Scholars LITERATURE

La Prensa Medica Argentina

Literature Review

DOI: https://doi.org/10.47275/0032-745X-S2-001
S2-001

Non-Vitamin K Oral Anticoagulants for the Treatment of a Left Ventricular Thrombus: Review of Literature and Case Series

Alaa Solaiman Algazzar[1]*, Mohamed Ahmed Qutub[2], Abrar Abdulhamaid Maghrabi[3], Halimah Musa Alemshani[3] and Hind Saeed Aloqbi[3]

[1]Consultant Cardiologist, Department of Cardiology, Ahmed Maher Teaching Hospital, Alsayeda Zainab, Cairo, Egypt
[2]Consultant Interventional Cardiology, Division of Cardiology, Department of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia
[3]Internal Medicine Resident, Department of Medicine, King Abdulaziz University Hospital, Jeddah, Saudi Arabia

Abstract

Left ventricular thrombus (LVT) formation is a well-recognized complication of both ischemic and non-ischemic cardiomyopathies with high incidence of embolic stroke 2-3% in untreated patients. The current therapeutic strategy for LVT is warfarin therapy. However, warfarin therapy has several limitations including a narrow therapeutic window, food and drug interactions, and the need for frequent laboratory monitoring. Non-vitamin K oral anticoagulants (NOACs) have several advantages over vitamin K antagonists (VKA) but their efficacy and safety in this context is unknown. We reviewed the literature and published case reports and series for efficacy, safety, and risks of using NOACs as a treatment option for adults with LVT. PubMed, Embase, Medline, Scopus, Web of Science, and Cochrane Library were searched for published articles and case reports. We included guidelines, and treatment reviews of NOACs use among patients with a diagnosis of LVT. The data was set until first of June 2019 with total of 53 cases. Published cases showed majority of cases used Rivaroxaban (60%), Dabigatran (18.8%), Apixaban (18.8%) and one case used Edoxaban. In six cases NOACs failed to dissolve the LVT, dabigatran was used in two cases and rivaroxaban was used in four cases. Two cases under rivaroxaban treatment developed GI bleeding and pulmonary hemorrhage. LVT was successfully resolved in (87.5%) of rivaroxaban cases, (80%) of Dabigatran cases and (100%) for Apixaban cases. The average duration for thrombus resolution was 3 months, 11 weeks, 4 months and 23 days for Rivaroxaban, Dabigatran, Apixaban and Edoxaban respectively. There is limited evidence about the efficacy of NOACs in LVT treatment, currently. published case reports and series showed successful resolution of LVT with NOACs but still NOACs are recommended for patients who are intolerable to VKA. Further randomized controlled trials are needed to confirm the encouraging observational data and determine optimal dosage of NOACs.

Keywords: Left Ventricular Thrombus; Myocardial Infarction; Vitamin K Antagonists; Non-Vitamin K Oral Anticoagulant; Dabigatran; Apixaban; Rivaroxaban; Edoxaban; NOACS

Correspondence to: Alaa Solaiman Algazzar, Department of Cardiology, Ahmed Maher Teaching Hospital, Port said St., Alsayeda Zainab, Cairo, Egypt, E-mail: goodminds@hotmail.com

Citation: Algazzar AS, Qutub MA, Maghrabi AA, et al. (2020) Non-Vitamin K Oral Anticoagulants for the Treatment of a Left Ventricular Thrombus: Review of Literature and Case Series. Prensa Med Argent, S2:001. DOI: https://doi.org/10.47275/0032-745X-S2-001.

Received: June 20, 2020; **Accepted:** July 28, 2020; **Published:** August 01, 2020

Introduction

Left ventricular thrombosis (LVT) was present in 7-46% of patients with myocardial infarction, dilated cardiomyopathy and acute myocarditis. Primary percutaneous coronary intervention (PCI) reduced the prevalence of LVT to 1.5%; because of that the randomized controlled trials to evaluate treatments are limited. LVT carries a significant risk of thromboembolic complications which occurred in 2-3% of patients within the first 3-4 months if left untreated, thus the recommendations regarding the duration of anticoagulant therapy [1,2]. Surgical treatment of thrombus has been reported previously [3] and according to current guidelines, the 2013 American College of Cardiology Foundation/AHA STEMI guidelines, the AHA/American Stroke Association 2014 stroke prevention guidelines and the European Society of Cardiology 2017 STEMI guidelines are advise to start on oral anticoagulant once diagnosed LVT with variation in the recommended duration of treatment [4-6]. Non-vitamin K oral anticoagulants (NOACs) have approved in non-valvular atrial fibrillation (AF) but there was only a small number of case reports and series evaluating their efficacy in LVT.

Overview of the NOACs

There was a lot of interest in the introduction of NOACs (dabigatran, rivaroxaban, apixaban and edoxaban) which were approved by the U.S. Food and Drug Administration (FDA) between 2010 and 2015 for the prevention and treatment of venous thromboembolism (VTE) (EINSTEIN-DVT, EINSTEIN-PE, RE-COVER, AMPLIFY -VTE trials) [7] and for prevention of stroke in non-valvular AF (RELY, ROCKET-AF, ARISTOTLE, and ENGAGE-AF trials) [8].

Two reversal agents were approved, idarucizumab for Dabigatran reversal and andexanet alfa approved as a reversal agent for factor Xa inhibitors [9]. Compared to warfarin, NOACs have few drugs and food interactions, not required regular monitoring, less labile anticoagulation effect and rapid onset of action. They are generally associated with fewer risk of bleeding comparing to warfarin. In patients with renal impairment, apixaban has the least renal excretion and may have lower bleeding risk than other NOACs in chronic kidney disease (CKD), as ARISTOTLE trial showed a comparable rate of GI bleeding in the apixaban compared to warfarin. There is also limited evidence that apixaban may be useful in end-stage renal disease (ESRD) especially when warfarin is contraindicated. On the other hand, edoxaban, rivaroxaban, and dabigatran are contraindicated in ESRD (GFR less than 15) and may increase bleeding risk as compared to warfarin (RE-LY trial). There is no significant comparable risk of gastrointestinal bleeding between edoxaban and warfarin, but the risk is significantly reduced with half the dose of edoxaban (ENGAGE-AF TIMI 48) [8]. In hepatic impairment, all NOACs are contraindicated in Child–Pugh Class C based on pharmacokinetic data and small studies, although rivaroxaban should not be used in Class B impairment [10].

Selecting the dose of the agents should be done in consideration of age of the patient and renal function, (The clinical approach to NOACs dosing is based on the renal function, patient age and weight) when the patient is elderly (age more than 80 years) or have CKD (creatinine clearance less than 50 mL/min) the dose should reduce to dabigatran 110-75 mg BID, rivaroxaban 15 mg daily, apixaban 2.5 mg BID and edoxaban 30mg daily, respectively [10].

Methods

PubMed, Embase, Medline, Scopus, Web of Science, and Cochrane Library were searched for published articles and case reports (Figure 1). We included guidelines, and treatment reviews of NOACs use among patients with a diagnosis of LVT. Our review was limited to human case reports and case series published in English language.

Results for NOACs in Management of LVT

Case reports and series were found through searching in PubMed, Embase, Medline, Scopus, Web of Science, and Cochrane Library. The data was set until first of June 2019 with total of 53 cases. Published cases showed that NOACs were used as a treatment of LVT due to different causes, e.g. ischemic heart disease, heart failure, hypertrophic cardiomyopathy, Left ventricle non-compaction cardiomyopathy, non-ischemic cardiomyopathy, protein C deficiency with multiple systemic thrombosis, active malignancy, and Chagas disease.

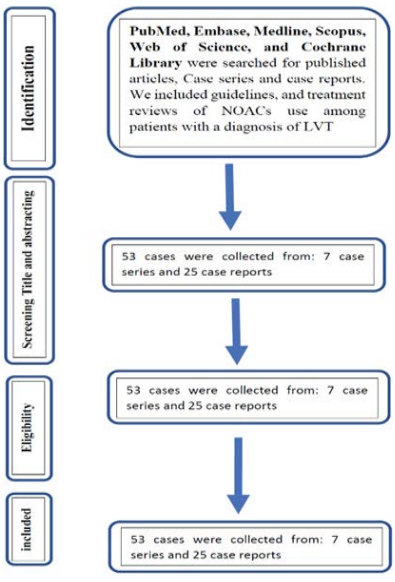

Figure 1: Flow chart of published case reports and case series.

Published cases showed majority of cases used Rivaroxaban (60%), Dabigatran (18.8%), Apixaban (18.8%) and one case used Edoxaban. In six cases NOACs failed to dissolve the LVT, dabigatran was used in two cases and rivaroxaban was used in four cases. Two cases under rivaroxaban treatment developed GI bleeding and pulmonary hemorrhage. LVT was successfully resolved in (87.5%) of rivaroxaban cases, (80%) of Dabigatran cases and (100%) for Apixaban cases. The average duration for thrombus resolution was 3 months, 11 weeks, 4 months and 23 days for Rivaroxaban, Dabigatran, Apixaban and Edoxaban respectively.

Dabigatran

The mean age of the 10 patients was 62-year-old, and the common dose used was 110 mg twice daily, in two case they used 150mg twice daily. The average duration for complete resolution of LVT was 11 weeks, shorter duration was one week [11-15] and longest duration was four months (Table 1).

In one case, dabigatran was successfully used in patient with acute ischemic stroke due to cardio-embolic disease. However, one patient developed multiple ischemic stroke secondary to LVT which was treated with dabigatran but due to nonadherence to the therapy his condition complicated to the extent that surgical excision of the LVT took place [16]. Another patient was diagnosed with AF and anterior myocardial infarction, he was started on dabigatran, but after 20 months patient's found to develop LVT. The dabigatran treatment was discontinued, and warfarin was initiated, and, in the follow-up, the thrombus was observed to shrink, and complete resolution was seen 6 weeks after treatment with warfarin. The patient did not experience any thromboembolic event [17]. In three cases dabigatran used concurrent with dual antiplatelet therapy (Aspirin and Clopidogrel). In one case, single antiplatelet (aspirin) added to dabigatran. No serious complications were mentioned in all patients.

Rivaroxaban

Rivaroxaban used in thirty-two cases whom had LVT due to different causes (Table 2). The mean age was 56-year-old, the doses was variable on whom thirteen cases were on Rivaroxaban 15 mg daily, four patients used 15 mg BID, twelve cases was on 20 mg daily, two cases on 10 mg daily and in one case the dose was not report. The average duration for complete resolution of LVT was 3 months, shorter duration was 7 days and longest duration was 436 days.

In nineteen cases were Rivaroxaban used concurrently with dual anti-platelet therapy (aspirin and clopidogrel), two cases were on aspirin only and one case used clopidogrel altogether with rivaroxaban. LVT completely resolved in 27 cases, although in one case 40% resolution of LVT reported, persistent in two cases and no data available for one case. Rivaroxaban was stopped after 40 days due to GI bleeding in one case, in another case it was stopped after 20 days due to Pulmonary hemorrhage and in one case the patient developed new LVT while on the Rivaroxaban treatment.

Apixaban

Table 1: Published cases for patient who have LVT and treated with Dabigatran.

Ref	Age	Dose (mg)	Clinical presentation	Duration of therapy	Size of thrombus (mm)	Adjuvant therapy	Resolution	Complication
Noflatscher et al.[12]	87	110 BID	NSTEMI	4 weeks	16	DAPT	Complete	None
Chung et al. [11]	57	110 BID	Acute ischemic stroke	7 days	11x8.9	IV alteplase	Complete	None
Kolekar et al. [13]	61	110 BID	DHF	4 months	23x11	None	Complete	None
Ohashi et al. [24]	78	110 BID	Acute STEMI	18 days	26x16	DAPT	Complete	None
Kaku et al. [15]	59	150 BID	MVOHCM	3 weeks	15x17	None	Complete	None
Moey et al. [16]	39	Not reported	IHD, Ischemic stroke	Not reported Non-adherence to therapy	56x34	Surgical thrombectomy	N/A	Developed LVT
Adar et al. [17]	56	150 BID	Routine investigation IHD and PAF	20 months	22.7x24.9	Switched to warfarin	Resolution after switch to warfarin	Developed LVT
Yamamoto et al. [18] 2 cases	52 & 51	110 BID	Old antroseptal MI And 2nd case was DHF	6 weeks and 2nd case was 2 weeks	7x9 and 2nd case was 24x19	DAPT 2nd case received Heparin infusion for 3 days Aspirin 100 mg/day	Complete	None
Nagamoto et al., [3]	77	110 BID	Preoperative assessment, IHD and AF	27 days	14x12	None	Complete	None

NSTEMI: Non-ST-Elevation Myocardial Infarction. **DHF**: Decompensated Heart Failure. **STEMI**: ST-Elevation Myocardial Infarction. **MVOHCM**: Midventricular Obstructive Hypertrophic Cardiomyopathy. **IHD**: Ischemic Heart Disease. **PAF**: Paroxysmal Atrial Fibrillation. **MI**: Myocardial Infarction. **AF**: Atrial Fibrillation. **N/A**: Not Applicable.

Table 2: Published cases and case series for patient who have LVT and treated with Rivaroxaban.

Ref	Age/y	Dose/ mg (daily)	Clinical presentation	Duration of therapy	Size of thrombus (mm)	Therapy	Resolution	Complication
Sun et al. [19]	43	10	Pre-syncopal attack, LVNC	3 months	11x24	None	Complete	None
Makrides et al. [1] 3 cases	52,75 and 69	15	One Subacute anterior STEMI and 2 cases STEMI	2 cases for1 month and 1 case for 2 weeks	16-25x17	DAPT	Complete	None
Abubakar et al. [20]	28	20	DHF Known non-ischemic cardiomyopathy	3 months	36x15	Was on apixaban but switched to rivaroxaban because of nonadherence	Complete	None
Summaria et al. [21]	66	15	NSTEMI and AF	6 months	Not reported	Clopidogrel 75mg/ daily	Complete	None
Las et al. [22]	61	20	Acute ischemic stroke Known Chagas disease	50 days	12.3x22.9	None	Complete	None
Shokr et al. [23] 4 cases	58-70	20	3 cases with STEMI and 1 case DHF	3-6 months	11-38x8-18	DAPT but one case received Heparin infusion for 7 days then DAPT	Complete	One case developed GI bleeding
Almaghraby et al.[24] 8 cases	40-69	15	3 cases with NSTEMI and 5 cases with STEMI	3 months	8-10 x2-12	DAPT	Complete Except one case persist with LVT	None
Azizi et al. [25]	54	20	Anterior STEMI	1 month	Not reported	DAPT	Complete	None
Nakasuka et al. [26]	42	15	DHF, SVT	7 days	20x10	Warfarin and heparin for 5 days	Complete	None
Degheim et al. [27]	57	Not reported	DHF, AF	Not reported	Not reported	None	N/A	Developed LVT complicated by ischemic stroke
Pérez et al. [28]	78	15	DHF, AF	4 weeks	Not reported	None	Complete	None
Maki et al. [29]	21	15	Multiple systemic thrombosis, Protein C deficiency	24 days	26x20	Heparin infusion, then warfarin then argatroban	Complete	None
Di Nisio et al. [30]	52	15mg BID for 3 weeks then 20mg daily	Fuhrman II renal carcinoma with lung metastases	4 months	30x19	Was on therapeutic dose of enoxaparin for 2 months then switched to rivaroxaban.	40%	None
Smetana et al. [31] 6 cases	39-76	20 mg daily and one case used 15mg BID	2 cases with active malignancy 2 cases NSTEMI 1 case with AF, IHD And 1 case with NICM	20 days	10-44x10-23	2cases with Aspirin 2 cases with DAPT	2 cases persisted with LVT	Pulmonary hemorrhage
Seecheran et al. [32]	53	10mg BID	Acute anterior STEMI, DKA and cardiogenic shock	3 months	25x15	DAPT	Complete	None

LVNC: Left Ventricular Non-Compaction Cardiomyopathy; **SVT**: Supraventricular Tachycardia; **NICM**: Non-Ischemic Cardiomyopathy; **DKA**: Diabetic Ketoacidosis

Table 3: Published cases for patient who have LVT and treated with Apixaban.

Ref	Age/y	Dose	Clinical presentation	Duration of therapy	Size of thrombus (mm)	Therapy	Resolution	Complication
Shokr et al. [23] 3 cases	28-60	5 mg BID for only one case received 2.5 mg	3 cases presented with DHF, one case with anterior STEMI	Shortest period 2 months but one case continued for 10 months	19x12, the largest one 15x36	All cases received DAPT but 1 case received Heparin infusion for 2 days	Complete	None
Yildirim et al. [33]	68	5 mg BID	NSTEMI	2 months	13x6	DAPT was on warfarin but stopped; due to GI bleeding.	Complete	None
Bolayr et al. [34]	70	5 mg BID	DHF, AF	1 month	40x30	None	Complete	None
Smetana et al. [31]	39	5 mg BID	STEMI	407 days	10x10	DAPT	Complete	None
Berry et al. [35]	67	5 mg BID	IHD	1 week	Not reported	Not reported	Complete	None
Kaya et al. [36]	60	5 mg BID	Ischemic stroke, HNCM, AF	1 month	30x20	None	Complete	None
Mano et al. [37]	62	5 mg BID	Acute STEMI	6 weeks	40x14	DAPT	Complete	None

HNCM: Hypertrophic Non-Obstructive Cardiomyopathy

In numerous case studies-about ten-apixaban was used in LVT secondary to different causes such as acute coronary syndrome (five in STEMI, two in NSTEMI) and three decompensated heart failure (Table 3). The mean age was 58.4 years and the usual dose used was 5 mg twice daily except in one case was 2.5 mg twice a day. Out of ten, six cases were on Apixaban with dual antiplatelet therapy (aspirin and clopidogrel) and one case received apixaban with aspirin only, others was not report if there is concurrent treatment with apixaban. The complete resolution of LVT was achieved in 100% of cases.

The average duration of complete resolution of LVT was four months, shorter duration was one week, and longest duration was 407 days. There were no major complications encountered in any of the cases. So, the treatment with Apixaban appeared to be effective and safe as it was significantly associated with Lower risk of complication, but without sufficient high-quality evidence we cannot know the most effective therapeutic doses and what is the ideal specific duration of treatment for complete resolution of LVT.

Edoxaban

Only one case in which edoxaban was used for LVT in patient with non-valvular AF after failure of warfarin therapy, 60 mg dose was used for duration of 23 days with complete resolution of LVT and no serious complication was mentioned [38]

Discussion

It is well known that the Standard screening tool for detection of LV thrombus is transthoracic echocardiography (TTE). High risk patients for apical LV thrombus (e.g., late presenter large or anterior MI or severe dilated cardiomyopathy with poor LV function) should be screened within 24 hrs. of admission. Small size thrombi could be missed by TTE especially with poor visualization of LV apex or high apical wall motion score. The use contrast TTE greatly improves sensitivity of TTE with sensitivity up to 61% and specificity up to 99%. Diagnosis is more difficult in patients with a layered thrombus (thrombus which consistent with to ventricular endocardial area) which support the role of Cardiac magnetic resonance imaging (CMR) as the gold standard and the most useful modality for diagnosis of LVT and it was proved to be superior to TTE [39].

Warfarin affects the anticoagulation cascade at several steps, and it could be effectively reversed in case of bleeding. However, it has the disadvantage of narrow therapeutic index. Other unfavorable challenges to both clinicians and patients are the need for regular monitoring, dietary restrictions, and extensive drug-drug interactions which makes its use is declining in favor of NOACs. Until now warfarin remains the first-line choice because of the lack of studies demonstrating the efficacy and safety of NOACs in this cohort of patients In 2014, the AHA/American Stroke Association guidelines on stroke prevention introduced a new recommendation advising that low- molecular-weight heparin, dabigatran, rivaroxaban, or apixaban may be considered as an alternative to VKA for post-MI LVT or anterior or apical wall-motion abnormalities with a left ventricular ejection fraction less than 40%, in patients with ischemic stroke who are intolerant of VKA because of non-hemorrhagic adverse events (Class IIb; Level of Evidence C) [5].

Compared to warfarin, NOACs neither inhibit protein C nor protein S nor has lower risk of intracranial bleeding and better efficacy of preventing stroke in AF patients. In addition, dabigatran and other NOACs offer rapid anticoagulation effect with peak plasma level 1-2 hrs. after administration. Therefore, in patients who require a rapid, effective, and safe anticoagulation strategy, NOACs might be a useful option.

There are a growing number of recently published case studies where NOACs show impressive results in treatments of LVT in patients with different pathologies including LV non-compaction, hypertrophic cardiomyopathy and Chagas disease, ischemic and non-ischemic cardiomyopathies. The case reports demonstrated that different doses of DOACs were used in the management of LVT. Makrides et al., showed that low dose rivaroxaban (15 mg/d) in combination with a dual antiplatelet therapy (DAPT) was effective for the treatment of left ventricular (LV) thrombus after short-duration of therapy in patients with acute coronary syndromes and drug-eluting stent implantation, and at low to intermediate bleeding risk [1].

Although, the size of the thrombus was not directly related to the duration of treatment. There was complete LVT resolution with variable duration of therapy except in six cases where NOACs failed to dissolve the LVT, dabigatran was used in two cases and rivaroxaban was used in four cases [16,17,24,27,31]. Most of published cases showed no embolic complications except one case which developed multiple ischemic stroke secondary to LVT which was treated with dabigatran but due to nonadherence to the therapy his condition complicated to the extent that surgical excision of the LVT took place [16]. This may support the statement that short-term thromboembolic risk increases with interruption of NOACs treatment. One patient was diagnosed with AF and started on dabigatran, but after 20 months patient was found to develop LVT. That is could make the efficacy of dabigatran for

LVT prevention questionable. However, there is increasing evidence questioning the efficacy of VKA to resolve large intracardiac thrombi. Literature showed that left atrial appendage (LAA) thrombi persisted in 40% of patients after VKA therapy. Hammerstingl C et al., reported successful resolution of giant left atrial appendage thrombus with rivaroxaban after failure of Warfarin [40,41]. Moreover, there are 2 case reports revealed LV thrombus resolution in 1 week [20,29]. This implies that LV thrombus treatment with NOACs may offer shorter duration than VKAs if future data demonstrate consistency of these findings and NOACs are approved for this indication. Further randomized controlled trials are still needed to provide evidence and to evaluate this treatment strategy. Some of these trials are ongoing (ClinicalTrials.gov identifiers: Dabigatran (NCT03415386) Rivaroxaban (NCT03764241 and NCT03786757), Apixaban (NCT02982590 and NCT03232398) which are investigating NOACs as a treatment option for treatment of LVT with estimated completion date in 2019 and 2020.

Conclusion

There is limited evidence about the efficacy of NOACs in LVT treatment, currently published case reports and series showed successful resolution of LVT with NOACs but still NOACs are recommended for patients who are intolerable to VKA. Further randomized controlled trials are needed to confirm the encouraging observational data and determine optimal dosage of NOACs.

References

1. Makrides CA (2016) Resolution of left ventricular postinfarction thrombi in patients undergoing percutaneous coronary intervention using rivaroxaban in addition to dual antiplatelet therapy. BMJ Case Rep 2016:bcr2016217843.
2. Shacham Y, Leshem-Rubinow E, Assa EB, Rogowski O, Topilsky Y, et al. (2013) Frequency and correlates of early left ventricular thrombus formation following anterior wall acute myocardial infarction treated with primary percutaneous coronary intervention. Am J Cardiol 5: 667-670.
3. Nagamoto Y, Shiomi T, Matsuura T, Okahara A, Takegami K, et al. (2014) Resolution of a left ventricular thrombus by the thrombolytic action of dabigatran. Heart Vessel 4: 560-562.
4. O'Gara P, Kushner F, Ascheim D, CaseyJr DE, Chung MK, et al. (2013) ACCF/AHA Guideline for the management of ST-elevation myocardial infarction. Circulation 127: 362-425.
5. Kernan WN, Ovbiagele B, Black HR, Bravata DM, Chimowitz MI, et al. (2014) Guidelines for the prevention of stroke in patients with stroke and transient ischemic attack: a guideline for healthcare professionals from the American Heart Association/ American Stroke Association. Stroke 45: 2160-2236.
6. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, et al. (2018) 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The task force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J 3: 119-177.
7. Cohen AT, Hamilton M, Mitchell SA, Phatak H, Liu X, et al. (2015) Comparison of the novel oral anticoagulants apixaban, dabigatran, edoxaban, and rivaroxaban in the initial and long-term treatment and prevention of venous thromboembolism: systematic review and network meta-analysis. PLoS One 10: e0144856.
8. Kirchhof P, Benussi S, Kotecha D, Ahlsson A, Atar D, et al. (2016) 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS. Eur Heart J 37: 2893-2962.
9. Heo Y (2018) Andexanet Alfa: first global approval. Drugs78: 1049-1055.
10. Amin A (2016) Choosing Non-Vitamin K antagonist oral anticoagulants: practical considerations we need to know. Ochsner J 16: 531-541.
11. Chung K, Paek Y, Lee H, Hong KS (2015) Dabigatran effect on left ventricular thrombus in a patient with acute ischemic stroke. J Stroke 17: 366-368.
12. Noflatscher M, Moes N, Gassner EM, Marschang P (2018) Dabigatran added to dual antiplatelet therapy to treat a left ventricular thrombus in an 87 year old patient with myocardial infarction and very high bleeding risk. Front Pharmacol 9:217.
13. Kolekar S, Munjewar C, and Sharma S (2015) Dabigatran for left ventricular thrombus. Indian Heart J 67: 495-496.
14. Ohashi N, Okada T, Uchida M, Amioka M, Fujiwara M, et al. (2015) Effects of dabigatran on the resolution of left ventricular thrombus after acute myocardial infarction. Intern Med 54: 1761-1763.
15. Kaku B (2013) Intra-cardiac thrombus resolution after anti-coagulation therapy with dabigatran in a patient with mid-ventricular obstructive hypertrophic cardiomyopathy: a case report. J Med Case Rep 7: 238.
16. Moey MY, Tomdio AN, Achike O, Kabirdas D (2018) Large left ventricular thrombus as a cause of recurrent cardioembolic stroke while on dabigatran. CASE 2: 222-224.
17. Adar A, Onalan O, and Cakan F (2018) Newly developed left ventricular apical thrombus under dabigatran treatment. Blood Coagul Fibrinolysis 29: 126-128.
18. Yamamoto T, Konishi T, Funayama N, Kikuchi B, Hotta D, et al. Resolution of left ventricular thrombus after dabigatran therapy in two patients with old anteroseptal myocardial infarction. Cardiol Pharmacol 4: 152.
19. Sun H, Zhao Q, Wang Y, Lakin R, Feng H, et al. (2018) Daily 10mg rivaroxaban as a therapy for ventricular thrombus related to left ventricular non-compaction cardiomyopathy: A case report. Medicine (Baltimore) 97: 9670.
20. Abubakar H, Yassin AS, Shokr M (2018) Rivaroxaban used for treatment of a left ventricular thrombus in a patient with nonischemic cardiomyopathy. Am J Ther 25: 706-709.
21. Summaria F, Sgueglia GA, D'Errico F, De Santis A, Piccioni F, et al. (2018) Safety and efficacy of triple therapeutic targets with rivaroxaban after acute myocardial infarction complicated by left ventricular thrombi in a case of nonvalvular atrial fibrillation. Case Rep Cardiol 2018: 6503435.
22. Las Casas Jr AA, Las Casas AA, Borges MA, Melo-Souza SE (2016) Rivaroxaban for treatment of intraventricular thrombus in Chagas disease. J Cardiol Cases 13: 75-77.
23. Shokr M, Ahmed A, Abubakar H, Sayedahmad Z, Rashed A, et al. Use of direct oral anticoagulants in the treatment of left ventricular thrombi: A tertiary center experience and review of the literature. Clin Case Rep 7: 135-142.
24. Almaghraby A, Abdelnaby M, Abdelkarim O, Saleh Y, Hammad B, et al. (2018) Role of rivaroxaban in left ventricular thrombi. Eur Heart J 39: 964.
25. Azizi A, Puricel S, Cook S, Brugger N (2016) Rivaroxaban dissolves postinfarction left ventricular thrombus. Cardiovas Med 19: 25-27.
26. Nakasuka K, Ito S, Noda T, Hasuo T, Sekimoto S, et al. (2014) Resolution of left ventricular thrombus secondary to tachycardia-induced heart failure with rivaroxaban. Case Rep Med 2014: 5.
27. Degheim G, Berry A, and Zughaib M (2017) Off label use of direct oral anticoagulants for left ventricular thrombus. Is it appropriate?. Am J Cardiovasc Dis 7: 98-101.
28. Padilla Pérez M, Salas Bravo D, Garcelán Trigo JA, Vazquez Ruiz de Castroviejo E, Torres Llergo J, et al. (2014) Resolution of left ventricular thrombus by rivaroxaban. Future Cardiol 10: 333-336.
29. Maki H, Nishiyama M, Shirakawa M (2017) Simultaneous left ventricular and deep vein thrombi caused by protein C deficiency. Case Rep Med 2017: 1-4.
30. Di Nisio M, Carella C, Natoli C, Porreca E, De Tursi M (2015) Rivaroxaban for Cancer-associated cardiac thrombosis. Am J Med 128: 43-44.
31. Smetana KS, Dunne J, Parrott K, Davis GA, Collier AC, et al. (2017) Oral factor Xa inhibitors for the treatment of left ventricular thrombus: a case series. J Thromb Thrombolysis 44: 519-524.
32. Seecheran R, Seecheran V, Persad S, Seecheran NA (2017) Rivaroxaban as an antithrombotic agent in a patient with ST-segment elevation myocardial infarction and left ventricular thrombus: a case report. J Investig Med High Impact Case Rep 5.
33. Yildirim E, Kalkan K, Ipek E, Demirelli S, Ermiş E (2016) Successful resolution of left ventricular thrombus with apixaban treatment. Heart Vessels 2:57-58.
34. Bolayır HA, Güneş H, Şahin Ö, Akaslan D, Kıvrak T (2016) Complete resolution of huge left ventricular thrombus with apixaban treatment. Int J Cardiovasc Acad 2: 160-161.
35. Berry A, Brancheau D, Zughaib M (2017) Rapid resolution of left ventricular thrombus with apixaban therapy. SAGE Open Med Case Rep 5.
36. Kaya A, Hayıroğlu Mİ, Keskin M, Tekkeşin Aİ, Alper AT, et al. (2016) Resolution of left ventricular thrombus with apixaban in a patient with hypertrophic cardiomyopathy. Turk Kardiyol Dern Ars 44: 335-337.

37. Mano Y, Koide K, Sukegawa H, Kodaira M, Ohki T (2016) Successful resolution of a left ventricular thrombus with apixaban treatment following acute myocardial infarction. Heart Vessels 3: 118.

38. Kao PH, Chou PY, Hsu PC, Huang TC (2019) Resolution of left ventricular thrombus by edoxaban after failed treatment with warfarin overdose: A case report. Medicine (Baltimore) 98: e14065.

39. Weinsaft JW, Kim J, Medicherla CB, Ma CL, Codella NC, et al. (2016) Echocardiographic algorithm for post-myocardial infarction LV thrombus: a gatekeeper for thrombus evaluation by delayed enhancement CMR. JACC Cardiovasc Imaging 9: 505-515.

40. Savelieva I, Camm AJ (2014) Practical considerations for using novel oral anticoagulants in patients with atrial fibrillation. Clin Cardiol 37: 32-47.

41. Hammerstingl C, Pötzsch B, Nickenig G (2013) Resolution of giant left atrial appendage thrombus with rivaroxaban. Thromb Haemost 109: 583-584.