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A COMPREHENSIVE REVIEW ON DIAGNOSTIC TOOLS USED IN FIELD OF PROSTHODONTICS

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ABSTRACT

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. Successful therapy begins with a thorough assessment of the patient's physical and psychological condition and determining a treatment that will deliver a functional prosthesis that will satisfy the expectations of the patient. With time, there have been various advances in all the branches of dentistry in respect to oral examination which includes a complete study of the teeth, jaws and other oral structures and further uplifts a practitioner's ability to reach an appropriate diagnosis. Therefore, the aim of this review is to illustrate in detail the diagnostic aids used in the field of prosthodontics and how these methods aid in increasing the efficiency of the dental operator in correct diagnosis and thereby, establishing a success rate of the treatment.

KEYWORDS: Oral examination, Diagnostic casts, Photographs, Dental surveyor, Radiological imaging.

INTRODUCTION

The value of dentistry as an important health service will be enhanced when the dental examination includes a complete study of the teeth, jaws, and other oral structures. From such a complete examination will frequently be uncovered conditions more detrimental to the health of the patient than the specific complaint for which relief may be sought.[1] Diagnosis involves development of a comprehensive and concise database of pertinent information, sufficient to understand the patient's problem as well as answer questions arising in the treating clinicians' mind. 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.[2] Diagnosis forms the basis of treatment. Direct clinical observations and radiographic findings are used to identify existing problems and to select the most appropriate dental treatment. Evaluation of a patient's health status determines how systemic illnesses can modify oral, dental, and craniofacial diseases and a patient's ability to tolerate dental treatment. Careful attention to diagnostic aids and an understanding of both their usefulness and limitations is essential if they are to be employed most effectively in clinical dentistry.

Diagnostic aids used in prosthetic dentistry include diagnostic casts, photographs and various imaging technique such as Computerized tomography, Cone beam computerized tomography, Ultrasonography, Magnetic resonance imaging and Stereolithography. System like Tekscan (T scan) and Matscan permit a precise study of occlusal contacts and the forces created examining even slightest of occlusal interferences, significant in full mouth rehabilitation and implant

protected occlusion (IPO). Other areas to be explored include use of virtual articulators and digital face bows to facilitate automatic design of the occlusal surface.[3]

WHY DO WE NEED "DIAGNOSIS"?

Diagnosis is the determination of the nature of a disease made from a study of the signs and symptoms of a disease. In the present era because of increased life expectancy of patient, the 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. 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. 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.[4]

ORAL EXAMINATION

A patient's health, pharmacological history, and current status are the foundation of the examination process. The goal of an enhanced examination and screening is to discover any abnormality, no matter what it may be. A more appropriate way to present and discuss the examination with patients is to tell them that an enhanced oral evaluation is going to be done, in which all of their teeth and surrounding structures will be examined, and everything will be checked. A thorough dental examination includes the following information-personal information, chief complaint, past and present dental history, extra oral examination, the tone of muscle attachments, the arch form, the amount of interarch space, the size of bony structures, the existing ridge relations, the position and form of tongue, character of saliva, the resorption of alveolar structures, and the mucosal conditions.

The biologic conditions, favorable and unfavorable to successful service, should be evaluated and then considered in conjunction with the information revealed in the patient's oral and general health history. Conclusions reached in visual and exploratory examinations of the dentulous patient must be verified by roentgenograms and vitality tests of the teeth. It should be remembered that complete and thorough examination always precedes the scientific plan for dental treatment. There are no "short-cuts" in dental examination. Cursory examinations reveal insufficient information of diagnostic value, bear little relationship to the proper conception of dentistry as an important health service, and prevent dentistry from performing its duties as an important health service to humanity.[1]

PRE EXTRACTION RECORDS

The complete denture (CD) replaces the entire dentition and associated structures of the maxilla or the mandible. Establishing the vertical dimension of occlusion (VDO), recording centric relation and arranging the maxillary anterior teeth in their proper position are important for the success of CDs. The most common pre extraction records include pre-extraction diagnostic casts, instruments (the Dakometer, Willis gauge, and Sorenson profile scale), measurements (between tattoo points, of the closest speaking space and of the physiological rest position), photographs and radiographs.[5] Some authors like Smith have also emphasized that pre-extraction records should be used in the prosthodontic curriculum. Silverman stated that "the greater the number of preextraction records available to the dentist, the greater the chance of success".[5]

1. Diagnostic Casts

Diagnostic casts are of paramount importance in maintaining records of the dentition of the patient before it is altered by treatment. 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[6] and buccal side on these casts and verified in the patient's mouth. Apart from the aforesaid features, diagnostic casts also aids in the evaluation of malocclusion, defective occlusal contacts, determinination of crown length, the plane of occlusion, orientation and angulations of natural teeth, esthetic evaluation, interarch space, anatomy of the teeth and soft tissues.

2. Photographs

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. 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[3] dimension, tooth color and facial changes. Furthermore, this can aid the prosthodontic practice by enabling more efficient visual communication and also supplement the better medico-legal documentation for contemporary practice.

3. Instruments

The most common instrument advocated for use in determining VDO was the Dakometer. This instrument

recorded both the VDO and the position of the maxillary anterior teeth. Willis gauge can also be used for measuring the vertical height from the under surface of the chin to the base of the nose. However, this method introduced inaccuracies because it depended on the operator applying the exact same degree of pressure when the instrument made contact with the skin of the face.[5] Other instrument such as Sorenson scale can also be used.

THE ORTHODONTIC PROSTHODONTIC RELATIONSHIP

Orthodontic analysis and adjunctive orthodontic treatment often can have a positive effect on the outcome of prosthodontic treatment. Cephalometric analysis when used to determine a patient's growth pattern or growth status can help to determine the best type of functional occlusal pattern or help to identify when the patient has largely completed facial growth for timing of implant placement. Prior and adequate understanding of the practitioners of accurate growth pattern assessment and implementation of pertinent procedures, the pre prosthodontic use of orthodontics aids in improvisation of patient outcomes and simplifies some otherwise intricate restorative situations.

When planning prosthodontic treatment, the dentist should embrace a dynamic view of tooth position and determine whether restorative treatment can be enhanced by tooth movement. Improved tooth position can eliminate potentially pathologic occlusion and create a healthier periodontal environment that is easier to maintain. In addition, it permits the dentist to place restorations that often require less natural tooth reduction during preparation, and that are more esthetic, functional, stable, and durable.[7]

PHONETICS

The proper knowledge about speech production and phonetic parameters will enable the clinician to fabricate dentures with good phonetic capabilities. Obtaining optimum phonetic potential by providing correlation among three key objectives (mechanics, esthetics and phonetics) of prosthodontics is the ultimate goal of every prosthodontist.[8] Very often we have to depend on pre-extraction records in order to achieve necessary objectives while replacing teeth. However if these records are missing, determining the position of artificial teeth becomes more challenging. Hence, phonetics can be used as a guideline for proper placement of artificial teeth.

A few factors, namely, the correct vertical dimension, the occlusal plane, the contour of the palate, and the positioning of the anterior teeth, are common requirements for the production of most speech sounds. Therefore, the vertical dimension of occlusion should be checked by the technique of Silverman's closest speaking space. Similarly, the occlusal plane should be checked phonetically with the labiodental sounds.[9]

DENTAL SURVEYOR

The surveyor (parallelometer) is a diagnostic tool which should be used by every practicing dentist who provides removable partial denture prosthesis service for his patients.[10] An intraoral surveyor can be used successfully to ensure that teeth are optimally prepared to serve as abutments for fixed or removable partial dentures.

Before tooth preparation for a fixed or removable partial denture, a diagnosis and a treatment plan are formulated by using a diagnostic cast. It is surveyed so that a path of insertion can be determined that best fulfils the requirements for parallelism, retention, and optimal aesthetic and functional advantages. The proper use of a surveyor will not only make the job of technician simple, but also precise. It reduces time spent in the laboratory in guessing the interferences to the path of placement of the removable prosthesis and hence the chair side time is also saved.

RADIOLOGICAL IMAGING IN PROSTHODONTICS

Dental radiographs are a necessary component of comprehensive patient care. In dentistry, radiographs enable the dental professional to identify many conditions that may otherwise go undetected clinically. 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.[11] The most common methods for daily-basis clinical imaging in dental medicine are intraoral and panoramic radiography, as well as three-dimensional (3D) Computerized tomography, Cone Beam Computed Tomography (CBCT), Magnetic Resonance imaging and Stereolithiography pertinently in maxillofacial prosthetics.

There have been tremendous advances in all the branches of dentistry over the past few decades for which the need for more precise diagnostic tools, specially imaging methods, has become paramount.

Two Dimensional Imaging

Two-dimensional intraoral and panoramic radiography are at present the most popularly used imaging techniques for dental examination.

1. Periapical radiography

Long cone paralleling technique is the technique of choice for taking periapical radiographs. Among all the imaging modalities, intraoral periapical radiographs offer the best resolution, area of interest can be examined for trabecular patterns, residual roots, periodontium, as well as angulation of adjacent teeth, readily available, inexpensive, less radiation dose. However, such radiographs provide a two dimensional perspective of three dimensional anatomy, thus not adequate to estimate the amount of available bone (facio-lingual dimension) in the edentulous site, their limited size makes them inadequate for evaluating large edentulous areas and associated maxillary and mandibular structures.[12]

2. Panoramic radiography

This outlines the bony anatomy clearly and is generally used for diagnosis of size and shape of abutment teeth, pulp chambers, gross pathoses, amount of ridge resorption within the jaws as well as the relation of anatomic structures such as sinuses, canals, fossa, and foramen in the implant site.[12] This modality is probably the most utilized diagnostic modality in fixed prosthodontics. However, in case of quantitative preprosthetic implant imaging, it is not the most diagnostic. This radiograph produces an image of a section of the jaws of variable thickness and magnification. But due to decreased resolution and sharpness, no cross-sectional imaging, varied magnification and usually unreliable (25-30%) especially in the vertical dimension and is more pronounced in posterior than in anterior areas, it might give a false sense that more bone exists between the crest of the alveolar process and the inferior alveolar canal, nasal fossa or maxillary sinuses. Improper patient positioning may further contribute to image distortion.[12]

Two dimensional imaging (2-D) allows the analysis of the internal architecture of teeth, its supporting structures and provides insight into the associated pathological conditions, such as incipient caries, periapical and periodontal lesions, that cannot be analysed clinically, thereby acts as an adjunct to diagnosis and treatment planning. A significant drawback of conventional radiography is the superimposition of overlying structures, which obscures the object of interest hence resulting in collapsed three dimensional structural information onto a 2-D image, which leads to loss of spatial information in the third dimension. 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. Such radiographs are inefficient in determining soft tissue to hard-tissue relationships. Due to all these shortcomings three dimensional imaging (3-D) has gained importance in field of dentistry. Specially in case of diagnostic dilemma and treatment planning of special cases, 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.[13]

Three Dimensional Imaging

Three dimensional information is essential for the implantologist before placement of osseointegrated dental implants. The fundamental basis for radiological examination is to maximize the ratio of the benefit/risk, as imaging for the planning of implant placement is confusing because of the large number of modalities available. Clinicians, however, must recognize that each technique has advantages and limitations.[12] 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.[13]

1. Computerized tomography (CT)

CT was the first technology to allow visualization of both hard and soft tissues of the facial bones by image processing enhancement and the ability to acquire multiple, non- superimposed cross-sectional images.[13] 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 can be determined with reformatted cross sectional images. In the last decade, CT scans have become one of the most frequently used imaging techniques for preoperative evaluation of the jaws before implant treatment. The first commercially developed program was DentaScan (General Electric, Milwaukee, Wis), which produced ‘‘dentist-friendly’’ images.[14]

2. Cone beam computed tomography (CBCT)

Another such advance imaging modality, that has gained momentum amongst dental practitioners nowadays, is the CBCT. Its wider and rapidly growing popularity is attributed to certain features such as minimal cost, easier accessibility and reduced radiation exposure to patients compared to other advance imaging technologies. This modality has also unfolded opportunities for the dental fraternity to evaluate the maxillofacial region using multiplanar imaging. CBCT has been 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 detailed and accurate information of the adjoining vital tissues, so that these could be protected during the placement of dental implant.[13]

CBCT is capable of providing sub-millimetre resolution in images of high diagnostic quality, with short scanning times (10–70 seconds) and radiation dosages reportedly up to 15 times lower than those of conventional CT scans. Increasing availability of this technology provides the dental clinician with an imaging modality capable of

providing a 3-dimensional representation of the maxillofacial skeleton with minimal distortion.[15]

3. Magnetic Resonance imaging

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[16] such as the iliac crest, to lower down surgical trauma.

In MRI, cortical bone can be clearly delineated from the cancellous bone. Vital structures such as nerves, vessels, and the floor and mucosa of the maxillary sinus are readily identified by the implant surgeon, exceptionally safe due to the absence of ionizing radiation, high image quality. However, high capital and running costs with lack of availability has been a significant barrier to the use of MRI for implant assessment.[12]

4. Stereolithiography (SLA)

Stereolithography offers the clinician a 3D solid model for analyzing diverse maxillofacial anomalies from numerous observation angles. The spatial realism and tactile abilities of the model afford a multisensorial approach with regard to the surgical procedure or the implant placement, without the surgeon even having met the patient.[17] It employs photopolymers that are sensitive to UV light, and on curing the resin, its solidifies photochemically to form a a single layer model of the area. The application of the most recent approach, i.e. surgical guides or templates during insertion of dental implants, is one of the magnificent features enabled by the SLA in dental practice. Many studies have documented that the genesis of SLA models have tremendously benefited in terms of high precision and accuracy in delivering dental treatment.

Stereolithiography applications in maxillofacial prosthesis such as 3D construction of auricular and nasal prosthesis, fabrication of obturators, construction of surgical stents for patients with large tumors scheduled for excision and manufacturing of lead shields for radiotherapy to protect healthy tissue during radiation exposure.[18]

5. Ultrasonography (US)

Ultrasonography (US), also known as real-time echography or sonography, is an imaging technique based on the propagation and reflection of ultrasound waves in the tissues. Diagnostic US has been used extensively for the assessment of soft tissue pathologic conditions of the head and neck with high-frequency transducers, including salivary gland disease, neck vascular pathologic conditions, maxillofacial fractures, muscle thickness, temporomandibular disorders as well as disease of floor of the mouth. In implant surgery, without incision and flap elevation requires precise determination of soft tissue thickness. During the subsequent healing period, location of implants can be challenging, especially if the implants are deeply submerged after thick connective tissue grafts. Studies investigating the role of US in implant dentistry showed that US can locate submerged implants for surgical exposure following prosthodontic restoration.[19]

CONCLUSION

The advent of several advanced technologies and diagnostic tools for patient evaluation and care substantially simplifies the diagnostic process, as well as benefits the treatment outcomes. New diagnostic aids in the field of dentistry play a pivotal role to comprehend a wide range of aesthetic options for patients that can transform a smile, an appearance, and sometimes also, a life. In the current era, a dentist has generous number of options to master the treatment however; it requires a parallel knowledge about the new innovations and developing technology to avail them all. The employment of newer ministrations with adequate comprehension about the subject greatly influences the upliftment of the entire dental fraternity. Thus, it can be concluded that, the genesis of new diagnostic tools undoubtedly unravel the diagnostic process and treatment outcomes. Further, their major role in improvising patient care and communication is irrefutable and consistent.

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