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DIAGNOSTIC AIDS USED IN PROSTHODONTICS- A REVIEW

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ABSTRACT

Background: diagnosis made in ancient times by various physicians was particularly based on what their eyes saw and ears heard. Since then there has been marked evolution in the field of diagnosis. The evolution is particularly true for dental profession. There have been tremendous advances in all branches of dentistry, with these advances the need for more precise diagnostic tools specially imaging methods have become mandatory.

Aim: the aim of this article is to review various diagnostic aids used for diagnosis and treatment planning in the field of prosthodontics.

Conclusion: diagnostic process and treatment outcomes have immensely been simplified with the advent of various diagnostic tools. Several new technologies used for diagnosis not only enhance patient care but also improves patient communication. Furthermore, the development of new dental diagnostic aids has allowed the dental profession to offer gamut of aesthetic options to patients that can transfigure a smile, an appearance that can change patient's life.

Clinical significance: basic goal of all health care professions is to improve health of a patient and to increase efficiency of healthcare system which will work together towards enhancing a society as a whole.

KEYWORDS : casts, diagnostic aids, photographs, prosthodontics, radiological imaging, recent advances

Introduction

The contemporary dental practice has endless options for preserving oral health and provides next to natural aesthetics with an enhanced approach, reduced treatment time, minimized error potential and better quality assurance. [1] The main objective of modern dentistry is to restore stomatognathic system of patient with normal function, comfort, aesthetics, speech, and for these, the need for more precise and advanced diagnostic tools have become compulsory which help to develop and execute a comprehensive treatment plan for the patient and moreover the long-term prognosis depends on fastidious care taken in the diagnosis and the treatment planning for the patient. [2-5] Proper diagnosis is essential to intelligent treatment for this diagnosis should first determine whether disease is present: then identify its type, extent, distribution and severity; and finally should amalgamate information obtained from a thorough clinical examination along with information gained from various diagnostic aids. [6] Diagnostic aids used in prosthodontics helps to assess the dentate as well as edentulous patients for oral rehabilitation, but pathologies in the edentulous patient are different from those in the dentate patient, however the problems related to routine screening are still present. Diagnostic aids used in prosthodontics include diagnostic casts, photographs and various imaging techniques. [7]

History

The first diagnoses made by humans were based on what ancient physicians observed with their eyes and ears. The treatment by earliest physician in ancient Egypt and Mesopotamia were mainly based on diagnosis made primarily on observation of clinical symptoms. More sophisticated diagnostic tools and techniques were used until the end of the 19th century. [8] This evolution is expressly true for the dental profession. Tremendous advances in all the branches of dentistry have been observed over the past three decades. These advances have occurred in the field over the past 50 years, and particularly in the past 20 years, have been transformative. [9] Hence the need of more precise diagnostic tools specially imaging methods, has become mandatory to move on in pace with the advances taking place in the field of dentistry. [3]

Need for diagnosis

Specialized skills of the practitioner are of utmost importance for patient care in the field of dentistry. These not only include knowledge and expertise in dental materials science, anatomy, surgery, and specialized restorative techniques, but also demand an emphasis on diagnosis and treatment planning for proper care of the stomatognathic system. The diagnosis should amalgamate information obtained from a detailed clinical examination with the information obtained from a properly conducted examination by various diagnostic aids. This is mandatory for the proper care of a patient. [10] For proper diagnosis and treatment of a particular disease, oral health care professional should create a differential diagnosis based on the medical history given by the patient and physical examination and direct the patient for necessary laboratory tests, such as biopsies or imaging studies required to arrive at the final diagnosis. [11] There is immense evolution in health care environment, including dentistry. In the present era because of increased life expectancy of patient, population is aging, more patients are retaining their teeth, edentulism is declining, and more people with multiple chronic diseases are seeking dental care it is because we have better understanding of the etiology of oral and systemic disorders and of primary and secondary risk factors for oral, dental, and craniofacial disorders due to advances in the field of dentistry. There arises gamut of treatment options to treat partial and complete edentulism (e.g., implants), periodontal diseases (e.g., new drug therapies, regenerative surgery), and caries (e.g., remineralization, conservative tooth preparation) because of availability of large variety of materials and new approachas that has been introduced. With a growing body of knowledge suggesting the association of oral infection and the associated tissue inflammation with systemic diseases and conditions (e.g., cerebrovascular/cardiovascular disease, pregnancy, respiratory disease, diabetes mellitus), there is an greater emphasis on the importance of oral diseases in the context of systemic health and for this improving diagnostic skills is must which is dependent on a complete understanding of the etiology of disease and their identification by clinical and laboratory means. Understanding of the pathologic basis of oral and dental diseases will guide to new diagnostic tests and computer-based tools for evaluating and treating patients in the dental office. Better understanding of systemic diseases by dentists will improve the management of patients presenting for dental care and help dentists to evaluate changes that can occur over the course of treatment. [12]

Various diagnostic aids used in prosthodontics:

Diagnosis by casts: casts obtained from dental impressions are useful component in the oral examination. [11] For diagnosis in prosthodontics, diagnostic casts mounted in centric relation on the articulator are an essential requirement. The casts determine the length of the edentulous spaces, the vertical distance between the dental arches, and the form, size and individual positions of the remaining teeth. Occlusion can also be observed both from lingual and buccal side on these casts and verified in the patient's mouth. [13] The position of the gingival margins (recession) and the position and inclination of the teeth, proximal contact relationships, and food impaction areas can also be determined with the help of casts. In addition, they provide a view of the lingual-cuspal relationships. [14] Casts are of paramount importance in maintaining records of the dentition before it is altered by treatment. They help in diagnosing malocclusion and deflective occlusal contacts, determining the length of clinical crowns, the plane of occlusion, the inclination and rotation of the remaining natural teeth, esthetic problems, the available interarch space, and the shape and contour of the teeth and soft tissues. [15] Finally, casts can also serve as visual aids in discussions with the patient for treatment planning and are useful for pretreatment and post treatment comparisons, as well as for reference at recall visits. They are also helpful to determine the position of implant placement if the case will require their use (table 1). [13]

Diagnosis by photographs

Every photograph lacks expressional quality without a smile that is choreographed by dentists. [16] Photography has a wide role of significance in teaching, research and clinical recording. Clinical photography has become an important part of standard dental practice. [17] Colorful photographs can precisely record the appearance of the tissue before and after treatment [14] Regular photographic records, at all dental visits could be of great help to examine the age changes like occlusal vertical dimension, tooth color and facial changes. [18] Photographs cannot always be dependent on for comparing faint color changes in the gingiva, but they do depict gingival morphologic changes. With the advent of digital clinical photography, record keeping for mucogingival problems, such as areas of gingival recession, frenum involvement, and papilla loss, has become important. [14]

Dental photography has always been an aid for diagnosis and aesthetic treatment planning. Intuitive software's make it possible to visualize post treatment effect, variation of tooth size and form etc. It is utilized for many web-based studies to survey opinions of dentists and non-dentist population. Photographic records are easier to store, can be viewed at various angulations and easily measured. Regular photographic records, at all dental visits could be great help to examine the age changes like occlusal vertical dimension, tooth color and facial changes. [18]

This can redefine practice of prosthodontics with their ability of visual communication and medico legal documentation for contemporary practice. [18]

Diagnosis by radiological imaging

Pre-operative radiographs can efficiently determine not only the existing bone quantity but also anatomic and topographic structures, which have to be preserved. Radiographs gives us the important information about anatomic structures such as the roots of the adjacent teeth, the floor of the nose, the course of the inferior alveolar nerve, the diameter of the incisal canal, and the morphology of the maxillary sinus including bony septi. Radiographs provide a good two-dimensional as well as three-dimensional overview; facilitate detection of pathologies in the jawbone and evaluation of bone quantity in the vertical and the mesiodistal dimension. Hence radiographs are therefore considered as important adjunct for the initial diagnosis and treatment planning. [19]

Two dimensional imaging (table 2)

Three dimensional imaging

All the branches of dentistry have observed tremendous advances over the past three decades for which the need for more precise diagnostic tools, specially imaging methods, has become paramount. Modern dentistry have given place to not only the simple intra-oral periapical X-rays, but also advanced imaging techniques like computed tomography, cone beam computed tomography, magnetic resonance imaging and ultrasound. [3] 2-D imaging techniques provide information which is sufficient for routine dental practice and exceptional images for most dental radiographic needs. 2-D imaging acts as an adjunct to clinical examination by providing insight into the internal structure of teeth and supporting bone to reveal caries, periapical diseases, periodontal, and other osseous conditions. A significant drawback of conventional radiography is the superimposition of overlying structures, which obscures the object of interest hence resulting in collapsed 3-D structural information onto a 2-D image, which leads to loss of spatial information in the third dimension. Radiographs provide a two-dimensional image of a three-dimensional object. Relationship of the tooth to the surrounding anatomical structures cannot be adequately determined which hinders its diagnostic performance. Mesial-distal and apical- coronal plane of the object can be easily assessed; however the buccal-lingual plane is not possible to assess because of superimposition. Complexity of maxillofacial skeleton prevents 2-D radiographic images to accurately replicate the anatomy that is being assessed. Moreover superimposition of anatomical structures surrounding the teeth may cause anatomical or background noise, which results in difficulty in interpreting periapical radiographs. 2-D radiographs show less severe bone destruction than is actually present. Radiographs are inefficient in determining soft tissue to hard-tissue relationships. [3] Due to all these shortcomings 3D imaging has gained importance in field of dentistry. Specially in case of diagnostic dilemma and treatment planning of special cases, [3] advanced 3-D imaging modalities, helps in providing additional information which is of paramount importance for optimal implant placement, it also finds important roles in pre- and postoperative evaluation of the implant patient especially in complex reconstructions during multiple implant placement. [3, 20] 3D reformatting is highly useful in augmentation process like sinus augmentation, uniform magnification, high contrast, definition, multiplanar views, 3D reconstruction of images and simultaneous study of multiple implant sites, and also enables software analysis. [20] Three-dimensional imaging helps in assessing the complex cranio-facial structures more adequately for examination as well as early and accurate diagnosis of deep-seated lesions. [3]

I. Computerized tomography

Information that intraoral and panoramic radiographs cannot provide to the clinician is provided by tomograms for example an accurate assessment of alveolar bone height, width, and inclination; bone quality; and the spatial relationship of anatomic structures at the proposed site of fixture placement. [21] Determination of the quality and the quantity of bone; the evaluation of potential recipient sites for implant placement, particularly with stents, evaluation of intraosseous pathologies, follow-up of regions where extensive surgery is performed. [22] The topography of the sinus location, maximum bone depth, and the specific density of the bone at each implant site can be adequately determined by reformatted cross-sectional images. [23]

ii. Cone beam computerized tomography

Unlike conventional CT scanners, which are large and expensive to purchase and maintain and which results in increased in patient radiation exposure, CBCT is suited to be used in clinical dental practice because cost and dose are markedly reduced which is very important. [24] It is mainly used for the evaluation of maxillofacial trauma, treatment planning for fixture placement, orthodontic diagnosis and treatment planning, temporomandibular joint (TMJ) analysis and various pathologies of the jaws. CBCT has been very

efficiently used for preoperative and postoperative dental implant assessment. Preoperatively, it can accurately determine the quantity and quality of bone available for placement of implant. It also provides more accurate and detailed information of the surrounding vital tissues. [3] Assessment can be done without image distortion in all three planes of space, superimposition of structures, also accurate location of anatomic landmarks as well as the height, width, angulation and differential magnification of the image based on geometry, and quality of alveolar bone for implant site can also be accurately assessed. It is also useful for case selection and a postsurgical evaluation to assess implant's position in the alveolus. [20]

iii. Magnetic resonance imaging

Preimplant imaging: MRI was not initially thought of as a useful modality for preimplant assessment (Taylor 1991), but the use of various parameters and appropriate succession allow us largely to overcome the recognized difficulties. Hence, the potential for bone imaging is well accepted, especially in regions where outline of soft tissues is also required. [25]

Sinus lift assessment**:** complete evaluation of the three-dimensional shape of the sinus is desirable before surgery (van den Bergh et al. 2000) with respect to both anatomical form and volume. Incompetency to recognize these structures can lead to unpredictable surgery due to incomplete filling of the sinus. T1-weighted sequences are appropriate for dimensional assessment of the graft and the demarcation of the sinus and oral mucosa (i.e. the boundaries of the available bone) may be enhanced by the use of intravenous Magnevist (Gray et al. 1999). This is particularly important when autogenous bone is being harvested from regions such as the iliac crest, to lower down surgical trauma. [25]

Quantification of human masticatory systems**:** Temporomandibular disorder (TMD) is a general term that includes a series of clinical alterations involving the temporomandibular joint (TMJ) and structures related to it, such as the ligaments and masticatory muscles. These muscles are frequently related to TMD since they receive brunt of overload, usually caused by parafunctional habits such as bruxism and clenching and occlusal disorders, so that clinical manifestation of this condition is manifested as pain, deviation in mandibular movements and difficulty in eating. [26]

Lateral pterygoid muscle, articular disc, and mandibular head and fossa in the same image can be observed in detail in MR images obtained in the oblique sagittal planes besides a complete observation of these structures, the relationship between, these structures can also be determined. [26]

iv. Ultrasonograpghy: structure of internal muscle of mastication can be more clearly demonstrated by ultrasonography than CT. It can also measure the thickness of muscles which can be a valuable tool in diagnosis and treatment for follow-up examination of inflammatory soft tissue conditions of the head and neck region and superficial tissue disorders of the maxillofacial region, US is a proved diagnostic technique in determining the pathological nature (granuloma vs. cysts) of periapical lesions. Accurate determination of soft tissue thickness is necessary for implant placement without incision and flap elevation. Location of implant is difficult after healing, especially if the implants are deeply submerged beneath thick connective tissue grafts and in such cases US plays an important role in locating these submerged implants accurately for surgical exposure for subsequent prosthodontics rehabilitation. [3]

v. Stereolithography

3D construction of auricular and nasal prosthesis
Fabrication of Obturators
Duplication of existing maxillary/mandibular prosthesis especially crucial when an accurate fit to natural teeth or an osseointegrated implant is needed
Construction of surgical stents for patients with large tumors scheduled for excision

Manufacturing of lead shields for radiotherapy to protect healthy tissue during radiation exposure.

- Fabrication of burn stents for scanning of burned area, which prevents subjecting delicate, sensitive burn tissue to impression taking procedures.
- For fabrication of computer generated surgical guides and implant placement. [27]

Conclusion

All professions, and especially the health care professions, are in a constant state of self-assessment aimed at advancing their disciplines in a consistent and measurable fashion. For the health care professions, the goal is to improve patient health, increase efficiency in the health care system, and ultimately enhance society as a whole.

This evolution is expressly true for the dental profession. The importance of correct diagnosis and treatment planning must not be ignored. All the relevant information must be collected; with the help of case history and various diagnostic aids. The practitioner should be fully acquainted with the prognosis for different clinical situations because only at this stage can the etiology of the disease be determined, a diagnosis made, definitive treatments discussed with the patient and informed or valid consent obtained. [28,29]

Patient care and communication can be enhanced substantially by using several new technologies and the advancement in various diagnostic aids have undoubtedly simplified the diagnostic process and improved treatment outcomes. Furthermore, the development of new dental diagnostic aids has allowed the profession to offer aesthetic options to patients that can transform a smile, an appearance, and in some cases a life. [18,28]

Table 1

Complete denture	Fixed partial denture	Removable partial denture
• Relation of edentulous arches of mandible and maxilla • Interarch space • Ridge parallelism • Severity of tissue undercut	• Mock preparation • Temporary restorations • Fabrication of custom trays	• For surveying • For determining tooth size, arch width and size • To assess designs suitable for a particular case.

Table 2

	Intraoral periapical	Occlusal	Panoramic	Cephalometric
• **Complete denture**	Root fragments, foreign bodies, impacted teeth, density of bone, bone pathosis, Alveolar ridge regularity, vertical bone height.		Retained roots, embedded teeth and foreign bodies, elongated styloid process, calcified lymph nodes and residual ridge resorption.	
• **Fixed partial denture**	Size shape and length of abutment tooth roots, size and position of pulp chambers, accuracy of root fillings.		Size and shape of abutment tooth roots, pulp chambers, amount and thickness of periodontal ligament, pathosis.	

• **Removable partial denture**	Amount and nature of alveolar bone, abutment tooth roots, periodontal ligament.		Bone loss, widening of periodontal ligament, crown root ratio, alveolar bone detail.	
• **Implants**	Pathosis, anatomical structures, osteotomy site, used in all three phases of implantology that is preprosthetic, prosthetic and postprosthetic phase, determining quality of traebecular bone.	Faciolingual width of alveolar ridge, preprosthetic phase for pathosis and anatomical structures and quality of trabecular bone.	This modality is the most used diagnostic modality in implant dentistry. Mainly used during preprosthetic phase and are rarely used for postprosthetic phase for evaluation of osseous bone levels and recall examinations because it uses intensifying screens, and resolution is not as good as with intraoral periapical radiographs. But when multiple implants need to be evaluated, panoramic radiography is the imaging of choice.	Vertical and Faciolingual dimension of alveolar bone in midsagittal plane. These radiographs may also be used to provide information regarding the relationship of the jaw in which the fixture will be placed to the remaining teeth or prosthesis in the opposite arch, the position of the mental foramen relative to the anterior portion of the mandible, and the relationship of the inferior border of the nasal fossa and maxillary sinuses to the crests of the edentulous ridges in the maxilla. Angulation, thickness and bone height in midline.

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