A Review of Emerging Techniques in Medical Imaging for Spleen Disease Detection

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***Abstract*—The spleen plays a critical role in immune function and blood filtration, yet its diseases often remain underdiagnosed due to subtle clinical symptoms. Medical imaging is essential for the detection and characterization of splenic disorders such as splenomegaly, cysts, infection, and malignancies. This review explores both conventional and emerging imaging techniques including ultrasound, CT, MRI, PET and advanced technologies such as radiomics and artificial intelligence (AI). Emerging methods show improved diagnostic accuracy, reduced radiation exposure, and enhanced disease characterization, offering promising advancements in clinical practice.**

***Index Terms*—CT, MRI, PET, Artificial intelligence**

I. INTRODUCTION

The spleen is the largest lymphoid organ, involving in immune surveillance and hematological regulation. Various conditions like infections, hematologic disorders, and malignancies affect the spleen. Early diagnosis in crucial but challenging due to non-specific symptoms. Medical imaging provides a non – invasion approach to evaluate splenic abnormalities. Conventional modalities are now being enhanced with AI- driven techniques and quantitative imaging methods.

II. LITERATURE REVIEW

Recent studies highlight the importance of medical imaging in detecting spleen diseases. Conventional modalities such as ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI) are widely used for identifying splenic abnormalities, with CT being the most reliable due to its high spatial resolution and diagnostic accuracy [1]. These imaging techniques play a crucial role in differentiating benign and malignant lesions and are essential for clinical evaluation [2]. Radiomics has recently emerged as an advanced approach that extracts quantitative features from medical images, improving diagnostic performance. Studies report that CT-based radiomics is widely used and enhances disease characterization and prediction [3]. In oncology, radiomic models have shown effectiveness in distinguishing splenic lymphoma from non-malignant conditions, providing a non-invasive diagnostic tool [4]. Artificial intelligence (AI) and deep learning techniques have further improved imaging analysis by enabling automated segmentation and classification of spleen images. AI-based systems assist in accurate detection of splenomegaly and other abnormalities, reducing human error and improving efficiency [5]. However, challenges such as limited datasets, variability in imaging protocols, and lack of standardization still exist. These issues highlight the need for large-scale validation and integration of multi-modal imaging techniques [6].

III. OBJECTIVE

To analyze and review emerging medical imaging techniques for accurate detection and diagnosis of spleen diseases.

IV. PROBLEM STATEMENT

Spleen diseases are difficult to detect early due to non-specific symptoms and limitations of conventional imaging methods. There is a need for advanced techniques like AI and radiomics to improve diagnostic accuracy and reliability. This paper deals with the review of all scanning techniques including artificial intelligence

V. AIM

To evaluate conventional and advanced imaging methods, including AI-based approaches, in order to enhance the accuracy, efficiency, and reliability of spleen disease detection.

VI. METHODOLOGY

6.1. Data Collection

Research papers were collected from Google Scholar, PubMed, and ScienceDirect.

6.2. Selection Criteria

Published within last 5–10 years, peer-reviewed journals, relevant to spleen imaging.

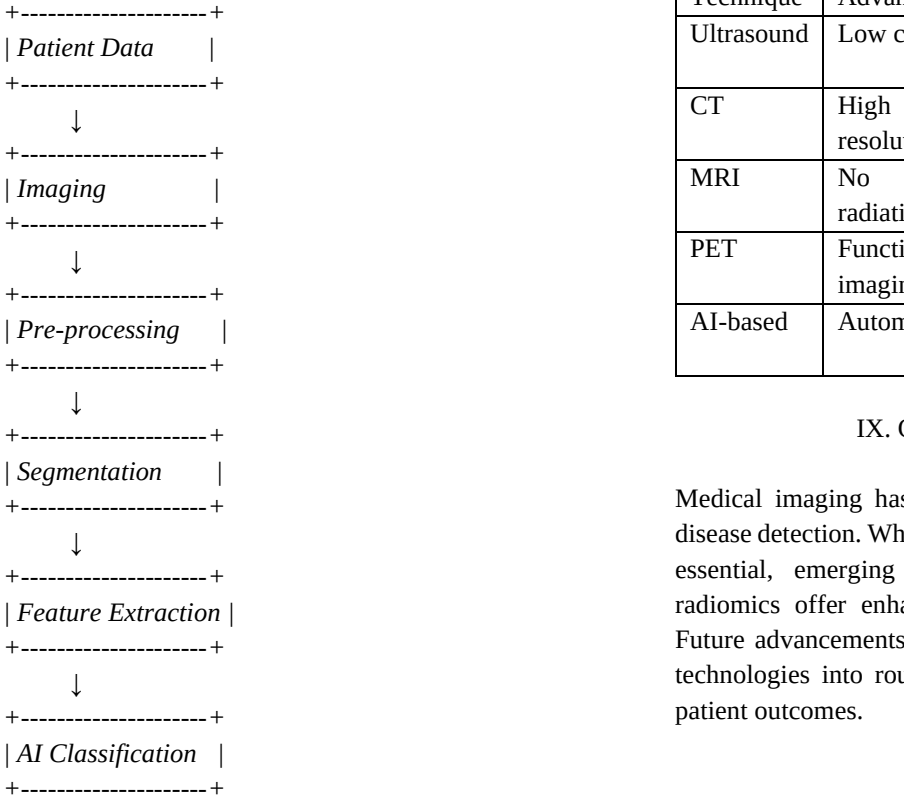
6.3. Imaging Techniques

Conventional: US, CT, MRI, PET
Emerging: Radiomics, AI, Elastography

6.4. Workflow

Image acquisition → Pre-processing → Segmentation → Feature extraction → Classification

6.5 Block diagram



VII. APPLICATION

7.1. Splenomegaly

Used for detecting enlarged spleen using US and CT.

7.2. Splenic Cysts

Helps identify fluid-filled lesions.

7.3. Trauma

CT is gold standard for injury detection.

7.4. Lymphoma

PET detects metabolic activity.

VIII. RESULT AND OBSERVATION

- CT shows highest anatomical accuracy
- MRI provides superior soft tissue contrast
- AI improves detection accuracy (~90%+)
- Radiomics enables early disease prediction

Technique	Advantage	Limitation	Accuracy
Ultrasound	Low cost	Operator dependent	Medium
CT	High resolution	Radiation	High
MRI	No radiation	Expensive	Very High
PET	Functional imaging	Costly	Very High
AI-based	Automated	Needs data	Highest

IX. CONCLUSION

Medical imaging has significantly improved spleen disease detection. While conventional methods remain essential, emerging techniques such as AI and radiomics offer enhanced accuracy and efficiency. Future advancements will focus on integrating these technologies into routine clinical practice for better patient outcomes.

APPENDIX

A: Abbreviations
US: Ultrasound
CT: Computed Tomography
MRI: Magnetic Resonance Imaging
PET: Positron Emission Tomography
AI: Artificial Intelligence
CNN: Convolutional Neural Network

Appendix B: Imaging Workflow Summary
The general workflow followed in spleen disease detection includes:
1. Image Acquisition
2. Image Pre-processing
3. Segmentation of spleen region
4. Feature Extraction
5. Classification using AI or clinical analysis
6. Diagnosis and treatment planning

Appendix C: Key Features Used in Analysis
Texture Features: Identify tissue patterns
Shape Features: Analyze size and structure
Intensity Features: Measure pixel brightness variations

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REFERENCES

[1] D. Fanni, C. Gerosa, G. Faa, and A. Faa, "Radiomics in spleen imaging: A systematic review," *Diagnostics*, vol. 13, no. 16, pp. 1–15, 2023.
[2] J. Enke et al., "Radiomics in lymphoma: Current status and future directions," Cancers, vol. 14, no. 3, pp. 713–725, 2022.
[3] P. Lambin, E. Rios-Velazquez, R. Leijenaar et al., "Radiomics: Extracting more information from medical images using advanced feature analysis," European Journal of Cancer, vol. 48, no. 4, pp. 441–446, 2012.
[4] R. J. Gillies, P. E. Kinahan, and H. Hricak, "Radiomics: Images are more than pictures, they are data," Radiology, vol. 278, no. 2, pp. 563–577, 2016.
[5] D. Shen, G. Wu, and H. I. Suk, "Deep learning in medical image analysis," Annual Review of Biomedical Engineering, vol. 19, pp. 221–248, 2017.
[6] G. Litjens, T. Kooi, B. E. Bejnordi et al., "A survey on deep learning in medical image analysis," Medical Image Analysis, vol. 42, pp. 60–88, 2017.
[7] S. Huang, J. Yang, S. Fong, and Q. Zhao, "Artificial intelligence in cancer diagnosis and prognosis: Opportunities and challenges," Cancer Letters, vol. 471, pp. 61–71, 2020.
[8] M. M. Khalil, J. L. Tremoleda, T. B. Bayomy, and W. Gsell, Molecular Imaging: Fundamentals and Applications. New York, NY, USA: Springer, 2011.
[9] K. J. Mortele and P. R. Ros, "Cystic focal liver lesions in the adult: Differential CT and MR imaging features," RadioGraphics, vol. 21, no. 4, pp. 895–910, 2001.
[10] D. Thut, R. L. Smoot, and M. B. Farnell, "Splenic cysts: Management and treatment," Journal of Gastrointestinal Surgery, vol. 11, no. 6, pp. 785–791, 2007.
[11] J. J. M. van Griethuysen et al., "Computational radiomics system to decode the radiographic phenotype," Cancer Research, vol. 77, no. 21, pp. e104–e107, 2017.
[12] W. L. Bi, A. Hosny, M. B. Schabath et al., "Artificial intelligence in cancer imaging," CA: A Cancer Journal for Clinicians, vol. 69, no. 2, pp. 127–157, 2019.