PEERIAN JOURNALS

Czech
Journal of Multidisciplinary Innovations

Volume 43, July 2025.
Website: www.peerianjournal.com

ISSN (E): 2788-0389
Email: editor@peerianjournal.com

Diagnostic Performance of Computed and Digital Radiography in Fracture Identification

1. **Adnan M. Khalid**- Physics department-Tikrit University- Adnan.Mahmod@tu.edu.iq
2. **Shaymaa Mohammed Fayyadh**- Physics department-Tikrit University- Shymafaydh@tu.edu.iq
3. **Ayob Alwan Jasim** - Physics department-Tikrit University- ayob.alwane@tu.edu.iq

Abstract
The x-ray imaging aspect is efficient and effective with little cost involved, which makes it common to be used in many sectors particularly in medical diagnostics. Its quality to pass through body tissues enables it to have clean and non-invasive imaging into the internal body organs and structures. Since it is a vital technology, its evolution became very fast so that today sophisticated X-ray detectors and associated imaging systems have been designed. This research look at two forms of X-Ray imaging devices which are currently being applied in hospitals located within the Kirkuk City in the Kirkuk hospital: Computed Radiography (CR) and Digital Radiography (DR). The study compares the strengths and the weaknesses of the two systems regarding the quality of images produced and performance. A group of bone fracture involvements was diagnosed with the aid of the two technologies. The findings indicated that Digital Radiography (DR) would have been more popularly preferred as it has faster imaging, high quality image production, reduced doses of radiation used and minimum maintenance. The latter features make DR systems more suitable in the contemporary medical environment, where the ability to be fast, accurate, and reliable is essential. In addition, the paper shows the wider applications of higher level of X-ray technology where bone fractures are detected within different areas of the human body which were taken from real cases in the hospital. It also determined that the quality of the pictures taken using CR tend to be less clear when compared to the use of DR.

Keywords: X-ray Imaging, Medical Diagnostics, Bone Fracture Detection, Computed Radiography (CR), Digital Radiography (DR)

1. Introduction

X-ray is any form of ionizing radiations whose wavelengths are within the limits of 0.01 to 10 nanometers [1]. X-rays can be transmitted, absorbed or scattered as they travel through materials. The level of absorption and scattering varies on the attenuation properties of the material which is defined by Lambert-Beer Law:

$$I = I_o e^{-ud} \quad \text{.................................(1)}$$

In which I is the strength of the X-ray photons passing through the field, and I_o is strength of the X-ray photons before they enter into the field, μ is the linear attenuation coefficient and d is the thickness of the medium[2,3]. The attenuation process is a result of varying proportions of the photoelectric effect, which occurs when a photon is absorbed; the Compton scattering, which involves the scattering of the X-rays; and the Rayleigh scattering which is a scattering process where the photon scatters without being absorbed as well as the amount of influence that they have varying depending on the composition of the material and the energy level of the X-rays [4]. In general photoelectric absorption predominates at lower X-ray energies and Compton scattering at higher (X-ray) energies, especially in low atomic number (Z) materials [5, 6].

The penetrating power of X-rays has made this a pillar of modern medicine through imaging [7]. The bar of technology on X-ray imaging has brought good results to the diagnostic radiography especially in imaging the skeletal system which includes bone fractures, dislocations, bone pathologies and location of foreign objects [8, 9]. Such imaging functions are also useful in surgical planning. X-ray imaging also finds extensive usage in industry and inspection testing to ensure nothing has been damaged albeit not destructively through non-destructive testing [10]. The history of X-ray imaging in the last century helped in both research and application areas greatly.
The general X-ray imaging system comprises an X-ray generator as well as a detector. It consists of a vacuum tank which has two electrodes in the generator [11]. A tungsten filament cathode, when activated, is heated to approximately more than 2000 °C releasing electrons by thermionic emission. The interaction of such electrons results into X-rays as the electrons are accelerated towards the anode [12, 13]. The resultant radiation is a combination of the bremsstrahlung and character X-rays, the former of which constitutes the greater part of the number of photons emitted in the diagnostic systems (i. e. about 80 %). X-ray output is affected by accelerating voltage, heating of the impacting filament and material of the cathode in the X-ray [14]. At the backend of the object sits the detector that captures the transmitted X-rays and displays it on a visible image. Such radiographic data may be reconstructed into 2D or 3D images, depending upon the imaging modality, and the contrast within the images is produced by modulation of material attenuation [15, 16].

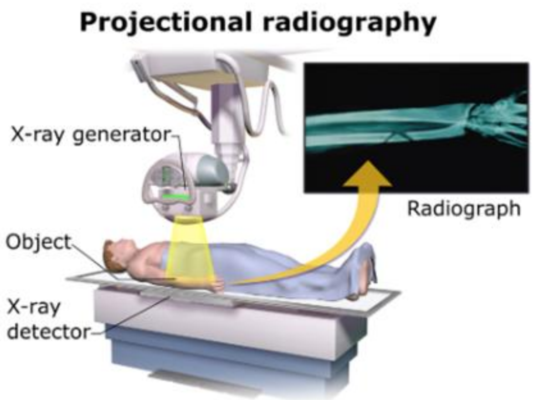

Figure 1: Shows the patient under x-ray machine [17]

Acquired during the radiography, radiographic imaging has been an essential part of the contemporary diagnostic medicine, due to the ability to visualize internal body structures in a non-invasive manner. Computed Radiography (CR) and Digital Radiography (DR) are common as two main digital radiographic technologies applied in clinical practice [18]. Computed Radiography (CR) was an intermediate technology between use of traditional films-screen radiography, and completely digital systems. It holds X-ray photographs by the use of photostimulable phosphor plates (imaging plates). These plates are then digitized with a laser on a separate unit reader after exposure. The use of CR is more flexible than film, as with easier storage facilities, sharing and the facilities to improve the image. Nevertheless, it does not allow handling automatically and processing of plates and this can be a drawback in work [19]. The next innovation is Digital Radiography (DR) which is applied with the usage of flat-panel devices or charge-coupled devices (CCDs) that convert the X-ray photons directly into electronic signals and enable generation of digital images in real time. DR systems do not require cassettes or any sort of independent processing units which speeds up the process of image acquisition, is highly efficient and patient throughput is also high. In addition, DR systems can also have high quality images and a reduced radiation dose when compared to CR [20]. With advances in medicine and the increased effectiveness, precision and patient friendly nature of new technologies, DR has become more and more the technology of choice in contemporary radiology departments but CR is still in use in situations where there are cost or infrastructure constraints [21].

2. Material and methods

This study describes in general terms the devices and techniques used in this research, also the samples from 6 patients' with different bones cases. A group of real cases of patients were taken during study at Kirkuk Hospital, and the majority of them had bone fractures

2.1 Materials

1. **X-ray Systems**
   - **Computed Radiography (CR) System:**
     - X-ray generator
     - Imaging plates (IP) with photostimulable phosphor (PSP)
     - CR reader/scanner (e.g., Fuji, Carestream)
     - Digital processing workstation
   - **Digital Radiography (DR) System:**
     - X-ray generator
     - Flat panel detector (FPD) (either direct or indirect conversion)
     - Digital image processing workstation
2. **Software and Image Processing**
   - Image acquisition software (e.g., PACS system)
   - Image enhancement and analysis software
   - DICOM-compatible image storage system
3. **Patient Preparation and Positioning**
   - Standard radiographic positioning aids (e.g., foam pads, lead markers)
   - Personal protective equipment (PPE) for radiation safety
4. **Quality Control and Calibration**
   - Radiation dosimeters
   - Phantom objects for image quality assessment
   - Regular calibration tools for detectors and X-ray generators

2.2 Methods

1. Image Acquisition Process

- **For CR:**
  1. Position the patient according to standard radiographic techniques.
  2. Expose the imaging plate (IP) to X-rays using appropriate exposure settings.

Czech
Journal of Multidisciplinary Innovations
Volume 43, July 2025.
ISSN (E): 2788-0389
Website: www.peerianjournal.com
Email: editor@peerianjournal.com

3. Insert the exposed IP into the CR reader, where the laser scans the plate to extract the latent image.
4. The image is digitized and processed in the workstation.

- **For DR:**
  1. Position the patient as per the required view.
  2. Activate the flat panel detector (FPD).
  3. Take the X-ray exposure, and the detector directly converts the X-ray photons into digital signals.
  4. The image is instantly available on the workstation for review.

2. Image Processing and Enhancement

- Adjust contrast, brightness, and sharpness using digital filters.
- Apply edge enhancement or noise reduction if necessary.
- Ensure proper annotation and patient identification.

3. Quality Assurance and Evaluation

- Compare image quality between CR and DR for contrast, resolution, and noise.
- Assess exposure index (EI) to ensure optimal radiation dose.
- Conduct routine quality control tests to maintain image consistency.

4. Data Analysis

- Store images in the PACS system for evaluation.
- Conduct comparative analysis of CR vs. DR in terms of resolution, radiation dose efficiency, and workflow speed.

3. Results and discussion

Digital x-rays as a term or reference is used to describe digital radiography (DR), which is a variant of x-ray radiography (DR) used in image capture that is electronic and not film-based. The connection between the computerized x-ray study and an image created by it consists in the diagnostic process of imaging [22]. The following are some of the benefits associated with the use of digital x-ray systems over the traditional film-based x-rays: Availability of Images: Digital x-rays are electronically captured and can be viewed immediately after they are taken, this aids in making faster diagnosis and treatment decisions High Resolution and Detail: The images produced using digital x-rays are of high resolution and can clearly detect a broken bone, condition, or even post-surgical implants. Moreover, Digital Storage and Processing: They can be stored on a computer and thus can be badly recovered and also manipulated as well as distributed to other medical practitioners to make a consultation with them [23].

Czech
Journal of Multidisciplinary Innovations
Volume 43, July 2025. ISSN (E): 2788-0389
Website: www.peerianjournal.com Email: editor@peerianjournal.com

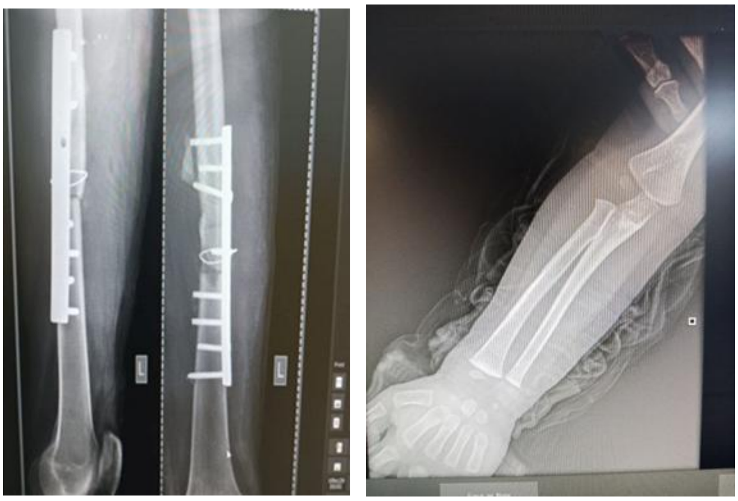

Figure1: Shows in the left fixed fracture, right is arm fracture.

The two X-rays images show some of the major differences that elude the nature of Computed Radiography (CR) and Digital Radiography (DR). The left picture, which is made through CR, demonstrates a fixed fracture with internal fixation but with a bit lower contrast and image sharpness inherent of cassette-based systems, which involved separate processing of images. On the contrary, the correct image, decomposed with the use of DR, reflects a fresh fracture with outstanding details, clear edges of the bones, and better visibility of the soft tissue. This presents the real-time data acquisition of the DR and increased resolution and therefore is preferable in making a fast diagnosis and in emergency cases.

Figure 2: Displays left femoral bones**,** right lower limb.

The left image is clear and there are well-defined edges of the femoral bones and knee joints. Image quality indicates few noise and good contrast resolution, such that fine details such as the spaces between the joint, and the structural outlines of bones are distinctly brought out. These are all the features of Digital Radiography (DR) which are characterized by the ability to acquire real-time image, work with high detector sensitivity and clearer images. The enhanced output quality and efficient flow of work characteristic of DR are probably some of the factors that gave the image its

Czech
Journal of Multidisciplinary Innovations
Volume 43, July 2025. **ISSN (E): 2788-0389**
Website: www.peerianjournal.com **Email:** editor@peerianjournal.com

accuracy and practicality in clinical use. Conversely, in the second picture, there is a postoperative picture of a lower limb with an intramedullary rod. Whereas the hardware appears, the picture becomes less contrasted and a little bit hazy, in particular, the soft tissues. This blurriness and potential overexposure in over some of the photographic elements are indications that it have been obtained through Computed Radiography (CR). CR systems tend to use phosphor plates, and like DR, are subject to a variable exposure (though the end result can be of similar fidelity) and need to be processed manually. In 2024, Nurmetova and Abdijamilova in their article showed that the images, captured by a digital instrument, were better as compared to the ones of CR systems, which served as good empirical evidence in support of the current study [24].

Figure 3 : Shows left the foot and the ankle, right foot fingers.

The image on the left courtesy of lateral view of is in focus, good contrast and it has a lot of clarity both to the bone structures and spaces at the joint. Even the smooth gradation of gray color and the distinction of the soft tissue indicates that the picture was taken under the use of Digital Radiography (DR). Comparative to DR, systems are recognised to produce high-resolution images in an instant and this provides precise visualisation of anatomy that is essential in diagnosis and evaluation. The right image by contrast is more noisy and lower in sharpness with more randomly distributed white specks (maybe due to digital noise or artifact), and less in contrast. The profiles of the bones and the soft tissue are not clearly described rather than in the left imaging and this is one of the drawbacks of the Computed Radiography (CR) systems. CR uses image plates which are exposed and then scanned individually and thus it may cause variability in the quality of the images and also introducing noise in the background such as this case.
The table 1. Provides the comparison of two groups of radiographic images with a specific focus on the distinctions in the quality of the obtained images, representation of the soft tissue and diagnostics potential between probable Computed Radiography (CR) and Digital Radiography (DR). The DR images, which can be found on the right image on the first set and the left one on the second set, have always been sharper, as well as having clearer bone margins, and better soft tissue

Czech
Journal of Multidisciplinary Innovations
Volume 43, July 2025.
ISSN (E): 2788-0389
Website: www.peerianjournal.com
Email: editor@peerianjournal.com

difference, thus better to diagnose fractures and checking of the alignment. Conversely, the images that are being credited to CR, especially the left image in the first series and the right image in the second series of the image set, are having relatively low contrast, stronger noise and less clarity and thus limitations in diagnostic accuracy can be made. Altogether, the study confirms DR as a more effective and secure form of imaging in the clinical setting, particularly during emergencies and postoperative practices. This also backs down the conclusion made by researcher Neitzel U in 2025, who demonstrates that such relevance has been shown in DR technology as it provides higher image quality due to its speed and wide dynamic range and thus better in identifying minute details and image distortions than CR systems [25].

Table 1: demonstrate some properties of CR and DR radiography for cases in this study.

Aspect	First Set (Upper Image)	Second Set (Lower Image)
View	Left: Post-op with bone plate fixationRight: Fractured forearm	Left: Knee joint (standing AP view)Right: Post-op tibia with rod
Image Sharpness	Good clarity in both, especially in the right image	Left: High clarity and fine detailRight: Slight blur and haziness
Soft Tissue Visibility	Right image shows good soft tissue contrast	Better in left knee image; right image has some overexposure and noise
Implants Present	Left: Plate and screws clearly visibleRight: No implant	Right: Intramedullary rod clearly seen
Modality Indication	Left image: likely CR (slightly lower contrast)Right: likely DR	Left image: likely DRRight image: likely CR due to increased noise
Contrast and Detail	DR image (right) shows sharper fracture lines	DR image (left) shows better bone margin definition
Workflow Implication	DR image allows better emergency evaluation	DR image suitable for joint and alignment assessment
Clinical Usefulness	Clear distinction in hardware positioning and fracture detail	Useful for assessing alignment, impla nt placement, and knee joint status

4. Conclusion

The two technologies employed in the present study can be applied to capture comprehensive radiographs, a combination of bone fracture and any parts of the human body, whereas it is outperformed by the CR imaging technology in other aspects of image quality, time, dose, and favorability. Although CR imaging can still be utilized due to its affordability and effectiveness, it may be observed that DR imaging is a known choice in larger and more affordable centers because of its holistic performance and the long-term advantages meant in patient care and efficiencies. The distinction between the DR and CR is left to variety, the budget and the necessity. In addition, modern hospitals and emergency departments are gradually shifting toward DR systems to enhance diagnostic accuracy, patient throughput, and overall radiographic performance for the following reasons:

1. Image resolution: Digital Radiography (DR) has the advantage of better image resolution to Computed Radiography (CR). The DR images are sharper and have a high contrast and it is easy to identify minute fractures or malformations that were not evident in the traditional X-Ray. This increased level of resolution came in due to the advanced sensors and quicker processing of images on DR.
2. Speed and Efficiency: The speed of DR imaging systems makes it possible to obtain faster diagnosis due to instant capturing of digital images. In particular, this is needed especially in time-sensitive cases, like cost or emergency care. Consequently, CR imaging is an elaborate procedure that involves the optimization of cassettes, hence it is slow when compared to the DR imaging in terms of the outcome.
3. Permits Reduced Radiation: The capability to hand out reduced radiation stands up to high image quality with the DR imaging, and makes patients safer. Though CR imaging too uses lesser radiations compared to conventional x rays, DR imaging experience can further enhance it, and unnecessary radiations are also eliminated.
4. Convenience and Workflow: DR imaging provides a workflow process that is simpler, which means you can print digital images in your computer without much labor, i.e. do not have to handle cassettes, scanners, and other devices manually. This eliminates the chances of human error whereas, CR imaging will need more steps thereby consuming extra time and complications.
5. Credit Card Cost: DR imaging has a very long term cost saving and reduced causes, and shorter lead time compared to CR imaging; however, it has higher initial cost than the CR.

References:

[1] Röntgen, W.C., 1945. On a new kind of rays. Radiology, 45(5), pp.428-435.
[2] Stöhr, J. and Scherz, A., 2015. Creation of x-ray transparency of matter by stimulated elastic forward scattering. Physical review letters, 115(10), p.107402.
[3] Russo, P. ed., 2017. Handbook of X-ray imaging: physics and technology. CRC press.
[4] Vinogradov, A.P., Shishkov, V.Y., Doronin, I.V., Andrianov, E.S., Pukhov, A.A. and Lisyansky, A.A., 2021. Quantum theory of Rayleigh scattering. Optics Express, 29(2), pp.2501-2520.
[5] Zhou, Y., Chen, J., Bakr, O.M. and Mohammed, O.F., 2021. Metal halide perovskites for X-ray imaging scintillators and detectors. ACS energy letters, 6(2), pp.739-768.
[6] Nikl, M. and Yoshikawa, A., 2015. Recent R&D trends in inorganic single-crystal scintillator materials for radiation detection. Advanced Optical Materials, 3(4), pp.463-481.
[7] Cervantes, G.A., 2016. The basics of x-rays. Technical Fundamentals of Radiology and CT, pp.1-1.
[8] Joshi, D. and Singh, T.P., 2020. A survey of fracture detection techniques in bone X-ray images. Artificial Intelligence Review, 53(6), pp.4475-4517.
[9] Myint, W.W., Tun, K.S., Tun, H.M. and Myint, H., 2018. Analysis on leg bone fracture detection and classification using X-ray images. Machine Learning Research, 3(3), pp.49-59.
[10] Behling, R., 2021. Modern diagnostic x-ray sources: technology, manufacturing, reliability. CRC Press.

[11] Behling, R., 2021. Modern diagnostic x-ray sources: technology, manufacturing, reliability. CRC Press.
[12] Omar, A., Andreo, P. and Poludniowski, G., 2020. A model for the energy and angular distribution of x rays emitted from an x-ray tube. Part I. Bremsstrahlung production. Medical Physics, 47(10), pp.4763-4774.
[13] Russo, P. ed., 2017. Handbook of X-ray imaging: physics and technology. CRC press.
[14] Prabhu, S., Naveen, D.K., Bangera, S. and Bhat, B.S., 2020, December. Production of x-rays using x-ray tube. In Journal of Physics: Conference Series (Vol. 1712, No. 1, p. 012036). IOP Publishing.
[15] Maken, P. and Gupta, A., 2023. 2D-to-3D: a review for computational 3D image reconstruction from X-ray images. Archives of Computational Methods in Engineering, 30(1), pp.85-114.
[16] Liu, J., Shabbir, B., Wang, C., Wan, T., Ou, Q., Yu, P., Tadich, A., Jiao, X., Chu, D., Qi, D. and Li, D., 2019. Flexible, printable soft-X-ray detectors based on all-inorganic perovskite quantum dots. Advanced Materials, 31(30), p.1901644.
[17] Behling, R., 2021. Modern diagnostic x-ray sources: technology, manufacturing, reliability. CRC Press.
[18] Elamri, N., Tahiri, M., El Baydaoui, R. and Mkimel, M., 2025. Evaluation of radiation dose and cancer risk for paediatric digital radiography in a Moroccan hospital. Radiation Physics and Chemistry, 227, p.112352.
[19] Sule, D.S. and Ampofo, R., 2025. Diagnostic Imaging Techniques: Current Trends and Challenges. Diagnostic Advances in Precision Medicine and Drug Development, pp.49-66.
[20] Delantoni, A., Sapountzis, A. and Orhan, K., 2024. Digital Radiographic Systems. In Digital Dentistry: An Overview and Future Prospects (pp. 13-23). Cham: Springer International Publishing.
[21] Birkenmaier, C., Levrard, L., Melcher, C., Wegener, B., Ricke, J., Holzapfel, B.M., Baur-Melnyk, A. and Mehrens, D., 2024. Distances and angles in standing long-leg radiographs: comparing conventional radiography, digital radiography, and EOS. Skeletal Radiology, 53(8), pp.1517-1528.
[22] Carroll, Q.B., 2023. Radiography in the Digital Age: Physics-exposure-radiation biology. Charles C Thomas Publisher.
[23] Ou, X., Chen, X., Xu, X., Xie, L., Chen, X., Hong, Z., Bai, H., Liu, X., Chen, Q., Li, L. and Yang, H., 2021. Recent development in x-ray imaging technology: Future and challenges. Research.
[24] Nurmetova, G. and Abdijamilova, Z., 2024. BETTER IMAGING: THE ADVANTAGES OF DIGITAL RADIOGRAPHY. Science and innovation, 3(D5), pp.285-291.
[25] Neitzel, U., 2005. Status and prospects of digital detector technology for CR and DR. Radiation protection dosimetry, 114(1-3), pp.32-38.