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Overview on Updates on Digital Dental Radiography

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Wilhelm Roentgen first discovered X-rays in 1895. Since its introduction in the mid-1980s, digital radiography has surpassed traditional screen-film radiography. Since 2000, more than 75 percent of medical clinics in the United States have migrated to digital radiography (DR). In fact, the US government has ordered that all medical records be converted to digital. Indirect, direct, or semi-direct digital radiography pictures are types of digital radiography currently available. Forensic radiology is a branch of medical imaging technology that helps clinicians. Radiology technology has evolved and grown tremendously in recent years. When comparing aggregated antemortem and postmortem information, radiographs are crucial. Adopting new technologies into a dental business demands a certain amount of bravery. After all, why alter things if your practise is running smoothly? To grasp the new equipment and procedures, the dentist and his or her staff will need further training. It's not always apparent how the new strategy will influence the practice's present

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logistics. These factors may cause the practitioner to be hesitant to alter present techniques. In this article we'll reviewing digital dental radiography, and what are the advantages of going digital. And also what are the challenges that face us.

Keywords: Dental practice; forensic radiology; digital imaging; dental imaging; X-ray photons.

1. INTRODUCTION

Since 2000, more than 75 percent of medical clinics in the United States have migrated to digital radiography (DR). In fact, the US government has ordered that all medical records be converted to digital. In contrast, a minority of dental offices in the United States and worldwide have migrated to digital radiography or other digital methods, according to numerous recent dental studies. According to these reports, the adoption of this technology in dentistry appears to be dependent on speciality (general dentists are more likely to utilise it), location (big population centres versus small cities), and cost [1-7].

Wilhelm Roentgen first discovered X-rays in 1895. Since its introduction in the mid-1980s, digital radiography has surpassed traditional screen-film radiography. A solid-state sensor is used in digital imaging, and the information is displayed and saved as an image on a computer. Dr. Francis Mouyen introduced the first digital radiography equipment, dubbed radio visio graphy (RVG), in 1987, signalling the start of the digital age in dental radiography. Paul Suni, a physicist and charge-coupled device (CCD) image sensor design engineer, developed the CCD image sensor technology that enabled the RVG digital radiography equipment to be developed. The reaction of digital systems to incoming radiation is the main difference between them and conventional systems. Between a totally brilliant and a completely dark picture, an imaging system functions. In comparison to film, digital detectors have a 400-fold dynamic range [8-10].

Only 36.5 percent of dentists in the United States employed digital imaging in a 2007 survey performed by the American Dental Association, and this was mostly for bitewing and periapical radiography. For panoramic research, around 20% of people employed this technique. Nonetheless, with each new technological advancement, public awareness of the potential benefits of digital imaging in general and digital radiography in particular grows. By 2016, it's expected that the number of digital dental imaging equipment will have doubled from what it was in 2009 [1].

Digital Radiographic Systems: Physics and Technology Indirect digital radiographs are typical film "analogue" radiographs that have been digitised using either a flatbed or slide scanner or a high-resolution digital camera. This method necessitates the exposure of an analogue film first, however it is a cost-effective approach to experience some of the benefits of digital radiography (such as archiving and telemedicine). Such pictures will not compare to the quality of either straight digital or analogue films,' and should not be used for fine fault analysis (e.g., cndodontic fills). Indirect digital pictures, on the other hand, are likely to be sufficient for the identification of many dental anomalies [11].

2. DIGITAL RADIOGRAPHY

Indirect, direct, or semi-direct digital radiography pictures are available. Indirect digital radiographs are radiographs created using flatbed scanners with a transparency adaptor, slide scanners, and digital cameras. A solid-state sensor, such as a CCD or complementary metal–oxide–semiconductor (CMOS)-based device, is used to capture direct digital pictures. Charge-coupling transmits the quantity of electrons deposited in each pixel from one well to the next in a sequential way to a readout amplifier for picture projection on the monitor to provide semi-direct images. Intraoral radiography uses an area digital sensor array, while extraoral imaging uses linear arrays. Active pixel technology is used in CMOS sensors. It decreases the amount of electricity required for the system by a factor of a hundred and removes the requirement for charge transfer. A polyester basis is covered with a crystalline emulsion of europium-activated barium fluorohalide Compound in the phosphor plate system. A latent picture is created by incident X-ray photons. To produce a digital image, a scanner scans the plate with a laser beam of near-red wavelengths to read the image information [8].

X-ray photons are converted directly into an electrical charge using a thin film transistor array, active matrix array, electrometer probe, or microplasma line in direct flat-panel detectors (FPDs). Amorphous selenium is one of the materials utilised in the FPDs (a-Se). The high-density line-scan solid-state detector, which is coated with photostimulable barium fluorobromide "doped" with europium or caesium bromide phosphor, is another direct sensor. A laser diode scans the energy acquired by x-ray exposure, and the excited energy emitted is read by a digital image capture array charge-coupled device (CCD) and converted to display. Prior to display, photostimuable phosphor plates (PSPs) are digitally scanned, whereas direct imaging sensors do not require any additional processing before being displayed on a computer monitor. Both of these sensor systems have their advantages and disadvantages [1].

PSP intraoral receptors are available in a variety of diameters, similar to standard dental radiography films. Unlike CCD receptors, they do not have a connected wire, making them more resemble simple film X-rays and hence easier to use because most doctors are familiar with analogue films. For the same reason, the recommended side of exposure in certain earlier models is not as evident as it is with CCD receptors. The receptor has been reported to be placed in the wrong spot. An indication has been introduced onto more contemporary receptors to aid with the orientation of films. When the incorrect side of the receptor is exposed, there is no visible hint to identify the inverted positioning, at least in one earlier model. When this happens, a physician may be unable to distinguish between the right and left sides, particularly if there are no or few restorations or distinguishing features [12].

It is also feasible to optimise the identification of caries by adjusting the contrast and density of an otherwise well illuminated picture. The doctor will be able to spot early caries lesions more easily if the contrast is increased (within limitation). Similarly, lowering the contrast to some amount will aid in the detection of periodontal bone diseases. Although changing contrast and density might be an arbitrary procedure, a practitioner with sufficient skill can extract far more information from a digital radiograph than an analogue radiograph. Some clinical imaging software uses conventional gamma optimization algorithms to prevent the subjectivity of adjusting picture density or contrast using slider bars. This is accomplished by more uniformly dispersing the grey values of the pixels over the whole grey scale [13].

3. FORENSIC ODONTOLOGY AND DIGITAL RADIOGRAPHY

Forensic radiology is a branch of medical imaging technology that helps clinicians. Radiology technology has evolved and grown tremendously in recent years. One of the forensic odontology for image analysis exams is cone beam computed tomography (CBCT). Evolutionary forensic odontology has been widely explored in many areas, including the assessment of age through teeth, the function of dentists in trials or as forensic witnesses, bite mark analysis, trauma case investigation, and sex and race determination. The speed with which radiographs are retrieved, the ability to view radiographs immediately on a computer screen, and the use of contrast, density, sharpness, picture, and colour modifications offered on the CBCT digital radiograph programme are all advantages of digital CBCT radiographs. These are quite useful in forensic identification examinations, particularly in skeleton and odontology instances [14].

The comparison of antemortem and postmortem information is the premise of identification by dental methods. Dental charts, written records, and dental radiographs are all examples of records. When comparing aggregated antemortem and postmortem information, radiographs are crucial. When antemortem and postmortem data are given to the end users of forensic odontological reports, radiographs are nonabstract and visible. Radiographs, on the other hand, are obtained through a multi-step technique, and operator mistake can occur at any point. The most common errors are those that result in problems or inaccuracies in radiograph orientation, as well as the potential consequences [12,15-19].

4. DISCUSSION

Non-radiographic dental records have been found to be a helpful source because the many permutations and combinations of missing and filled tooth patterns may allow identification to be done with some certainty. Mischarting, inaccurate reporting, and even fraud have all been discovered in such data. As a result, radiographs have traditionally been thought to be more trustworthy. According to McKenna, a radiograph gives "irrevocable proof." Clinical notes, according to Forrest and Wu, "are a direct representation of a physical item and are an objective method of recording information," whereas radiographs "are a direct representation of a physical item and are an objective method of recording information," whereas radiographs "are a direct representation of a physical item and are an objective method of recording information." Few odontologists would be confident enough to rely exclusively on non-radiographic data, according to Wood and Kogon, and X-rays constitute a key component in identification [12,20,21].

Semi-direct and direct digital systems are the two main categories of real digital systems. The picture created by these technologies does not need analogue (film) radiography. Semi-direct systems use a phosphor crystal-covered photo-stimulative phosphor (PSP) plate to temporarily store x-ray photon energy for future scanning. Depending on the technique of preservation, the storage duration might range from minutes to hours. The picture on these plates will be destroyed if they are exposed to direct strong light before scanning. The film is withdrawn from the patient's mouth after exposure and scanned with a near-red wavelength laser beam. The information is subsequently sent to the computer for processing. It's worth noting that when a picture is scanned, some (but not all) of the energy contained in the plate is lost. converting x-ray photons striking the sensor into electrical signals [11].

Adopting new technologies into a dental business demands a certain amount of bravery. After all, why alter things if your practise is running smoothly? The intricacy of the software and technology has been cited by several dentists as a reason for not transitioning to a digital system. To grasp the new equipment and procedures, the dentist and his or her staff will need further training. It's not always apparent how the new strategy will influence the practice's present logistics. These factors may cause the practitioner to be hesitant to alter present techniques [13].

Even though certain records appear to be unimportant, it is critical to present original and complete documents. Full records provide the dentist who gets the antemortem record for transcription into the antemortem chart the chance and potential of catching this mistake. Otherwise, owing to visually noticeable non-matching of X-rays, mistakes of this sort might lead to exclusion. Furthermore, in mass fatality cases where several reconciliations are necessary, incomplete recovery of remains or untrained forensic odontologists may lead to exclusion [12].

There might be a number of reasons for the poor adoption of digital radiography. The financial expenditure necessary to replace traditional radiography with digital imaging is the major argument provided by general practitioners. In terms of implementation expenses, however, there isn't much of a difference between traditional and digital radiography when a dentist is establishing a new business. Charge-coupled device (CCD) or complementary metal-oxide semiconductor (CMOS)–based systems may have cheaper maintenance costs than film-based imaging systems. Traditional radiography costs include film mounts, processing solutions, and time spent cleaning the film processor, in addition to the cost of the films themselves [13].

since repeated scannings can diagnose an overexposed image, reducing the number of retakes. The picture is "erased" from the PSP plate by exposing it to intense visible light after it has been scanned and saved. Solid state sensors are used in direct digital systems. CCD (charge-coupled device) and CMOS (complementary metal oxide semiconductor) are the two main forms of solid state sensors (complementary metal oxide semiconductor). The energy from x-ray photons hitting the sensor is converted into electrical signals using CCD devices. A scintillation layer is put on top of the CCD sensor to convert x-ray photons into light photons, which are then absorbed by the microprocessing chip, increasing efficiency. This is analogous to an analogue film's intensifying screen [11].

The use of artificial intelligence (AI) to the interpretation of digital radiography is a field that is constantly evolving. AI was predicted to address all diagnostic difficulties ten or fifteen years ago. Computers, according to popular thought, would be able to collect data on their own and solve diagnostic issues without the assistance of a doctor. Today, this optimism is waning, and the target has been scaled back. Today's systems leave the clinician in charge and just assist him or her in accomplishing the diagnostic task [13].

5. CONCLUSION

Digital transitioning is the trend that drives all fields right now especially after the pandemic, medical and dental field is no exception.

Radiology technology has evolved and grown tremendously in recent years. But it faces its own challenges. Having the critical knowledge and training for the medical staff so they can use it is one of them. It's not always apparent how the new strategy will influence the practice's present logistics. But surely digital radiography have a lot more advantages than traditional ones. We hoe that this adaptation continues to expand until it includes all medical records.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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