ADVANCES IN RADIOGRAPHIC AIDS IN PERIODONTOLOGY: REVIEW ARTICLE

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Abstract: Radiographical investigations are one of the most important aspects with any evidence of periodontal tissue degradation. There are a lot of radiographic methods which can be used according to the type of periodontal pathology. These radiographic images help to assess the current status and latest architecture of alveolar bone and its height, highlight the factors which are causing plaque retention, help to detect difficult interproximal carious lesions which otherwise can't be seen clinically, to visualize bony defects at the furcation areas, in detecting calculus which are retained subgingivally as well as any undermined pathological issues. It has been seen that, there is a link between probing attachment loss and the level of bone height which is visible radiographically, whereas articles and studies suggest that clinical attachment is more closely related to that bone height which is measured surgically. Radiographs are the most helpful diagnostic aids in corrective phase as well as in the supportive periodontal therapy phase, although, there are certain clinical scenarios where a clinician can make decisions only relying upon the clinical assessments. The aim of this review article is to describe the recent advances in radiographic aids in the field of periodontology.

Keywords: Bony regeneration, treatment plan, radiographic image, CBCT, Ultrasonography.

INTRODUCTION:

Radiographs are extremely valuable aid in diagnosis, drawing out the accurate treatment plan and in the measurement of probable treatment outcome in the areas where periodontium has been deteriorating since a very long time. The radiographic images give exact morphology of the tooth as well as the present status of alveolar bone which can't be assessed clinically otherwise. So this tool basically helps the periodontal surgeons in proper decision making, for example: using radiographic aids, adequate and exact knowledge about the length of the roots and the remaining level of bony tissues can be perceived. Although, it's a well-known fact that, these radiographs are just an adjunct to clinical assessment and obviously, it can't be assumed, this tool as a substitute for clinical examination.[1]

WHEN RADIOGRAPHIC ASSESSMENT IS CRUCIAL:

After taking the history (both medical and dental history) and extensively examining the periodontium, a periodontist can make decisions whether to go for radiographic investigations or not, and if yes, then exactly when to prescribe. No doubts that, the radiographs are an excellent diagnostic aid in periodontal diagnosis, but there are certain limitations as well, for example: radiographs can't assess redness of the gingiva, presence of any swelling, bleeding from the gums, enlargement in the gingival tissue, exudative discharge and mobility of the dentition. But in certain cases, where radiograph is a must, are: where there is bony degeneration (vertical or angular bone loss), radiolucency at the furcation area, detecting the calculus at the subgingival region, to assess the topography of the roots and measuring crown to root ratio, for detecting the interproximal open contacts where food impaction isn't avoidable, periapical periodontitis as well as locating certain important structures like: maxillary sinus in relation to the adjacent periodontal structures etc.[2]

DIGITAL RADIOGRAPHY:

In the recent times, there are some radiographic techniques which don't require films. This is known as 'Direct digital radiography' or 'Filmless radiography'. This technique uses an intraoral detector to capture a radiographic area of interest. This technique also gives various advantages during taking the intraoperative radiographic images. The solid state detector holds the film in such a way that there will be no delay while the film is processing. As a result, the radiographic image instantly shows in the monitor. The brightness and contrast of the image can be manipulated even after the radiation exposure. For that reason, artifacts like, burnout effect on the thin bone, will not have any adverse impact in the utility of diagnosis purposes. At last but not least, this technique reduces radiographic exposure up to 90% than the conventional intraoral radiographic technique. As these techniques are digital in nature, images can be printed out and these can be stored in a hard disk system of a computer for future comparison as well.[3]Digital radiography is a very important technique during implant surgeries. Although, these digital radiographs are having various positive aspects in the field of dentistry, it's noted from a study done by Wenzel and Hintze, that dentists still prefer conventional intraoral radiographs rather than digital radiographs.[4]

ULTRASONOGRAPHY:

Orban described ultrasonography as the examiner's eyes beyond the margin of the gingiva.[5,6] Simonton (1925)[7] and

Box (1928)[8] were the first ones to use calibrated probes to study the extend of the detachment and degeneration of the periodontal ligament and document it for future purpose in routine dental practices. Pihlstrom in the year 1992 classified probes into 3 generations.[9] Watts in the year (2000) extended this Classification by adding Fourth and Fifth Generation probes.[10] The unique features about 5th generation probes are: these are three dimensional (3D) and non-invasive in nature. The 5th generation probe or Ultrasonographic probe uses ultrasound waves for detection, draw and map the upper margin of the periodontium and also its other variations over time as a sign of indication of degeneration in the periodontal tissues. This ultrasonographic probe gives three distinct advantage over any other diagnostic technique; these helps in earliest diagnosis in the cases of periodontal tissue degeneration, non-invasive diagnosis as well as best reliable measurements.[11]

CONE BEAM COMPUTED TOMOGRAPHY (CBCT):

Radiographs are the only widely available clinical tool for assessing hard-tissue support in situ and for generating a permanent record during the treatment of an ongoing case.[12] The retained data will be used for the comparison with those radiographic images which will be obtained in future examinations. When it comes to conventional radiographs, they are very specific in nature but these don't have any sensitivity.[13] To overcome these difficulties, newer and more standardized radiographic methods are innovated. The initiation of the CBCT technique is dedicated towards the imaging of the various facial region indicating a true paradigm shift from 2-D radiographic view to 3-D view. It is also ideal for approaching data-recordsand various image reconstruction procedures. As the exposure of the CBCT comprises of the entire FoV, one series of rotation of the gantry is more than sufficient for data reconstruction.[14]This is the main reason why the dose of radiation exposure is so less in CBCT geometry. This reason i.e. reduced dosage of radiation, along with the use of "FAST" receptors as well as the reduced cost of manufacturing thismachine: all these reasons combined and make it possible to powerfully introduce this radiographic method in the field of Periodontology.[15]

OPTICAL COHERENCE TOMOGRAPHY (OCT):

OCT is a non-invasive method of imaging dental microstructure and this can further potentially detect if there is any kind of destruction or damage or even initiation of these degenerative pathways inside the periodontal structures. This radiographic technique gives a basic lay out of the area of interest, which is known as 'Optical biopsy' of the tissues up to at least 2 to 3 mm in depth. This newer technique of imaging was first launched at the Lawrence Livermore National Laboratory in USA. This radiographic technique is basically hinge on the nature of optical scattering inside any soft tissue structure.[16]High resolution, 3D structure imaging as well as showing cross sectional image of any structure with the help of scanning a light beam which is lightly focused across the tissue surface, can be produced by this radiographic technique.[17] Considerable penetration inside the tissue structure without any kind of damaging effects can be delivered by this imaging method as low coherent near infrared light sources have been used in its mechanism.[18] There are certain changes in the reflected, scattered and transmitted types of photons which further make it possible to study a tissue at a microstructural level with the help of this device.[19]

RADIOVISIOGRAPHY (RVG):

This radiographic machine has the potential to show the radiographic image very quickly in a digital mode. It is widely accepted by the clinicians because the radiation exposure in this system is quite low. Along with a timer, an x-ray generator has been assembled as the 'Radio' component which is able to keep the exposure time at minimum. The 'Visio' part of this apparatus is used for the conversion of the input signal into a digital platform and shows it on a video monitor. And lastly, the 'Graphy' part comprises of a unit which accumulates all the radiographic data which is attached to a printer.[20] Duret F et al in the year 1988 stated that RVG machine is basically worked on the principle of a CCD sensor. The main feature of RVG is that, this radiographic technique doesn't require any kind of film which further permits image production in a very fast speed; the storage is not at all expensive in nature, one can view the image multiple times as well as these images can be sent to a person sitting faraway. This filmless system also provides ample scope for the teaching purposes as well. This further helps in conferences which aretaking place electronically, provides patient details in the field of teleconsultation and many other types of communication where electronic mode of transfer of radiographic data is essential. It is very useful in terms of detection of any hidden proximal carious lesion, to diagnose the defects in the bony architecture as well as to display any long standing endo-Perio lesion.[21]

COMPUTER ASSISTEDDENSITROMETRIC IMAGE ANALYSIS SYSTEM (CADIA):

CADIA is basically a video based radiographic image analysis system to measure the changes in alveolar densities between two standardized radiographs of interest. Grey level corrections of the succeeding image with the image taken at the baseline, is done with the help of an algorithm. And the best part is that, the changes in grey level in positive or negative measurements can be acquired automatically. If we compare the accuracy of detecting bone loss which is surgically induced, we get to know that CADIA is the most sensitive of all the other radiographic techniques, whereas digital substation radiographic images stood at the second position for interpreting this radiographic sensitivity.

CADIA is also able to detect as well as quantify the measurement of bony changes after periodontal surgery with or without otectomy or osteoplasty procedures. Even, CADIA can measure the differences in the osteoblastic and osteoclastic activities happening as remodelling inside the bony structures after periodontal surgery. CADIA provides an objective method to measure bone densities quantitatively over a certain period of time.**CT SCAN &**

IMPLANT DENTISTRY:

There are a lot of factors which are directly related to the durability of the osseointegration of the implant. 'Overload', as the etiological factor, has been documented as one of the most important causes of failure of the implant after constructing the prosthesis over it. In this kind of scenarios, detailed three dimensional data records by a CT scan machine helps us to provide with the orientation of the placed implant. The configuration of the image sections, when combined with other parts, provides a proper imagination of the topography of the bone, location of various nerves and sinuses as well as density of the bony architectures. CT is a unique type of radiographic method which depicts image of an object in a transversion mode without any kind of superimposition in the view. It is said that, Computed tomography is 100 times more sensitive than the other conventional radiographic techniques. The most unique feature of CT is the, it can provide the differences between the numerous other soft tissues structures in the oral cavity. The potential of CT scan is to differentiate between objects of similar density and encapsulate the data in a digital format for the next analysis and reformatting, blocks its use as one of the modern diagnostic aid in the field of periodontology. Various studies had shown that, the judgement made with the help of CT scan in the bone height measurements and intrabony pockets, are very meticulous in nature. Although, higher radiation exposure restricts its application in periodontal surgeries.

MAGNETIC RESONANCE IMAGING (MRI):

Paul Lauterbur had narrated the first 'Magnetic resonance image' in the year 1973 and Peter Mansfield later spread the use of 'magnetic field' and the 'mathematical analysis' of the signals for reconstruction of the radiographic image. MRI was progressed for the clinical uses in the 1980s. Later, Lauterbur and Mansfield were allocated with the prestigious Nobel Prize in the year 2003 for their revolutionary innovation of this radiographic technique in the field of medicine.

In dentistry, especially in the field of periodontology, MRI helps in a lot of ways. As it's having its superb soft tissue contrast resolution, MRI is a very convenient radiographic tool for assessing the conditions of the soft tissues, for instance, to evaluate the exact orientation as well as the location of the temporomandibular disk in TMJ. In cases of the soft tissue lesions, especially the malignant ones; deciding the involvement of the lymph nodes; and to dictate the invasion of the lesion in the perineural areas, MRI technique is a kind of life-saver. A contrast agent for example: 'gadolinium' can be included to upgrade the resolution of the neoplastic image. It is a traditional way for removing the high signal of encompassing fat tissues to increase the view of the neoplastic growth.

DIGITAL SUBSTACTION RADIOGRAPHY (DSR):

Digital subtraction radiography i.e. DSR, allows depletion of structured noise from successively acquired radiographic images containing changes of diagnostic interest. This radiographic technique is best for the diagnosis of smallest changes in the periodontium, as the base of the teeth gives firm bases to standardizethe projection-geometry from one radiation exposure to another, as the structured noise is prevalent on all the unprocessed radiographic images of the periodontal tissues. A remarkable refinement can be shown from visual observation of the final changes after applying the digital subtraction radiography in the pre and post-induction radiographs.

While implementing the periodontal treatment measures, this DSR technique provides the most accurate and sensitive details for measuring the changes in the alveolar crest from the specific standardized radiographs taken before and after the treatment process. When there is no availability of DSR technique, the bone to crestal height measurement would be the only process to measure the alveolar bone difference before and after treatment. But whenever it is possible to use DSR technique, we should always go for it as it's said the digital subtraction radiography is one of the most sensitive radiographic measure while detecting even the slightest changes in the bone density.[22]

SIMPLANT SOFTWARE PROGRAMME:

SimPlant is basically a type of software which helps in performing guided implant surgeries. It is literally the combination of a 3-D cone beam scanner along with impressions, generating digitally. A customized guide specifically drafted for a special anatomy of that particular area of interest can be visualized with the help of the software.

Integrating a CBCT technique with a digital impression along with SimPlant services, we can very easily customize, scrutiny and adjust implants according to our particular ongoing case, to get our appropriate implant into the ideal site. For providing our best treatment in the implant dentistry, we are in need of turning the imagination power into a physical existence. A totally particular, patient-specific 'SimPlant' programming system helps us to put us in our own control during implementation of these imaginations. We dentists and this path towards the digital world of implant-dentistry has been accrediting us with greater success rate and we can plan our implant surgery

more safely. ‘Simplant’ software basically provides a smoother arrival into the world of implant procedures, as well as it has been blessed with the feature to handle more complicated scenario of implant cases. So finally we can conclude that, with the help of SimPlant, we can obtain behind-the-scenes potential of handling the most difficult implant cases, while still remaining in the main mode of control.

CONCLUSION:

Radiographic techniques must not be a replacement with the clinical examinations. But, X-rays as a diagnostic measure of periodic follow ups, cannot be excused as well. Advanced imaging techniques i.e. CTs,CBCTs, have made it possible for the better visualization inside the periodontal tissues as well as while dealing with the pathologies in a 3-D view and thus providing better diagnosis along with the best treatment planning. Further upgradations are call for in field of digital radiography and in the near future, it is expected that all these imaging measures will be in daily use as the other routine diagnostic tools.

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