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Diagnostic aids in dentistry-An overview

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ABSTRACT

Oral Diagnosis" simply represents "analysis of the inner mouth". An effective treatment for any oral disease is only feasible if correct and precise diagnosis has been made. In field of dentistry oral diagnosis involves examination and finding all problems inside and outside of the oral cavity by using scientific knowledge and also to find the relationship between them. Thus helping in making final accurate treatment plan based on the collected findings. Efficient treatment for any dental problem needs accurate diagnosis. Diagnosis involves collection of information by history taking and clinical examination of patient which is confirmed by using various diagnostic aids and more precise and elaborated information is obtained from these diagnostic aids. This paper will discuss various diagnostic aids used in dentistry.

1. Introduction

The word diagnosis is came from two Greek words "dia" and'gnosis" which means "through" and "knowledge" respectively.[1] So "to diagnose" means to gain through knowledge about the disease. Diagnosis can be a complex procedure.[1,2] An accurate and feasible treatment plan does not just happen, but created from sequence of steps taken carefully. The two prime steps in diagnosis are History taking and clinical examination for the patient assessment procedure, and these two steps complement each other to such an extent that it is not feasible to make a successful treatment plan for a problem without collaborating and correlating findings obtained from these two steps.[3]

The oral cavity of an individual consists of:

1. Hard tissues of oral cavity include bones such as maxilla & mandible, palate, and teeth.
2. Soft tissues include periodontal ligament, gingiva, soft palate, tongue, floor of the mouth, muscles, cheeks & lips. The most commonly affected tissue by diseases are teeth and the periodontium.[4]

A successful diagnosis for oral problems can be made through intra oral examination, extra oral examination, radiological examination and using other diagnostic aids. An extraoral examination is inspection outside the oral cavity that includes examination of the tissues in and around the oral cavity such as examination of facial parts, jaws which are maxilla and mandible, temporomandibular joint, lips, nose, neck, and chin etc. Intraoral examination involves examination of all the teeth in a systematic manner for any problem, gingiva, periodontal ligament, plaque, calculus accumulations, examination for presence of any cyst, tumor, or abscess, mobility and caries of teeth, defective restorations of teeth, alterations in color, count, and shape of teeth and changes in periodontium and malocclusion involving teeth and both jaws. After

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examination of individual teeth for associated problems, both maxilla and mandible of patient are inspected in terms of mouth closure and their relationship with each other whether it is normal or not. After completion of intra and extra oral examination, it is duty of clinician to inform the patient for any further investigation needed or any necessary treatment for their teeth that presently is not problematic but can cause discomfort in future.

Oral dia gnosis is complicated process like diagnosis of diseases in other parts of the body. Diagnosis is complicated by various factors such as;

1. Different diseases have similar symptoms E g pulpitis and atypical odontalgia have same symptoms.
2. Sign of a disease is any change in body which is perceived by clinician. Some different diseases may be similar for their signs. E.g. An ulcer may be caused by minor trauma or potentially be a squamous cell carcinoma.
3. Signs and symptoms may be hidden. So it is dentist's duty to find out these by careful examination and questioning.
4. Signs and symptoms of same diseases may be different in different patients 5.

1.1. Steps in diagnosis

1. History of patient
2. Examination
3. Diagnostic tests

1.2. History

It is personal account of patient's problem and is has prime importance in clinical diagnosis. Sometimes patient is unable to provide accurate history for his/her problem, then questions may be asked to patient's parent or guardian. However, history from patient is preferred as third person may provide variable interpretation of the problem. The main objectives of taking history are: to establish good rapport with patient, to collect appropriate information for provisional diagnosis and to know patient's expectations for treatment.

The history taking includes: short Introduction of patient, giving attention to patient's problem and structured questioning to gather needed information. This structured questioning involves questions related to present chief complaint of patient, present and past medical history, past dental history, family history of patient and also his/her social history.

1.3. Examination

This step of diagnosis includes observation of patient's general health, extra oral examination of head and neck region and intra oral examination.

Intra oral examination must be done in a systematic approach so that all areas are examined. Intra oral examination involves examination of intra oral soft and hard tissues such as tongue, floor of mouth, gingiva, periodontal ligament, hard palate and soft palate, salivary glands, mucosa lining the oral cavity and teeth. Examination is done with gloved hands using mouth mirror and explorer. Visual inspection supplemented by palpation of any suspicious lesion is done.

After taking history and performing clinical examination, it is possible to form provisional diagnosis. For confirmation of this provisional diagnosis, diagnostic tests are needed.[5]

Various diagnostic aids are used for diagnosis and treatment planning for different types of dental problems.

1.4. Diagnostic aids for caries detection

Accurate detection of caries at appropriate time is important part for its management. The advanced Diagnostic aids for caries detection are**:**

1. Fiber-optic trans illumination (FOTI)
2. Wavelength dependent FOTI
3. Digital imaging FOTI (DIFOTI)

1.5. Fiber-optic transillumination (FOTI)

This method uses a light emitting diode for detecting caries, in this method a narrow beam of white light is used to trans illuminate the tooth for detecting caries presence. This method, is based on the fact that index of light transmission of carious enamel is less than sound enamel. The crystalline structure of enamel and dentin get disturbed due to demineralization, leading to more light absorption resulting from changes in the light scattering and absorption of light photons. This gives that area a more darkened appearance as compared to other normal areas.[6]

FOTI was first introduced by Friedman and Marcus in 1970 for the detecting proximal caries. For diagnosis of posterior proximal caries light probe is placed on the gingiva below cervical margin of the tooth, whereby light passes through the tooth structures making proximal decay area of tooth appears as dark shadow on the occlusal surface. This method has higher sensitivity for dentin lesions as compared to enamel lesions.

A large proportion of results obtained from this method are false-negative results so it is not routinely used method by dental clinicians and is not recommended as a technique of choice in clinical practice.

1.6. Advantage of FOTI is

1. This method has most favorable positive predictive value performance, which means that any positive value obtained with this method is indicative of certain presence of a lesion.

2. There is no exposure to radiation using this method.
3. Using this method one can achieve instant images and it is simple to use.
4. Use of this technique is time saving, and its use does not cause any discomfort to patients.[7]

1.7. Wavelength dependent FOTI

In case of incipient white-spot lesions, mineral loss is associated with an increase in light scattering. In older, discolored lesions, light absorption is also increased. The induced effect at the occlusal surface is resulted from combination of material properties and the distance that light travels through tooth structure from the source of light to detector. This combination effect is referred as "effective decadic optical thickness" and it depends on the wavelength of light. It is considered that, in the case of small sized lesions, this effective decadic optical thickness increases linearly with loss of mineral structure.[8,9]

1.8. Advantages

1. This method provides quantitative information regarding the depth of the lesion.
2. With this method, no radiation hazard to patients.

1.9. Limitations

1. This technique is not applied in all areas of carious lesions.
2. There is considerable intra and inter-examiner variations, when using this method.

1.10. Difoti

This method was found to eliminate the shortcomings of previous method that is FOTI. This method combined FOTI with a digital charge-coupled device (CCD) camera. This is one of the approved diagnostic aids for detecting incipient, frank, and recurred caries lesions.[10] It can also be used for diagnosing fractures, cracks, and secondary caries which occur around restorations.

1.11. Principle

More light is absorbed by carious part of tooth than surrounding non carious normal part of tooth and it is darker in appearance than normal tooth structure. DIFOTI technique consists of two handpieces (one headpiece for occlusal surface of tooth and other for smooth, interproximal surfaces of tooth), a disposable mouthpiece, a foot pedal which is used for selecting the image of focus along with a computer system to record and preserve the resulting image.

1.12. Advantages

It gives instant images which can be stored for future uses.

1.13. Shortcomings of DIFOTI

It does not give any information regarding depth of lesion.

1.14. Diagnodent

Diagnodent is a device which is based on laser fluorescence measuring the difference between the fluorescence of normal dental tissue and carious dental tissue. DIAGNOdent provides a different score to each tissue thus, reducing human error.[11,12] Various studies reported the higher accuracy of DIAGNOdent comparing to radiographic evaluation,.

Diagnodent with a laser diode produced a pulsed 655 nm laser beam through a central fiber, which reached to tooth through the tip of this tool. The fluorescence intensity produced depends on the extent of demineralization or accumulation of bacteria in the probed area.

1.15. Advantages

1. This tool is 90% effective in diagnosis of pit and fissure lesions.
2. This method has higher sensitivity as compared to electronic caries monitor.
3. It has more reproducibility and reliability.
4. It is simple, quick method, and also fast to transport.
5. It is non-invasive and causing no pain.
6. Its use is safe, and it causes no X-ray radiation hazards.

2. Limitations

1. It produces false results if plaque and debris are present.
2. It is unable to differentiate between less mineralized tooth part and part of tooth with caries.
3. Values obtained from this tool do not show any relationship with the amount of damaged dentin.
4. It cannot be used for detecting recurrent carious lesions.

2.1. Cariescan

In this method electrical current is passed through the tooth to detect any lesion and to find the location of the decay area. It is the first dental diagnostic tool making use of an impedance spectroscopy to find dental caries at earliest stage so that preventative intervention can be done for it. Cariescan cannot be affected by optical factors such as staining or discoloration of the tooth. Using this method, qualitative readings are achieved based on the disease state instead of the optical properties of the tooth.[13]

Bader et al.[14] in their systematic review article where they compared CarieScan with other methods like clinical visual examination, bitewing radiograph, and DIAGNOdent. They observed that this method is more sensitive and specific as compared to other techniques.

3. Digital Subtraction Radiography (DSR)

Subtraction methods were introduced by B.G.Zeides des Plantes in the 1920s.Subtraction image technology avoids background features and decrease the background complexity, compress the dynamic range, and also amplify the small variations by superimposing the scenes achieved at different times.[14,15] Subtraction radiography use was started in dentistry in 1980 and it was used to compare standardized radiographs taken at sequential examination. Structures showing no change were subtracted and presented in neutral gray shade in the subtraction image. Areas that had changed represented in darker or lighter shades of gray color.[16] The principle behind this technique is that two digital radiographic images received at variable time intervals, with the same projection geometry, are spatially and densitometrically aligned using specific software. This technique counteracts the complex anatomic background, against which the fine changes occur. This makes the alterations more remarkable.

3.1. Applications

1. This method is used to evaluate the healing of periapical lesions
2. Used for evaluating development, ending or decline of carious lesion
3. It is also helpful in temporo-mandibular joint examination along with panaromics.[17]

3.2. Tuned aperture computed tomography (TACT)

It is a faster method by which tomographic images can be reestablished. It was developed by Webber and colleagues. It is based on tomo-synthesis and optical-aperture theory. TACT utilizes two dimensional periapical radiographs obtained from variable angles used for projection as base images and allows retrospective production of longitudinal tomographic slices which are lined up in the Z axis of the area of focus. It generates true three dimensional records from any number of arbitrarily positioned two dimensional projections. This method is powerful alternative to other conventional methods.[18] Radiation used in this method is not more than one or two times that is used in conventional periapical X-ray film technique and the resolution of this method is same as 2-D radiographs.[19]

In 1998, Nair et al.[20] observed that this type of computed tomography is more potent imaging technology than film or individual digital images for detecting recurrent carious lesions. Webber et al.[21] in 1999 also reported that it is more diagnostically informative. It is powerful tool for the determination of root fractures, especially vertical fractures. It is also useful in identifying radicular fracture or mandibular fracture, identification of the caries and extra canal present in root of a tooth more precisely as compared to conventional techniques. It can also be used in finding the degree of radiopacity of restorative material used for restoration overlying or adjacent to it.[22]

3.3. Infra-Red thermography

Infra-Red thermography is a branch of science based on detection of infrared radiation from an object at temperature above absolute zero. The energy is recorded by using a detector is processed to generate a pixel map containing temperature values defined using a color scale.

As there is association between body temperature and metabolism of tissues, this connection permits thermal imaging to be used for assessing diseases, injuries and inflammation in the body and also helps in follow-up and tracking of treatment procedures.[23]

It can be used for detection of infra alveolar nerve defect, diagnosis of TMJ disorder and observing endodontic treatments.[17]

Infrared thermography is method that can be used to inspect all diseases that were difficult to diagnose in field of dentistry. This is safe and simple technique to use. It is well accepted by patients as its use is painless and straightforward to perform, so it has become an prime part of complicated diagnostic procedures, such as in diagnosis of various diseases in the field of social interaction, emotion feeling, including dentistry.[23,24]

3.4. Infrared thermography is also used

1. It is used for neurodegenerative and musculoskeletal diseases.
2. Used for examination of the temporomandibular joints helping to make treatment more successful and also to arrest crippling deformation of the joints
3. For evaluation of craniomandibular disorders.
4. For detecting the diseases associated with carotid occlusion.
5. Used for quantification of the effects of post-surgical inflammation.[25]

3.5. Laser doppler flowmetry (LDF)

LDF is a noninvasive, objective, painless, semi-quantitative method, has been shown to be reliable for measuring pulpal blood flow. LDF technique is based on Doppler effect which was first described in 1842 by Austrian physicist Christian Doppler in a paper entitled ‘On the Colored Light of Double Stars and Some Other Heavenly Bodies’. Laser Doppler flowmetry is an optical measuring method that allows the number and velocity of particles conveyed by a fluid flow to

be measured. The particles (1–20 lm) must be big enough to scatter sufficient light for signal detection but also small enough to follow the flow faithfully.

The original technique utilized a light beam from a helium–neon (He–Ne) laser emitting at 632.8 nm. Some other wavelengths of semi-conductor laser have also been used that are 780 nm and 780–820 nm. Laser light is transmitted to the dental pulp by using a fibre optic probe placed against the tooth surface Two equal-intensity beams (split from a single beam) intersect across the target area. The scattered light beams from moving red blood cells will be frequency-shifted whilst those from the static tissue remain unshifted in frequency. The reflected light, composed of Doppler-shifted and unshifted light, is returned by an afferent fibre within the same probe to photodetectors in the flowmeter and a signal is produced The photodetectors change the interference pattern arising from the mixing of shifted and unshifted light into a semiquantitative measurement of blood flow, termed the Flux signal, which is measured in arbitrary units. The received signal is calculated with a preset algorithm in the LDF machine. The LDF output signal or Flux can be simplified as a function of the product of red blood cells' concentration as well as their mean velocity.[26,27]

4. Indications

1. Used for estimation of the pulp vitality
2. It is used for Pulp-testing in children as in children other sensibility tests are not reliable, because these are subjective test based on patient's response, so this method is appropriate for the measurement of PBF in primary incisors.
3. For estimating gingival or sulcular blood flow in healthy and disease conditions
4. For estimation of the degree in healing and revascularization of surgical wounds
5. To check the impact of orthodontic treatment therapy or the injection of vasoconstrictive anaesthetics on blood flow.
6. Sometimes, periapical radiolucencies may have non endodontic origins, in such cases LDF can help in differential diagnosis.
7. It helps in monitoring age related changes in PBF
8. For observing the effect of exercise on PBF. It has been reported that PBF alters during exercise, and there is average 38% change occurs from the level at rest.
9. Monitoring of reactions to electrical or thermal pulp stimulation
10. For estimating PBF after orthognathic surgery. Patients undergoing a segmental maxillary osteotomy or Le fort I osteotomy, showed significant decrease in pulpal sensibility in teeth which are present in the osteotomized segment or maxilla.
11. Monitoring of revascularization of replanted teeth: LDF values precisely predict the pulp status in vital vs nonvital teeth.[26–28]

5. Cone Beam Computed Tomography (CBCT)

G.N. Hounsfield, in 1972 launched computerized transverse axial scanning system which resulted in introduction of Computed Tomography (CT). Conventional CT machine uses a fan shaped X- ray beam and captures a series of axial plane slices or from a continuous spiral motion over the axial plane. But in a CBCT machine, a cone-shaped beam is used and a reciprocating solid state flat panel detector, that rotates once around the patient, 180-360 degrees, covering the defined anatomical volume instead of slice-by-slice imaging found in conventional CT. The scanning time of CBCT equipment is variable ranging from 5 to 40 seconds according to manufacturers recommendations. The X-ray parameters used in CBCT are comparable to that used for panoramic radiography with a usual operating range of 1-15 mA at 90-120 kVp.[29]

User-friendly viewing software comes with CBCT machine containing basic three dimensional imaging tools. Third party software is available at a broad range of price, providing great tools to investigate and do treatment plans. These third party softwares are also used to fabricate surgical guides, virtual study prototypes, and laser based resin models, making the process of diagnosis, treatment plan and delivery of the treatment more easy.[30,31]

6. Applications in Endodontics

CBCT helps in:

1. Diagnosis of periapical lesion
2. Visualisation of canal

For detection of root fracture and for identifying dento-alveolar trauma as well

7. Application in Periodontics

For visualization of lamina dura, crater defects of bone, furcation involvement and to check bone quality.

7.1. Orthodontic application

CBCT is used for the diagnosis and treatment planning of much complex orthodontic malocclusions such as in facial growth problems, tooth eruption problems or impacted teeth, cleft lip and palate and in orthognathic surgical treatment or craniofacial surgery.[32]

7.2. Paranasal sinus evaluation

The inner walls of the paranasal sinuses are covered with a thin layer of mucosa which is less than 1 mm

in thickness and is typically not seen radiographically. Procedures involve sinus lift and removal of foreign body is two important indications which need a CBCT scan. CBCT helps in finding three-dimensional location of a foreign body within the maxillary sinus and this will be helpful in finalizing the most suitable surgical approach for removal of foreign body from sinus.[33,34]

7.3. TMJ (Temporo mandibular joint) evaluation

A CBCT scan is used for examination of osseous alterations in the mandibular condyle or glenoid fossa of the temporal bone. These osseous changes may be created from trauma/fracture, degenerative changes or neoplastic processes.[35,36]

Bony surface can be checked in all dimensions for the detection of any pathology such as cortical erosion, subchondral sclerosis, flattening and subchondral cysts.[32]

7.4. Implant site assessment

In 2D images, the buccolingual width of the alveolar bone and cortical plates cannot be precisely checked which may result in errors in implant positioning and a compromised final outcome of treatment.CBCT technology provides accurate assessment of dimensions and contours of the residual ridge in a buccolingual dimension. CBCT used multiplanar and 3D images to aid in determining the exact height, width and alveolar ridge anatomy of the alveolar bone, as well as the relationship of the edentulous sites with adjacent anatomical structures.[37]

7.5. CBCT in oral and maxillofacial surgery

The exact location of impacted tooth can be identified. It is always necessary to access the proximity of the impacted tooth to inferior alveolar canal in mandible and Maxillary sinus in maxilla and palatal orientation of canine.[32]

7.6. CBCT in identification of pathological condition

It is used to access any pathological conditions such as lesions, cyst, or tumors.[32]

7.7. Advantages of CBCT

1. Low radiation exposure in this technique.
2. It is convenient and cause no pain to patients
3. Helps in the diagnosis and treatment planning.
4. Better analyze position and orientation of surrounding structures.
5. It is cost effective technique.
6. Its use is safe for patients from any age.[38]

7.8. Disadvantages of CBCT

1. It provides less contrast resolution.
2. Emits radiation
3. Streaking and motion artifacts are possible.[38]

7.9. OrthoCad

It is technology used for digital study model collection and evaluation. In this method an optical scanner is used to filming the model's picture from its plaster equivalent. Then using the patent Ortho Cad software user interface, they are presented to the orthodontist, who may manipulate the models in virtual space as well as collect data using a variety of diagnostic instruments. An accurate bite record and high-quality impressions are necessary for using this technology. Impressions taken with high-quality alginate, polyvinyl silicone, or polyether are acceptable. Alginate impressions are taken, cleaned by wrapping them in a heated paper towel and then sealed in a plastic bag to retain the moisture. For long-term storage and transit, polyether materials may be used. Plaster counterparts from impressions are made and optically scanned into the Ortho Cad computer system without damaging the original plaster counterparts. The patient's 3D virtual models are saved to the computer. Ortho Cad D3 browsers enable models to be seen from five distinct angles at the same time, eliminating the need to rotate.[39,40]

7.10. Advantages

1. Data can be stored with ease and efficiently.
2. Data can be retrieved and seen along with the patient's other clinical data such as digital photographs, X-rays, history and clinical notes in digital file of patient at the chair side.
3. Data can be easily shared with other clinicians through hard copies or email attachments.

Disadvantages: Virtual models obtained with this method cannot be installed and described in terms of the TMJ capabilities of patients. They are costly, as well as more time-consuming. Most orthodontists only employ them in 10% of their practices.[41]

7.11. Ultrasonography (USG)

USG is a noninvasive aid that utilizes very high-frequency pulsed ultrasound beam. The contrast medium used over the years in USG allowed radiologists or clinicians to evaluate blood flow and its echogenecity more precisely. This imaging system is based on the detection and presentation of acoustic energy reflected from interfaces within the body. It is an important and versatile medical and dental imaging tool.[42]

7.12. Applications

1. It is used for assessing swallow pattern.
2. In imaging of position of condyle.
3. For detecting Zygomatic fracture.

4. For assessment of Muscle mass.
5. To evaluate root resorption induced by Orthodontic treatment.
6. To fasten orthodontic tooth movement.[43]
7. Intraoral USG is considered to be more convenient and accurate in the evaluation of tumor depth instead of the most commonly used imaging techniques such as CT or MRI in patients with tongue carcinomas.

8. Used for Differential Diagnosis of Periapical Lesions[44]

8.1. Radiographs

1. *Cephalograms:* Cephalograms used in orthodontic diagnosis. Using various anatomical landmarks, taking linear and angular measurements, these are used for assessing the growth pattern, decision for extraction plan, determining type of malocclusion, need for surgery, and degree of proclination/retroclination of teeth. They are also used to evaluate skeletal maturity of patient using cervical vertebrae. Postero-anterior or frontal cephalograms are also used to evaluate facial asymmetry. These are also used to evaluate Orthodontic treatment results.
2. *Orthopantomograph (OPG):* It is used for pre and post-treatment comparison, for examining the presence or absence of teeth, root length of a tooth, axial inclinations of teeth, morphological structure and TMJ examination. An OPG also provide information regarding the number, position and growth of all the teeth including those teeth that have not yet erupted to occlusal level.[45]

8.2. Pulse oximetery

It is a noninvasive oxygen saturation monitoring diagnostic tool which is broadly used in medical field for evaluating blood oxygen saturation levels at the time of the administration of intravenous anesthesia through the use of finger, foot or ear probes. It was introduced by Takuo Aoyagi, who was a biomedical engineer working for the Shimadm Corporation in Kyoto, Japan, in early 1970s. Red and infrared wavelengths are used in this technique to transilluminate a tissue bed, for detection of absorbance peaks due to pulsatile blood circulation and this information is used to calculate oxygen saturation and pulse rate.[7]

9. Equipment

1. *Pulse oximeter probe/ pulse oximeter sensor (POS):* It consists of two light-emitting diodes (LEDs) - One transmits red light and the other transmits infrared light.. It operates at 500 on/off cycles /sec.

2. *Pulse oximeter monitor:* It provides digital display of oxygen saturation values and connects to POS.

3. *Photo detector:* It detects the amount of light absorbed by oxygenated and deoxygenated hemoglobin and connected to a microprocessor.[46]

Beeby and Thurlow[47] evaluated the Nellcor N-100 pulse oximeter in a dental outpatient clinic in 30 children requiring tooth extractions under general anesthesia. This device gave early warning of airway obstruction before that had been recognized clinically by the anesthetist. Mueller reported that pulse oximetry to be "more sensitive to hypoxemic alterations than measurements of heart rate, blood pressure, respiratory rate or visual observation of cyanosis in sedated pediatric dental patients."

The pulse oximeter may be useful in medically compromised patients. Also, this type of monitoring beneficial for Oral surgeons, periodontists and others clinicians who use conscious sedation techniques.[48,49]

10. Conclusion

Impaired oral hygiene can lead to various problems ranging from caries, tooth sensitivity to more advanced gum disease and loss of tooth in extreme conditions. However, appropriate oral hygiene, regular dental checkups and appropriate treatment can easily prevent and cease further worsening of most of dental problems. Facial and smile esthetics may be impaired due to various types of malocclusions and malocclusions also lead to impaired oral hygiene and occlusion functioning. So treatment of such malocclusions is also necessary. To provide the most suitable and effective treatment for any dental problem needs accurate diagnosis and treatment plan.

An effective and feasible treatment plan does not just happen, but it is result of sequence of systematic steps taken carefully such as history taking and clinical examination. Information gained from these two is further confirmed and elaborated with the help of various diagnostic aids. We are fortunate to have variety of diagnostic aids, introduced in the last century to detect the disease at early stage rather than later, which permits their treatment at initial phase.

As the field of dentistry is moving towards a more conservative approach when treating dental problems. Recent diagnostic technologies help in detection of dental problems at their early stages, which helps in providing non-invasive intervention as early as possible to prevent further damage.

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None.

12. Conflict of Interest

None.

References

1. Thylstrup A, Fejerskov O. Textbook of clinical cariology. 2nd ed. Copenhagen (Denmark: Munksgaard; 1994. Available from: https://www.worldcat.org/title/textbook-of-clinical-cariology-ed-by-anders-thylstrup-ole-fejerskov/oclc/30742792?referer=di&ht=edition.
2. Ekstrand KR, Ricketts DN, Kidd EA. Occlusal caries: pathology, diagnosis and logical management. *Dent Update*. 2001;28(8):380–7.
3. Newsome P, Smales R, Yip K. Oral diagnosis and treatment planning: part 1. Introduction. *Brit Dent J*. 2012;213:15–9.
4. Braga MM, Mendes FM, Ekstrand KR. Detection activity assessment and diagnosis of dental caries lesions. *Dent Clin N Am*. 2010;54(3):479–93.
5. Birnbaum W, Dunne SM. Oral Diagnosis: The Clinician's Guide. and others, editor; 2010. p. 320.
6. Abogazalah N, Ando M. Alternative methods to visual and radiographic examinations for approximal caries detection. *J Oral Sci*. 2017;59(3):315–37.
7. Saxena AS, Patle B. Advanced diagnostic aids in endodontics. *J Indian Acad Oral Med Radiol*. 2011;23(3):221–4.
8. Bosch T, Van Der Mei J, Borsboom HC. Optical monitor of in vitro caries. A comparison with chemical and microradiographic determination of mineral loss in early lesions. *Caries Res*. 1984;18(6):540–7.
9. Brinkman J, Bosch JJ, Borsboom PC. Optical quantitation of natural caries in smooth surfaces of extracted teeth. *Caries Res*. 1988;22(5):257–62.
10. Kidd EA. Essentials of Dental Caries. 3rd ed. and others, editor. Oxford University Press; 2005. p. 42–4.
11. Lussi A, Imwinkelried S, Pitts N, Bottom CL, Reich E. Performance and reproducibility of a laser fluorescence system for detection of occlusal caries in vitro. *Caries Res*. 1999;33(4):261–7.
12. Shi XQ, Welander U, Månsson BA. Occlusal caries detection with KaVo DIAGNOdent and radiography: An in vitro comparison. *Caries Res*. 2000;34(2):151–9.
13. Amaechi BT. Emerging technologies for diagnosis of dental caries: The road so far. *J Appl Phys*. 2009;105:102047–56.
14. Woo B, Zee KY. In vitro calibration and validation of a digital subtraction radiography system using scanned images. *J Clin Periodontol*. 2003;30(2):114–32.
15. Vannier MW. Subtraction radiography. *J Periodontol*. 1996;67(9):949–50.
16. Hekmatian E, Sharif S, Khodaeian N. Literature review Digital Subtraction Radiography in Dentistry. *Dent Res J*. 2005;p. 2–8. Available from: https://applications.emro.who.int/imemrf/drj_2005_2_2_106.pdf.
17. Pandey D, Chaturvedi P, Shuklai V. Recent Diagnostic Aids in Endodontics. *IOSR J Dent Med Sci*. 2020;19(6):1–05.
18. Shah N, Bansal N, Logani A. Recent advances in imaging technologies in dentistry. *World J Radiol*. 2014;6(10):794–807.
19. Krishna RN, Solete P. Recent Diagnostic Aids in Endodontics- A Review. *Int J Pharm Clin Res*. 2016;8(8):1159–62.
20. Nair MK, Tyndall DA, Ludlow JB, May K. Tuned aperture computed tomography and detection of recurrent caries. *Caries Res*. 1998;32(1):23–30.
21. Webber RL, Messura JK. An in vivo comparison of diagnostic information obtained from tuned-aperture computed tomography and conventional dental radiographic imaging modalities. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 1999;88(2):239–47.
22. Barnett SB, Ziskin C, Rott HD. Duck FA MK. International recommendations and guidelines for the safe use of diagnostic ultrasound in medicine. *Ultrasound Med Biol*. 2000;26(3):355–66.
23. Campbell J. Guidelines for Dental-Oral and Systemic Health Infrared Thermography. *Pan Am J Med Thermol*. 2015;2(1):44–53.
24. Haddad DS, Brioschi ML, Vardasca R, Weber M, Crosato EM, Arita ES. Thermographic characterization of masticatory muscle regions in volunteers with and without myogenous temporomandibular disorder: preliminary results. *Dentomaxillofac Radiol*. 2014;43(8):20130440. doi:10.1259/dmfr.20130440.
25. Nasution1 A, Pankov N. The Advantage and Basic Approach of Infrared Thermography. *J Int Dent Med Res*. 2020;13(2):731–7.
26. Vaghela DJ, Sinha AA. Pulse oximetry and laser Doppler flowmetry for diagnosis of pulpal vitality. *J Interdiscip Dent*. 2011;1(1):14–21.
27. Jafarzadeh H. Laser Doppler flowmetry in endodontics: A review. *Int Endod J*. 2009;42(6):476–90.
28. Todea C, Canjau S, Miron M, Vitez B, Noditi G. Microcirculation Revisited - From Molecules to Clinical Practice. InTech. and others, editor; 2016. p. 286. Available from: http://dx.doi.org/10.5772/64926.
29. Venkatesh E, Elluru V, Cone S. Beam Computed Tomography: basics and applications in dentistry. *J Istanb Univ Fac dent*. 1931;51(3):102–21.
30. Danforth RA, Miles DA. Cone beam volume imaging (cbvi): 3d applications for dentistry. *Irish Dent*. 2007;10(9):14–22.
31. Howerton WB, Mora MA. Advancements in digital imaging: what is new and on the horizon? *J Am Dent Assoc*. 2008;139:20–4. doi:10.14219/jada.archive.2008.0354.
32. Fathima S. CBCT in dentistry-an overview. *Eur J Mol Clin Med*. 2020;7(5):1403–8.
33. Angelopoulos C. Anatomy of the maxillofacial region in the three planes of section. *Dent Clin North Am*. 2014;58(3):497–521.
34. Report No. 177 – Radiation Protection in Dentistry and Oral & Maxillofacial Imaging (2019) (Supersedes Report No. 145). Available from: https://ncrponline.org/shop/reports/report-no-177/.
35. Tikku T, Khanna R, Sachan K. Dimensional and volumetric analysis of the orophayngeal region in obstructive sleep apnea patients: A cone beam computed tomography study. *Dental Research Journal*. 2016;13(5):396–404.
36. Barghan S, Tetradis S, Mallya S. Application of cone beam computed tomography for assessment of temporomandibular joints. *Aust Dent J*. 2012;57(1):109–27.
37. Abramovitch K, Rice DD. Basic principles of cone beam computed tomography. *Dent Clin North Am*. 2014;58(3):463–84.
38. Miami CBCT center. Advantage and disadvantage of CBCT. Available from: Courtesy:www.wikipedia.com.
39. Joffe L. OrthoCAD: digital models for a digital era. *J Orthod*. 2004;31(4):344–7.
40. Redmond WR. Digital models: a new diagnostic tool. *J Clin Orthod*. 2001;35(6):386–7.
41. Baxi S. Recent advanced diagnostic aids in orthodontics. *Cureus*. 2022;14(11):e31921. doi:10.7759/cureus.31921.
42. Alok A, Singh S, Kishore M, Shukla AK. Ultrasonography - A boon in dentistry. *SRM J Res Dent Sci*. 2019;10(2):98–104.
43. Orhan K, Görürgöz C. USG Imaging in Orthodontics. and others, editor; 2021. p. 227–76. Available from: https://link.springer.com/chapter/10.1007/978-3-030-62179-7_15.
44. Hayashi T. Application of ultrasonography in dentistry. *Jpn Dent Sci Rev*. 2012;48(1):5–13.
45. Shrivastava S. Diagnostic aids in Othodontics- A review. *J Pharm Negative Results*. 2022;13(10):54–8.
46. Dutt SD, Maria R. Pulse Oximetery: A new tool in pulpal vitality testing. People's. *J Sci Res*. 2013;6(1):49–52.
47. Beeby C, Thurlow AC. Pulse oximetry during general anesthesia for dental extractions. *Br Dent J*. 1986;160(4):123–5.
48. Schratz WW. Pulse Oximetery: A review, with emphasis on applications in dentistry. *Anaesthesia Progress*. 1987;34(3):100–1.
49. SrilathaA, Doshi D, Kulkarni S, Reddy P, Bharath M. Advanced diagnostic aids in dental caries - A review. Systematic Reviews and Meta-analysis. *J Adv Health Sci Res*. 2019;2(2):118–27.

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