ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

# A review study on radiation dose reductions techniques and optimization techniques in Computed Tomography

**Zosangliani*[1], Hrisab Deb[2], Dr. Mrinal Kanti Sinha[3]**

*[1]Assistant Professor, Faculty of Paramedical Sciences, Radiography & Imaging Technology, Assam Downtown University*

*[2]Assistant Professor, Department of Radiology, School of Health Science, The Neotia University*

*[3]HOD, Dept. of Radiology, Downtown Hospital, Guwahati Assam*

**Corresponding Author**

*Zosanglian, Assistant Professor, Faculty of Paramedical Sciences, Radiography & Imaging Technology, Assam Downtown University*

## ABSTRACT

Computed Tomography (CT) uses sophisticated computation and X-rays to provide accurate cross-sectional body imaging. It helps in identifying a variety of ailments, but for patient safety, careful radiation dosage optimization is needed. This research evaluates several CT imaging strategies for lowering radiation doses while maintaining image quality. These strategies include modifying technical parameters, applying post-processing techniques, tube current modulation, and organ-based dose modulation, employing iterative reconstruction algorithms, putting AEC systems into place, and adjusting technical parameters. The paper outlines efficient CT dose reduction methods, optimizing dose delivery without compromising accuracy. Varying tube parameters like current, voltage, pitch, and rotation time are key. Automated exposure management and iterative reconstruction reduce noise while maintaining optimal dosages. Techniques such as organ-based and tube current modulation enhance dose efficiency based on anatomy. Low-dose protocols and post-processing methods, including iterative reconstruction and noise reduction, enhance image quality in low-dose scans. Minimize patient radiation in CT scans while preserving quality by adjusting parameters, improving reconstruction, and using low-dose protocols. Maintenance and staff training are crucial for success, prioritizing patient safety.

**Keywords:** Computed Tomography, Diagnostic imaging, Patient Safety, Radiological imaging, Radiation dose management.

## INTRODUCTION

Computed Tomography (CT) offers precise cross-sectional body images using sophisticated computational methods and X-rays, aiding the diagnosis of various conditions including cancer, vascular diseases, and trauma. Advanced scanners provide diverse imaging modes, yet careful dose optimization is crucial due to radiation exposure. Ongoing research introduces innovations like spectral imaging and dual-energy CT, enhancing diagnostic accuracy.[1]

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

Optimizing CT dosage is vital for high-quality images with minimal radiation exposure. Adjusting parameters like pitch, rotation time, tube voltage, and current balances safety and accuracy. Iterative reconstruction reduces noise, while automated exposure control tailors radiation output. Tube current modulation optimizes dose distribution, and organ-based modulation tailors radiation to specific areas. Low-dose protocols and post-processing methods enhance image quality.[2] Proper training and maintenance ensure efficient dose reduction and safety. Monitoring and audit programs track exposure levels and ensure compliance, prioritizing patient care and safety.[2] In the USA, common diagnostic imaging examinations have standard effective dose values, as does the annual background radiation exposure for individuals (Table 1).[3] The aim of this review paper is to compile all the radiation or optimization techniques and parameters in Computed Tomography.

**Table 1: The dose values, along with the annual background radiation per individual in the USA.**

| **CT*** | **Effective dose (mSv)** |
|---|---|
| Abdomen and pelvis CT | 8–14 |
| Abdomen CT | 5–7 |
| Chest CT | 5–7 |
| Coronary calcium CT | 1–3 |
| Coronary CT angiography | 5–15 |
| Head CT | 1–2 |
| ***Radiographic/fluoroscopic**** | |
| Barium enema exam | 3–6 |
| Chest radiograph | 0.1–0.2 |
| Dental bitewing | <0.1 |
| Hand radiograph | <0.1 |
| Lumbar spine radiograph | 0.5–1.5 |
| Mammogram | 0.3–0.6 |
| Coronary angiogram (diagnostic) | 5–10 |
| ***Nuclear medicine**** | |
| Bone scan | 3–5 |
| Heart scan – sestamibi | 13–16 |
| Heart scan – thallium | 35–40 |
| Lung scan | 2–3 |
| ***Ubiquitous background (per individual in US population)‡*** | ***3.11*** |

## DISCUSSION

The following modules and parameters which are used for radiation dose reduction or optimization of radiation dose are discussed below:

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

**ADJUSTING TECHNICAL PARAMETERS:**

Optimizing CT parameters (pitch, rotation duration, kVp, mA) reduces radiation while maintaining image quality. Effects on dosage, image quality, and optimization factors are outlined:

**Tube Current (mA):**

Lowering tube current reduces radiation exposure but may increase image noise, affecting image quality. Balancing tube current based on patient size and anatomy helps optimize dose while maintaining image quality. Automatic Exposure Control (AEC) systems adjust tube currents based on patient attenuation characteristics, contributing to dose optimization.[5,6]

**Tube Voltage (kVp):**

Lowering tube voltage decreases radiation dose but may lead to increased image noise and reduced tissue penetration. Selecting an appropriate tube voltage based on patient size and imaging needs optimizes dose and image quality. Lower kVp settings are commonly applied in pediatric imaging and specific body parts to minimize dose.[5,6]

**Pitch:**

The pitch of a CT gantry describes the movement of the table per rotation. A higher pitch value indicates faster table movement, which reduces scan time. In helical scans, pitch can reduce radiation exposure by shortening scan time, but it may compromise image quality. Pitch values should strike a balance between dose reduction and image quality considerations.[5,6]

**Rotation Time:**

Rotation time impacts scan duration and radiation exposure, with shorter rotations reducing these factors. However, compromising image quality, especially in dynamic studies. Balancing rotation time optimizes dose while maintaining diagnostic quality.[5,6]

**USE OF ITERATIVE RECONSTRUCTION ALGORITHMS:**

Iterative reconstruction techniques surpass conventional filtered back projection (FBP) methods, presenting significant advancements in CT imaging. Key advantages include:

**Iterative Reconstruction Process:**

Iterative reconstruction algorithms refine images using mathematical models and statistical techniques. They start with an initial estimate and continually update based on acquired data, effectively reducing noise and artifacts while maintaining or enhancing spatial resolution.[8]

**Noise Reduction:**

Iterative reconstruction reduces image noise, particularly in low-dose CT scans, a challenge with traditional FBP methods. Unlike FBP, it suppresses noise effectively through statistical models and iterative refinement, yielding smoother, improved images.[8]

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

**Improved Spatial Resolution:**

Iterative reconstruction enhances spatial resolution in CT by refining the reconstruction process, mitigating blurring, and improving visualization of anatomical structures compared to traditional FBP methods.[8]

**Dose Reduction:**

Iterative reconstruction yields high-quality images with lower radiation doses than traditional methods like FBP, improving patient safety and diagnostic accuracy in modern CT imaging.[8]

**Clinical Applications:**

Iterative reconstruction techniques are widely used in diverse clinical applications, including routine and pediatric imaging, as well as for sensitive populations. Particularly valuable in dose-sensitive scenarios like screening programs and longitudinal studies, they ensure diagnostic efficacy while minimizing radiation exposure, underscoring their crucial role in modern healthcare.[8]

**AUTOMATIC EXPOSURE CONTROL (AEC):**

AEC systems optimize CT dose by adjusting exposure based on patient size and tissue, improving image quality while minimizing unnecessary radiation:

**Patient Size Detection:**

This measurement helps the system determine the appropriate radiation exposure parameters for the specific patient, ensuring that the dose is tailored to their anatomy.[9,10]

**Tissue Attenuation Analysis:**

AEC systems also analyze the attenuation characteristics of the tissues being imaged. By assessing the density and composition of tissues, the system can adjust radiation output to achieve optimal image quality while minimizing unnecessary exposure.[9,10]

**Real-Time Adjustment:**

AEC systems continuously monitor radiation exposure during the scan and make real-time adjustments to exposure parameters as needed. If the system detects variations in patient size or tissue attenuation, it automatically adapts the radiation output to maintain consistent image quality throughout the examination.[10,11]

**Dose Optimization:**

By tailoring radiation dose to the specific patient's anatomy, AEC systems help optimize dose levels while ensuring diagnostically useful images. This individualized approach to dose

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

modulation helps minimize unnecessary radiation exposure, particularly in sensitive populations such as pediatric patients or individuals with higher inherent radiation sensitivity.[10,11]

**Image Quality Maintenance:**

Despite reducing radiation dose, AEC systems are designed to maintain image quality by adjusting exposure parameters intelligently. By optimizing dose levels based on patient anatomy and tissue attenuation, AEC ensures that diagnostic information is preserved without compromising image quality.[10,11]

**Clinical Applications:**

AEC systems are extensively used in various CT examinations, including routine diagnostics, emergencies, and specialized studies. Particularly valuable in critical dose reduction scenarios like pediatric imaging or longitudinal studies, they optimize imaging protocols effectively.[11,12]

**TUBE CURRENT MODULATION:**

Tube current modulation optimizes CT radiation dose by adjusting mA based on anatomy attenuation. This minimizes exposure without compromising diagnostic quality:

**Anatomy-Based Adjustment:**

Tube current modulation algorithms analyze tissue attenuation to adjust radiation doses accordingly. Dense areas like bone need higher doses for quality images, while less dense areas like soft tissue can suffice with lower doses.[13]

**Dynamic Adjustment throughout the Scan:**

During CT scans, tube current adjusts based on anatomy's attenuation. Higher attenuation areas demand more radiation, so tube current may increase for image quality. Conversely, lower attenuation areas require less radiation, allowing tube current reduction to minimize exposure.[13]

**Dose Reduction in Low-Attenuation Regions:**

During CT scans, tube current adjusts based on anatomy's attenuation. Higher attenuation areas demand more radiation, so tube current may increase for image quality. Conversely, lower attenuation areas require less radiation, allowing tube current reduction to minimize exposure.[13,14]

**Maintaining Image Quality in High-Attenuation Regions:**

Tube current modulation maintains dose in high-attenuation areas for quality images of critical structures like bones or organs.[14]

**Clinical Applications:**

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

Tube current modulation is common in CT exams, spanning routine diagnostics to specialized studies. It's crucial for dose optimization in routine scans and screenings, prioritizing reduced radiation while preserving diagnostic accuracy.[15]

**ORGAN-BASED DOSE MODULATION:**

Organ-based dose modulation in CT adjusts tube current (mA) based on the imaged organ, optimizing dose levels for enhanced safety and imaging effectiveness.

**Organ-specific attenuation analysis:**

Organ-based dose modulation algorithms analyze the attenuation characteristics of the specific organ being imaged. Different organs have varying densities and attenuation properties, which influence the amount of radiation needed to produce diagnostically useful images.[16]

**Customized Dose Adjustment:**

The CT adjusts tube current based on organ attenuation for optimized doses. Higher doses suit organs like the liver for quality images, while lower doses work for less attenuating organs like the lungs.[16]

**Selective Dose Reduction and Enhancement:**

Organ-based dose modulation selectively adjusts radiation doses in organs with lower attenuation, reducing unnecessary exposure while preserving diagnostic image quality. Conversely, in organs with higher attenuation, dose levels may be increased to ensure proper visualization of anatomical structures and pathology.[17]

**Dose Optimization for Specific Examinations:**

Organ-based dose modulation tailors CT scans for specific anatomical regions or organs. In abdominal scans, dose optimization considers organ attenuation like the liver, pancreas, or kidneys. Similarly, in chest scans, modulation enhances lung and mediastina imaging.[17,18]

**Clinical Applications:**

Organ-based dose modulation is extensively applied in diverse clinical scenarios like routine diagnostic imaging, oncologic imaging, and follow-up studies. These techniques particularly excel in reducing radiation exposure in vulnerable populations like pediatric patients, all the while maintaining the quality of diagnostic images at a high standard.[17,18]

**USE OF LOW-DOSE PROTOCOLS:**

Low-dose CT protocols minimize radiation exposure while maintaining diagnostic image quality, particularly important for screening and follow-up studies prioritizing dose reduction.

**Optimized Scanning Parameters:**

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

- Low-dose protocols involve the adjustment of various scanning parameters, such as tube current (mA), tube voltage (kVp), pitch, and rotation time, to reduce radiation dose without compromising image quality.
- These protocols are carefully designed to balance the trade-off between radiation dose reduction and maintaining sufficient image quality for accurate diagnosis.[19]

**Iterative Reconstruction Algorithms:**

- Low-dose protocols often incorporate advanced iterative reconstruction algorithms to further reduce image noise and improve image quality.
- Iterative reconstruction techniques allow for dose reduction while preserving spatial resolution and diagnostic accuracy.[19]

**Patient Selection and Clinical Indications:**

- Low-dose protocols are commonly used for screening examinations, such as lung cancer screening, cardiac calcium scoring, and colorectal cancer screening.
- They may also be employed for follow-up imaging studies in patients with chronic conditions or surveillance of certain diseases, where repeated scans are necessary over time.[20]

**Pediatric Imaging:**

- Low-dose protocols are particularly important in pediatric imaging to minimize radiation exposure in children, who are more sensitive to the effects of ionizing radiation.
- Pediatric CT protocols often include specialized low-dose techniques tailored to the specific clinical indication and patient age.[20]

**Dose Monitoring and Optimization:**

- Continuous monitoring of radiation dose is essential in low-dose protocols to ensure that dose levels remain as low as reasonably achievable (ALARA) while maintaining diagnostic image quality.
- Radiology teams may implement dose optimization strategies, such as iterative adjustments to scanning parameters and dose tracking tools, to further refine low-dose protocols based on clinical experience and feedback.[21]

**Regulatory Compliance and Guidelines:**

- Low-dose protocols are developed by regulatory requirements and guidelines, such as those provided by organizations like the American College of Radiology (ACR) and the Image Wisely campaign.[21]
- These guidelines offer recommendations for optimizing radiation dose in CT imaging while ensuring patient safety and diagnostic accuracy.[21]

## IMAGE NOISE REDUCTION TECHNIQUES:

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

Low-dose CT protocols prioritize dose reduction while maintaining diagnostic quality, crucial for screening and follow-up studies.

**Noise Reduction Algorithms:**

Noise reduction algorithms are integral to low-dose CT scans, suppressing inherent image noise during reconstruction or post-processing. They differentiate between true features and noise, smoothing out noise while preserving anatomical details, thus improving image appearance and diagnostic confidence.[22]

**Iterative Reconstruction:**

Iterative reconstruction algorithms refine images iteratively using statistical models. Besides reducing noise, they improve spatial resolution and overall image quality compared to traditional FBP methods. By optimizing the reconstruction process, these algorithms produce clearer, sharper, and diagnostically valuable images from low-dose CT data.[22]

**Artifact Reduction:**

Post-processing techniques aid in mitigating artifacts in low-dose CT scans, like streak, beam hardening, and motion artifacts, which can degrade image quality. These algorithms identify and correct such artifacts, ensuring accurate interpretation of imaging findings.[23]

**Preservation of Image Detail:**

The key aim of noise reduction and iterative reconstruction is to preserve vital image details while reducing noise, ensuring visibility of anatomical structures and diagnostic features remains uncompromised in low-dose acquisitions.[23]

**Clinical Applications:**

Noise reduction and iterative reconstruction techniques are widely utilized in various clinical CT examinations, including routine diagnostic, oncologic, and cardiovascular imaging. Particularly valuable in low-dose scans, they ensure image quality remains crucial for accurate diagnosis despite reduced radiation exposure.[24]

## EDUCATION AND TRAINING:

CT imaging personnel need thorough education and training to reduce doses effectively while maintaining diagnostic accuracy:

**Understanding Radiation Physics and Safety:**

Healthcare professionals must understand radiation physics, CT operation, dose calculation, and risks of ionizing radiation. Radiation safety training is crucial for effective dose reduction and minimizing exposure risks.[25]

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

**Knowledge of Dose Reduction Techniques:**

Healthcare professionals require knowledge of dose reduction techniques like parameter adjustment, automatic exposure control, and iterative reconstruction. Education programs offer comprehensive instruction on their benefits, limitations, and clinical applications.[25]

**Optimizing Imaging Protocols:**

Radiologists and technologists optimize CT protocols, balancing dose reduction with diagnostic quality. Training enables customization based on patient factors, clinical needs, and imaging goals, adjusting parameters like tube current and voltage for the desired balance.[26]

**Quality Assurance and Quality Control:**

Education and training programs must address CT imaging quality assurance, covering equipment calibration, dose monitoring, and image quality assessment protocols. Healthcare professionals must grasp their responsibilities in ensuring CT imaging system and protocol quality and safety.[26]

**Communication and Collaboration:**

Collaboration among radiologists, technologists, physicists, and healthcare teams is vital for implementing dose reduction strategies. Education emphasizes interdisciplinary teamwork in optimizing CT imaging for patient safety.[27]

**Continuing Education and Professional Development:**

Continuing education is essential for healthcare professionals to stay current with CT imaging advancements and dose reduction techniques. Programs, conferences, workshops, and online resources aid radiologists, technologists, and others in keeping abreast of the latest practices in CT imaging and radiation dose optimization.[28]

## REGULAR EQUIPMENT MAINTENANCE AND CALIBRATION:

Ensuring that CT equipment is properly maintained and calibrated is crucial for optimizing image quality and dose efficiency. Here's why equipment maintenance and calibration are essential:

**Consistent Performance:**

Regular maintenance and calibration help ensure that CT equipment operates reliably and consistently over time. This consistency is vital for obtaining high-quality images and accurate diagnostic information.[29]

**Optimal Image Quality:**

Properly maintained and calibrated equipment helps produce images with optimal contrast, resolution, and sharpness. Calibration ensures that imaging parameters such as tube current, tube voltage, and detector sensitivity are accurately set, resulting in images of superior quality.[29]

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

**Dose Optimization:**

Well-maintained equipment is more efficient in delivering radiation doses accurately and precisely. Calibration ensures that dose levels are calibrated correctly, minimizing the risk of overexposure or underexposure to patients while maintaining diagnostic image quality.[30]

**Artifact Reduction:**

Equipment malfunctions or inaccuracies can lead to imaging artifacts, which may degrade image quality and compromise diagnostic accuracy. Regular maintenance and calibration help identify and address potential sources of artifacts, resulting in cleaner, artifact-free images.[31]

**Compliance with Regulations:**

Healthcare facilities are required to adhere to regulatory standards and guidelines regarding equipment maintenance and calibration. Regular maintenance and calibration activities help ensure compliance with regulatory requirements, reducing the risk of penalties and legal liabilities.[31]

**Longevity of Equipment:**

Proper maintenance and calibration extend the lifespan of CT equipment by minimizing wear and tear and preventing premature equipment failures. This reduces downtime and ensures that the equipment remains operational, providing uninterrupted diagnostic services to patients.[31]

**Patient Safety:**

Maintaining properly calibrated equipment is essential for patient safety. Accurate calibration helps ensure that radiation doses are delivered as intended, minimizing the risk of overexposure or unnecessary radiation exposure to patients.[32]

**Quality Assurance Programs:**

Implementing comprehensive quality assurance programs, which include routine equipment maintenance and calibration, helps identify and address potential issues proactively. These programs contribute to the overall quality and safety of CT imaging services provided by healthcare facilities.[33]

**DOSE MONITORING AND AUDIT PROGRAMS:**

Dose monitoring and audit programs are crucial for managing radiation exposure levels in Computed tomography (CT) imaging, benefiting patient care.[34] Dose monitoring programs systematically track radiation doses in CT scans, recording metrics like CT dose index (CTDI) and dose length product (DLP) to monitor exposure trends and identify high doses.[35] Analysis of dose data improves imaging practices, optimizing protocols and training to reduce radiation dose without compromising image quality. These programs ensure compliance with dose reduction guidelines from regulatory bodies like the American College of Radiology (ACR) and International Commission On Radiological Protection (ICRP), supporting quality improvement

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

through audits and standardization.[36] Their primary goal is to minimize patient radiation exposure while maintaining diagnostic accuracy, supported by staff education initiatives.[37] Implementing these programs demonstrates transparency and accountability, fostering trust by openly monitoring and reporting dose levels to patients and regulators.[38]

## CONCLUSION:

By adjusting technical parameters, employing iterative reconstruction, integrating exposure control systems, and utilizing dose modulation, healthcare providers can reduce radiation doses in CT imaging while maintaining diagnostic accuracy and patient safety. Tailored radiation exposure optimizes dose levels while preserving image quality. Post-processing techniques enhance image quality in low-dose scans. Education and training are essential for personnel involved in CT imaging. Regular equipment maintenance and dose monitoring ensure compliance with regulations. Balance dose optimization with clinical requirements, prioritizing patient safety and accuracy.

**Ethical Clearance:** Not required.

**Source of Funding:** self-funding.

**Conflict of Interest:** Nil.

## REFERENCES

1. Sarma A, Heilbrun ME, Conner KE, Stevens SM, Woller SC, Elliott CG. Radiation and chest CT scan examinations: what do we know? Chest. 2012;142(3):750-60.
2. Zhao J, Zhang Y, He X, Xie P. Covid-ct-dataset: a ct scan dataset about covid-19. arXiv preprint arXiv:200313865. 2020;490(10.48550).
3. Lifeng Yu,† Xin Liu, Shuai Leng, James M Kofler, et al. Radiation dose reduction in computed tomography: techniques and future perspective. Imaging Med. 2009 Oct; 1(1): 65–84.doi: 10.2217/iim.09.5
4. Russell M.T, Fink J.R, Rebeles F, Kanal K, Ramos M,and Anzaia Y, et al. Balancing Radiation Dose and Image Quality: Clinical Applications of Neck Volume CT. AJNR Am J Neuroradiol. 2008 Apr; 29(4): 727–731.doi: 10.3174/ajnr.A0891
5. Shah V, Keniya R, Shridharani A, Punjabi M, Shah J, Mehendale N. Diagnosis of COVID-19 using CT scan images and deep learning techniques. Emergency radiology. 2021;28:497-505.
6. Yang X, He X, Zhao J, Zhang Y, Zhang S, Xie P. COVID-CT-dataset: a CT scan dataset about COVID-19. arXiv preprint arXiv:200313865. 2020.
7. Makaju S, Prasad P, Alsadoon A, Singh A, Elchouemi A. Lung cancer detection using CT scan images. Procedia Computer Science. 2018;125:107-14.

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

8. Nault M-L, Hébert-Davies J, Laflamme G-Y, Leduc S. CT scan assessment of the syndesmosis: a new reproducible method. Journal of orthopaedic trauma. 2013;27(11):638-41.
9. Mamatha H, Shamasundar N, Bharathi M, Prasanna L. Variations of ostiomeatal complex and its applied anatomy: a CT scan study. Indian J Sci Technol. 2010;3(8):904-7.
10. Haruna A, Muro S, Nakano Y, Ohara T, Hoshino Y, Ogawa E, et al. CT scan findings of emphysema predict mortality in COPD. Chest. 2010;138(3):635-40.
11. Ramakrishnan S, Nagarkar K, DeGennaro M, Srihari M, Courtney AK, Emick F. A study of the CT scan area of a healthcare provider. Proceedings of the 2004 Winter Simulation Conference, 2004; 2004: IEEE.
12. Victor J, Van Doninck D, Labey L, Innocenti B, Parizel P, Bellemans J. How precise can bony landmarks be determined on a CT scan of the knee? The knee. 2009;16(5):358-65.
13. Johnson P, Federico M, Kirkwood A, Fosså A, Berkahn L, Carella A, et al. Adapted treatment guided by interim PET-CT scan in advanced Hodgkin's lymphoma. New England Journal of Medicine. 2016;374(25):2419-29.
14. Lagleyre S, Sorrentino T, Calmels M-N, Shin Y-J, Escudé B, Deguine O, et al. Reliability of high-resolution CT scan in diagnosis of otosclerosis. Otology & neurotology. 2009;30(8):1152-9.
15. Kalita J, Misra U. Comparison of CT scan and MRI findings in the diagnosis of Japanese encephalitis. Journal of the neurological sciences. 2000;174(1):3-8.
16. Salem T, Molloy R, O'dwyer P. Prospective study on the role of the CT scan in patients with an acute abdomen. Colorectal disease. 2005;7(5):460-6.
17. Dierick M, Van Loo D, Masschaele B, Van den Bulcke J, Van Acker J, Cnudde V, et al. Recent micro-CT scanner developments at UGCT. Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms. 2014;324:35-40.
18. Soares E, Angelov P, Biaso S, Froes MH, Abe DK. SARS-CoV-2 CT-scan dataset: A large dataset of real patients CT scans for SARS-CoV-2 identification. MedRxiv. 2020:2020.04.24.20078584.
19. Pasquier G, Ducharne G, Ali ES, Giraud F, Mouttet A, Durante E. Total hip arthroplasty offset measurement: is CT scan the most accurate option? Orthopaedics & traumatology: surgery & research. 2010;96(4):367-75.
20. Spanier BM, Nio Y, van der Hulst RW, Tuynman HA, Dijkgraaf MG, Bruno MJ. Practice and yield of early CT scan in acute pancreatitis: a Dutch observational multicenter study. Pancreatology. 2010;10(2-3):222-8.
21. Razi T, Niknami M, Ghazani FA. Relationship between Hounsfield unit in CT scan and gray scale in CBCT. Journal of dental research, dental clinics, dental prospects. 2014;8(2):107.
22. Tan WJ, Acharyya S, Goh YC, Chan WH, Wong WK, Ooi LL, et al. Prospective comparison of the Alvarado score and CT scan in the evaluation of suspected appendicitis:

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

a proposed algorithm to guide CT use. Journal of the American College of Surgeons. 2015;220(2):218-24.
23. Marx M, Lagleyre S, Escudé B, Demeslay J, Elhadi T, Deguine O, et al. Correlations between CT scan findings and hearing thresholds in otosclerosis. Acta oto-laryngologica. 2011;131(4):351-7.
24. McCollough CH, Bushberg JT, Fletcher JG, Eckel LJ, editors. Answers to common questions about the use and safety of CT scans. Mayo Clinic Proceedings; 2015: Elsevier.
25. Ahuja S, Panigrahi BK, Dey N, Rajinikanth V, Gandhi TK. Deep transfer learning-based automated detection of COVID-19 from lung CT scan slices. Applied Intelligence. 2021;51:571-85.
26. Brenner D. Slowing the increase in the population dose resulting from CT scans. Radiation research. 2010;174(6b):809-15.
27. Afshar P, Heidarian S, Enshaei N, Naderkhani F, Rafiee MJ, Oikonomou A, et al. COVID-CT-MD, COVID-19 computed tomography scan dataset applicable in machine learning and deep learning. Scientific Data. 2021;8(1):121.
28. Kroeker KI, Lam S, Birchall I, Fedorak RN. Patients with IBD are exposed to high levels of ionizing radiation through CT scan diagnostic imaging: a five-year study. Journal of clinical gastroenterology. 2011;45(1):34-9.
29. Greffier J, Fernandez A, Macri F, Freitag C, Metge L, Beregi J-P. Which dose for what image? Iterative reconstruction for CT scan. Diagnostic and Interventional Imaging. 2013;94(11):1117-21.
30. Elmuogy S, Hikal NA, Hassan E. An efficient technique for CT scan images classification of COVID-19. Journal of Intelligent & Fuzzy Systems. 2021;40(3):5225-38.
31. Fernandez LM, Parlade AJ, Wasser EJ, Dasilva G, de Azevedo RU, Ortega CD, et al. How reliable is CT scan in staging right colon cancer? Diseases of the Colon & Rectum. 2019;62(8):960-4.
32. Sharma S. Drawing insights from COVID-19-infected patients using CT scan images and machine learning techniques: a study on 200 patients. Environmental Science and Pollution Research. 2020;27(29):37155-63.
33. Giurazza F, Del Vescovo R, Schena E, Battisti S, Cazzato RL, Grasso FR, et al. Determination of stature from skeletal and skull measurements by CT scan evaluation. Forensic science international. 2012;222(1-3):398. e1-. e9.
34. Roy D, Ahad HA, Chinthaginjala H, Kumar GA, Reddy GG, Teja AST. A possible alternative to Opiorphin and its stable analogues for treating fibromyalgia pain: A clinical hypothesis. Northern Clinics of Istanbul. 2023;10(1):122-6.
35. Gupta PK, Krishna A, Dwivedi AN, Gupta K, Madhu B, Gouri G, et al. CT scan findings and outcomes of head injury patients: A cross sectional study. Journal of Pioneering Medical Sciences. 2011;1(3):78.
36. Benmalek E, Elmhamdi J, Jilbab A. Comparing CT scan and chest X-ray imaging for COVID-19 diagnosis. Biomedical Engineering Advances. 2021;1:100003.

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 10, 2024

37. Marchiori E, Zanetti G, Escuissato DL, Souza Jr AS, Meirelles GdSP, Fagundes J, et al. Reversed halo sign: high-resolution CT scan findings in 79 patients. Chest. 2012;141(5):1260-6.
38. Kumar YB, Ahad HA, Haranath C, Sumanth G, Pasupuleti DS, Reddy SS. Platelet Rich Plasma Therapy: A quick note for every health care professional.(2020). Int J Life Sci Pharma Res. 2020;10(5):P84-9.

**Acknowledgement**

First and foremost, I would like to thank my supervisor Dr. Mrinal sir, HOD Dept. Radiology, Downtown Hospital, Guwahati, for his guidance and support throughout the study. I would also like to thanks Mr. Hrisab Deb, Assistant professor, The Neotia University, for his continuous help to complete the article. Finally, I would like to thank my parents for their continuous support.