ADAMOWSKA, Agnieszka, ŚNIATAŁA, Alicja, BARTKOWIAK, Hanna, GRUBSKI, Damian, ZIARNIK, Kacper, NADOLNY, Filip, JABŁOŃSKI, Jędrzej and KANIA, Martyna. Left ventricular pseudoaneurysm - a rare complication of myocardial infarction - a systematic review. Journal of Education, Health and Sport. 2024;75:56277. eISSN 2391-8306.
https://dx.doi.org/10.12775/JEHS.2024.75.56277
https://apcz.umk.pl/JEHS/article/view/56277

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences).
Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).
The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 18.11.2024. Revised: 20.11.2024. Accepted: 02.12.2024. Published: 02.12.2024.

Left ventricular pseudoaneurysm - a rare complication of myocardial infarction - a systematic review

Agnieszka Adamowska
Józef Struś Multispecialist Muncipal Hospital
Szwajcarska 3, 61-285 Poznań
https://orcid.org/0009-0009-1977-2522
a.adamowska12@gmail.com

Alicja Śniatała
Regional Hospital in Poznań,
Juraszów 7-19, 60-479 Poznań
https://orcid.org/0009-0003-8488-3268
ala.sniatala@gmail.com

Hanna Bartkowiak
Józef Struś Multispecialist Muncipal Hospital
Szwajcarska 3, 61-285 Poznań
https://orcid.org/0009-0000-6914-4908
hannabartkowiak22@gmail.com

Damian Grubski
Józef Struś Multispecialist Municipal Hospital
Szwajcarska 3, 61-285 Poznań
https://orcid.org/0009-0003-9501-9950
damianxgrubski@gmail.com

Kacper Ziarnik
Regional Hospital in Poznan
Juraszow 7/19 60-479 Poznan
https://orcid.org/0009-0006-4676-3232
kacper.ziarnik@gmail.com

Filip Nadolny
University Hospital in Poznań
Przybyszewskiego 49, 60-355 Poznań
https://orcid.org/0009-0000-6433-5975
nadolnyfilip@gmail.com

Jędrzej Jabłoński
Regional Hospital in Poznań,
Juraszów 7-19, 60-479 Poznań
https://orcid.org/0009-0009-6204-407X
jedrzejkosma@gmail.com

Martyna Kania
University Hospital in Poznań
Przybyszewskiego 49, 60-355 Poznań
https://orcid.org/0009-0006-4400-0258
martyna.kania@outlook.com

ABSTRACT

Introduction

Left ventricular (LV) pseudoaneurysm is a rare but life-threatening complication following myocardial infarction (MI). Unlike true aneurysms, pseudoaneurysms lack myocardial elements in their structure, which increases the risk of rupture and sudden death. The diagnosis is challenging due to its often subtle and nonspecific symptoms. The high mortality rate associated with untreated pseudoaneurysms highlights the importance of awareness and prompt diagnosis. All patients after MI should receive specialized care and follow-up examinations to prevent unattended states of emergency.

Purpose of research

This systematic review aims to discuss a rare complication of MI in a form of LV pseudoaneurysm. Due to its potential asymptomatic course, it is important to highlight the importance of a meticulous clinical and echocardiographic follow-up in all patients with a history of MI.

Materials and methods

The study was conducted through search across PubMed and Google Scholar databases, using keywords such as “left ventricular pseudoaneurysm”, “myocardial infarction”, “post-infarction imagining”, “surgical treatment of pseudoaneurysms”. The analysis focused on scientific literature with validated insights into the pathophysiology, clinical presentation, diagnostic methods and treatment strategies of the MI complication in a form of left ventricular pseudoaneurysm.

Results and conclusions

The potentially fatal consequences of pseudoaneurysm dictate proactive approach in the treatment of patients with a history of MI. Routine follow-up examinations, comprehensive cardiac imaging and a high clinical alertness are essential for early diagnosis. By providing meticulous post-MI care, healthcare professionals can improve patients outcomes and reduce mortality.

Keywords: myocardial infarction, left ventricular pseudoaneurysm, false aneurysm, cardiothoracic surgery, echocardiography

INTRODUCTION

Myocardial infarction (MI) remains one of the leading causes of morbidity and mortality worldwide, affecting millions of people each year. [1] While advances in acute cardiac care have significantly improved survival rates, the long-term complications of MI remain a considerable medical concern.[2] Epidemiologically, post-MI complications can range from common conditions such as heart failure and arrhythmias to less common but more severe issues. Their incidence has decreased since the development of percutaneous coronary interventions. [3] Follow-up care typically involves clinical evaluations and diagnostic imaging to assess the structure and function of the heart, ensuring that any developing abnormalities are detected in a timely manner. [4] Examples of such complications include left ventricular free-wall rupture, ventricular septal rupture, papillary muscle rupture, formation of pseudoaneurysm or true aneurysm.[5] Typically, a free rupture into the pericardium causes cardiac tamponade and death. [6] Nevertheless, in rare cases, the rupture is limited, leading to LV pseudoaneurysm. [7] What makes this condition valid is the challenges in diagnosis caused by nonspecific clinical presentations and limitations of routine imaging techniques. [8] It often leads to delays in treatment, which can result in unfavorable outcomes. When diagnosed and treated in time, surgical intervention can significantly improve survival rates.[9]

Pathogenesis

The formation of a LV pseudoaneurysm generally begins with a rupture in the ventricular wall that occurs due to an increased wall stress and loss of myocardial integrity. [10] It is particularly determined by the pressure within the left ventricle and the size of the ventricular cavity. [8] It can arise following MI, cardiac surgery or trauma and is mostly located at the inferior and posterolateral wall. [8] Pseudoaneurysm consists of a narrow neck connecting the left ventricle to an outwardly bulging sac, which is filled with blood and thrombus and is surrounded by fibrous tissue. This containment allows the pseudoaneurysm to develop, although it remains structurally unstable. Its risk of rupture is significant due to the absence of myocardial tissue in its wall, making it less stable than a true aneurysm. [11] Rupture often results in catastrophic bleeding into the pericardial space, leading to cardiac tamponade and, if untreated, death. [12]

Unlike true aneurysms, which involve all layers of the myocardial wall, pseudoaneurysms lack myocardial tissue, making them structurally weaker and more prone to rupture. [11] Instead, they are composed of fibrous tissue and pericardium. [8] Recognizing the differences between aneurysms and pseudoaneurysms is essential for guiding diagnostic and therapeutic strategies, as pseudoaneurysms usually require urgent surgical intervention, while true aneurysms can be treated more conservatively, depending on symptoms and associated risks.

Table 1. Key differences between true aneurysm and pseudoaneurysm.[11 13 14]

Feature	True aneurysm	Pseudoaneurysm
Wall structure	Contains all layers of the heart (endocardium, myocardium, and pericardium).	Lacks myocardial and endocardial layers, only contained by pericardial or fibrous tissue.
Cause	Commonly caused by weakening of the ventricular wall due to myocardial infarction (MI) or chronic heart disease.	Typically caused by myocardial rupture contained by pericardium or fibrous tissue, often following MI, surgery, or trauma.
Neck size	Broad neck connecting the aneurysm to the ventricle.	Narrow neck compared to the size of the aneurysmal sac.
Rupture risk	Lower risk of rupture, as the aneurysm is composed of all heart layers.	Higher risk of rupture due to the lack of myocardial support.
Ventricular shape	Often results in a spherical or elongated bulging of the ventricular wall.	Appears as a discrete outpouching of the wall, usually contained by scar or pericardium.
Hemodynamics	May lead to heart failure due to ventricular dilation and poor	Can cause severe hemodynamic instability if it ruptures, leading

	contractility.	to tamponade.
Imaging findings	All ventricular layers visible in imaging, showing thinning and dilation of the wall.	Imaging shows a rupture with a narrow neck and blood-filled sac, often surrounded by pericardial tissue.
Management	Managed with medical therapy, monitoring, or surgery in severe cases.	Requires urgent surgical repair due to the high risk of rupture.

Clinical presentation

LV pseudoaneurysms form as a result of transmural myocardial infarction (55%), surgery (33%), trauma (7%), or infection (5%). [7]

Their clinical presentation is highly variable, ranging from asymptomatic to severe, life-threatening cases. [15] The nonspecific nature of symptoms often complicates the diagnosis, necessitating increased caution in patients with a history of myocardial infarction or cardiac surgery.

Asymptomatic Presentation:

A significant number of LV pseudoaneurysms are detected incidentally during scheduled follow-ups or imaging studies performed for other reasons.[8] Patients may be completely asymptomatic, particularly in the early stages of pseudoaneurysm formation. The lack of symptoms can delay diagnosis, increasing the risk of sudden rupture, which is estimated at 30% to 45% [8].

Chest Pain:

Chest pain is a common symptom in patients with LV pseudoaneurysms.[16] The pain may mimic angina pectoris or myocardial infarction itself. It is usually described as persistent and may vary

in intensity. It can be caused by the stretching of the pericardium or may indicate impending rupture of pseudoaneurysm, which requires urgent medical intervention.

Heart Failure Symptoms:

Patients may present with symptoms indicating heart failure, which include dyspnea, orthopnea or peripheral edema.[8] These symptoms arise from the hemodynamic consequences of the pseudoaneurysm, which can affect the heart's ability to circulate blood efficiently.

Syncope and Hypotension:

In cases where the pseudoaneurysm is large or has begun to rupture, patients may experience syncope or hypotension.[17] These symptoms indicate a significant compromise in cardiac output and may foreshadow a catastrophic rupture, which demands immediate surgical intervention.

Arrhythmias:

LV pseudoaneurysms can disrupt the normal electrical conduction pathways in the heart, leading to various arrhythmias.[18] Patients may experience palpitations, dizziness, or even sudden cardiac arrest in severe cases.[19] Arrhythmias can complicate the clinical course and increase the risk of negative outcomes.

Murmur:

On physical examination, patients with LV pseudoaneurysm may present with a new heart murmur.[20] This murmur is typically systolic and may be caused by turbulent blood flow through the narrow neck of the pseudoaneurysm. The presence of a murmur in patients with a history of myocardial infarction should prompt further investigation.

Symptoms of Cardiac Tamponade:

If the pseudoaneurysm ruptures into the pericardial space, the patient may rapidly develop symptoms of cardiac tamponade.[21] These symptoms include severe chest pain, hypotension, jugular venous distension, and muffled heart sounds.[22] Cardiac tamponade requires an immediate intervention.

Imagining

The nonspecific nature of symptoms often leads to delayed or missed diagnosis.

The main purpose of imaging is to distinguish pseudoaneurysms from true aneurysms, assess the extent of the lesion and make therapeutic decisions. Different imaging methods are used to capture different aspects of a pseudoaneurysm.

Table 2. Comparison of imaging methods used to diagnose LV pseudoaneurysm [8 9 23]

Imagining Method	Role	Strengths	Limitations	Specific Uses
Transthoracic Echocardiography (TTE)	Initial screening tool to assess structure and function of the heart	Widely available; non-invasive; no radiation exposure; bedside use	Limited resolution; operator-dependent; difficult with obesity or poor windows	Early detection of pseudo-aneurysm morphology and ventricular function
Transesophageal Echocardiography (TEE)	Provides more detailed images, especially of posterior structures	Higher resolution than TTE; useful for posterior pseudo-aneurysms	Semi-invasive; requires sedation; limited availability	Superior to TTE in detecting small pseudo-aneurysms or complex anatomy
Cardiac Magnetic Resonance Imaging (CMR)	Gold standard for detailed cardiac imaging and tissue characteriza-tion	High spatial resolution; no radiation; excellent tissue definition	Expensive; limited availability	Precise size and morphology assessment; fibrous tissue characterization

Computed Tomography (CT)	Useful for detailed structural imaging; often used in emergencies	High spatial resolution; fast scan; good for patients unsuitable for MRI	Ionizing radiation; contrast-induced nephropathy risk	Detection of rupture; evaluating size and assessing calcifications
Coronary Angiography	Used to assess coronary artery disease associated with pseudo-aneurysm	Simultaneous evaluation of coronary arteries; suitable for surgical planning	Invasive; risk of complications and contrast use	Identifies coronary artery involvement, often used prior to surgery
Cardiac Catheterization (Ventriculography)	Provides real-time dynamic imaging of the ventricular function	Can confirm diagnosis; evaluates hemodynamics; direct pressure measurements	Invasive; radiation exposure and contrast use	Assessing pseudo-aneurysm's impact on hemodynamics and cardiac function
Nuclear Imaging (SPECT or PET)	Assesses myocardial viability and perfusion	Provides functional data; useful in viability assessment	Low spatial resolution; radiation exposure	Identifies ischemia or infarcted areas around the pseudo-aneurysm

Together, these imaging techniques help to identify the morphology, size and neck of pseudoaneurysms. By evaluating the risk of sudden rupture, they make a crucial role in guiding further management decisions and determining whether surgical intervention is necessary.

Given the potential for catastrophic outcomes, any patient with a history of myocardial infarction, cardiac surgery, or chest trauma should be evaluated for an LV pseudoaneurysm.

Treatment

Surgical intervention

The treatment of LV pseudoaneurysm typically involves surgical intervention.[24] The specific approach may vary depending on the patient's clinical status, the size and location of the pseudoaneurysm, and the presence of comorbid conditions.[25] Surgery is the definitive treatment for LV pseudoaneurysms and is usually recommended as soon as the diagnosis is confirmed, due to the high risk of rupture.[26] The surgical approach generally involves resection of the pseudoaneurysm and repair of the ventricular wall. This can be achieved through direct suturing, patch closure, or a combination of both, depending on the extent of the defect and the surrounding myocardial tissue's viability. [27] [28]

Conservative Management

While surgical intervention is the preferred treatment, there are cases in which conservative management may be considered.[29] This approach is typically reserved for patients who are asymptomatic, have a small pseudoaneurysm, or are deemed too high-risk for surgery due to other medical conditions.[30] Conservative management may include close monitoring with regular imaging studies to detect any changes in the size or characteristics of the pseudoaneurysm. Medical therapy to control blood pressure and reduce wall stress may also be employed as part of a conservative approach.

Percutaneous Approach

In recent years, percutaneous techniques have been explored as a less invasive alternative to surgery for certain patients.[31] These approaches, such as coil embolization or the placement of a closure device, may be suitable for patients with specific anatomical features or those who are poor surgical candidates.[32]

Prognosis and Follow-Up

The prognosis after surgical repair of an LV pseudoaneurysm is generally positive, with a significant reduction of the risk of rupture.[33] Long-term follow-up is necessary to monitor for any recurrence or complications, particularly in patients who have undergone complex repairs.[34] Regular imaging and clinical evaluations are essential to ensure the ongoing stability of the repair and the overall health of the patient.

Conclusions

Complications following myocardial infarction, though considered rare, are among the most serious challenges in cardiac care. They can potentially cause life-threatening outcomes. This review highlights the importance of meticulous follow-up in all patients after MI to detect and manage these complications early. LV pseudoaneurysm is a rare but severe complication. It often presents with nonspecific symptoms, making timely diagnosis a significant challenge. Unlike true aneurysms, pseudoaneurysms lack myocardial integrity in their walls and are more predisposed to spontaneous rupture. Such ruptures can result in critical consequences, including cardiac tamponade and sudden death, which underscores the importance of vigilance in post-MI care.

Advanced imaging modalities such as echocardiography, cardiac magnetic resonance imaging (CMR), and computed tomography (CT) are essential for precise diagnosis of pseudoaneurysms. They help identify the structure and size of the pseudoaneurysm and assist in planning treatment. Surgical repair remains the most effective approach, aiming to remove compromised tissue, restore the structural integrity of the left ventricular wall, and avert fatal outcomes. Innovations in surgical techniques and perioperative care have led to improved success rates and significantly better survival outcomes for patients.

Raising awareness among healthcare professionals regarding the clinical presentation and risks of LV pseudoaneurysms is essential for timely diagnosis and intervention. Moreover, educating patients about the importance of regular follow-up after MI is vital to monitor for any evolving complications. This review underscores the combined importance of clinical alertness,

advanced diagnostic tools, and effective surgical management in improving prognosis and survival in patients with this rare but critical condition.

DISCLOSURES:

Author's contribution:

Conceptualization: Agnieszka Adamowska, Alicja Śniatała;

Methodology: Agnieszka Adamowska;

Software: Damian Grubski;

Check: Kacper Ziarnik, Jędrzej Jabłoński, Hanna Bartkowiak;

Formal analysis: Martyna Kania;

Investigation: Alicja Śniatała;

Resources: Filip Nadolny;

Data curation: Damian Grubski;

Writing - rough preparation: Kacper Ziarnik;

Writing - review and editing: Jędrzej Jabłoński, Agnieszka Adamowska

Visualization: Hanna Bartkowiak;

Supervision: Martyna Kania;

Project administration: Filip Nadolny;

Receiving funding: not applicable

All authors have read and agreed with the published version of the manuscript.

Funding Statement: This Research received no external funding.

Institutional Review Board Statement: Not applicable

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interests: The authors declare no conflict of interest.

References:

1. Heart Disease and Stroke Statistics—2021 Update | Circulation. Accessed November 3, 2024. https://www.ahajournals.org/doi/full/10.1161/CIR.0000000000000950

2. Bajaj A, Sethi A, Rathor P, Suppogu N, Sethi A. Acute Complications of Myocardial Infarction in the Current Era: Diagnosis and Management. *J Investig Med Off Publ Am Fed Clin Res*. 2015;63(7):844-855. doi:10.1097/JIM.0000000000000232

3. López-Sendón J, Gurfinkel EP, Lopez de Sa E, et al. Factors related to heart rupture in acute coronary syndromes in the Global Registry of Acute Coronary Events. *Eur Heart J*. 2010;31(12):1449-1456. doi:10.1093/eurheartj/ehq061

4. Prastaro M, Pirozzi E, Gaibazzi N, et al. Expert Review on the Prognostic Role of Echocardiography after Acute Myocardial Infarction. *J Am Soc Echocardiogr Off Publ Am Soc Echocardiogr*. 2017;30(5):431-443.e2. doi:10.1016/j.echo.2017.01.020

5. Gong FF, Vaitenas I, Malaisrie SC, Maganti K. Mechanical Complications of Acute Myocardial Infarction: A Review. *JAMA Cardiol*. 2021;6(3):341-349. doi:10.1001/jamacardio.2020.3690

6. Alerhand S, Adrian RJ, Long B, Avila J. Pericardial tamponade: A comprehensive emergency medicine and echocardiography review. *Am J Emerg Med*. 2022;58:159-174. doi:10.1016/j.ajem.2022.05.001

7. Prêtre R, Linka A, Jenni R, Turina MI. Surgical treatment of acquired left ventricular pseudoaneurysms. *Ann Thorac Surg*. 2000;70(2):553-557. doi:10.1016/s0003-4975(00)01412-0

8. Frances C, Romero A, Grady D. Left ventricular pseudoaneurysm. *J Am Coll Cardiol*. 1998;32(3):557-561. doi:10.1016/S0735-1097(98)00290-3

9. Meng X, Yang YK, Yang KQ, et al. Clinical characteristics and outcomes of left ventricular pseudoaneurysm: A retrospective study in a single-center of China. *Medicine (Baltimore)*. 2017;96(18):e6793. doi:10.1097/MD.0000000000006793

10.Parness S, Tasoudis P, Agala CB, Merlo AE. Management of Myocardial Infarction and the Role of Cardiothoracic Surgery. *J Clin Med*. 2024;13(18):5484. doi:10.3390/jcm13185484

11. Brown SL, Gropler RJ, Harris KM. Distinguishing Left Ventricular Aneurysm From Pseudoaneurysm: A Review of the Literature. *Chest*. 1997;111(5):1403-1409. doi:10.1378/chest.111.5.1403

12. Stremmel C, Scherer C, Lüsebrink E, et al. Treatment of acute cardiac tamponade: A retrospective analysis of classical intermittent versus continuous pericardial drainage. *Int J Cardiol Heart Vasc*. 2021;32:100722. doi:10.1016/j.ijcha.2021.100722

13. Miltner B, Dulgheru RE, Nchimi Longang A, Pierard L, Davin L. Left ventricular aneurysm: true, false or both? *Acta Cardiol*. 2016;71(5). doi:10.2143/AC.71.5.3167507

14. Konen E, Merchant N, Gutierrez C, et al. True versus false left ventricular aneurysm: differentiation with MR imaging--initial experience. *Radiology*. 2005;236(1):65-70. doi:10.1148/radiol.2361031699

15. Alapati L, Chitwood WR, Cahill J, Mehra S, Movahed A. Left ventricular pseudoaneurysm: A case report and review of the literature. *World J Clin Cases WJCC*. 2014;2(4):90. doi:10.12998/wjcc.v2.i4.90

16. Naser JA, Anavekar NS. Left Ventricular Pseudoaneurysm: A Rare Cause of Chest Pain to Keep in Mind. *Mayo Clin Proc*. 2022;97(8):1523-1524. doi:10.1016/j.mayocp.2022.05.006

17. Witalka T, Smith M, Lee S. Anterior wall ventricular pseudoaneurysm presenting as dizziness and syncope. *Am J Emerg Med*. 2019;37(1):175.e3-175.e5. doi:10.1016/j.ajem.2018.09.046

18. Amin S, Hossain R, Jeudy J, Frazier AA, White C. A Sensible Approach to Diagnosing Cardiac Aneurysms, Pseudoaneurysms and Common Mimickers. *J Thorac Imaging*. 2018;33(6):W39. doi:10.1097/RTI.0000000000000355

19. Kumar R, Halder V, Prasad K, Sharma A, Dahiya N. Idiopathic right ventricular pseudoaneurysm presenting with ventricular tachycardia: a case report. *Gen Thorac Cardiovasc Surg*. 2021;69(7):1151-1154. doi:10.1007/s11748-021-01633-1

20. Naseerullah FS, Baig M, Wool KJ, Murthy A. Left ventricle pseudoaneurysm: Diagnosis by a new murmur. *J Cardiol Cases*. 2018;18(1):20-24. doi:10.1016/j.jccase.2018.03.002

21. Mahesh B, Ong P, Kutty R, Abu-Omar Y. Tamponade by an expanding left ventricular pseudoaneurysm: A unique presentation. *Asian Cardiovasc Thorac Ann*. 2015;23(8):976-978.

doi:10.1177/0218492314530135

22. Adler Y, Ristić AD, Imazio M, et al. Cardiac tamponade. *Nat Rev Dis Primer*. 2023;9(1):1-18. doi:10.1038/s41572-023-00446-1

23. Inayat F, Ghani AR, Riaz I, et al. Left Ventricular Pseudoaneurysm: An Overview of Diagnosis and Management. *J Investig Med High Impact Case Rep*. 2018;6:2324709618792025. doi:10.1177/2324709618792025

24. Ricci MA, Trevisani GT, Pilcher DB. Vascular complications of cardiac catheterization. *Am J Surg*. 1994;167(4):375-378. doi:10.1016/0002-9610(94)90119-8

25. Atik FA, Navia JL, Vega PR, et al. Surgical Treatment of Postinfarction Left Ventricular Pseudoaneurysm. *Ann Thorac Surg*. 2007;83(2):526-531. doi:10.1016/j.athoracsur.2006.06.080

26. Ouazzani JE, Jandou I. Aneurysm and pseudoaneurysm of the left ventricle. *Ann Med Surg*. 2022;75:103405. doi:10.1016/j.amsu.2022.103405

27. Prifti E, Bonacchi M, Baboci A, et al. Surgical treatment of post-infarction left ventricular pseudoaneurysm: Case series highlighting various surgical strategies. *Ann Med Surg*. 2017;16:44-51. doi:10.1016/j.amsu.2017.03.013

28. Fedakar A, Bugra O, Onk A, Mataraci I, Eren E, Zeybek R. Repair of Left Ventricular Pseudoaneurysms. *Asian Cardiovasc Thorac Ann*. 2010;18(1):39-43. doi:10.1177/0218492309353988

29. Yeo TC, Malouf JF, Oh JK, Seward JB. Clinical profile and outcome in 52 patients with cardiac pseudoaneurysm. *Ann Intern Med*. 1998;128(4):299-305. doi:10.7326/0003-4819-128-4-199802150-00010

30. Mujanovic E, Bergsland J, Avdic S, Stanimirovic-Mujanovic S, Kovacevic-Preradovic T, Kabil E. Surgical treatment of left ventricular pseudoaneurysm. *Med Arch Sarajevo Bosnia Herzeg*. 2014;68(3):215-217. doi:10.5455/medarh.2014.68.215-217

31. Naguib M, Elsayed M, Khouzam RN, Iskander A. Percutaneous Closure of Post-infarct Left Ventricular Pseudoaneurysm: A Review of Literature. *Curr Probl Cardiol*. 2023;48(8):101743. doi:10.1016/j.cpcardiol.2023.101743

32. Kumar PV, Alli O, Bjarnason H, Hagler DJ, Sundt TM, Rihal CS. Percutaneous therapeutic approaches to closure of cardiac pseudoaneurysms. *Catheter Cardiovasc Interv*. 2012;80(4):687-699. doi:10.1002/ccd.24300

33. Zhong Z, Song W, Zheng S, Liu S. Surgical and Conservative Treatment of Post-infarction Left Ventricular Pseudoaneurysm. *Front Cardiovasc Med*. 2022;9:801511. doi:10.3389/fcvm.2022.801511

34. Keeling AN, McGrath FP, Lee MJ. Interventional Radiology in the Diagnosis, Management, and Follow-Up of Pseudoaneurysms. *Cardiovasc Intervent Radiol*. 2009;32(1):2-18. doi:10.1007/s00270-008-9440-3