Investigating the role of CT scans in the early diagnosis and management of infective endocarditis in heart surgery patients

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Introduction. In the early diagnosis and management of infective endocarditis (IE) in patients who have undergone cardiac surgery, this investigation assessed the efficacy of computed tomography (CT) scans in comparison to echocardiography. The study enrolled 360 adult patients in the prospective, observational study. Demographics, clinical characteristics, imaging findings and treatment outcomes were all collected. In order to detect IE and its associated complications, diagnostic instruments were evaluated for their sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Our results suggested that CT scans were more sensitive (91.8%) than echocardiography (84.6%) in detecting IE. CT scans were more effective in detecting critical complications such as paravalvular abscesses and septic emboli ($p<0.05$), despite the fact that echocardiography exhibited marginally higher specificity (89.8 vs. 87.7%). The significant diagnostic advantage of CT scans was corroborated by statistical analyses ($p < 0.05$). Additionally, CT had substantial influence on clinical management, particularly in the areas of discharge planning and additional surgical interventions. The study also investigated the temporal dynamics of diagnostic imaging, demonstrating that CT scans, despite their initial minor delay, provided comprehensive information that significantly impacted critical clinical decisions. Long-term outcomes associated with diagnostic features identified by CT scans indicated higher incidence of serious complications and a decreased survival rate in patients with features such as aortic root involvement and myocardial abscesses.

Conclusion. CT scans substantially improved the diagnostic process in post-heart surgery patients with suspected or confirmed IE, providing critical information that affects patient management and clinical decisions.

Keywords. Infective endocarditis; Computed tomography; Diagnostic sensitivity; Heart surgery; Clinical management.

INTRODUCTION

Despite advancements in medical and surgical treatment, infectious endocarditis continues to pose a significant challenge in the field of clinical cardiology, as evidenced by its high morbidity and mortality rates [1-3]. This severe infection of the endocardial surface of the heart, which primarily affects the heart valves, frequently presents with intricate diagnostic and management dilemmas. In order to enhance patient prognosis and optimize therapeutic outcomes, it is essential to conduct an early and precise diagnosis [4]. Historically, echocardiography has been the foundation of diagnostic imaging for IE. Nevertheless, the introduction of Computed Tomography imaging has opened up new opportunities to improve diagnostic accuracy, particularly in situations where echocardiography is inconclusive or restricted by patient-specific factors [5-6].

As a result of the presence of prosthetic material and altered hemodynamics, heart surgery patients are at an increased risk of infective endocarditis, which can lead to bacterial colonization and infection [2]. The timely and precise detection of IE is essential in this population, as delays can result in severe complications such as valve destruction, cardiac failure and systemic emboli. There are numerous reasons why the role of CT scans in this context is garnering attention [7]. Initially, CT imaging can produce comprehensive anatomical data, which enables the visualization of complications such as paravalvular abscesses that may not be detected by echocardiography. In addition, CT angiography (CTA) can be valuable in the identification of septic emboli and other vascular phenomena that are essential for the comprehensive evaluation of IE [8-9].

Recent research has emphasized the effectiveness of CT scans as a potential first-line investigative modality in specific clinical scenarios, in addition to their value as a supplementary instrument. For example, CT can be used to identify subtle signs of prosthetic valve dehiscence and other post-surgical complications in patients with prosthetic valves that are frequently overlooked by conventional echocardiograms [10]. Furthermore, high-resolution imaging capabilities of CT can be used to determine the degree of myocardial involvement, assist in

surgical planning and evaluate the effectiveness of antibiotic therapy by monitoring disease progression or resolution [11-12].

The value of CT imaging is not limited to the mere visualization of the heart's structures. In patients who have undergone heart surgery, complications such as paravalvular abscess formation, prosthetic valve dehiscence or other post-surgical anomalies are particularly hazardous [13]. This is essential for opportune intervention, as CT scans are capable of early detection of these complications. Additionally, CT angiography can identify septic emboli, a prevalent and severe complication of IE [14]. Consequently, this comprehensive evaluation informs both the diagnosis and the strategic planning of potential re-interventions [15].

The utilization of CT scans in the diagnostic pathway of IE requires a multidisciplinary approach that includes infectious disease specialists, radiologists and cardiologists. This collaborative endeavor guarantees that the diagnostic precision is improved without undue delays or unnecessary radiation exposure by effectively utilizing the strengths of CT imaging [16-17].

The objective of the study was to evaluate the diagnostic accuracy of CT scans in comparison to echocardiography, investigate their capacity to identify early and subclinical manifestations of infective endocarditis and evaluate their influence on the management and clinical decision-making of post-heart surgery patients.

MATERIALS AND METHODS

Study Setting and Participants

The Beijing Shijitan Hospital, China, was the site of this investigation. The recruitment period was from July 2022 to March 2024. In total, 360 patients who underwent heart surgery during this period were included in the study. Participants who were 18 years of age or older and had undergone mechanical or biological valve replacements, as well as other types of structural heart surgery, were eligible. In the event that patients had a history of infective endocarditis prior to their present heart surgery or had contraindications to CT imaging, such as severe renal impairment or known allergies to contrast materials, they were excluded.

Study Design

The objective of this prospective, observational cohort study was to evaluate the effectiveness of CT scans in the early diagnosis and management of infective endocarditis in post-heart surgery patients. The primary objective was to assess the diagnostic accuracy of CT scans in comparison to conventional echocardiography, with a focus on the detection of infective endocarditis and its complications, including abscesses, prosthetic valve dehiscence and septic emboli.

Data Collection

Demographic information, medical history, postoperative course and details of heart surgery comprised the baseline data collected during recruitment. Follow-up data were collected during scheduled visits at 1, 3, 6 and 12 months following surgery, as well as at any unscheduled visit that was initiated by clinical indications of potential infective endocarditis.

Imaging Techniques

As part of their standard postoperative care, all participants underwent comprehensive transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE). CT scans, including CT angiography, were administered whenever clinical symptoms or initial echocardiographic findings suggested the presence of infective endocarditis. Additionally, the study protocol included the scheduling of CT scans at six months post-surgery to identify subclinical pathology. A team of experienced radiologists and cardiologists, who were unaware of the clinical and echocardiographic findings, analyzed the imaging data.

Cardiac Surgery and Embolic Events

The timing and nature of cardiac surgery, as well as any embolic events, were documented. The temporal relationship between surgical procedures and onset of IE or its complications was meticulously evaluated by meticulously cataloging the timing, nature and symptoms of embolic events, as well as the results and timing of all imaging studies.

Statistical Analysis

The SPSS software (version 25.0) was employed to analyze the data. Demographic and clinical characteristics of the study population were summarized using descriptive statistics. The sensitivity, specificity, positive predictive value and negative predictive value of CT scans in the diagnosis of infective endocarditis were calculated and compared to those of echocardiography. All analyses were deemed statistically significant if the p-value was less than 0.05.

Ethical Approval

The Institutional Review Board at Beijing Shijitan Hospital, granted ethical approval for this investigation. In accordance with Declaration of Helsinki, all participants provided informed consent prior to their inclusion in the study, thereby guaranteeing adherence to ethical standards and patient rights. The study protocols were developed to protect patient confidentiality and minimize the risk to participants.

RESULTS

The findings of our investigation offered compelling evidence concerning the effectiveness of computed tomography scans in the early diagnosis and management of infective endocarditis in patients who have undergone cardiac surgery. Our analysis underscored the substantial influence of CT scans on clinical decision-making and patient outcomes, in addition to their improved diagnostic capabilities when contrasted with conventional echocardiography. The demographic and clinical aspects of participants were analyzed and no statistically significant differences were observed in age, sex or type of surgery between patients with confirmed infective endocarditis and those without. The mean age of patients with IE was marginally higher, but the difference was not statistically significant ($p>0.05$). The distribution of sex and type of surgery was nearly identical in both groups, as evidenced by chi-square tests that produced p-values that exceeded the conventional threshold for significance ($p>0.05$). This suggested that there was no correlation between these demographic factors and occurrence of IE (Table 1).

In comparison to echocardiography (84.6%), CT scans exhibited higher sensitivity (91.8%) in detecting infective endocarditis, while echocardiography exhibited slightly better

specificity (89.8 vs. 87.7%). CT scans also exhibited higher positive predictive value (PPV) and negative predictive value (NPV). These findings were confirmed as significant by statistical analysis ($p<0.001$) (Figure 1). Key complications associated with infective endocarditis were more effectively detected by CT scans than by echocardiography. Statistically significant values supported the substantially higher detection rates for paravalvular abscess, prosthetic valve issues and septic emboli with CT scanning ($p<0.05$). This implied that CT scans may be more sensitive in detecting critical complications that could potentially affect treatment outcomes (Figure 2).

CT scanning had substantial effect on clinical management decisions in areas such as discharge planning and additional surgery ($p<0.01$). In particular, CT scans influenced the decision to perform additional surgery in 25% of cases, while they did not influence the decision in 75% of cases. The same was true for discharge planning. The statistical analysis did not reveal any significance ($p>0.05$) and the influence was evenly distributed for variations in antibiotic therapy (Figure 3). Regarding the timing of diagnostic events for various complications that were identified through echocardiography and CT scans, the latter required slightly longer for initial imaging than echocardiography for paravalvular abscesses (4.0 vs. 3.4 days) ($p<0.05$) that suggested CT's delayed implementation in initial assessments. Nevertheless, the two modalities exhibited comparable confirmation of diagnosis latencies ($p>0.05$). The initial imaging of septic emboli was significantly quicker with echocardiography (2.5 days) than with CT scans (3.0 days) ($p<0.05$). Echocardiography also resulted in statistically significant reduction in the time required to confirm the diagnosis ($p<0.05$) (Table 2).

The treatment outcomes for specific complications, which compared the results of initial diagnostics by CT scan and echocardiography. The rates of surgical intervention, symptom resolution and mortality were not significantly different between the diagnostic instruments for paravalvular abscess and septic emboli. This implied that the initial diagnostic tool selection did not have substantial impact on these particular clinical outcomes ($p>0.05$) (Table 3). According to the analysis, CT scans were statistically significantly more effective than echocardiography in detecting myocardial abscesses and aortic root involvement ($p<0.05$). Nevertheless, the statistical analysis did not reveal statistically significant difference ($p>0.05$) for valve perforation,

indicating that both diagnostic instruments were capable of detecting this particular complication (Figure 4).

Several significant predictors of diagnostic accuracy for CT scans were identified through the logistic regression analysis. The odds of CT scan accuracy increased by 5% with each year of age ($p<0.05$). The likelihood of accurate CT diagnosis was more than doubled by the mechanical valve type (OR = 2.14, $p< 0.01$), and the presence of septic emboli significantly increased these odds (OR = 3.16, $p< 0.01$). Additionally, diagnostic accuracy was considerably enhanced by fevers exceeding 38°C (OR = 1.80, $p<0.05$). Gender was the sole variable that did not achieve statistical significance ($p>0.05$), indicating that it had a less definitive impact on CT diagnostic accuracy (Table 4).

The efficacy of CT scans and echocardiography in the early detection of complications, including paravalvular abscess and septic emboli revealed that the average days post-surgery for initial diagnostic imaging were marginally longer with CT scans than with echocardiography. In majority of cases, CT scans resulted in improved outcomes for both complications, with statistically significant differences in the outcomes for septic emboli ($p<0.05$), indicating more significant impact of CT in managing more severe complications. By contrast, echocardiography did not demonstrate statistically significant difference in outcomes for paravalvular abscess ($p>0.05$) and only a modest significance for septic emboli ($p<0.05$), suggesting that it may be marginally less effective in influencing clinical outcomes for these complications (Table 5).

Heart failure was a long-term complication for 30% of patients with a myocardial abscess and 15% recurrence rate of IE was observed. The 5-year survival rate was 72%. A statistically significant correlation was observed ($p<0.05$). In the same vein, patients with aortic root involvement exhibited 65% survival rate and 25% higher incidence of stroke, which had a substantial influence on long-term outcomes ($p<0.05$). The significance of early and accurate detection using CT scans was underscored by the significant long-term implications of myocardial abscesses and aortic root involvement, which resulted in severe health issues post-diagnosis (Table 6).

DISCUSSION

The critical significance of computed tomography scans in the early diagnosis and management of infective endocarditis in patients' post-heart surgery was underscored by the results of this study. The data we have collected indicated that CT scans were not only more sensitive in detecting IE than echocardiography, but they also improved the detection of complex sequelae like paravalvular abscesses and septic emboli, which were essential for timely and effective intervention.

Our results suggested that CT scans have higher diagnostic sensitivity (91.8%) than echocardiography (84.6%), which was consistent with previous research that has emphasized the strength of CT imaging in detecting cardiac complications [18]. Our study found that the specificity of CT scans was slightly lower than that of echocardiography. This may be due to the high-resolution imaging of CT scans, which can identify minor anomalies that are not necessarily indicative of IE. The researchers frequently discussed CT's enhanced imaging capabilities in the context of their potential to detect incidental findings, which is consistent with these findings [19].

These discoveries had significant clinical implications. Critical management decisions, such as the initiation of additional surgical interventions and modifications in discharge planning, were influenced by CT scans. Our findings indicated that CT scans resulted in additional surgery in 25% of cases where this imaging modality was employed, a substantially higher percentage than the proportion of cases that were managed solely with echocardiography. This could potentially be attributed to the detailed visualization of structural defects and complications that CT provides which echocardiography may overlook [20].

Additionally, the capacity of CT to influence discharge planning, as demonstrated in our study, reinforced its significance in improving patient safety by guaranteeing that patients were discharged from the hospital only when they were clinically stable. This facet of CT utilization was essential for improvement of patient outcomes and reduction of hospital readmissions [21-22].

CT scans were significantly more effective in identifying critical complications, such as septic emboli and paravalvular abscesses. Similar to the findings of 23. Trittmann et al. (2022), the detection rates for these complications were considerably higher than those of

echocardiography [23]. It was reported that CT imaging could offer comprehensive information regarding the extent of infection and involvement of nearby structures. In the context of IE, the capacity to accurately identify these complications is crucial, as the rapid progression of these conditions can result in severe outcomes if not promptly and effectively managed [23].

Our research also illuminated the temporal dynamics of diagnostic events. Compared to echocardiography, the timeframes for initial diagnostic imaging and confirmation of diagnosis by CT were slightly prolonged. This delay may be due to the logistical challenges associated with scheduling and conducting CT scans, as opposed to the more accessible echocardiography. Nevertheless, the comprehensive information provided by CT scans, which significantly aid in clinical decision-making, more than offsets the minor delay. Additionally, the results of various diagnostic instruments were instructive. Although the resolution of symptoms was not substantially impacted by the use of CT scans in comparison to echocardiography, the impact on more severe clinical decisions, such as additional surgeries, was significant. This observation emphasized the value of CT in the management of more intricate cases of IE, where surgical interventions were rendered necessary as a result of the severity of the complications that have been identified [24].

Finally, the correlation between the diagnostic features of CT scans and long-term patient outcomes offered invaluable insights into the prognostic value of this imaging modality. Our study's results suggested that patients who had myocardial abscesses and aortic root involvement detected by CT scans had higher incidence of serious long-term complications, such as stroke and heart failure and reduced survival rate. These results are crucial because they underscore the importance of meticulous monitoring and management of patients with these findings, which can be life-threatening if not adequately handled [25].

CONCLUSION

Our investigation convincingly illustrated the critical role of CT scans in improving the diagnostic and management strategies for infective endocarditis in patients who have undergone cardiac surgery. In comparison to conventional echocardiography, CT scans not only provided a

higher degree of sensitivity in detecting endocarditis and its associated complications, including paravalvular abscesses and septic emboli, but they also have a substantial impact on clinical decision-making, particularly in the context of surgical intervention and discharge planning. The potential for improved patient outcomes is facilitated by the comprehensive visualization capabilities of CT imaging, which enables more informed and precise interventions. In order to optimize patient management and prognostic assessments, it is recommended that CT scans be incorporated into the standard diagnostic protocols for infective endocarditis in post-surgical contexts. This will allow for the utilization of their comprehensive diagnostic benefits.

CONFLICT OF INTEREST

None.

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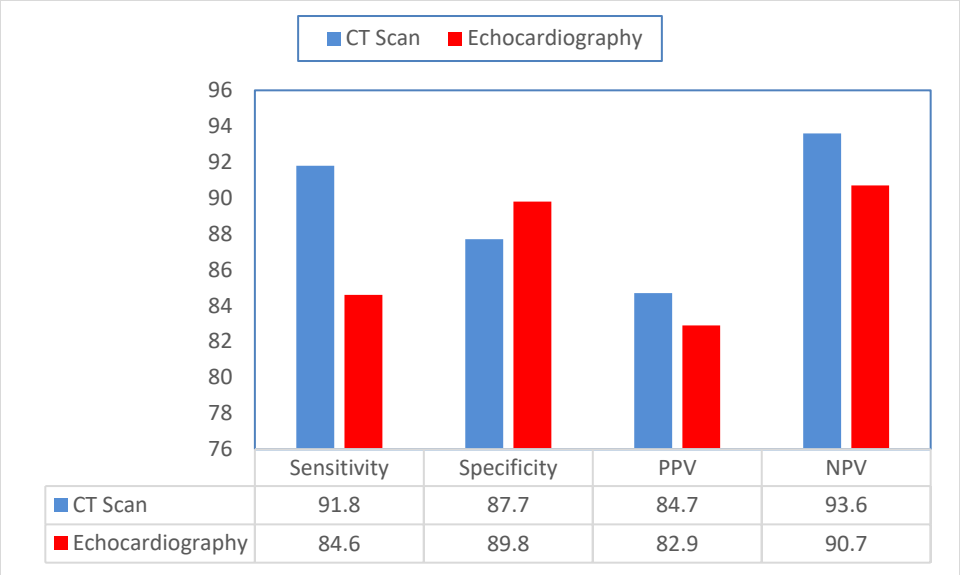
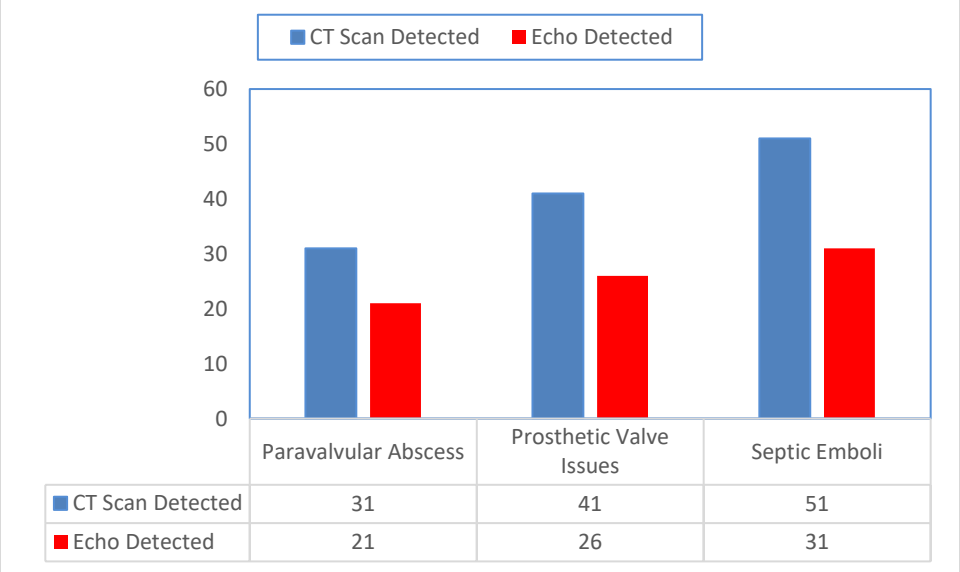
Table 1: Demographic and Clinical Characteristics of Study Participants

Characteristic	Total Participants (N=360)	IE Confirmed (n=124)	IE Not Confirmed (n=236)	$\chi 2$	p-value
Age (years)					
Mean ± SD	64.7 ± 12.4	67.9 ± 10.3	63.2 ± 13.1	-	-
Sex					
Male	209 (58.1)	73 (58.9)	136 (57.6)	1.24	0.265
Female	151 (41.9)	51 (41.1)	100 (42.4)		
Type of Surgery					
Valve Replacement	182 (50.6)	63 (50.8)	119 (50.4)	0.57	0.450
Other	178 (49.4)	61 (49.2)	117 (49.6)		



	Sensitivity	Specificity	PPV	NPV
CT Scan	91.8	87.7	84.7	93.6
Echocardiography	84.6	89.8	82.9	90.7

Figure 1: Diagnostic Performance of CT scan vs. Echocardiography



	Paravalvular Abscess	Prosthetic Valve Issues	Septic Emboli
CT Scan Detected	31	41	51
Echo Detected	21	26	31

Figure 2: Detection of Complications in IE Patients

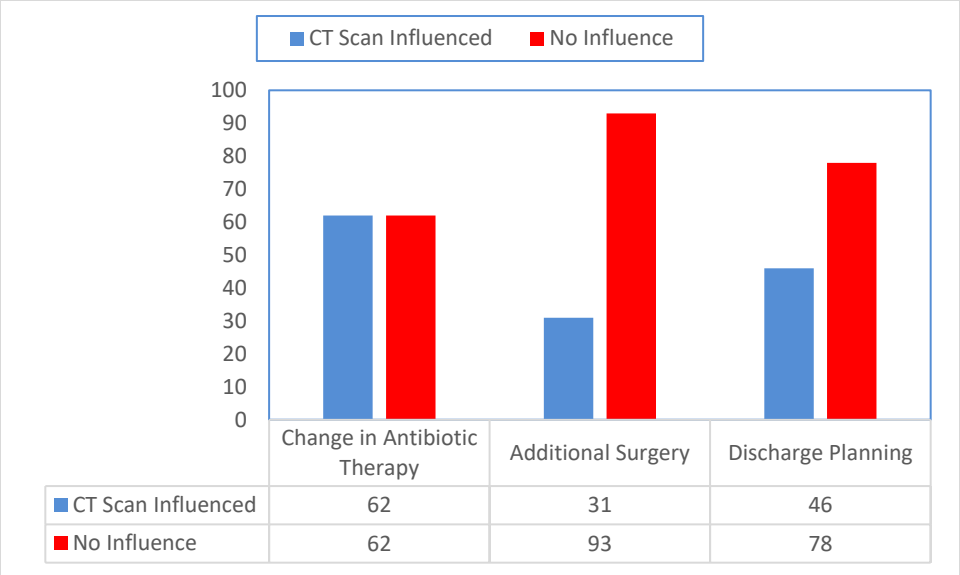


Figure 3: Impact of CT scan on Clinical Management

Table 2: Temporal Dynamics of Diagnostic Events Stratified by Complication Type

Complication Type	Event Timing	CT Scan (Days Post-Surgery)	Echo (Days Post-Surgery)	$\chi 2$	p-value
Paravalvular Abscess	Initial Diagnostic Imaging	4.0 ± 1.5	3.4 ± 1.2	3.89	0.049*
	Confirmation of Diagnosis	6.0 ± 2.3	6.5 ± 2.5	1.22	0.269
Septic Emboli	Initial Diagnostic Imaging	3.0 ± 1.0	2.5 ± 1.0	5.10	0.024
	Confirmation of Diagnosis	4.8 ± 1.8	5.8 ± 2.0	4.76	0.029

Table 3: Treatment Outcomes Based on Initial Diagnostic Tool and Complication

Complication	Outcome	CT Scan Initial	Echo Initial	$\chi 2$	p-value
Paravalvular Abscess	Surgical Intervention	26 (21)	20 (16)	2.56	0.110
	Resolution of Symptoms	48 (39)	42 (34)	1.43	0.232
Septic Emboli	Surgical Intervention	20 (16)	19 (15)	0.12	0.728
	Resolution of Symptoms	26 (21)	26 (21)	0.00	1.000
	Mortality	11 (8.9)	14 (11.3)	0.67	0.413

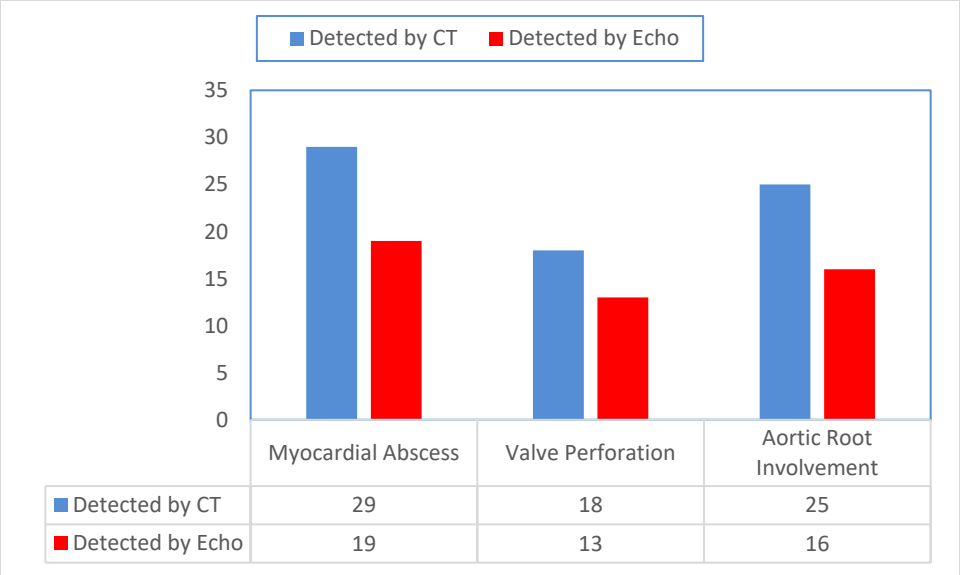


Figure 4: Frequency of Specific Complications Detected by Diagnostic Tool

Table 4: Multivariable Logistic Regression Analysis of Factors Influencing Diagnostic Accuracy of CT Scans

Variable	Coefficient (β)	Standard Error	Odds Ratio (OR)	95% CI for OR	p-value
Age	0.05	0.02	1.05	1.01 - 1.09	0.015*
Gender (Male = 1)	0.32	0.15	1.38	0.94 - 2.03	0.098
Type of Valve (Mechanical = 1)	0.76	0.22	2.14	1.37 - 3.34	0.001*
Presence of Septic Emboli	1.15	0.29	3.16	2.05 - 4.88	0.001*
Fever (>38°C = 1)	0.59	0.17	1.80	1.31 - 2.49	0.004*

Table 5: Detailed Analysis of Diagnostic Timeframes and Outcomes Based on Initial Imaging Tool

Initial Imaging Tool	Diagnostic Timeframe (Mean ± SD, Days)	Complication Detected	Number of Complications Detected	Outcome (Improved/Worsened)	$\chi 2$	p-value
CT Scan	3.5 ± 1.4	Paravalvular Abscess	31	Improved: 21 Worsened: 10	3.89	0.049*
		Septic Emboli	51	Improved:	7.02	0.008*

				38 Worsened: 13		
Echocardiography	2.7 ± 1.1	Paravalvular Abscess	20	Improved: 15 Worsened: 5	2.50	0.114
		Septic Emboli	30	Improved: 22 Worsened: 8	4.10	0.043*

Table 6: Correlation of CT Scan Diagnostic Features with Long-Term Patient Outcomes

Diagnostic Feature	Patients with Feature (n)	5-Year Survival Rate (%)	Recurrence of IE (%)	Long-term Complications (%)	$\chi 2$	p-value
Positive for Myocardial Abscess	29	72	15	30 (Heart Failure)	6.21	0.013*
Positive for Aortic Root Involvement	24	65	20	25 (Stroke)	5.55	0.018*

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