Since 2004 For free Circulation

ISRRT
INTERNATIONAL SOCIETY OF RADIOGRAPHERS & RADIOLOGICAL TECHNOLOGISTS

# Radiographers' Journal

The official magazine of Society of Indian Radiographers (SIR)
Published by Radiographers' Association of Maharashtra (RAM)

September 2025

# Editorial

Shankar K. Bhagat
Editor-in-chief

Dear Readers,

It gives me great pleasure to present the September 2025 issue of the Radiographers Journal. As always, this edition brings together a rich spectrum of articles contributed by experts, academicians, and practitioners from across the field of radiological sciences. The diversity of subjects covered this month reflects not only the rapid pace of technological advancements but also the evolving roles and responsibilities of radiography professionals in modern healthcare.

We begin with a thought-provoking article on “Medico Legal Issues for Diagnostic Imaging Technologists”, which underscores the increasing need for radiographers to remain vigilant about legal and ethical aspects in their practice. From patient consent to maintaining records and ensuring radiation safety, this piece highlights how medico-legal awareness is becoming as important as technical competence in safeguarding both patients and professionals.

Equally compelling is “Beyond the Button: The Expanding Role of Radiography Technologists in Modern Healthcare”, which moves beyond the stereotype of technologists as mere button pushers. The article emphasizes their integral role in multidisciplinary teams, patient counseling, research, and the broader healthcare ecosystem—illustrating how radiographers are truly at the heart of precision medicine.

This issue also delves into specialized applications of imaging. The article on “The Utility of Advanced Imaging in Forensic Anthropology” shows how imaging technologies, from CT to MRI, are revolutionizing the identification and analysis of skeletal remains. Such advances highlight radiology’s importance beyond clinical settings, extending its impact into forensic science and justice.

Technology continues to drive innovation, particularly in cancer care. “Machine Learning in MRI-Based Cancer Characterization” and “Deep Learning Approaches for Enhanced Lung Cancer Detection” both explore the transformative role of artificial intelligence. These articles review how algorithms and convolutional neural networks can boost accuracy, reduce diagnostic delays, and provide clinicians with powerful tools for early detection and personalized treatment planning.

Equally forward-looking is the contribution on “O-ARM Surgical Imaging System”, which details the integration of intraoperative imaging in complex surgical procedures. The O-ARM’s ability to provide real-time, 3D visualization represents a leap toward safer and more precise surgical interventions, making it indispensable in neurosurgery and orthopedic domains.

A fascinating clinical focus is offered in “Diagnostic Accuracy of MRI-Based Radiomics Models for Prenatal Detection of Placenta Accreta Spectrum Disorders”. This article provides insights into how advanced radiomics techniques enhance early diagnosis and risk stratification in obstetric care—crucial for maternal and fetal safety.

From a biomechanical perspective, the paper on “DEXA-Based Finite Element Analysis” examines how dual-energy X-ray absorptiometry, when coupled with finite element modeling, can better predict fracture risk and guide osteoporosis management strategies. It is a striking example of how imaging, analytics, and engineering intersect to improve patient outcomes.

Cardiac imaging also takes the spotlight with “AutoMate Cardiac: Making the Complexity Simpler with Next-Generation Cardiac MRI”. This article illustrates how automation and advanced software are reducing complexity, improving reproducibility, and offering clinicians more robust diagnostic insights into cardiovascular disease.

Collectively, the articles in this issue not only inform but also inspire. They remind us that radiography is not confined to the operation of equipment but encompasses legal responsibility, patient-centered care, technological innovation, and interdisciplinary collaboration. The future of radiology will be shaped by those who embrace these dimensions with curiosity, responsibility, and passion.

As you engage with these insightful contributions, I encourage you to reflect on how each development can be translated into better clinical practice, safer patient outcomes, and a more empowered professional community.

Happy Reading!

# Society of Indian Radiographers (SIR) CEO Srinivasulu Siramdas Appointed President of Professional Council under NCAHP

The Radiographers fraternity in India has reached a moment of great pride and recognition. Shri Srinivasulu Siramdas, CEO – Society of Indian Radiographers (SIR) and I/c Principal & RSO, Nizam's Institute of Medical Sciences, Hyderabad, has been appointed as the President of the Medical Radiology, Imaging & Therapeutic Technology Professional Council under the National Commission for Allied and Healthcare Professions (NCAHP), Ministry of Health & Family Welfare, Government of India.

This appointment is a landmark for the radiographer community, as one of our own now holds a distinguished leadership role at the national level. Shri Srinivasulu's contribution to radiography and imaging sciences has been immense. As CEO of SIR, he has consistently worked to strengthen professional unity, raise academic standards, and advocate for the recognition of radiographers in the healthcare system.

His new role as President of the Professional Council opens exciting possibilities for shaping policies, standardizing education, and enhancing the visibility of radiographers in India. It ensures that the profession will have a strong and visionary voice in the corridors of healthcare policymaking.

The Society of Indian Radiographers and the entire community stand proud of this achievement. We are confident that his leadership will inspire radiographers nationwide and contribute significantly to the advancement of our profession.

On behalf of the Radiographers Journal and the radiography fraternity, I extend warm congratulations and best wishes to Shri Srinivasulu Siramdas on this well-deserved honor.

सत्यमेव जयते

Government of India
Ministry of Health and Family Welfare
National Commission for Allied and Healthcare Professions

**NOTIFICATION**

New Delhi, the 2nd September, 2025

In exercise of the powers conferred by Section (10) and sub-section (2) of section 11 of the National Commission for Allied and Healthcare Professions Act, 2021 (14 of 2021) read with Rule 10 of the NCAHP Rules, 2021, the National Commission for Allied and Healthcare Professions (NCAHP) vide notification number 40/1/2025-AHS-DOHFW DEPARTMENT, dated 26.03.2025 has constituted ten (10) Professional Councils.

In continuation of the above-mentioned notification, and as per Section (10) of NCAHP Act 2021, the President of each Professional Council is hereby notified as under:

| SN | Professional Council | Name of President of Professional Council |
|---|---|---|
| 1 | Medical Laboratory and Life Sciences Professional Council | Dr. Rashmi Shukla (PhD), Scientist II, Cytogenetics and Molecular Genetics, AIIMS, New Delhi |
| 2 | Trauma, Burn Care and Surgical/ Anaesthesia related technology Professional Council | Shri. Ravi Surla, GVK, EMRI, Hyderabad |
| 3 | Physiotherapy Professional Council | Dr. KM Annamalai (PhD), Chancellor-Gandhigram Rural Institute, Gujarat |
| 4 | Nutrition Science Professional Council | Dr. Jagmeet Madan (PhD), Principal and Professor - Dept of Food Nutrition and Dietetics, Director, Research, Consultancy and Collaboration Centre, Sir Vithaldas Thackersey College of Home Science, Mumbai |
| 5 | Ophthalmic Science Professional Council | Dr. Ramani Krishna Kumar (PhD), Faculty, Elite School of Optometry, Chennai |
| 6 | Occupational Therapy Professional Council | Dr. Akhilesh Kumar Shukla (PhD), Director, NIMHR, Madhya Pradesh |
| 7 | Community Care, Behavioural Health & Other Professionals Professional Council | Dr. Sonia Deuri (PhD), Professor and Head, Department of Psychiatric Social Work, LGBRIMH, Assam |
| 8 | Medical Radiology, Imaging & Therapeutic Technology Professional Council | Shri Srinivasulu siramdas, I/c Principal & RSO, Nizam's Institute of Medical Sciences, Hyderabad |
| 9 | Medical Technology & Physician Associates, Biomedical & Medical Equipment Technology Professional Council | Dr. Jagadeswaran D (PhD), Principal and Professor Saveetha College of Allied Health Sciences Chennai |
| 10 | Health Information Management & Health Informatic Professional Council | Dr. Sabu K M (PhD), Professor, Dept. Health Information Management, Manipal College of Health Professions (MCHP), Manipal Academy of Higher Education (MAHE), Udupi |

Page 1 of 2

The tenure of the President of each Professional Council will be for a period of two years, w.e.f. the date of the notification or until further orders, whichever is earlier.

[F. No. Z-1011/05/2025/NCAHP(AHS)]

Umesh Balonda, Secretary, NCAHP

**https://ncahp.abdm.gov.in/**

Page 2 of 2

# Establishment of NCAHP – A New era for Healthcare Professionals

**Srinivasulu Siramdas,** President, Medical Radiology, Imaging & Therapeutic Technology Professional Council, NCAHP

The Government of India notified the National Commission for Allied and Healthcare Professions (NCAHP) Act in the Gazette of India on March 28, 2021, after it received the assent of the President of India.

Till date there were only few regulatory bodies such as National Medical Commission (NMC) for Doctors, Dental Council India for Dentists, Nursing Council of India for Nursing Fraternity and Pharmacy Council for Pharmacists exist in India to regulate those professions. But the larger sector of Paramedics who play a vital role in the healthcare industry in Diagnosis, treatment and therapeutic have no such statutory body to regulate their professions. There was a long demand from those sectors since decades to establish the respective Councils. After careful examinations of the demands of the Paramedics, Associations, the Union Government of India has notified the National Commission for all Allied Healthcare Professionals including Physiotherapists, Technologists of Anaesthesia, Cardiovascular, Dialysis, Radiography & Imaging, Radiotherapy, Nuclear Medicine, Laboratory Technology, Neurotechnology, Respiratory Therapy Medical Physicists about 57 professions under one umbrella on March 28, 2021. With this establishment of Commission, the Allied Healthcare Professionals will get a Registration, Recognition and Regulation.

As a common regulatory body, the NCAHP Act provides for regulation and maintenance of standards of education and services by Allied and Healthcare professionals, assessment of institutions, maintenance of a Central Register and State Register, and creation of a system to improve access, research and development and adoption of latest scientific advancement and connected matters. NCAHP Act covers 57 Allied and Healthcare Professions categorized under 10 broad recognized categories with distinct Professional Councils.

The Govt. of India has appointed Dr. Yagna Shukla as Chairperson of the National Commission and 5 members in each Professional council for 10 categories from the Allied and Healthcare Professionals on 26th March 2025.

**There are 10 Professional Councils as follows:**

1. Medical Laboratory and Life Sciences Professional Council
2. Trauma, Burncare and Surgical/Anaesthesia related technology professional council
3. Physiotherapy Professional Council
4. Nutrition Science Professional Council
5. Ophthalmic Science Professional Council
6. Occupational Therapy Professional Council
7. Community Care, Behavioural Health & Other Professionals Professional Council
8. Medical Radiology, Imaging & Therapeutic Technology Professional Council
9. Medical Technology & Physician Associates, Biomedical & Medical equipment Technology Professionals Council
10. Health information Management & Health Informatic Professional Council.

The Act defines the Allied and Healthcare Professionals as Healthcare Professional and Allied Healthcare professional.

**Allied Healthcare Professional:** "Allied health professional" includes an associate, technician or technologist who is trained to perform any technical and practical task to support diagnosis and treatment of illness, disease, injury or impairment, and to support implementation of any healthcare treatment and referral plan recommended by a medical, nursing or any other healthcare professional, and who has obtained any qualification of diploma or degree under this Act, the duration of which shall not be less than two thousand hours spread over a period of two years to four years divided into specific semesters.

"Healthcare professional" includes a scientist, therapist or other professional who studies, advises, researches, supervises or provides preventive, curative, rehabilitative, therapeutic or promotional health services and who has obtained any qualification of degree under this Act, the duration of which shall not be less than three thousand six hundred hours spread over a period of three years to six years divided into specific semesters;

"Allied & Healthcare qualification" means a recognised diploma or degree possessed by an allied and healthcare professional through regular learning mode under this Act or any additional recognised course obtained thereafter;

**State Councils for Allied Healthcare Professionals:**

1) Every State Government shall, by notification, within six months from the date of commencement of this Act, constitute a State Council to be called the State Allied and Healthcare Council for exercising such powers and discharging such duties as may be laid down under this Act.

(2) The State Council shall be a body corporate by the name aforesaid, having perpetual succession and a common seal, with power to acquire, hold and dispose of property, both movable and immovable, and to contract and shall by the same name sue or be sued.

As per the Act every state government should establish a State Council for Allied Healthcare Professionals with a Chairperson, Ex officio members and part time members from the professionals of recognised categories. The Council should establish the four autonomous boards namely

- Under graduate Allied Healthcare Educational Board
- Post-graduate Allied and Healthcare Educational Board.
- Allied and Healthcare Professions Assessment Board
- Allied and Healthcare Professions Ethics and Registration Board.

Every autonomous board will have the President and Part time members from the recognised professions. At least two members from each category shall be placed in each autonomous board.

The Under-graduate Allied and Healthcare Education Board and Post-graduate Allied and Healthcare Education Board shall determine standards of allied and healthcare education at the graduate, postgraduate level and super-speciality level, develop competency based on dynamic curriculum content, reviewing institutional standards against norms, faculty development, approval of courses of recognised qualification and other functions as entrusted by the State Council for Under Graduate Education and Post Graduate Education.

The Allied and Healthcare Profession Assessment and Rating Board shall determine the procedure for the assessment and rating of allied and healthcare institutions by providing for inspection of institutions, grant permission for establishment of new allied and healthcare institutions and seat capacity, empanelling assessors, imposing warnings or fines, recommend for withdrawal of recognition of institutions and any other function as entrusted by the State Council to ensure maintenance of minimum essential standards.

The Allied and Healthcare Profession Ethics and Registration Board shall maintain online and live State Registers of all licensed allied and healthcare practitioners in the State, regulate the professional conduct and promotion of ethics and undertake any other function as entrusted by the State Council.

**Functions of the State Councils:**
The state council have a major role in registering, recognising and regulating (RRR) the healthcare professionals. The State Council shall enter the name of the healthcare professional in the state live register of recognised categories enforce the professional conduct, code of ethics and etiquette to be observed by the State AHP council in the state to take disciplinary action, including the removal of a professionals' name from the State Register, ensure minimum standards of education, courses, curricula, physical and instructional facilities, staff pattern, staff qualifications, quality instructions, assessment, examination, training, research, continuing professional education.

State councils ensure uniform entry examination with common counselling for admission into the allied and healthcare institutions at the diploma, undergraduate, postgraduate and doctoral level under this Act and ensure uniform exit or licensing examination for the allied and healthcare professionals under this Act.

The state councils should inspect allied and healthcare institutions and register allied and healthcare professionals in the State to ensure compliance of all the directives issued by the Commission and to provide minimum standards framework for machineries, materials and services.

The state council shall approve or recognise courses and intake capacity for courses and impose fine upon institutions in order to maintain standards; and perform any other functions as may be entrusted to it by the State Government for implementation of the provisions of this Act.

The National Commission shall frame the rules and guidelines, but the implementation part is by the state councils only. In fact, the state councils will be more powerful than the National Commission. The autonomous boards mentioned above come under National Medical Commission for medical stream but for allied healthcare professionals, the establishment and functioning of autonomous boards comes under the state council.

**How to register as Allied and Healthcare Professionals?**
The Commission shall maintain online and live Register of persons in separate parts in each of the recognised categories to be known as the Central Allied and Healthcare Professionals' Register which shall contain information including the name of persons and qualifications relating to any of their respective recognised categories in the manner as may be specified by the regulations. person possessing certain recognised allied and healthcare qualifications, every person whose name is for the time being borne on the Central Register shall be entitled according to his qualifications to provide any service within the defined scope of practice as an allied and healthcare professional under this Act.

The Central Register shall be deemed to be a public document within the meaning of the Indian Evidence Act, 1872 and may be proved by a certified copy provided by the Commission.

The State Council shall maintain online and live State Register of persons in separate parts for each of the recognised categories to be known as the State Allied and Healthcare Professionals' Register which shall contain information including the name of person and qualifications relating to any of their respective recognised categories in such manner as may be specified by regulations.

The State Register shall contain the details of academic qualification institutions, training, skill and competencies of Allied and Healthcare Professionals related to their profession in the manner as may be specified by regulations The professionals possessing the qualifications as mentioned in the act can register in the state register as Regular registration and he/she will be issued a certificate of registration with unique Id. Once a candidate is registered online and fulfil all the conditions, automatically the details reflect in the Central Register. No need to register separately in the central register.

**Why should a healthcare professional register with State Council?**
Once the registration process is started, No person, other than a registered allied and healthcare professional, shall
**(a)** hold office as an allied and healthcare professional (by whatever name called) in Government or in any institution maintained by a local or other authority;
**(b)** provide service in any of the recognised categories in any State; and
**(c)** be entitled to sign or authenticate any certificate required by any law for the time being in force to be signed or authenticated by a duly qualified allied and healthcare professional.

Hence it is mandatory to register to practice the profession, open an institution and provide the service in any category.

**Why the word Paramedical is replaced with Allied & Healthcare Professional?**
The term "Paramedical" has long been used to describe various healthcare related professions that provide support services in healthcare delivery. However, with the enactment of the National Commission for Allied and Healthcare Professions (NCAHP) Act, the term "Allied and Healthcare" has been formally adopted to define, standardize, and recognize these professions under a unified framework.

In view of the above and for the purpose of ensuring uniformity, standard terminology and alignment with the provisions of the NCAHP Act, it is recommended by the Commission to implement the followings:

**a)** All State Governments, Union Territories and relevant Universities / Institutions are recommended to discontinue the use of the term "Paramedical" in all official correspondence, communications, policies, advertisements, training programmes, institutional titles, recruitment notifications, educational materials and any other Government-related documents or portals.

**b)** The term "Allied and Healthcare" as defined under Section 2 (b), (c), (d), (e) and (J) of the NCAHP Act, 2O2l shall be used henceforth in place of "Paramedical" in all forms of usage [verbal, written or electronic)'

**c)** The Health Departments of the States/UTs are requested to communicate this to all concerned authorities, institutions and stakeholders under their jurisdiction and ensure necessary compliance at the earliest through F. No. Z I L03 / 202 4-AHS- D OH FW DE PARTM E NT, FTS-8 3095 47, by the National Commission for Allied and Healthcare Professionals. Government of India.

**One Nation and One Curriculum:**
The report "From Paramedics to Allied Health Professionals - Landscaping the Journey and Way Forward" that was published in 2012, marked the variance in education and training practices for the allied and healthcare courses offered by institutions across the country. This prompted the Ministry of Health and Family Welfare to envisage the creation of national guidelines for education and career pathways of allied and healthcare professionals, with a structured curriculum based on skills and competencies. The National Commission of AHCPs is developing the curricula for the allied sciences. So far, the unique curricula were released for 10 Professional Courses and the course curriculum for Medical Laboratory technology is published for public opinion. Many are in progress to ensure One Nation and One curriculum.

It is mandatory to follow the curricula designed by the NCAHP from 2026-27 onwards by all the institutions conducting allied health sciences.

**Establishment of New Allied and Healthcare Institution:**
Notwithstanding anything contained in this Act or any other law for the time being in force, on and from the date of commencement of this Act, No person or Allied and healthcare institution shall open a new or higher course of study or training (including post-graduate course of study or training) which would enable students of each course of study or training to qualify himself for the award of any recognised allied and healthcare qualification; or increase its admission capacity in any course of study or training (including post-graduate course of study or training); or admit a new batch of students in any unrecognised course of study or training (including post-graduate course of study or training), except with the previous permission of the State Council obtained in accordance with the provisions of this Act:

Provided that the allied and healthcare qualification granted to a person in respect of a new or higher course of study or new batch without previous permission of the State Council shall not be a recognised allied and healthcare qualification for the purposes of this Act:

**What about the existing Paramedical Colleges and Institutions which are conducting these courses?**
Any University or college or institution imparting education in any recognised category shall furnish information to the State Council regarding course of study, duration of course, scheme of assessment and examinations and other eligibility conditions in order to obtain the requisite qualifications as an allied and healthcare institution under this Act as the State Council may from time to time require.

As of now there are thousands of colleges in paramedical sciences conducting Diploma, Degree and PG courses across the country with different curricula. Many of them do not have any affiliations from the UGC or state paramedical boards. There are hundreds of private institutions, universities on the name of deemed to be universities are conducting various allied sciences courses. Now the all-existing and new institutions/colleges/universities should register in the state council. They should follow the curriculum designed and recommended by the NCAHP.

If State Council is not constituted by the State Government, the National Commission shall give the previous permission for the purposes of this section.

With the establishment of National Commission and State councils for allied healthcare professionals, the registration of the qualified technologists/professionals will be streamlined. The quality of the services in the healthcare will be improved.

Considering the need of the present and future healthcare delivery system, the curriculum was designed by the National Commission, so far curricula is released for 10 disciplines and more in progress. The curriculum for the Allied Courses is developed to reach the global standards and world class services in the healthcare sector. Soon the Diplomas in these allied sciences shall be discontinued. No short term/skill development/Vocational Courses shall be entertained. The candidates must be studied in regular mode at least to 2 – 4 years of Professional education Diploma or Degree not less than 2000 hrs to spread over 2 years of study to register as allied healthcare Professional and the persons with the Professional Degree with the duration not less than 3600 hrs of study spread over 3 to 6 years can be registered as the Healthcare Professional.

The candidates with Certificate/Diplomas less than 2000 study hrs/2 years of duration can get provisional registration later they can be upgraded by upgrading their knowledge and skills. The Diploma candidates can improve their standards by appearing Bachelor degree courses through lateral entry admission.

However, the registration of a healthcare professional with the State and National Council is mandatory to practice the profession hereafter. All the Institutions running such courses must register with the state councils and follow the curricula designed by the National Commission.

With the formation of the National Commission, Professional councils and state councils a new era begins in allied healthcare professions, the registration, recognition and regulation shall be possible to cater better services as per the present demand, provide standard education and training and prevent illegal practice.

**Srinivasulu Siramdas**
**Principal**
College of Allied Health Sciences
Nizam's Institute of Medical Sciences, Hyderabad.

**Member**
National Commission for Allied Healthcare Professionals.

Government of India
Ministry of Health & Family Welfare
National Commission for Allied Healthcare Professions

2nd Floor, Academic Block,
NIHFW Campus, Munirka,
New Delhi – 110 067

File No: Z-1011/16/2025/NCAHP(AHS) Dated: 25.09.2025

# PUBLIC NOTICE

The draft of "Registration of Allied and Healthcare Professionals Regulations 2025", is placed in the public domain through the National Commission for Allied and Healthcare Professionals (NCAHP) website in accordance with Sub-section 1 of Section 66 and clauses (b), (f), (g), (h), (k), (l), (m), (n) and (q) of Sub- Section 2 of Section 66 read with Section 11(1) (f) and (n), 13(1) & (2), 19, 32 (1) & (2), 33 (4), 36 (2), 39 of the National Commission for Allied and Healthcare Professions Act 2021, inviting comments from public in general, experts, stakeholders and organizations etc.

2. Objections, suggestions/comments, if any, on the above draft regulations, should be sent to email at **ncahpregulationspublicopinion@gmail.com,** within one month i.e. by 25.10.2025.

25.09.2025
(Umesh Balonda)
Secretary, NCAHP

https://ncahp.abdm.gov.in/DraftRegulations/Public%20Notice_Regulation_Annexure.pdf


One Stop Shop
Products & Solutions
AMS
Cath Lab
Radiation Protection
C-ARM
PACS
Dental Solutions
CBCT
OPG
X - Ray
Computed Radiography
Digital Radiography
CT Scan
MRI
Ultrasound
X-Ray Accessories

# Medico Legal issues for Diagnostic Imaging Technologists

**P. Ramasudheer Reddy,** MRIT, Senior MRI Technologist, Medicover Hospitals, Nellore, AP
**S. Sentil Kumar,** MRIT, Senior MRI Technologist, Apollo Hospitals, Chittoor, AP

## Legal Definitions for Radiology Technologist

Radiology technologist usually focus on completing their daily tasks and may not always think about legal risks. However, as patients become more aware of their rights and standards of care, radiographers must understand legal concepts to avoid liability or lawsuits.

## Civil Law

- Civil law governs relationships between individuals in non-criminal matters.
- Tort law is part of civil law and deals with personal injury cases.
- A tort occurs when someone's actions cause harm, either:

1. Intentionally (deliberate harm), or
2. Unintentionally (negligence or carelessness).

## Types of Torts

### 1. Intentional Torts

These are acts done on purpose that can lead to legal action.

Examples include:

- Assault
- Battery
- False imprisonment
- Libel and slander
- Invasion of privacy

## Assault

- Assault is threatening to injure someone.
- It includes actions like threatening with poison, anesthesia, or harmful instruments.
- Even threatening to touch someone in a harmful way may be considered assault if the person believes they are in danger.
- How to avoid it:
  - Always explain procedures clearly to patients.
  - Never use threats or intimidation to gain cooperation.
  - Work gently and reassuringly, especially with children.
- If proven guilty, the radiographer may have to compensate the patient for emotional or physical harm.

## Battery

- Battery is actually touching someone without their consent.
- It implies intent to harm or provoke, but even accidental touching without permission may be considered battery.
- For example:
  - Performing an X-ray on the wrong patient.
  - Touching a patient who has expressly refused the procedure.
- How to avoid it:
  - Always explain the procedure beforehand.
  - Obtain permission before touching the patient.
  - Double-check patient identity before starting the procedure.
- Even if well-intentioned, an action may be considered battery if it violates the patient's rights.

## Case Summary – Assault and Battery

### What happened?

- A student and a staff technologist were asked to perform an intravenous pyelogram (a type of X-ray test).
- The patient was a 58-year-old woman with hypertension.
- The staff radiology technologist, known for joking around, loaded two syringes:
  a. One with contrast media (used in the test).
  b. The other with isopropyl alcohol (a harmful substance in this context).
- The staff left the room, leaving the student with the patient.
- The radiologist came in, grabbed one syringe without verifying its contents, and injected the patient.
- The patient immediately became comatose and was sent to the ICU.
- A blood test confirmed high levels of alcohol in the patient's bloodstream.
- Upon investigation, the staff radiographer and the student were questioned.

### Who is liable?

**1. Staff Radiology technologist → Assault**

- Assault is the threat or preparation to harm.
- By ordering the student to prepare a syringe with alcohol and leaving the patient at risk, the staff radiographer is liable for assault.
- This is because the staff's actions exposed the patient to potential harm intentionally.

**2. Radiologist → Battery**

- Battery is the actual harmful or unauthorized contact.
- The radiologist injected the patient without verifying the syringe's contents.
- This act caused real harm (alcohol poisoning) and constitutes battery.
- The radiologist is responsible because the injection was done without proper checks and patient consent.

**3. Student → Not Liable**

- The student followed the staff radiographer's orders and was under supervision.
- Therefore, the student is not held liable, though ethically, he should have spoken up and warned the radiologist before the injection.

**False Imprisonment**

- False imprisonment happens when a person is kept in a place against their will, without permission or legal reason.
- It can happen by:
  - Using force,
  - Threatening to use force,
  - Or by locking someone in or restraining them.
- If a patient wants to leave but is stopped or restrained without justification, it could be considered false imprisonment.
- Even using restraints like straps or devices without explaining to the patient or family can be illegal.
- Patients have a right to move freely, and if this right is violated, they can ask for compensation through the law.
- However, if the patient is dangerous to themselves or others, restraints may be allowed, but they must be used properly and explained clearly.

**Libel and Slander**

- **Libel** is harming someone's reputation by writing false things about them.
- **Slander** is harming someone's reputation by saying false things aloud.
- These are forms of **defamation**, which is a civil wrong that can lead to legal action.
- For defamation to be proven:
  - The false statement must be shared with someone other than the person being harmed.
- Some exceptions exist, like supervisors giving honest work evaluations — they are protected as long as they act in good faith.
- Radiographers should be careful not to gossip or speak irresponsibly where patients or others can hear them.

**Invasion of Privacy**

- Invasion of privacy occurs when a patient's private information or body is exposed or handled inappropriately.
- This includes:
  - Sharing confidential information without permission,
  - Exposing or touching a patient unnecessarily during medical procedures.
- Protecting a patient's modesty and keeping their personal information private is very important in healthcare.

**Explanation of Legal Issues in lible, slander and invasive privacy**

**Key Facts:**

- A 16-year-old female with lower abdominal pain was sent for an abdominal x-ray.
- The abbreviation **PID** (Pelvic Inflammatory Disease) was misunderstood by staff.
- The technologist jokingly told the orderly that the patient had **syphilis**, a communicable disease, and instructed him to handle the patient as if she were infectious.
- The orderly spread this misinformation verbally and via a written note to others, causing distress to the patient.
- The patient's father filed a civil suit for **defamation of character**.

**1. Who is liable for slander?**

**Slander** refers to a spoken false statement that damages someone's reputation.

- The **technologist** is liable for **slander**, because he verbally misinformed the orderly that the patient had syphilis. Even though it was a joke, it was false, communicated to another person, and caused emotional distress to the patient when it reached her ears.

**2. Who is liable for libel?**

**Libel** refers to a written false statement that damages someone's reputation.

- The **orderly** is liable for **libel**, because he wrote and sent a note falsely claiming that the patient had syphilis. This written statement was defamatory, untrue, and circulated to others, potentially harming the patient's reputation.

**3. Was the patient's privacy invaded?**

- The **patient's privacy** was violated when confidential medical information was shared without authorization, leading to emotional and reputational harm

**Unintentional Misconduct (Negligence) – Key Concepts**

**➤ Definition of Negligence**

- Negligence is the **neglect or omission** of reasonable care.
- It's judged by the **"doctrine of the reasonably prudent man"**—meaning what an average person with similar training and experience would do in the same situation.
- Even if a person acts carefully, negligence can still occur if the person attempts something they are not trained for and causes harm.

**Elements Needed to Prove Negligence**

For a radiographer to be held liable in court, these four elements must be proven:

1. **Duty –** A responsibility exists, such as properly performing an x-ray.
2. **Breach of Duty –** The radiographer failed to meet the standard of care (e.g., imaging the wrong body part).
3. **Cause –** The injury must be directly caused by the radiographer's action or inaction.
4. **Injury –** The patient must have sustained actual harm or damage.

**Examples of Negligence**

- Imaging the wrong body part.
- Poor-quality images that prevent diagnosis.
- Leaving a patient unattended, leading to injury.

The court will seek expert testimony to determine if the radiographer acted according to accepted standards.

**Defenses Against Negligence**

- **Contributory Negligence** – The patient's own negligence contributed to the injury.
- **Comparative Negligence** – Fault is shared between patient and provider.
- **Assumption of Risk** – The patient knowingly accepted the danger involved.

Proper documentation, informed consent, and accurate communication help protect against such claims.

**Malpractice**

The term **malpractice** is commonly linked to **negligence**, especially in radiology where errors or lapses in care can directly harm patients. Below are the **three areas of frequent litigation** and illustrative examples:

**1. Patient Falls and Positioning Injuries**

These occur when proper care isn't taken during patient handling or monitoring.

**Examples:**

- **A sedated patient** is left unattended on the x-ray table and falls, resulting in injury.
- A patient with a **spinal injury** is improperly moved from a stretcher to the table, causing irreversible spinal cord damage.

**Key Issue:** Radiographers/technologists have a duty to ensure patient safety, especially when patients are unconscious, sedated, or vulnerable.

**2. Pregnancy-Related Issues**

Failing to ask about or confirm pregnancy before an imaging procedure can lead to harm to the fetus.

**Example:**

- The radiographer doesn't inquire if the patient is pregnant before conducting an x-ray. Later, the patient contacts the facility, worried about the potential harm to the fetus from radiation exposure.

**Key Issue:** Radiographers/technologist must always ask about pregnancy and follow safety protocols before imaging, especially with radiation-sensitive areas.

**3. Errors or Delays in Diagnosis**

Mistakes in interpreting images or failing to promptly communicate results can cause serious patient harm.

**Example:**

- A patient's x-ray /scan is performed in the emergency department, but the radiologist delays reporting findings. The emergency physician doesn't learn of a serious condition until two days later, by which time permanent damage has occurred.

**Key Issue:** Timely and accurate communication between radiologists and other medical staff is essential to ensure proper patient care.

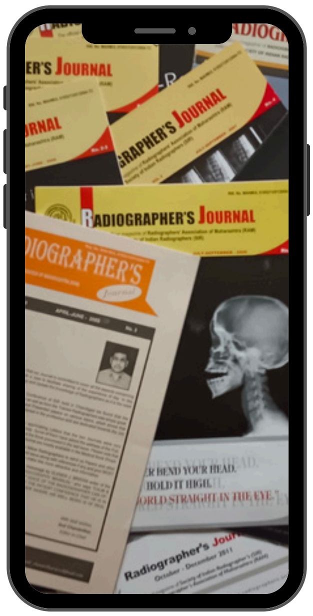
**Why These Areas Lead to Malpractice Claims**

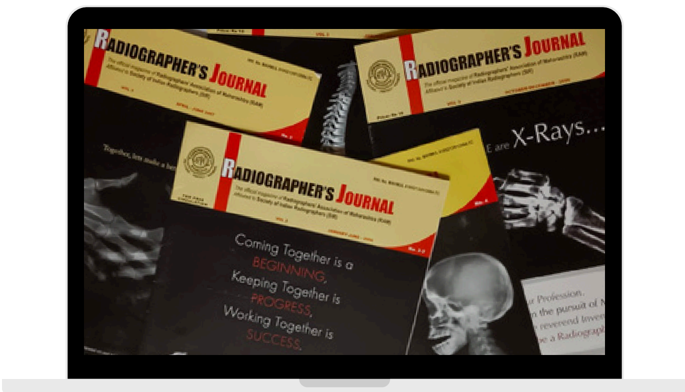
- **Patient falls** often result from neglect in supervision or improper handling.
- **Pregnancy issues** stem from not following protocols that protect vulnerable patients.
- **Diagnostic errors** are often the result of lapses in communication or failure to act promptly.

**Best Practices to Avoid Malpractice in Radiology**

1. **Ensure patient safety—** always monitor sedated or immobile patients.
2. **Ask critical questions,** like pregnancy status, before procedures.
3. **Verify orders and instructions,** and double-check patient identity.
4. **Maintain clear and timely communication** with physicians and other healthcare providers.
5. **Document thoroughly—** include procedures, patient interactions, and warnings.
6. **Use established protocols** and industry guidelines to reduce risk.





# RAD SALEM 2025 – A Grand Success

**Report on the 7th State Conference of SIR TN**

Reported by Mr. C. Marimuthu, Organizing Secretary

The 7th State Conference of the Society of Indian Radiographers, Tamil Nadu & Puducherry Chapter (SIR TN) with the theme "Radiologic Advancement & Development – Scientific Approaches to Learning and Education in Medical Imaging" (RAD SALEM 2025) was successfully held on September 13th, 2025 at the Government Mohan Kumaramangalam Medical College Auditorium, Salem.

The event was jointly organized by the Department of Radio-Diagnosis, Government Mohan Kumaramangalam Medical College, and SIR TN, attracting nearly 550 participants, including students, technical experts, academicians, and professionals from across Tamil Nadu and neighbouring states.

**Dignitaries and Inauguration**

The inauguration set a remarkable tone for the conference. Dr. J. Devimeenal, Dean of Government Mohan Kumaramangalam Medical College, Salem, graced the occasion as the Chief Guest, emphasizing the critical role of radiologic advancements in modern healthcare.

**Notable dignitaries included:**

- Dr. P. Kumar, Professor & HOD of Radio-Diagnosis, GMKMC
- Dr. P. Kannan, Professor & HOD of Cardiology, GMKMC
- Dr. N. Suryaprakash, Radiologist, Government Tiruppur Medical College
- Prof. S. Pannerselvam, Adjunct Faculty of Medical Physics, SRIHER, Chennai
- Mr. K. Munirathnam, Founder President of SIR TN&PY & Chairman of SIR
- Mr. K. P. Udayakumar, President, SIR TN Chapter
- Mr. C. Marimuthu, Vice President & General Secretary of SIR TN
- Mr. Vijayakumar K. S., Pioneer Icon in Radiography

**Special felicitation ceremonies honored achievers in the field:**

- Mr. Vijayakumar K. S. was recognized for his 34 years of exemplary service as an Advisory Committee Member, inspiring generations of radiographers.
- Mr. K. Munirathnam was honoured for his 30 years of significant contributions to the Society of Indian Radiographers.



**Academic Highlights**

The Scientific Programme of RAD SALEM 2025 was rich and impactful, featuring:

- 3 Guest lectures by eminent academicians
- 6 Proffered papers by experts
- 16 Student oral presentations
- 27 Student poster presentations

The event provided a vibrant platform for students to showcase their research. Oral papers and posters were evaluated by expert judges including Mr. Jerald, Mrs. Akila M. Vinothraj, Mr. Thulsidoss, Mrs. Suganthi, and Mrs. Mahalakshmi.

**Awards presented included:**

- Prof. Paneer Selvam Endowment Award
- K. Munirathinam Endowment Award
- M. G. Pandeyan Endowment Award

A vibrant quiz competition, with enthusiastic participation from around 350 students, added energy to the event, with the top three teams claiming prizes.

**Organizing Team**

Behind the success was a committed team that worked diligently to ensure smooth execution. The contributions of Mr. M. Saravana Kumar, Mr. K. Somasekar, Mr. R. Vijayaraghavan, Mr. E. Murugesh, Mrs. Mahalakshmi, Mr. G. Balasubramanian, Mr. M. Kannan, Mr. V. G. Bijukrishnan, Mr. Janarthanan, and Mr. J. Prabhakar were acknowledged with gratitude.

The Academy for Radiation Technology team meticulously prepared and coordinated the scientific programs, ensuring quality and professional standards throughout.

**Valedictory Session and Conclusion**

The Valedictory Program brought the event to a memorable close, with dignitaries and judges distributing awards and prizes to winners of the competitions.

RAD SALEM 2025 concluded as a resounding success, celebrated for its enriching discussions, knowledge-sharing, and networking opportunities. The conference not only strengthened professional bonds but also inspired future innovations in radiographic education and medical imaging across Tamil Nadu.


RAD-SALEM
2025


SOCIETY OF INDIAN RADIOGRAPHERS
( TN CHAPTER )


SOCIETY OF INDIAN RADIOGRAPHERS
( TN CHAPTER )
DEPARTMENT OF RADIO DIAGNOSIS

# Beyond the Button: The Expanding Role of Radiography Technologists in Modern Healthcare

**Firdous Nazir,** Radiographic Technologist, DMST, Pulwama, Jammu & Kashmir

**Introduction:**
Radiography is often called the "eyes of medicine" because it allows doctors to see inside the human body without making a single incision. From the first X-ray taken by Wilhelm Roentgen in 1895 to the advanced CT, MRI, and PET scanners of today, medical imaging has revolutionized diagnosis and treatment. But behind every image that changes a patient's life stands a skilled professional who is sometimes overlooked—the radiography technologist.

To many outside the hospital world, technologists are simply the people who "press the button" to take an X-ray. This stereotype hides the reality of their contribution. Radiography technologists are highly trained healthcare professionals who combine technical knowledge, patient care, safety awareness, and adaptability. They create diagnostic images that guide radiologists, surgeons, and physicians in life-saving decisions. Without them, modern medicine would lose one of its most vital tools.

Over the years, their role has expanded far beyond conventional X-ray. Today, technologists work with advanced imaging systems, adapt protocols for each patient's unique needs, and ensure radiation safety in every procedure. They are the human connection between cutting-edge machines and vulnerable patients—comforting, explaining, and positioning individuals who may be anxious, sick, or in pain.

**Historical Background: From X-ray Pioneers to Professionals**
When Roentgen discovered X-rays in 1895, medical pioneers rushed to use them for diagnosis. Early operators were often doctors, nurses, or even photographers with knowledge of chemicals and film. There was no clear profession of "radiographer." Tragically, many of these early users worked without protection and suffered radiation burns, cancers, or amputations. Their sacrifices laid the foundation for a safer profession.

By the early 20th century, hospitals recognized the need for trained staff who could safely and effectively use X-ray machines. Formal training programs emerged, giving birth to the profession of the radiography technologist.

In the mid-20th century, technologists worked mainly with conventional radiography and fluoroscopy, producing films for radiologists to interpret. Their skills included patient positioning, knowledge of anatomy, exposure techniques, and darkroom film processing. At this stage, the role was often underestimated—seen as "technical help" rather than a professional career.

The arrival of CT (1970s), MRI (1980s), PET and SPECT (1990s), and digital radiography (2000s) completely transformed the field. No longer confined to a single

modality, technologists became multi-skilled professionals mastering advanced computer systems, cross-sectional anatomy, and digital image manipulation. The shift from film to digital imaging also gave them a stronger role in image quality assessment and dose management.

Today, radiography technologists are recognized as essential healthcare workers. Many countries require university-level education, licensure, and continuing professional development. Their role is no longer limited to producing films but extends into clinical decision support, patient advocacy, and even leadership in imaging services.

**The Modern Role of Radiography Technologists**
The work of a radiography technologist in the 21st century is complex, multifaceted, and vital. Their role can be understood in three broad dimensions: technical expertise, patient care, and professional responsibility.

**Technical Expertise**
Technologists operate sophisticated imaging systems—X-ray, CT, MRI, mammography, ultrasound, and interventional radiology suites. They must:

- Select correct imaging protocols.
- Adjust exposure settings to minimize radiation dose.
- Ensure images are of diagnostic quality for interpretation.
- Troubleshoot technical issues and maintain equipment performance.

They work in real time with physicians during procedures such as angiography or fluoroscopic interventions, where accuracy and quick decisions are critical.

**Patient Care**
Imaging is not just about machines; it is about people. Patients may be anxious, in pain, or vulnerable. The technologist's role includes:

- Explaining the procedure in simple, reassuring language.

- Positioning patients carefully, often adapting for fractures, disabilities, or limited mobility.
- Monitoring patient comfort and safety throughout the exam.
- Providing emotional support, especially in sensitive exams like mammography or pediatric imaging.

This human connection is what transforms imaging from a mechanical process into compassionate care.

**Professional Responsibility**

Technologists are guardians of radiation safety. They follow ALARA principles (As Low As Reasonably Achievable) to minimize exposure for patients and staff. They also:

- Maintain accurate records.
- Ensure infection control standards.
- Contribute to research, audits, and quality assurance programs.
- Stay updated through lifelong learning in a rapidly evolving field.

Their responsibility extends beyond patients—they also educate junior staff, collaborate with radiologists and physicians, and advocate for safe and ethical imaging practices.

**Challenges in the Profession**

While radiography technologists play a critical role, their profession is not without challenges:

- **Workload and Stress –** Imaging is required 24/7 in emergency, trauma, and intensive care settings. Long hours and high patient volumes can cause fatigue.
- **Radiation Risk –** Despite safety measures, technologists remain at risk of occupational radiation exposure, particularly in interventional radiology.
- **Recognition Gap –** In many regions, technologists are still undervalued or seen as “assistants” rather than professionals in their own right.
- **Rapid Technological Change –** New equipment and software require constant retraining, which may not always be supported by employers.
- **Emotional Burden –** Imaging patients with severe injuries, cancer, or terminal illness can take a psychological toll.

Despite these challenges, technologists continue to deliver care with professionalism, resilience, and dedication.

**The Future of Radiography Technologists**

The profession is evolving rapidly, shaped by technology, healthcare needs, and patient expectations. Some key future directions include:

- **Artificial Intelligence (AI):** AI will increasingly assist in image analysis and workflow optimization. Rather than replacing technologists, AI will free them from repetitive tasks, allowing more focus on patient care and advanced decision-making.
- **Advanced Practice Roles:** In many countries, technologists are moving into advanced practice, taking on responsibilities such as preliminary image interpretation, reporting, and interventional assistance.
- **Specialization:** Subfields like mammography, cardiac imaging, MRI, and interventional radiology will continue to grow, requiring highly specialized skills.
- **Global Collaboration:** The concept of “Radiology Without Borders” highlights how technologists can contribute to global health by bringing imaging to underserved areas. Mobile units, teleradiology, and cross-border training programs are expanding access worldwide.
- **Patient-Centered Imaging:** As healthcare shifts toward holistic care, technologists will play an even greater role in communication, empathy, and ensuring patient dignity during imaging.

The future will demand not only technical mastery but also leadership, adaptability, and advocacy from technologists.

**Why Recognition Matters**

Despite their essential role, radiography technologists often remain invisible in the eyes of the public. Doctors, nurses, and surgeons are celebrated, but the professionals producing the diagnostic images are rarely acknowledged. Recognition matters because:

- It validates the profession’s contribution to patient care.
- It motivates technologists to continue advancing their skills.
- It raises awareness of the importance of safe imaging.
- It attracts the next generation of dedicated professionals into the field.

Hospitals, academic institutions, and healthcare leaders must make efforts to highlight and honor the work of technologists. Professional societies and journals are already doing this, but broader recognition is still needed.

**Conclusion**

Radiography technologists are not just the people behind the machines. They are highly skilled professionals who balance technology with compassion, precision with safety, and speed with empathy. Their work is woven into every corner of healthcare—from emergency rooms and operating theaters to cancer centers and rural clinics.

The journey of radiography has always been tied to innovation, and so has the journey of technologists. From the darkrooms of the early 20th century to today’s AI-driven imaging suites, they have adapted, grown, and redefined their role.

To view them as mere “button pressers” is to overlook the reality of modern medicine. They are the unsung heroes of radiology, ensuring that doctors have the clearest images, patients receive the safest care, and the future of imaging remains both innovative and humane.

As healthcare continues to evolve, one thing is certain: the role of the radiography technologist will only expand, becoming even more central to the delivery of effective, compassionate, and life-saving care.


www.alerio.in
MAKE IN INDIA
neo
Smaller Smarter Safer
Smart 1600
PORTABLE X-RAY SYSTEM
ALERIO®
X-RAYS
Smart 4200MDR
DIGITAL MOBILE X-RAY SYSTEM
Smart 8000
DIGITAL MOBILE X-RAY SYSTEM
Maestro
FIXED X-RAY SYSTEM
500i
Maestro
FIXED X-RAY SYSTEM
8000
Excellence In X-Ray Imaging
CDSCO CERTIFIED
AERB CERTIFIED
ISO 13485:2016
CERTIFICATION
intertek
BIS CERTIFIED
IATOME
www.iatome.in
+91 9787505551 | +91 9943475551 | +91 7418365551 | +91 8870011990
sales@alerio.in | enquiry@alerio.in
IATOME ELECTRIC (I) PVT LTD, COIMBATORE, INDIA - 641049
Ahmedabad | Bangalore | Chennai | Delhi | Hyderabad | Indore | Jaipur | Kolkata | Lucknow | Mumbai | Nagpur | Patna | Pune | Surat | Visakhapatnam

## QUIZ to Recapitulate

**Pawan Kumar Popli,** Chief Technical officer-Radiology (Retd.), AIIMS, New Delhi

**1.** Name the agency responsible for regulating radiology installations in India at present?

**2.** For what purpose 'Dionosil oily' has been used in the Radiology department?

**3.** What is the use of 'mannitol' in CT enterography?

**4.** Patient observation window in MRI room is made of what material with which purpose?

**5.** What is the recommended patient to image receptor distance in fluoroscopy?

**6.** What is the size of IOPA film normally used for adult patients?

**7.** Which view is used to visualize the frontal sinuses?

**8.** Name the view & purpose

**9.** Name the view & purpose

**10.** Name the View and common indications

- Please send your answers through email on **pkpopli@gmail.com** on or before **10th October 2025.**
- Send your **Name with Hospital/Institution Information** and Passport size **photograph** along with the answers.
- **Best 3 participants** (early birds and correct) in each month will get the prizes **(Sponsored by JBD Publications).**
- Correct answers will be published in the next issue.
- If required /requested by participants more details about any question can be provided in upcoming issues under title **"Your Requests"**

## Answers for the Quiz - August 2025 issue

**1.** On 28 March 2021, act was named as : THE NATIONAL COMMISSION FOR ALLIED AND HEALTHCARE PROFESSIONS ACT, 2021.

**2.** In conventional film developer as secondary reducing agent.

**3.** It should be placed beyond the ligament of Treitz crossing the DuodenoJejunal junction, ideally into the proximal jejunum.

**4.** Jug handle view is usually done to look at the zygomatic arch and surrounding structures, specially fractures etc.

**5.** 6 feet or 180 cm

**6.** MRI has largely replaced conventional Myelography

**7.** In Radiology IHE stands for – Integrating the Healthcare Enterprise

**8.** Carpal tunnel view

**9.** Lateral Cephalogram, it is used in maxillofacial diagnosis and treatment planning particularly in orthodontics.

**10.** Transjugular Intrahepatic Portosystemic Shunt (TIPS), in this procedure a connection is created between the portal and hepatic veins in the liver to reduce portal hypertension.

**The following readers participated in the Quiz – August 2025 issue.**

**Gukanraj N,**
Asst. Professor
Sri Venkateswaraa College of
Paramedical Sciences, Puducherry.

**Sriram. R,**
Scientific Asst. (Radiography),
DAE Hospital
Kalpakkam, Tamil Nadu

**Rashmi Singh**
M. Sc. Research Fellow
Teerthankar Mahaveer University
Moradabad, Uttar Pradesh

**Ekta Singh**
MRIT Research Scholar,
Swami Vivekanand Subharti
University, Meerut, Uttar Pradesh

**Firdous Nazir**
Radiological Technologist
Govt medical College, Anantnag, J & K

**Parul Nakai**
Radiological Technologist
AIIMS Bilaspur, Himachal Pradesh

**R. Ramiya**
Lecturer, Panimalar College of Allied
Health Sciences, Chennai, Tamil Nadu

**Vaishali Rawat**
Chatrapati Shivaji Subharti Hospital,
Meerut, Uttar Pradesh

**Simi Paxleal J**
B.Sc. RIT Intern
Dr. Jeyasekharan Medical Trust
Nagercoil

**Keerthika**

**Remya Krishnan**

B. Sc. RIT Students,
Panimalar College of Allied Health Sciences,
Chennai

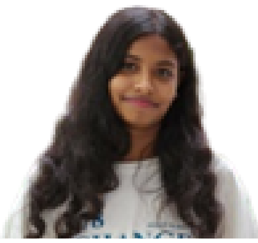
**Zainab Ansari**

**Nishat Siddiqui**

B.Sc. RIT Interns
Swami Vivekanand Subharti University,Meerut
Uttar Pradesh

**M. Gokul Shankar**

**Rohith M**



**P.Lavanya**

**G.Mubarak**

**CB Manikandan**

**Tagore Institute of Allied Health Sciences Rathinamangalam Vandalur**

# Machine Learning in MRI-Based Cancer Characterization Enhancing Precision and Early Detection

**Shrawan Kumar Yadav,** Research Scholar, **Dr. Harish Kumar,** Guide, Department of Applied Sciences, NIMS University Rajasthan, Jaipur, **Dr. Amit Kumar Janu,** Co-Guide, Tata Memorial Hospital, Mumbai

**Abstract**

This paper presents a comprehensive review and analysis of machine learning (ML) applications in magnetic resonance imaging (MRI) for cancer characterization, with a focus on enhancing diagnostic precision and early detection capabilities. Various machine learning algorithms, including convolutional neural networks (CNNs), support vector machines (SVMs), random forests (RFs), and ensemble methods, are evaluated across multiple cancer types. The analysis includes the implementation of these techniques on publicly available datasets, with performance metrics for detection accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AUC-ROC). Additionally, the integration of radiomics features with deep learning architectures is explored to improve diagnostic capabilities. Results demonstrate that ensemble approaches combining multiple ML techniques achieve superior performance (average accuracy of 92.7%) compared to standalone algorithms. Further, key challenges in clinical translation, including interpretability, generalizability, and the need for larger, diverse datasets, are identified. Recommendations for future research directions focus on multimodal integration and federated learning approaches to address current limitations.

**Keywords:** Machine Learning, Deep Learning, MRI, Cancer Detection, Computer-Aided Diagnosis, Radiomics, Convolutional Neural Networks

Cancer remains one of the leading causes of mortality worldwide, with an estimated 19.3 million new cases and 10 million cancer deaths globally in 2020 (WHO, 2023). Early and accurate detection significantly improves treatment outcomes and survival rates across all cancer types. Magnetic Resonance Imaging (MRI) has emerged as a powerful, non-invasive imaging modality for cancer detection and characterization due to its excellent soft tissue contrast, multiplanar capabilities, and absence of ionizing radiation. However, traditional MRI interpretation faces challenges including inter-observer variability, subtle feature recognition limitations, and the increasing complexity of imaging data.

Recent advances in machine learning (ML) and artificial intelligence (AI) have revolutionized medical image analysis, offering potential solutions to these challenges. ML algorithms can analyze complex patterns in MRI data that may be imperceptible to the human eye, potentially improving diagnostic accuracy and consistency. Despite significant progress, the clinical implementation of ML in MRI-based cancer characterization faces numerous challenges including model interpretability, generalizability across different scanners and protocols, and integration into existing clinical workflows.

## Background

### MRI in Cancer Imaging

MRI employs strong magnetic fields and radio waves to generate detailed anatomical and functional images. Various MRI sequences—including T1-weighted, T2-weighted, diffusion-weighted imaging (DWI), dynamic contrast-enhanced (DCE), and spectroscopy—provide complementary information about tissue characteristics. This multiparametric approach makes MRI particularly valuable for cancer assessment, enabling visualization of tumor morphology, cellularity, vascularity, and metabolism.

**The advantages of MRI in cancer imaging include:**

- Superior soft tissue contrast compared to CT and ultrasound
- Multi-parametric capabilities for functional and anatomical assessment
- Absence of ionizing radiation, allowing repeated examinations
- Three-dimensional imaging capabilities

However, traditional MRI interpretation has limitations: Inter- and intra-observer variability, time-consuming analysis of complex datasets, qualitative assessment, challenges in detecting abnormalities.

## Methodology

### Datasets

For implementation case studies, publicly available datasets are used: Breast Cancer dataset with 64 patients, Prostate Cancer dataset with 346 patients, and Brain Tumors dataset with 369 subjects. The datasets contain MRI scans and histopathology findings.

Traditional Machine Learning: SVMs with linear and radial kernels, Random Forests with optimized depth and estimators, Logistic Regression with L1 and L2 regularization, k-NN with varying k values. Deep Learning: CNNs like VGG16, ResNet50, and custom architectures, U-Net for segmentation, Transfer learning with pre-trained networks on MRI datasets, Ensemble methods. Radiomics-based Approaches: Extraction of handcrafted features using PyRadiomics, Feature selection with LASSO, mutual information, PCA, Combination of radiomics with deep learning features.

A hybrid approach was developed, integrating traditional radiomics features with deep learning, and its performance was compared against standalone methods.

**Table 1: Performance Comparison of Radiomics, Deep Learning and Hybrid Approaches**

| Approach | Cancer Type | Accuracy (%) | Sensitivity (%) | Specificity (%) | AUC |
|---|---|---|---|---|---|
| Radiomics | Breast | 84.5 | 83.2 | 85.8 | 0.865 |
| Deep Learning | Breast | 90.1 | 89.3 | 90.8 | 0.923 |
| Hybrid | Breast | 93.2 | 92.5 | 93.8 | 0.948 |
| Radiomics | Prostate | 82.9 | 81.4 | 84.3 | 0.854 |
| Deep Learning | Prostate | 89.6 | 88.7 | 90.4 | 0.915 |
| Hybrid | Prostate | 92.3 | 91.2 | 93.4 | 0.942 |
| Radiomics | Brain | 85.1 | 83.9 | 86.3 | 0.873 |
| Deep Learning | Brain | 92.5 | 91.8 | 93.2 | 0.946 |
| Hybrid | Brain | 94.7 | 93.9 | 95.4 | 0.965 |

The hybrid approach consistently outperformed both standalone radiomics and deep learning methods across all cancer types. The improvement was particularly pronounced in cases with limited labeled data, suggesting that radiomics features provide valuable domain-specific information that complements the pattern recognition capabilities of deep learning.

**Performance Analysis and Clinical Implications**

The comprehensive analysis revealed several key findings with significant clinical implications. Across all cancer types, ML-based approaches demonstrated superior performance compared to conventional radiological assessment, with the highest gains observed in detecting subtle abnormalities and distinguishing between benign and malignant lesions.

The observed performance improvements translate to potential clinical benefits including:

- Earlier detection of malignancies, particularly for small lesions that might be overlooked in conventional interpretation
- More consistent characterization, reducing inter-observer variability
- Improved risk stratification to guide treatment decisions
- Potential reduction in unnecessary biopsies through more accurate non-invasive assessment

However, the translation of these technical advances into clinical practice faces several challenges. The "black box" nature of many deep learning approaches limits interpretability, creating barriers to clinical acceptance. Additionally, while the results demonstrate impressive performance on retrospective datasets, prospective validation in diverse clinical settings remains essential before widespread implementation.

**Future Directions**

Based on the findings and identified limitations, several promising directions for future research are proposed:

**Technical innovations:** Development of explainable AI for insight into decision-making processes, Integration of radiogenomics to correlate imaging features with genetic profiles, Multimodal approaches combining MRI with other imaging modalities and clinical data, Federated learning to leverage data across institutions while preserving privacy.

**Clinical translation:** Prospective validation in multi-center trials. Development of standardized reporting formats for ML-assisted interpretations. Integration with electronic health records and clinical decision support systems. Cost-effectiveness studies to demonstrate economic value.

**Emerging applications:** Prediction and monitoring of treatment response, recurrence risk, disease progression, treatment effects, identification of imaging biomarkers, personalized treatment planning based on ML-derived prognostic factors.

**Conclusion**

This comprehensive analysis of machine learning applications in MRI-based cancer characterization demonstrates the significant potential of these approaches to enhance diagnostic precision and enable earlier detection across multiple cancer types. The implementation case studies across breast, prostate, and brain cancers reveal that ensemble approaches integrating radiomics features with deep learning architectures achieve the highest performance, with accuracy improvements of 5-10% compared to conventional assessment.

The technical performance improvements observed in this study have meaningful clinical implications, potentially enabling earlier intervention, more precise characterization, and improved risk stratification. However, several challenges remain before widespread clinical implementation, including the need for improved model interpretability, robust external validation, and seamless integration into clinical workflows.

**Reference**


- He, M.; Cao, Y.; Chi, C.; Yang, X.; Ramin, R.; Wang, S.; Hu, K. Research progress on deep learning in magnetic resonance imaging–based diagnosis and treatment of prostate cancer: A review on the current status and perspectives. Front. Oncol. 2023, 13, 1189370.
- Li, H.; Lee, C.H.; Chia, D.; Lin, Z.; Huang, W.; Tan, C.H. Machine learning in prostate MRI for prostate cancer: Current status and future opportunities. Diagnostics 2022, 12, 289.
- American Cancer Society. Cancer Facts & Figures 2024. 2024. Available online: https://www.cancer.org/research/cancer-facts-statistics/all-cancer-facts-figures/2024-cancer-facts-figures.html (accessed on 17 January 2024).
- Fernandes, M.C.; Yildirim, O.; Woo, S.; Vargas, H.A.; Hricak, H. The role of MRI in prostate cancer: Current and future directions. Magn. Reson. Mater. Phys. Biol. Med. 2022, 35, 503–521


KASTURBA MEDICAL COLLEGE
MANGALORE
*(A constituent unit of MAHE, Manipal)*
INSPIRED BY LIFE

# 23RD NATIONAL CONFERENCE OF SOCIETY OF INDIAN RADIOGRAPHERS

# IMAGINE

in association with

*Society of Indian Radiographers*
*Karnataka Medical Radiographers and Allied Technologists Association*
*Karnataka State Government Radiology Imaging Officers Central Association*

**HOST:** *Department of Radiodiagnosis and Imaging, Kasturba Medical College, Mangalore*

**THEME:** *Advancing Frontiers: Ushering in a New Era of Medical Imaging*

31st October - 2nd November 2025 | TMA Pai Convention Centre, Mangalore

## WELCOME Message

**Namaskara from Mangaluru,**

We are delighted to extend a warm welcome for the 23rd National Conference of Society of Indian Radiographers – IMAGINE 2025, in association with Karnataka Medical Radiographers and Allied Technologist Association and Karnataka State Government Radiology Imaging Officers Central Association, hosted by the Department of Radiodiagnosis and Imaging, Kasturba Medical College, Mangalore (unit of Manipal Academy of Higher Education).

IMAGINE 2025 brings together leading researchers, clinical experts, industry pioneers, and aspiring professionals to explore the latest innovations, share groundbreaking research, and foster collaboration in the dynamic field of medical imaging.

The theme, ***"Advancing Frontiers: Ushering in a New Era of Medical Imaging,"*** the conference will spotlight cutting-edge technologies, transformative ideas, and emerging trends shaping the future of healthcare. It's an opportunity to engage in thought-provoking discussions, attend insightful keynote sessions, and participate in interactive workshops.

Whether you are an academic, healthcare professional, student, or industry partner, IMAGINE 2025 offers a platform to connect, learn, and inspire innovation.

kmicon2025.com

We welcome you to Mangalore – the coastal city, the educational hub and famous for its cuisine, beaches and temples. Join us as we push the boundaries of medical imaging technology and drive progress in healthcare.

**Organizing Committee...**

**Registration details (fees in rupees)**

| # | Category | From 11th July 2025 to 31st August 2025 | Spot Registration |
|---|---|---|---|
| 1 | Students (BSc, MSc) | Rs. 2,000/- | Rs. 5,000/- |
| 2 | Members of SIR, KMRATA, KSGRIOCA (Faculty & PhD) | Rs. 3,000/- | Rs. 5,000/- |
| 3 | Non-Members of SIR, KMRATA, KSGRIOCA (Faculty & PhD) | Rs. 3,500/- | Rs. 5,000/- |
| 4 | Members of SIR, KMRATA, KSGRIOCA (Technologist) | Rs. 3,000/- | Rs. 5,000/- |
| 5 | Non-Members of SIR, KMRATA, KSGRIOCA (Technologist) | Rs. 3,500/- | Rs. 5,000/- |
| 6 | Radiology Faculty | Rs. 4,000/- | Rs. 5,000/- |
| 7 | Radiology PG's | Rs. 3,500/- | Rs. 5,000/- |
| 8 | Accompany | Rs. 3,000/- | Rs. 5,000/- |
| 9 | Retired Technologist | Rs. 3,000/- | Rs. 5,000/- |
| ***GST is applicable** | | | |
| ***Cancellation policy: 50% refund till one month of the event** | | | |

Registration fee includes entry to all scientific sessions, entry to trade expo, delegate kit (laptop bag) and electronic ID, all meals for all days, entry to musical night, access to scientific material, opportunity to submit abstract for scientific competition and credit points with certificate.

IMAGINE

31ST OCTOBER 2025 TO 2ND NOVEMBER 2025

**TO REGISTER SCAN HERE**

# O-ARM Surgical Imaging System

**Javeriya Muskan, ,** B.Sc. MRIT Student, **Bibin Joseph**, Assistant Professor, M.S. Ramaiah University of Applied Sciences

**Abstract**

An advanced imaging tool designed to improve accuracy in cranial and spinal surgery is the O- ARM surgical imaging system. During surgery, it continuously takes X-rays to create2D and 3D images of the patient. This enables surgeons to precisely map intricate and delicate structures.

For the surgical team aiming to achieve the best possible patient outcomes in the modern operating room, intra-operative imaging is an essential tool. The O-arm® Intra-operative Imaging System elevates intra-operative imaging to a new level and can be used during surgery

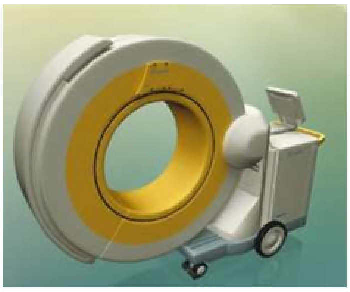
**Introduction**

- The O-arm was designed as a movable CT imaging
- System to provide real-time 2D and 3D imaging
- It was developed to enhance surgical accuracy, especially for procedures requiring precise placement of implants like pedicle screws.
- The system evolved from earlier imaging technologies like the C-arm, offering full 360- degree rotation for better visualization.

The O-ARM surgical imaging system is an imaging device that aims to enhance accuracy in spinal and cranial surgery. It produces real-time 2D and 3D images of the patient through ongoing X-rays during surgery. it allows surgeons to map complex and fragile structures with accuracy. The O-ARM machinecomes under familyof a C-arm that encircles the patient in a full ring after it has been in the position. The ring spins offering 360-degree visualization. Some features of the O-ARM are multiple fields of view, low-dose radiation mode, and stereotactic mode – The O-ARM is literally the future of high-tech spine surgery. Completely optimized for AI and VR integration, the O-ARM does away with the necessity for pre-op and post-op scans. Which leads to conserves precious time and simplifies the process. The O-ARM is utilized in procedures such as spinal fusion, tumor excision, joint replacement and spinal fracture repair.

**Keys Benefits**

- Delivers simple and fast access to real-time, multi-plane 3D images (as well as 2D images) when the surgeons need them most, for full support of the unique workflow of spinal procedures
- Improves safety for the surgeon and staff
- Confidence in the achievements of surgical goals and hardware therapy placement, by eliminating revision surgeries
- Improved visualization for surgeons to complete complex and minimally invasive procedures easily
- Enhanced Insights to the Patients with Large field-of-view and great image quality allows the surgeon to quickly obtain crucial visibility to any part of the patient's anatomy. This information is used to optimally treat spine, orthopedic and pelvic trauma cases with the ability to choose 2D or 3D imaging during surgery



**Methodology or Working Principle**

The O-Arm rotates around the patient by acquiring a full 3D dataset. It then reconstructs those images in near real time, right there in the OR. It integrates with navigation

**This gives surgeons:**

- Millimeter-level accuracy
- Live updates on screw placement
- Reduced need for post-op CTs Working Principle

The O-ARM machine is attached to a wheeled X-ray console and has a C arm-like shape. It can create a full ring around the patient by extending its second telescopic arc out from the C. The ring revolves around the flatbed's central axis, which is where the patient's body is resting. This allows the surgeon to see the patient's spine in 360 degrees. Along the central axis, it can also move laterally. The system can create an accurate and comprehensive 3D image by combining the data from the two scan types. This 3D image offers a number of advantages over real-time fluoroscopy systems, including the ability for the surgeon to move and rotate in real time.

Additionally, the system removes the requirement for commitment from

- The image quality of the O-arm® System is impressive and is based on the use of free flat panel technology. 30cm x 40cm flat panel detector with 3 Mega-pixels (1.5k x 2k) has exceptional resolution and a high dynamic range for better accuracy. This System combines a flat panel detector with a powerful 32kW generator by enabling imaging of heavier patients and hard to image anatomy, such that cervical-thoracic junction. A full 360° 3D scan can be performed in just a few seconds
- Superior Viewing, Easy Controls Image Display, Images are displayed on the large, 30" digital flat screen of the O-arm® System Mobile View Station(MVS), providing the surgeon with excellent visibility. Viewing options comprises:- 3D orthogonal and oblique views- 2D views,- MIP (Maximum Intensity Projection)- Surface rendering - Digital light box views Network Interface.

The O-arm® System is fully DICOM 3 and compatible for simple transfer of O-arm® System data to the hospital network.

**Applications**
**Spinal Surgery:**

- Like pedicle screw placement with great accuracy.
- Provides real-time 3D imaging for spinal fusion operations.
- Aids surgeons for planning implant placement before finishing surgery.

**Orthopedic Surgery:**

- during joint replacement procedures for accurate alignment.
- Aids in the treatment repair of fractures by providing high-quality bone imaging.

**Neurosurgery:**

- aids tumor excision by offering precise anatomical visualization.
- Improves brain stimulation procedures with stereotactic precision.
- Minimizes requirement for extensive incisions through real-time imaging to guide instruments.
- Enhanced operating accuracy with a reduced exposure to radiation.
- Postoperative follow-up
- Enables surgeons to make alignment and accuracy prior to completing the surgery, by minimizing reoperations.

**Advantages:**
The O-arm® System – Designed for the OR Image quality, patient safety, sterility and ease of use in the OR. The system supports the surgical work flow with a benefit of creating a controlled surgical environment also by minimizing manipulations needed during the procedure.

- Full Mobility Motorization for easy positioning in the OR.
- Lateral Patient Access "breakable" gantry opens to allow lateral patient access
- Easy Draping ,Multiple draping options exist.

- absolute Sterility. The closed gantry designed to stay sterile during the procedure, by eliminating parts moving in and out of the sterile field.
- Easy Beam Positioning Moves the beam at the touch of the button. All motions of the O-arm® System gantry and source detector-unit are motor controlled.

**Despite of the advantages O-arm also has some disadvantages**

**Cost:** The O-arm is a sophisticated and specialized equipment, it can be quite expensive to acquire and also to maintain.
**Limited Field of View:** The field of view of O-ARM limited to the area it is positioned to. Which means for procedures that require a larger area of coverage, the O-arm needs to be positioned multiple times, which can effect on consuming time to the surgical procedure.
**Learning Curve:** the use of the O-arm requires specialized training and experience. Surgeons and operating room staff needs to become familiar with the equipment.
**Space Requirements:** The equipment requires a dedicated space in the operating room, and its size and positioning can be a concern in smaller or more crowded surgical environments.
**Electromagnetic Interference:** The O-arm, can potentially interfere with other electronic devices in the operating room. So basically it requires careful coordination and shielding
**Patient Positioning and Size Limitations:** several patients may not be suitable for O-arm imaging due to their size or positioning considerations. For example, extremely corpulent patients may not fit properly under the O-arm
**Not Suitable for All Surgical Specialties:** the O-arm is used in orthopedics and neurosurgery, it may not be as beneficial in other surgical specialties where real-time imaging is not critical.

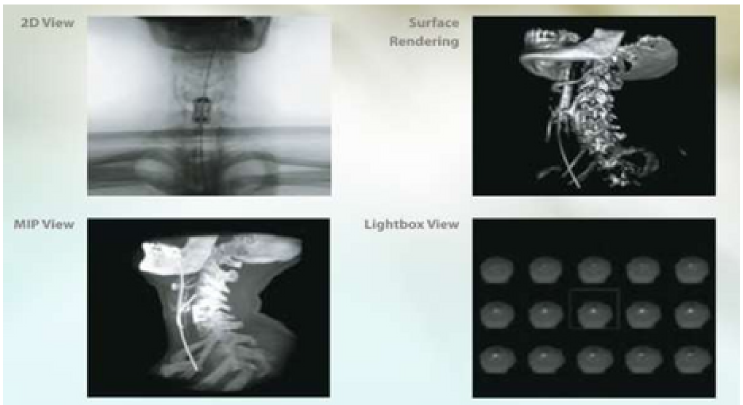
The O-ARM is Excellence in 2D and 3D ,Surgeons have the flexibility to choose between a full 3D scan, low-radiation 2D fluoroscopic image, depending on the information needed


**Movement of O-ARM**

- Sacrum and lower lumbar spine in the 3D
- Lumbar spine lateral and AP images using the full field-of view in 2D

**Key Features :**

- 2D Fluoroscopic Images In order to treat larger fractures, the detector takes pictures three times larger than a typical 9" C-arm.
- The entire cervical spine can be scanned and captured by the O-arm® System. The scanned volume of 3D reconstructions is three times larger than the obtained volume. The surgeon can more easily handle cases where large areas need to be visualised because of the large image volume, which also lessens the need for re centring.
- High Definition 3D (HD3D) Imaging Mode: exposure time ~26 sec, 750 images over 360°, with improved contrast and spatial resolution o Standard Definition 3D Imaging Mode: exposure time ~13 sec, 391 images over 360




**References**


- https://www.neurosurgeonadelaide.com.au/pdfs/oarm_9670939v2.pdf
- www.europe.medtronic.com© 2011 Medtronic Navigation, Inc. All Rights Reserved. Printed in the USA
- www.medtronic.com 2024,2025
- About - abavistwellness.com Author ,LisaHicks the creatorof Abavist
- The O-ARM Surgical Imaging System – Enhanced Precision, Versatility and Safety ,2025 https://www.kauveryhospital.com/blog/o-arm-imaging
- ™Liu Y, Li X, Sun H, Yang H, Jiang W. Transpedicular wedge osteotomy for treatment of kyphosis after L1 fracture using intraoperative, full rotation, three-dimensional image (O-arm™)-based navigation: a case report. Int J Clin Exp Med. 2015www.medtronic.com 2024,2025
- Houten JK, Nasser R, Baxi N. Clinical assessment of percutaneous lumbar pedicle screw placement using the O-arm™ multidimensional surgical imaging system. Neurosurgery. 2012 Apr www.medtronic.com 2024,2025


**Be a Good Reader**

**Got the issue of the magazine, downloaded it, read it and deleted it. Only this does not prove you a good reader. You can agree with or add to the content published in the magazine, so in such cases please write us your comment or feedback. Similarly, debate openly on the issues rose in the magazine and the questions raised and send it to us in writing. With this act of yours, where other readers will be benefited; we will also get guidance in various forms. So, whenever the time demands, do not forget to pick up the pen.**

**And one more thing, we have conveyed this issue to you, as an enlightened Radiographer, now it is your responsibility to forward this issue to other Radiographers.**

**Thanks in advance,**
**Editor**

# Diagnostic Accuracy of MRI Based Radiomics Models for Prenatal Detection of Placenta Acreta Spectrum Disorders

**Sai Akshaya S,** B.Sc. MRIT Intern, **Bibin Joseph**, Assistant Professor, M.S. Ramaiah University of Applied Sciences

## Abstract

Placenta accreta spectrum (PAS) disorder is a severe obstetric complication characterized by abnormal placental invasion into the uterine wall, leading to significant maternal morbidity and mortality. Prenatal diagnosis remains challenging due to the subjective interpretation of conventional ultrasound and qualitative MRI assessments. In recent years, MRI-based radiomics, an advanced computational approach that quantifies image texture, shape, and intensity patterns, is increasingly being recognized as a valuable method for improving diagnostic accuracy. Through data-driven computational models, radiomics can uncover patterns not easily noticed during routine interpretation, enabling earlier and more objective PAS detection. This study evaluates the diagnostic performance of MRI radiomics models in PAS detection and explores their potential to enhance risk stratification and clinical decision-making in high-risk pregnancies.

**Keywords:** Placenta accreta spectrum, Prenatal diagnosis, MRI, Radiomics, Machine learning, Risk stratification, Quantitative imaging, Data-driven computational models

## Introduction

Placenta accreta spectrum (PAS) encompasses a group of abnormal placental implantation disorders that have become increasingly prevalent in parallel with rising cesarean delivery rates. These conditions carry a high risk of massive haemorrhage, peripartum hysterectomy, and maternal morbidity, underscoring the importance of accurate prenatal diagnosis for optimizing clinical management. While ultrasound remains the first-line imaging modality, its performance is highly operator-dependent, and MRI is often reserved as a problem-solving tool. However, conventional MRI interpretation remains largely qualitative and subject to interobserver variability, limiting its reliability.

Radiomics has emerged as a novel approach that transforms standard medical images into high-dimensional quantitative data. By capturing subtle imaging characteristics beyond human perception, radiomics allows deeper phenotypic characterization of the placenta. Recent investigations have shown that integrating radiomics with clinical information, or employing deep learning–based radiomic models, can substantially improve diagnostic performance across diverse cohorts. Such advances highlight the potential of MRI radiomics not only for PAS detection but also for stratifying invasion depth and guiding peripartum decision-making.

Despite encouraging results, existing studies are limited by heterogeneity in methodology, relatively small sample sizes, and lack of external validation, raising questions about generalizability. Addressing these gaps is crucial for translating radiomics into clinical practice. Building on this need, the present study examines the diagnostic performance of MRI radiomics models in PAS and considers their role in supporting risk stratification and management in high-risk pregnancies.

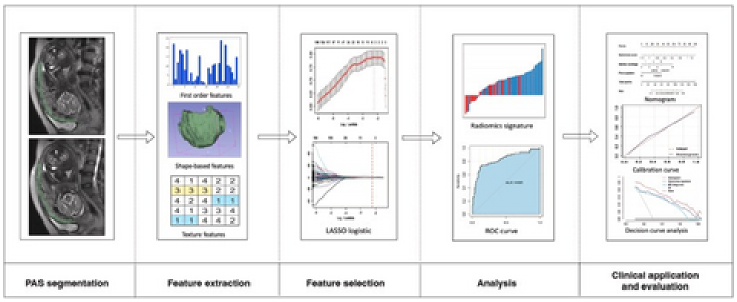



**FIG 1. Radiomics modelling process for placenta accreta spectrum (PAS)**

## Methods

### Study Design and Population

This investigation was designed as a combined retrospective and prospective study involving pregnant women at elevated risk for placenta accreta spectrum (PAS) who underwent MRI as part of their prenatal evaluation. Eligibility criteria included a clinical suspicion of PAS based on sonographic findings or relevant obstetric history. Patients were excluded if imaging quality was suboptimal, clinical data were incomplete, or histopathological confirmation at delivery was unavailable.

### MRI Acquisition

All MRI examinations were performed on a [1.5T/3T] scanner. The imaging protocol included sagittal, axial, and coronal T2-weighted fast spin-echo sequences. When clinically indicated, diffusion-weighted and contrast-enhanced sequences were also obtained. Protocols were standardized across participants to minimize variability and enhance reproducibility.

### Placental Segmentation

Segmentation of the placenta was performed manually (or semi-automatically) on T2-weighted images by two radiologists with expertise in obstetric imaging, both blinded to clinical outcomes. Regions of interest (ROIs) were delineated to encompass the placenta in its entirety while excluding the maternal myometrium and adjacent structures. Interobserver agreement was assessed using the intraclass correlation coefficient (ICC).

### Radiomic Feature Extraction

Quantitative radiomic features were extracted from the segmented ROIs using the PyRadiomics platform. Extracted features were categorized as follows: (i) first-order statistics describing voxel intensity distributions, (ii) shape-related metrics including placental volume and surface area, (iii) texture features derived from gray-level co-occurrence (GLCM), run-length (GLRLM), size-zone (GLSZM), dependence (GLDM), and neighbourhood difference (NGTDM) matrices, and (iv) higher-order features generated through wavelet transformations and Laplacian of Gaussian filters.

**Feature Selection and Model Development**

Dimensionality reduction and prevention of model overfitting were achieved using the least absolute shrinkage and selection operator (LASSO) regression. The selected features were then applied to develop predictive models using logistic regression, support vector machines (SVM), and random forest classifiers.

**Workflow Analysis**

Placenta accreta spectrum (PAS) represents an increasing clinical challenge, where timely and accurate prenatal diagnosis is critical yet often limited by the constraints of conventional imaging modalities. Ultrasound remains the first-line tool; however, its operator dependence frequently necessitates MRI as a complementary problem-solving modality. Despite this advantage, MRI interpretation is largely qualitative and subjective, which introduces variability. This limitation has prompted growing interest in radiomics a computational approach that extracts high-dimensional quantitative features from medical images allowing for a more comprehensive characterization of the placenta than is achievable through visual assessment alone.

Emerging evidence supports the application of radiomics in PAS. For instance, (Yu et al. 2024) developed a radiomics clinical nomogram based on T2-weighted MRI, demonstrating improved diagnostic accuracy compared to standard imaging approaches. Likewise, (Peng et al. 2022) applied PyRadiomics to extract shape and texture features, integrating them with clinical data to build predictive models with enhanced diagnostic performance. More advanced frameworks have also been reported, including a multicenter study in (2022) that combined radiomics-derived features with deep learning outputs, further improving predictive accuracy across heterogeneous patient populations. Comparative modeling studies published in (2024) further emphasized that while radiomics-only models are effective, optimal performance is typically achieved when radiomics features are integrated with clinical and MRI data within combined nomograms.

The utility of radiomics extends beyond diagnosis to clinical management, particularly in risk stratification and surgical planning. For example, an MRI-based radiomics nomogram reported in (2023) successfully predicted intraoperative blood loss, underscoring both technical robustness and clinical relevance through superior calibration and decision curve analysis. Collectively, these

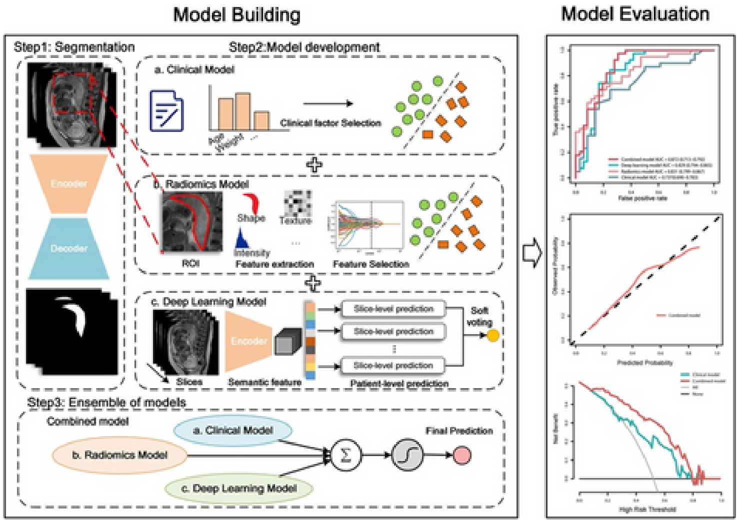



**FIG 2. Workflow for model development and evaluation**

studies demonstrate a reproducible workflow: standardized MRI acquisition, placental segmentation, quantitative feature extraction, feature selection through techniques such as LASSO, and model development using logistic regression, support vector machines, random forests, or deep learning algorithms.

Taken together, current findings highlight a translational pathway from imaging data to clinically actionable prediction. They reinforce the promise of MRI-based radiomics for improving PAS detection, stratifying invasion depth, and guiding peripartum decision-making, while also underscoring the need for larger, standardized, and externally validated studies before routine integration into clinical practice.

**Advantages**

**1.Improved diagnostic accuracy-** A radiomics clinical nomogram based on T2-weighted MRI significantly enhanced diagnostic performance for PAS compared with conventional MRI assessment. (Yu et al., 2024)

**2.Added value** of combining radiomics with clinical data-Incorporating by Radiomics derived texture and shape features with clinical information yielded predictive models with superior accuracy. (Peng et al., 2022)

**3. Clinical utility through calibration and decision curve analysis -** An MRI-based radiomics nomogram accurately predicted intraoperative blood loss and showed good calibration and clinical net benefit. (Zhu et al., 2023)

**4.Standardized radiomics workflow -** Adoption of consistent steps including MRI acquisition, segmentation, feature extraction, and LASSO-based selection ensures methodological reproducibility. (van Timmeren et al., 2020)

**Disadvantages**

**1.Segmentation challenges -** Manual or semi-automatic placental segmentation is labour-intensive and subject to interobserver variability. (Chen et al., 2022)

**2.Small dataset limitations –** Radiomics and deep learning studies with limited samples risk model overfitting and reduced reliability. (Liu et al., 2022)

**3. High technical and computational demands –** Radiomics pipelines involve complex steps requiring advanced expertise and resources, hindering widespread adoption. (van Timmeren et al., 2020)

**4.Limited generalizability –** Models developed on single-center datasets often fail to perform equally well in external populations, highlighting the need for multicentre validation. (Park et al., 2021)

### Application and Implication in Clinical Practice

MRI-based radiomics represents a promising advancement in the prenatal evaluation of placenta accreta spectrum by offering detailed quantitative information that complements traditional imaging methods. Its potential applications in clinical practice are multifaceted:

**Improving Diagnostic Precision:** Radiomic analysis can reveal subtle placental tissue characteristics that are often difficult to discern on conventional MRI. This enhances the accuracy of PAS diagnosis, particularly in cases where ultrasound results are inconclusive or heavily dependent on operator experience.

**Assessing Invasion Depth:** Determining the extent of placental invasion is critical for anticipating surgical complexity. Radiomic models can help differentiate between accreta, increta, and percreta, providing valuable guidance for preoperative planning and optimal allocation of clinical resources.

**Supporting Risk Stratification and Peripartum Planning:** By combining radiomic features with relevant clinical information, predictive models can identify pregnancies at higher risk for severe hemorrhage, hysterectomy, or other complications. Such insights allow for individualized peripartum strategies, including precise timing of delivery, assembly of specialized surgical teams, and preparation of necessary blood products.

**Facilitating Multidisciplinary Care:** Quantitative radiomic assessments enable early coordination among maternal-foetal medicine specialists, anaesthesiologists, and interventional radiologists, helping to optimize outcomes for both mother and child.

**Monitoring and Follow-up:** Beyond initial diagnosis, radiomic biomarkers can be used to track placental development in high-risk pregnancies, allowing timely intervention if abnormal growth patterns are observed.

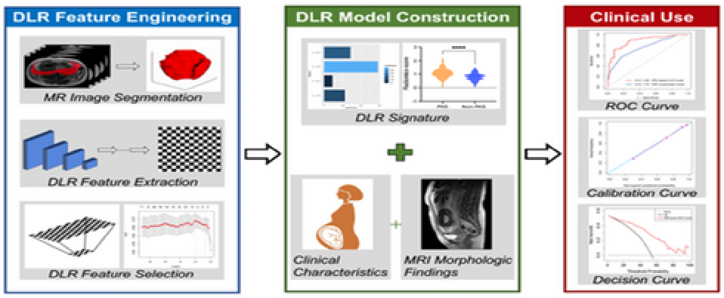



**FIG 3. MRI-based deep learning radiomics (DLR) for PAS assessment**

### Reference

1. Peng L, Zhang X, Liu J, Liu Y, Huang J, Chen J, Su Y, Yang Z, Song T. MRI-radiomics-clinical-based nomogram for prenatal prediction of the placenta accreta spectrum disorders. Eur Radiol. 2022 Nov;32(11):7532-7543. doi: 10.1007/s00330-022-08821-4. Epub 2022 May 19. PMID: 35587828.
2. Huang L, Ma L, Zhou Q, Hu Y, Hu L, Luo Y, Li Y. Accuracy of MRI-Based Radiomics in Diagnosis of Placenta Accreta Spectrum: A PRISMA Systematic Review and Meta-Analysis. Med Sci Monit. 2024 Mar 15;30:e943461. doi: 10.12659/MSM.943461. PMID: 38486373; PMCID: PMC10949827.
3. Peng L, Yang Z, Liu J, Liu Y, Huang J, Chen J, Su Y, Zhang X, Song T. Prenatal Diagnosis of Placenta Accreta Spectrum Disorders: Deep Learning Radiomics of Pelvic MRI. J Magn Reson Imaging. 2024 Feb;59(2):496-509. doi: 10.1002/jmri.28787. Epub 2023 May 24. PMID: 37222638.
4. Stanzione A, Verde F, Cuocolo R, Romeo V, Paolo Mainenti P, Brunetti A, Maurea S. Placenta Accreta Spectrum Disorders and Radiomics: Systematic review and quality appraisal. Eur J Radiol. 2022 Oct;155:110497. doi: 10.1016/j.ejrad.2022.110497. Epub 2022 Aug 22. PMID: 36030661.
5. Wang Z, Jiao X, Liu W, Song H, Li J, Hu J, Huang Y, Liu Y, Huang S. Comparative Evaluation of Clinical-MRI, Radiomics, and Integrated Nomogram Models for Preoperative Prediction of Placenta Accreta Spectrum. Acad Radiol. 2025 Apr;32(4):2041-2052. doi: 10.1016/j.acra.2024.10.021. Epub 2024 Nov 24. PMID: 39581784.

### आप भी अपना पाठक धर्म निभाएँ

पत्रिका का अंक मिला, डाउन लोड किया, पढा और डिलीट कर दिया. केवल इससे पाठक धर्म नहीं निभ जाता. पत्रिका में प्रकाशित सामग्री से आप सहमत हो सकते हैं या उसमें आप कुछ और जोड़ सकते हैं, तो ऐसे मामलों में अपनी टिप्पणी अथवा प्रतिक्रिया हमें अवश्य लिख भेंजे. इसी प्रकार पत्रिका में जो मुद्दे उठाए गए हों, जो प्रश्न खड़े किए गए हों, उन पर भी खुल कर बहस करें और हमें लिख भेंजे. तात्पर्य यह है कि आप केवल पाठक ही न बने रहें, पाठक धर्म भी साथ में निभाते रहें इससे जहां अन्य पाठक बंधु लाभान्वित होंगे वहीं हमें भी विभिन्न रूपों से मार्गदर्शन मिलेगा. हाँ तो, जब भी समय की मांग हो, कलम उठाना न भूलें.

और एक बात, ये अंक हमने आप तक पहुंचाया, एक प्रबुद्ध रेडियोग्राफर के नाते अब ये आप की ज़िम्मेदारी बनती है कि इस अंक को आप भी और रडीओग्राफेर्स तक पहुंचाए यानि फॉरवर्ड करें.

अग्रिम धन्यवाद.

**संपादक**

# DEXA-Based Finite Element Analysis

**Harshita,** BSc. MRIT Student, M.S. Ramaiah University of Applied Sciences

**Abstract**

This study explores the application of Dual-Energy X-ray Absorptiometry (DXA)-based finite element analysis in predicting bone strength and fracture risk. By reconstructing 3D hip anatomy from 2D DXA images, finite element models can be created to simulate bone behavior under various loads, providing a more accurate estimate of bone strength than areal bone mineral density (aBMD) alone.

**Key Words -** Improved Fracture Risk Prediction , Clinically Feasible ,Potential Applications.

## Introduction

Osteoporosis is a prevalent skeletal disorder characterized by a decline in bone strength, leading to an increased risk of fractures. Dual-Energy X-ray Absorptiometry (DXA) is a widely used technique for diagnosing osteoporosis and assessing fracture risk. However, DXA's two-dimensional nature limits its ability to accurately predict bone strength.

**Figure 1 : Modern Dexa Machine**

Finite element analysis (FEA) is a computational method that can simulate bone behavior under various loads, providing a more accurate estimate of bone strength. By combining DXA with FEA, researchers can create patient-specific models to predict fracture risk.

## Significance of DXA-Based FEA

DXA-based FEA offers several advantages over traditional methods:

**Improved accuracy :** By accounting for bone geometry and material properties, DXA-based FEA can more accurately predict bone strength and fracture risk.

**Non-invasive and low-radiation :** DXA-based FEA is a non-invasive and low-radiation technique, making it suitable for routine clinical use.

**Personalized medicine :** Patient-specific models can be created using DXA-based FEA, enabling personalized fracture risk assessment and treatment planning.

## Objective

This study aims to investigate the application of DXA-based FEA in predicting bone strength and fracture risk. By exploring the potential of this technique, we can improve osteoporosis diagnosis and management, ultimately reducing the burden of fractures on individuals and healthcare systems.

## Working Principle of DEXA-Based Finite Element Analysis

### Step 1: DXA Image Acquisition

- Dual-Energy X-ray Absorptiometry (DXA) scans are used to acquire images of the bone.
- DXA images provide information on bone density and geometry.

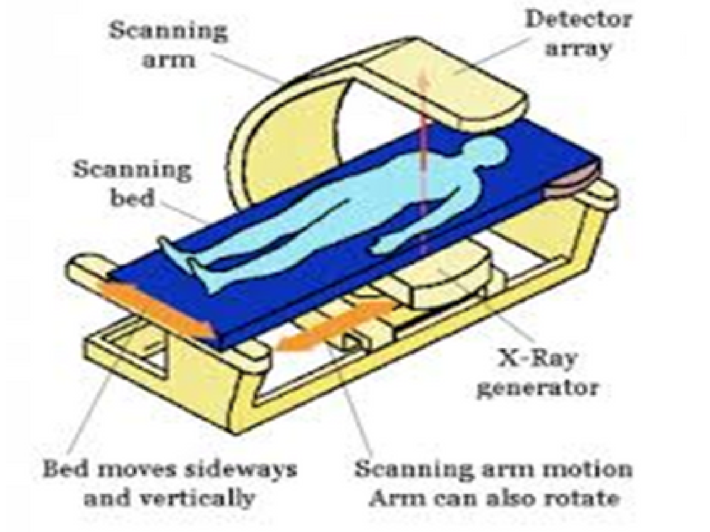



**Fig: DEXA machine in 3D**

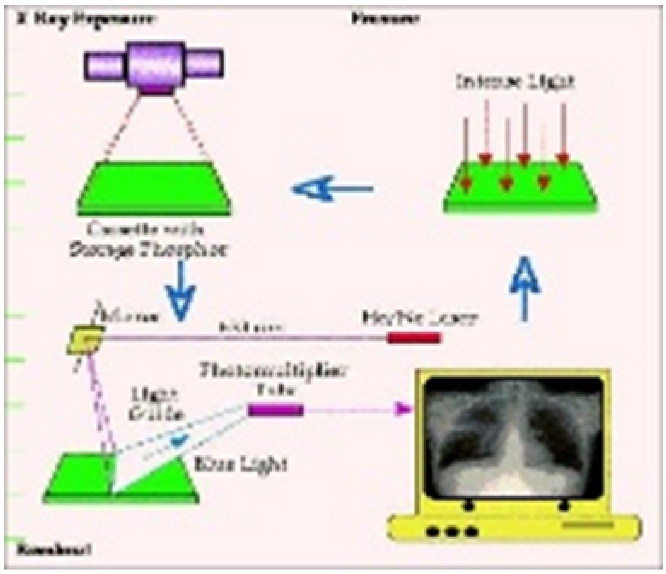


**Fig : Working principle of Dexa**

### Step 2: 3D Reconstruction

- The 2D DXA images are used to reconstruct a 3D model of the bone.
- - This 3D model is created using specialized software that takes into account the bone's geometry and density distribution.

### Step 3: Finite Element Modeling

- The 3D model is then used to create a finite element model (FEM) of the bone.
- The FEM divides the bone into small elements, allowing for the simulation of bone behavior under various loads.

**Step 4: Material Properties Assignment**

- Material properties, such as bone density and elastic modulus, are assigned to each element based on the DXA image data.
- These properties are used to simulate the bone's response to different loads.

**Step 5: Simulation and Analysis**

- The finite element model is then used to simulate the bone's behavior under various loads, such as compression or impact.
- The results of the simulation provide information on bone strength and fracture risk.

**Uses of DEXA-Based Finite Element Analysis**

**Osteoporosis Diagnosis and Management :** Helps identify individuals at high risk of fracture and informs treatment decisions.

**Fracture Risk Assessment :** Provides a more accurate estimate of fracture risk than traditional methods.

**Personalized Medicine :** Enables patient-specific assessment and treatment planning.

**Research and Development :** Useful for studying bone mechanics, testing new treatments, and developing new biomaterials.

**Clinical Decision Support :** Assists healthcare professionals in making informed decisions about patient care.

**Advantages of DEXA-Based Finite Element Analysis**

**Improved Accuracy :** Provides a more accurate estimate of bone strength and fracture risk compared to traditional methods.

**Patient-Specific Modeling :** Enables personalized assessment and treatment planning.

**Non-Invasive :** Uses existing DXA technology, reducing the need for additional imaging modalities.

**Low Radiation :** Utilizes low levels of radiation, making it a safer option for patients.

**Disadvantages of DEXA-Based Finite Element Analysis**

**Limited Validation :** Requires further validation in vivo to confirm accuracy.

**Complexity :** Finite element modeling requires specialized expertise and computational resources.

**Cost :** May require significant investment in software, hardware, and personnel.

**Interpretation Challenges :** Requires careful interpretation of results, considering limitations and assumptions of the model.

**Future Advancements and Challenges**

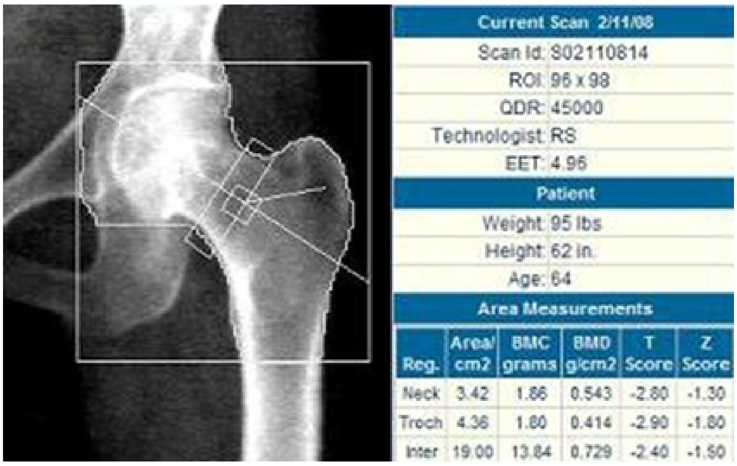
Future advancements in DXA-based finite element analysis may include:

**Integration with Artificial Intelligence (AI) and Machine Learning (ML) :** Enhancing simulation accuracy and efficiency

**Cloud Computing :** Enabling scalable and collaborative simulations

**High-Performance Computing (HPC) :** Accelerating complex simulations and data analysis

**Virtual Reality (VR) and Augmented Reality (AR) :** Providing immersive visualization and interactive experiences




**Conclusion**

DXA-based finite element analysis is a promising technique for estimating bone strength and predicting fracture risk. By combining DXA scans with finite element modeling, patient-specific models can be created to simulate bone behavior. This approach has shown high accuracy in predicting femoral strength and potential to improve osteoporosis diagnosis and management. Further research is needed to validate its accuracy in vivo and address implementation challenges. With potential to improve patient outcomes and reduce osteoporosis burden, DXA-based finite element analysis is an exciting area of research holding promise for bone health assessment and managements.

**References**

National Institute of Health (2024)
Muhammad Qasim
High-Performance Computing (HPC) : Accelerating complex simulations and data analysis
Virtual Reality (VR) and Augmented Reality (AR) : Providing immersive visualization and interactive experiences

National Institute of Health (2018)
S Yang
High-Performance Computing (HPC) : Accelerating complex simulations and data analysis
Virtual Reality (VR) and Augmented Reality (AR) : Providing immersive visualization and interactive experiences

·Research gate (2022)
Sofia Cuttone, Luca Rinaudo, Cristina Bignardi, Alessandra Aldieri
High-Performance Computing (HPC) : Accelerating complex simulations and data analysis
Virtual Reality (VR) and Augmented Reality (AR) : Providing immersive visualization and interactive experiences

·Longdom publishing SL (2016)
M Vijay Kumar Reddy, BKC Ganesh , KCK Bharathi and P ChittiBabu
High-Performance Computing (HPC) : Accelerating complex simulations and data analysis
Virtual Reality (VR) and Augmented Reality (AR) : Providing immersive visualization and interactive experiences

·Oxford Academic (2012)
Kim E Naylor, Richard Eastell , Lang Yang
High-Performance Computing (HPC) : Accelerating complex simulations and data analysis
Virtual Reality (VR) and Augmented Reality (AR) : Providing immersive visualization and interactive experiences

# AutoMate Cardiac: Making the Complexity Simpler with Next-Generation Cardiac MRI

**Nayeem Ahmad Sheikh, Mohammad Umar Zakee,** M. Sc. Research fellows, **Amit Bisht, Raushan Kumar,** Assistant Professors, College of Paramedical Sciences, Teerthankher Mahaveer University, Moradabad, UP.

**Abstract**

A vital component of non-invasive cardiovascular imaging, cardiac magnetic resonance imaging (MRI) provides in-depth understanding of the anatomy and physiology of the heart. However, its efficiency and accessibility may be constrained by its intricacy and the requirement for specific knowledge. By utilizing artificial intelligence and machine learning to streamline the cardiac MRI procedure, AutoMate Cardiac, a sophisticated automated MRI device, tackles these issues. AutoMate Cardiac ensures high-quality, repeatable findings with minimal user intervention by streamlining image acquisition, reconstruction, and analysis. Automating the workflow lowers the amount of time needed for imaging and interpretation, increasing the accessibility and affordability of cardiac MRI while preserving clinical accuracy. This breakthrough could potentially influence the direction of cardiac treatment by improving patient outcomes, facilitating quicker decision-making, and increasing diagnostic precision.

**Keywords:** AutoMate Cardiac, Cardiac MRI, Next-generation imaging

## Introduction

The process of two-dimensional cardiac magnetic resonance imaging (CMR) is quite complicated, and 3D CMR presents even more difficulties. New workflow-simplifying technologies have been developed in response to the need to enable operators with different levels of experience to achieve accurate, consistent outcomes. We launched Auto- Mate Cardiac, an AI-powered platform that automates many of the manual tasks necessary for reliable CMR tests, to make cardiac imaging available to a wider variety of technicians. Additionally, Auto Positioning is an essential component of AutoMate Cardiac. We had plenty of time to annotate data and train neural networks during the global COVID-19 lockdown, which is when this was produced. Using AI, the module finds the proper anatomical placements for the imaging volume, navigators, and saturation volumes and automatically places the patient's heart in the magnet isocenter. Lastly, a third module named Auto TI selects inversion times (TI) for late gadolinium enhancement (LGE) scans automatically. This can be used for both 3D LGE with 3D WholeHeart Pro and normal 2D LGE imaging.

## Technical features

The Auto-Positioning, Auto-Resting Phase, and Auto-TI modules make up AutoMate Cardiac. Planning tasks that are normally carried out by the technician manually are automatically carried out by the modules.

## Auto-positioning

A cutting-edge AI-driven function in cardiac MRI, auto-

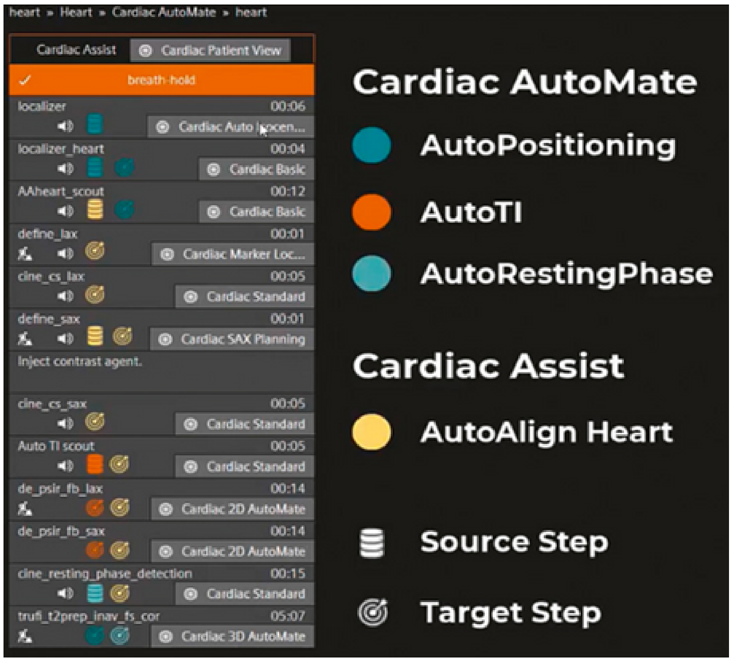



**Figure 1: Illustrates a collection of protocols that are frequently learnt during a CMR exam and demonstrates how the modules operate together to automate the scan process.**

maximise scan planning, and boost workflow effectiveness. Reproducible results are guaranteed, operator dependence is decreased, and imaging precision is improved using this technology.

Use coronal/transverse localizer image segmentation to identify the arms', left ventricle's, and heart's overall bounding boxes. These structures were segmented using a UNet model. A second model was developed using a heat map regression to locate the hepatic dome. Using the size and location of the whole-heart bounding box, the adjustment volume was positioned, and the transverse center of the detected left ventricle was used to determine the isocenter position. For successive heart-centered scans, the slice groups were positioned in the middle of the whole-heart bounding box. For 3D Whole Heart Pro scans, image navigator (iNav) positioning was done using the left ventricle bounding box, and saturation bands were applied over the arms. Overview of the Auto Positioning capability for respiratory-gated scans for the detected liver 2. To place the diaphragmatic pencil-beam navigator, the dome landmark was used.

## Auto-Positioning's Process

AI-Based Landmark Detection- The technology uses artificial intelligence (AI) and machine learning algorithms to detect important anatomical landmarks, such as the heart, aorta, and lungs.

Automated Slice Planning – Without human intervention, AI chooses the best cardiac imaging planes (such as short-, long-, and four-chamber views).

Real-Time Adjustments- The program continuously improves placement to account for changes in the patient's respiration and movement.

Seamless Integration – A fully AI-assisted cardiac MRI workflow is created through seamless integration with automated scan procedures and image processing tools.

**Principal Benefits of Cardiac MRI Auto-Positioning**

**Improved Workflow Efficiency:** More patients can be scanned each day because setup time is decreased.

**Improved Image Quality:** Assures ideal and reliable placement, minimising motion artefacts and misaligned images.

**Reduced Operator Dependency:** makes cardiac MRI more widely available by reducing the need for highly qualified technologists.

**Standardized and Reproducible Results:** guarantees consistent imaging across various institutions and operators.

**Increased Patient Comfort:** Particularly for critically ill patients, quicker placement shortens scan times and minimises suffering.

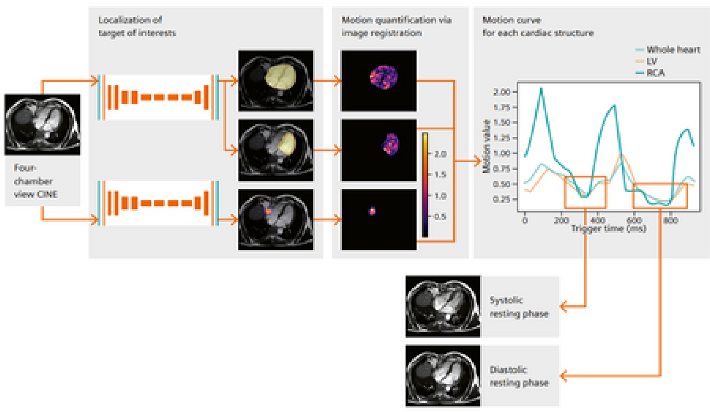



**Figure 2: Overview of the AutoPositioning feature. Using heat map regression, a second model was trained to locate the liver dome.**

## Auto-resting phase

Using articial intelligence (AI) and real-time physiological monitoring, the auto-resting phase of next-generation cardiac MRI automatically recognises and synchronises picture acquisition with the best cardiac and respiratory resting phases. Image quality is improved, motion artefacts are decreased, and workflow efficiency is increased thanks to this invention.

Based on identifying quiescent intervals in the cardiac cycle by segmenting regions of interest in a four-chamber view film series and applying motion quantification using image registration throughout the film series, weighted on the localized regions. Two networks—the right coronary artery (RCA) detection network and a multi-region segmentation network for the left and right ventricles and atria—were trained to locate the regions of interest (ROIs). Both the segmentation and RCA landmark detection tasks were performed using UNet models. The anatomical positions of these ROIs in conjunction with image registration might then be used to calculate motion curves for each ROI. Imaging without motion artifacts can be accomplished by using valleys in the motion curves, which indicate quiet phases of the relevant anatomical structures.

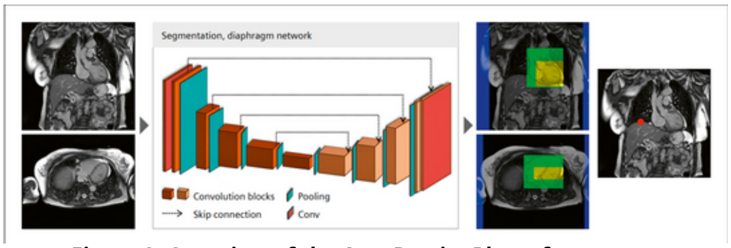



**Figure 3: Overview of the AutoRestingPhase feature.**

**Key Advantages of Auto-Resting Phase in Cardiac MRI**

**Minimized Motion Artifacts-** reducs motion blur by automatically identifying the diastole or systole, the heart's most stable phase.

**Optimized Respiratory Gating-** synchronises imaging with the patient's respiration, improving the clarity of scans that involve free breathing.

**Faster Image Processing-** Faster image reconstruction is made possible by AI automation, which simplifies data collecting.

**Lower Breath-Hold Requirements-** permits acquisitions of free breathing, which is advantageous for individuals who have trouble holding their breath.

## Auto T1

Based on identifying the ideal TI for the ensuing LGE acquisitions by segmenting the myocardium and left-ventricular blood pool from a TI scout series of a mid-ventricular short-axis slice . The average tissue intensity of the myocardium and blood pool at each inversion time in the TI scout series is calculated using the segmentation masks following segmentation using a trained UNet model. The TI is first chosen at the lowest intensity value determined by the myocardial intensity curve. In order to maximize blood-myocardium contrast, the ideal TI is ultimately chosen during a brief window of time following the initial TI, when the relative difference between the blood pool and myocardium signal is at its maximum.

**Key Advantages of Auto T1 in Cardiac MRI**

**Faster Scan Time-** shortens the duration of the test by automating the acquisition and processing of T1 mapping.

**Standardized T1 Mapping-** AI makes sure that T1 readings from various scanners and operators are reliable and consistent.

**Accurate Myocardial Tissue Characterization-** helps diagnose cardiac conditions such as fibrosis and oedema by providing accurate measurement of native T1 and post-contrast T1 values.

**Reliable Quantification-** AI-powered algorithms reduce T1 measurement errors, increasing the accuracy of diagnosis and treatment planning.

**Optimized Contrast Use-** Adjusting contrast dose and reducing needless exposure is made easier with more accurate post-contrast T1 mapping.

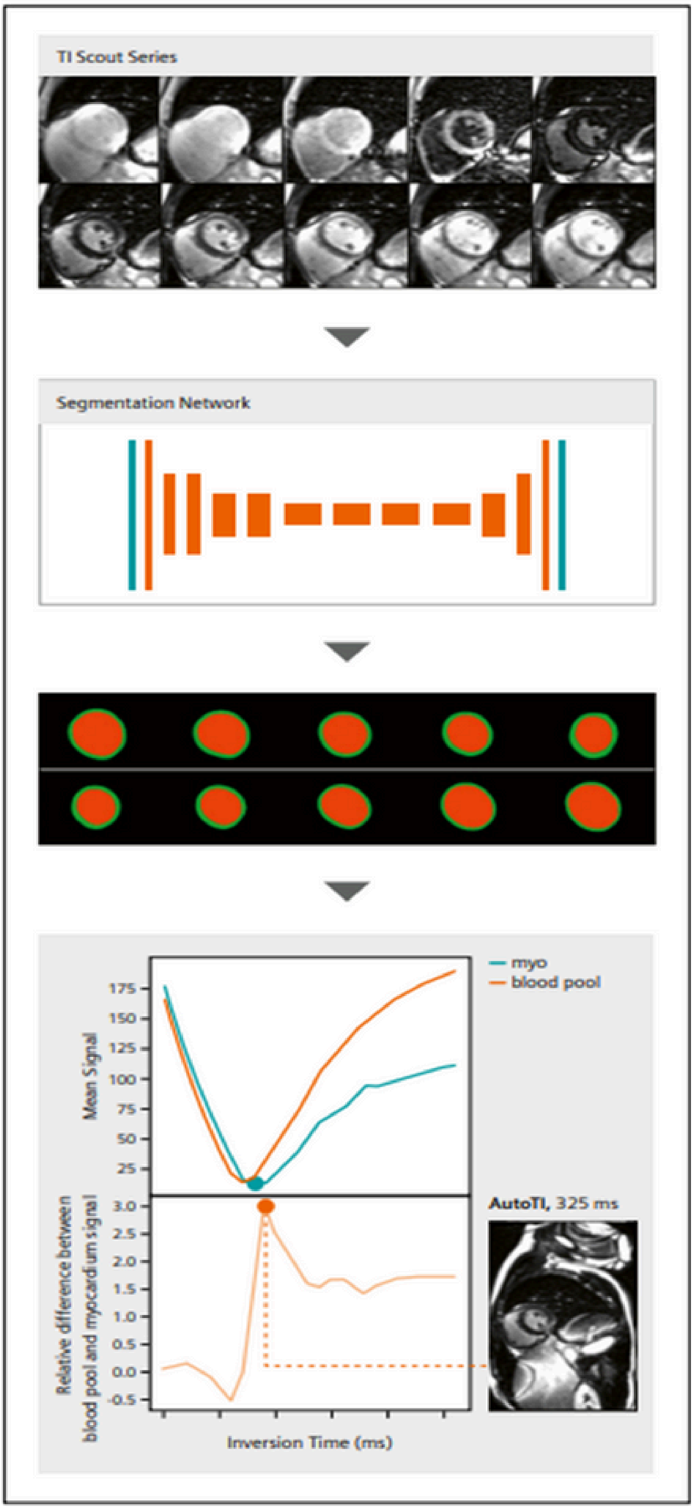



**Figure 4: Overview of the AutoTI feature.**

**Conclusion**

A major breakthrough in CMR scan automation, AutoMate Cardiac uses AI-powered features like Auto Positioning, AutoTI, and Auto Resting Phase to create a comprehensive tool that streamlines imaging, improves accuracy, and lowers operator variability. With continued validations and growing clinical applications, AutoMate Cardiac is poised to revolutionise CMR procedures worldwide and push the limits of automated imaging solutions. With next-generation cardiac MRI, auto-positioning greatly improves patient comfort, speed, and consistency while lowering operator reliance. AI-driven positioning combined with automated workflows makes cardiac MRI more widely available, consistent, and efficient for patients and physicians. Next-generation cardiac MRI auto-positioning is a big step towards automation that will increase accessibility, accuracy, and efficiency. It is essential for improving patient care and cardiac diagnostics since it lessens operator reliance and guarantees standardised imaging. Next-generation cardiac MRI's auto-resting phase, which automatically chooses the most stable cardiac and respiratory phases, greatly improves image quality, efficiency, and patient comfort. It is essential to making cardiac MRI quicker, more accurate, and easier to use when paired with other AI-driven automation capabilities.

**References**

1. Ogawa R, Kido T, Shiraishi Y, Yagi Y, Yoon S, Wetzl J, et al. Neural network-based fully automated cardiac resting phase detection algorithm compared with manual detection in patients. Acta Radiologica Open. 2022;11(10):20584601221137772.

2. Wood G, Pedersen A, Kunze K, Neji R, Hajhosseiny R, Wetzl J, et al. Automated detection of cardiac rest period for trigger delay calculation for image-based navigator coronary magnetic resonance angiography. J Cardiovasc Magn Reson, 2023;25(1):52.

3. McDermott S, Wetzl J, Schmidt M, Benbow M, Yoon S, Geppert C, et al. AI-based Cardiac Scan Automation: A Prospective Comparison of Highly Automated Scan Workflows in 32 Patients. J Cardiovasc Magn Reson. 2024;26(1):100674.


BLUENEEM®
BLUENEEM® UROLOGY
YOUR FELT NEEDS PARTNER
BLUENEEM® INTERVENTIONAL SYSTEMS
YOUR INNOVATION PARTNER
BLUENEEM PEDIATRIX
OUR KIDS DESERVE THE BEST
CLINICIANS' TRUSTED PARTNER
EXPLORE COMPLETE PRODUCT RANGE
LEADER IN DESIGN, DEVELOPMENT AND END-TO-END MANUFACTURING OF MINIMALLY INVASIVE MEDICAL DEVICES
OPTICORE
BIOPSY GUN - FULLY AUTOMATIC
CYTOCORE
BIOPSY GUN - SEMI AUTOMATIC
TRACER™
HYDROPHILIC GUIDEWIRE
+91 80 2976 1335/36
+91 97399 72854, 97399 72855
contact@blueneem.com
marketing@blueneem.com
CE 0123
TÜV SÜD

# The Utility of Advanced Imaging in Forensic Anthropology

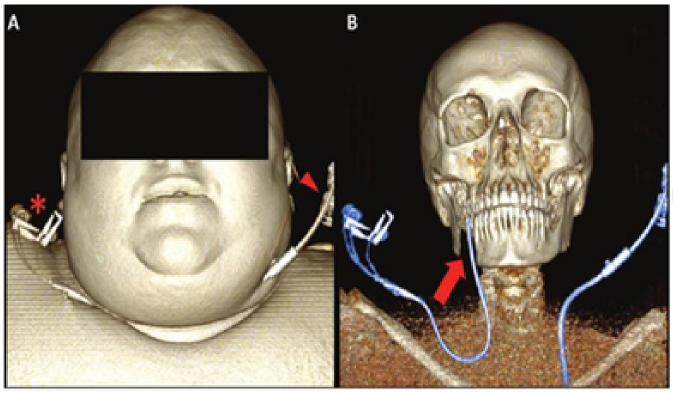
**Pratik Virat,** M. Sc. Research fellow, **Mamta Verma, Raushan Kumar,** Assistant Professors, College of Paramedical Sciences, Teerthankher Mahaveer University, Moradabad, UP.

**Abstract**

Imaging technologies play an integral role in forensic anthropology cases. Advances in digital photography allow the anthropologist to photo-document the scene and skeletal remains in exceptional detail. Traditionally, radiographs have been used to document remains, potential trauma, and any individualizing characteristics such as healing trauma and frontal sinus morphology. Given technological advances, some forensic anthropologists have begun to incorporate more advanced imaging methods in their case analyses and research, such as computed tomography and three-dimensional (3D) surface scans. These advanced imaging technologies provide a means to document skeletal remains and trauma, and can be used to create 3D replicas of the elements for archival and illustrative purposes. Re searchers have begun to develop novel methods for estimating biological parameters from these 3D virtual models, using new variables such as surface areas and volumes, and advanced statistical methods (e.g., geometric morphometric analyses) to quantitatively analyse skeletal variation for sex and ancestry estimation. The use of these technologies in forensic anthropology remains somewhat limited, however, due to required costs, expertise, and the time involved in collecting and processing the data. Newly developed methods require further validation, and some areas of advanced imaging, such as photogrammetry, remain relatively unexplored in the field. Interdisciplinary collaborations between forensic anthropologists and other medicolegal professionals can help alleviate some of these resource constraints and facilitate advancements in forensic case analysis and research.

**Introduction**

Modern forensic investigation utilises novel tools and advanced technologies to solve criminal and civil cases. Forensic imaging is obviously a powerful tool in this new era. Thanks to X-ray, computed tomography (CT), magnetic resonance imaging (MRI) and other medical imaging technologies, which have laid a solid foundation for the development of forensic imaging. Forensic imaging is the use of images to explain and document findings for forensic and medico-legal purposes. It includes the X-ray, the multi-slice CT, MRI, the augmented minimally invasive techniques through CT and MRI such as angiography and biopsy, and three-dimensional (3D) surface scanning as an adjunct or alternative to the traditional invasive autopsy. Because of its non-invasive features, postmortem imaging is often used in pathology instead of a traditional autopsy when the case is of sensitive religious concern, or a traditional autopsy is rejected by family members for other reasons. In death investigations, postmortem




Virtual autopsy

imaging is also frequently applied prior to a traditional autopsy, in order to accurately locate traumas and pathological changes in the deceased. In some traumatic deaths, such as fatal motor vehicle accidents, post-mortem imaging has the ability to detect or presume fatal traumas. In the circumstances such as fatal traumas, an autopsy is not necessary if the forensic pathologists can determine the cause of death according to imaging results. Since forensic imaging has been used in forensic investigation, it mainly focused on research and applications of forensic pathology. It is worth noting that in recent years, this technique has been adopted in other forensic investigative disciplines including forensic anthropology, odontology, forensic ballistics, wildlife forensics and clinical forensic medicine. Clearly, forensic imaging has become a powerful tool for modern forensic investigation. This article summarizes the application and research progress on forensic imaging in different forensic investigative disciplines.

**Computed Tomography**

More advanced technologies have recently been, and continue to be, incorporated in the forensic anthropologist's arsenal of imaging techniques. One such technique, computed tomography (CT) scanning, was originally developed for use in the clinical setting, and is primarily used as a medical diagnostic procedure. Computed tomography scans essentially take a series of radiographs from a full complement of angles and the resultant images are then combined using digital algorithms to produce tomographic (i.e., cross-sectional) images that can be stacked to create a virtual 3D reconstruction of the object scanned. This procedure constitutes an essentially non-invasive and non-destructive method for visualization of both the external and internal structures of materials and organisms. Since CT scanning's introduction to the mainstream medical community, major advances in safety and resolution have occurred, and along with a concomitant reduction in cost, these factors have resulted in the increasing prevalence of patients receiving CT scans. For these reasons, CT scans are also gaining traction in the worlds of research and education, bolstered by a robust and growing body of scholarly work. Despite the obvious benefits of this technology and its potential utility for both forensic casework and research, CT scanning remains limited in use within the forensic anthropological community. Many practitioners do not have access to facilities with the necessary equipment to perform CT scanning, and even for those who do, the relatively high cost of scanning may in itself be prohibitive. Furthermore, working with CT images requires access to specialized (and expensive) computer software as well as experience with manipulating 3D datasets.

**The global impact of forensic imaging**

In recent years, with the increasing recognition of its strengths, forensic imaging has been explored globally in forensic practice and research. For example, the forensic imaging research teams at the University Centre of Legal Medicine Lausanne-Geneva ,the University of Berne and the University of Zurich in Switzerland, employed forensic imaging techniques, particularly CT and MRI in their outstanding research; the Chief Medical Examiner's Office of Maryland in the United States utilises CT as an auxiliary method in autopsy the Armed Forces Institute of Pathology (disestablished in 2011, continues as American Institute of Radiologic Pathology) performed CT especially in gunshot and drown cases the Victorian Institute of Forensic Medicine in Australia and the Institute of Forensic Medicine at University of Southern Denmark performed CT scan along with standard autopsy in forensic cases; forensic pathologists in Italy made use of CT scan as a screening diagnostic test before conducting a traditional autopsy in Austria, researchers utilised forensigraphy imaging technique to detect relevant traces on and within the body of an examined per son in Japan, 26 of 47 prefectures have at least one autopsy imaging centre with scanners that are dedicated for postmortem imaging the Academy of Forensic Science in China started conducting postmortem multi-slice computed tomography (PMCT) research since 2005 and has completed more than 500 forensic imaging cases with different causes of death this team also contributed thin layer CT scanning and imaging reconstruction to estimate the age of teenagers through the sternal end of clavicle epiphyseal growth The application of forensic imaging in different forensic disciplines

**Pre - CT time**

Before the CT technology was invented in 1972, the use of medical imaging in forensic investigation was not uncommon. X-ray was the primary imaging technique employed in forensics. As early as in the end of 19th century, X-ray was used for post-mortem purposes. In 1940s, stereoscopic radiography was utilised in hypertensive and ischemic heart disease deaths investigation in order to obtain pathological information. Later, X-ray was widely used in forensic investigation, such as to assist in investigating the skull fracture mechanism and the cause of death , to identify individuals and study Egyptian mummy in forensic anthropology, to develop the procedures and techniques in dental identification to calculate gunshot size and pattern in forensic ballistics , to study the putrefaction which could cause radiographic postmortem changes in feline and canine cadavers in wildlife forensics, to investigate the injuries in industrial accidents, suicidal attempts and criminal assault of forensic living cases etc. Since CT and MRI were invented and used in the medical field in the 1970s, they have been increasingly used in forensic investigations.

**Forensic anthropology**

CT imaging technology was widely used in forensic anthropology since 1980s. In 1981, Wong was able to identify Hirschsprung disease in desiccated human remains by using CT. In 1993, Haglund and Flinger successfully utilised CT to confirm human identification by comparing antemortem and postmortem skull CT scan scout views. In 1996, for facial reconstruction purposes, Phillips and Smuts found the variation of the facial tissue thickness for the mixed racial population group of South Africa by CT scanning. In 1997, Quatre homme et al. proposed a new computerized methodology with the advantages of CT scan for facial reconstruction. By performing this new method, this research team was able to reconstruct by computer 3D facial model of the deceased. In 2006, Turner et al. reported the first mathematical representation of the face continuum associated with given skull and collected a comprehensive CT head-scan database for forensic facial reconstruction, in order to assist in the identification of missing person and victims of violent crime. In the same period, Sidler et al. [59] proved that CT may be used as a valuable tool in disaster victim identification after a mass fatality incident because of the high efficiency of the technology. By the end of the 20th century, forensic imaging application in forensic anthropology was elevated to a new level. In 2009, Harth et al. applied Flat-Panel-CT explore Locus Ultra (eLU) system in determining the correlation between age and the stages of skull suture closure. The research team appraised that this method is useful in conjunction with other methods in age estimation. In 2014, López-Alcaraz et al. applied CT on the pubic symphysis surface and the pubic body to relate them with age, and suggested that the image analysis of pubic bone offers a valid and alternative method for age estimation. In 2017, Ikeda used Bayesian statistics in combination with CT imaging and suggested that they together can be used to estimate age at death based on costal cartilage calcification. Recently, Fan et al. developed the CT image reconstruction of laryngeal cartilage and hyoid bone in adult age estimation using data mining methods. They suggested that this reconstruction should not be used alone in practice but can be used in com bination with other indicators.

**Forensic pathology**

In 1979, Flodmark et al. performed CT 10 days before autopsy in 90 neonates that had suffered peri natal hypoxia. They confirmed that findings at autopsy were correlated with the CT diagnosis. In 1987, Varnell et al. found that CT could reveal the marked diffuse cerebral swelling with associated loss of gray-white differentiation in cyanide poisoning death, whereas this type of death may masquerade as natural disease and can be difficult to diagnose both clinically and pathologically. In 1999, Oliver et al. demonstrated the advantages and pitfalls of CT in forensic pathological diagnosis of arterial gas embolism in fatal diving accidents, they pointed out that an understanding of pitfalls will aid in an accurate imaging diagnosis in diving accident cases. Based on the development of CT and MRI in medicine, forensic imaging ushered in its improvement heyday. CT was proved to be an excellent visualisation tool with great potential for forensic documentation and evaluation of decomposed bodies [38]; it assisted in finding intrahepatic gas in deceased with the exceptions of putrefied or burned corpses it also showed the reliability in estimation of abdominal blood volume. CT and MRI techniques were used to assist in correct examination of charred bodies ; CT and MRI showed comparable potential as forensic diagnostic tools for traumatic extra-axial haemorrhage, and revealed that MRI is more sensitive than CT for detection of subarachnoid haemorrhagic findings CT and MRI also assessed postmortem weights of liver and spleen accurately, and CT even could overcome the limitation of putrefaction and venous air embolism by the possibility to exclude gas, and in congestion cases, the imaging might be even more accurate than autopsy in weighing the livers . After 2006, angiography was incorporated in forensic imaging. It was first tested in animal models for rapid vascular phenotyping . Subsequently, a minimally invasive two-step postmortem angiographic technique was established with the first step of a bolus injection of oily contrast agent into human cadavers and the second step of radiographic imaging. Postmortem angiography enabled detailed examination of the vascular system which is difficult to be examined by traditional autopsy methods . The whole body postmortem MR angiography (PMMRA) was proved to be feasible . However, pitfalls of postmortem CT angiography (PMCTA) were reported as a haemorrhagic pericardial effusion happened during the venous phase of angiography, and suggested it is necessary to critically analyse CT and PMCTA images in order to distinguish between artifacts, true pathologies and iatrogenic findings . With this lesson in mind, in the sub sequent studies, angiography incorporated forensic imaging emerged remarkable role in differentiation of hemopericardium due to ruptured myocardial infarction or aortic dissection on unenhanced CT . In addition, researchers successfully applied angiography without traditional autopsy in a fatal Broncho vascular fistula after lobectomy case  which further confirmed angiography is technically feasible in forensic pathology. With the advent of the new approach which has the capability to perform 3D surface scans as well as postmortem image-guided bones and soft tissues biopsy, forensic imaging has developed into a 3D and micromorphology era. In 2010, Virtobot, a multi-functional robotic system for 3D scanning and automatic postmortem biopsy was first introduced to the research field . In 2014, the second prototype of Virtobot updated the previous prototype, and the updated Virtobot is more accurate in biopsy and focuses on streamlining the workflow and increasing the level of automation . Recently, a more advanced 3D scanning technology multispectral full-body imaging employed multispectral photogrammetry between 365 and 960 nm by utilising modified digital cameras, ultraviolet, near-infrared light sources and lens filters to visualise the latent evidence on the body such as latent bodily fluids and latent bruises

**Forensic odontology**

Forensic odontology is the study of deceased's dental records in order to identify the unknown individual. Dental radiology plays a critical role in forensic odontology. After forensic imaging was applied in forensic studies, researchers started utilising this technology in forensic odontology. In 2005, Jackowski et al. introduced the application of CT in a burned corpse dental identification. They believe that transportable dental CT scanner can greatly help identify disaster victims and offers new possibilities of comparison of antemortem and postmortem dental information. In 2008, Jackowski et al. successfully performed CT and 3D volume rendering to distinguish between dental ceramics and composite fillings and proved that this method is suitable for human dentition visualisation for forensic purposes. Bassed and Hill utilised postmortem CT to determine the deceased children's age by dentition in 2009 Victorian Bushfire disaster in Australia. They concluded that CT imaging is a useful tool for age estimation in certain conditions including the dental development can be obviously visualised and the presence or absence of restorations is irrelevant. In 2013, Franco et al. observed the 3D reconstructions and CT slices of 103 postmortem full body CT and obtained optimal dental chart, which can serve as a valuable additional tool in the human dental identification. In 2014, Trochesset et al. proposed the application of cone beam CT (CBCT) to forensic odontology, because the CBCT data sets can be dis played in three dimensions to visualise the dentition. They successfully generated intra-oral-like images from CBCT volumes and proved that these images are similar enough to traditional dental radiographs to allow for forensic dental identification. In 2015, Sakuma et al. compared five corresponding anatomical reference points between postmortem CT images and dental original radiographs by superimposing the two types of images, and they found out there were significant anatomical differences in these two type images, which suggested odontology forensic imaging can aid in avoiding incorrect personal identification owing to erroneous information.

Forensic ballistics In forensic ballistics, forensic imaging is primarily used in the study of gunshot residues, shooting distance, foreign body's location, and paths in the livings and deceased. In 2000, Stein et al. conducted the gunshot wound forensic assessment research with CT application. In this research, caliber .38 Special, 357 magnum and 22 LR bullets were shot at experimental fresh pink skins from a range of 0 cm to 100 cm. The results suggested that CT records can differentiate between a contact shot and firing ranges of more than 10 cm. In 2003, Thali et al. performed forensic imaging on eight gunshot fatalities, and the findings were confirmed by traditional autopsy that PMCT, MRI, 2D multi-planar reformation (MPR) and 3D shaded surface display (SSD) reconstruction have the capability to visualise the ballistic fracture pattern, the bullet track and localisation, trauma, pathological changes and gunshot residue deposition in a non-destructive method. In 2009, Puentes et al.applied 3D-multislice computed tomography (MSCT) in a non-fatal gunshot case. In this case, the bullet's trajectory was accurately determined by 3D-MSCT and this technology was proved to be helpful in estimating the victim and suspects

locations in a multiple aggressor situation in crime scene investigation. In 2014, Maiese et al.reported that PMCT and the 3D rendering of CT slice stack images not only helped with the wound path visualisation and bullet localisation, but also offered data for the crime scene reconstruction . In 2019, Gascho et al. assessed the synergy of CT and MRI in gunshot wound cases with foreign bodies in head. They suggested that MRI provides a valuable supplement to postmortem CT for the detection of wound channel and soft tissue injuries. In 2020, Gascho et al. emphasized the importance of MRI in gunshot case investigation. In one of the shooting investigations, MRI clearly showed the soft tissue injuries and the ruptured medulla oblongata, providing the investigators the graphic information on the death. Gascho et al. also pointed out that special MRI sequences at 7 tesla MRI can delineate micro injury in soft tissue which could be easily ignored by microscopical autopsy.

**Advantages, disadvantages and prospects**

**Advantages**

The advantages of forensic imaging are obvious. First, forensic imaging is the most suitable alternative of a traditional autopsy, especially when the case is religious sensitive, or the family member of the deceased cannot accept a traditional autopsy . Second, high-resolution CT scan can be used to obtain the best quality images in forensic imaging because the radiation exposure issue can be neglected for postmortem examination . Third, when performing the autopsy on the deceased who had an infectious disease such as tuberculosis and coronavirus disease . In this circumstance, forensic imaging can prevent practitioners from being directly exposed to uncertain pathogens, this irreplaceable advantage is particularly important during the global COVID-19 pandemic, suggesting the inestimable social value of the forensic imaging—the potential of being used in any unpredict able pandemic in the future. Fourth, in traditional experience-dependent investigations, forensic imaging can provide objective data to enhance the credibility of results. For example, in forensic anthropology and odontology age estimation, imaging data are a reliable reference in age determination by skeleton and dentition ; in forensic odontology, imaging can be used to com pare the dental repair material of the suspect with the suspicious material found at crime scene to support the evidence chain . Fifth, true-to-scale 3D non-destructive gathering of forensic imaging findings can reveal the original injuries and pathological changes instead of destructing original evidence by surgical procedure. For example, in forensic ballistics, it is important to find out the bullet path in victims, and forensic imaging is definitely a fantastic method to investigate the original trajectory instead of destructively dissect the paths.

Disadvantages

In order to apply forensic imaging objectively and correctly, the disadvantages of this technique should not be ignored. Forensic imaging has formally entered the field of forensics for nearly two decades, but due to its high cost, it is still not widely used in the daily work of forensics. The high costs include the instruments, the facility, the professional operator's training, the hardware and software accessories and the maintenance. In forensic pathology, sometimes imaging is unable to detect the pathological conditions in the deceased. For example, solely CT scanning has the limitation in detecting soft-tissue injury, MRI or 3D surface scanning are needed to assist in such cases ; forensic imaging did not reveal all the haemorrhagic sites in the brain injury, and a direct comparison between neuroimaging and

**Prospects**

Due to the high cost of forensic imaging, it is not realistic for all forensic institutes to own the facility. In order to make better use of resources, a forensic imaging resource sharing platform can be established in the region. The forensic imaging resource sharing platform can include the facility access information, the training resources, the general guideline of forensic imaging performances, etc. Forensic imaging relies on instruments and technologies derived from the medical field. Any update or development of medical imaging technology may help to promote the development of imaging applications in forensics. With the maturity of deep learning technology and artificial intelligence technologies, they are promising for potential applications as a screening tool or in computer-aided diagnostics in forensic cases.

**Conclusion**

For current anthropological purposes, MSCT has many ad vantages over dry bone analysis. One of its major assets in forensic anthropology is the elimination of lengthy bone preparation, which may damage fragile bone. This can be particularly useful when bones are very burned or charred. Documentation by radiological imaging is classically described as observer-independent, objective and non-invasive. Another advantage of MSCT is the virtual access to bones, where physical access is impossible, such as bones embedded in sediment or concrete blocks.18,92 Also, of major interest is the conservation of images and the reconstructions. Further studies can be carried out on the object scanned, independently of its state of preservation. This opens up a new approach to quality control and expert supervision, as well as image transmission and use in forensic telemedicine. Additionally, MSCT can be per formed in the country where the bones or body were discovered, whereas further work on image analysis and reconstructions can be continued in another country. Image and data pro cessing offer objective visualization and recapitulation of forensic results, with the high spatial resolution of MSCT. Unfortunately, the main drawbacks to routine use of MSCT in anthropology are the limited accessibility of such systems, their cost and the real need for the radiologist to be familiar with anthropological techniques. To conclude, a multidisciplinary approach is crucial in such work, as it involves communication and data exchange between radiologists, forensic pathologists, anthropologists and radiographers.

**Refrences**


- Grabherr S, Egger C, Vilarino R, et al. Modern post-mortem imaging: an update on recent devel opments. Forensic Sci Res. 2017;2:52–64.
- Dirnhofer R, Jackowski C, Vock P, et al. VIRTOPSY: minimally invasive, imaging-guided virtual autopsy. Radiographics. 2006;26:1305–1333.
- Sonnemans LJP, Kubat B, Prokop M, et al. Can virtual autopsy with postmortem CT improve clinical diagnosis of cause of death? A retrospective observational cohort study in a Dutch tertiary referral Centre. BMJ Open. 2018;8:e018834
- Shiotani S, Shiigai M, Ueno Y, et al. Postmortem computed tomography findings as evidence of traffic accident-related fatal injury. Radiat Med. 2008;26:253–260.
- Thali MJ, Yen K, Schweitzer W, et al. Virtopsy, a new imaging horizon in forensic pathology: virtual au topsy by postmortem multislice computed tomography (MSCT) and magnetic resonance imaging (MRI)—a feasibility study. J Forensic Sci. 2003;48: 386–403.
- Ampanozi G, Halbheer D, Ebert LC, et al. Postmortem imaging findings and cause of death determination compared with autopsy: a systematic review of di agnostic test accuracy and meta-analysis. Int J Legal Med. 2020;134:321–337.
- Christensen AM, Passalacqua NV, Bartelink EJ. Forensic anthropology: current methods and practice. London (UK): Academic Press; 2019. p. 100–103.
- Puentes K, Taveira F, Madureira AJ, et al. Three-dimensional reconstitution of bullet trajectory in gunshot wounds: a case report. J Forensic Leg Med. 2009;16:407–410.
- Maiese A, Gitto L, De Matteis A, et al. Post mortem computed tomography: useful or unnecessary in gunshot wounds deaths? Two case reports. Leg Med (Tokyo). 2014;16:357–363.
- Gascho D, Tappero C, Zoelch N, et al. Synergy of CT and MRI in detecting trajectories of lodged bullets in decedents and potential hazards concerning the heating and movement of bullets during MRI. Forensic Sci Med Pathol. 2020;16:20–31.

# Deep Learning Approaches for Enhanced Lung Cancer Detection: A Review of Convolutional Neural Networks and Image Processing Techniques

**Ishant, Syed Anam Parvez, Nikita Upadhyay, Unnati Pant ,** M. Sc. Research fellows, **Raushan Kumar,** Assistant Professors, College of Paramedical Sciences, Teerthankher Mahaveer University, Moradabad, UP.

## Abstract

The study's abstract provides a concise summary of the research focused on lung cancer detection using deep learning and image processing techniques. Here are the key points :

**Focus on Deep Learning:** The study emphasizes the role of convolutional neural networks (CNNs) in lung cancer detection. CNNs are highlighted as powerful tools that can automatically extract and learn features from medical images, which is crucial for accurate diagnosis [1].

**Model Performance:** Various CNN models, including VGG16, ResNet50, and Inception V3, have been reviewed for their effectiveness in identifying both malignant and benign lung nodules. These models have demonstrated high accuracy, showcasing the potential of AI in medical imaging [1].

**Dataset Utilization:** The proposed CNN model was trained on a substantial dataset of 220,025 lung tissue images sourced from Kaggle. This extensive dataset contributed to achieving an impressive validation accuracy of 99.3% at Madras Medical College, indicating the model's reliability in clinical settings [1].

**Image Processing Techniques:** The study also discusses the importance of image acquisition and pre-processing methodologies, which are essential for enhancing the quality of input data for the CNN models. This aspect is critical for improving diagnostic efficiency [1].

**Future Directions:** The abstract outlines potential future advancements, such as integrating additional layers into CNNs, conducting real-world clinical validations, and developing user-friendly AI interfaces. These advancements are aimed at further improving the early diagnosis of lung cancer and enhancing patient outcomes [1].

## Introduction

Lung cancer is a major health concern, accounting for a significant number of cancer-related deaths globally. The introduction of this study highlights the urgent need for improved diagnostic methods and the transformative role of artificial intelligence (AI) in this field. Here are the key points:

**Significance of Lung Cancer:** Lung cancer is one of the leading causes of cancer mortality worldwide. Traditional diagnostic methods, such as chest X-rays and CT scans, often require considerable time and expertise, which can lead to delays in diagnosis and treatment [1].

**Need for Advanced Detection Techniques:** The rising prevalence of lung cancer necessitates the development of automated, accurate, and efficient detection techniques. Advances in AI, particularly deep learning, have revolutionized medical imaging, providing high-precision diagnostic tools that can significantly enhance the speed and accuracy of lung cancer detection [1].

**Role of Convolutional Neural Networks (CNNs):** CNNs have emerged as one of the most effective AI models for medical image analysis. They can automatically extract and learn hierarchical features from medical images, significantly outperforming traditional machine learning models like Random Forest and Support Vector Machines (SVMs) [1].

**Limitations of Traditional Methods:** While chest X-rays are a preliminary and cost-effective method for lung cancer detection, they are limited in detecting small nodules. CT scans are more effective, producing detailed cross-sectional images that facilitate accurate lung nodule detection. CT-guided lung biopsy is also used for histopathological analysis to confirm malignancy [1].

**Dataset Overview:** The study utilized a dataset comprising 220,025 RGB lung tissue images from Kaggle. However, the dataset was imbalanced, with only 41% of images being cancerous. To address this issue, downsampling techniques were applied, resulting in a final dataset of 160,200 training images and 17,800 validation images [1].

**Importance of Pre-processing:** Pre-processing plays a crucial role in optimizing input images for CNNs. The study involved resizing all images to 224×224 pixels to standardize input dimensions and normalizing pixel values to improve contrast and reduce noise, which are essential for enhancing model performance [1].

| Location Side: | Right | Left | Both |
|---|---|---|---|
| Site: | Upper<br>Middle<br>lower | Upper<br>Middle<br>lower | Bilateral |
| | Infectious<br>Pleura Effusion | Neuro Plastic Consolidation<br>Aspergilloma | Iatrogenic |
| Benign Cases | COPD<br>Fibrotic stands<br>Pneumonia | Fungal Ball<br>Emphysematous<br>TB Infection | Bronchiectasis<br>GGO<br>Cardiogenic<br>Metastasis |
| Specification | No bone Erosion<br>Cavity Interior | Well-defined<br>Mideastern Shift | Bulla<br>Collapsed |

**Table 1 - Benign Lung Lesion Description**

**Image Acquisition and Pre-Processing :** Image acquisition is the first and most critical step in automated lung cancer detection. High-quality images ensure better training and performance of deep learning models. The primary imaging techniques include:

**Chest X-ray:** A preliminary and cost-effective method but limited in detecting small nodules.

**CT Scans:** More effective than X-rays, producing detailed cross-sectional images that facilitate accurate lung nodule detection.

| Location Side: | Right | Left | Both |
|---|---|---|---|
| Site: | Upper<br>Middle<br>lower | Upper<br>Middle<br>lower | Bilateral |
| Abutting | Pleura | Mediastinum | Nil |
| Size | < 1cm | 1 – 3 cm | > 3cm |
| Margine | Smooth | Lobulated | Spiculated |
| Shape | Round | Irregular / Linear | Ovoid |
| Texture | Non-Solid / GGO | Part Solid Mixed | Solid |
| Tumor – Lung Interface | Coarse | Unclear | Smooth |

**Table 2 - Malignant Lung Lesion Description**

**CT-Guided Lung Biopsy:** Used for histopathological analysis, confirming malignancy.

The dataset used in this study comprises 220,025 RGB lung tissue images from Kaggle. However, the dataset was imbalanced, with only 41% of images being cancerous. To address this issue, downsampling techniques were applied, resulting in a final dataset of 160,200 training images and 17,800 validation images.

Pre-processing plays a crucial role in optimizing input images for CNNs. The following steps were performed:

**Resizing:** All images were resized to 224×224 pixels to standardize input dimensions.
**Normalization:** Pixel values were normalized to improve contrast and reduce noise.
**Edge Detection and ROI Localization:** Helps focus on nodules and eliminate irrelevant regions.
**Data Augmentation:** Techniques such as rotation, flipping, and contrast adjustments were applied to increase the diversity of training data.

Image acquisition and pre-processing are critical steps in the development of effective deep learning models for lung cancer detection. Here's a detailed overview based on the study:

**Image Acquisition:**
The study utilized a comprehensive dataset sourced from Kaggle, consisting of 220,025 lung tissue images. This dataset is essential for training convolutional neural networks (CNNs) to identify malignant and benign lung nodules effectively. The large volume of images helps in capturing a wide variety of lung tissue characteristics, which is crucial for model training and validation.

**Challenges with Dataset Imbalance:**
One of the significant challenges faced during image acquisition was the imbalance in the dataset, where only 41% of the images were cancerous. This imbalance can lead to biased model training, where the model may perform well on the majority class (non-cancerous images) but poorly on the minority class (cancerous images). To address this, downsampling techniques were applied, resulting in a balanced dataset of 160,200 training images and 17,800 validation images, which is vital for improving model accuracy and generalization.

**Pre-processing Techniques:**
Pre-processing is crucial for optimizing input images for CNNs. The following steps were performed:
**Resizing:** All images were resized to 224×224 pixels to standardize input dimensions. This uniformity is essential for ensuring that the CNN can process images consistently, as varying dimensions can lead to errors during training and inference [1] [2].
**Normalization:** Pixel values were normalized to improve contrast and reduce noise. Normalization helps in enhancing the quality of the images, making it easier for the CNN to learn relevant features without being affected by variations in lighting or other factors [3].
**Data Augmentation:** Techniques such as rotation, flipping, and contrast adjustments were applied to increase the diversity of the training data. Data augmentation is a powerful strategy to artificially expand the training dataset, helping to prevent overfitting and improving the model's ability to generalize to unseen data [4].

**CNN Model Architecture and Training :** The proposed CNN model employs a deep neural network constructed using the Keras Sequential API. The model processes input images using multiple convolutional and pooling layers, extracting low-level and high-level features for classification. The architecture consists of:
**Convolutional Layers:** Three layers with 32, 64, and 128 filters, each using a 3×3 kernel and ReLU activation.
**Max-Pooling Layers:** Applied after each convolutional layer to reduce spatial dimensions.
**Flattening Layer:** Converts multidimensional feature maps into a one-dimensional array.
**Fully Connected Layers:** A dense layer with 128 neurons using ReLU activation.
**Output Layer:** A single neuron using sigmoid activation for binary classification.

Transfer learning was also explored, utilizing pre-trained models such as VGG16 and Inception V3. The Inception V3 model, combined with a random forest classifier, showed superior performance. The Adam optimizer was employed for model training, with binary cross-entropy used as the loss function.

**Model Performance and Evaluation in Lung Cancer Detection**
The evaluation of the model's performance is crucial in determining its effectiveness in lung cancer detection. The study employed several metrics to assess the model's capabilities, which are outlined below:
**Accuracy:** The model achieved an impressive validation accuracy of 99.3%. This high accuracy indicates that the model correctly identified a significant majority of lung tissue images, demonstrating its potential for reliable lung cancer detection [1].

CT Scans: More effective than X-rays, producing detailed cross-sectional images that facilitate accurate lung nodule detection.

**Precision and Recall:**
The model exhibited high precision and recall rates. High precision means that when the model predicts a positive case (cancerous), it is likely correct, while high recall indicates that the model successfully identifies most actual positive cases. Together, these metrics reflect the model's reliability in distinguishing between malignant and benign lung nodules [1].
**F1-score:**
The F1-score is a harmonic mean of precision and recall, ensuring a balance between the two. This metric is particularly important in medical diagnostics, where both false positives and false negatives can have significant consequences. The model's F1-score indicates its overall effectiveness in making accurate predictions [1].
**Specificity:**
Specificity measures the model's ability to correctly identify

negative cases (non-cancerous). A high specificity rate suggests that the model minimizes false positives, which is crucial in clinical settings to avoid unnecessary anxiety and further testing for patients [1].

**Comparison with Traditional Classifiers:**
The CNN-based approach outperformed traditional classifiers such as Random Forest and Support Vector Machine (SVM) in terms of accuracy and generalizability. This suggests that the deep learning model is more effective in capturing complex patterns in the data, leading to better diagnostic performance. Additionally, the inclusion of dropout layers in the CNN architecture improved robustness and helped prevent overfitting, further enhancing the model's reliability [1].

**Precision and Recall:**
The model exhibited high precision and recall rates. High precision means that when the model predicts a positive case (cancerous), it is likely correct, while high recall indicates that the model successfully identifies most actual positive cases. Together, these metrics reflect the model's reliability in distinguishing between malignant and benign lung nodules [1].

**F1-score:**
The F1-score is a harmonic mean of precision and recall, ensuring a balance between the two. This metric is particularly important in medical diagnostics, where both false positives and false negatives can have significant consequences. The model's F1-score indicates its overall effectiveness in making accurate predictions [1].

**Specificity:**
Specificity measures the model's ability to correctly identify negative cases (non-cancerous). A high specificity rate suggests that the model minimizes false positives, which is crucial in clinical settings to avoid unnecessary anxiety and further testing for patients [1].

**Comparison with Traditional Classifiers:**
The CNN-based approach outperformed traditional classifiers such as Random Forest and Support Vector Machine (SVM) in terms of accuracy and generalizability. This suggests that the deep learning model is more effective in capturing complex patterns in the data, leading to better diagnostic performance. Additionally, the inclusion of dropout layers in the CNN architecture improved robustness and helped prevent overfitting, further enhancing the model's reliability [1].

**Conclusion on Deep Learning for Lung Cancer Detection**
The study presents significant findings regarding the application of deep learning techniques, particularly convolutional neural networks (CNNs), in the detection of lung cancer. Here are the key conclusions drawn from the research:

**High Accuracy:**
The proposed CNN model achieved a remarkable validation accuracy of 99.3% using a large dataset of 220,025 lung tissue images. This level of accuracy indicates the model's strong potential for reliable lung cancer detection, which is crucial for early diagnosis and treatment [1].

**Effectiveness of Image Processing:**
The study emphasizes the importance of image processing techniques, such as resizing and normalization, in enhancing the quality of input data. Resizing images to 224×224 pixels standardizes the input dimensions, while normalization improves contrast and reduces noise, contributing to better model performance [2] [3].

**Role of CT Scans:**
The research highlights that CT scans are more effective than traditional X-rays for detecting lung nodules. They provide detailed cross-sectional images that facilitate accurate diagnosis, underscoring the importance of advanced imaging techniques in conjunction with AI models [4] [5].

**Future Directions:**
The study discusses potential future advancements, including the integration of additional CNN layers and real-world clinical validation. These developments could further enhance the model's performance and usability in clinical settings, making AI-driven lung cancer detection a promising approach for improving patient outcomes [1].

**Clinical Implications:**
The findings suggest that AI can significantly improve diagnostic efficiency in lung cancer detection. By leveraging deep learning models, healthcare professionals can enhance early diagnosis, leading to better treatment options and improved patient care.

**References**

[1] Prashanthi, B. and Claret, S.A., 2024. Lung Nodule Detection For CT-Guided Biopsy Images Using Deep Learning. Journal of Applied Engineering and Technological Science (JAETS), 5(2), pp.909-924.

[2] Abd Al-Ameer, A.A., Hussien, G.A. and Al Ameri, H.A., 2022. Lung cancer detection using image processing and deep learning. Indonesian Journal of Electrical Engineering and Computer Science, 28(2), pp.987-993.

[3] P. de Groot and R. F. Munden, “Lung cancer epidemiology, risk factors, and prevention,” Radiologic Clinics of North America, vol. 50, no. 5, pp. 863–876, 2012, doi: 10.1016/j.rcl.2012.06.006.

[4] S. S. Ramalingam, T. K. Owonikoko, and F. R. Khuri, “Lung cancer: New biological insights and recent therapeutic advances,” CA: A Cancer Journal for Clinicians, vol. 61, no. 2, pp. 91–112, Mar. 2011, doi: 10.3322/caac.20102.

[5] L. A. Torre, R. L. Siegel, and A. Jemal, “Lung cancer statistics,” in Lung Cancer and Personalized Medicine, vol. 893, 2016, pp. 1–19.

[6] E. A. Zang and E. L. Wynder, “Differences in lung cancer risk between men and women: examination of the evidence,” JNCI Journal of the National Cancer Institute, vol. 88, no. 3–4, pp. 183–192, Feb. 1996, doi: 10.1093/jnci/88.3-4.183.


IITPL
Made in India For the World
PREMIER
elite
Experience the Unmatched Flexibility of
Operating Space and Deepest Angles on a
Floor Mounted Cath Lab
COMING SOON
IITPL'S LATEST AND MOST ADVANCED CATH LAB
+/-120 Gantry Movement Provides Unmatched Space Optimization Enabling a Wide Range of Cardiac, Neuro, and Peripheral Vascular Procedures
3 MHU Grid Controlled Liquid Metal Bearing Tube
100 KW High Frequency X-Ray Generator
43" Medical Grade Monitor for Sharper and Consistent Image Quality
Backed by Superlative Software Intelligence, Real-Time Stent Enhancement Saves Precious Procedural Time and Facilitates Clinical Judgement for Optimal Stent Placement
Optional OCT/IVUS Co-registration with any Brand of IVUS and OCT Equipment
Optional Virtual FFR Integration Capabilities
Contact us:
Innovation Imaging Technologies Private Limited
Manufacturing Unit: #121F, Bommasandra Industrial Area, Phase 1, Hosur Main Road, Electronic City, Bangalore-560099, Karnataka, India
R&D Center: #B-705, Baner Bizbay, 110/11/23, Baner Road, Baner, Pune-411045, India
Sales : +91-63648 82806 | Service : +91-63648 82820 | Mail : pinnacle@innvolution.in | Website : innvolutionimaging.com


## Advertising in Radiographers' Journal

Advertise your business or market your product on "Radiographers' Journal" - monthly ebulletin.

Radiographers' Journal is circulated electronically to thousands of Radiographers across the globe and posted on Social media platforms.



Mobile: +91 93220 35920
Email: shankar.bhagat@gmail.com
Website: www.radiographers.org

### Monthly Tariff for Advertisement

- Full page - Rs. 3000/-
- Half page - Rs. 1500/-
- Quarter page. - Rs. 1000/-

For **yearly subscription of advertisement 50% discount in above charges**

To book your advertisement call on **+91 9322035920**