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# CT and MRI for Assessment of Pericardial Disease: Systematic Review of Clinical Implications

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## ABSTRACT

**Background:** Clinical manifestations of pericardial disorders include constrictive pericarditis, effusion of the pericardium, and acute pericarditis. Later on, patients may experience recurrent or chronic pericarditis. Regarding the many pericardial illnesses, clinicians frequently encounter a number of diagnostic and treatment-related queries.
**Objectives:** To evaluate the clinical implications of using computed tomography (CT) and cardiac magnetic resonance imaging (MRI) in the assessment of pericardial diseases.
**Methods:** A comprehensive search of four databases led to the discovery of 611 relevant publications. After eliminating duplicates with Rayyan QCRI and assessing each article for relevance, 66 full-text articles were examined, and ultimately, 6 studies were selected based on the inclusion criteria.
**Results:** We included six studies with a total of 250 patients with pericardial disease and 142 (56.8%) were males. Cardiac MRI was shown to be a valuable adjunct to standard diagnostic approaches, particularly in pediatric and recurrent pericarditis, by detecting pericardial inflammation even when traditional markers such as C-reactive protein were normal. Early MRI—performed within two weeks of symptom onset—improved diagnostic accuracy and helped identify patients at risk for complications or recurrence, supporting more targeted therapy. Additionally, 4D CT showed promise as an efficient tool for evaluating pericardial adhesions and aiding in preoperative planning.
**Conclusion:** CT and MRI are essential components in the multimodal assessment of pericardial disease, providing critical information that influences both diagnosis and management. Although additional research is necessary to establish standardized protocols and evaluate long-term effects, the existing evidence encourages their wider adoption in clinical practice.
**Keywords:** Cardiac MRI, Cardiac CT, Pericardial Disease, Pericarditis, Advanced Imaging.

## INTRODUCTION

Pericardial diseases represent a diverse range of conditions—including inflammation, fluid buildup, constriction, tumors, and congenital abnormalities that can present in acute, recurrent, or chronic forms [1].

Diagnosing these conditions can be difficult, yet it's essential for starting the appropriate treatment and improving outcomes for patients who may face serious health risks. Over the past twenty years, cardiac MRI has become a crucial tool in the evaluation of pericardial disorders, playing a central role alongside other imaging techniques [2,3].

Diagnosing and managing pericardial diseases can be difficult due to their wide range of presentations and the limited clinical data available to support guideline development by the American College of Cardiology and the American Heart Association. Nonetheless, the European Society of Cardiology (ESC) released standardized guidelines for pericardial disease back in 2004 [4].

Cardiac CT and cardiac MRI are playing an increasingly important role in diagnosing pericarditis. Both techniques are highly sensitive in detecting pericardial effusions, whether they are widespread or localized, and can also be used to assess pericardial thickness. Typically, the normal pericardial thickness ranges from 1 to 2 mm and is considered abnormal if it exceeds 4 mm. While cardiac CT may reveal thickening of the pericardium in cases of acute pericarditis, this finding alone is not definitive for diagnosis. The most reliable imaging feature for identifying acute pericarditis is delayed pericardial enhancement observed on Cardiac MRI [5,6].

While echocardiography is commonly the first-line modality, it has limitations in tissue characterization and comprehensive anatomical assessment. In recent years, cross-sectional imaging—particularly CT and cardiac MRI—has emerged as an essential component in the diagnostic workup of pericardial disease. These modalities offer superior spatial resolution, detailed visualization of pericardial anatomy, and the ability to assess inflammation, fibrosis, and hemodynamic impact. However, despite their growing clinical use, there remains variability in imaging protocols and a lack of standardized integration into clinical pathways. A systematic review of the available literature is needed to consolidate current knowledge, clarify the clinical value of CT and MRI in this context, and identify gaps that require further research.

The main objective of this comprehensive review is to evaluate the clinical implications of using CT and MRI in the assessment of pericardial diseases.

## METHODS

This systematic review was performed in alignment with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [7] to uphold rigorous methodological standards and ensure transparency throughout the process. The



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primary aim was to explore the clinical relevance of CT and MRI in evaluating pericardial diseases. To accomplish this, an extensive search was conducted across several electronic databases, comprising PubMed, Web of Science, SCOPUS, and ScienceDirect, to locate relevant studies published in English. Two reviewers separately examined the search results, chose studies based on pre-established criteria, extracted essential data, and assessed the quality of the selected studies using standardized evaluation tools.

**Inclusion Criteria**

1. Peer-reviewed study articles including randomized controlled trials (RCTs), cohort studies, and observational studies were included.
2. We included both the adult and pediatric population.
3. Studies that assess the clinical implications of using CT and MRI in the assessment of pericardial diseases.
4. Studies published between 2017-2025.
5. Articles published in English.

**Exclusion Criteria**

1. Editorials, opinion pieces, reviews (systematic or narrative), abstracts, and case reports.
2. Studies with incomplete data or those lacking specific outcomes related to the use CT and MRI in the assessment of pericardial diseases.

**Data Extraction**

The Rayyan platform, created by the Qatar Computing Research Institute (QCRI) [8], was utilized to streamline and manage the search results, ensuring consistency and reliability in the study selection process. Initially, titles and abstracts were reviewed for relevance based on established inclusion and exclusion criteria. For studies that seemed to meet these criteria, the full texts were retrieved and assessed independently by two researchers to confirm eligibility. Any disagreements between the reviewers about study inclusion or data extraction were addressed through discussion until a consensus was reached.

To ensure accurate and consistent data collection, a standardized extraction form was utilized. This form captured essential information such as the article title, first authors, year of publication, geographic location, study design, participant demographics (including age and gender), the imaging modality used, the specific type of pericardial disease investigated, and the main clinical outcomes reported.

**Risk of Bias Assessment**

We applied the ROBINS-I framework to assess bias risk, as it offers a comprehensive analysis of confounding factors, which is especially important due to the frequent occurrence of bias from overlooked variables in research within this domain. The ROBINS-I instrument is tailored for non-randomized studies and is suitable for cohort designs where participants are observed over time while being exposed to varying levels of staffing. Two independent reviewers evaluated the bias risk for each article, and any discrepancies in their assessments were resolved through collaborative discussion [9].

**RESULTS**

The search process initially identified 611 publications **(Figure 1)**. After removing 342 duplicates, 269 trials were screened based on their titles and abstracts. Of these, 201 did not meet the eligibility criteria, leaving 66 full-text articles for in-depth evaluation. In the end, 6 studies met the inclusion criteria and were selected for evidence synthesis and analysis.

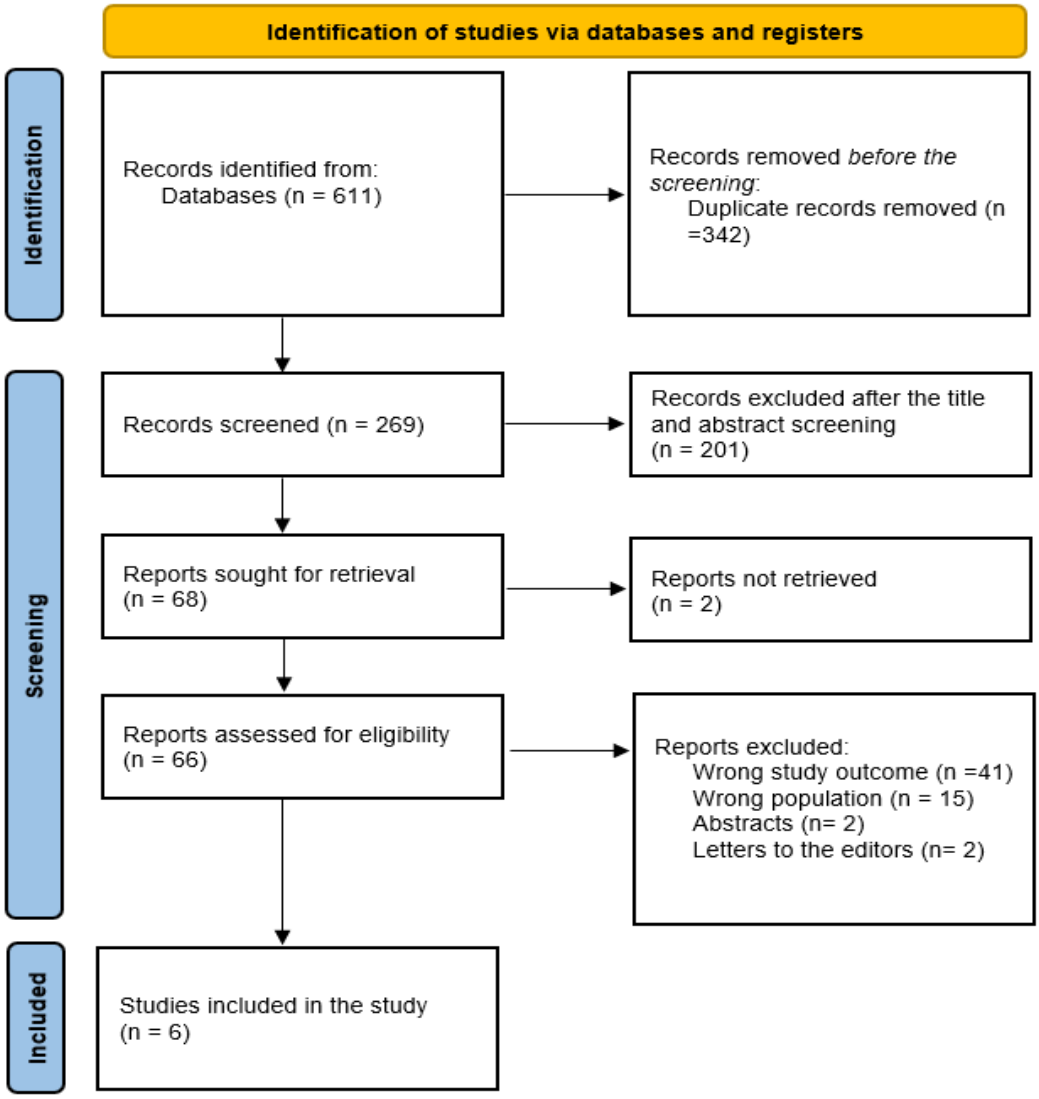


**Figure (1): Search summary illustrated in PRISMA flowchart.**

**Sociodemographic and clinical outcomes**

Six studies were included, with a total of 250 patients suffering from pericardial disease, of whom 142 (56.8%) were male. The study designs consisted of four retrospective cohort studies [10-12,15], one observational cohort study [13], and one case series [14]. The research took place across different countries: three studies in Italy [11-13], one in the USA [10], one in China [14], and one in Egypt [15] **(Table 1)**.

The findings across the reviewed studies emphasize the expanding role of advanced imaging, particularly cardiac MRI and CT, in evaluating pericardial diseases **(Table 2)**. One study highlighted how cardiac MRI can act as a meaningful addition to standard diagnostic methods, especially in pediatric pericarditis, by providing detailed insights that can influence clinical decisions in select cases [10].

In patients with recurrent pericarditis, MRI was found to detect signs of ongoing pericardial inflammation, which could help identify individuals at greater risk of experiencing further episodes. Interestingly, this risk appears to be independent of traditional inflammatory markers like peak C-reactiveprotein levels, even after just one acute episode [11]. MRI findings also proved helpful in guiding treatment decisions, as detecting inflammation may indicate the need for more intensive anti-inflammatory therapy to lower the chances of recurrence [12].

The timing of imaging was also noted to be crucial. Performing a cardiac MRI within two weeks of symptom onset was shown to enhance its diagnostic value and assist in identifying patients who might face future complications [13]. In addition to MRI, 4D CT imaging was explored for its ability to assess pericardial adhesions. This approach demonstrated potential as an efficient and objective tool for preoperative planning in clinical practice [14].

Furthermore, MRI showed high diagnostic accuracy—up to 93%—in differentiating constrictive pericarditis from restrictive cardiomyopathy by evaluating pericardial thickening. In situations where echocardiography is inconclusive or inconsistent with the patient's symptoms, both CT and MRI were found to be especially beneficial, highlighting their importance in complex diagnostic cases [15].

**Table (1): Summary of demographic from the included studies.**

| Study ID | Country | Study design | Participants | Males (%) | Mean age (years) |
|---|---|---|---|---|---|
| **Baskar *et al.* 2018** [10] | USA | Retrospective cohort | 21 | 17 (81%) | 17 |
| **Conte *et al.* 2022** [11] | Italy | Retrospective cohort | 26 | 16 (61.5%) | Not mentioned |
| **Conte *et al.* 2021** [12] | Italy | Retrospective cohort | 25 | 17 (68%) | Not mentioned |
| **Imazio *et al.* 2020** [13] | Italy | Observational cohort study | 128 | 60 (46.9%) | 48.5 |
| **Ren *et al.* 2025** [14] | China | Case-series | 20 | 12 (60%) | 53.2 |
| **Aborashed *et al.* 2019** [15] | Egypt | Retrospective cohort | 30 | 20 (66.7%) | 15-59 (range) |

**Table (2): Summary of clinical outcome measures from the included studies.**

| Study ID | Imaging modality | Disease | Main outcomes |
|---|---|---|---|
| **Baskar *et al.* 2018** [10] | Cardiac MRI | Pediatric pericarditis | This study suggests that cardiac MRI can serve as a valuable complement to traditional evaluation methods in specific cases. |
| **Conte *et al.* 2022** [11] | Cardiac MRI | Recurrent pericarditis | A cardiac MRI showing signs of pericardial inflammation may help identify patients who are more likely to experience recurrent pericarditis, regardless of their peak C-reactive protein levels, even after just the initial episode of acute pericarditis. |
| **Conte *et al.* 2021** [12] | Cardiac MRI | Pericarditis | When cardiac MRI detects pericardial inflammation, it may help pinpoint patients who could benefit from more intensive anti-inflammatory treatment to reduce the risk of pericarditis coming back. |
| **Imazio *et al.* 2020** [13] | Cardiac MRI | Recurrent pericarditis | Cardiac MRI criteria can be especially useful for diagnosing pericarditis when the scan is done within two weeks of symptom onset. It can also help identify patients who are more likely to face complications. |
| **Ren *et al.* 2025** [14] | 4D CT | Pericardial adhesions | This proof-of-concept study presents and validates a novel quantitative method for assessing pericardial adhesions using 4D CT imaging. It provides a practical and efficient tool for objective preoperative evaluations in clinical settings. |
| **Aborashed *et al.* 2019** [15] | CT and MRI | Pericardial disease | MRI demonstrated a 93% accuracy rate in distinguishing constrictive pericarditis from restrictive cardiomyopathy by identifying a thickened pericardium. CT and MRI are especially useful when echocardiography results are unclear or do not align with the patient's clinical presentation. |

**Table (3): Risk of bias assessment using ROBINS-I**

| Study ID | Bias due to confounding | Bias in the selection of participants | Bias in the classification of interventions | Bias due to deviations from the intended interval | Bias due to missing data | Bias in the measurement of outcomes | Bias in the selection of reported result | Overall bias |
|---|---|---|---|---|---|---|---|---|
| **Baskar *et al.* 2018** [10] | Low | Low | Mod | Low | Low | Low | Mod | Low |
| **Conte *et al.* 2022** [11] | Mod | Low | Low | Low | Low | Mod | Low | Low |
| **Conte *et al.* 2021** [12] | Low | Low | Mod | Low | Low | Low | Mod | Low |
| **Imazio *et al.* 2020** [13] | Mod | Mod | Low | Low | Low | Mod | Mod | Moderate |
| **Aborashed *et al.* 2019** [15] | Mod | Mod | Low | Low | Low | Mod | Mod | Moderate |
| **Ren *et al.* 2025** [14] | Crit | Mod | Low | Low | Low | Mod | Mod | Critical |

## DISCUSSION

The evidence gathered from the reviewed studies underscores the significant role that cardiac MRI and CT play in evaluating and managing pericardial conditions. Cardiac MRI, in particular, has emerged as a highly effective tool for detecting inflammation and pericardial thickening. It has shown clinical value across different age groups, notably in recurrent pericarditis cases. Beyond its diagnostic capabilities, MRI offers valuable prognostic insight by identifying patients at risk of future complications or recurrence. **Wang *et al.*** [16] reported that cardiac MRI has become an essential tool in the comprehensive evaluation of suspected pericardial conditions. The insights gained from cardiac MRI can support more informed clinical decision-making and help tailor management and follow-up strategies to individual patient needs. However, there is still a need for further research to refine LGE reporting protocols, enhance diagnostic accuracy, and better understand how imaging findings influence treatment [16]. Additionally, **Anthony *et al.*** [17] confirmed that cardiac MRI has become a highly valuable technique in diagnosing pericardial disease.

Meanwhile, this review stated that the application of 4D CT imaging presents a promising advancement in visualizing pericardial adhesions, offering clinicians a practical and efficient tool for preoperative assessment. Altogether, these findings highlight the importance of incorporating advanced imaging into routine evaluation—especially in cases where echocardiography results are inconclusive or limited. Because CT and MR imaging can better visualize and characterize lesions, their value is likely understated, even though echocardiography is the preferred modality when extra imaging is required to diagnose pericarditis or to direct diagnostic or therapeutic procedures. The pathologic substrate determines the imaging results. Following the introduction of contrast material, the pericardial layers thicken and exhibit diffuse enhancement on CT scans. In cases of exudative or purulent forms, the diminution of pericardial fluid may be enhanced or it may be comparable to that of water. There could be cardiac tamponade symptoms. Pericardial layers often thicken irregularly in chronic kinds of pericarditis, and adhesions may cause effusions to be loculated [18].

To give superior anatomic information of the pericardium, contemporary multidetector CT scanners combine volumetric scanning, high spatial and contrast settlement, and acquisition speed. The preferred technique for showing pericardial calcifications is unquestionably multidetector CT [16].

On a wider perspective, **Yevenes *et al.*** [19] demonstrated that while echocardiography is typically the first-line imaging tool for evaluating pericardial disease, CT and MRI serve as important complementary methods, especially when initial results are unclear. Their strength lies in offering both detailed anatomical and functional information, along with a broader field of view. Additionally, a solid understanding of how conditions like cardiac tamponade and constrictive pericarditis appear on these advanced imaging modalities can significantly improve the speed and accuracy of diagnosis, causing more timely and effective patient care.

From a practical standpoint, integrating cardiac MRI and CT into diagnostic workflows can significantly enhance the precision and efficiency of pericardial disease management. These imaging methods allow for a more detailed and individualized assessment, guiding both diagnosis and treatment decisions. For instance, detecting active inflammation through MRI may support the early use of anti-inflammatory therapies and encourage more rigorous follow-up in high-risk

patients. In surgical contexts, 4D CT can assist in preoperative decision-making by accurately mapping the extent of pericardial adhesions, thereby reducing intraoperative uncertainties. These contributions are particularly valuable in complex cases, where standard assessments fall short in capturing the full picture[19].

However, the review also has its limitations. The majority of the studies were retrospective, which may introduce bias and limit the strength of their conclusions. The relatively small sample sizes in several reports reduce the generalizability of findings. Variability in imaging protocols and diagnostic criteria across studies may also influence the consistency of outcomes. Furthermore, long-term follow-up data were scarce, making it difficult to assess how imaging findings correlate with clinical progression over time.

## CONCLUSION

In summary, cardiac MRI and CT have become essential tools in the assessment of pericardial diseases. MRI provides detailed insight into inflammatory activity and structural abnormalities, while CT, including newer 4D techniques, delivers critical anatomical information for surgical planning. When used alongside echocardiography, these modalities enhance diagnostic clarity and contribute to more effective, individualized care. Although the current evidence base has some limitations, the overall findings strongly support broader adoption of advanced imaging in clinical practice. Moving forward, larger prospective studies are needed to refine imaging protocols, validate findings, and ultimately optimize care for patients with pericardial disorders.

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## REFERENCES


1. **Adler Y, Charron P, Imazio M *et al.* (2015):** 2015 ESC guidelines for the diagnosis and management of pericardial diseases the task force for the diagnosis and management of pericardial diseases of the European society of cardiology (ESC) endorsed by: the European association for cardio-thoracic surgery (EACTS). European Heart Journal, 36(42):2921-64.
2. **Klein A, Abbara S, Agler D *et al.* (2013):** American Society of Echocardiography clinical recommendations for multimodality cardiovascular imaging of patients with pericardial disease: endorsed by the Society for Cardiovascular Magnetic Resonance and Society of Cardiovascular Computed Tomography. Journal of the American Society of Echocardiography, 26(9):965-1012.
3. **Leiner T, Bogaert J, Friedrich M *et al.* (2020):** SCMR Position Paper (2020) on clinical indications for cardiovascular magnetic resonance. Journal of Cardiovascular Magnetic Resonance, 22(1):76. doi: 10.1186/s12968-020-00682-4.
4. **Maisch B, Seferovic P, Ristic A *et al.* (2004):** Guidelines on the diagnosis and management of pericardial diseases executive summary: The task force on the diagnosis and management of pericardial diseases of the European Society of Cardiology. Eur Heart J., 25(7):587-610.
5. **Ling L, Oh J, Breen J *et al.* (2000):** Calcific constrictive pericarditis: is it still with us? Ann Intern Med., 132(6):444-450.
6. **Zayas R, Anguita M, Torres F *et al.* (1995):** Incidence of specific etiology and role of methods for specific etiologic diagnosis of primary acute pericarditis. Am J Cardiol., 75(5):378-382.
7. **Page M, McKenzie J, Bossuyt P *et al.* (2021):** The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. International Journal of Surgery, 88:105906. doi: 10.1016/j.ijsu.2021.105906.
8. **Ouzzani M, Hammady H, Fedorowicz Z *et al.* (2016):** Rayyan—a web and mobile app for systematic reviews. Systematic Reviews, 5(1):210. doi: 10.1186/s13643-016-0384-4.
9. **Sterne J, Hernán M, Reeves B *et al.* (2016):** ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ., 355:i4919. doi: 10.1136/bmj.i4919.
10. **Baskar S, Betancor J, Patel K *et al.* (2018):** Cardiac MRI in evaluation and management of pediatric pericarditis. Progress in Pediatric Cardiology, 50:39-45.
11. **Conte E, Agalbato C, Gaudenzi-Asinelli M *et al.* (2022):** Prognostic role of cardiac MRI after first episode of acute pericarditis: a long-term follow-up study. European Heart Journal, 354: 63-67.
12. **Conte E, Lauri G, Agalbato C *et al.* (2021):** Prognostic role of cardiac MRI in the evaluation of patients with pericarditis: a long-term follow-up study. European Heart Journal-Cardiovascular Imaging, 22(1):jeaa356-332. https://doi.org/10.1093/ehjci/jeaa356.332
13. **Imazio M, Pivetta E, Restrepo S *et al.* (2020):** Usefulness of cardiac magnetic resonance for recurrent pericarditis. The American Journal of Cardiology, 125(1):146-51.
14. **Ren T, Wang S, Cheng N *et al.* (2015):** Quantitative detection of pericardial adhesions using 4D CT: A novel motion-based analysis framework. Bioengineering, 12(3): 224. https://doi.org/10.3390/bioengineering12030224
15. **Aborashed A, Ahmed M, Ali A (2019):** Role of CT and MRI in diagnosis of pericardial diseases. Egypt J Hosp Med., 76(4):3950–56.
16. **Wang T, Ayoub C, Chetrit M *et al.* (2022):** Cardiac magnetic resonance imaging techniques and applications for pericardial diseases. Circulation: Cardiovascular Imaging, 15(7):e014283. doi: 10.1161/CIRCIMAGING.122.014283.
17. **Anthony C, Akintoye E, Wang T *et al.* (2024):** Role of cardiac MRI in pericardial diseases. Current Cardiovascular Imaging Reports, 17(4):43-51.
18. **Taylor A, Dymarkowski S, Verbeken E *et al.* (2006):** Detection of pericardial inflammation with late-enhancement cardiac magnetic resonance imaging: initial results. Eur Radiol., 16(3): 569–574.
19. **Yevenes S, Broncano J, Gutierrez F (2016):** CT and MR update of pericardial diseases: a systematic review. Current Radiology Reports, 4:1. DOI:10.1007/s40134-016-0180-x.