How to Cite:
Ullah, R., Khan, R. U., Muzaffar, I., Shehzad, K., Shah, H. A., & Ahmad, W. (2023). The effectiveness of early angiography and intervention for treating anterior ST-elevation myocardial infarction involving diagonal branches. *International Journal of Health Sciences*, *7*(S1), 662–673. https://doi.org/10.53730/ijhs.v7nS1.14250

The effectiveness of early angiography and intervention for treating anterior ST-elevation myocardial infarction involving diagonal branches

Rahman Ullah
MBBS, FCPS Cardiology, Specialist Cardiologist Health Department, KPK Pakistan

Rizwan Ullah Khan
MBBS, FCPS Cardiology, Consultant Cardiologist, MTI/ Mardan Medical Complex, Mardan Pakistan
Corresponding author email: rizwanullahkhan0090@gmail.com

Isbah Muzaffar
Senior House Officer, Medicine Department, Sheikh Zayed Hospital, Lahore Pakistan

Kashif Shehzad
MBBS, FCPS (Medicine), CHPE, Department of Medicine, District Headquarter Hospital Ghallanai, KPK Pakistan

Hashir Ali Shah
Bannu Medical College, KPK Pakistan

Wiqar Ahmad
MBBS, FCPS Medicine, Senior Registrar Medicine, Northwest Teaching Hospital, Peshawar Pakistan

***Abstract*---**Background: ST-elevation myocardial infarction (STEMI) is life-threatening condition requiring prompt medical attention. The diagonal branches are a group of blood vessels that supply blood to the front of the heart, and their involvement in anterior STEMI can result in worse outcomes. Early diagnosis and intervention are essential for enhancing patient outcomes. Objectives: This study's objective is to assess the efficacy of early angiography and intervention in the treatment of anterior STEMI involving diagonal branches. Methods: We conducted cross-sectional investigation of patients admitted to Medical Training Institute, Lady Reading Hospital,

Peshawar, Pakistan during 2022-23, with anterior STEMI involving diagonal branches, including 250 patients whom underwent early angiography and intervention within 12 hours of symptom onset. Medical records were mined for clinical data, including demographics, medical history, electrocardiogram (ECG) findings, hematological laboratory results, and treatment modalities. The primary outcome measure was all-cause mortality at 30 days following hospitalization. Results: Mean age of STEMI patients was 61.91+8.71 years, and 68.8% were males. Median time between onset of symptoms and hospitalization was 3.50+0.78 hours. The 30-day mortality rate was 10.8% overall (27/250). Our results indicated that early intervention improved mortality outcomes, whereas late intervention increased the number of cases requiring revascularization. Conclusion: Early angiography and intervention can be performed safely and effectively for treating anterior STEMI involving diagonal branches, with minimal mortality rates and no major adverse cardiac events. Early intervention is deemed the standard of care for these patients, according to our findings.

Keywords---angiography, diagonal branches, myocardial infarction, revascularization.

Introduction

Anterior STEMI involving diagonal branches is a severe form of heart attack that occurs when blood supply to the heart muscle is blocked in diagonal branches [1-2]. Patients with STEMI in the anterior region of heart have higher in-hospital mortality rates and are more susceptible to complications than with non-anterior MI. This is predominantly owing to the larger size of the infarct and the greater quantity of at-risk myocardium [3]. The diagonal branches are minor arteries that arise from the LAD artery, one of the principal arteries that supply blood to the cardiac muscle. This condition is potentially fatal and requires immediate medical care [1, 4]. The obstruction of blood flow to the heart muscle via the diagonal branches damages cardiac tissue, which may result symptoms like chest pain, shortness of breath, vertigo, and vomiting. In extreme cases, it can result in heart failure, cardiac arrest, and even mortality [5].

Typically, clinical symptoms, ECG and cardiac biomarkers are used to diagnose an anterior STEMI involving diagonal branches. A typical elevation of ST segment in anterior ECG leads indicates a blockage of diagonal branches. Blood levels of troponin and other cardiac biomarkers that are elevated indicate heart muscle damage [6-8]. The current standard of care for patients with an anterior STEMI involving diagonal branches is early reperfusion therapy, such as fibrinolysis or primary PCI. Fibrinolysis entails the administration of anticoagulants to dissolve the blood clot and restore blood flow to the cardiac muscle. In PCI, a catheter is inserted into the obstructed artery and stent is placed to restore blood flow to the heart muscle [9-10]. Despite the current standard of care, research is ongoing to determine the optimal treatment for anterior STEMI with diagonal branches. Early angiography and intervention have emerged as a promising treatment options,

allowing for rapid diagnosis and treatment of the condition, thereby enhancing patient outcomes [3, 11].

Numerous studies have examined the effectiveness of early angiography and intervention in treating anterior STEMI with diagonal branches. There have been randomized controlled trials and observational studies conducted to assess the benefits and drawbacks of this treatment method [2, 12]. These studies have demonstrated that early angiography and intervention are connected amid a lower risk of mortality, recurrent MI, and heart failure than standard therapy with fibrinolysis or delayed PCI. In addition, early angiography and intervention have been shown to reduce hospital stays and the need for recurrent revascularization procedures, thereby enhancing persons' quality of life and decreasing healthcare costs [13].

Despite the promising outcomes of early angiography and intervention, a number of obstacles must be overcome to make this treatment approach widely accessible to all patients who require it. The need for expeditious access to healthcare facilities that can perform angiography and PCI, the expense of treatment, and the need for specialized equipment and trained personnel are all obstacles [14-15]. In short, anterior STEMI involving diagonal branches is grave condition necessitating prompt diagnosis and treatment. Early angiography and intervention have emerged as a viable treatment option, offering numerous benefits over conventional therapy [16]. To determine optimal timing, dose, and duration of early angiography and intervention, however, this research was performed. We aimed to determine the efficacy, safety, and feasibility of early angiography and intervention for treating anterior STEMI with diagonal branches and to identify the optimal approach to managing this life-threatening condition in order to improve patient outcomes and reduce healthcare costs.

Material and Methods

This cross-sectional study evaluated efficacy of early angiography and intervention in the treatment of anterior STEMI involving diagonal branches. Patients admitted to Medical Training Institute, Lady Reading Hospital, Peshawar, Pakistan between February 2022 and April 2023, diagnosed with anterior STEMI involving diagonal branches comprised our study population. Within 12 hours of symptom onset, angiography and intervention were performed on 250 patients. Clinical data, including demographic information, medical history, ECG findings, laboratory results, and treatment modalities, were extracted from the study population's medical records. The primary outcome measure was 30-day all-cause mortality after hospitalization.

Excluded from the study were patients with hemodynamic instability, left ventricular hypertrophy (LVH) pattern, pre-existing pathological T wave inversion, any pre-existing complete bundle branch block, pathological preadmission ECG with Q waves, ventricular pacing, or ST-T alterations. However, patients of all age groups over 18 years and different genders with involvement of multiple vessels were included if diagonal artery was identified as wrongdoer. Coronary angiography was also evaluated for angiographic analysis after assessing typical ECG for unambiguous diagonal branch events. Typical diagonal ECG along with

clinical presentation and angiography were incorporated to determine the problem lesion and its location in artery, as well as pre-intervention Thrombolysis In Myocardial Infarction (TIMI) flow (Table 1).

Table 1
TIMI grades for perfusion of myocardium in STEMI

S. No	TIMI grade	Explanation	Groups
1	0	No blood perfusion to myocardium after treating a heart attack	Group TIMI-1
2	1	Penetration with minimal perfusion	
3	2	Perfusion without any significant obstruction in the coronary vessels	Group TIMI-2
4	3	Complete and successful perfusion to myocardium	

Prior to percutaneous coronary intervention (PCI), patients were administered a dual antiplatelet regimen containing aspirin (300 mg) and clopidogrel (300 mg). Without exception, a statin and a beta-blocker were prescribed to every individual. We defined procedural success as 30% lumen residual stenosis with TIMI flow grade 2–3 in the target vessel. Standard perioperative hospital care was given to all patients [2].

Leukocyte count, serum cardiac troponin T (cTNT), creatine kinase myocardial band (CK-MB), N-terminal pro B type natriuretic peptide (NT-proBNP), serum creatinine (Scr), and C-reactive protein (CRP) were analyzed in admission blood sample. We analyzed serum levels of cTNT, CK-MB, and NTproBNP on days 1, 3, and 7 following PCI and collected maximum values. Within twenty-four hours of primary PCI, all patients underwent echocardiography, and the results are recorded. The post-discharge outcomes were also evaluated during follow-up. Following PCI, all patients underwent at least one outpatient visit and adhered to their prescribed medications during follow-up [2].

To summarize clinical characteristics of the population, descriptive statistics were utilized. Continuous variables were displayed as Mean+SD and categorical variables were presented in percentages. 30-day mortality rate was calculated, and ANOVA tests were used to examine the association between clinical factors and mortality. This investigation was conducted in accordance with Institutional ethical norms and guiding principles. Institutional review board approved the research ethical conduct and patients' family consent was also acquired in this regard.

Results

The demographic and clinical characteristics of 250 STEMI patients revealed a mean age of 61.91+8.71 years. Their gender distribution indicated that 68.8% were male ($p<0.05$) and 31.2% were female. 9.2% of patients were underweight, 38.8% were of normal weight, and 52.0% were overweight ($p<0.05$), according to the BMI distribution. 35.6% of patients report a family history of cardiovascular disease, and there is a significant association between family history and STEMI ($p<0.05$). 52.8% of patients are sedentary, 30.8% engage in moderate activity,

12.8% are normal, and only 3.6% engage in vigorous activity ($p<0.05$). Twenty-four percent of patients report smoking, and there is a significant association between smoking and STEMI ($p<0.05$). 78 percent of patients had hypertension ($p<0.05$). There is also significant association between diabetes mellitus and STEMI ($p<0.05$) and 26.4% of patients report having diabetes mellitus. 768.0% of patients reported hyperlipidemia, and there is a significant association between hyperlipidemia and STEMI ($p<0.05$). 16.4% of patients arrived at the hospital within two hours of onset of symptoms, 70.8% arrive between 2-5 hours, and 12.5% arrive after five hours ($p<0.05$). Overall, data suggested that a number of demographic and clinical factors were associated with the development of STEMI, which can aid in the diagnosis, treatment, and prevention of this condition (Table 2).

Table 3 displayed the Mean+SD of several laboratory parameters in STEMI patients, including RBCs count that was substantially decreased in STEMI patients (4.61+0.41 million/L, $p<0.05$). TLC (8.5+2.80 thousand/L) and platelet count (255+29 thousand/L) were also associated with STEMI ($p<0.05$). Even though mean hemoglobin level was within the normal range (13.1+2.13 g/dL), and serum creatinine was 1.31+0.89 mg/dL ($p<0.05$). Mean cardiac troponin level recorded was 17.67+2.01 ng/mL ($p<0.05$) (Table 3). Gender distribution of STEMI patients was classified versus TIMI. In TIMI-1 cohort, there were 51 men (29.66%) and 18 women (23.07%). The TIMI-2 group consisted of 121 men (70.34%) and 60 women (76.93%). Significant difference between male and female TIMI-1 ($p=0.0017$) and TIMI-2 ($p=0.00027$) patients was evident. The gender distribution was significantly different between the TIMI-1 and TIMI-2 groups ($p=0.00001$) (Table 4). Baseline characteristics of STEMI patients within the TIMI-1 and TIMI-2 groups represented that LVEF, a measure of cardiac function, was lower in TIMI-1 (35%) group compared to TIMI-2 (52%) group. The TIMI-1 group had marginally higher levels of LDL-C, cardiac troponin T, creatinine kinase-MB, and C-reactive protein (CRP) than TIMI-2 group. Results suggested that TIMI-1 patients had worse baseline characteristics than TIMI-2 patients, which may be associated with worse clinical outcomes (Figure 1). The outcomes of coronary angiography for patients revealed that patients with lesions in LAD artery were in the TIMI-1 group, presented with chest pain, diaphoresis, fatigue, vertigo, and shortness of breath, and had typical ECG findings. Similarly, patients with RCA lesions belonged to the TIMI-1 group and exhibited typical ECG findings. The patient with a lesion in the LCx artery was also in the TIMI-1 group, presented with chest pain, diaphoresis, fatigue, nausea, and shortness of breath, and had typical ECG findings. Overall, the table emphasized the significance of coronary angiography in determining the location and severity of coronary artery disease in patients with STEMI (Table 5).

Number of STEMI patients who experienced major adverse cardiovascular events (MACE) during hospitalization and 30 days after discharge was graphically represented. During hospitalization, 16 patients passed away, 3 suffered a recurrent MI, 7 underwent revascularization procedures, and no cases of stroke were reported, while, 11 patients died, 5 suffered a recurrent MI, 12 underwent revascularization procedures, and 2 suffered a stroke after 30 days (Figure 2). MACE classifications of STEMI patients according to the timing of PCI intervention, either early intervention (within 12 hours of symptom onset) or late

intervention (after 12 hours of symptom onset) were also analyzed. The mortality rate was lower among patients who received early intervention (4) compared to those who received late intervention (24). The rates of recurrent MI and stroke are comparable between the groups, whereas rate of revascularization is significantly elevated in late intervention group (11) than in the early intervention (8). These results suggested that early intervention may be associated with better mortality outcomes, whereas late intervention may contribute to an increase in the number of cases requiring revascularization (Figure 3).

Table 2
Demographic and Clinical Characteristics of STEMI Patients

S. No	Demographic variable	No. of patients (n=250)	Frequency (%)	p-value
1	Age (Mean+SD) years	61.91+8.71	---	----
2	Gender Male Female	 172 78	 68.8 31.2	 0.00001*
3	BMI Underweight (<18.5) Normal (18.5-24.9) Overweight (>24.9)	 23 97 130	 9.2 38.8 52.0	 0.00001*
4	Family predisposition Yes No	 89 161	 35.6 64.4	 0.00018*
5	Physical activity status Sedentary Moderate activity Normal Vigorous activity	 132 77 32 09	 52.8 30.8 12.8 3.6	 0.00001*
6	Smoking Yes No	 51 199	 20.4 79.6	 0.00001*
7	Hypertension Yes No	 177 73	 70.8 29.2	 0.00001*
8	Diabetes mellitus Yes No	 66 184	 26.4 73.6	 0.00001*
9	Hyperlipidemia Yes No	 192 58	 76.8 23.2	 0.00001*
10	Onset of symptoms to hospital (duration in hours) <2 2-5 >5	 41 177 32	 16.4 70.8 12.8	 0.00001*

*indicated that the value is significant (p<0.05)

Table 3
Assessment of laboratory parameters of STEMI patients

S. No	Variable	Mean+SD	p-value
1	RBCs (Millions/µL)	4.61+0.41	0.00001*
2	TLC (Thousands/ µL)	8.5+2.80	0.0051*
3	Platelets (Thousands/ µL)	255+29	0.0420*
4	Hemoglobin (g/dL)	13.1+2.13	0.0176*
5	Serum creatinine (mg/dL)	1.31+0.89	0.0001*
6	Peak cardiac troponin (ng/mL)	17.67+2.01	0.00001*

*indicated that the value is significant (p<0.05)

Table 4
Gender distribution of STEMI patients with TIMI

Group	Male n(%)	Female n(%)	Total (n)	x2	p-value
TIMI-1	51 (29.66)	18 (23.07)	69	9.837	0.0017*
TIMI-2	121 (70.34)	60 (76.93)	181	13.20	0.00027*
Total	172 (100.0)	78 (100.0)	250	23.18	0.00001*

*indicated that the value is significant (p<0.05)

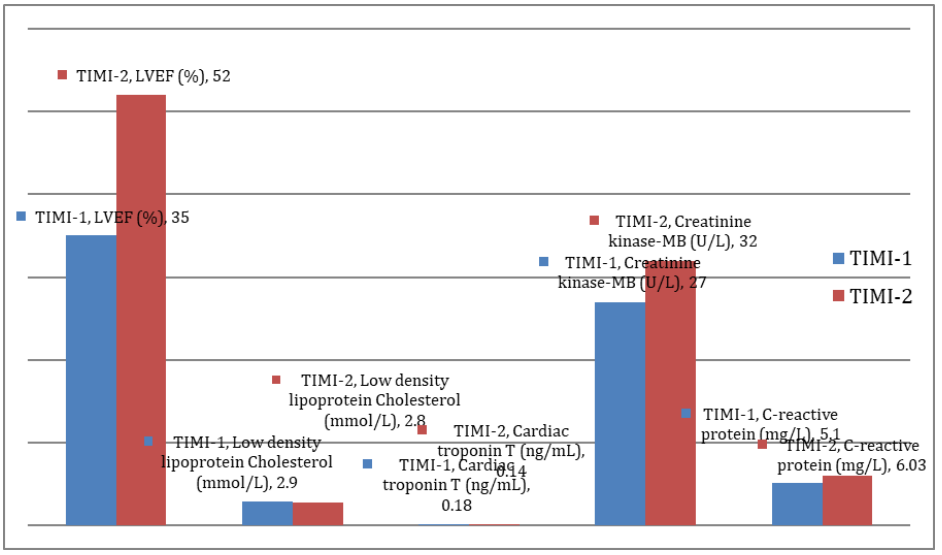

Figure 1. Baseline laboratory characteristics of STEMI patients

Table 5
Coronary angiography results of STEMI patients

S. No	Location of lesion	TIMI Group (pre-intervention)	Typical ECG	Clinical presentation
1	LAD	TIMI-1	Yes	Chest pain, diaphoresis, fatigue, nausea, shortness of breathe
2	RCA	TIMI-1	Yes	
3	LCx	TIMI-1	Yes	

LAD= Left anterior descending; RCA= Right coronary artery; LCx= Left circumflex

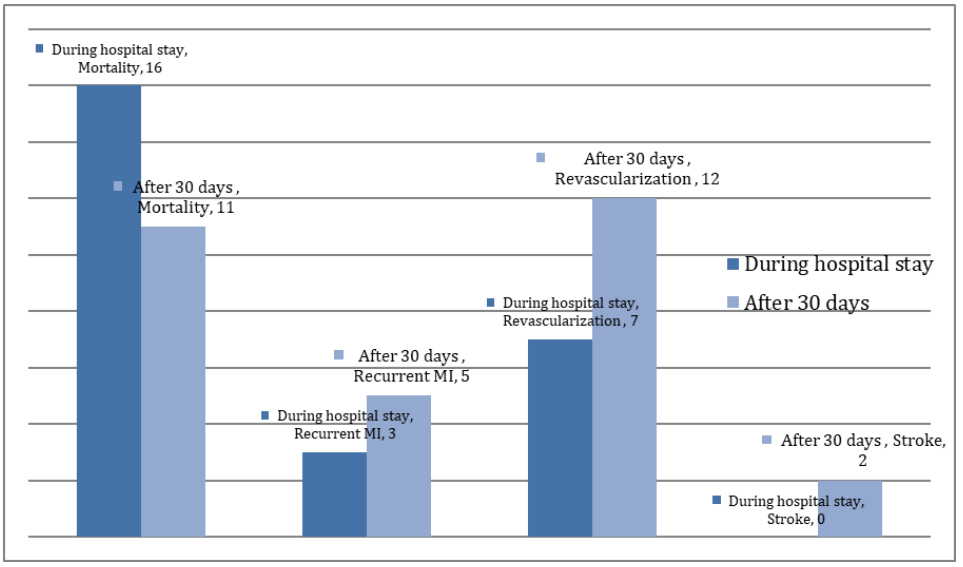

Figure 2. Overall MACE grading of STEMI patients in hospital and after 30 days

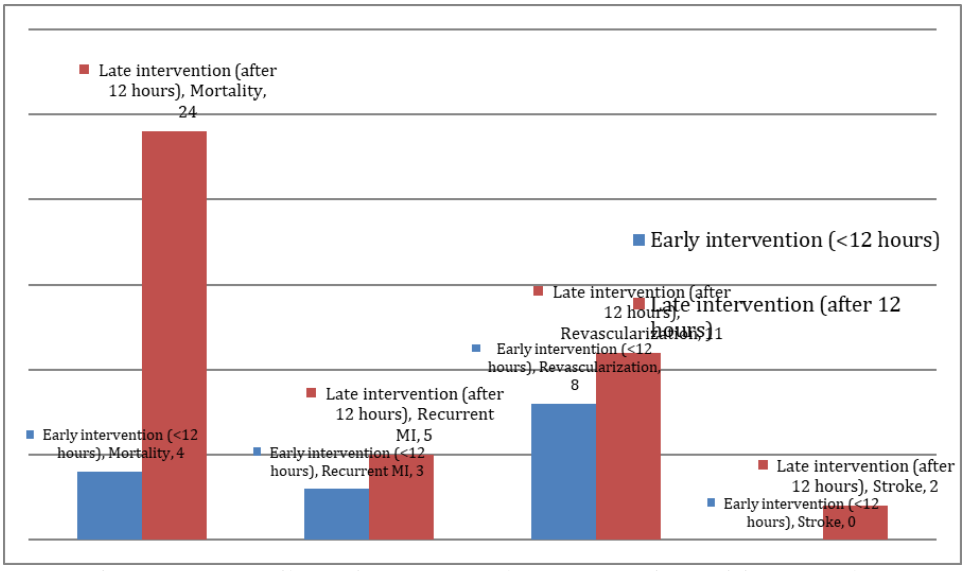

Figure 3. The MACE grading of STEMI patients at early and late PCI intervention

Discussion

Early angiography and intervention are efficacious in treating anterior STEMI involving diagonal branches, with a 30-day all-cause mortality rate of 10.8%. Late intervention increased the need for revascularization, whereas early intervention decreased mortality rates. Patients with STEMI had reduced RBC, TLC, and platelet counts, as well as elevated serum creatinine and cardiac troponin levels, indicating that these laboratory parameters could be employed in predicting severity of STEMI with prognosis. Patients with TIMI-1 had poorer baseline characteristics than those with TIMI-2, which may be associated with poorer

clinical outcomes. The study highlights the significance of coronary angiography in determining the location and severity of coronary artery disease, as well as the need for early intervention and appropriate medical management to enhance patient outcomes. Mean values of RBCs, TLCs, and platelets, were declined and increase in serum creatinine and cardiac troponin was seen. Gender distribution of STEMI patients classified by TIMI revealed significant differences between male and female patients and between TIMI-1 and TIMI-2 groups. STEMI patients in the TIMI-1 group had worse baseline characteristics than those in the TIMI-2 group. The MACE classifications of STEMI patients indicated that early intervention leads to better mortality outcomes, whereas late intervention may result in a higher rate of revascularization.

It was reported that 392 patients with anterior STEMI who received primary PCI were organized into two groups; 69 patients in loss group (TIMI grade 0-1) and 323 patients in no loss group (TIMI grade 2-3) experienced loss of D flow before primary PCI. Group with loss of D flow had significantly lower LVEF after PCI (41 vs. 48.8%) and a substantially higher incidence of MACEs, particularly all-cause mortality ($p<0.05$). Significant differences in 18-month outcomes between the groups were primarily due to disparities during hospitalization, according to a landmark analysis. Thus, loss of main D flow was found to be independently associated with an increased risk of MACEs and all-cause mortality and diminished LVEF [2]. It was reported that complications of coronary artery interventions and surgeries are uncommon, yet can be catastrophic. CT is the most effective noninvasive imaging modality for assessing these complications. MRI provides exceptional insight into the condition of the myocardium. ICA is the diagnostic standard of reference [18].

As a reperfusion strategy, PCI is highly recommended for STEMI patients with substantial risk of hemorrhage. Dual antiplatelet therapy consisting of aspirin and an ADP receptor blocker must be given at the earliest of feasibility prior to angiography and parenteral anticoagulation. Given that the efficacy of fibrinolysis and duration between the onset of symptoms and fibrinolysis bear negative linear correlation [19-21]. Insufficient diagonal branch flow after primary angioplasty was associated with worse LVEF and higher LV WMSI in patients with a first acute anterior STEMI undergoing primary angioplasty, according to a study [3].

Insufficient diagonal flow had lower left ventricular systolic function and worse RWMSA. Hospital-acquired adverse events were comparable between patients with and without adequate diagonal blood flow. Due to limited sample size, there was no hospital-acquired mortality in the reported study. In contrast, LVESV after primary angioplasty was greater in the group with inadequate diagonal flow, which indicated greater left ventricular remodeling in this group. Thus LVESV is one of the most important prognostic echocardiographic factors for short-term as well as long-term survival and adverse events in patients with acute MI and chronic coronary artery disease [22-24].

Conclusion

Early angiography and intervention appear to be highly effective for the treatment of anterior diagonal STEMI. Restoring blood flow to the affected coronary artery

and minimizing myocardial injury requires prompt reperfusion therapy. The use of diagnostic angiography and subsequent intervention permits a rapid and accurate diagnosis of the underlying pathology, allowing cardiologists to formulate and implement an appropriate treatment immediately. Early angiography and intervention should be considered standard of care for the treatment of anterior STEMI involving diagonal branches, as they reduce the risk of complications and improve patient outcomes. To optimize the timing and technique of reperfusion therapy and to identify patients who may benefit from more aggressive treatment strategies, additional research is required.

Limitations

This study has limitations that research was conducted at single centre, which may limit the generalizability of the results. Further research is required to confirm our findings in larger, more diverse populations.

Conflict of Interest

None.

References

1. Solsi A, Gandhi D D. An Unusual Case of ST Elevation Myocardial Infarction in Angiographically Non-Obstructed Coronary Arteries. Cureus. 2021 Jan;13(1):e12657.
2. Zhang S, Deng X, Yang W, Xia L, Yao K, Lu H, Ge L, Shen L, Sun A, Zou Y, Qian J, Ge J. The diagonal branches and outcomes in patients with anterior ST- elevation myocardial infarction. BMC Cardiovasc Disord. 2020 Mar 4;20(1):108.
3. Raadi M, Javanshir E, Salehi R, Separham A. Association of Left Ventricular Systolic Function with Diagonal Branch Flow in Patients with First Anterior ST-Elevation Myocardial Infarction Treated with Primary Angioplasty. Int J Cardiovasc Pract. 2022;7(1):e129928.
4. Bansal K, Gore M, Nalabothu P. Anterior Myocardial Infarction. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.
5. Bauer M. Cardiovascular Anatomy and Pharmacology. Basic Sciences in Anesthesia. 2017 Jul 3:195–228.
6. Aslam A, Stojanovska J, Khokhar US, Weinberg RL, Ganesh SK, Labounty T, Sutton NR, Patel S. Spontaneous Coronary Artery Dissection: An Underdiagnosed Clinical Entity—A Primer for Cardiac Imagers. Radiographics. 2021;41(7):1-20.
7. Bhattarai S, Chhabra L, Hashmi MF, et al. Anteroseptal Myocardial Infarction. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.
8. Ludhwani D, Chhabra L, Goyal A, et al. Lateral Wall Myocardial Infarction. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2021.
9. Bendary A, Tawfik W, Mahrous M, Salem M. Fibrinolytic therapy in patients with ST-segment elevation myocardial infarction: Accelerated versus standard Streptokinase infusion regimen. J Cardiovasc Thorac Res. 2017;9(4):209-214.

10. Stiermaier T, Desch S, Schuler G, Thiele H, Eitel I. Reperfusion strategies in ST-segment elevation myocardial infarction. Minerva Med. 2013 Aug;104(4):391-411.
11. Mughal LH, Sastry S. Advances in the treatment of ST Elevation Myocardial Infarction in the UK. JRSM Cardiovasc Dis. 2022 Feb 16;11:20480040221075519.
12. Paradies V, Smits PC. Culprit-Only Artery Versus Multivessel Disease. 2018 Jul 14. In: Watson TJ, Ong PJL, Tcheng JE, editors. Primary Angioplasty: A Practical Guide. Singapore: Springer; 2018.
13. Madan M, Halvorsen S, Mario CD, Tan M, Westerhout CM, Cantor WJ, et al. Relationship Between Time to Invasive Assessment and Clinical Outcomes of Patients Undergoing an Early Invasive Strategy After Fibrinolysis for ST-Segment Elevation Myocardial Infarction: A Patient-Level Analysis of the Randomized Early Routine Invasive Clinical Trials. JACC: Cardiovascular Interventions. 2015;8(1):166-174.
14. Blumenstein J, Kim WK, Liebetrau C, Gaede L, Kempfert J, Walther T, Hamm C, Möllmann H. Challenges of coronary angiography and intervention in patients previously treated by TAVI. Clin Res Cardiol. 2015 Aug;104(8):632-9.
15. Noc M. Urgent coronary angiography and percutaneous coronary intervention as a part of postresuscitation management. Crit Care Med. 2008 Nov;36(11 Suppl):S454-7.
16. Akbar H, Foth C, Kahloon RA, et al. Acute ST Elevation Myocardial Infarction. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.
17. Abu Fanne R, Kleiner Shochat M, Shotan A, Frimerman A, Maraga E, Amsalem N, Levi Y, Meisel SR. Acute diagonal-induced ST-elevation myocardial infarction and electrocardiogram-guidance in the era of primary coronary intervention: New insights into an old tool. Eur Heart J Acute Cardiovasc Care. 2020 Dec;9(8):827-835.
18. Goerne H, de la Fuente D, Cabrera M, Chaturvedi A, Vargas D, Young PM, Saboo SS, Rajiah P. Imaging Features of Complications after Coronary Interventions and Surgical Procedures. Radiographics. 2021 May-Jun;41(3):699-719.
19. Ganatra S, Sharma A, Levy MS. Re-evaluating the safety of drugeluting stents in cancer patients. JACC Cardiovasc Interv. 2017;10(22):2334–2337.
20. Roffi M, Patrono C, Collet JP, Marco L, Carlo PJP. 2015 ESC guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC). Eur Heart J. 2016;37(3):267–315.
21. Handoyo V, Pertiwi GAR, Prabawa IPY, Manuaba IBAP, Bhargah A, Budiana IPG. Management of ST-elevation myocardial infarction in the setting of anterior epistaxis: focused on antiplatelet and antithrombotic therapies. Int Med Case Rep J. 2019 Feb 8;12:33-38.
22. McManus DD, Shah SJ, Fabi MR, Rosen A, Whooley MA, Schiller NB. Prognostic value of left ventricular end-systolic volume index as a predictor of heart failure hospitalization in stable coronary artery disease: data from the Heart and Soul Study. J Am Soc Echocardiogr. 2009;22(2):190–7.

23. Reddy K, Khaliq A, Henning RJ. Recent advances in the diagnosis and treatment of acute myocardial infarction. World J Cardiol. 2015 May 26;7(5):243-76.
24. Yamamoto K, Sakakura K, Akashi N, Watanabe Y, Noguchi M, Taniguchi Y, et al. Comparison of clinical outcomes between sufficient versus insufficient diagonal branch flow in anterior acute myocardial infarction. Heart Vessels. 2019;34(7):1096–103.