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Review Article

A review of the application of computers in the field of prosthodontics and related specialities

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ABSTRACT:
One of the positive outcomes of the covid 19 pandemic has been a new wave of online tools and software, which opened doors to digital applications. Computers played an essential role globally to run various institutes and organizations. With a renewed interest generated during this time, many advances were witnessed in dentistry especially in computer software. This review was therefore aimed to investigate the role of computers and its associated applications in the field of prosthodontics, which is one of the most commercial branches of dentistry. The literature related was searched from year 2000 to 2024 on four scientific databases. From past to present, the role of computer hardware and software has been presented under various headings. Some advances that have happened in branches that are closely related to prosthodontics have also been included. The review presents a comprehensive presentation of role of computer in prosthodontics and associated fields.

Key words: Computer assisted design, computer assisted machining, three-dimensional printing, milling, dental implants, cone beam computed tomography

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INTRODUCTION

While ‘change’ has been philosophically considered to be one of the most permanent aspects of human life, it is though reflected in every sphere of one’s lives, attitudes, feelings and thought process. If one were asked to pinpoint one thing that has brought about a tremendous change in our life style, one would say it is the “Computer”.[1] A computer is basically an electronic device, that process data according to a set of instructions.[2] From earliest abacus computers to present artificial intelligence run machines, computers have impacted every walk of life ranging from travelling reservations to the engines running an automobile. With the advent of microchips, the computer has made an inroad into the study rooms in homes. It has also made a significant contribution to dental / medical diagnosis in capturing of images from satellite as well as medical equipment such as RVG (RadioVisiography), CT (computed tomography) scans, MRI (magnetic resonance imaging), ECG (electrocardiogram), EMG (Electromyography), CADCAM (computer assisted diagnosis, computer assisted machining), 3D (three dimensional) printing etc. which facilitates physician to make precise diagnosis with no human error in interpreting the results.[3-6]The use of computers in dental education and practice goes back to the mid 1960’s when they were used for specific and limited tasks in the administration of dental schools and large dental practices. An early educational use was in the marking and correcting of multiple-choice examinations in universities.[7] The widespread availability of both the apple and personal computers in the early 1980’s changed the emphasis and role of the computer thereby altering their relation with dentist.The so-called computer specialist lost power as the dentists gained more authority. It was investigated whether dentists, in all their forms, were inherently "gadget mad" and would make excellent computer enthusiasts.[8] This has resulted in dentistry

being in the forefront of the development of computer uses in universities and dental practice. At one time dentistry was ahead of medical practice in both administrative and in office/surgery functions. In recent years, however, the lead has been eroded and there is now little innovation that is specifically dental as we are using and adapting existing techniques, hardware and software or sharing developments in order to reduce escalating costs. Despite several odds, the fast pace of technological advancement has finally merged with the world of dentistry. Computers and digital imaging, digital x-rays, lasers, CADCAM and fiber optics all play a major role in dentistry today. All these advances play a major role in dental diagnosis and treatment planning today, including the post operative patient education and motivation. Its role is incomplete without contribution and application in health education, to intentionally embrace healthy lifestyles and health promoting behaviour.[9] While computers on side have advantages their excessive use by individuals have also led to the development of unhealthy behaviour like physical inactivity, which in turn has led to the rise of non communicable diseases like obesity and diabetes.[10] A computer system basically consists of hardware and software. Hardware is the term used to describe the electrical and electronic or even mechanical components that make up a computer system.[2,11] Hardware items can be seen and touched. They will vary in size, color and shape depending upon the manufacturer. Any computer system's performance is limited by the quality of hardware component. Machine, disk drives, video terminals, printer and plotters are example of computer hardware.[2] A computer that is used in dentistry is in different forms depending upon size (main frame computer, mini computer, micro computer) and its mode of operation (digital, analog and hybrid computer).[11]The use of main frame computers is generally meant for hospital and educational institutions, mini computers help in maintaining patient records and micro computer is a personal computer that has wide applications including the present-day mobile devices that are used in dentistry. [3, 5, 11, 12] The onset of covid 19 pandemic saw a steep rise in the online activities mainly based on digital economy. The use of mobile became a norm for daily life activities, with which we observed an exponential rise in the use of various applications and software. Many manufacturers in dentistry also introduced new instruments and materials that have been either designed or run through computer technology with superior results. Since most of these newly introduced computer-based technologies are mostly in the field of prosthodontics and its associated subjects. This review was therefore aimed to review the current role and application of computers and its associated applications in the field of prosthodontics. This review is based on the search of four scientific data base (pubmed, google scholar, scopus and medline). The search for the literature was conducted in the first half of year 2024, which yielded 349 articles related to terms 'prosthodontics', 'computer', 'digital', 'radiography', 'dental materials', 'geriatrics', 'patient education', 'three-dimensional printing' and 'milling'. The search was confined to those published articles between year 2000 to 2024. The final review was based on 94 articles which also included those articles which presented historical perspective and evolution of computers in prosthodontics.

Application of computers and related technology in the field of prosthodontics: The technological trends that have evolved in the field of prosthodontics and its associated branches can be studied under different categories as mentioned below.

Video imaging systems (VIS): Video imaging systems (VISs) were among the first electronic devices to be used in dentistry. Original VIS's included gastroenterology endoscopes, however, newer models have been designed exclusively for dental use. The main purpose of VIS is to improve clinical visualisation through monitor-based intraoral image display.[13]In addition, these systems can replicate, stock and recover the images while some also have capacity of limited image annotation. Its chief advantages include increased visibility, allows patient education and marketing, medico legal documentation and evaluating treatment effectiveness.[14,15] Its chief disadvantages have been high cost, complex applications, increased chairside time, moderate resolution, limited extraoral imaging, large size and ever evolving technology which makes previous versions redundant.[14,16] Most systems contain a video input and output device, transmission cable, light source (xenon or quartz), video display, central processing and video storage unit.[15]Some of the systems that have been used or are in use in the field of prosthodontics include Dentalvision (Dentsply International, Inc), Fuji Dentacam EDC 2 (Patterson Dental Co), Oral Scan Video Imaging System (Lester A Dine, Inc), Oral Video Scope (Video Dental Concepts), KTD Dentvision (KTD, Inc), Perspective Dental Imaging System (Dentsply International, Inc), Ultra-Eye (Trojan Intra-Oral Camera Systems), (CEREC Omnicam; Sirona), (CEREC Bluecam; Sirona) and Visioner 21a (J Morita USA, Inc).[4,6,8,17] Clinically, the individual control of all these systems varies greatly however many elements are common to all. Most xenon-based video heads are designed specifically for use with a xenon light source. To obtain an optimum image, one needs to dim the overhead and room lights to prevent background light from interfering with color balancing.

Computer imaging systems (CIS): The computer imaging system (CIS) has revolutionized diagnosis

and treatment planning since intraoral and extraoral images can be altered to enhance clinical and radiographic features and creating "what if" scenarios.[18] Patients see not only their current condition, but also the possible results of various treatment plans. Their capabilities include cropping, moving, copying, magnification or shrinking of image, besides also being able to change contrast and shape of an image. It can store and retrieve image cut outs, create print of altered image, take measurement from the screen and change facial features. Facial approximation can be achieved with the help of software's like Forensic Anthropology Computer Enhancement System (FACE) and Computer-Assisted Recovery Enhancement System (CARES).[19]In addition to the disadvantages mentioned for VIS, CIS has one added disadvantage of inaccurate prediction of the final results from a treatment.[18] The method by which images are manipulated is different from the way teeth are treated clinically, therefore it is important to emphasize to the patient that a predictive simulation is therefore only an approximation.[20] Its hardware components are more of less similar to VIS. A major difference among the different computer imaging systems is software. All use menu systems, but their implementation is different. Early systems were written under a graphical environment called True Vision Imaging Software (TIPS).[21] This is a very powerful program which allows such extreme customization that it is virtually impossible to determine which systems utilize TIPS software and which use a different program. Other systems use a graphical environment called Freestyle or other proprietary operating system in order to obtain additional features. The available products till date include Cosmetic Imaging Systems (CIS-2), Dentavision (Envision Imaging Technologies, formerly Business Information Technologies, Inc.), Fuji Vision Plus (Patterson Dental Co, Imagemaker), Oral Scan Computer Imaging System (Lester A. Dine, Inc), Preview (New Visions, Inc., formerly McGhan InstruMed Corporation) and Retrospective Treatment Consultant (Dentsply Co).[18,22] Clinical techniques are extremely simple, due to the flexible nature of the software which allows multiple ways to achieve desired result. Personal experience with the system is required in order to understand which method will have the greatest predictive value of the final outcome or a case.

Computer-Aided Design, Computer Aided Manufacturing Systems (CAD/CAM): These systems have literally revolutionized the entire dentistry especially restorative and prosthetic dentistry. Not only the technology has removed the errors due to variables in manual processing but the technology has led to development of new materials. Restorative materials like composites are available in multi shades within a single blank and so are the dental ceramics including zirconia-based ceramics.[4,23,24] Clinicians have modified clinical techniques according to the clinical requirement mainly due to advances in computerized fabrication system. Since dental practice involves major use of materials, machines, chemicals and instruments,[25] new biomaterials have become more biocompatible than earlier.[26]Pre-polymerized poly methyl methacrylate is manufactures that contains much less residual monomer than it earlier bottled version. These products that are designed and machined by computers have also benefitted manufacturers due to their shorter processing time and economics.[27]

All CADCAM systems receive a video input, manipulate the image, and guide a computer controlled milling device, which fabricates a final restoration. The chief advantages are elimination of impression making and its associated errors, total control of manufacture by dentist, single visit restorations and different applications.[4,6,23] Disadvantages are associated with its high cost, fabrication limits in terms of multiple units, characterization of shades (overcome by multi shaded prefabricated blanks), image distortion in presence of moisture and incompatibility with other systems.[24,27] Various systems that have been presented include Celay (Mikrona Technologie), Cerec (Siemens Corp), DentiCAD (DentiCAD USA), Duret (Hennson International), DUX (Titan) (DCS Dental), Procera (Nobelpharma, Inc) and Rekow (Digital Dental Systems). Presently there are four generations of CADCAM systems, which can machine different materials like metals (titanium and its alloys, chrome cobalt alloys), resin materials (Paradigm MZ100, 3M ESPE, St. Paul, Minnesota, USA), silica-based ceramics, infiltrated ceramics [Vita In-Ceram Alumina (Al2O3), Vita In-Ceram Zirconia (70% Al2O3, 30% ZrO2) and Vita In-Ceram Zirconia (70% Al2O3, 30% ZrO2)] and zirconia [Yttrium stabilized zirconium oxide (ZrO2, Y-TZP)].[28-32]Most common systems are cerec, E4D dentist, iTero (cadent), lava, Procera, DCS Precident, CICERO, Cercon and CELAY systems.

Occlusal Recording Systems: The T-Scan is the most accurate system available to measure occlusal forces and quantify how well balanced a patient's occlusion is. Now, the experts can perfect their precision and know for certain the result of their efforts. The novices can use the T-Scan to more quickly develop their skills. The on target occlusal analysis is less subjective than traditional use of interocclusal bite registration materials.[33]With the T-Scan, evaluating these forces is as simple as having a patient bite down on our ultra-thin sensor (above) and having the computer analyze and display the data. The center of force (COF) is the balance point of the occlusal forces. The closer the patient's COF icon is to the center of the gray ellipse, the more balanced the occlusal forces.[34] The COF is a unique software

feature of the T-Scan II. The patient's COF is represented by a small red icon. Research has shown that a patient with "normal" occlusion shows the resultant forces from tooth contacts in the midline of the hard palette and centered in the second premolar first molar region.[34] The large gray and white ellipse represent this balanced, average force distribution and acts as a COF reference target. By comparing the position of the patient's COF (red icon) in relation to normal force distribution (ellipse), a dentist can easily see how well-balanced the patient's occlusion is in respect to the reported normal population. The center of force trajectory (COF Trajectory) is a line which measures incrementally, in time, the path of occlusal force distribution from the first contact of a bite through complete closure into maximum intercuspation.[35] This trajectory path is seen on the T-Scan "force plots" (arch form diagrams). The line begins near the first contacts. As more teeth come into contact, it follows the path of the forces. The COF trajectory line helps illustrate premature contacts. With occlusal correction to the premature contacts, the entire closure can be fine tuned to be more balanced, more simultaneous, and involve fewer premature contacts.[33] The COF trajectory is a powerful tool that assists the doctor in assessing and locating prematurity. It is also invaluable in communicating occlusal problems to the patient and provides valuable documentation. Both COF and individual occlusal force levels are important in evaluating and protecting: prosthodontic cases (fixed & removable), implants, TMJ splint adjustments, periodontics, orthodontic case finishing and restorative adhesion dentistry.[36]The T – Scan can be viewed in 2D or 3D views, with 2D Contour view looking most similar to articulation paper markings on a patient's teeth while in 3D view, the force levels are shown by both color and column height. The 3D view also makes it easier to visualize and understand occlusal relationships during excursive movements. T scan has the capability to measure force over time, making it avital tool for evaluating the successive relationships of a mandibular excursion. One can view, on screen, a patient sliding from MIP (maximum intercuspation) or CR (centric relation) location into a lateral excursion. This is instrumental in locating occlusal interferences, determining the relative force on each interference, and evaluating the potential for trauma caused by the occlusal interferences. With the aid of the T-Scan II, occlusal forces on implant prosthesis are quantitatively presented which aids in accurate corrections through occlusal equilibration.[37] The resultant occlusal force distribution can then be far less destructive to the prosthesis, and the underlying implant-bone interface. Articulating paper on the other hand is not capable of demonstrating any occlusal force and time data. These ink-marking systems illustrate contact location and some degree of contact surface width. The color, intensity, and size have never been demonstrated in scientific studies to describe any quantitative or qualitative force and timing information. In the absence of a periodontal ligament, implant loading is devoid of neurological feedbacks to the brain, making patients ability to perceive occlusal errors, more subjective and fuller of error.[38]Also, because of the lack of periodontal ligament fibers between dental implants and the surrounding bone, an implant has virtually no depressibility in the alveolar bone that anchors it. Because of this lack of a cushioning ligament surrounding an implant, more occlusal precision by the operator is necessitated to ensure implant and prosthesis longevity.[38]T scan II can increase level of occlusal precision through centering of occlusal forces, removing lateral interferences, establish natural tooth loading, removing excursive interferences and loading implant in segments.[39]Accuracy of contacting teeth in occlusal rehabilitation cases should be accurately place in a biocompatible position which in turn relies on the accuracy of the centric relation record.[40]

Computerized Jaw Relation Recording System: The human face contains numerous numbers of plane and line references which present artistic relationships that are utilized to create a facial harmony while recording jaw relations for a patient.[41]Various dental software's extend and enhance the competences and offers many choices for data analysis and presentation. Overlying curves are displayed on screen for progressive treatment monitoring, includingmagnification for diagnostically pertinent parts of the occlusal curves. Both sided recordings can be viewed simultaneously, in real time or slow motion. Options for case presentations include three-dimensional movement of the hinge axis and time curves.[42] More detailed calculations of the condylar data can be repeated for various articulators. Sophisticated devices like telemetry and hall effect have been reported to be impractical for a prosthodontist clinician.[43] Individual condyle paths digitized with electrooptical recording systems contain a large amount of valuable information about different parameters of temporomandibular joint movement.[44]Three-dimensional visualization of the trajectories and of additional quantitative properties like velocity and acceleration in a skull related co-ordinates system can help to reveal this information for medical diagnostics. To take advantage of its full potential, however, it is necessary to integrate data of the individual jaws as well. This task has been achieved by digitizing anatomically oriented plaster casts with the technique of optical profilometry (fringe projection technique).[45,46] A computer-controlled measuring system for automated 3D scanning of such models has been developed which allows digitizing with a height resolution better than 50 microns. Using a multi axis positioning device, the model can be measured from different viewpoints and thus all relevant surface data may be acquired

and integrated by the computer to achieve a complete digital model. The skull related orientation of the model, previously adjusted in an articulator, is conserved by an appropriate mounting plate on which the plaster cast is placed during the measurement. The result of the scanning process, a set of approximately 150,000 (3D) coordinates, is further processed to reconstruct the object surface by triangulation.[45] Software has been developed that offers a graphical user interface for semiautomatic definition and measurement of selected features such as cusps from the digitized data sets as well as its storage and retrieval with an integrated data base. The results can then be displayed in 3D form in form of point marks and curves (e.g., representing the dental arches) in combination with the digitized condylar paths. By reproducing these movements with, e.g. the schematized dental arches of the upper and lower jaws, the observer is given a vivid impression of the three-dimensional connections which may be used for diagnostic as well as for educational purposes.Conventional non-contact systems (digital mouse technology), whether manufactured independently or commercially, can measure with a high degree of accuracy. However, due to their complex mechanisms, these systems [multiple charge-coupled devices (CCD) cameras and magneto metric sensors] are expensive and not user friendly.[47]

Computerized Removable Partial Denture Design: Stelligraph is a powerful and simple professional tool. A few clicks of the mouse indicate the teeth absent and pose the crowns and the bridge restoration. The last click of the stelligraph realize instantaneously an automatic layout of the dental prosthesis with the programmed methods (deadened, semi-rigid, mixed), three prosthetic concepts whose clinical results are largely shown.[48]A manual layout offers the expert a total freedom of design. Stelligraphe proposes three programmed clinical methodologies and also makes it possible to work out layouts with many other methodologies such as Hook RPI, millings, the attachments and the implants.[49]

Application of computer in shade selection:Most previous porcelain shade selection systems combined the dental colorimeter, shade eye system (SES) and vintage halo porcelain.[50] The main drawback was that if one tries to restore the same case at different times, it requires to save the porcelain buildup and use same recipe. The data can be written down on a sheet of paper, but it is quite cumbersome to do so. Since SES data are digital, a commercial database software, called "Shade Eye File" (SEF), is used to store the data and illustrations for porcelain buildup.[50] The colorimeter-based devices recently introduced on the other hand offer multiple advantages like ambiguity of the shade taking is reduce, less time is required for color reconstruction, proper porcelain shade powders can be selected even in difficult cases and gives a clean and safe image to patients in terms of infection control.[51]

Computerized Color Formulation: Spectrophotometry combined with computerized color formulation provides an objective means of achieving a skin color match through a mix-correct procedure.[52] This is accomplished by computing a pigment formula with color formulation software that matches a measured skin color.[53] Skin measured with the spectrophotometer yields a spectral with the spectrophotometer yields a spectral curve between 400 and 700 mm, the visible range of the electromagnetic spectrum. [52] The pigment formula that is derived from the color formulation process yields a spectral curve that mimics that of the skin color measure. By establishing this fundamental spectral curve of the patient's skin color and its respective pigment formula, one can approach the color-matching process with greater precision. Spectrophotometry and color formulation offer several advantages over traditional trial-and-error methods of color matching.[54] First, the clinical time required for color mixing is reduced since a patient's skin can be measured using the spectrophotometer at one appointment for evaluation at a subsequent appointment. Once a skin measure is taken the formula can be prepared in the laboratory and ready at the onset of the color mixing appointment. Second, the formula can be mixed repeatedly and accurately. Third, metamerism is minimized since the formula is established based on three different illuminants. Finally, translucency can be controlled as pigment loading is defined by the user in the color formulation software. A handheld spectrophotometer measures spectral reflectance in the range of 400 to 700n mm.[52,54] Spectral reflectance of skin is measured at 10mm increments, which is sufficient resolution to perform color formulation. The review port of the spectrophotometer is 5mm in diameter, which represents the area of skin measured, and an average value is determined. Prior to taking a skin color measurement, the spectrophotometer must be calibrated according to the manufacturer's instructions.

Delta E is a numerical value of color difference used to determine required formula correction.[23] It has been reported that with available color formulation algorithms, iterative correction is necessary to improve a color formula until the Delta E value is within an acceptable range. Generally, a Delta E of less than 2.0 is acceptable for a base color.[23,27] Clinical trials demonstrate that two corrections are required to establish an acceptable skin color match.

Computer workstations as adjunct to patient education: patient education is an important aspect of comprehensive prosthodontic treatment. Many technically correct treatments have been reported to

have failed due to lack of emphasis on patient education.[55]Current computer system improves educator's ability to store, retrieve, and present volumes of visual data in a way never before possible. An example of this is the development of desktop slide generation and presentation software. One of the earliest clinical computers used for video-based education was equipped with a video board (24STV; RasterOps), 27-in television (Magnavox, Greenville, TN), video camera (Sharp Slimcam; Sharp Electronics Corporation, Mahwah, NJ), and a video cassette recorder (Goldstar GVR-B445; Goldstar Electronic International, Inc, Huntsville, AL).[56] In addition to the hardware mentioned above, the software programs used included Media grabber, Still Capture (RasterOps) and Adobe Photoshop (Adobe Systems Inc, Mountain View, CA).[57] Media grabber allows input of single video frames, sound, or movies. Still Capture is a compression program that works with media grabber to reduce an image storage size. Tooth modifications, planned gingivectomy, diastema correction, or shade changes can be effortlesslyassessed. Networking software programs developed help users easily navigate and find information on the internet.[58]The user interface of these network programs combinespersonal computer with the multimedia.Most of them have a basic format that usually starts with home pagewith the information on the server. Data is placed in many forms including graphic, sound, and video.

Drug reference is another program of note that was used in clinics to improve the information available to the students during the diagnosis and treatment-planning procedures.[59] It was designed to allow students to quickly look up pertinent drug information, including cross-reactions, adverse reactions, pharmacology, and dosages for medications that patients may be presently taking or that may need to be prescribed. The data for each drug were compiled on a separate card that can be located using the navigator. This stack also allows cross referencing thereby improving the student's ability to determine potential cross-reactions of drug. It is available free of charge from the author.

Radiographic Imaging and processing Systems: After xeroradiography and RadioVisiography, the current technology of cone beam computed technology (CBCT) has allowed prosthodontist to simplify placing dental implants in the most ideal locations, which has resulted in dental implants being practiced by a wide array of specialists.[60] With lesser radiation than multislice computed tomography (MSCT) and panoramic x rays, there is less concern of radiation overdose for patients. Likewise, the radiographic image processing system is also based on computer hardware and software. The most common use is to obtain cephalometric measurements from lateral and anterior facial films, which are then viewed using different softwares (CephNinja, OneCeph) for orthodontic cephalometric analysis.[61] There are many systems that can be used on most personal computers. Most systems require the dentist to place the film on a graphics tablet and mark the appropriate points.[62] The computer can output both the appropriate measurement and a cephalometric tracing. It minimizes errors caused by incorrect positioning, which is among the most frequent reasons for film retakes. The operator can monitor the patient from the front and the side, making patient positioning quick, easy and accurate. All exposure values and other controls are logically grouped on a central control panel with a hygienic, wipe-clean surface. Pre-programmable exposure values allow the user to quickly choose the correct values for the most commonly used exposure settings.[63] The optional Automatic Exposure Control (AEC) measures the patient's radiation transparency and adjusts the correct exposure values to achieve the desired optical density and contrast in the image.[63] The imaging geometry significantly increases the diagnostic value of radiographs by eliminating redundant shadows and ghost images caused by objects outside the image layer. Typical redundant shadows are caused by anatomical structures such as cervical vertebrae, mandibular ramus, hyoid bone, or artificial objects like metallic dental crowns, metallic wires and jaw reconstruction plates.[64] The shape, size and position of the path of the effective rotating center of the radiation beam has a critical influence on image quality and radiation dosage. The path of the effective rotating center of the radiation beam follows the anatomically correct jaw shape, beginning and ending well outside the jaw.[65] This results in a focal layer that is thicker, particularly in the critical front area and allows the radiation dosage to be reduced. Cephalometric radiography has also been automatized in terms of aligning the radiation source according to the mode selected.[64] The functionally designed head positioner guarantees accurate patient positioning for all projections. Selects the aperture when the cassette is placed in the cassette holder in the correct position. Light beam assisted positioning of the soft-tissue filter is quick, easy and accurate has motorized functions for cephalometric apertures and the soft-tissue filter and the operator selects the settings from the control panel.[63,64] Artificial intelligence has been implemented in dental radiography and has been shown to improve diagnostic imaging efficiency and accuracy.[66]Such advances have been thought to reduce treatment times especially when implants are considered. Due to high accuracy in positioning of dental implants, they can be placed during ongoing pre prosthetic treatments.[67]

Quality Assurance & Digital Storage of Conventional X-Rays: In Dentistry, computers started playing a greater role in ensuring quality and timely access of patient information especially, the X-rays. The digitalization of X rays, is done directly

after developing the film by means of a CCD camera.[63] The signal of this camera is digitized using a frame grabber board in a normal PC. The image is stored on hard disk using the control number and a time code as filename. This file is also available on local network.[62]All information regarding the picture is kept in the patient file and the control file of X-ray unit, for future reference and all of this information is available in a database. On the other hand, it is easy to check the quality of the pictures regarding the X-ray technique and the dental procedures. This has made implant placement in critical areas more accurate and predictive.[68]

Education, Management and administration: many graduate courses have been developed using WebCT.[69] The course contains lessons, glossary, quizzes and chat periods that can be assessed from any computer using the internet. The course also involves classroom sessions for review of articles dealing with dental caries. Additionally, each student is required to prepare and deliver a case presentation explicating how to deal with a patient suffering from pre-cancerous lesions.Relevant learning issues arising during the presentations and literature reviews are investigated by the students independently using electronic sources of literature including the world wide web. Many computer-based office management systems now store patient charting information in a computer, allowing quick access to patient data. In addition, these systems provide excellent charting, data analysis, and longitudinal comparison of a patient's periodontal condition. In the future, automated record keeping systems will be able to link video, computer, and radiographic images, occlusal, restorative, and periodontal information and allow instant access to a patient's complete denture record. Infection control procedures in hospital has been predicted to be done by mobile ultra violet robots in coming years, that kill microorganisms within predicted time.[70]

SUMMARY AND CONCLUSION

Sophisticated new technologies are continually being introduced to dentistry because of the rapid scientific progress occurring today. Today, more than ever, there is a need for such expanding technology. While we are seeing a decline in dental disease among young patients. we also are facing an aging population. People are living longer, keeping their dentitions longer and waiting to main their dentitions throughout their lives. They need and demand services that are often complex. Technology needs to evolve to respond the shift in dental concerns. These advances should make consistently successful treatment of increasingly complex conditions possible.

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