JOURNAL OF HEALTHCARE SCIENCES
Volume 2 Issue 6 2022, Article ID: JOHS2022000456
http://dx.doi.org/10.52533/JOHS.2022.2605
e-ISSN: 1658-8967

Review

Digital Diagnostics and Orthodontic Practice

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Received: 18 June 2022, Accepted: 22 June 2022, Published: 23 June 2022

Abstract

Orthodontic diagnosis is mostly dependent on the patient's dental and medical history, clinical examination, study models, and cephalometric radiographs, which are the most important tool for orthodontic diagnosis since they are used to identify abnormalities in the dental and craniofacial skeleton. An ever-increasing array of digital technologies is transforming dental therapy in a variety of ways. Digital dental models, the use of digital dental set-ups to simulate the eventual result of orthodontic therapy, and three-dimensional imaging of the dentofacial region are among the technological advances that provided new choices for patient documentation. Digital records allow for a three-dimensional evaluation of a patient's dentofacial morphology, which is critical for orthodontic diagnostics and treatment planning. Additionally, these digital records increase record storage, access, conservation, communication with patients, and duplication possibilities. The purpose of this research is to review the available information about the digital diagnostics and orthodontic practice. Since the introduction of three-dimensional techniques, which have found different uses in orthodontics as well as oral and maxillofacial surgery, imaging technology in the dentistry sector has emerged as one of the most significant parts of identifying and managing oral problems. With the growing availability of cone-beam computed tomography, three-dimensional depiction of dentition, maxillofacial skeleton, and soft tissues in all phases of interactions is now possible. In orthodontics, digital scanning can be utilized for a variety of purposes. However, more research is needed to generate evidence-based results regarding the utilization of digital diagnostics in orthodontics.

Keywords: *digital, diagnosis, orthodontics, dental, dental practice*

Introduction

Orthodontics is one of the nine dental specialties that focuses on the identification of malocclusions with the goal of preventing and curing them. It is concerned primarily with the craniofacial skeleton, particularly having a focus on dentoalveolar modification. Because an accurate diagnosis and treatment plan is critical to the effectiveness of orthodontic treatment, orthodontists must be extremely exact when diagnosing and planning treatment. Orthodontic diagnosis is mostly dependent on the patient's dental and medical history, clinical examination, study models, and cephalometric radiographs, which are the most important tool for orthodontic diagnosis since they are used to identify abnormalities in the dental and craniofacial skeleton (1).

Orthodontic diagnosis is comprised of three components: facial, dental, and skeleton. An orthodontist's major job is to reposition the various components of the craniofacial complex in anatomical and dynamic balance while also making them aesthetically acceptable. This procedure necessitates knowledge of the relationships between all of the components of the craniofacial complex in three spatial planes. The majority of traditional diagnostic aids simply show a two-dimensional depiction of the patient (2). Advanced technology provides orthodontists with high-quality diagnostic evidence in three dimensions, allowing them to create effective treatment plans for their patients. Digital dental models, the use of digital dental set-ups to simulate the eventual result of orthodontic therapy, and three-dimensional imaging of the dentofacial region are among the technological advances that provided new choices for patient documentation. Recent and valuable technologies for orthodontic diagnosis and treatment planning include multi-slice computed tomography and lower dosage cone-beam computed tomography (3). Traditional two-dimensional recordings are still widely used, but emerging technologies may provide a more targeted selection of records to facilitate orthodontic diagnosis and treatment planning (4).

Dental professionals deal with a variety of changes in their jobs, many of which are influenced by societal changes. Innovations in the workplace and work as a result of the ongoing growth of digital technology are one example. Such technological advancements have the potential to transform a profession. In dental offices, for example, computerized administration has largely replaced handwritten and cabinet-filed patient data. Furthermore, an ever-increasing array of digital technologies is transforming dental therapy in a variety of ways. Intra-oral scanning, for example, has enabled dentists to transfer some of the manufactures of restorations into the practice, and computer-aided technology has allowed dentists to move part of the production of restorations into the practice with digital technology (5).

Diagnostic setups are often used to model different treatment possibilities and facilitate decision-making in treatment planning since 1947, when Kesling initially advised their usage. When considering extraction patterns, interproximal reduction, anchoring control, and other treatment mechanics, creating numerous setups to reflect different treatment strategies can be beneficial. Setups are also beneficial when it comes to presenting the situation to the patient and discussing treatment options with other dentists (6). Diagnostic setups that are as precise and dependable as wax setups may now be constructed digitally owing to the switch to digital research models. Dealing with digital setups provides new benefits not available with plaster, including the capability to overlay the setup over the existing model and the capacity to define the specific amount of activity for each tooth (7).

Digital records allow for a three-dimensional evaluation of a patient's dentofacial morphology, which is critical for orthodontic diagnostics and treatment planning. Additionally, these digital records increase record storage, access, conservation, communication with patients, and duplication possibilities. These, however, have some restrictions. As a result, an orthodontist must be well-versed in the indications, benefits, potential risks, and special recommendations that must be followed when employing these digital diagnostic devices. As a result, if these sophisticated treatments are employed creatively, the future of orthodontics looks brighter (8). The purpose of this research is to review the available information about the digital diagnostics and orthodontic practice.

Methodology

This study is based on a comprehensive literature search conducted on April 21, 2022, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference

http://dx.doi.org/10.52533/JOHS.2022.2605

lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the information about the digital diagnostics and orthodontic practice. There were no restrictions on date, language, participant age, or type of publication.

Discussion

One of the most complicated fields of dentistry, orthodontics and dentofacial orthopaedics, necessitates the careful analysis of a vast quantity of data in order to arrive at an accurate diagnosis and treatment plan. Since the introduction of three-dimensional techniques, which have found different uses in orthodontics as well as oral and maxillofacial surgery, imaging technology in the dentistry sector has emerged as one of the most significant parts of identifying and managing oral problems. The technological age that has transpired in recent times has had a tremendous impact on orthodontics. The orthodontist now has access to a wealth of digital documentation that aids in orthodontic diagnosis, treatment planning, as well as follow-up. Concurrent cone-beam computed tomography is increasingly used in conjunction with digital radiographs and digital pictures, which have largely supplanted traditional techniques of physical imaging (9).

There are various advantages of using digital models in orthodontics. These models can be stored on hard drives, memory sticks, CDs, and DVDs, obviating the need for additional storage space. If digital models are available, they can be utilized to gather information for diagnosis and treatment planning; they can also be used to assist the transfer of dental models and to create custom appliances using a virtual setup. These models can also be used to visualize orthodontic treatment programs. It is desirable and now possible to simulate orthodontic treatment results prior to the start of treatment. However, the exorbitant expense of gear and software, as well as a lack of training in dental virtual setup and software use, are now limiting its application in orthodontics (10).

Carvalho et.al states that intraoral scanning enabled a more thorough diagnosis, as well as more precise and efficient treatment planning. However, there are certain drawbacks, such as the scanner tip size, which makes reading the maxillary tuberosity region difficult. Other limitations include the patient's mouth opening restriction, humidity management such as saliva, and light reflection by mini-implants and bars during scanning. When the obtained files are merged with cone-beam computed tomography information, facial digital scanning has a significant application in situations of orthodontic treatment accompanied with orthognathic surgery. Facial scanners are useful for facial analysis investigations, but they are still expensive or, in the context of the newer, more economical, and portable systems, have accuracy limitations (11).

Findings of a pilot study conducted in United Kingdom in 2014 revealed that treatment planning was carried out by four expert orthodontists, first following a clinical examination, then using normal records, and finally utilizing digital data. For half of the observers, a variation in the diagnostic information format influenced treatment planning repeatability. When compared to digital records, inter-observer repeatability was higher when using hard copy records. There were no participants who were dissatisfied with their face-to-face sessions (12). Another retrospective clinical study conducted in 2015 showed that for all parameters studied, the concordance and uniformity of digital and manual measurements were significant. There was high reliability in terms of measurements. Digital models created by a cone-beam computed tomography scan of traditional casts are suitable for trustworthy diagnostic measurements that compare favourably to those acquired from plaster casts, the current gold standard (13). Results of a systematic review in 2016 depicted that digital model provide the same precision, reliability, and reproducibility as traditional plaster models. The largest constraint appears to be landmark identification instead of the measuring instrument or software. Furthermore, digital models could be considered an emerging gold standard in contemporary practice owing to their advantages in terms of cost, time, and space requirements (14).

Results of cross-sectional study assessing the impact of digital diagnostics in orthodontic treatment planning showed that in 9.2% of the cases, the treatment strategy was significantly altered after examining the digital setups. Changes such as modifying the extraction pattern or recommending space closure rather than opening space for an implant were among them. In another 14.4% of patients, treatment plans were modified in some way, such as by adding interproximal reduction or temporary anchoring devices. The practitioner's trust in the treatment plan improved the greatest when the treatment plan was altered, and almost all practitioners had high confidence levels. The capacity to overlay the setup with the original model, calculate the amount of tooth movement required, check the final incisal relationship such as overjet and overbite, and determine the amount of interproximal reduction required were among the most

http://dx.doi.org/10.52533/JOHS.2022.2605

useful features of digital setups, according to practitioners (15).

There are several advantages of digital radiography over traditional radiography in field of orthodontics such as while the patient is still seated, the image can be visualized, the chance of the video being incorrectly linked to another patient's file is reduced, printing errors are no longer a possibility. Allows for rapid adjustment of brightness and contrast inconsistencies. Calibrates photos as soon as possible. Allows the digital radiograph to be overlapped with the digital picture. Provides photos of a higher quality than the standard (16). The application of digital diagnostics such as cone-beam computed tomography in field of orthodontics include an examination of the skeletal and dental structures, jaw skeleton relationship, symmetry or asymmetry, three-dimensional analysis of impacted tooth structure and location. Evaluation of progress, analysis of the pharyngeal airway, three-dimensional analysis of the temporomandibular joint complex and evaluation of a cleft palate (17).

In orthodontics, digital scanning can be utilized for a variety of purposes. This is mostly determined by the devices, software, clinicians, and laboratories capabilities. Treatment planning, indirect bonding tray fabrication, palatal and lingual custom appliance design, and construction, clear aligner technology, orthognathic surgery simulation, and wafer construction, and, more recently, the scoring of surgical outcomes in patients with cleft, lip, and palate abnormalities have all been described as applications (18). It is now possible to create digital orthodontic setups owing to the growing use of digital dental models. These allow the comparison of different orthodontic treatment choices and sharing them with other orthodontists and healthcare professionals. Furthermore, digital setups make it easier to provide therapeutic options to patients and their legal guardians, helping them to comprehend which therapy option is ideal for them. Digital settings appear to have advantages over manual setups. The program is simple to understand and use at first. Furthermore, picture configurations are simple to preserve since they do not need large physical locations, unlike plaster models, which have high storage expenses in many places across the world. Finally, because setups may be transmitted over the internet, contact between specialists and patients is improved, eliminating any damage during transport and handling. This benefit is also stated by several authors in the context of digital models (19).

An accurate diagnosis of skeletal dentofacial abnormalities is required before orthodontic treatment can begin. Detecting occlusal characteristics is a critical part of diagnosing orthodontic problems. Several studies have shown that traditional methods do not accurately measure dimensional occlusal force. Digital occlusal analysis in diagnosis, on the other hand, allows us to learn about the type of occlusal interference and its association with temporomandibular joint symptoms. Improving the administration and equipping dental clinics with contemporary equipment and technology for the assessment and restoration of dentofacial problems is one of the most essential actions that must be addressed (20).

With the growing availability of cone-beam computed tomography, three-dimensional depiction of dentition, maxillofacial skeleton, and soft tissues in all phases of interactions is now possible. With the advent of cone-beam computed tomography technology, two major innovations have been presented to clinical orthodontic treatment. The possibility of reconstructing cone-beam computed tomography data to generate novel images previously inaccessible in orthodontic treatment and allowing viewing facial anatomic features and the teeth in three-dimensional from limitless angles is the most noticeable advantage for the physician. The ability to create traditional pictures such as panoramic radiography and lateral and posteroanterior cephalograms from a single cone-beam computed tomography scan is the second benefit (21). One of today's significant diagnostic tool advances in orthodontics is the development of digital scanners coupled with computer-aided design. The assessment for diagnosis, treatment planning, and prediction of the eventual outcome is one of the most important applications in orthodontics. However, the research studies regarding the clinical application and evidence of utilization of digital diagnostics in field of orthodontics are lacking. Hence, more clinical research-based studies are need of time to better signify the importance and benefit of digital diagnostics in orthodontics clinically.

Conclusion

Digital technology has already become important in modern dentistry, and three-dimensional technology in orthodontics has grown in popularity in recent years. Intraoral and face scanners, digital radiology, and cone-beam computed tomography have all helped to convert diagnostic and treatment planning from a two-dimensional to a three-dimensional approach. However, more research is needed to generate evidence-based

http://dx.doi.org/10.52533/JOHS.2022.2605

results regarding the utilization of digital diagnostics in orthodontics.

Disclosure

Statement:

The authors declare no conflict of interest.

Funding:

No funding.

Ethical consideration:

Non-applicable.

Data availability:

Data that support the findings of this study are embedded within the manuscript.

Authors' contribution:

All authors contributed equally to the drafting, writing, sourcing, article screening and final proofreading of the manuscript.

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