*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*
*e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 23, Issue 2 Ser. 2 (February. 2024), PP 20-27*
*www.iosrjournals.org*

# 3D Imaging Technologies In Dentistry: Clinical Applications And Future Perspectives

Klever Esteban Moreta Lezcano[1], Viviana Lizeth Arauz Vicente [2], Silvana Karolina Baño Ramírez [3], José Luis Llanos Arteaga[4], María Soledad Peñaherrera Manosalvas[5]

[1]*(Dentistry/ Universidad Tecnológica Equinoccial, Ecuador)*
[2]*(Dentistry/ Universidad Tecnológica Equinoccial, Ecuador)*
[3]*(Dentistry/ Universidad San Francisco De Quito, Ecuador)*
[4]*(Dentistry/ Universidad De Guayaquil, Ecuador)*
[5]*(Dentistry/ Universidad De Los Hemisferios, Ecuador)*

***Abstract:***
***Background**: With the advancement of 3D imaging technology, dentists now have access to sophisticated diagnostic and treatment planning tools. This research examines the latest advancements and practical uses of 3D imaging in dentistry across a range of specializations.*
***Materials and Methods**: Reputable academic databases were used to perform a thorough literature review. Articles describing developments in 3D imaging technology in dentistry that were published in English during the last five years (2018–2023) were considered. After screening, 114 of the 1219 originally found articles satisfied the inclusion requirements, and 42 of them were chosen for further study.*
***Results**: Based on how 3D imaging technologies are used in clinical settings, the findings were classified. Cone Beam Computed Tomography (CBCT), which offers more accuracy in fracture diagnosis and pathology evaluation, has proven useful in oral surgery, orthodontics, and endodontics. Intraoral scanners (IOSs) have shown potential in assessing dental wear, whereas photogrammetry developed as a dependable dental imaging technique. Endodontics and implantology benefited from the strong soft tissue contrast that Magnetic Resonance Imaging (MRI) offered without using ionizing radiation.*
***Conclusion:**In conclusion, dentistry has undergone a revolution with the integration of 3D imaging, which has made accurate diagnosis, treatment planning, and result assessment possible. Future developments in 3D imaging might improve patient outcomes and the way dental treatment is delivered.*
***Key Word**:3D, Imaging, dentistry.*

---

Date of Submission: 27-01-2024 Date of Acceptance: 07-02-2024

---

## I. Introduction

The process of converting 2D data into 3-dimensional format is known as 3D imaging, and it develops or generates the illusion of depth inside a picture. 3D imaging has emerged as a very effective tool to support industrial quality regulation operations. Numerous unique technologies exist that may assist in this process of creating 3-D images for examination and testing (Alshammery 2020).

Imaging and orthodontic history may be a technologically mediated story of biology. Modern bands, brackets, and archwires have revolutionized orthodontics, and particularly the mechanics of dentistry. Innovations in imaging have changed our way of thinking. This could be because imaging provides the field with a scientific tool to examine potential craniofacial development and the impact of therapy on this dynamic approach (Hans, Martin Palomo, and Valiathan 2015). Nowadays, we get more comprehensive information with less radiation exposure since the new 3-dimensional (3D) scanner uses less ionizing radiation than panoramic views and standard cephalograms.

Imaging is the best investigative technique available, and it is one of the most important instruments used in orthodontics to assess and record the dimensions and architecture of the structures in the craniofacial area (UÇAR et al. 2012). Orthodontists often use 2-dimensional (2D) static imaging technologies to capture the craniofacial anatomy; however, 2D imaging cannot be used to ascertain the depth of the structures. The discipline of dentistry has benefited greatly from the development of 3D imaging, which was completed at the beginning of the 1990s. The fields of orthodontics and oral surgery, orofacial procedures, have benefited most from this technology. In 3D investigative imaging, a sequence of anatomical data points is gathered using sophisticated, high-tech apparatus, controlled by a computer, and then verified on a two-dimensional display to demonstrate the misinterpretation of depth.

When creating plans for orthodontic treatment, the three components of the face—the teeth, the soft tissues, and the hard tissues—play a significant role (Plooij et al. 2011). Therefore, one of the useful diagnostic tools for doctors to evaluate a therapy modality is imaging of such anatomical areas.[6] Specifically, 3D imaging for orthodontic purposes includes assessing the dento-skeletal and craniofacial associations, facial appearance, and beauty before and after treatment, evaluating the results of treatment about hard and soft tissues, developing research choices, and therapeutic planning in addition to 3-D treatment projections (Karadeniz et al. 2011)

A variety of research techniques that were established to illustrate face and oral cavity features, such as dentition, were rendered obsolete due to their numerous drawbacks (Alshammery 2020) Currently, the most popular method is probably 3D imaging, which provides detailed and negatively adjusted information about soft and onerous tissues. Examples of this type of imaging include Cone Beam computed axial tomography (CBCT), Photogrammetry, magnetic resonance imaging (MRI), and intraoral scanners. Therefore, the purpose of this research was to examine developments in 3D imaging in dentistry across a range of specializations.

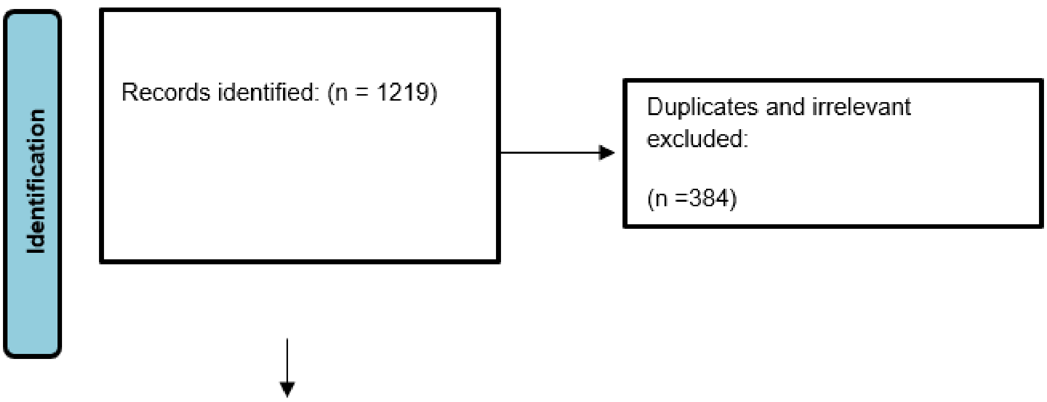
## II. Material And Methods.

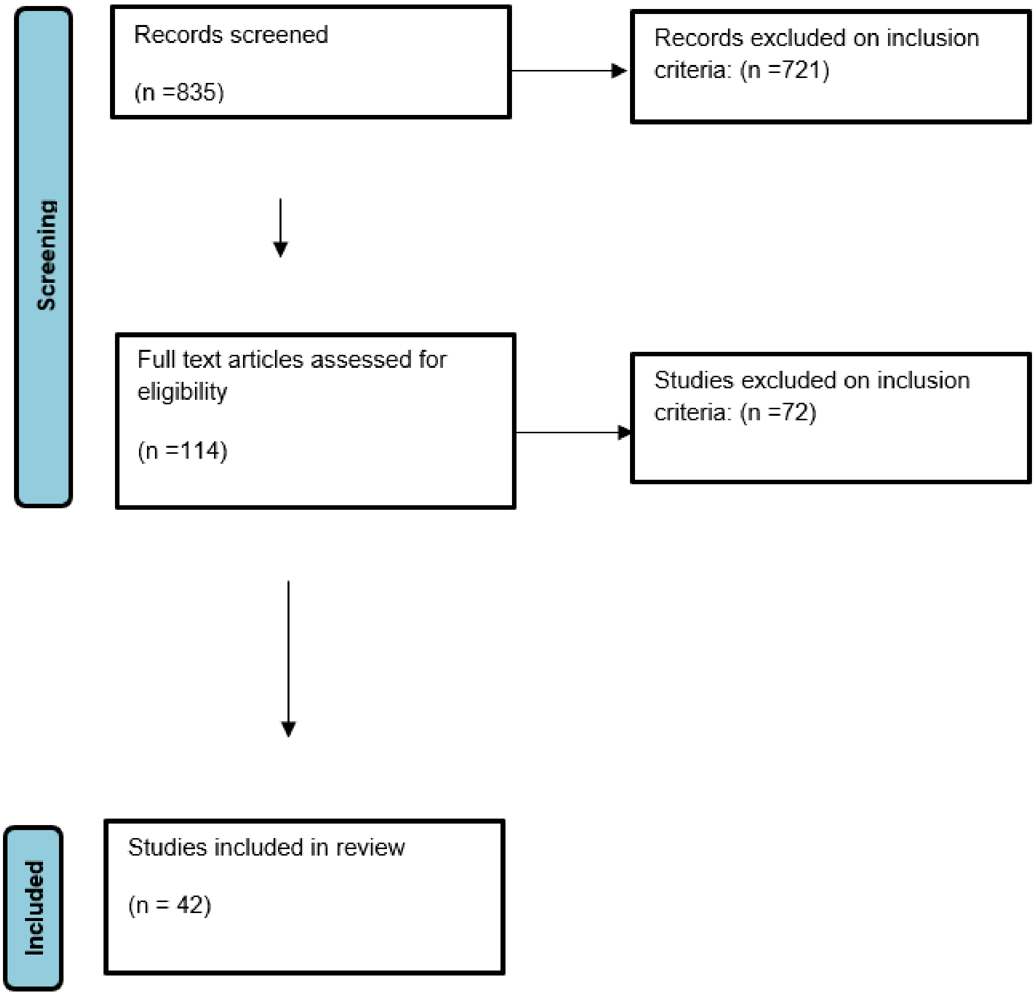
Using an integrated methodology, this study methodically looks through and assesses pertinent information that was found in academic databases including ScienceDirect, Google Scholar, and PubMed. The approach, includes adjustments from tried-and-true techniques in similar review papers. To find relevant literature, search phrases including "3D imaging," "dentistry," "clinical applications," and "future perspectives" were used. To concentrate on relevant material and refine search queries, boolean operators (AND, OR) were used.

**Criteria for Inclusion and Exclusion:**

Papers published in English within the previous five years (2018–23) that highlight new developments in the clinical uses of 3D imaging technology in dentistry are acceptable for inclusion. Excluded studies included non-human participants, irrelevant results, or poor methodology. 1219 articles were found after a preliminary screening that mostly focused on titles and abstracts. The selection process resulted in 114 articles after inclusion and exclusion criteria were applied. A thorough evaluation process that included a full-text analysis resulted in the inclusion of 42 publications that provide important supporting data for this study.

The findings of literature research on current developments in the clinical uses of 3D imaging technology in dentistry and their prospects were categorized using a methodical methodology. To promote coherence and clarity, analytical categories emphasizing cutting-edge methods and technology were developed. The use of intraoral scanning, photogrammetry, and Cone Beam Computed Tomography (CBCT) in dental imaging were among the diagnostic advances. Innovations in treatment were divided into three categories: precision surgical planning, augmented reality in dental operations, and 3D printing in dental prostheses. This methodical classification makes it easier to comprehend the many ways that 3D imaging technology has advanced in dentistry, including both practical uses and potential future paths






## III. Results.

Oral and maxillofacial surgery makes considerable use of CBCT. CBCT can accurately detect surface continuity and distances between various surfaces in the event of damage to the oral and maxillofacial structures (Nimeshkumar and Ekta 2021). When it comes to orbital, midfacial, mandibular, and dentoalveolar fractures, CBCT may provide important insights for a thorough assessment of the fractures. Furthermore, it permits bone assessment intraoperatively while doing surgery. CBCT offers important information for post-fracture assessment after the surgical operations are finished. Pathologies include cysts, osteomyelitis, calcifications, and odontogenic tumors may be detected with CBCT (Nimeshkumar and Ekta 2021). The number of incident findings on CBCT is much greater than that of two-dimensional radiography. Unerupted teeth, impacted teeth, and extra teeth may all be examined using CBCT.

**CBCT and orthodontics**

The orthodontist may assess the hard and soft tissues of the face in panoramic, frontal posteroanterior, and lateral cephalometric views using CBCT. It gives the orthodontist the ability to superimpose photos without distortion by providing them without magnification. In order to apply micro implants in orthodontics, CBCT may also be used to assess the thickness and density of the ramal, buccal, and palatal bones. Aligners have become quite popular in the orthodontic community in recent years. This is because of their more attractive look than orthodontic equipment that are fixed. Thanks to advancements in aligner technology, even intricate dental motions may now be treated with aligner treatment (Eğlenen and Yavan 2023). Nonetheless, other writers contest the claim that aligners simply move the crown tilting and ineffectively shift the roots (Haouili et al. 2020). To detect the root and bone structure and plan therapy for better results, efforts have thus been undertaken in a few trials to employ CBCT prior to aligner treatment. Furthermore, CBCT may be used to quantify a patient's airway volume (Mehta, Wang, et al. 2021). CBCT may be used to examine the results of orthodontic interventions such as micro implant aided quick palatal expansion and rapid palatal expansion (Abu

Arqub et al. 2021). Additionally, CBCT may be utilised to assess differences in dental eruption and facial development, particularly in individuals undergoing orthodontic therapy and Class III malocclusion (Mehta, Chen, Upadhyay, et al. 2021).

The treatment planning is a crucial component of the CBCT examination. Following the widespread use of CBCT, several surgical techniques and virtual treatment planning tools were created. With the use of CBCT, orthodontic patients may experience maxillary and mandibular surgery in three dimensions. This is a significant development in recent years as it allows for the virtual three-dimensional planning of surgical procedures for yaw correction, rotation, and advancement of the mandible and maxilla (Alkhayer et al. 2020). Because computer-designed splints may be generated, performing mandibular setback and maxillary down fracture in three-dimensional surgical simulations using CBCT can also be done easily.

To determine the unfavorable effects of orthodontic treatment, examination of treatment results, such as root resorption, is essential in addition to treatment planning. Micro-Computed Tomography (micro-CT), which has a very high resolution and enables the computation of root volume following tooth movement, makes it simple to conduct this with animal investigations (Mehta, Chen, Kalajzic, et al. 2021). Although micro-CT cannot be used in clinical investigations, researchers have been able to assess the volumetric root resorption after orthodontic treatment because to advancements in CBCT resolution technology (Aras et al. 2018). Maxillary incisors are the teeth that experience root resorption following orthodontic treatment the most often (Puttaravuttiporn et al. 2018). As a result, CBCT is a crucial tool for assessing therapy results in addition to diagnosing and planning treatments.

**CBCT and endodontics**

It has been found that when it comes to diagnosing periapical lesions, CBCT is superior to two-dimensional radiography. It enables the visibility of lesions next to the maxillary sinus, as well as those involving the maxillary sinus membrane and those near the mandibular canal. It is possible to record a modest volume CBCT for endodontic reasons. It enables a thorough assessment of the canal's path, including its bends and bifurcations, as well as the examination of root canals in teeth (Nimeshkumar and Ekta 2021). During endodontic operations, CBCT may be useful in determining the root canal's working length. Additionally, since CBCT aids in the detection of accessory root canals, it has contributed to an increase in endodontic treatment success rates. Additionally, regardless of whether root resorption is internal or exterior, it might help diagnose it. Identification of pulp horn extensions in talons cups has been made possible in large part by CBCT (Nimeshkumar and Ekta 2021). This enables the medical professional to determine how much the talons' cusps can be recontoured.

*Photogrammetry:*

The stringent need to employ specialized equipment for both taking and processing photos made photogrammetry difficult to use for a long time (Stuani et al. 2019). According to a study, photogrammetry has developed into an accurate, dependable, and reasonably priced method for most dentists, and it is now emerging as a valuable resource in the field (Revilla-León et al. 2021). This is largely because of technological advancements in the field of digital photography and the development of specialized software. Precision, which measures the difference between datasets acquired using the same technique, and trueness, which measures the difference between datasets acquired using various methods, were used to assess the accuracy of photogrammetry (Mangano et al. 2017). The current study's findings were found to be consistent with those of Stuani et al. in terms of photogrammetry precision (Stuani et al. 2019). Furthermore, the measurements collected on the clay model that served as the reference and the digital models generated via photogrammetry agreed with each other. The Correlation Between Classes There was an almost perfect concordance between the two measures, indicating that there were no mistakes in the model measurements. The coefficient assessed between each pair of measurements made on each digital dental model created by photogrammetry and on the plaster, model was equal to 0.99. This approach has high repeatability as shown by the coefficient of variation that was determined for each reference between the values obtained from the measurements on the plaster model and the digital dental models P1, P2, P3, and P4. This coefficient of variation was always less than 3%. Using a total of 72 photos taken around the model, Xiaoming Fu et al. utilized the photogrammetric approach and showed the same result. Additionally showing almost perfect agreement in this instance were the ICCs computed for linear measurements on digital dental models, which ranged from 0.879 to 0.998 (Fu et al. 2017). This method's strong repeatability is shown by the percentage coefficient of variation, which varied from 0.165% to 6.731%. It was also determined by Xiaoming Fu et al. that measurements taken on digital dental models should be regarded as repeatable.

When comparing the photogrammetry's accuracy to intraoral and extraoral scanning, no statistically significant differences were found between the values obtained from the plaster model's linear measurements and the digital dental models from the three different acquisition methods that were tested. The test's nonsignificance may be used to show that, even when acquired via diverse means, the linear dimensions found on a digital dental model are same (Zotti et al. 2022). It also shows how reconstructions from photogrammetric acquisitions may be processed by software to assess the total dimensions of the breadth and height of the crown, as well as the transversal measures between canines and between molars.

Prior research has shown that photogrammetry is capable of accurately capturing the digitized object's shape and yielding measurements that are on par with models derived from high-resolution 3D scans (Da Pozzo et al. 2020). The small-scale representation of the occlusal topography was subpar in comparison to the three-dimensional models obtained with the other acquisition methods and to the plaster model, even though photogrammetry was able to recreate a digital dental model with an excellent shape and size of the dental elements. One of the study's shortcomings was that each acquisition technique only used one digital dental model. The random variability would be raised, and the statistical tests might be more precise by creating several digital dental models for every acquisition technique (Zotti et al. 2022). To get more accurate dental plaster models, it would be reasonable to assess a high-performance imprint material in these regards. Furthermore, a variety of dental plasters might be evaluated to determine the relative importance of the many factors that go into making plaster models.

*Intraoral Scanners:*

The assessment of dental wear was discovered to be the primary diagnostic application area for iOS's. Dental wear involves both functional and structural issues, such as increased tooth sensitivity, chewing difficulty, headaches, loss of the vertical dimension of occlusion, and support structures, all of which have an impact on general health and well-being (Angelone et al. 2023). To avoid a variety of illnesses, it might be highly helpful to evaluate tooth wear.

To be more specific, Kühne et al. compared the reference model obtained through noncontact white light profilometry with 3D models obtained using various scanners (TRIOS 3, Cerec Omnicam, True Definition Scanner) at three distinct wear stages simulated with a diamond bur using the Geomagic Qualify 2012 version (Kühne et al. 2021). This confirmed that IOSs can assess dental wear even when considering an imprecision level of plus or minus 20 µm in relation to the profilometry. IOSs are promising for the evaluation of dental wear, although they could miss tiny alterations, according to Kumar et al., who used chemically induced wear and only the True Definition Scanner (Kumar et al. 2019). Since the triangles formed by the True Definition Scanner had a 50 µm diameter, after 10 minutes of exposure, a volume change of −0.45 mm3 (±2.59) was seen with a significant standard deviation that was too big to conduct an accurate volumetric analysis. Using the Planmeca scanner to acquire the arches and Geomagic Control X for metrology software, a researcher found that the latter scanner can detect even minute variations, detecting 65 µm of dental tissue on average over a 19-hour exposure period (Angelone et al. 2023). This was after three periods of tooth soda exposure.

The potential of this IOS for evaluating tooth wear was confirmed by Michou et al., who also used TRIOS 3 and associated TRIOS Patient Monitoring software to analyze wear after a session of citric acid exposure (Michou, Vannahme, et al. 2020). In addition to TRIOS Patient Monitoring, which is helpful in determining depth loss (mm), Machado et al. [23] also obtained the volume loss (mm3) and area loss (mm2) using WearCompare software. These results show that depth (mm2) and time ($r = 0.9993$ $p < 0.0001$), volume (mm3) and time ($r = 0.9968$, $p < 0.0001$), and area (mm2) and time ($r = 0.9475$, $p = 0.0003$) have strong correlations (Michou, Vannahme, et al. 2020). Determining criteria that can be identified objectively and statistically is crucial for conducting an effective assessment of tooth wear. Although helpful, the indices for the visual evaluation of tooth wear that are now available (such the Basic Erosive Wear Examination (BEWE) [66]) might be biased based on the clinical background of the operator. Indeed, Travassos da Rosa Moreira Bastos et al. conducted a study to evaluate intra- and interobserver concordance using scans obtained one month after baseline (Travassos da Rosa Moreira Bastos, Teixeira da Silva, and Normando 2021). They found that the intraoral scanner analysis ($K = 0.595$) produced a lower bias for the visual evaluation based on intraoral scanning, with a moderate level of agreement. Alwadai et al. sought to determine how well occlusal topographical analyses—which are particularly vulnerable to wear—worked in evaluating the course of simulated wear, to bring the evaluation closer to objectivity (Alwadai et al. 2020). This abrasion was mechanically replicated using silicon carbide grind papers, and the digital imprint scanner and dental topographic analysis parameters (Slope, Relief, RFI, and OPCr) computed in RStudio using the “molaR” package served as the basis for the assessment. It was anticipated that these topographic features would diminish as generated wear grew, and this was indeed the case (for example, the slope changed between 54.6 (±4.3) and 46.6 (±6.4) as the wear rose from 0 mm to 1.5 mm).

Analysis of tooth wear in vivo is done over a longer period. As an example, wear was assessed in comparison to baseline at six months and a year, with clearly smaller fluctuations and using the visual assessment and the microCT as benchmarks, respectively (F. Esquivel-Upshaw et al. 2020). When lithium disilicate implant crowns and their enamel antagonists are assessed for wear, as Stück et al. did, the time is further prolonged (12 and 24 months) (Stück, Raith, and Reich 2022).

Caries detection is another clinical domain in which scanners may provide reliable diagnostic outcomes. In this area, scanners with integrated caries detection systems—discussed in Section 3.5—based on noninvasive optical technologies are now under development and becoming more widely available. The diagnostic reliability of fluorescence technology, which was implemented into the first scanner with integrated caries detection technology, TRIOS 4, was examined in several studies (Davidovich, Shay, et al. 2020) (Davidovich, Dagon, et al. 2020) (Revilla-León et al. 2019). Carious lesions may even be found using near-infrared lighting; iTero Element 5D has this capability. Even when compared to radiography, which is regarded as the gold standard for these assessments, a higher capacity to identify interproximal caries was discovered in this instance (Sobral et al. 2022). When Schlenz et al. compared the three previously discussed scanners to conventional techniques, they discovered that Planmeca Emerald S, which uses transilluminescence technology, had the highest degree of reliability for occlusal caries diagnosis in permanent teeth (Schlenz et al. 2022). Another pertinent investigation was conducted by Michou et al., who created a prototype intraoral scanner that uses fluorescent light to produce light at 415 nm (Michou, Benetti, et al. 2020). They demonstrated the fluorescent light's promising performance by comparing it to radiographic, histological, and visual-tactile evaluations of caries.

**MRI:**

*Fundamental Parameters in MRI:*

The two most important characteristics in dental MRI are resolution and signal-to-noise ratio (SNR), which are determined by dividing the signal's standard deviation from the background by the signal's intensity in a region of interest (Di Nardo et al. 2018). The picture voxel size determines the image resolution. Reduced matrix size, increased voxel size, increased field of view (FOV), reduced bandwidth using surface coils, increased slice thickness, shortest possible spin echo sequence echo time (TE), and increased number of signal acquisitions (NA) are some ways to improve SNR in MRI (Di Nardo et al. 2018).

*Diagnosis of Apical Periodontitis:*

A persistent bacterial infection of the root canal system near the bone is often the cause of apical periodontitis, a chronic inflammatory disease of the peri-radicular tissues. A study has discussed in detail the pathophysiology of apical periodontitis and the reason of endodontic failure: bacteria, mostly obligate anaerobes and fungi, play a major part in these processes, depending on how they interact with the host's immune system (Reda et al. 2021). The development of endo-osseous disorders impedes the bloodstream's ability to receive immune cells and antibiotic compounds. A periapical radiolucency must reach between 30% and 50% of bone mineral loss to be radiographically detectable with bidimensional RX (Chang et al. 2020).

A primary benefit of magnetic resonance imaging (MRI) over computed tomography (CT) and computed tomography (CBCT) is its high soft tissue contrast. This contrast may be adjusted by modifying the MRI sequence design, and MRI does not emit ionizing radiation (Juerchott et al. 2018). To be more precise, MRI not only offers superior contrast for soft tissues but also makes it possible to assess distinct tissue components in different orders.

*Conservative dentistry, endodontics, and endodontic anatomy*

In terms of endodontic anatomy, it is crucial to accurately create a topographic image of the root canal system before beginning any endodontic treatment. This allows the clinician to use the right instruments in the right way and prevents the instruments from being subjected to significant stress, which could cause intracanal separation (Seracchiani et al. 2021) (Mazzoni et al. 2020).

Numerous studies have shown the value of single point imaging, SPRITE and STRAFI techniques, spin echo and gradient echo imaging, and these methods for visualizing tooth surface geometry and differentiating between soft and mineralized tissue in removed teeth (Gambarini et al. 2021). The contour of the pulp chamber, root canals, and carious lesion, as well as the strong contrast that is produced by the high-intensity signal from water and the low signal from mineralized tissues, enable identification of the dental crown (Reda et al. 2021).

Microscopy magnetic resonance imaging (MRI) is defined as an MRI with voxel resolutions higher than 100 mm3. This degree of scanning is required for MRI to be utilized to endodontic clinical practice. Chambers used for magnetic resonance microscopy are usually rather tiny, usually measuring less than 1 cm3. With a resolution of around 100–300 mm, magnetic resonance microscopy may help us comprehend the internal workings of teeth.

*The Study of Implants*

The purpose of the research put out by Probst et al. in the field of implantology was to determine whether or not computer-aided 3D implant planning with template-guided placement of dental implants based on MRI data is a process that is clinically valid (Probst et al. 2020).

Hard tooth tissues and bone tissues look quite black in the conventional MRI image because of their low liquid content. However, it is feasible to give the teeth and other bone structures a bright or white color by inverting the dark signal values of the MR image files; as a result, an image that is more like to CBCT is created (Kajima et al. 2020) (Hilgenfeld et al. 2018).

Given that the sequence parameters were designed with consideration for both spatial resolution and total picture acquisition time, the likelihood of motion artifacts increasing with image acquisition duration increases. Still, by applying soft tissue contrast in some sequences, MR imaging provides a special benefit and value addition. Although T1-weighted sequences are like CBCT imaging since they are essentially "bone sequences," T2-weighted STIR sequences may function as "soft tissue and nerve sequences" during implant design, enabling direct imaging of blood vessels and nerves (Probst et al. 2020).

*Maxillary Sinus Identification and Treatment:*

As noted by Panou et al. and Özdemir et al., the assessments conducted by Aktuna Belgin et al. and Dong et al. highlighted the significance of the maxillary sinus and demonstrated how effectively it can be investigated by MRI (Aktuna Belgin et al. 2019) (Ozdemir and Pelin Kavak 2019).

The volumetric changes in the maxillary sinus, its relationship to tooth position, changes induced by orthodontic treatment (e.g., rapid expansion, septal deviation, sinus pathologies), and variations in the maxillary sinus's size and anatomy according to age, sex, and race have all been studied in the past (Ozdemir and Pelin Kavak 2019).

While MRI takes longer to complete exams than CT and CBCT, it has fewer metallic artifacts and can be used with 3D medical imaging software to examine images obtained in the axial, coronal, and sagittal planes. These images closely resemble those obtained from CBCT, and by using certain filters, it can also be used to enhance the contrast between different structures (Hilgenfeld et al. 2018)(Kajima et al. 2020).

MRI is positioned in this assessment as a very fascinating examination with enough room for development. It has also been shown to be helpful in determining the condition of the maxillary sinus and the Schneiderian membrane for any bone regeneration (Laurino et al. 2020)(Munhoz, Abdala Júnior, and Arita 2019).

Furthermore, it is imperative to acknowledge that several imaging systems are experiencing significant transformations because of ongoing advancements in techniques that use artificial intelligence (AI).

## IV. Discussion

The use of 3D imaging technology in dentistry has greatly improved the accuracy of diagnosis and the ability to plan treatments. Cone Beam Computed Tomography (CBCT) is becoming a vital tool in oral and maxillofacial surgery, offering critical information on fracture assessments, distance measures, and surface continuity (Nimeshkumar and Ekta, 2021). Because it provides frontal, lateral, and panoramic cephalometric images, CBCT is a great tool for orthodontic applications. Its distortion-free picture superimposition helps orthodontists do accurate assessments, especially when evaluating the implantation of micro-implants (Nimeshkumar and Ekta, 2021). When it comes to endodontics, computed tomography (CBCT) performs better than standard radiography. It provides better diagnoses for periapical lesions and increased visualization of intricate root canal systems, both of which improve the success rates of endodontic treatments (Nimeshkumar and Ekta, 2021). Thanks to developments in digital photography and software, photogrammetry has grown to be a reliable and affordable technique for dentists, with potential uses in the reconstruction of complete dental models (Stuani et al., 2019; Revilla-León et al., 2021). When it comes to evaluating dental wear, intraoral scanners (IOSs) are essential because they can address both structural and functional problems related to tooth wear. Notwithstanding their promise, more investigation is required to tackle the constraints associated with identifying minute variations in dental wear (Angelone et al., 2023; Kumar et al., 2019).

MRI has potential uses in dentistry because to its excellent soft tissue contrast and lack of ionizing radiation. MRI's promise as an advanced diagnostic tool is highlighted by its use in the diagnosis of apical periodontitis, conservative dentistry, endodontics, and implantology (Juerchott et al., 2018; Reda et al., 2021; Probst et al., 2020). According to Nimeshkumar and Ekta (2021), Stuani et al. (2019), and Angelone et al. (2023), prospects for these technologies include continuous improvements in CBCT methods, possible integration with artificial intelligence (AI) for automation and improvement, and ongoing innovation in IOS technology to overcome its shortcomings. Furthermore, further investigation is necessary to examine more sophisticated uses of MRI in dentistry, such as enhanced anatomical structure visualization and possible improvements to imaging sequences and designs (Juerchott et al., 2018).

## V. Conclusion.

To sum up, the incorporation of 3D imaging technology into dentistry has ushered in a revolutionary period that improves treatment planning and diagnostic accuracy across a range of dental specialties. These technologies have been crucial in changing the face of dental treatment, from the crucial function that CBCT plays in oral surgery, orthodontics, and endodontics to the developing uses of photogrammetry and the exciting promise of Intraoral Scanners (IOSs). With its great soft tissue contrast and radiation-free imaging capabilities, MRI is used in a variety of fields, including conservative dentistry, implantology, and apical periodontitis. The synergy between technology innovation and dental practice promises continual advances as research into refinements and developments continues, eventually improving patient outcomes and enhancing the discipline of dentistry.

## References.


[1]. Abu Arqub, Sarah Et Al. 2021. "Does Mini Screw Assisted Rapid Palatal Expansion (Marpe) Have An Influence On Airway And Breathing In Middle-Aged Children And Adolescents? A Systematic Review." International Orthodontics 19(1): 37–50. Https://Pubmed.Ncbi.Nlm.Nih.Gov/33516650/ (February 1, 2024).

[2]. Aktuna Belgin, Ceren Et Al. 2019. "Three-Dimensional Evaluation Of Maxillary Sinus Volume In Different Age And Sex Groups Using Cbct." European Archives Of Oto-Rhino-Laryngology.

[3]. Alkhayer, Ali, József Piffkó, Carsten Lippold, And Emil Segatto. 2020. "Accuracy Of Virtual Planning In Orthognathic Surgery: A Systematic Review." Head & Face Medicine 16(1). Https://Pubmed.Ncbi.Nlm.Nih.Gov/33272289/ (February 1, 2024).

[4]. Alshammery, Fahadabdullah. 2020. "Three-Dimensional (3d) Imaging Techniques In Orthodontics-An Update." Journal Of Family Medicine And Primary Care 9(6): 2626. Https://Pubmed.Ncbi.Nlm.Nih.Gov/32984098/ (February 1, 2024).

[5]. Alwadai, Ghadeer S. Et Al. 2020. "Monitoring Of Simulated Occlusal Tooth Wear By Objective Outcome Measures." Journal Of Dentistry 102.

[6]. Angelone, Francesca Et Al. 2023. "Diagnostic Applications Of Intraoral Scanners: A Systematic Review." Journal Of Imaging 2023, Vol. 9, Page 134 9(7): 134. Https://Www.Mdpi.Com/2313-433x/9/7/134/Htm (February 2, 2024).

[7]. Aras, Isil, Idil Unal, Gencer Huniler, And Aynur Aras. 2018. "Root Resorption Due To Orthodontic Treatment Using Self-Ligating And Conventional Brackets: A Cone-Beam Computed Tomography Study." Journal Of Orofacial Orthopedics = Fortschritte Der Kieferorthopadie : Organ/Official Journal Deutsche Gesellschaft Fur Kieferorthopadie 79(3): 181–90. Https://Pubmed.Ncbi.Nlm.Nih.Gov/29651519/ (February 1, 2024).

[8]. Chang, Lindsey Et Al. 2020. "Periradicular Lesions In Cancellous Bone Can Be Detected Radiographically." Journal Of Endodontics 46(4): 496–501.

[9]. Davidovich, Esti, Shlomi Dagon, Et Al. 2020. "An Innovative Treatment Approach Using Digital Workflow And Cad-Cam Part 2: The Restoration Of Molar Incisor Hypomineralization In Children." International Journal Of Environmental Research And Public Health 17(5).

[10]. Davidovich, Esti, Boaz Shay, Eyal Nuni, And Eitan Mijiritsky. 2020. "An Innovative Treatment Approach Using Digital Workflow And Cad-Cam Part 1: The Restoration Of Endodontically Treated Molars In Children." International Journal Of Environmental Research And Public Health 17(4).

[11]. Eğlenen, Merve Nur, And Mehmet Ali Yavan. 2023. "Has The Covid-19 Pandemic Affected Orthodontists' Interest In Various Orthodontic Appliances?" Turkish Journal Of Orthodontics 36(4): 216–23. Http://Www.Ncbi.Nlm.Nih.Gov/Pubmed/38164005 (February 1, 2024).

[12]. F. Esquivel-Upshaw, Josephine Et Al. 2020. "Novel Methodology For Measuring Intraoral Wear In Enamel And Dental Restorative Materials." Clinical And Experimental Dental Research 6(6): 677–85.

[13]. Fu, Xiaoming Et Al. 2017. "The Application Of Multi-Baseline Digital Close-Range Photogrammetry In Three-Dimensional Imaging And Measurement Of Dental Casts." Plos One 12(6).

[14]. Gambarini, Gianluca Et Al. 2021. "Influence Of Shaft Length On Torsional Behavior Of Endodontic Nickel–Titanium Instruments." Odontology 109(3): 568–73.

[15]. Hans, Mark G., J. Martin Palomo, And Manish Valiathan. 2015. "History Of Imaging In Orthodontics From Broadbent To Cone-Beam Computed Tomography." American Journal Of Orthodontics And Dentofacial Orthopedics: Official Publication Of The American Association Of Orthodontists, Its Constituent Societies, And The American Board Of Orthodontics 148(6): 914–21. Https://Pubmed.Ncbi.Nlm.Nih.Gov/26672697/ (February 2, 2024).

[16]. Haouili, Nada Et Al. 2020. "Has InvisalignImproved? A Prospective Follow-Up Study On The Efficacy Of Tooth Movement With Invisalign." American Journal Of Orthodontics And Dentofacial Orthopedics: Official Publication Of The American Association Of Orthodontists, Its Constituent Societies, And The American Board Of Orthodontics 158(3): 420–25. Https://Pubmed.Ncbi.Nlm.Nih.Gov/32620479/ (February 1, 2024).