# Treatment Of Concurrent Cardio-Cerebral İnfarction: Meta-Analysis

**Mohammed HABIB**
*İstanbul Atlas Üniversitesi, Tıp Fakültesi*
*cardiomohammad@yahoo.com*
ORCID: 0000-0001-7756-7249

## ABSTRACT

**Background:** The synchronous occurrence of acute ischemic stroke and acute myocardial infarction is an extremely rare condition that can be lethal. The causes and optimal treatment in these cases is still unclear.

**Methods:** We conducted on the literature review, we analyzed clinical presentations, causes, type of myocardial infarction, site of stroke, modified ranking scale at discharge and treatment options. We compare mortality rate at hospital discharge and 90 days after discharge between patients with combination intervention treatment (both percutaneous coronary intervention for coronary arteries and mechanical thrombectomy for cerebral vessel) and medical treatment.

**Results:** We identified 94 cases of concurrent cardio-cerebral infarction from case reports and case series. The mean age was 62.5±12.6 years. Male 58 patients (61.7%). In patients with combination intervention treatment group: hospital mortality rate was 13.3% and 90-days mortality rate was: 23.5% compared with mortality rate in medical treatment (23.5% at hospital and 59.5% at 90 days (P value 0.038 and 0.012 respectively)

**Conclusion:** Concurrent cardio-cerebral infarction prognosis is very poor, without intervention about 25% of patients died before discharge 60% of patients died at 90 days after stroke. Despite only one quarter of patients treated by combination intervention treatment, this treatment modality significantly reduces mortality rate compared medical treatment.

***Keywords:*** *acute stroke, myocardial infarction, percutaneous coronary intervention*

[1] Makale geliş tarihi: 02/03/2024 Makale kabul tarihi: 13/06/2024

## Eş Zamanlı Kardiyo-Serebral Enfarktüsün Tedavisi: Meta-Analiz


## ÖZET

**Amaç**: Akut iskemik inme ve akut miyokard enfarktüsünün eş zamanlı ortaya çıkması son derece nadir görülen bir durumdur. Bu vakalarda nedenler ve optimal tedavi hala belirsizdir.

**Yöntemler**: Literatür taraması yaparak klinik tabloları, nedenlerini, miyokard enfarktüsünün tipini, inme bölgesini, taburculukta değiştirilmiş sıralama ölçeğini ve tedavi seçeneklerini analiz ettik. Kombinasyon müdahale tedavisi (koroner arterler için perkütan koroner girişim ve serebral damar için mekanik trombektomi) ve tıbbi tedavi uygulanan hastalar arasında hastaneden taburcu olurken ve taburcu olduktan 90 gün sonra ölüm oranlarını karşılaştırıyoruz.

**Bulgular** : Vaka raporlarından ve vaka serilerinden 94 eş zamanlı kardiyo-serebral enfarktüs vakasını belirledik. Ortalama yaş 62, 5±12, 6 yıl idi. 58 hasta (%61,7) erkek. Kombinasyon müdahaleli tedavi grubundaki hastalarda: hastane mortalite oranı %13, 3 ve 90 günlük mortalite oranı: tıbbi tedavide ki mortalite oranıyla karşılaştırıldığın da %23,5 (hastane de %23,5 ve 90 gün de %59,5 (sırasıyla P değeri 0,038 ve 0,012)

**Sonuç**: Eş zamanlı kardiyo-serebral enfarktüs prognozu çok kötü olup, müdahale edilmezse hastaların yaklaşık %25'i taburcu olmadan kaybedilmiştir. Hastaların %60'ı inmeden 90 gün sonra ölmüştür. Hastaların yalnızca dörtte birinin kombinasyon müdahale tedavisi ile tedavi edilmesine rağmen, bu tedavi yöntemi, tıbbi tedaviye kıyasla mortalite oranını önemli ölçüde azaltmaktadır.


***Anahtar Kelimeler***: *Akut inme, miyokard infarktüsü, perkütan koroner girişim (PKG), mekanik trombektomi (MTE), modifiye sıralama ölçeği (mRS)*

## INTRODUCTION

Synchronous occurrence of Acute ischemic stroke (AIS) and ST elevation or non-ST elevation acute myocardial infarction (AMI) are very rare medical emergency conditions and may be lethal (1). Both conditions have a narrow treatment time-window. The use of intravenous thrombolytics for acute myocardial infarction(AMI) can be increase the risk for intracranial bleeding (2-3), also the use of a thrombolytic in patients with history of recent ST elevation myocardial infarction (after 6 hours of stating AMI) for treatment of acute ischemic stroke (AIS) increases the risk of cardiac wall rupture and mortality (4).

Global Registry of Acute Coronary Event (GRACE) trial suggested that, the incidence of intra-hospital acute ischemic stroke was 0.9% in patients presenting with acute coronary syndrome, and the incidence was much higher among patients with ST elevation myocardial infarction than the non-ST elevation myocardial infarction (5).

Multiple metanalysis suggested primary PCI reduce mortality compared with thrombolytic treatment among patients with ST elevation myocardial infarction. (6)

Also the shorter time of reperfusion was directly associated with a higher probability of functional independence after Mechanical thrombectomy (MTE) for patients with acute ischemic stroke (7). In 2015 several randomized trials showed the superiority of MTE combined with thrombolytics for stroke patients with a large vessel occlusion.

Until now no trial was found to compare the benefit of PCI and MTE over medical treatment for patient with co-incidence of AMI and AIS. The present Review analyzed the comparison between combination intervention strategy versus medical treatment in these cases.

## METHODS

### Study design and Patient selection

In this Review, we screened retrospective a comprehensive analysis of five databases, PubMed, Embase, Scopus, Research Gate and Google Scholar on concurrent or simulations and synchronous Cardio-cerebral infarction to locate all case report or case series done on this topic (Figure 1).

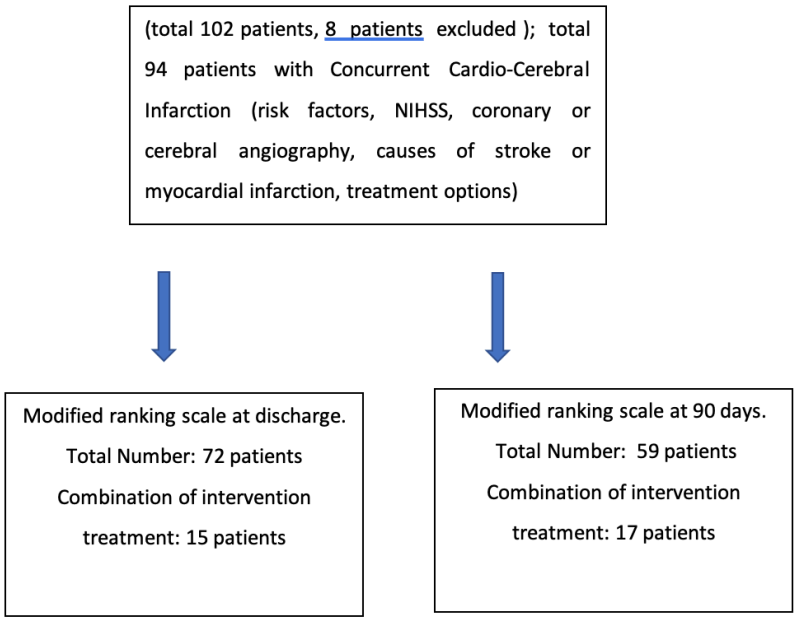


**Figure 1** flowchart summarizing case report selection

## Inclusion criteria

We analyzed all the cases of concurrent or synchronous cardiocerebral infarction (The occurrence of acute ischemic stroke and acute myocardial infarction either at the same time or one after the other within 12 hours) from first symptoms to first medical contact.(8-76)

## Exclusion criteria

The occurrence of two conditions of acute ischemic stroke and acute myocardial infarction one after the other more than 12 hours

## Definitions of concurrent cardio-cerebral infarction:

The occurrence of first sign of acute ischemic stroke and first sign of acute myocardial infarction either at the same time or one after the other within 12 hours

## Data collection

The following variables were collected: age and sex, medical treatment such as thrombolytics, anticoagulant and antiplatele. Intervention treatment of AMI by percutaneous coronary intervention (PCI) and AIS treatment by mechanical thrombectomy (MTE). antithrombotic medication.

**Combination intervention treatment**
Combination of intervention treatment for both percutaneous coronary intervention (PCI) for coronary arteries and for mechanical thrombectomy (MTE) for cerebral arteries.

**Outcome**
1. Calculated the outcome according to modified ranking scale which 0-2: mild disability, 3-5: moderate to severe disability and 6: death at hospital discharge and 90 days after discharge.
2. Comparison of mortality rate during hospital stay and 90 days after discharge between patients with combination intervention treatment and medical treatment.

**Statistical analysis**
Baseline variables continuous data are reported as means ± SD. Categorical data are presented as absolute values and percentages. Using the x2, Fisher for calculation mortality rate between patient who treated with combination intervention treatment and medical treatment . Significance level was set at P value < 0.05. Statistical analysis was performed with SPSS Statistics, Version 23.0.

**RESULTS:**
**Patient Characteristics**
Total 94 cases were analyzed, the mean age 62.5±12.6 years. Female 36 patients (38.3%), male 58 patients (61.7%). The median time between stroke and myocardial infarction was 0.5 hour (0-12 hours).

**Table 1-** Baseline characterizes of patients

| **Risk factors:** | **N (%)** |
|---|---|
| Hypertension | 45 (46.8%) |
| Diabetes mellitus | 26 (27.7%) |
| Previous stroke | 11 (11.5%) |
| Smoker | 19 (19.8%) |
| History of Coronary artery disease | 13 (13.5%) |
| Dyslipidemia | 22 (22.9%) |
| **Stroke severity NIHSS (median)** | 15 (1-30) |

The resting ECG findings were reported in table 2

**Table 2 -**Resting ECG findings in the patients:

| Resting ECG findings | N (%) |
|---|---|
| Anterior ST segment elevation | 37 (38.5%) |
| Inferior wall St segment elevation | 27 (28.1%) |
| Non-ST elevation myocardial infarction | 20 (20.8%) |
| Inferior ST elevation and Right ventricle infarction | 5 (5.2 %) |
| High Lateral ST elevation Myocardial infarction | 2 (2.0%) |
| Non-Reported | 5 (5.2%) |
| Atrial fibrillation | 21 (21.9%) |

Culprit stenosis in cranial arteries in angiography findings suggested culprit intracranial artery in (Table 3).

**Table 3 -** Culprit stenosis in cranial arteries

| Target cranial artery | N (%) |
|---|---|
| Middle cerebral artery | Right 19 (19.8%), Left 30 (31.2%) |
| Basilar artery | 10 (10.4%) |
| Internal carotid artery | Right 7(7.3%), Left 5 (5.2%) |
| Non reported | 17 (17.8%) |
| No stenosis | 4 (4.2 %) |
| Anterior cerebral artery | 1 (1 %) |
| Left common carotid artery | 2 (2.1%) |
| Right vertebral artery | 1(1%) |

**Treatments in concurrent cardio-cerebral Infarction Patients**
**1-Drug Medication**:

1. Thrombolytics: intravenous t-PA 42 patients (44.7%) and one patient Tenecteplase.
2. Antiplatelet treatment was reported in 69 (73%) patients and not reported in 25 (27%) patients.
3. Anticoagulation; 4 (4.2%) patients (1 Novel oral anticoagulation and 3 warfarin) .
4. Combination of dual antiplatelet and anticoagulation: 26 (27.7%) patients (5 patients; Novel oral anticoagulation and 21 patients' warfarin),

5. combination of single antiplatelet and anticoagulation: 5 (5.3%) patients (3 warfarin and 2 Novel oral anticoagulation).

**2-Interventions of procedures:**

1. Percutaneous coronary intervention (PCI) was used to treat 29 patients (30.8%): PCI with balloon only 9 (9.6%), PCI with aspiration only 1 (3.2%), PCI with Bare metal stent 3 (3.2%), PCI with Drug eluting stent 16 (17%).
2. Mechanical thrombectomy of cerebral vessels in 24 patients (25.5%).

**3- Combination of intervention treatment.**

Only 21 (22.3%) were treated by both PCI for coronary arteries and Mechanical thrombectomy of cerebral vessels.

## OUTCOMES

We calculated outcome according to modified ranking scale which 0-2: mild disability, 3-5: moderate to severe disability and 6: death. The modified Rankin Score (mRS) was measured in 72 patients at hospital and in 59 patients at 90 days. The mortality rate was 33.3% at hospital discharge measured from 72 (76.6%) patients and at 90 days the mortality rate was (49.2%) measured from 59 (62.8%) patients. (Table4)

**Table 4 -** Modified ranking scale (mRS) outcomes at hospital discharge and at 90 days after cardio-cerebral infarction:

| **Modified ranking scale** | **At hospital discharge 72 patients (%)** |
|---|---|
| **Mild disability** | 32 (44.4%) |
| **Moderate – severe disability** | 16 (22.3%) |
| **Death** | 24 (33.3%) |
| **Modified ranking scale** | **At 90 days after discharge 59 patients (%)** |
| **Mild disability** | 22 (37.3%) |
| **Moderate – severe disability** | 8 (13.5%) |
| **Death** | 29 (49.2%) |

**Combination of intervention (PCI plus MTE)**

We identified 21 cases of concurrent cardio-cerebral infarction. Female 8 patients (38.1%), male 13 patients (61.9%). Interventions procedures: percutaneous coronary intervention (PCI) was used to treat PCI with balloon only 3 (14%), PCI with aspiration only 1 (5%), PCI with Bare metal stent 1 (5%), PCI with Drug eluting stent 16 (76%). Treatment with mechanical thrombectomy of cerebral vessels in 21 patients (100%). (Table 5).

**Table 5 -** The outcome of patients with combination intervention treatment

| **Modified ranking scale** | **At hospital discharge 15 patients (%)** |
|---|---|
| **Mild disability** | 6 (40%) |
| **Moderate – severe disability** | 7 (46.7%) |
| **Death** | 2 (13.3%) |
| **Modified ranking scale** | **At 90 days after discharge 17 patients (%)** |
| **Mild disability** | 7(41%) |
| **Moderate – severe disability** | 6 (35 %) |
| **Death** | 4 (23.5%) |

**Comparison of mortality rate between combination intervention treatment and medical treatment.** The mortality rate was significantly lower in patient with combination intervention group than medical treatment during hospital stay (P:038) and at 90 days after discharge (P:0.012). In medical group patients: 8 patients were treated with PCI plus medications and 3 treated with MTE plus medications and other patients treated with medication alone (Table 6).

**Table 6 -** Mortality rate between combination intervention treatment and medical treatment

| | **Combination intervention (Death/total patient), %** | **Medical treatment (Death/total patient), %** | **P value** |
|---|---|---|---|
| Mortality during hospital stay | (2/15),13.3% | (22/57) 38.6% | 0.038 |
| Mortality 90 days after discharge | (4/17), 23.5% | (25/42)59.5% | 0.012 |

## DISCUSSION

The mortality rate was 33.3% at hospital discharge and at 90 days the mortality rate was (49.2%). Only 21 (22.3%) were treated combination by both PCI for coronary arteries and Mechanical thrombectomy of cerebral vessels. The main concerns about giving alteplase to patients with AIS and history of recent MI are divided into 3 items.

1. Thrombolysis-induced myocardial hemorrhage predisposing to myocardial wall rupture

2. Possible ventricular thrombus that could be embolize because of thrombolysis.

3. Post-myocardial infarction pericarditis that may become hemopericardium.

According to the 2018 scientific statement guideline from the American Heart Association/American Stroke Association (AHA/ASA), For patients presenting with synchronous AIS and AMI, treatment with intravenous alteplase at the dose appropriate for acute ischemic stroke, followed by percutaneous coronary intervention (PCI) and stenting if indicated, is reasonable. (77). The new recommendation according to 2021 guidelines of European Stroke Organization (ESO) on intravenous thrombolysis for acute ischemic stroke suggested that (78): Contraindication of alteplase for patients with acute ischemic stroke of < 4.5 h duration and with history of subacute (> 6 h) ST segment elevation myocardial infarction during the last seven days. The intravenous alteplase also contraindications in patients with acute STEMI with recent acute ischemic stroke if stroke duration more than 4.5 hours from onset symptoms (79). So that if AIS after 6 hours from STEMI onset, or STEMI after 4.5 hours from AIS intravenous alteplase is contraindication. In these conditions we recommended intervention treatment with PCI and/or MTE.

Our metanalysis showed that concurrent CCI had high in-hospital mortality rate 33.3%, and 3-month mortality rate 49.2%. Lennie Lynn C. de Castillo et al, in case series involved 9 patients with concurrent CCI reported mortality rate 45% (8), In another metanalysis of 44 patients, ten patients (23%) died (80). The use of combination of intervention reduce hospital mortality to 13.3% and 90-days mortality to 25.3% (P VALUE: 0.038 and 0.012 respectively). To the best of our knowledge, this is the largest meta-analysis, on the concurrent cardio cerebral infarctions, encompassing of

94 patients. The combination intervention (PCI and MTE) treatment was significantly reduce mortality.

## CONCLUSION

The occurrence of concurrent cardio cerebral infarction is rare with high risk of mortality and disability rate especially. The intervention with PCI and MTE was significantly reduces the mortality rate. Further studies will need to examine the optimum treatment strategies

## Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## REFERENCES

Abdi IA, Karataş M, Abdi AE, Hassan MS, Yusuf Mohamud MF. Simultaneous acute cardio-cerebral infarction associated with isolated left ventricle non-compaction cardiomyopathy. Ann Med Surg (Lond). 2022 Jul 16;80:104172.

Abe S, Tanaka K, Yamagami H, Sonoda K, Hayashi H, Yoneda S, Toyoda K, Koga M (2019) Simultaneous cardio-cerebral embolization associated with atrial fibrillation: a case report. BMC Neurol 19(1):152.

ABUHEIT E, Lu F, Liu S, et al. Mechanical thrombectomy for ischemic stroke during Percutaneous Coronary Intervention for Acute Myocardial Infarction in a three- vessel disease patient: a case report and literature review. Research Square; 2022. DOI: 10.21203/rs.3.rs-2044174/v1.

Almasi M, Razmeh S, Habibi AH, Rezaee AH. Does Intravenous Administration of Recombinant Tissue Plasminogen Activator for Ischemic Stroke can Cause Inferior Myocardial Infarction? Neurol Int. 2016 Jun 29;8(2):6617.

Bao C-h, Zhang C, Wang X-m and Pan Y-b (2022) Concurrent acute myocardial infarction and acute ischemic stroke: Case reports and literature review. Front. Cardiovasc. Med. 9:1012345. doi: 10.3389/fcvm.2022.1012345.

Bersano A, Melchiorre P, Moschwitis G, Tavarini F, Cereda C, Micieli G, Parati E, Bassetti C. Tako-tsubo syndrome as a consequence and cause of

stroke. Funct Neurol. 2014 Apr-Jun;29(2):135-7. PMID: 25306124; PMCID: PMC4198162.

Bhandari M, Pradhan AK, Vishwakarma P, Sethi R. Concurrent Coronary, Left Ventricle, and Cerebral Thrombosis - A Trilogy. Int J Appl Basic Med Res. 2022 Apr-Jun;12(2):130-133.

Borja Ibanez et al. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. European Heart Journal (2018) 39, 119–177

Brz˛eczekM, KidawaM, Ledakowicz-Polak A, et al. Myocardial infarction with simultaneous acute stroke in a patient with prior aortic graft replacement - what is the origin of the embolic incident? Folia Cardiol 2019;14(2):166-168.

Budaj A, Flasinska K, Gore JM, et al. Magnitude of and risk factors for in-hospital and postdischarge stroke in patients with acute coronary syndromes: Findings from a global registry of acute coronary events. Circulation 2005;111:3242-7

Cabral M, Ponciano A, Santos B, Morais J. Cardiocerebral Infarction: A Combination to Prevent. Int J Cardiovasc Sci 2022; 01 Aug 2022 • https://doi.org/10.36660/ijcs.20210276

Cai X-Q, Wen J, Zhao Y, Wu Y-L, Zhang H-P, Zhang WZ. Acute ischemic stroke following acute myocardial infarction: adding insult to injury. Chin Med J (Engl). 2017;130(9):1129-1130.

Chang GY. An ischemic stroke during IV tPA infusion for evolving myocardial infarction. Eur J Neurol 2001;8:267-8.

Chen KW, Tsai KC, Hsu JY, Fan TS, Yang TF, Hsieh MY. One-step endovascular salvage revascularization for concurrent coronary and cerebral embolism. Acta Cardiol Sin 2022;38:217-20.

Chlapoutakis GN, Kafkas NV, Katsanos SM, Kiriakou LG, Floros GV, Mpampalis DK. Acute myocardial infarction and transient ischemic attack in a patient with lone atrial fibrillation and normal coronary arteries. Int J Cardiol. 2010 Feb 18;139(1):e1-4.

Chong CZ, Tan BY, Sia CH, Khaing T, Yeo LL. Simultaneous cardiocerebral infarctions: a five-year retrospective case series reviewing natural his-

tory. Singapore Med J. 2021 Apr 19. doi: 10.11622/smedj.2021043. Epub ahead of print. PMID: 33866711.

Chong, Cheryl Zhiya MBBS; Tan, Benjamin Yong-Qiang MBBS; Sia, Ching-Hui MBBS; Khaing, Thet MBBS[3]; Yeo, Leonard Leong Litt MBBS[1]Simultaneous cardiocerebral infarctions: a five-year retrospective case series reviewing natural history. *Singapore Medical Journal* 63(11):p 686-690, November 2022.

de Castillo LLC, Diestro JDB, Tuazon CAM, Sy MCC, Añonuevo JC, San Jose MCZ. Cardiocerebral Infarction: A Single Institutional Series. J Stroke Cerebrovasc Dis. 2021 Jul;30(7):105831.

de Castillo LLC, Diestro JDB, Tuazon CAM, Sy MCC, Añonuevo JC, San Jose MCZ. Cardiocerebral Infarction: A Single Institutional Series. J Stroke Cerebrovasc Dis. 2021 Jul;30(7):105831.

Eivind Berge et al. European Stroke Organisation (ESO) guidelines on intravenous thrombolysis for acute ischaemic stroke. European Stroke Journal 2021 http://dx.doi.org/10.1177/2396987321989865.

Eskandarani R, Sahli S, Sawan S, Alsaeed A (2021) Simultaneous cardio-cerebral infarction in the coronavirus disease pandemic era: a case series. Medicine (Baltimore) 100(4):e24496.

Fitzek S, Fitzek C. A myocardial infarction during intravenous recombinant tissue plasminogen activator infusion for evolving ischemic stroke. Neurologist 2015; 20(3):46–7.

González-Pacheco H, Méndez-Domínguez A, Vieyra-Herrera G, Azar-Manzur F, Meave-González A, Rodríguez-Zanella H, Martínez-Sánchez C (2014) Reperfusion strategy for simultaneous ST-segment elevation myocardial infarction and acute ischemic stroke within a time window. Am J Emerg Med 32(9):1157.e1–4.

Grogono J, Fitzsimmons SJ, Shah BN, Rakhit DJ, Gray HH. Simultaneous myocardial infarction and ischaemic stroke secondary to paradoxical emboli through a patent foramen ovale. Clin Med (Lond). 2012 Aug;12(4):391-2.

Gungoren F, Besli F, Tanriverdi Z, Kocaturk O. Optimal treatment modality for coexisting acute myocardial infarction and ischemic stroke. Am J

Emerg Med. 2019 Apr;37(4):795.e1-795.e4.

Hashimoto O, Sato K, Numasawa Y, Hosokawa J, Endo M (2014) Simultaneous onset of myocardial infarction and ischemic stroke in a patient with atrial fibrillation: multiple territory injury revealed on angiography and magnetic resonance. Int J Cardiol 172(2):e338–e340.

Hosoya H, Levine JJ, Henry DH, Goldberg S (2017) Double the trouble: acute coronary syndrome and ischemic stroke in polycythemia vera. Am J Med 130(6):e237–e240.

Ibekwe E, Kamdar HA, Strohm T. Cardio-cerebral infarction in left MCA strokes: a case series and literature review. Neurol Sci. 2022 Apr;43(4):2413-2422. doi: 10.1007/s10072-021-05628-x. Epub 2021 Sep 29. PMID: 34590206; PMCID: PMC8480750.

Iqbal P (2021) The role of anticoagulation in post-COVID-19 concomitant stroke, myocardial infarction, and left ventricular thrombus: a case report. Am J Case Rep 22(1):1–6.

K, Shindo S, Yamada K, Shirakawa M, Uchida K, Horimatsu T, Ishihara M, Yoshimura S (2016) Acute embolic cerebral infarction and coronary artery embolism in a patient with atrial fibrillation caused by similar thrombi. J Stroke Cerebrovasc Dis 25(7):1797–1799.

Katsuki M, Katsuki S (2019) A case of cardiac tamponade during the treatment of simultaneous cardio-cerebral infarction associated with atrial fibrillation - case report. Surg Neurol Int. 10:241.

Kawano H, Tomichi Y, Fukae S, Koide Y, Toda G, Yano K. Aortic dissection associated with acute myocardial infarction and stroke found at autopsy. Intern Med. 2006;45(16):957-62.

Khairy M, Lu V, Ranasinghe N, Ranasinghe L. A Case Report on Concurrent Stroke and Myocardial Infarction. Asp Biomed Clin Case Rep. 2021 Jan 23;4(1):42-49.

Kijpaisalratana N, Chutinet A, Suwanwela NC (2017) Hyperacute simultaneous cardiocerebral infarction: rescuing the brain or the heart first? Front Neurol 8:664.

Kim HL, Seo JB, Chung WY, Zo JH, Kim MA, Kim SH (2013) Simultaneously presented acute ischemic stroke and non-st elevation myocardial

infarction in a patient with paroxysmal atrial fibrillation. Korean Circ J 43(11):766–769.

Kleczyński P, Dziewierz A, Rakowski T, Rzeszutko L, Sorysz D, Legutko J, Dudek D (2012) Cardioembolic acute myocardial infarction and stroke in a patient with persistent atrial fibrillation. Int J Cardiol 161(3):e46–e47.

Koneru, S.; Jillella, D.V.; Nogueira, R.G. Cardio-Cerebral Infarction, Free-Floating Thrombosis and Hyperperfusion in COVID-19. Neurol. Int. 2021, 13, 266–268.

Lee Kijeong, Park Woohyun, Seo Kwon-Duk and Kim Hyeongsoo. (2021). Which one to do first?: a case report of simultaneous acute ischemic stroke and myocardial infarction. Journal of Neurocritical Care, 14(2), 109-112.

Loffi M, Besana M, Regazzoni V, Enrico P, Giuli VD, et al. A masked ST-elevation myocardial infarction. J Clin Images Med Case Rep. 2021; 2(4): 1249.

Maciel R, Palma R, Sousa P et al (2015) Acute stroke with concomitant acute myocardial infarction: Will you thrombolyse? J Stroke 17:84–86.

Mai Duy T, DaoViet P, Nguyen Tien D, Nguyen QA, Nguyen Tat T, Hoang VA, Le Hong T, Nguyen Van H, Anh Nguyen D, Nguyen Van C, Thai Lien NV, Nga VT, Chu DT. Coronary aspiration thrombectomy after using intravenous recombinant tissue plasminogen activator in a patient with acute ischemic stroke: a case report. J Int Med Res. 2019 Sep;47(9):4551-4556.

Manea MM, Drago¸sD, Stoica E, Buc¸sa A, MarinicaI, Tu¸ta S. Early ST-segment elevation acute myocardial infarction after thrombolytic therapy for acute ischemic stroke: a case report. Medicine (Baltimore) 2018;97(50):e13347.

Mehdiratta M, Murphy C, Al-Harthi A, Teal PA. Myocardial infarction following t-PA for acute stroke. Can J Neurol Sci. 2007; 34:417–420. [PubMed: 18062448].

Meissner W, Lempert T, Saeuberlich-Knigge S, Bocksch W, Pape UF. Fatal embolic myocardial infarction after systemic thrombolysis for stroke. Cerebrovasc Dis. 2006; 22:213–214. [PubMed: 16766875].

Mohammed H Habib, "Synchronous Cardio-Cerebral Infarction Syndrome with Cardiogenic Shock. Is it Safe to Perform Rescue Percutaneous

Coronary Intervention and Mechanical Thrombectomy for Middle Cerebral Artery?". EC Neurology 2022: 14.12 .

Mohammed Habib, Salama Awadallah. Acute Ischemic Stroke Followed by Acute Inferior Myocardial Infarction. Tech Neurosurg Neurol. 5(3). TNN. 000612. 2022

Mohammed Habib. Cardio-Cerebral Infarction Syndrome (CCIS): Definition, Diagnosis, Pathophysiology and Treatment. Cardiology and Cardiovascular Research. Vol. 5, No. 2, 2021, pp. 84-93.

Nakajima H, Tsuchiya T, Shimizu S, Watanabe K, Kitamura T, Suzuki H. Endovascular therapy for cardiocerebral infarction associated with atrial fibrillation: A case report and literature review. Surg Neurol Int. 2022 Oct 21;13:479.

Nardai S, Vorobcsuk A, Nagy F, Vajda Z. Successful endovascular treatment of simultaneous acute ischaemic stroke and hyperacute ST-elevation myocardial infarction: The first case report of a single-operator cardio-cerebral intervention. Eur Heart J Case Rep 2021;5:ytab419.

Nguyen TL, Rajaratnam R. Dissecting out the cause: a case of concurrent acute myocardial infarction and stroke. BMJ Case Rep. 2011 Jun 3;2011:bcr0220113824.

O. Kawarada, Y. Yokoi, Brain salvage for cardiac cerebral embolism following myocardial infarction, Catheter. Cardiovasc. Interv. 75 (2010) 679–683.

Obaid O, Smith HR, Brancheau D. Simultaneous Acute Anterior ST-Elevation Myocardial Infarction and Acute Ischemic Stroke of Left Middle Cerebral Artery: A Case Report. Am J Case Rep. 2019 Jun 2;20:776-779.

Omar HR, Fathy A, Rashad R, et al. Concomitant acute right ventricular infarction and ischemic cerebrovascular stroke; possible explanations. Int Arch Med 2010;3:25.

Parackrama Karunathilake, Arun Rajaratnam, WKS Kularatne et al. Lessons learned from the management of a case of acute synchronous cardio cerebral infarction in a resource-poor setting, 09 June 2022, PREPRINT (Version 1).

Patel MR, Meine TJ, Lindblad L, et al. Cardiac tamponade in the fibrinolytic era: analysis of >100,000 patients with ST-segment elevation myocardial infarction. Am Heart J 2006;151:316-22.

Peng H, Chen M, Li G, et al. Combination refusion therapy for a hemodynamically unstable patient with acute myocardial infarction complicated by acute ischemic stroke within a time window. Int J Cardiol 2015 Dec;201:152-153.

Plata-Corona JC, Cerón-Morales JA, Lara-Solís B (2019) Nonhyperacute synchronous cardio-cerebral infarction treated by double intervensionist therapy. Cardiovasc Metab Sci 30(2):66–75.

Polo Taborda, Nelson; Besteiro, Guillermo; Pfirter, Flavia.Rev. Méd. Clín. Condes ; 31(5/6): 487-490, sept.-dic. 2020.

Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al; American Heart Association Stroke Council. 2018 Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2018; 49: e46–e110.

Sakuta K, Mukai T, Fujii A, Makita Kand Yaguchi H (2019) Endovascular Therapy for Concurrent Cardio-Cerebral Infarction in a Patient With Trousseau Syndrome. Front. Neurol. 10:965.

Sandercock PA, Counsell C, Kane EJ. Anticoagulants for acute ischaemic stroke. Cochrane Database Syst Rev 2015.CD000024.

Seiya Nagao, Yasuhide Tsuda, Michihisa Narikiyo, Gota Nagayama, Hirokazu Nagasaki, Yoshifumi Tsuboi, Noritoshi Itou, Chisaku Kambayashi, A case of a patient with endovascular treatment after intravenous t-PA therapy for the acute cerebral infarction and acute myocardial infarction, Japanese Journal of Stroke, 2019, Volume 41, Issue 1, Pages 7-12, Released on J-STAGE January 25, 2019, Advance online publication May 07, 2018, Online ISSN 1883-1923, Print ISSN 0912-0726.

Stafford P J, Strachan C J, Vincent R, Chamberlain D A. Multiple microemboli after disintegration of clot during thrombolysis for acute myocardial infarction. British Medical Journal 1989; 299 :1310.

Sweta A, Sejal S, Prakash S, Vinay C, Shirish H. Acute myocardial infarction following intravenous tissue plasminogen activator for acute ischemic

stroke: An unknown danger. Ann Indian Acad Neurol. 2010; 13:64–66. [PubMed: 20436751].

Teddy Arnold Sihite, Michi Astuti Rehmenda Mario Sitepu, Cut Azlina Effendi Review on Acute Cardio-Cerebral Infarction: a Case Report IJIHS. 2021;9(2):84–88

Tomoya NISHIMURA, Daisuke KOBASHI, Mitsunobu NAKAMURA, Yoshihiko TAKAHASHI, Jun MARUYAMA, Takashi SASAKI, Cardio-cerebral infarction with splenic infarction, Journal of Japanese Society for Emergency Medicine, 2022, Volume 25, Issue 1, Pages 84-88, Released on J-STAGE February 28, 2022, Online ISSN 2187-9001, Print ISSN 1345-0581, https://doi.org/10.11240/jsem.25.84.

Trina Priscilla Ng, Chloe Wong, Evangeline Li En Leong et al. Simultaneous Cardio-Cerebral Infarction — A Meta-Analysis. QJM. 2022 Jun 7;115(6):374-380

Wallace EL, Smyth SS. Spontaneous coronary thrombosis following thrombolytic therapy for acute cardiovascular accident and stroke: a case study. J Thromb Thrombolysis 2012;34:548–51.

Wan Asyraf WZ, Elengoe S, Che Hassan HH, Abu Bakar A, Remli R (2020) Concurrent stroke and ST-elevation myocardial infarction: is it a contraindication for intravenous tenecteplase? Med J Malaysia 75(2):169–170.

Wang B, Patel H, Snow T, et al. ST-elevation myocardial infarction following thrombolysis for acute stroke: a case report. West Lond Med J 2011;3:7–13.

Wang X, Li Q, Wang Y, Zhao Y, Zhou S, Luo Z, Gu M. A case report of acute simultaneous cardiocerebral infarction: possible pathophysiology. Ann Palliat Med. 2021 May;10(5):5887-5890.

Wee CK, DivakarGosavi T, Huang W (2015) The clot strikes thrice: case report of a patient with 3 concurrent embolic events. Acta Neurol Taiwan 24(3):92–6.

White H, Boden-Albala B, Wang C et al. Ischemic stroke subtype incidence among whites, blacks, and Hispanics: the Northern Manhattan Study. Circulation 2005;111:1327

Yang CJ, Chen PC, Lin CS, Tsai CL, Tsai SH. Thrombolytic therapy-associated acute myocardial infarction in patients with acute ischemic stroke: A treatment dilemma. Am J Emerg Med. 2017 May;35(5):804.e1-804.e3.

Yeo LL, Andersson T, Yee KW et al (2017) Synchronous cardiocerebral infarction in the era of endovascular therapy: which to treat first? J Thromb Thrombolysis 44:104–111.

Yeo LLL, Andersson T, Yee KW, Tan BYQ, Paliwal P, et al. (2017) Synchronous cardiocerebral infarction in the era of endovascular therapy: which to treat first? J Thromb Thrombolysis 44: 104-111

Y-Hassan S, Winter R, Henareh L. The causality quandary in a patient with stroke, Takotsubo syndrome and severe coronary artery disease. J Cardiovasc Med (Hagerstown). 2015 Jan;16 Suppl 2:S118-21.

Yong TH, See JHJ, Liew BW (2022) STEMI during Cardiocerebral Infarction (CCI): Is it Safe to Perform Primary Percutaneous Coronary Intervention?. Int J Clin Cardiol 8:251. doi.org/10.23937/23782951/1410251.

Yusuf M, Pratama IS, Gunadi R, Sani AF. Hemodynamic Stroke in Simultaneous Cardio Cerebral Infarction: A New Term for Cardiologist. Open Access Maced J Med Sci. 2021 Aug 05; 9(C):114-117.

Zinkstok SM, Roos YB. Early administration of aspirin in patients treated with alteplase for acute ischaemic stroke: A randomised controlled trial. Lancet 2012;380:731-7.