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The Evolution of Electronic Cropping in Digital Radiography: A Paradigm Shift in Collimation

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Introduction:
Breast cancer remains a significant global health concern, with early detection being paramount for successful treatment outcomes. Traditional screening methods, such as mammography, have limitations, especially in dense breast tissue or in detecting small lesions. Recent advancements in medical imaging, particularly the integration of ultrasound (US) and magnetic resonance imaging (MRI), offer promising solutions to enhance the accuracy of breast cancer detection. This review aims to explore the efficacy and advantages of combining US with MRI in identifying cancerous lesions within breast tissue.

US and MRI:
Complementary Imaging Modalities Ultrasound imaging utilizes high-frequency sound waves to generate real-time images of breast tissue. It is non-invasive, readily available, and cost-effective, making it a valuable tool in breast cancer diagnosis. However, its efficacy is limited in differentiating between benign and malignant lesions, especially in dense breast tissue.

On the other hand, MRI provides high-resolution, multi-dimensional images of breast tissue by utilizing a magnetic field and radio waves. It offers superior soft tissue contrast and is highly sensitive in detecting small lesions. MRI is particularly advantageous in screening high-risk individuals and assessing the extent of disease.

Combining US with MRI:
Enhanced Diagnostic Accuracy Several studies have demonstrated the synergistic benefits of combining US with MRI in breast cancer detection. By integrating the real-time visualization of US with the detailed anatomical information provided by MRI, radiologists can achieve a comprehensive assessment of suspicious lesions.

The complementary nature of these modalities is evident in various aspects of breast imaging. US excels in identifying microcalcifications and assessing lesion vascularity, while MRI offers detailed morphological information and evaluates the surrounding tissue for additional lesions. The combination of both modalities allows for more accurate characterization of lesions, leading to improved diagnostic confidence.

Clinical Applications and Impact on Patient Care:
The integration of US and MRI has significant implications for patient care and management. In cases where mammography or clinical examination yield inconclusive results, combining US with MRI can provide additional information for guiding biopsy decisions and treatment planning. Furthermore, this approach reduces the need for unnecessary biopsies by accurately identifying benign lesions, thus minimizing patient anxiety and healthcare costs.

Moreover, the enhanced sensitivity of combined US and MRI facilitates early detection of breast cancer, leading to improved prognosis and survival rates. This is particularly crucial for high-risk populations, such as individuals with a family history of breast cancer or those with dense breast tissue.

Conclusion: In conclusion, the integration of ultrasound with MRI represents a significant advancement in breast cancer detection. By harnessing the strengths of both modalities, radiologists can achieve higher diagnostic accuracy and confidently differentiate between benign and malignant lesions. This synergistic approach not only improves patient outcomes but also streamlines healthcare resources by reducing unnecessary interventions. Moving forward, further research and technological innovations in breast imaging will continue to enhance our ability to detect and treat breast cancer at its earliest stages.

This review highlights the importance of adopting a multimodal imaging approach in breast cancer diagnosis and emphasizes the transformative impact of combining ultrasound with MRI in clinical practice.


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National CME
Organised by: SIR Telangana State Chapter
at NIMSME Auditorium, Hyderabad on 10th March 2024

The Society of Indian Radiographers Telangana State Chapter has conducted a National level CME in commemoration of the eminent radiologist, the former director NIMS late Prof. Padmasri Kakarla Subbarao on 10.03.2024 at NIMSME, Hyderabad. The Director NIMS, Dr. Bheerappa Nagari has attended as the Chief Guest and inaugurated the CME. Students from various states have participated in the competition and Ms. Ravi Revvaty of M.Sc Radiology Imaging Technology student of Govt. Kilpauk Medical College & Hospital Chennai has won the Prof. Kakarla Subbarao Best Scientific Paper Award 2024. Mr. K. Srisailam Retd Sr. Radiographer from Telangana has been honored with Prof. Kakarla Lifetime Achievement Award 2023 on this occasion. Dr. Vijay Kumar Kuthala, the Chairman of State Allied Healthcare Professionals Council, Mr. Vilas B Badhane President SIR and Mr. Jagadish N Jagtap, the Secretary General have attended as Guests of Honor.

Mr. Srinivasulu Siramdas, the CEO of SIR and General Secretary of Telangana State Chapter, Mr. Damodara Naidu Koti, the Director Academics, SIR and President Telangana State Chapter have also taken part in the event. Mr. M.A Waris was the Organizing Secretary and Mr. Mahesh Basaveni was the Program Coordinator for the national CME.

About 400 delegates across the country participated in the event. The Scientific Programs with informative Guest lectures, Student Presentations and Cultural Programs performed by the children attracted the audience.








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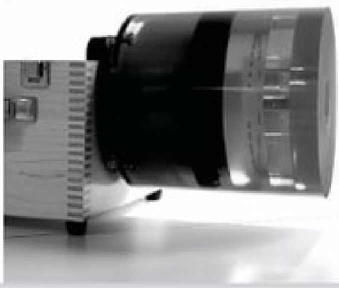

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How to choose the right Digital X-ray System

Ramesh Sharma, Retd. Chief Technical Officer, Radiology –NCI-AIIMS, New Delhi

A Digital Radiography (DR) system is a significant and an integral part of a medical imaging system to give better workflow. It is a highly efficient system that can render an image preview in 5-10 seconds. Choosing the right DR system is instrumental in improving a radiographer's efficiency as it offers highly advanced imaging applications for better disease diagnosis and patient care. Furthermore, digital detector systems for projection radiography have been prevalent for several years and their use is increasing day by day. Digital detectors are now becoming clinically common as they are equipped with the implementation and deployment of Picture Archiving and Communication Systems (PACS) in medical and radiology enterprises.

While choosing a DR system to install in facility, here are two things one needs to do:

- Examine clinic's requirements.
- Check the different attributes in models available in the market.

Consider this: Emergency care facilities need to serve non-ambulatory patients and require mobile diagnostic imaging equipment; so only a fixed DR system would not serve their purpose well. In such facilities, if budgets are not scarce, both a mobile and fixed imaging system should be planned.

In addition to the above two factors, one should take out time to stay updated with technological innovations and their applications so that they can choose a digital radiography system, which is best suited for the intended application.

The most important point here is not to base the decision to choose a system solely on the price, but on the return on investment, it is going to offer you in the long term.

Here are three kinds of DR systems to choose from for a medical facility:

- Fixed (Ceiling suspended/ceiling free/floor to ceiling) DR systems.
- Mobile DR systems (Motor driven/manual).
- Portable DR systems.

Fixed DR systems (ceiling suspended/ceiling free/floor to ceiling)

A fixed X-ray DR system needs a dedicated room for its installation. It has a generator, tube stand, examination table and chest stand which requires a full room. The fixed system also needs a high-power AC line (440V) in the room.

The room cannot serve any purpose other than imaging. As such fixed radiography systems prove most useful for large corporate/government hospitals and research institutes and diagnostic centers.

There are three kinds of fixed DR systems -ceiling suspended, ceiling free and floor to ceiling digital X-ray systems. They are helpful in different general radiographic applications due to various favorable features improving clinical workflow. In general, these features are as under:

- Digital touch display on tube stands for various parameters and selections.
- DAP reading dose with a display on the software screen.
- High image quality with fine pixels and high contrast range.
- Image post-processing feature for easy workflow management.
- High-resolution 3K x 3K detector with DICOM 3.0 Compatibility.
- Easy to connect with existing HIS/HMS/RIS/PACS in a hospital environment.

Here's a sneak peek into the prominent features of the three types of fixed DR systems.

a) Ceiling suspended DR system: The ceiling-suspended (single/dual FPD) digital system gives maximum flexibility and clinical productivity suited for all-purpose radiography. This is an integrated system combining the modern technology of a high-frequency X-ray generator with flat panel technology for direct digital acquisition, making it both operator and patient-friendly. As the tube stand is ceiling suspended, it saves floor occupancy giving free space to the operator. This leads to enhanced convenience.

The high-frequency X-ray generator provides optimal image quality and productivity with DR solutions. Its X-ray tube provides manual overhead movements with electromagnetic brakes, including: 1) Angulations 2) Overhead rotation 3) Vertical, longitudinal and transversal movements.

A ceiling suspended system digital radiography system may also be equipped with auto tracking/auto positioning features, proving helpful for general and specialized radiography applications.

b) Ceiling-free DR system: Ceiling-free systems are digital radiography systems specialized models for general radiographic applications. These systems feature the X-ray tube head mounted on a ceiling free stand, a single detector embedded in the movable detector stand housing, a mobile table, and a high-frequency X-ray generator per user-intended applications.

c) Floor-to-ceiling DR systems: They are systems comprising high-frequency X-ray generators per user requirements for different functions with floor-to-ceiling tube stands. They are available in single/dual FPD systems. The flat panel detector/detectors in such a system provide comprehensive imaging solutions to handle an increased workflow. All DR systems are DICOM compliant and provide fast and wireless image transfer to PACS. The power and capacity serve different modality requirements and can go up to 1000 mA and 150 KV.

Mobile DR systems: Mobile X-ray machines have adequate output to deliver good-quality radiographs. Wheel mounting makes mobile X-ray machines convenient to move on smooth or level surfaces within the radiology section or even from the radiology section to emergency, ICU wards, etc. These machines need a 15 A socket for operation. They are a great solution for imaging non-ambulatory patients who cannot move easily. Mobile X-ray machines provide the advantage of giving better access due to its mobility and do not need lead shielding in the walls of the room.

Mobile DR systems features: There are prominent benefits of mobile radiography systems.1) Lightweight and compact (in the range of 4.2 KW to 30 KW) .2) Allows swift examinations 3) Render HD digital images 4) Have HF-ray generators with variable power range as per user-intended applications. Both manually operated and battery-powered mobile digital radiography systems with motor-assisted noise-free movements are available.

Portable DR systems: Portable DR systems prove a top-notch tool for patient diagnosis and monitoring requiring more mobility, for example: Intensive care units, home care, Nursing homes This kind of equipment is most useful for low-volume or small startup facilities. Using portable DR machines does not need lead shielding in the walls, similar to Mobile DR systems. Portable DR systems can start operations with minimal or zero construction costs. Portable DR Machines have an intuitive and practicable design integrated with FPDs and PACS systems. High-quality images acquired with these machines can be easily transferred to a laptop and can be sent to a medical facility. The portable DR machine substantially lowers the time and expenses involved in film processing in dark rooms, especially in emergency vehicles.

Other important considerations to choose the right DR machine.

The other key considerations while choosing a highly suitable DR machine for your facility, include a) Costs and financing b) Right technology c) Right manufacturer d) Reliable service support Overall, a DR system will help in rapid processing and high-image-quality formation.

Make sure you only go for a manufacturer with a great market reputation that uses the latest technology for manufacturing high-quality products, expert installation advice and team, regular staff training, prompt service back and customer support after the purchase.

Last but not least, decide what budget you want to set apart to purchase DR system.

Advancements in Radiomics and Radiogenomics: Transforming Oncology Through Imaging and Genetics

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Abstract:
Radiomics and radiogenomics represent cutting-edge fields in oncology that leverage advanced imaging techniques and genomic insights to revolutionize cancer diagnosis, prognosis, and treatment. Radiomics involves the extraction and analysis of quantitative features from medical images, offering valuable insights into tumor biology and patient outcomes. Radiogenomics integrates imaging data with genomic information to unravel the genetic underpinnings of disease and its correlation with imaging features. This abstract provides an overview of the principles, applications, and future directions of radiomics and radiogenomics in oncology, highlighting their potential to advance precision medicine and improve patient care.

In the dynamic landscape of medical imaging and oncology, the integration of radiomics and radiogenomics has emerged as a transformative approach to understanding and treating cancer. These rapidly evolving fields harness the power of advanced imaging techniques and genomic data to unlock new insights into disease biology, prognosis, and treatment response.

Radiomics: Deciphering the Language of Medical Images
Radiomics, a computational discipline at the forefront of medical imaging, delves into the intricate quantitative features latent within images procured from diverse modalities such as CT scans, MRI, and PET scans. These features, including texture, shape, intensity, and spatial relationships, constitute the essence of radiomics, unveiling nuanced information imperceptible to the human eye. Employing sophisticated computational algorithms and machine learning techniques, radiomics endeavors to decode the language embedded within medical images.

In the realm of oncology, radiomics emerges as a transformative asset with multifaceted applications. From facilitating cancer diagnosis and subtyping to offering prognostic insights and gauging treatment response, radiomics stands as an indispensable adjunct to the oncologist's toolkit. Through meticulous analysis of radiomic features, clinicians adeptly distinguish between various cancer types and subtypes, prognosticate patient outcomes, monitor the efficacy of treatments, and customize therapeutic approaches tailored to the unique characteristics of individual tumors.

The pivotal role of radiomics in oncology underscores its significance as a paradigm-shifting discipline, empowering clinicians with precise diagnostic and prognostic tools to optimize patient care. As radiomics continues to evolve, fueled by advances in computational methodologies and imaging technologies, its potential to enhance precision medicine in oncology remains boundless. Embracing the insights unearthed by radiomics, clinicians are poised to navigate the complexities of cancer treatment with heightened precision and efficacy, ultimately fostering improved outcomes and quality of life for patients grappling with the challenges of cancer.

Radiogenomics: Bridging Imaging with Genetics
Radiogenomics stands at the forefront of medical research, bridging the realms of imaging and genetics to unravel the intricate genetic underpinnings of disease and their correlation with imaging features. Through the amalgamation of imaging data with genomic insights, radiogenomics seeks to elucidate the biological mechanisms steering disease progression and influencing treatment response.

At its core, radiogenomics endeavors to establish associations between imaging phenotypes and the underlying genetic alterations that dictate disease pathogenesis. By deciphering these intricate connections, researchers aim to unlock novel avenues for personalized treatment strategies in oncology and beyond.

The applications of radiogenomics are as diverse as they are promising. From the discovery of biomarkers to predictive modeling and therapeutic targeting, radiogenomic studies hold profound implications for patient care. By integrating data from radiomics and genomics, clinicians can refine predictive models for patient outcomes, identify imaging-based biomarkers that herald treatment response, and unravel the complexities of tumor heterogeneity across spatial and temporal dimensions.

The potential of radiogenomics to transform personalized medicine in oncology is undeniable. As research in this burgeoning field continues to evolve, fueled by advancements in computational methodologies and genomic technologies, its impact on clinical practice is poised to expand exponentially. Embracing the insights gleaned from radiogenomics, clinicians are empowered to navigate the intricacies of disease with newfound precision, offering tailored treatment approaches that resonate with the unique genetic makeup and imaging profile of each patient. In doing so, radiogenomics heralds a new era of patient-centered care, where the convergence of imaging and genetics illuminates the path towards improved outcomes and enhanced quality of life for individuals grappling with the complexities of disease.

Harnessing the Power of Radiomics and Radiogenomics for Precision Medicine

The integration of radiomics and radiogenomics marks a pivotal advancement in the realm of precision medicine, reshaping our approach to disease characterization and treatment guidance. Through the synergistic fusion of non-invasive, quantitative methods with insights gleaned from imaging and genetics, clinicians are poised to usher in a new era of enhanced patient outcomes and refined therapeutic efficacy, transcending the boundaries of oncology and extending to diverse fields of medical practice.

At its essence, this integration empowers clinicians with a comprehensive understanding of disease pathology, enabling nuanced insights into individual patient profiles that were previously inaccessible. By leveraging the wealth of information offered by radiomics and radiogenomics, clinicians are equipped to tailor treatment strategies with unprecedented precision, aligning interventions with the unique characteristics of each patient's disease.

In the domain of oncology, this synergy holds transformative potential. From the initial stages of diagnosis and disease subtyping to the ongoing monitoring of treatment response and prognosis, radiomics and radiogenomics serve as invaluable allies, guiding clinicians through the intricate landscape of cancer care with heightened clarity and precision.

Beyond oncology, the implications of this integration reverberate across diverse medical specialties. From neurology to cardiology, radiomics and radiogenomics offer a paradigm shift in our understanding of disease processes and treatment paradigms, paving the way for personalized interventions that resonate with the individual needs and complexities of each patient.

As research in radiomics and radiogenomics continues to burgeon, fueled by technological advancements and interdisciplinary collaboration, the future of precision medicine shines brightly. Embracing the insights offered by these innovative approaches, clinicians are poised to embark on a transformative journey towards optimized patient care, where the convergence of imaging and genetics illuminates the path towards improved outcomes, enhanced therapeutic efficacy, and ultimately, a future where precision medicine is not just a vision, but a tangible reality.

Conclusion:

In conclusion, radiomics and radiogenomics have emerged as powerful tools in the oncologist's toolkit, offering novel insights into cancer biology and treatment response. Through the extraction of quantitative imaging features and integration with genomic data, these interdisciplinary approaches hold promise for personalized treatment strategies and improved patient outcomes. The ability to decipher the complex interplay between imaging phenotypes and genetic alterations opens new avenues for precision medicine in oncology and beyond. As research in radiomics and radiogenomics continues to evolve, collaboration among clinicians, radiologists, and computational biologists will be key to unlocking their full potential in guiding clinical decision-making and transforming cancer care.

Future Directions:

Looking ahead, the future of radiomics and radiogenomics holds immense potential for further advancements in oncology and medical imaging. Key areas for future research include the refinement of computational algorithms for feature extraction and analysis, the validation of radiomic and radiogenomic biomarkers in large-scale clinical trials, and the development of standardized protocols for data acquisition and analysis. Additionally, efforts to integrate multi-omics data, including transcriptomics, proteomics, and metabolomics, will enhance our understanding of tumor biology and treatment response. Collaboration across disciplines, the sharing of data and resources, and the adoption of open science principles will drive innovation and accelerate the translation of radiomics and radiogenomics into clinical practice. Ultimately, by harnessing the synergistic potential of imaging and genetics, radiomics and radiogenomics will play a pivotal role in shaping the future of precision oncology, guiding personalized treatment strategies, and improving outcomes for patients with cancer.

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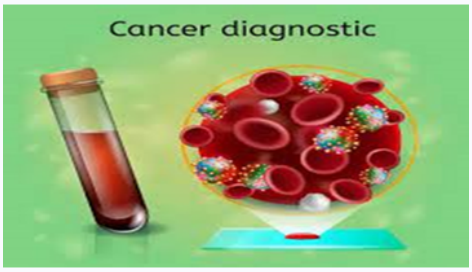
And one more thing, we have conveyed this issue to you, as an enlightened Radiographer, now it is your responsibility to forward this issue to other Radiographers.

Thanks in advance,
Editor

Tumor Markers – A Diagnostic Tool

Priyanka Vinod Mishra, Homi Bhabha Cancer Hospital/Mahamana Pandit Madan Mohan Malviya Cancer Centre, Varanasi. A Unit Of "Tata Memorial Hospital", Mumbai



Introduction

Tumor markers are present in or produced by cancer cells or other cells of the body in response to cancer.

It provides information about cancer such as

1. How aggressive it is?
2. What kind of treatment it may respond to?
3. Whether it is responding to treatment?

Tumor markers have traditionally been protein /other substances that are made at higher amounts by cancer cells than normal cells.

They are found in blood, urine, stool, tumors /other tissues / body fluids.

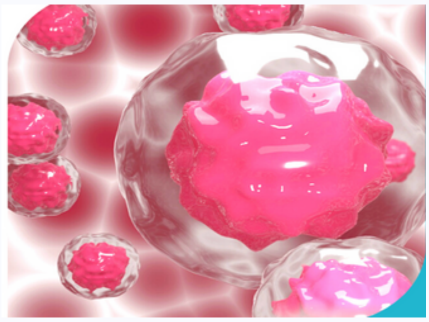
Measurable biochemicals associated with malignancy.

Advantages

- Marker may be a way of monitoring success/failure of treatment.
- May reflect the extent (stage) of disease.
- Screening & early detection of cancer.
- Aid in the diagnosis of cancer.
- Determine response to therapy.
- Prognostic indicator of disease progression.
- Indicate relapse during follow-up period.

Disadvantages

- Deduce diagnostic patterns due to biological variability in an individual patient sample.
- Huge range of biomarker concentrations in all patients compared.
- Differences in sample collection, handling or storage & profiling techniques among various research sites may change the protein profile.



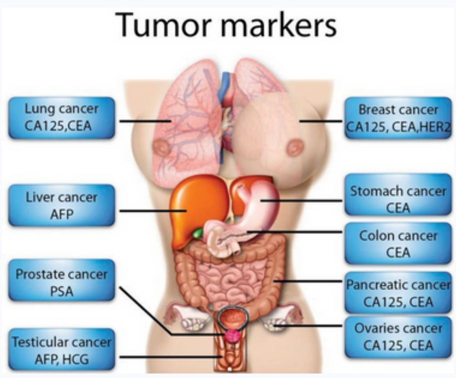
Major problems:

In identification of cancer biomarkers is very low concentration of markers obtained from tissues with small, early-stage cancer lesions.

Other problems:

- Lack of reliability
- Variability of proteins / modified proteins among individuals.
- Not always present in early - stage cancers.
- Can be present because of non-cancerous conditions.
- People with cancer may never have elevated tumor markers in their blood.
- Not specific enough to confirm the presence of cancer.

Some examples:



Carcinoembryonic Antigen (CEA)

- Produced by embryonic tissue of gut, pancreas & liver.
- Complex glycoprotein elaborated by many different neoplasms.

Serum level is positive in –

1. 60 - 90% (Colorectal Carcinoma)
2. 50 - 80 % (Pancreatic Carcinoma)
3. 25 - 50 % (Gastric & Breast Carcinoma)

- CEA is elevated in many benign disorders.

1. Alcoholic cirrhosis
2. Hepatitis
3. Ulcerative colitis
4. CEA lacks both sensitivity & specificity required for detection of early cancers.

Prostate- Specific Antigen & Prostate –Specific Membrane Antigen (PSA)

- Detects prostate cancer.

Human Chronic Gonadotropins (HCG)

- Detects testicular tumors.

CA 125

- Detects ovarian cancer.

Proteins

- Detection of 4 proteins 14, CD59, PROFILIN 1, CATALASE) in the saliva of cancer patients
- Has been found to be useful markers of oral cancer= 90 % sensitivity
- Specificity for oral squamous cell carcinoma = 83 % specificity

Mitochondrial Markers

- Several mutations in the mt DNA particularly in d-loop region have been found in breast, colon, esophageal, endometrial, head & neck, liver, kidney, leukemia, lung, melanoma, oral, prostate & thyroid cancers.

Role of Dual Energy CT to analyse Bone Marrow Edema in Acute Fracture

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Moderator: Dr.S.Tamijeselvan. Ph.D., Asst. Professor in Radiography, MTPGRIHS

Introduction:

MRI is considered the standard for depicting nondisplaced fractures, as it is sensitive for associated bone marrow edema (BME). Despite its excellent diagnostic performance, there are several barriers to performing MRI in the emergent setting because of cost, access limitations, the need to thoroughly screen patients, a relatively lengthy examination, and incompatibility with some pacemakers and other implants. In such cases the dual energy CT can be used for imaging. Dual-energy CT has emerged as a valuable imaging modality in the assessment of acute fracture particularly in the evaluation of bone marrow oedema in the current scenario. Visualization of bone marrow oedema can be used to identify occult or mildly displaced fracture or pathological fracture.

Principle:

Dual-energy CT acquires data with two different X-ray energy spectra and can help differentiate materials based on their differential energy-dependent X-ray absorption behavior. The virtual non-calcium (VNCa) technique can be used to suppress the high attenuation of trabecular bone, thus enabling visualization of subtle changes in the underlying attenuation of the bone marrow. Dual-energy CT is increasingly used in emergency and trauma patients for early diagnoses of acute conditions. This technique is mostly used to detect fractures in long bones, carpal bones, vertebral compression fractures, and knee and hip fractures. The dual-source dual-energy systems we used acquire data using a low-energy x-ray source between 70 to 100 kVp and a high-energy x-ray source at 140 or 150 kVp with an added tin filter to reduce the low-energy components of this spectrum to reduce spectral overlap and improve spectral separation between the high- and low-energy spectra.

Image Acquisition, Processing and Data Extraction

The Image acquisition, processing and data extraction of Dual CT is illustrated in the below diagram.

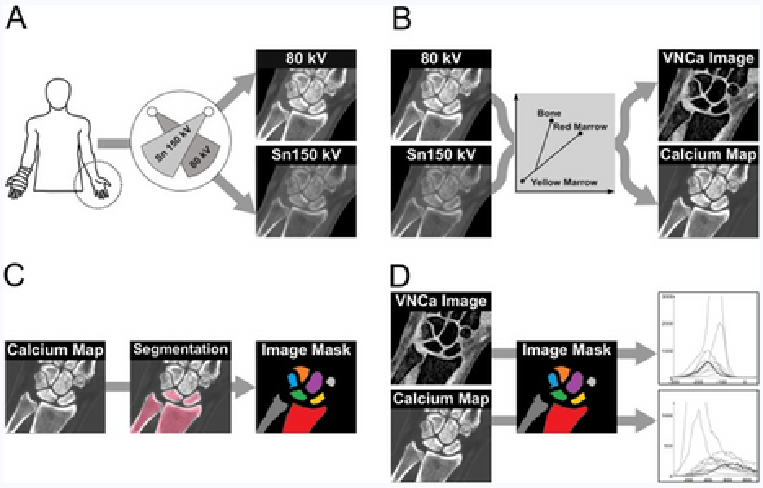
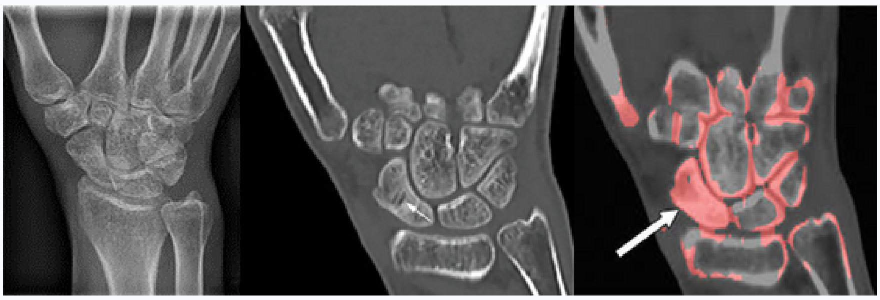


Image acquisition, processing and data extraction.

(A) Patients with a suspected wrist fracture not visible on x-ray are scanned using a dual source dual energy scanner resulting in two scan series (80 kV and Sn150kV). Both the affected wrist and the contra lateral healthy wrist are scanned, but data from the affected wrist not analyzed in this study. The two-scan series are subjected to a three-material decomposition (B) resulting in both a Calcium Map and a virtual non-calcium (VNCa) image. Based on the Calcium Map each bone is semi-automatically segmented (C) and segmentation masks for each bone created. The distribution of VNCa and calcium values is then automatically recorded (D) based on the individual segmentation mask of each bone.

Case 1

A 25-year-old man with a fall on outstretched hand injury was diagnosed with non-displaced fracture at the scaphoid waist, consistent with color coded virtual non-calcium dual energy.



Scaphoid waist fracture clearly seen, consistent with color coded virtual non-calcium dual energy.

Conclusion:

The dual energy CT with virtual non calcium imaging algorithm is a promising technique to demonstrate bone marrow edema in acute fracture. It's a short scanning time, no contraindication and availability in the emergency department DECT can be an effective alternative to Magnetic resonance imaging (MRI) in the detection of bone marrow edema.

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Role of Mammography in Detection of Breast Cancer

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This is the article which is going to give basic idea and explanation about the Crucial Role which a Mammography nowadays plays for the early detection of Breast cancer due to increase cases of Breast Cancer in the Current few years.

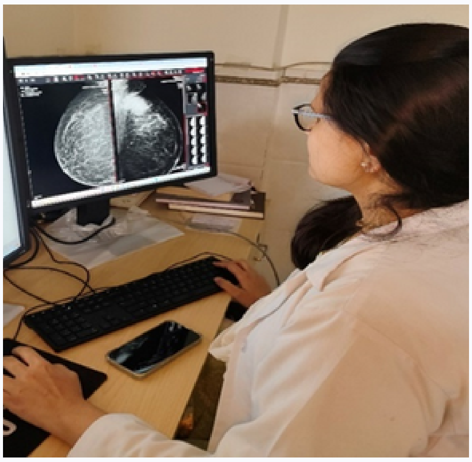
Overview of U.K Breast Screening:
If we see the previous records of U.K, it shows the highest incidence of mortality and occurring of Breast Cancer in the world in 1985, Breast Cancer is the commonest form of Cancer in the U.K which is affecting 1 of 12 women.

By keeping this high record in the eyes ,the Forrest Report in 1986in U.K recommended that all females between the age of 50yrs to 65yrs should be screened in every three years because Screened Mammography was advocated as the preferred method for early detection of Breast Cancer and on demand Screening was also available to women over 65yrs of age and routine Screening was extended to age of 70yrs and ,it had been recognized for some years that if Cancer were detected at a time when they were too small and early treatment initiated, then prognosis could be improved.

And in,1986, According to Forrest Report, it was suggested that mortality could be reduced 30% to 40%with the early screening.

Overview of India Breast Screening: -
In India, Breast Cancer is the most common type of Cancer which accounts for 14% of Cancer in Indian women and It is reported that with every 4minute, an Indian Women is diagnosed with the Breast Cancer in both Rural and Urban Areas.

If we see the Statics of 2018Report 1,62,468 new Cases of Breast Cancer are registered from which 87,090 are reportedly dead because Cancer survival becomes more difficult in



higher stages of its growth and more than 50%of Indian Women suffer from stage 3 and stage 4 of Breast Cancer.

Post Breast Cancer survival for Indian Women is 60%which is 80%in U.K and the very known reason for a low breast cancer survival rate in India is due to the lack of awareness and poor early screening as well as diagnosis rates and the number of detections could only get changed if awareness got increased.

In India, Kerala State shows highest Cancer rates along with Mizoram, Haryana, Delhi and Karnataka.

Breast Cancer shows its appearance more in the younger age group and it is about 50%in the age group from 25yrs to 50yrs and among them 70% of cases had poor survival and high mortality till it gets diagnosed.

What is the Actual meaning of Mammography?
So, it is basically a specialized medical procedure used primarily for the early detection of Breast Cancer with the help of Mammography machine, which generally emits a low doses of x rays to capture images of a Breast tissue and such images are called a mammogram which provides the detailed visualizations of the internal structure of the Breast which can clearly shows the abnormalities or changes that may indicate the presence of cancerous or precancerous cells.

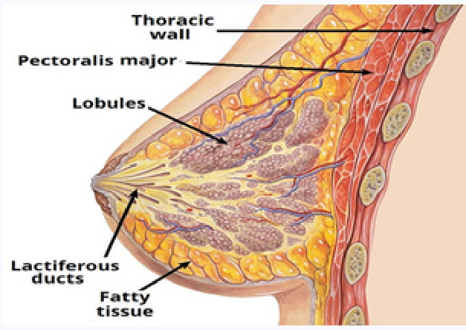
During the Mammography procedure, the Breast is gently compressed between the two plates to spread out the Breast tissue, which helps to obtain clear and accurate images, the compression could cause some discomfort to the patients, but it ensures that the images should be of highest quality.

Mammography can detect tumors that are too small to be felt during a physical examination.

In Screening Purpose: -
We generally do the screening in those patients in which there are chances of ok occurrence of Breast Cancer is high for e.g. Family History and mostly done in the asymptomatic patient.

In Diagnostic Purpose: -
Mammography is used for diagnostic purpose in such cases where there are symptoms such as a lump, breast pain or nipple discharge is present.

General Anatomy of Female Breast: -
The Breast is one of the Accessory organs of the female reproductive system, the adult breast composite two rounded eminences situated on the anterior and lateral wall of the chest, lying superficially to the pectoral muscles and separated from them by areolar tissue. They mainly extend from the second to the sixth rib s and from the lateral border of the sternum of the mid-axillary line.



- The nipple is the Conical projection just below the center of the Breast, corresponding approximately to the 4/5th intercostal space.

- The Breast is Composed of glandular, Fibrous and areolar tissue and its shape, size and consistency vary significantly, depending on the patient size, shape and age.
- Each breast is consisting of 15-20 lobes each of which is divided into several lobules and these lobules comprise large number of secretary alveoli, which drain into the single lactiferous duct of each lobe, before converging towards the nipple into the ampulla before opening into the surface.
- The blood supply is derived from branches of axillary, intercostal and internal mammary arteries.
- With Increasing age and especially after the menopause, the glandular element of the breast become less prominent and tend to be replaced by adipose tissue and fat attenuates the beam less than a glandular Breast tissue as a result fatty breast is darker and younger breast tissue is whiter (dense).

Preparation of Patient: -

- Wear a two-piece outfit along with loose clothing.
- Avoid deodorant, perfume, talcum powder or lotion under arms or breasts as they may appear on the mammogram and interfere with the correct diagnosis.
- Patient is asked to bring histopathological report if done before procedure for clinical correlation.

Indications: -

- Breast Cancer
- Breast lump.
- Nipple discharge.
- Focal Breast pain tenderness.
- Follow up for previously evaluated Mammographic finding.

Contraindication: -

- Breast implant.
- Inflammation.
- Women within reproductive age(15-40yrs).
- Pregnancy.
- Active Collagen Vascular disease.
- Prior Radiation therapy to chest / mediastinal.

Procedure: -

- Women stands in front of an x-ray machine.
- Breast is placed on a plastic plate.
- Another plate presses the breasts firmly from above.
- Breast is flattened due to the plate (women in this step feels some pressure which can cause some pain or comfortability, but it lasts only for some moment)
- To obtain the side view of breast, these steps are repeated, and the x-ray image of the other breast is also taken in the same way.

Specific features of Mammographic procedure: -

- Exposure factor kept between 25 to 35 kVp with at least 100mA.
- Radiographic Device-Specially designed with Mb, Rh, W Anode Material.
- Focal spot size-~0.6mm
- Total filtration -0.03mm Mb,0.5mm Al equivalent.
- Film / Screen Combination -High Resolution film/screen combination.
- FFD-~60cm.
- Exposure time-~ 2second.
- Breast Compression -200N or which a woman can tolerate.

Views taken in Mammography: -

- 45° medio-lateral oblique.
- Cranio-Caudal view

Steps which can reduce the mortality rate due to breast cancer around the worldwide: -

- **R**egular Screening Mammography in the age group between 50yrs to 70 yrs.
- Self-Breast examination.
- (Steps to do self-breast examination)
- Stand in front of a mirror &look for any changes in both breasts.
- Have look, feel or measure the size of the breast, breast swelling.
- Dimpling or puckering of the skin.
- Change in the look or feel of the nipple or discharge from the nipple.

Conclusion: -

Mammography plays a crucial role in breast health management, by providing healthcare providers with valuable information to detect and monitor breast abnormalities, ultimately leading to the improved patient outcomes and survival rates, along with this various measures should be taken related to the awareness of the breast cancer specially in the rural areas and how they can do self-Breast examination at home by themselves and could avoid the occurrence of breast cancer after they turned 30.

Prevention is a step away from cure, So, Be Aware, Be Prepared.

Reference: -

- PubMed.
- Clarks Positioning in Radiography.
- Various Survey Reports.

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

Magnetomotive Ultrasound: An Emerging Modality

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The development of molecular imaging is considered one of the interesting trends in the field of medical imaging, which provides the molecular basis of disease rather than anatomical changes. In clinical routine, PET (Positron Emitting Tomography) and SPECT (Single Photon Emission Computed Tomography) are used for molecular studies that use radioactive tracers and ionizing radiation, which expose patients and staff.

Magnetomotive ultrasound is an emerging technique that is a type of molecular ultrasound imaging that uses superparamagnetic iron oxide nanoparticles as the primary contrast agent. Magnets produce an external magnetic field, which induces motion in nanoparticles. This motion is detected by the ultrasound using frequency- or time-domain analysis of echo data.

Operating Principle

Nanoparticles are injected into a volume of tissue. Then a time-varying external magnetic field is applied to the selected tissue volume. The nanoparticles will be set in motion as they start responding to the attractive force of an external magnetic field. When this field starts vanishing, particles will tend to achieve their initial stage. This property of displacement and its distribution in the body can be detected by this proposed multimodal imaging system (Fig.1).

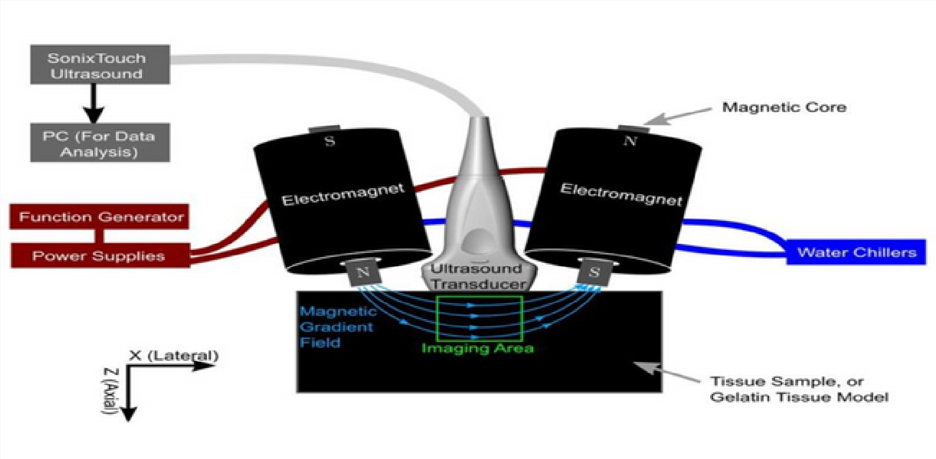

Fig.1: Operating principle of MMUS

Magnetic Contrast Agents

It is the crucial part of the MMUS system that needs to move in response to the magnetic field. It rises to displace, and their movements can be detected by an ultrasound machine. It should reach their intended site and non-toxic.

Superparamagnetic iron oxide nanoparticles (SPION) are the most commonly used nanoparticles for MMUS imaging and can be detected in extravascular targets. It is an approved MRI contrast agent and is frequently used in medical imaging procedures.

In vivo agglomeration can be prevented by biocompatible coatings, which stabilize them. Alternatively, dextran-coated iron oxide nanoparticles (Feridex I.V.) can also be used. It is considered safe because the rate of allergic reactions is very low and does not cause serious adverse effects.

The biodistribution of nanoparticles depends on the method and route of administration.

Route of Administration

Subcutaneous Injection: The nanoparticles enter the reticuloendothelial system through lymph nodes, and iron oxide particles are converted into serum ferritin. The retention time and position are dependent on the particle size, as smaller particles have higher mobility than large particles.

Intravenous Injection: The circulation time is dependent on the size of nanoparticles and the surface chemistry of the coating. Small-sized particles can penetrate endothelial and cancerous tissue more effectively than large-sized particles. Smaller particles having a size less than 10 nm are mainly removed by renal excretion. While larger particles are filtered by the spleen.

Indirect Administration: It can be carried out by the injection of iron-loaded platelets into the blood streams. Although it has not been clinically tested in vivo by MMUS, only a phantom study has been conducted.

Tissue Response

Biological tissues are viscoelastic, there will be a recoil in the tissue after the induced displacement. The measurement of such a response will be dependent on setup parameters and the tissue itself.

The tissue displacement exhibits resonance behavior, and the tissue response is frequency dependent. The maximum induced displacement is varied according to the material-dependent optimum frequency (Fig.2).

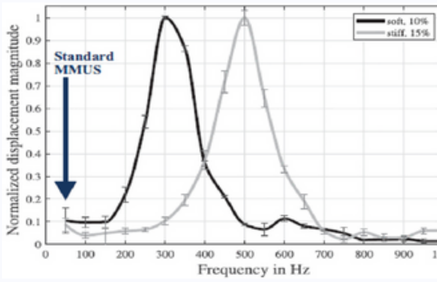

Fig.2: Tissue response

It has been depicted from Fig.2 that the frequency response of 300 bloom gelation at 10% and 15% is different, and as a result, a lower concentration (10%) produces softer gel.

Generation of Magnetic Field

It is a fundamental component of the MMUS system that produces a displacement force of generally less than 1 tesla. The magnetic field can be produced in continuous or pulsed form. Continuous excitation is considered beneficial in terms of sensitivity and sustaining of signals as it is present only for a fraction of time during acquisition by a pulsed system.

Several designs have been suggested in which electromagnets were used as MMUS magnetic field generators in the form of simple solenoids with an iron core.

Different configurations of magnetic field source and ultrasound have been reported, in which both can be applied from the same or opposite side. Different designs

In most of the studies conducted, the body is placed between the electromagnet and transducer (Fig.3.a). But this configuration is not reliable in terms of inducing magneto motion due to the larger distance through the patient's body. Alternatively, the second coil can be tilted toward the first (Fig.3.b). It can accommodate an imaging depth of 5 cm when operated in anti-parallel form.

Other variants have been depicted in Fig.3.c and 3.d, where the magnetization coil can be positioned around the ultrasound probe and on the same side of the probe, respectively.

In a most recent study, a new patented MMUS probe device was constructed by employing rotating permanent magnet in order to acquire signals from human tissue (Fig.4).

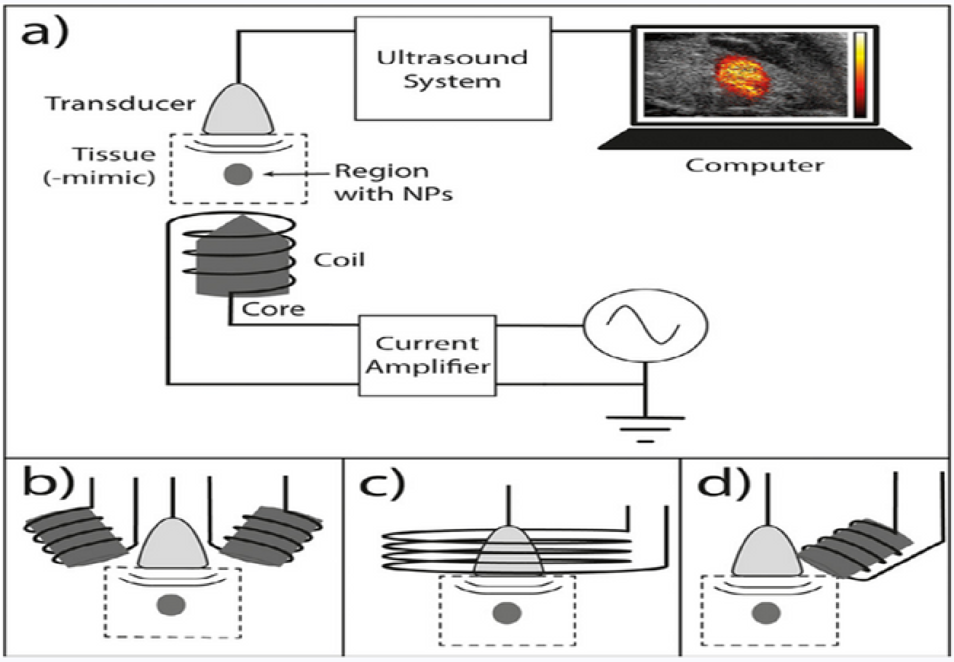

Fig.3: Configuration of magnetic field source

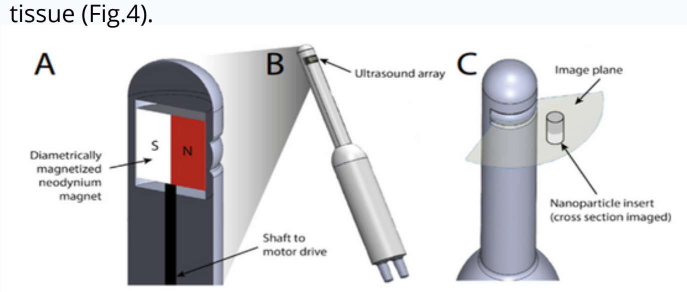

Fig.4: MMUS probe configuration

Ultrasound Acquisition

Temporal resolution should be sufficient to detect the induced motion, which is directly related to frame (pulse) repetition rate. The sampling frequency should be at least twice the movement frequency (Nyquist-Shannon sampling theorem) to capture harmonic oscillations. While in pulsed doppler, pulse repetition time should exceed the propagation time to the desired depth.

When using impulse excitation, it requires a high frame rate; an insufficient frame rate may not be able to detect particle displacement. While using the harmonic magnetic field excitation, extending the acquisition time can improve the image quality.

Signal Processing

The magnetomotion induced by sinusoidal magnetic input can be detected in the range of cm/s. Difficulty in producing a strong magnetic field at deeper imaging depths and the presence of magnetic materials in minute volume generate small magnetomotion within the sub-micrometer range. The detection of this small axial displacement can be difficult, but it can be detected by using the phase difference in the succeeding RF.

For the transmitting frequency range of 7.5–21 MHz, only axial displacement is considered. Several studies have discussed the direct approach to extracting the induced movements based on excitation frequency. These methods can eliminate unwanted and out-of-phase movements by applying a simple phase filter.

For the transmitting frequency range of 7.5–21 MHz, only axial displacement is considered. Several studies have discussed the direct approach to extracting the induced movements based on excitation frequency. These methods can eliminate unwanted and out-of-phase movements by applying a simple phase filter. The resultant signals can be displayed separately on a grayscale image after processing. The online implementation and automation of the MMUS algorithm could obtain images after 1.2 seconds. Studies have shown a further reduction in processing time after integration with the imaging system.

Conclusion

In several in vivo trials, MMUS has been demonstrated, which shows its potential as a multimodal imaging technique. Although this technique is still in a developing stage, it is considered a promising candidate for molecular ultrasound imaging.
To reach clinical translation, several technical developments have been suggested, as follows:

- Advancement in magnetic configuration: The combination of an electromagnetic coil and a permanent magnet can reduce the size and weight of the devices.
- Doping: magnetic properties like susceptibility and saturation magnetization can be increased by doping the particle core. Additionally, it increases sensitivity and reduces contrast doses.
- Advancement in signal processing: A continuous magnetic excitation can lead to increased detectability, and better frequency discrimination can be achieved by sliding windowing.
- Ongoing work aims to develop integrated real-time implementation, which can make MMUS a strong potential candidate for molecular ultrasound imaging. As a result, it can compete with established clinical practices and eliminate the need to use ionizing radiation with comparable spatial resolution and sensitivity.

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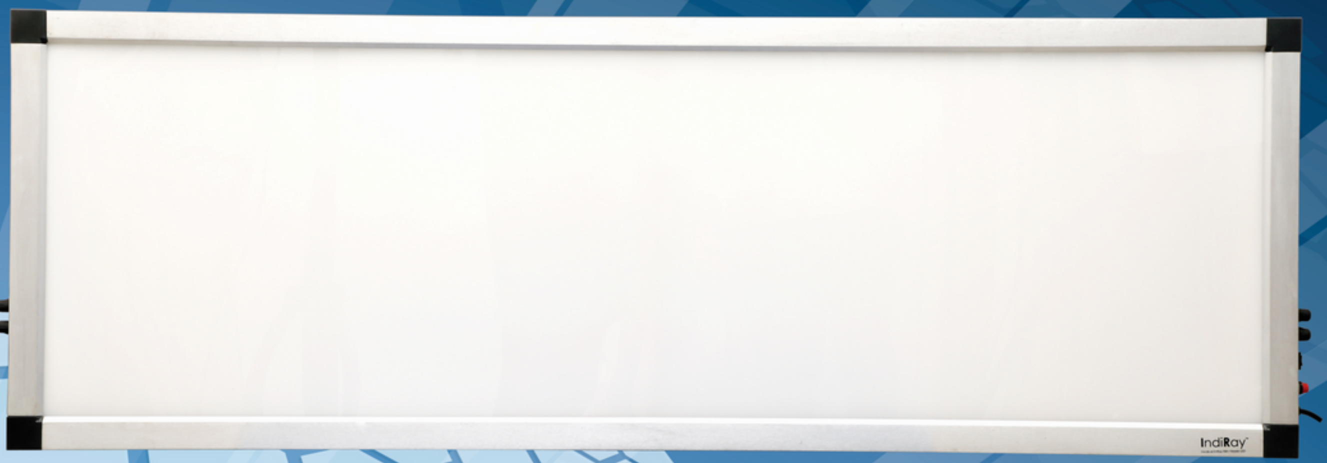

Artificial Intelligence, Virtual Reality, and Augmented Reality: Developments and Applications in Radiology.

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Introduction

The area of artificial intelligence (AI) is now important to radiology owing to recent advancements in powerful computational gear that can gather, store, and process vast volumes of data. With regard to interventional radiology (IR), in particular, the sector is uniquely positioned to gain from AI advancements in order to guide and anticipate outcomes of their minimally invasive procedures in addition to enhancing image processing.

Radiologists may now view tissue, organ, vascular, and other abnormality scans in three dimensions through this technology. It gives one a greater comprehension of human anatomy. The images can be viewed by doctors as a realistic scene from any perspective. It offers thorough and accurate details about the various body parts of humans.

The four main categories of virtual reality technologies are augmented reality, collaborative virtual reality, fully immersive virtual reality, and semi-immersive virtual reality. (Fig.1)
Unlike virtual reality, augmented reality does not obscure the user's view of the outside world. The user can interact with virtual things and the actual environment at the same time.
time.

1. Technology Development

Cinematographer Morton Heilig created the first virtual reality application in 1962 when he created and patented a wide-angled video booth called a "Sensorama."

Fig. 1: Types of virtual reality

Growing web connectivity and the availability of open-source software have contributed to the popularity of immersive reality by promoting exploration, cooperation, and the creation of VR and AR applications. Numerous uses in medicine, such as therapeutic intervention, procedural planning, and medical education, have been made possible by these advancements.

A recent development in the use of virtual reality in the field of radiological medical care is the VR-specified head-mounted merging cubes with three-dimensional avatars.

2. Current and future applications.

When dealing with some epidemics, such as COVID-19, etc., when patients aren't even permitted to go outside to receive treatment, the services of such qualities become even more crucial. Starting with the training, communicating, referencing, and aiding features, these are the fundamental components of virtual reality. These chosen components go into additional detail about stereoscopic analysis,

smart wearables for ongoing care and support, smart tooling, simulators, multiple data processing, integrative solutions, improved training, etc. With their cell phones, students may now adequately view the interventional procedure.

With improved communication with one another, doctors can better plan complex surgical procedures. Via virtual reality, patients can comprehend the steps of the procedure. With the use of this technology, interventional radiology operations can be rapidly aided and visualized.

3. Alternative to 3D printing.

Appealing aspects of VR and AR include their customizability, simplicity of use, reduced cost, and quicker turnaround times. In certain applications, these technologies can replace or enhance 3D printing. Table 1 determines the comparison between 3D printing and VR and AR.

For instance, users claimed that virtual reality (VR) had more instructional potential and resolution than 3D printing while analyzing cerebrovascular anatomy for neurosurgical training. Fig. 2 describes the difference between a 3-D printed model and a virtual reconstruction of a conjoined twin for surgical planning.

4. Diagnosis and surgical planning

AR applications can project the endoscopic view onto the patient in a camera-assisted surgery scenario where the operator's field of vision is constrained by the endoscope, facilitating the surgeon's navigation.

In the end, these instruments might enhance the identification and localization of tumors and aberrant microcalcifications.

Virtual reality reconstructions of the breast have also been launched to help with surgical planning and to evaluate the tumor response following neoadjuvant chemotherapy.

Features	3D printing	VR AND AR
Turnaround time	Hours to weeks	Minutes to hours
Ease of use	Easy to use	Difficult to use
Side effects	None	Cyber sickness

Table 1. Comparison between 3D printing and VR and AR.

5. Interventional radiology

Compared to traditional localization methods, AR reconstructions placed on patients for percutaneous and endovascular treatments may offer advantages.

Before endovascular embolization, VR reconstructions of splenic artery aneurysms increased operator trust.

AR reconstructions of the aorta and its main branches were projected onto a phantom, and an endovascular catheter was tracked inside the digitally created vascular tree using electromagnetic markers.

6. Disease detection

VR helps with early disease detection, including Alzheimer's, colon, and breast cancer. VR for therapeutic purposes includes enhanced image monitoring, enhanced comprehension of image reports, enhanced examinations, and methodical surgical planning. The VR has access to the patient's current image, which could be useful in identifying the illness and making the best choice at the proper moment. Moreover, breast cancer detection can be aided by virtual reality technologies.

7. Applications of VR

- Interventional radiology treatments.
- Decision making.
- Medical imaging inspection.
- Reduction in overall expenditure.
- Patient relaxation
- Disease awareness.
- Improve radiologists' knowledge.
- Access patient images from any angle.
- Clear images of blood vessels.
- Patient abnormalities.
- Preoperative planning.
- Tumor detections

8. Radiation exposure

Through ultrafast collimation, endoscopy with AI-equipped fluoroscopy minimizes radiation exposure by 38%. AR integration, such as superimposing preprocedural 3D anatomic data onto 2D fluoroscopic images to achieve multi-modality picture fusion and better guidance, A large number of patients in IR require frequent maintenance treatments, such as routine fistulography and intervention for patients with dialysis access, as well as routine nephrostomy or biliary drain exchanges. Consequently, over time, an even greater cumulative drop in radiation will result from even a slight reduction in radiation for each surgery.

9. Benefits of VR

Radiologists are able to realistically disassemble, recreate, and choose the best course of action for human bodily components. This method of finishing a

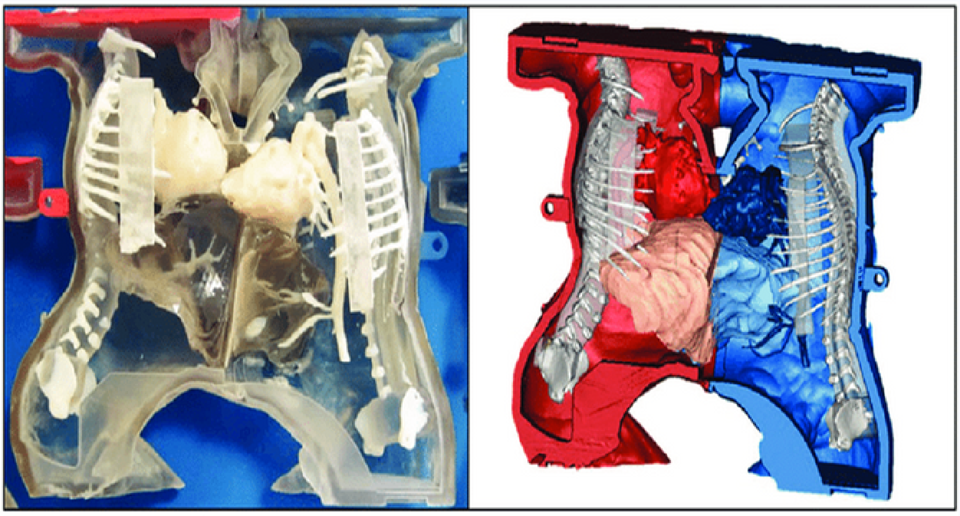

Fig.2 3-D printed model and virtual reconstruction of conjoined twin for surgical planning.

medical diagnosis is both accurate and invasive.

The following are VR's advantages:

- It lowers the risk.
- It aids in simulating.
- It aids in carrying out a less uncomfortable operation.
- Boost patient security.
- Increase procedure precision.
- Visualize pertinent data.
- Develop new abilities and knowledge.
- See the complete course of treatment.
- Support the gathering of inpatient data.
- Aids in carrying out difficult medical operations.

10. Limitations. (Fig.3)

- Explains unpleasant feelings such as headaches, nausea, and dizziness.
- Vestibular mismatch, or the visual perception of motion in a simulation without corresponding vestibular system input, is the cause of cyber sickness.
- VR discomfort may also be attributed to eye strain.
- Achieving ideal AI learning.
- There are little datasets to train artificial intelligence. Uniformity in Interventional Radiology.
- The ability to apply new technology and procedures to an existing healthcare system.
- Changes in the anatomy and pathology of the patients.
- Compared to diagnostic radiology, there are currently less appropriate applications of AI in interventional radiology.
- Ergonomics
- Expensive
- A creative staff is needed.

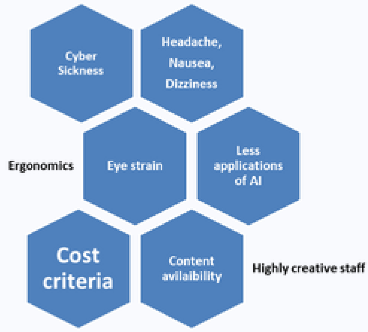

Fig. 3 Several limitations to applying the VR, AR and AI concepts in radiology.

11. Conclusion

Information obtained through various reality devices is simulated in a virtual environment by virtual reality (VR). A radiologist with depth awareness can quickly engage with volumetric pictures. This technique can help to improve treatments in interventional radiology. It will be crucial to future applications of sophisticated imaging processes.

Incorporating AI approaches has the potential to reduce hospital expenses and unfavorable events, enhance patient experience, lower radiation exposure for both patients and operators, and help with procedural planning, execution, and treatment follow-up. To fully realize the potential AI applications in interventional radiology, more research and data collecting are necessary in addition to persistent enthusiasm.

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Advancement in Breast MRI

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Breast cancer is a disease that occurs when abnormal cells in the breast grow uncontrollably.

Symptoms:

- A breast lump or thickened area of skin that feels different from the surrounding tissue.
- A nipple that looks flattened or turns inward.
- Changes in the color of the breast skin (pink or red in white skin, darker in brown or Black skin).
- Change in the size, shape, or appearance of a breast.

A developing method for breast cancer screening and imaging that is being used in clinical practice is abbreviated breast magnetic resonance imaging. The use of conventional breast MRI in the screening context is complicated by factors including high examination costs and extended examination periods.

In order to avoid these problems, abbreviated magnetic resonance imaging (MRI) shortens the duration of the entire examination and makes MRI more accessible while maintaining diagnostic precision.

The sequences chosen for shortened MRI protocols maintain the accuracy of breast cancer identification and classification.

When it comes to identifying breast cancer, magnetic resonance imaging (MRI) is the most sensitive test. According to the American College of Radiology, women who have a lifetime risk of 20% or higher of developing breast cancer should get an MRI every year.

In addition, breast MRI is used to monitor a patient's reaction to neoadjuvant chemotherapy and to determine the degree of disease as part of the preoperative evaluation process for women who have recently been diagnosed with breast cancer.

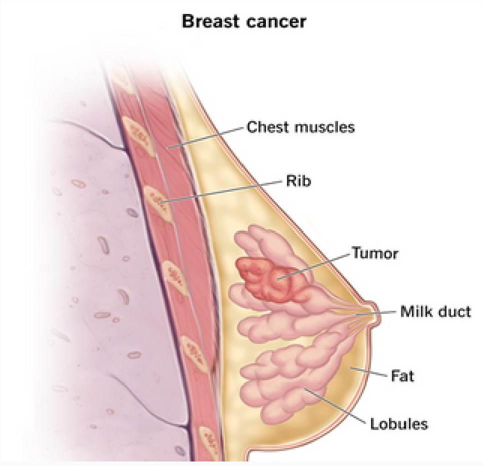

Fig-1: Diagrammatic representation of breast cancer

Advantages:

High Sensitivity: Breast MRI is exceptionally sensitive in detecting breast cancer, especially in high-risk women with a strong family history or dense breast tissue.

Improved Screening: It significantly enhances breast cancer screening for those at elevated risk, providing an early detection advantage.

Clinical Diagnosis: Breast MRI plays a crucial role in clinical diagnosis, aiding in problem-solving and staging, which directly impacts patient management.

Disadvantages:

False Positives: Occasionally, breast MRI may yield false positive results, leading to unnecessary breast biopsies. It might not always distinguish between cancerous abnormalities.

Not Perfect: While it's a powerful tool, it's not infallible. Some breast cancers can still be missed despite its sensitivity.

Risk Stratification: Experts recommend against routine MRI use for patients with low-average risk of breast cancer.

Advances in Making MRI Better for Breast Screening

MRI may be the preferred method of breast screening in place of mammography. Technological developments have made breast screening using MRI faster, more accurate, and less expensive. Breast MRI has historically been hampered by lengthy examination periods, the requirement for contrast materials, and, of course, it's expensive price in comparison to traditional x-ray mammography. However, MRI technology is gradually becoming more widely available for breast screening because to recent technological breakthroughs.

Abbreviated protocols

The development of abbreviated protocols can reduce the duration of a breast scan to only a few minutes is one of the largest developments in MRI breast imaging. A three-minute breast scan may be achieved with a shortened MRI protocol that contained the most important pre-contrast and post-contrast images.

A 10-minute MRI scan detected more than twice as many invasive tumors in women with dense tissue as digital breast tomosynthesis (DBT), according to one of the most recent studies on abbreviated MRI. The goal of the project was to use MRI to quickly scan more women. Consequently, this would decrease the amount of time women had to spend inside the MRI scanner and increase access to MRI screening for more women. With the abbreviated MRI protocol three patients can be scanned per hour.

DIXON sequence, Perfusion TWIST sequence, resolve diffusion sequence.

Diffusion-weighted imaging

The most promising method for non-contrast imaging is diffusion weighted imaging (DWI). Breast cancers frequently show lower apparent diffusion coefficients (ADC) and more limited diffusion on DWI compared to benign lesions.

Many of us would really like to see diffusion-weighted imaging become high-resolution and [good] enough in quality so that patients may be screened using it instead of needing to have that intravenous contrast once a year.

Application of MR spectroscopy for predicting the onset of invasive breast cancer. It is possible to use MR spectroscopy to learn more about the chemical composition of breast lesions.

Numerous studies from 1.5 T have demonstrated specificities of 67% to 100% and sensitivities of 70% to 100%.

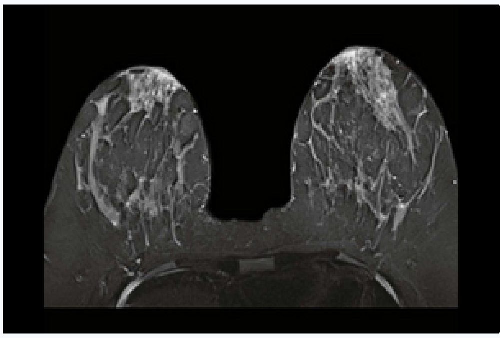

Fig-2: T2-W Sequence

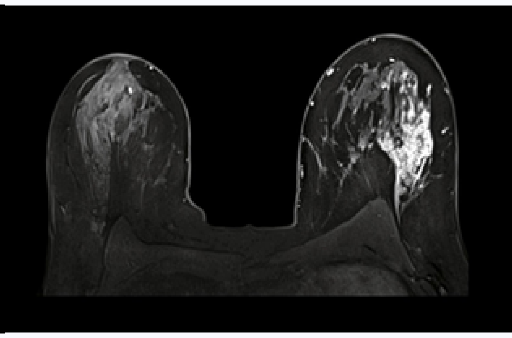

Fig-3: DIXON Sequence

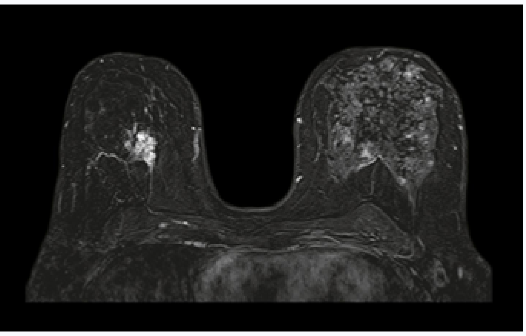

Fig-4: TWIST Sequence

Patients with breast illness may benefit from the clinical data that proton spectroscopy can provide.

Breast tumour tissue can be measured utilizing a variety of innovative methods such as DCE, diffusion, and tCho MRS, and the results can be used as a biomarker for tumour diagnosis and treatment response.

Breast implant
The most common reason for implant removal is breast implant rupture. When an implant gets older, the rupture rate rises significantly. The majority of implant ruptures don't hurt.

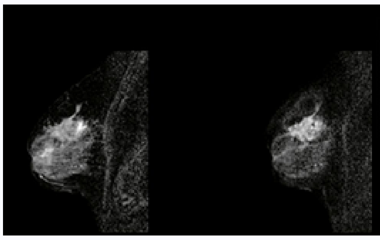

Fig-5: RESOLVE Diffusion with b-values

Fig-6: RESOLVE Diffusion with ADC Value

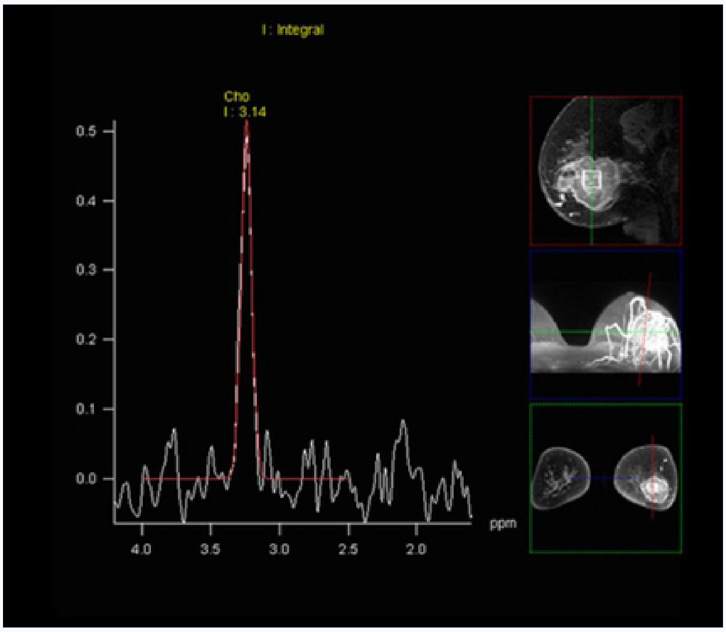

Fig-7: Spectroscopy Showing Choline Peak

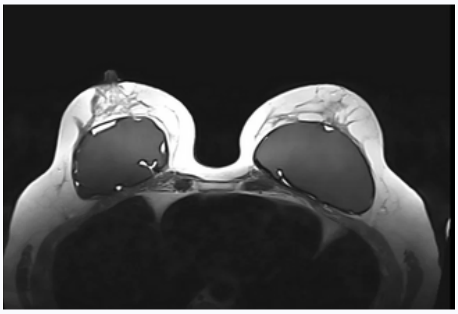

Fig-8: T2 SPACE Axial

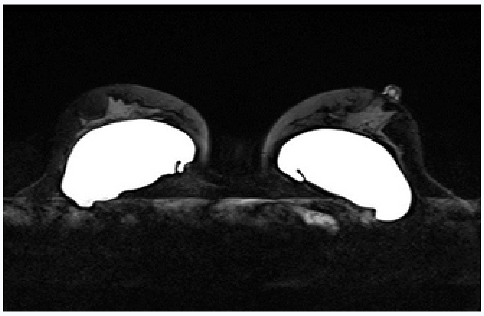

Fig-9: T2 STIR Axial Water Sat

One of the most frequent implant problems is implant rupture. The older an implant is, the higher the chance of rupture. It might be challenging to diagnose implant rupture only on the basis of clinical findings because the majority of these ruptures do not cause any symptoms or accompanying damage.

Non-contrast magnetic resonance imaging (MRI) is the preferred imaging modality for assessing the integrity of breast implants and associated issues due to its soft tissue contrast and signal suppression capabilities.

Limitations
False Positives: Breast MRI can sometimes yield false-positive results. This means that the test identifies a mass or change in the breast that appears cancerous but is actually benign. These false positives can lead to unnecessary anxiety and additional testing.
Not a Replacement for Mammography: While breast MRI is highly effective, it cannot replace mammography. Unlike mammograms, which use X-rays, MRI may occasionally miss cancers that mammograms can detect.
Tissue Expanders with Magnetic Ports: an important limitation is that breast MRI is unsafe for individuals with tissue expanders containing magnetic ports. These devices can interfere with the MRI process.

Conclusion

In conclusion, breast MRI is a valuable diagnostic tool, especially for women at high risk of breast cancer or those with dense breast. Combining MRI with other imaging modalities can enhance early detection and improve patient outcomes. Regular communication with healthcare providers is essential to make informed decisions about breast health.

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Diffusion Tensor Imaging and it's Clinical Applications in Neurological Disorders

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Diffusion Tensor Imaging:
It is a newly developed magnetic resonance imaging technique that analyzes the anatomy of nerve cells and a complex neuronal network of the brain. It uses the diffusion of water as a probe to determine the anatomy of a brain network, which basically provides information on static anatomy that is not influenced by brain functions.

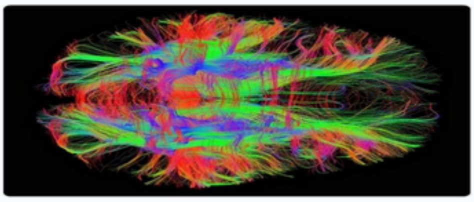

Fig.1: White matter fibre tracts in the adult human brain.

Principles of Diffusion Tensor Imaging:

- The diffusion of water molecules in a tissue is not the same in all directions (anisotropic diffusion) due to tissue heterogeneity. This anisotropic (directional dominance of water diffusion within a region) is used in DTI to determine the nerve cell organization in the brain. The basic principle is that the water molecules should move faster along the axon fiber instead of moving upright to the fiber because obstructions present along the fiber are comparatively lesser to restrict it's movement. Depending on axonal orientation, anisotropic diffusion can produce completely new image contrast which is very useful in visualizing important brain structures.
- The DTI technique involves the delivery of external magnetic pulses to impose a random phase shift for water molecules that diffuse. This leads to a loss of signal from diffusing molecules, which subsequently creates darker volumetric pixels or voxels.
- It provides a quantitative analysis of the magnitude and directionality of water molecules.
- The word tensor indicates the use of a 3×3 matrix with eigenvalues and eigenvectors of its constituents.
- The two main parameters derived from DTI data are Mean diffusivity (MD) also called as Apparent Diffusion Coefficient (ADC) and Fractional anisotropy.
- FA reflects the directionality of molecular displacement by diffusion and varies between 0 (isotropic diffusion) and 1 infinite (anisotropic diffusion). FA value if CSF is 0.
- ·MD reflects the average magnitude of molecular displacement by diffusion. The higher the MD value, the more isotropic the medium.
- Axial diffusivity (AD) –It refers to the magnitude of diffusion parallel to fiber tracts. Lower AD might reflect axonal injury, reduced axonal caliber.
- Radial diffusivity (RD) –It represents the average of two shorter eigenvectors.
- To measure the diffusion using MRI, magnetic field gradients are employed to create an image that is sensitized to diffusion in a particular direction. By repeating this process of diffusion weighting in multiple direction, a three -dimensional diffusion model (the tensor) can be estimated.

Clinical Applications of Diffusion Tensor Imaging in Neurological Disorders:
It is very powerful technique for investigating important aspects of basic neurophysiology as well as pathophysiological consequences associated with the central nervous system.

1. Brain anatomy – The spatial distribution of complex brain network can also be investigated by measuring microscopic length scale of the water diffusion. It is useful to investigate normal brain development as well as congenital brain disorder.

- Neuropathology –Since diffusion anisotropy is significantly related to the axon myelination status, measurement of this parameter using DTI cam also provide substantial insights into neuro pathological conditions like demyelination, multiple sclerosis, etc… .
- Alzheimer's disease –detection of early disease.
- Focal cortical Dysplasia.
- Multiple sclerosis – plaque assessment.
- Pre surgical planning.

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Flat Panel Detectors CT

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Flat-detector CT (FD-CT) involves conducting CT imaging with C-arm systems originally designed for radiography and fluoroscopy, featuring a flat detector (FD) and configured to capture projection data spanning 180° or beyond in angular range (Kalender & Kyriakou, 2007). An initial instance of employing this data collection principle, encompassing over 180 degrees in addition to the x-ray beam's fan angle, emerged in interventional angiography through image intensifier-based C-arm units (Fahrig et al., 2006).

While these units exhibited excellent visualization of high-contrast vascular structures following intra-arterial administration of contrast media, along with satisfactory spatial resolution, they lacked the ability to discern low-contrast details typical of soft tissues. This deficiency served as the driving force behind the transition from the image intensifier tube to the flat-panel digital detector employed in digital radiography imaging systems. FD-CT systems are now used in interventional and intraoperative imaging, radiation therapy, maxillofacial scanning, micro-CT imaging (micro-CT scanners are now used to image small animals), breast CT imaging (Machida et al., 2010), CT brain imaging (Struffert et al., 2010), and in a physical setup where they are incorporated in a standard CT gantry (Kalender & Kyriakou, 2007).

Technical Elements

Kalender and Kyriakou (2007) presented an excellent technical overview of the major components of FD-CT systems. These include the x-ray tube, the digital detectors, image reconstruction, image quality, artifacts, and radiation dose.

1. Disparities exist between MSCT and FDCT technologies concerning parameters such as kVp, mA, generator power, focal spot size, rotation time, detector elements, field of measurement, slice thickness, and data rate.
2. Among the two flat-panel digital detectors utilized in digital radiography, FD-CT systems employ the indirect conversion flat-panel detector.
3. The x-ray beam emitted from the x-ray tube onto a 2D detector assumes a cone-shaped configuration; thus, the image reconstruction process employs a cone-beam algorithm, specifically the Feldkamp algorithm.
4. Assessment of image quality encompasses parameters like spatial resolution, noise, and contrast resolution. While the spatial resolution for MSCT systems typically ranges from 1.2 lp/mm to 1.4 lp/mm (in high-resolution mode), FD-CT achieves approximately 1.5 lp/mm with pixel binning (where pixels within a specified region, say n × n, are amalgamated and read out as one to enhance frame rates and diminish noise). Spatial resolution without binning stands at 3.0 lp/mm.
5. In comparison to MSCT detectors, FD-CT detectors exhibit higher noise levels and diminished low-contrast resolution for a given dose.
6. Various artifacts may arise, including those stemming from beam hardening, defective detector elements, and the presence of metal within the patient. Other artifacts such as cupping and truncation can also occur. However, these artifacts are addressable through the application of appropriate correction algorithms, such as the Feldkamp algorithm.
7. The radiation dose administered by an FD-CT system surpasses that of a clinical CT study for equivalent image quality due to the lower detection efficiency of the FD-CT detector (Kalender & Kyriakou, 2007).

Radiation dose and image quality:

The comparison between radiation dose and image quality was conducted by Bai et al. (2012), who evaluated the radiation dose of FD-CT (DynaCT) in contrast to that of a multi-slice CT (MSCT) using a phantom model. Their study revealed that the effective doses for the FD-CT system were notably lower compared to MSCT across various anatomical regions. Specifically, for a 20-second scan, the effective doses for the head, chest, and abdomen were 1.18 mSv, 7.32 mSv, and 7.48 mSv, respectively, for FD-CT, whereas they measured 3.33 mSv, 7.62 mSv, and 8.42 mSv, respectively, for MSCT. Moreover, the researchers highlighted a significant difference in organ doses between DynaCT and MSCT ($p < 0.05$). Despite the lower radiation dose, DynaCT achieved comparable spatial resolution to MSCT, with both systems capable of resolving details up to 12-line pairs per centimetre. Additionally, DynaCT demonstrated similar low contrast detectability to MSCT, being able to identify a 3 mm low contrast object at a 0.5% contrast level. In essence, the findings suggest that the FD-CT scanner applies substantially less radiation dose to patients while maintaining a comparable level of spatial resolution and low contrast detectability to standard diagnostic MSCT.

Advantages of FPCT Detectors

The adoption of FPCT detectors brings forth several compelling advantages over traditional CT imaging systems:

1. Improved Image Quality: FPCT detectors offer superior spatial resolution and contrast sensitivity, enabling clinicians to visualize intricate anatomical structures with unprecedented clarity.
2. Faster Image Acquisition: FPCT detectors enable significantly faster image acquisition times compared to their predecessors.

3. Versatility in Applications: FPCT detectors find versatile applications across various medical disciplines, including radiology, cardiology, oncology, and neurology. From routine diagnostic scans to intricate interventional procedures, these detectors empower clinicians with the flexibility to address a diverse range of clinical challenges effectively.

Clinical Applications of FPCT Detectors

The widespread adoption of FPCT detectors has catalyzed advancements in numerous clinical applications:

1. **Interventional Procedures:** In interventional radiology and cardiology, FPCT detectors facilitate real-time guidance during minimally invasive procedures, such as angiography, embolization, and biopsy. (eg. 3D rotational Angiogram) Vendors like Siemens: Artis Zee Biplane C-arm systems have this advantage)
2. **Radiation Therapy Planning:** In radiation oncology, FPCT detectors play a pivotal role in treatment planning by providing precise anatomical localization and delineation of target volumes. These detectors enable clinicians to tailor radiation therapy protocols with unprecedented accuracy, maximizing therapeutic efficacy while minimizing radiation exposure to healthy tissues.
3. **FD CT Mammogram:** Interest in developing dedicated breast CT scanners using FD detector technology surfaced as early as 2001 (Boone et al., 2004). The advantages offered by FD technology such as wide dynamic range, high spatial resolution, excellent linearity, high detective quantum efficiency, and no geometric distortion provide a good rationale for using them in the design of FD-CT scanners for breast imaging (Chen & Ning, 2002).

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