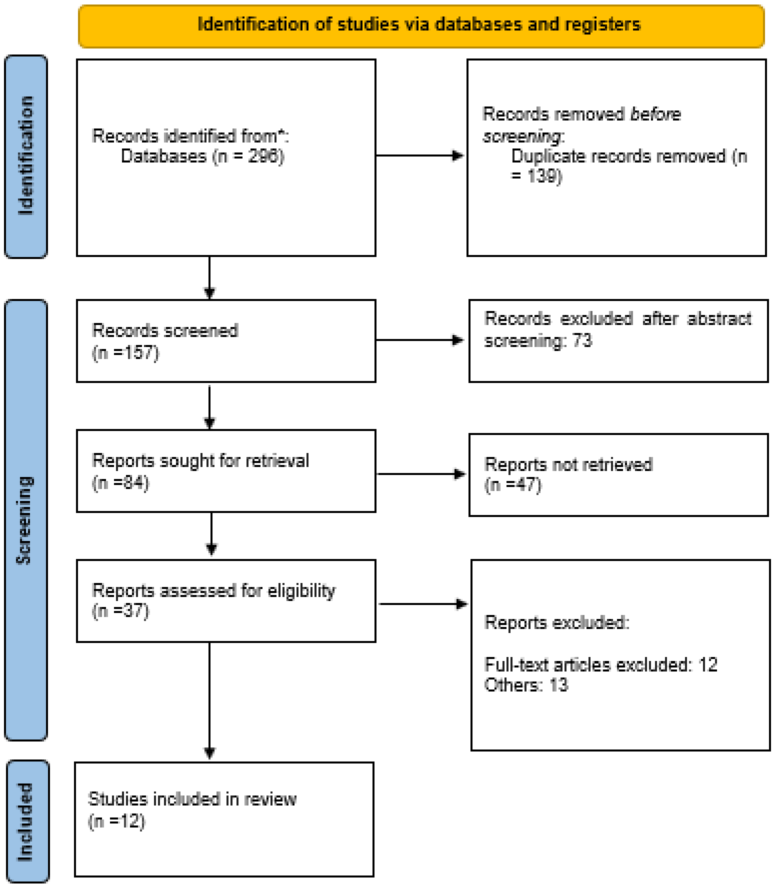

Figure 1: Prisma Flowchart of the Study

3. RESULTS

A total of 91 patients with maxillofacial trauma were included in this cross-sectional study. The majority of patients were male (98.9%), with road traffic accidents accounting for the predominant cause of injury (94%). Common clinical features observed included pain, swelling, nasal bleeding (73.6%), and oral bleeding (39.6%), which were often associated with zygomatic complex fractures and dentoalveolar injuries.

Imaging Findings:

CBCT demonstrated a significantly higher diagnostic yield compared to conventional radiography. Fracture fragments were detected in 98.9% of cases using CBCT, whereas only 51.6% were identified on conventional radiographs. CBCT was also superior in evaluating displacement, with an accuracy rate of 98.9%, compared to 54.9% for 2D imaging modalities. Moreover, CBCT provided detailed information regarding fracture extensions, comminution, and spatial relationships with critical anatomical structures, which were either partially visualized or missed entirely on plain radiographs [Figure 2].

Fracture Distribution and Localization: The most frequently affected regions were the zygomatic complex, mandible (especially the body and condyle), and orbital floor. CBCT enabled better visualization of complex fracture lines, especially in anatomically challenging areas such as the mandibular condyle, orbital rim, and pterygoid plates. In contrast, conventional imaging failed to provide adequate visualization in such cases.

Impact on Clinical Management: CBCT findings led to a modification in the initial treatment plan in 43.9% of cases, particularly in surgical planning, approach selection, and fixation methods. CBCT was instrumental in preoperative assessments that improved alignment, reduced operative time, and enhanced surgical precision. Postoperative follow-ups using CBCT allowed early identification of complications such as malunion or displacement, which contributed to timely interventions and improved outcomes.

Statistical Analysis: The sensitivity, specificity, and diagnostic accuracy of CBCT in detecting fractures were calculated at 98.9%, 97.2%, and 98.5%, respectively, significantly higher than those of conventional radiographs (sensitivity: 54.9%, specificity: 61.3%, accuracy: 58.1%). The inter-observer agreement for CBCT interpretation was excellent ($\kappa = 0.89$), while it was moderate for 2D radiography ($\kappa = 0.63$). These results affirm CBCT's diagnostic reliability and reproducibility in clinical settings.

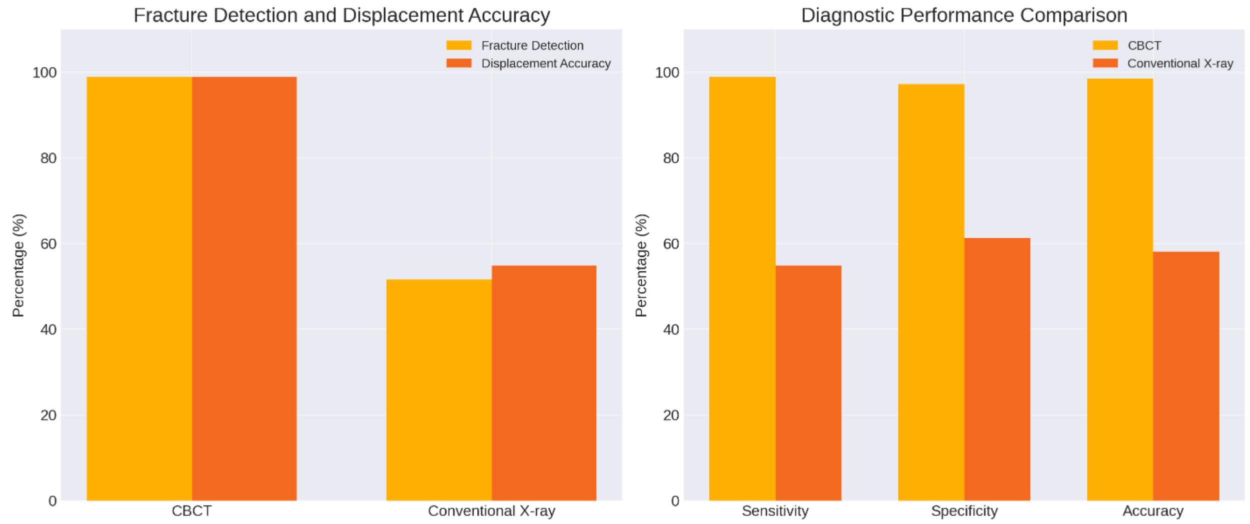

Figure 2: Comparison of CBCT and Conventional Radiography in Diagnosing Maxillofacial Trauma

4. DISCUSSION

The assessment of maxillofacial trauma plays a pivotal role in determining treatment outcomes and recovery times for patients. Accurate and timely diagnosis is critical, as the injuries can range from mild fractures to severe bone displacements and soft tissue damage [21]. In recent years, CBCT has emerged as a valuable imaging tool, offering high-resolution 3D images that provide a comprehensive view of the facial structures involved in trauma. One of CBCT's main strengths in maxillofacial trauma assessment lies in its ability to generate high-resolution, three-dimensional images with relatively lower radiation exposure compared to conventional CT scans [22]. This advantage is especially important for trauma patients who may require repeated imaging throughout their treatment. CBCT has been shown to offer superior image quality, allowing for better visualization of complex fractures in regions that are often difficult to assess with standard radiographs, such as the zygomatic arch, orbital floor, and mandible [23].In comparison with traditional X-rays, which provide limited information and often fail to evaluate complex fractures comprehensively, CBCT offers a more thorough and accurate assessment of facial injuries [24]. Moreover, while conventional CT scans provide cross-sectional images, they involve higher radiation doses, posing potential risks, particularly to pediatric or elderly populations. CBCT's reduced radiation exposure makes it a safer alternative for trauma patients requiring repeated imaging, enhancing its utility in clinical settings [25].In this study, CBCT demonstrated its diagnostic efficiency by detecting fractures and evaluating the involvement of surrounding soft tissues. The ability to generate detailed 3D reconstructions of the affected area helps clinicians make more precise assessments of injury severity, which is crucial for formulating appropriate treatment plans. CBCT's capacity to visualize both bone and soft tissue together proves invaluable, especially for complex fractures involving both structures, such as mandibular fractures with associated soft tissue lacerations [26].CBCT plays a crucial role in enhancing clinical outcomes, especially in treatment planning and postoperative monitoring. By providing accurate fracture imaging, CBCT enables surgeons to plan surgeries with greater precision, reducing complications like malunion or nonunion. Preoperative planning based on CBCT images improves both functional and aesthetic outcomes, while postoperative follow-up ensures proper fracture healing and timely identification of complications. Additionally, CBCT offers minimal radiation exposure during follow-up imaging, facilitating faster recovery and better outcomes [27].

Collaboration among specialists is essential in complex trauma cases, and the integration of CBCT improves communication, ensuring a comprehensive understanding of the injury and treatment plan. This leads to improved patient care and satisfaction. However, challenges such as high costs, maintenance, and the need for specialized training may hinder its widespread adoption. The balance between detailed imaging and minimizing radiation exposure is also a concern, especially in vulnerable populations [28].Despite these challenges, the advantages of CBCT—such as high-resolution 3D imaging with lower radiation doses—make it an ideal tool for maxillofacial trauma management. It enhances fracture detection, soft tissue evaluation, and treatment planning, contributing to improved clinical outcomes [29]. Future research should explore CBCT's long-term impact and its potential in various trauma settings to optimize patient care and diagnostic efficiency[30].The International Commission on Radiological Protection (ICRP) outlines essential principles for radiation protection, which are often embedded in national regulations. Among these principles, justification and optimization are pivotal. Justification dictates that ionizing radiation should only be used when its benefits outweigh the potential risks. According to the Royal College of Radiologists (RCR), a valuable diagnostic test is one where the results—whether positive or negative—contribute to clinical management or increase diagnostic confidence [31]. Optimization, on the other hand, emphasizes minimizing radiation exposure to levels that are as low as reasonably practicable (ALARP), while considering economic and social factors. In line with these principles, it seems appropriate to consider three-dimensional imaging techniques when they enhance diagnostic certainty and aid in selecting the most appropriate treatment or surgical intervention [32]. Both CBCT and conventional CT provide high-resolution imaging of hard tissues. CBCT, being a lower-dose alternative, aligns with the ALARP principle, offering a potential benefit in reducing radiation exposure while still delivering critical diagnostic information [33].Radiation doses are measured in different ways, with the absorbed dose being a fundamental one. Expressed in Grays, it refers to the amount of radiation energy deposited per unit mass of tissue [34]. While absorbed dose is useful, it doesn't factor in the ionization potential of radiation or the radiosensitivity of specific tissues. A more comprehensive measure is the effective dose, expressed in Sieverts. This takes into account tissue radiosensitivity and the type of radiation, allowing for comparisons across various imaging techniques. It is also linked to cancer risk. For instance, the risk of cancer from dental radiography is estimated to be 1 in 15 million per microsievert for men, and 1 in 18 million for women. However, calculating the effective dose is more complex, so most scanners provide absorbed dose values instead [35].Studies have provided data on radiation doses for both CT and CBCT imaging [36]. A meta-analysis of data from nine CBCT units revealed an average effective dose of 212 µSv for large field-of-view imaging, covering the entire maxillofacial skeleton [36]. In comparison, CT scans in similar settings delivered an effective dose of 860 µSv, with some studies reporting values ranging from 685 µSv to 1410 µSv. This indicates that CT imaging often delivers 4-5 times the radiation dose of CBCT for the same anatomical region [37]. However, CBCT still involves higher doses than conventional 2D radiographs. For example, a panoramic radiograph delivers about 20 µSv, and a single facial X-ray is around 10 µSv [38]. A typical series of 2D facial images for trauma amounts to 20–30 µSv, while CBCT gives approximately 200 µSv and CT delivers around 1000 µSvM [39]. Although CBCT provides a clear dose advantage over CT, it still exposes patients to about eight times the dose of 2D imaging. In many cases, this increased dose is justified by the substantial diagnostic improvement and the detailed information it provides for surgical planning[40].Maxillofacial trauma is a prevalent injury in emergency departments, often leading to both skeletal and soft tissue damage. Effective clinical assessment and high-resolution imaging are essential for optimal care [41]. A study of 91 patients with maxillofacial trauma found that the majority of injuries occurred in men (98.9%), with road traffic accidents (RTAs) being the leading cause (94%). The rise in urbanization and industrialization, especially with more motorcycles on the roads, has led to an increase in facial injuries. Common symptoms among patients included pain, swelling, and nosebleeds, which occurred in 73.6% of cases, often linked to zygomatic complex fractures. Additionally, 39.6% of patients had bleeding from the mouth, typically due to soft or hard tissue injuries. Soft tissue injuries, such as lacerations, were most common, while hard tissue injuries involved tooth fractures and dentoalveolar damage. Subconjunctival hemorrhage or ecchymosis was present in 79.1% of cases, typically associated with zygomatic complex fractures [42]. In fracture evaluation, CBCT was found to be more effective than conventional radiographs in assessing fracture site extension, fragment location, and displacement, offering superior sensitivity and specificity [43].For example, CBCT identified fracture fragments in 98.9% of cases, while conventional radiography only detected them in 51.6%. Additionally, CBCT was more effective in evaluating displacement, with an accuracy of 98.9%, compared to 54.9% for conventional radiography [44]. [Table 1] shows that overall, the evidence supports the use of CBCT over conventional radiography for diagnosing facial fractures, as it provides more detailed and accurate diagnostic information.

Table 1: Review of Literature on CBCT in Maxillofacial Trauma

Author(s)	Year	Study Design	Sample Size	Imaging Modalities Compared	Key Findings	Clinical Implications
Brüllmann et al. [45]	2012	Retrospective cross-sectional	120 CBCT scans	CBCT with dental diagnoses	Maxillary sinus findings on CBCT showed correlation with dental pathologies such as apical periodontitis and periodontal disease.	CBCT is valuable in evaluating maxillary sinus pathologies associated with dental conditions.
Wang et al. [46]	2016	Cross-sectional	316 molars in 272 patients	CBCT	Proximity of third molar roots to lingual plate varied; CBCT crucial to avoid nerve injury.	CBCT should be considered before third molar extraction for risk assessment.
Li et al. [47]	2018	Cross-sectional	112 patients with dental trauma	CT (presumed MDCT)	CT was effective in detecting complex dental trauma and root fractures not visible on plain radiographs.	Emphasizes CT's diagnostic value in complicated trauma cases.
Chandra et al. [48]	2019	Retrospective cross-sectional	476 patients	CT, CBCT, panoramic	Majority of trauma cases were diagnosed using CT; zygomatic and mandibular fractures most common.	Stresses CT/CBCT importance in trauma mapping in urban emergency settings.
Aydin et al. [49]	2020	Retrospective	62 patients	CBCT	CBCT efficiently diagnosed mandibular and alveolar fractures, often missed in 2D imaging.	Recommends CBCT for precise fracture evaluation, especially in trauma cases.
Gluckman et al. [50]	2021	Descriptive cross-sectional	100 patients	CBCT	Quantified dentogingival dimensions in anterior maxilla using CBCT.	Provides CBCT-based reference values useful for esthetic and surgical planning.
Hui et al. [51]	2022	Cross-sectional	80 cases of impacted incisors	CBCT	CBCT provided accurate assessment of root development, position, and associated anomalies.	Supports CBCT use in orthodontic evaluation of impacted teeth.

Patil et al. [52]	2022	Cross-sectional	300 ENT clinicians	Awareness of CBCT	Moderate awareness among ENT professionals; CBCT recognized for sinus and airway evaluation.	Recommends interdisciplinary training for ENT specialists regarding CBCT.
Abate et al. [53]	2022	Cross-sectional	122 Caucasian subjects	CBCT	A correlation was found between sinus volume and vertical facial growth patterns.	CBCT-based sinus analysis can inform craniofacial growth assessment.
Baldini et al. [54]	2022	Cross-sectional	38 patients	CBCT vs 2D cephalograms	Differences existed in cephalometric values between CBCT and reconstructed 2D images.	Highlights the need for standardization when comparing cephalometric data across modalities.
Rashid et al. [55]	2024	Review with case analysis	Not specified	CBCT	CBCT offers enhanced detection and management of complex maxillofacial trauma compared to conventional radiographs.	Advocates CBCT as the preferred imaging for trauma cases due to its accuracy and 3D evaluation.
Nahir et al. [56]	2024	Cross-sectional	387 pediatric patients	CBCT in pediatric dentistry	CBCT use in children is increasing, but concerns about radiation persist; used mainly for complex cases.	Highlights the need for radiation justification and tailored CBCT protocols in children.

Future prospects:

The future prospects of CBCT in the assessment of maxillofacial trauma hold considerable promise, particularly in terms of enhancing diagnostic accuracy, improving treatment outcomes, and reducing radiation exposure. Building on the findings from the current study, which demonstrates the superior diagnostic efficiency of CBCT compared to conventional radiography, several avenues for further research and clinical advancement can be explored.

1. Advancements in Technology and Imaging Resolution

Improved Image Quality: Future developments in CBCT technology may lead to enhanced image resolution, allowing for even more precise visualization of complex fractures, particularly in regions like the zygomatic complex and mandibular condyle. Advancements in hardware, such as faster detectors and higher sensitivity imaging systems, may further reduce artifacts and increase clarity in the evaluation of fractures.High-definition CBCT: The development of high-definition CBCT scanners will allow clinicians to detect subtle fractures and micro-fractures that may be missed with current CBCT or conventional methods. This will be particularly beneficial in trauma cases involving soft tissue or intricate facial structures [58].

2. Radiation Dose Reduction

Dose Optimization Algorithms: Future CBCT machines may incorporate advanced dose-reduction algorithms and settings, ensuring that radiation exposure are minimized while maintaining diagnostic image quality. This could further optimize the ALARP (As Low As Reasonably Practicable) principle in radiation protection.

Personalized Exposure Parameters: Tailoring radiation doses based on individual patient characteristics (such as age, body size, and specific injuries) could become standard practice. This approach would help balance the benefits of detailed imaging with the risks of radiation exposure, particularly in pediatric or sensitive populations [59].

3. Integration with Artificial Intelligence (AI) and Machine Learning

AI-driven Diagnosis: The integration of AI and machine learning in the analysis of CBCT images will likely improve diagnostic accuracy. AI systems can be trained to automatically detect and classify fractures, predict complications, and assist clinicians in treatment planning. This could lead to quicker, more reliable diagnoses, particularly in busy emergency departments or rural settings with limited radiological expertise [60].

Predictive Models for Treatment Outcomes: By analyzing large datasets of CBCT scans alongside clinical outcomes, machine learning models could predict the prognosis of various types of maxillofacial trauma. This would allow for more personalized treatment strategies and improve patient outcomes by identifying high-risk cases early [61].

4. 3D Reconstruction and Virtual Surgical Planning

Enhanced 3D Imaging: As CBCT technology continues to advance; the ability to create detailed 3D reconstructions of the injured facial structures will further improve surgical planning. Surgeons will be able to view the trauma in multiple dimensions (axial, coronal, sagittal), potentially leading to better surgical outcomes. Virtual Reality (VR) and Augmented Reality (AR): The use of VR and AR in conjunction with 3D CBCT models will enable real-time interaction with the data during surgery. This will allow surgeons to simulate surgical procedures before the actual operation, potentially reducing errors and enhancing patient recovery [62].

5. Broader Clinical Applications Beyond Trauma

Routine Assessment for Facial Abnormalities: As the clinical use of CBCT expands, it may also be applied to routine assessments for congenital facial abnormalities, developmental disorders, or post-surgical evaluations. By providing detailed, non-invasive views of facial structures, CBCT can assist in early diagnosis and intervention.

Post-operative Monitoring: CBCT could become a standard tool for post-operative monitoring of maxillofacial trauma patients, allowing for the early detection of complications like infection, malunion, or non-union of fractured bones [63].

6. Cost-effectiveness and Accessibility

Wider Adoption in Clinical Practice: As CBCT technology becomes more affordable and widely available, particularly in resource-limited settings, its use in emergency departments and dental clinics could become more commonplace. Training healthcare providers in the efficient use of CBCT, combined with the development of cost-effective units, would enhance patient access to this advanced imaging modality.

Telemedicine Integration: CBCT images could be transmitted to specialist centers for remote evaluation, improving the reach of radiological expertise in underserved areas. This is especially valuable in trauma situations where time is of the essence, and rapid consultation with experts can significantly influence patient outcomes.

7. Long-term Clinical Outcomes and Evidence-based Guidelines

Longitudinal Studies: To better understand the impact of CBCT on treatment outcomes, future research should focus on long-term clinical studies that assess the correlation between CBCT imaging, surgical outcomes, and patient recovery. By tracking patients over extended periods, researchers can establish definitive evidence on the effectiveness of CBCT in different trauma contexts.

Development of Evidence-based Protocols: As CBCT becomes more widely adopted; standardized, evidence-based guidelines should be developed to ensure its optimal use. These protocols would outline when CBCT is appropriate in various clinical scenarios, considering factors like trauma severity, anatomical regions involved, and alternative imaging methods [64].

5. CONCLUSION:

The future of CBCT in the assessment of maxillofacial trauma is promising, with the potential to enhance diagnostic accuracy, reduce radiation exposure, and improve clinical outcomes. Advancements in technology, the integration of AI, and the development of evidence-based protocols will be crucial in further enhancing CBCT's value in clinical practice. As these innovations evolve, the role of CBCT in both acute trauma care and long-term management will likely expand, resulting in better patient care and more efficient healthcare delivery. This cross-sectional study underscores the significant role of CBCT in diagnosing and managing maxillofacial trauma. The findings highlight that CBCT provides superior diagnostic efficiency compared to traditional imaging techniques, especially in assessing complex fractures and soft tissue involvement. The high-resolution 3D imaging capabilities of CBCT are particularly beneficial for visualizing the extent of injuries, guiding treatment planning, and improving clinical outcomes.While CBCT offers numerous advantages, it is important to consider factors such as radiation dose and cost-effectiveness in routine clinical settings. Further research is necessary to evaluate the long-term clinical outcomes of patients treated with CBCT-assisted planning and to refine protocols for its optimal use. In conclusion, CBCT is a valuable tool in maxillofacial trauma diagnosis, offering enhanced precision and contributing to better clinical outcomes. Its adoption in routine clinical practice should be carefully considered, with a focus on radiation safety and cost considerations.

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