Digital Era in Dentistry-Review

Choudhary. A[1], Gutpa.R[2], Nagpal .A[3],Sidhu.S.S[4], Mirza.A[5], Thakur.A[6]

[1]Postgraduate Student of Department of Prosthodontics, Himachal dental college, sundernagar.

[2]Professor, Department of Prosthodontics ,Himachal dental college ,sundernagar.

[3]Professor and HOD of Department of Prosthodontics, Himachal dentalcollege, sundernagar.

[4] Private practitioner (Punjab) Department of Orthodontics.

[5]Postgradute Student of Department of Prosthodontics, Himachal dental college, sundernagar

[6]Postgradute Student of Department of Prosthodontics, Himachal dental college, sundernagar

Corresponding Author: Alka Choudhary, Postgradute Student of Department of Prosthodontics, Himachal dental college, sundernagar.

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Abstract

Our lives are now lived on mobile devices, the digital extensions of ourselves. Digital world refers to the use of computed controlled technology for designing, fabrication of the prostheses for the patient taking away the traditional method of planning patient treatment plan. Digital world has decreased the time span of treatment as well increased the quality of treatment. The digital dentistry has increased the efficacy of dental procedures in restorative and diagnostic field and more efficient than conventional mechanical procedures. The digital dentistry has created a boom in dental industry. The technical innovations has played important role in dental care. They have bought significant changes in diagnosis and treatment of dental diseases. The intraoral scanners have made the life of patient and dentist easy by increasing the precision and accuracy of impression making and helpful in time proficiency .the digital photography and intra oral cameras are seen to be helpful in forensic dentistry.

Keywords: IOC, IOS, Digital photography.

Introduction

The new advances in the computer based technology have efficiently increased the quality of patient care and encounters. The computerised technology incorporates the collection of data, restoring, documentation, manufacture of dental treatment under the umbrella of recent 3D technology. This is done by assembling patient based records and documentation of these records into planning software. 3D technology can be used for the collection of symptomatic data through radiographs, surface analysis, scanned photographs and videos which can be further used to   outline the prostheses through computer numeric control (CNC) frameworks which can either use additive or subtractive creation plans. Also, uses optical and non-ionizing radiation techniques for analysis for treatment purpose for instance, lasers. Continuous endeavours are coordinated toward incorporating these advancements synergistically to enhance the use of the digital dentistry. Another territory of innovation which has changed drastically over the ongoing years is dental photography.

Computerized innovation, connecting photographic information to pcs and the scaling down of complex high amplification cameras has brought about numerous dental experts prescribing utilization of photography as an instructive apparatus, for encouraging medico-legal records and helping with the determination of clinical issues. The adaptability of intra-oral cameras may be the explanation behind which they have turned out to be very prevalent in private dental practice

Advanced photography can impact sly affect your dental practice: photos can teach patients and improve case acknowledgment, convey shade to the dental lab, and improve patients' certainty following treatment.

3D printing has been hailed as a attention seeking innovation which will change the idea of manufacturing used in aerospace, defence, art and design, 3d printing is becoming a subject of great interest in surgery. The technology has a specific reverberation with dentistry a , with advances in 3d imaging and modelling technologies it has gained utmost importance in the dentistry .technologies such as cone beam computed tomography and intraoral scanning , cad cam has become integral part of modern dentistry. Uses of 3D printing include the production of drill guides for dental implants, the production of physical models for prosthodontics, orthodontics and surgery, the manufacture of dental, craniomaxillofacial and orthopaedic implants, and the manufacturing of copings and frameworks for implant and dental restorations[1].

The intraoral cameras are becoming the most advanced and progressive tool for escalating treatment plan acceptance and patient education. According to ken neuman (1996), the learning curve for the use of the camera is very short. The intraoral camera is proving itself to be an incredible technological breakthrough in patient care. Patients can see their mouth color pictures in fraction of seconds. Viewing their mouth from the dentist's prospective can prove very illuminating[2].

The term 'computer aided design/computer aided machine ' in dental innovation is as of now utilized as an equivalent word for prostheses created by 'milling technology'. This isn't completely right.cad is short form of computer aided design and cam is computer aided machine. The term 'cad/cam' cannot provide information on how it works and what techniques it use for manufacturing. The numerous advantages related with cad/cam related dental restoration includes: access to new error free, milled prefabricated materials as well enhanced quality and reproducibility. Increased efficiency is seen along with the improvement in precision.

Teledentistry is a blend of broadcast communications and dentistry including the swaping of clinical data and pictures over remote areas for treatment planning. Teledentistry can improve access to oral healthcare, improve the conveyance of oral human services, and lower its expenses . It additionally can possibly wipe out the abberations in oral human services among rural and urban networks. This article reviews the origin, rationale, scope, basis, and requirements for teledentistry, along with the current evidence that exists in the literature.

Various digital technologies overpowering conventional mechanical tools are:

Intraoral scanners

Intraoral scanners (IOS) are digital device which is used to record digital impressions for [3-5]dental use .Intraoral scanners works on additive principle. The dental arches are scanned by projecting the light source on the surface to be scanned. The images which are captured by imaging sensors are than send scanning software which produces point clouds[6] .Point clouds are triangulated by the software thus generating 3D surface models. This method

will eliminate the need for the traditional plaster models[6-7] by the virtual 3d surface models.

IOS is a medical device composed of a handheld camera (hardware), a computer, and software. The main aim of IOS is to record with precision the three-dimensional geometry of an object. Widely used digital format is the open stl (standard tessellation language) or locked stl-like. The type of imaging technology employed by IOS, all cameras require the projection of light that is then recorded as individual images or video and compiled by the software after recognition of the poi (points of interest). The first two coordinates (x and y) of each point are evaluated on the image, and the third coordinate (z) is then calculated depending on the distance to object technologies of each camera.[8]

The edge of optical impression over conventional impression

Less patient distress: The intraoral scanners can record the full mouth information of the patient as 3D models and can reduce patient 'discomfort to dental material [9-10]

Enhanced communication

3D imaging can enhance communication between dental practitioners, patients, dental lab experts, and third party suppliers by electronic patient records. The computerized record can quicken, enhance accuracy and empower digital commerce three-dimensional imaging using radiographic or surface scans improves diagnosis, arranging and communication amongst dental practitioners and other human care professionals, dental research facility specialists, patients, and third party suppliers.

Time proficiency

Optical impressions are time-proficient, when analyzed to conventional impression technique. In less than 3 minutes full arch scan is possible by the intraoral scanners thus saving dentist time and also omit the step of pouring cast.

Enhanced quality

After the digitalization, pixel/voxel and the digitization of information bolsters quality control measures. This multilevel quality change upgrades work process and productivity, record keeping, information devotion, and therapeutics. Software can guarantee information exchange and enhance and decision making. According to **fasbinder** (2013) digital impression technique is quick. Marginal accuracy of crown fabricated by optical impression is similar or equal or greater than manual technique in 2016 **chochlidakis** culminated that intraoral scanners provides a improved quality of marginal and internal fit of crowns fabricated by conventional techniques . The digital technology provides a improved quality of care which proves to be main clinical edge over conventional techniques.

**No more plaster casts**

Individual patient information

Positive effect on the patient experience

The up gradation in diagnostic data helps to improve treatment plans. The digital platform improves planning and provides clarity in 3 dimensions. It eliminate the additional dental laboratory step thus computerized innovation improves arranging and execution by fast prototyping, improves fabrication via computerization and high constancy of the CNC process to the clinical site , also helpful in archiving prostheses for repair/retreatment.

Precision of optical impressions

A scanner should be able to detect an accurate impression .according to iso5725-1, accuracy can be defined as the closeness of the measurement to the true value .when accuracy is applied to the set of measurements of the same measureand it involves component of random error and a component of systematic error, whereas precision is the closeness of agreement[11] among a set of results .The trueness of intraoral scanner is checked by overlapping the

ios scans with a reference scan. After overlapping of images/models reverse-engineering software is used to generate colorimetric maps. These colorimetric maps will display the differences ios scan and the reference model at micrometric level. For IOS to be technically accurate it should have high trueness but low precision or vice versa. The trueness and precision feature of intra oral scanner mainly rely on the scanner acquisition/processing software. This processing software is responsible for the fabrication of 3D virtual models
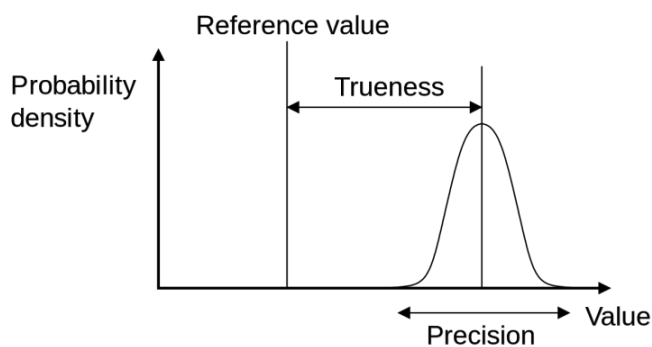
Clinical application of intra oral scanners

Intraoral scanners have wide range of applications in field of dentistry .it has enhanced the treatment plan by accurate diagnosis. IOS not only have applications in the Prosthodontics but vast ranges of applications are seen in orthodontics and surgery.

Used for the fabrication of restorations or custom devices in prostheses, surgery and orthodontics. 3D models obtained from IOS can be used for diagnostic purposes; which can be further used for communicating with the patients.

In Prosthodontics, IOS can be used for making impressions prosthetic restorations: resin inlays/onlays , zirconia copings , single crowns in lithium disilicate , zirconia , metal-ceramic and all-ceramic as well as frameworks and fixed partial dentures clinically acceptable marginal gap of ceramic single crowns from

intraoral scans can be made which is similar to conventional crowns.

IOS can be used to capture the 3D position of dental implants and for the fabrication of implant-supported restorations. At present, implant-supported single crowns, bridges and bars can be successfully fabricated from optical impressions. Used for digital smile design applications, post and core fabrication and for fabricating obturators, in complex cases. The scanning resolution of CBCT is low as compared to IOS so it can record the fine occulsal details with accuracy.

In surgery, IOS can be used for guided surgery.

In orthodontics, IOS is very useful tool in the diagnosis and treatment plan. It can be used for the fabrication of the orthodontic appliances such as aligner. In the near future the IOS will be used for fabrication of all orthodontic appliances which will be entirely customized and according to the patient need.

Various scanners available for use are

3m true definition scanner, 3 shape trios 3d,carestream cs 3600 ,cerec omnicam,condor, dental wings,itero element 2,itero element flex, planmeca emerald ,viz intraoral scanner by adin

3D printing

3D printing is additive manufacturing device which produce representatives of the images or objects either planned with computer aided design program or scanned with 3D scanner.[12] Replication by this method is done with the help of ink on paper .Various methods used for 3D printing are selective laser sintering (sls), stereolithography, fused deposition modelling, and laminated object manufacturing

Advantages of 3d technology

The following are some of the advantages of 3D dentistry from a diagnostic standpoint:

- Beam limitation : patient exposure is reduced as the size of the primary X-ray beam in 3D CBCT scanners limits the radiation to only the area of interest

- Short scan time:scan the image in single rotation thus minimize image distortion and prevents the chances of image defect.

- **Image accuracy and detail** exact location of the pathologies , infection ,nerves can be captured by it. Proper diagnosis and treatment plan for dental-caused sinus issues and plan for root canals, implants and extractions. The possibilities are endless with 3D CBCT scans.

- **Bone quality assessment:** bone quality assessment for implant placement and for the determination of location and size of lesions.

- **User-friendly**: no professional skills are required for the operation of the 3D dental equipment.

- **Interactive display**: help in the better understanding of the lesion or treatment plan to the patient as well as patient.

   Uses of 3D printing in dentistry

- **Drilling and cutting guides** can be prepared by using virtual 3D plan

- **Dental models for restorative dentistry-**3D printed model fabricated from the 3D printing can be used for the fabrication of veeners.it can be used for the customization of the restoration displayed digitally Patient model data may be digitally recorded, and only printed when required, easing storage requirements.

Digital orthodontics

Digital repositioning of teeth using invisalign system make a series of 3D printed models for the fabrication of aligners which further can be used over a period of time for alignment of teeth.

3D printing can be used for the planning and creation of orthodontic appliances.some of the examples of digital orthodontics are fabrication of indirect bracket bonding splints,precise bracket placement using 3 shape system

Dental implants

Implant platform can be designed using 3D printing as it has ability to produce complex geometries for example bone like structure which may not be produced by milling alone.

Digital photography

Dental digital photography has become important part of dental practice. Dental photography not only provide information for the further treatment .it also provides a clinical edge to dentist in identification of the things which are not visible with the naked eyes . Photographs also allow the patient to visualize the same acute perspective as the dentist and help the patient to understand the rationale for treatment.

Photographs are an essential part of clinical records for number of reasons:

- Visual representation help in the comparison between the before and after condition

- Successive comparison of the photographs help the patient and dentist to better understand the desirable treatment plan

- Future documentation of the cases in the form of the lectures , papers and posters

- Enhanced transmission of knowledge through screening by forwarding images of the pathology to the specialists

- Better communication with the dental laboratory.

Classification

Digital dental cameras can be divided into 3 categories.[13]

a) The **compact point-and-shoot cameras** have a unique setting for the oral cavity. Allows varying amounts of exposure control. This type of cameras are without interchangeable lenses

b) **Dslr (digital single lens reflex)** camera-dslr are different from compact point and shoot cameras as they have interchangeable lenses, including macro (or micro ina anikon system)

C) intraoral cameras[14]- handy intraoral device that have a camera attached to it which move around inside the oral cavity and help in the surface video examination of the teeth .this further helps in better understanding of the condition to the dentist and also allows better education of the patient. Help in the better diagnosis of the condition.

Intra oral cameras

Working principle of an intra-oral camera

Intraoral cameras works on the sensors attached to the hand piece. The sensors receive light which is converted into electric signal and this electric signal is converted into images by processing through ioc software. These sensors can be CCD OR CMOS.

Applications of IOC
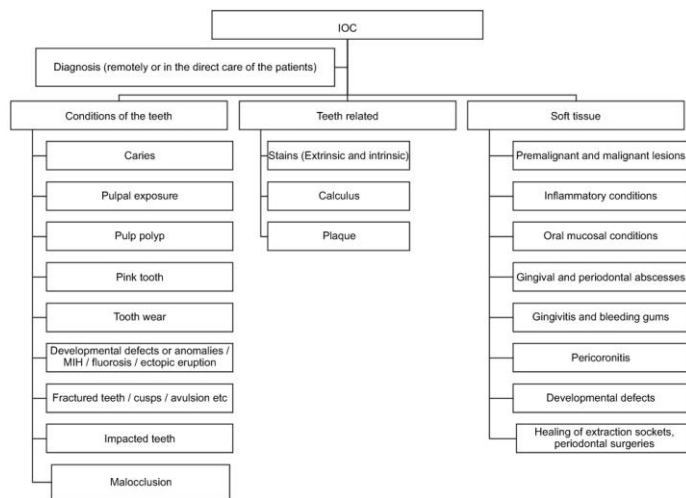
Diagnosis of plaque, calculus, and gingival inflammation

Convenient accesses to the lingual surfaces have increased in the reduction of the plaques as seen in various clinical trials. Intraoral images have 3 times more capability of plaque removal than manual tooth brushing as studied by staudt et al in 2001.[15]

Endodontics

The application of IOC can guide the clinician with augmented reality and can enhance treatment procedures with high sensitivity. Various drawbacks of the ios can be overcome by skilled dentist such as unfavourable dentinal shadows and occurrence of nonexistent canal orifices.

Orthodontics

The orthoscan camera is an IOC with a mouthpiece and self-illuminated camera which can be placed on the occlusal surfaces. This device can be used in tooth measurements and highly reliable and flat, distortion-free one to one size relationship can be obtained.

Oral medicine

IOS can be used to capture the clinical images of the various intra oral disorders clearly which can be used to evaluate the potential for treatment.[16]

Diagnosis of dental hypoplasia, molar hypomineralization, and fluorosis

Boteva and peycheva used light-induced fluorescence (lif) method applied with soprolife ioc, diagnodent and visual clinical examination to diagnose dental hypoplasia of third molars.[17]

Oral and maxillofacial surgery

Can be used in diagnosis, treatment plan, monitoring, evaluation of healing, dentoalveolar fractures, impactions, pericoronitis, abscess, etc., and the same can be used to communicate with other surgeons. To monitor the size of the fistulas in cleft lip and palate patients. Ioc method is a suitable alternative in monitoring the size of fistulas for clinical and research purposes with multiple advantages like quick, non-invasive, ease of use especially in children, patient education, tracking changes over time, visualization and objective assessment of the fistula, repeatability, and archiving of the data.

Forensic dentistry

IOS can be indispensable in forensic dentistry and can be used to visualize or examine and capture images of the oral cavity.

Other potential applications of IOC relevant to forensic dentistry include identification of rugae, fractured teeth or crown, traumatic dental injuries, palate, tongue, missing tooth or teeth, tooth wear, fluorosis, soft tissue lesions or injuries, lip prints, fraenum, developmental defects or anomalies, the colour of the mucosa, etc.

IOC can also be used to evaluate the conditions of the oral cavity, and teeth in archaeological remains non-invasively.

Indirect or remote applications of IOC

To educate and to create awareness about the appropriate oral hygiene, proper use of mechanical plaque control aids, demonstration of oral conditions.

It is possible to incorporate an approach called "co-diagnosis," which combines the views of patients and oral health care provider in planning the treatment.

IOC can also be used to train the individual for placement and removal of cast partial dentures, acrylic dentures, complete dentures, implant retained dentures. Maintenance of hygiene by the use of interdental aids can be demonstrated with the help of ioc in areas below the fixed partial denture and adjacent teeth of the abutment.

Conclusion

In all digital dental applications from electronic patient records to selective laser sintering of complex prosthetic frameworks, the common advantages is improved communication, increased control, greater quality and data archiving, and improved patient experiences simply cannot be matched using exiting conventional methods. The basic setback of optical impression is that it cannot be used for long span restorations, such as fixed partial denture and implants. Optical impressions are as accurate as conventional impressions. Optical impressions are equally accurate for individual restorations or 3–4-element bridges on natural teeth and on implants.

Currently available IOS differ in the accuracy. The new generations devices are more accurate and have wider clinical indication compared to old generation with less clinical indications .other consideration to be kept in mind when buying ios are the need for opacization, scanning speed, wand dimensions and possibility of obtaining in-colour images. Technically, the ios can be integrated in a closed system, generating proprietary files only, or can be open, producing files (.stl, obj, ply) that can be opened using any cad software

Finally, IOS not only have wide clinical application in the field of prosthodontics which include fixed prosthodontics on natural teeth and implants, but also in implant logy for guided surgery and in orthodontics.

At present, the literature does not support using IOS for fabricating long-span restorations, such as fixed full arches supported by natural teeth or implants. In the near future, the dentogingival information captured with ios will be added to the bone tissue information obtained by CBCT. Along with the information of the patient's face captured with a face scanner, this will allow clinicians to integrate different file formats into a single model that can be used for surgical, prosthetic and orthodontic planning: this will be the 'virtual patient'

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