

## **Concurrent Cardio-Cerebral Infarction**

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### **Abstract**

**Background:** The concurrent occurrence of acute ischemic stroke and acute myocardial infarction (concurrent Cardio-cerebral infarction) is an extremely rare emergency condition that can be lethal. The causes, prognosis and optimal treatment in these cases is still unclear.

**Methods:** We conducted a comprehensive review of five databases, PubMed, Embase, Scopus, Research Gate and Google Scholar on concurrent or simultaneous and synchronous cardio-cerebral infarction to locate all case reports or case series done on this topic, we analyzed clinical presentations, risk factors, type of myocardial infarction, site of stroke, modified ranking scale at discharge and at 90 days after discharge and treatment options.

**Results:** we identified 94 cases of concurrent cardio-cerebral infarction from case reports and series with mean age  $62.5 \pm 12.6$  years. Female 36 patients (38.3%), male 58 patients (61.7%). Median admission NIHSS 15 (range 1–30). 29 patients (30.8%) were treated using percutaneous coronary intervention (PCI) and Mechanical thrombectomy of cerebral vessels was done in 24 patients (25.5%). Only 21 (22.3%) were treated combination by both PCI and Mechanical thrombectomy of cerebral vessels.

The outcome of 94 patients, the mortality rate at hospital discharge were in 24 patients from 72 patients with mortality rate (33.3%), the mortality rate at 90 days we recorded in 29 patients from 59 patients with mortality rate (49.2%). 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% and 59.5% respectively (P value 0.038 and 0.012 respectively)

**Conclusion:** despite its rarity, concurrent cardio-cerebral infarction prognosis is very poor, about third of patients died before discharge and half of patients died at 90 days after stroke. Only 22 % of patients treated by combination of both percutaneous coronary intervention and mechanical thrombectomy. Thus, further studies would be important to outline new possibilities in the management of this emergency condition.

**Keywords:** Acute stroke; Myocardial infarction; Percutaneous Coronary Intervention (PCI); Mechanical Thrombectomy (MTE); Modified Ranking Scale (mRS)

### **Introduction**

Concurrent occurrence of Acute Ischemic Stroke (AIS) and Acute Myocardial Infarction (AMI) are very rare medical emergency conditions and leading causes of morbidity and mortality worldwide [1]. Both conditions have a narrow therapeutic time-window and have high risk of mortality. The use of intravenous thrombolytics for acute myocardial infarction (AMI) increase the risk for intracranial hemorrhagic [2,3], and the use of a thrombolytic in acute ischemic stroke (AIS) increases the risk of cardiac wall rupture in the setting of early hours of AMI [4].

The association between cerebrovascular disease and coronary artery disease were reported in the Global Registry of Acute Coronary Event (GRACE) trial suggested the incidence of intra-hospital stroke 0.9% in patients presenting with acute coronary syndrome, and the incidence was much higher in patients with ST elevation myocardial infarction than the non-ST elevation myocardial infarction [5].

The definition of concurrent cardio-cerebral infarction according to Alshifa Hospital classification [6], Concurrent cardio-cerebral infarction syndrome can be diagnosed by the presence of simultaneous onset of a focal neurological deficit, indicating acute stroke and a chest pain with evidence of elevation of cardiac enzymes and electrocardiogram changes to confirm myocardial infarction. The prevalence rate of concurrent CCI were between 0.009 to 0.29 % [7-9]. The present review examines that we analyzed clinical presentations, risk factors, type of myocardial infarction, site of stroke, modified ranking scale at discharge and at 90 days after discharge hemorrhage and treatment options.

### **Methods**

#### **Study design and patient selection**

In this metanalysis, we screened retrospective a comprehensive review of five databases, PubMed, Embase, Scopus, Research Gate and Google Scholar on concurrent or simultaneous

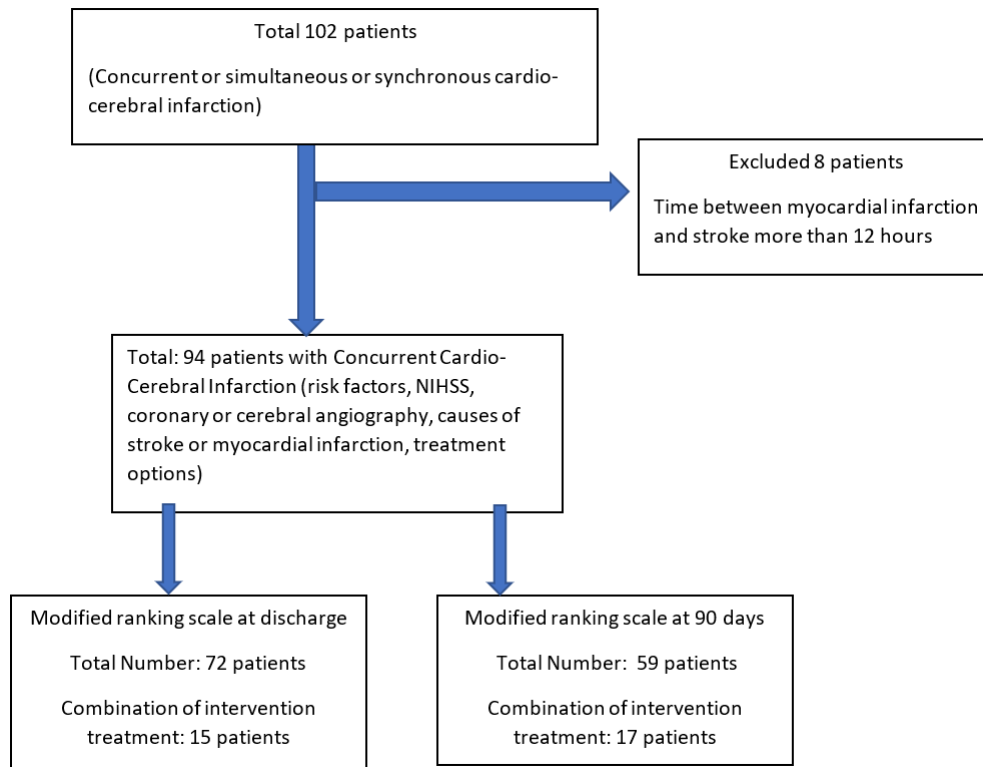


Figure 1: Flowchart summarizing case report selection.

and synchronous Cardio-cerebral infarction to locate all case report or case series done on this topic. Based on the literature review, we analyzed all the cases of concurrent cardiocerebral infarction (Figure 1).

#### Definitions of concurrent cardio-cerebral infarction:

The occurrence of acute ischemic stroke (onset of a focal neurological deficit) and acute myocardial infarction (elevation of cardiac enzymes plus ischemic symptoms and/or ECG changes and/or loss of viable myocardium on noninvasive test and/or coronary artery thrombus on angiography) either at the same time or one after the other within 12 hours

#### Data Collection

The following variables were collected: age and sex, vascular risk factors (hypertension, diabetes mellitus, atrial fibrillation, history of coronary heart disease, dyslipidemia, smoking and previous stroke), stroke location (anterior vs posterior circulation; in anterior circulation strokes, right or left), stroke severity at admission evaluated by the National Institutes of Health Stroke Scale (NIHSS), first symptoms of cardio cerebral infarction (chest pain: Myocardial infarction or neurological deficit: acute ischemic stroke or synchronous symptoms chest pain and neurological deficit at same time) stroke etiology, presence of large vessel occlusion, myocardial infarction electrocardiographic subtype (ST elevation myocardial infarction: STEMI vs Non ST elevation myocardial infarction: NSTEMI), in STEMI Cases localization: anterior, inferior and lateral, coronary angiography findings and infarcted related artery (culprit lesion), AMI treatment namely percutaneous coronary intervention (PCI) and AIS treatment by mechanical thrombectomy (MTE). antithrombotic medication. Outcomes according to modified Rankin Scale (mRS) in-hospital and the 3-months were registered (Table 1).

N: not done, NR: not reported, NS: non-significant lesion, Y: yes- done, M: male, F: female, LAD: left anterior descending artery, RCA: right coronary artery, LCX: left circumflex, RMCA: right middle cerebral artery, LMCA: left middle ce-

rebral artery, PCA: posterior cerebral artery, ACA: anterior cerebral artery, RICA: right internal carotid artery, LICA: left internal carotid artery, LCCA: left common carotid artery, RVA; right vertebral artery. A: thrombus aspiration, B: balloon angioplasty, DES: drug eluting stent, BMS: bare-metal stent, SYN: synchronized.

#### Intervention treatment

Combination of treatment by: AMI treatment namely percutaneous coronary intervention (PCI) and AIS treatment by Mechanical Thrombectomy (MTE) from cerebral arteries.

#### Statistical analysis

Baseline variables Continuous data are reported as means  $\pm$  SD. Categorical data are presented as absolute values and percentages. NIHSS, hospitalization time, and time between acute ischemic stroke and acute myocardial infarction calculated as median (lower-upper value). Using the  $\chi^2$ , Fisher for calculation mortality rate between female and male, and between patient treated with combination treatment with PCI plus MTE 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 102 cases were collected from literature; 8 cases were excluded due to the time between stroke and myocardial infarction were more than 12 hours. Total 94 cases were analyzed, the mean age  $62.5 \pm 12.6$  years. Female 36 patients (38.3%), male 58 patients (61.7%). Median hospital duration 24 hours (0-792 hours). Time between stroke and myocardial infarction 0.5 hour (0-12 hours). The most common risk factors of concurrent CCI were hypertension (46.8%) followed by diabetes mellitus and atrial fibrillation. The median NIHSS was 15 (range: 1-30) and the most type of myocardial infarction type was anterior ST segment elevation myocardial infarction (38.3%), the most culprit lesion in coronary arteries was left

anterior descending artery (28.7%), the most common culprit artery in brain was left middle cerebral artery (30.9%). Cardiac and neurological investigations were performed on 94 patients by both ECG and computed tomography (CT) or magnetic resonance imaging (Table 2).

**Treatments in concurrent Cardio-cerebral Infarction Patients**

**Medication:** Alteplase forty-one patients were treated with intravenous t-PA (43.6%), for antiplatelet and anticoagulation 69 (73%) patients were reported and 25 (27%) patients not reported, Dual antiplatelet 27 (39 %) patients, single antiplatelet 7 (10%) patients, combination of dual antiplatelet and anticoagulation 26 (37.7%) patients (5 NOAC and 21 warfarin), combination of single antiplatelet and anticoagulation 5 (7%) patients (3 warfarin and 2 NOAC), anticoagulation alone 4 (6%) patients ( 1 NOAC and 3 warfarin).

**Intervention's procedures:** 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%). Treated via Mechanical thrombectomy of cerebral vessels in 24 patients (25.5%). Only 21 (22.3%) were treated combination by both PCI and Mechanical thrombectomy of cerebral vessels.

**Causes of cardio cerebral infarction:**

the most common cause of cardio cerebral infarction was cardiogenic shock. Hypotension (37.2%), and heart failure (37.2%), then by atrial fibrillation (25.5%) and left ventricle thrombus (21.3%) (Table 3).

|                               |            |
|-------------------------------|------------|
| Cardiogenic shock/hypotension | 35 (37.2%) |
| Atrial fibrillation           | 24 (25.5%) |
| Left ventricle thrombus       | 20 (21.3%) |
| Atherosclerosis               | 32 (34%)   |
| COVID-19 infection            | 6(6.4%)    |
| Heart failure                 | 35 (37.2%) |
| Aortic dissection             | 4 (4.3%)   |
| Malignancy                    | 2(2.1%)    |
| Patent foramen ovale          | 1 (1.1)    |

Table 1: concurrent CCI cases (age, sex, culprit lesion, treatment options, mRS in hospital and at 90 days) Results.

| No. | Name/REF             | age | Sex | Culprit |       | Treatment |           |     | MRS       | MRS  | 1 <sup>st</sup> event |
|-----|----------------------|-----|-----|---------|-------|-----------|-----------|-----|-----------|------|-----------------------|
|     |                      |     |     | heart   | Brain | tPA       | PCI       | MTE | discharge | 90 d |                       |
| 1   | Bao C-h [10]         | 75  | M   | LCX     | NS    | Y         | DES       | N   | 0         | 6    | MI                    |
| 2   | Bao C-h [10]         | 84  | M   | RCA     | NS    | Y         | A, DES    | N   | 4         | NR   | CVA                   |
| 3   | Habib M [11]         | 61  | M   | LAD     | LMCA  | Y         | B, DES    | Y   | 1         | 0    | MI                    |
| 4   | Nakajima H [12]      | 86  | F   | RCA     | LMCA  | N         | A         | Y   | 4         | NR   | SYN                   |
| 5   | Chong CZ [13]        | 45  | M   | LAD     | RICA  | N         | DES       | Y   | NR        | 3    | SYN                   |
| 6   | Chong CZ [13]        | 53  | M   | LAD     | LMCA  | N         | DES       | Y   | NR        | 5    | SYN                   |
| 7   | Chong CZ [13]        | 71  | F   | LAD     | PCA   | N         | DES       | Y   | NR        | 6    | SYN                   |
| 8   | Chong CZ [13]        | 55  | M   | NR      | LMCA  | Y         | NO        | N   | NR        | 1    | SYN                   |
| 9   | Chong CZ [13]        | 57  | M   | NR      | LMCA  | Y         | NO        | N   | NR        | 1    | SYN                   |
| 10  | Chong CZ [13]        | 51  | M   | LAD     | LMCA  | Y         | DES       | N   | 0         | 0    | SYN                   |
| 11  | Chong CZ [13]        | 70  | M   | NR      | PCA   | N         | NO        | N   | NR        | 6    | SYN                   |
| 12  | Chong CZ [13]        | 45  | M   | LAD     | LMCA  | Y         | DES       | N   | NR        | 1    | SYN                   |
| 13  | Chong CZ [13]        | 67  | M   | LAD     | NS    | N         | DES       | N   | NR        | 1    | SYN                   |
| 14  | Chong CZ [13]        | 76  | M   | NR      | RMCA  | N         | NO        | N   | NR        | 6    | SYN                   |
| 15  | Ibekwe E [14]        | 43  | M   | LAD     | LMCA  | N         | NO        | N   | 6         | 6    | CVA                   |
| 16  | Ibekwe E [14]        | 80  | F   | NR      | LMCA  | Y         | NO        | N   | 5         | 6    | CVA                   |
| 17  | Ibekwe E [14]        | 72  | M   | NR      | LMCA  | N         | NO        | N   | 6         | 6    | CVA                   |
| 18  | Eskandarani R [15]   | 62  | M   | NR      | LCCA  | N         | NO        | N   | 6         | 6    | CVA                   |
| 19  | Eskandarani R [15]   | 50  | M   | NR      | NR    | N         | NO        | N   | 5         | NR   | CVA                   |
| 20  | Eskandarani R [15]   | 50  | M   | NR      | LMCA  | N         | NO        | N   | 2         | NR   | CVA                   |
| 21  | Eskandarani R [15]   | 67  | F   | NR      | RICA  | NR        | NO        | N   | 6         | 6    | SYN                   |
| 22  | Eskandarani R [15]   | 56  | M   | NR      | RICA  | N         | NO        | N   | 5         | NR   | MI                    |
| 23  | Iqbal P [16]         | 65  | M   | NR      | LMCA  | Y         | NO        | N   | NR        | NR   | CVA                   |
| 24  | Abe S [17]           | 73  | F   | RCA     | LMCA  | Y         | NO        | Y   | 2         | 2    | CVA                   |
| 25  | Katsuki M [18]       | 72  | M   | RCA     | PCA   | N         | NO        | N   | 5         | NR   | MI                    |
| 26  | Gungoren F [19]      | 69  | M   | LAD     | LMCA  | Y         | DES       | N   | 2         | NR   | SYN                   |
| 27  | Obaid O [12]         | 41  | F   | LAD     | LMCA  | Y         | A, DES    | N   | 5         | NR   | CVA                   |
| 28  | Sakuta K [21]        | 55  | F   | RCA     | LMCA  | N         | B         | Y   | 3         | 3    | CVA                   |
| 29  | Wan Asyraf WZ [22]   | 33  | M   | NR      | LMCA  | Y         | NO        | N   | 1         | NR   | CVA                   |
| 30  | Chen KW [23]         | 76  | M   | LAD     | RICA  | Y         | A         | Y   | 1         | NR   | CVA                   |
| 31  | Nardai S [24]        | 67  | F   | LAD     | LMCA  | N         | DES       | Y   | 1         | NR   | CVA                   |
| 32  | Seiya Nagao [25]     | 86  | F   | LCX     | LMCA  | Y         | DES       | Y   | 3         | NR   | CVA                   |
| 33  | Cabral M [26]        | 46  | F   | RCA     | LICA  | N         | B, A, DES | N   | NR        | NR   | MI                    |
| 34  | Plata-Corona JC [27] | 46  | M   | LAD     | RMCA  | Y         | DES       | Y   | 2         | 0    | CVA                   |
| 35  | Yeo LL [28]          | 45  | M   | LAD     | RICA  | N         | DES       | Y   | NR        | 3    | MI                    |
| 36  | Yeo LL [28]          | 53  | M   | LAD     | LMCA  | N         | BMS       | Y   | NR        | 5    | CVA                   |
| 37  | Yeo LL [28]          | 71  | F   | LAD     | PCA   | N         | DES       | Y   | 6         | 6    | CVA                   |
| 38  | Yeo LL [28]          | 55  | M   | NR      | LMCA  | Y         | NO        | N   | 1         | 1    | CVA                   |
| 39  | Yeo LL [28]          | 57  | M   | NR      | LMCA  | Y         | NO        | N   | 1         | 1    | CVA                   |
| 40  | Kijpaalratana N [29] | 65  | M   | LCX     | RMCA  | Y         | DES       | N   | NR        | NR   | CVA                   |
| 41  | Kijpaalratana N [29] | 64  | M   | LAD     | RMCA  | N         | B         | N   | 6         | 6    | SYN                   |
| 42  | Hosoya H [30]        | 50  | M   | NR      | NR    | N         | NO        | N   | NR        | NR   | MI                    |
| 43  | Maciel R [31]        | 44  | M   | NR      | RMCA  | Y         | NO        | N   | 3         | 2    | MI                    |
| 44  | Wee CK [32]          | 49  | M   | RCA     | PCA   | N         | A         | N   | 5         | 2    | CVA                   |

|     |                      |    |   |     |      |    |        |   |    |    |     |
|-----|----------------------|----|---|-----|------|----|--------|---|----|----|-----|
| 45  | Tokuda K [33]        | 87 | F | RCA | RMCA | N  | A      | Y | NR | 3  | CVA |
| 46  | González- H [34]     | 66 | F | RCA | NR   | Y  | B      | N | NR | NR | SYN |
| 47  | Hashimoto O [35]     | 84 | M | LAD | NR   | N  | A      | N | 2  | NR | SYN |
| 48  | Kim HL [36]          | 58 | M | LAD | LMCA | N  | A, DES | N | NR | NR | CVA |
| 49  | Kleczyński P [37]    | 62 | M | LAD | NR   | N  | A, B   | N | NR | NR | MI  |
| 50  | Omar HR [38]         | 48 | M | NR  | PCA  | N  | NO     | N | 6  | 6  | SYN |
| 51  | Khairy M [39]        | 70 | F | NR  | NR   | Y  | NO     | N | 6  | 6  | SYN |
| 52  | Lee Kijeong [40]     | 54 | M | RCA | RMCA | Y  | DES    | Y | 6  | 6  | CVA |
| 53  | Yusuf M [41]         | 56 | M | RCA | NR   | N  | DES    | N | NR | 1  | MI  |
| 54  | Bhandari M [42]      | 38 | M | NR  | LMCA | N  | NO     | N | 6  | 6  | MI  |
| 55  | Mai Duy T [43]       | 79 | M | RCA | NS   | Y  | A      | N | 2  | NR | CVA |
| 56  | Bersano A [44]       | 70 | F | NR  | RMCA | N  | NO     | N | 4  | 1  | SYN |
| 57  | T. NISHIMURA [45]    | 50 | F | RCA | RMCA | N  | NO     | N | 2  | NR | MI  |
| 58  | Grogono J [46]       | 39 | F | LAD | NR   | N  | NO     | N | 1  | NR | SYN |
| 59  | Almasi M [47]        | 78 | F | RCA | ACA  | Y  | A, BMS | N | NR | NR | CVA |
| 60  | Karunathilake P [48] | 59 | F | NR  | NR   | N  | NO     | N | 3  | 3  | MI  |
| 61  | Polo Taborda [49]    | 64 | F | NR  | RMCA | Y  | NO     | N | NR | NR | CVA |
| 62  | Nguyen TL [50]       | 60 | M | RCA | LCCA | N  | NO     | N | NR | NR | SYN |
| 63  | Loffi M [51]         | 69 | F | LCX | LICA | Y  | A      | N | 6  | 6  | CVA |
| 64  | Yong TH [52]         | 53 | M | RCA | RMCA | N  | DES    | N | 1  | 1  | SYN |
| 65  | Yong TH [52]         | 61 | M | LCX | LICA | N  | DES    | N | 5  | 4  | CVA |
| 66  | Yong TH [52]         | 80 | M | RCA | NR   | N  | DES    | N | 2  | 1  | CVA |
| 67  | Kawano H [53]        | 49 | M | NS  | RMCA | N  | NO     | N | 6  | 6  | SYN |
| 68  | Wang X [54]          | 72 | F | NR  | RICA | N  | NO     | N | 6  | 6  | CVA |
| 69  | Chlapoutakis GN [55] | 50 | F | NS  | NS   | N  | NO     | N | 1  | 1  | CVA |
| 70  | Koneru S [56]        | 50 | M | NR  | LICA | N  | NO     | N | 1  | 1  | CVA |
| 71  | Wallace EL [57]      | 70 | M | RCA | LICA | Y  | A, BMS | N | NR | NR | CVA |
| 72  | Meissner W [58]      | 62 | F | LAD | RMCA | Y  | B      | N | 6  | 6  | CVA |
| 73  | Sweta A [59]         | 78 | M | NR  | RMCA | Y  | NO     | N | 6  | 6  | CVA |
| 74  | Sweta A [59]         | 58 | F | NR  | LMCA | Y  | NO     | N | 6  | 6  | CVA |
| 75  | Yang CJ [60]         | 79 | M | RCA | LMCA | Y  | B, DES | N | 2  | NR | CVA |
| 76  | BrzeczekM [61]       | 62 | M | RCA | LMCA | NR | A, DES | N | 1  | NR | MI  |
| 77  | Manea MM [62]        | 87 | F | RCA | RMCA | Y  | A, DES | N | 6  | 6  | CVA |
| 78  | Cai X-Q [63]         | 59 | M | LAD | RICA | Y  | DES    | Y | 1  | 1  | MI  |
| 79  | Fitzek S [64]        | 88 | F | NR  | RMCA | Y  | NO     | N | 6  | 6  | CVA |
| 80  | Mehdiratta M [65]    | 65 | F | NR  | RMCA | Y  | NO     | N | 6  | 6  | CVA |
| 81  | Mehdiratta M [65]    | 81 | F | LAD | LMCA | Y  | B, DES | N | 6  | 6  | CVA |
| 82  | Mehdiratta M [65]    | 75 | F | NS  | RMCA | Y  | NO     | N | NR | NR | CVA |
| 83  | Y-Hassan S [66]      | 67 | F | NS  | PCA  | N  | NO     | Y | 2  | 2  | SYN |
| 84  | Wang B [67]          | 84 | M | LAD | PCA  | Y  | DES    | N | 1  | NR | CVA |
| 85  | Stafford P J [68]    | 69 | F | NR  | NR   | Y  | NO     | N | 6  | 6  | MI  |
| 86  | Stafford P J [68]    | 57 | M | NR  | NR   | Y  | NO     | N | 6  | 6  | MI  |
| 87  | Peng H [69]          | 60 | M | RCA | NR   | Y  | DES    | N | 1  | 1  | SYN |
| 88  | Chang GY [70]        | 56 | M | NR  | LMCA | Y  | NO     | N | NR | NR | MI  |
| 89  | O. Kawarada [71]     | 64 | F | LAD | RMCA | N  | A, DES | Y | 1  | 1  | MI  |
| 90  | Sihite T A [72]      | 69 | M | LAD | NR   | N  | DES    | N | 1  | NR | MI  |
| 91  | ABUHEIT E [73]       | 49 | M | RCA | RMCA | N  | DES    | Y | 4  | 1  | MI  |
| 92  | Abdi IA [74]         | 51 | M | NR  | RMCA | Y  | NO     | N | 2  | 1  | MI  |
| 93  | de Castillo LLC [75] | 56 | M | NR  | PCA  | Y  | DES    | y | 2  | 1  | CVA |
| 94  | de Castillo LLC [75] | 56 | M | NR  | PCA  | N  | NO     | N | 2  | 2  | CVA |
| 95  | de Castillo LLC [75] | 56 | M | NR  | PCA  | N  | NO     | N | 6  | 6  | CVA |
| 96  | de Castillo LLC [75] | 56 | M | NR  | NR   | N  | NO     | N | 6  | 6  | CVA |
| 97  | de Castillo LLC [75] | 56 | F | NR  | NR   | N  | NO     | N | 6  | 6  | CVA |
| 98  | de Castillo LLC [75] | 56 | F | NR  | NR   | N  | NO     | N | 4  | 2  | CVA |
| 99  | de Castillo LLC [75] | 56 | F | NR  | NR   | N  | NO     | N | 4  | NR | CVA |
| 100 | de Castillo LLC [75] | 56 | F | NR  | NR   | N  | NO     | N | 4  | NR | CVA |
| 101 | de Castillo LLC [75] | 56 | F | NR  | NR   | N  | NO     | N | 4  | NR | MI  |
| 102 | M. Habib [76]        | 72 | M | RCA | RMCA | Y  | DES    | Y | 1  | 6  | MI  |

**Causes of death**

We identified confirm causes of death in only 23 patients. The most causes of patient were cardiac causes 18 (78%) such as ventricle tachyarrhythmias, cardiac Tamponade, aortic dissection, ventricle septal rupture or sudden death. Noncardiac causes 5 (22%): sepsis, infections and multi organ failure.

**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 (**Table 3**).

Table 2: Baseline characterizes in patients with cardio-cerebral infarction.

|                                                      |                                      |
|------------------------------------------------------|--------------------------------------|
| <b>Risk factors:</b>                                 |                                      |
| Hypertension                                         | 44 (46.8%)                           |
| Diabetes mellitus                                    | 26 (27.7%)                           |
| Atrial fibrillation                                  | 19 (20.2%)                           |
| Previous stroke                                      | 11 (11.7%)                           |
| Smoker                                               | 16 (17%)                             |
| History of Coronary artery disease                   | 11(11.7)                             |
| Dyslipidemia                                         | 19 (20.2%)                           |
| <b>Stroke severity NIHSS (median)</b>                | 15(1-30)                             |
| <b>The type of myocardial infarction:</b>            |                                      |
| Anterior ST segment elevation                        | 36 (38.3%)                           |
| Inferior wall St segment elevation                   | 26 (27.7%)                           |
| Non-ST elevation myocardial infarction               | 20 (21.3%)                           |
| Inferior ST elevation and Right ventricle infarction | 5 (5.3%)                             |
| High Lateral ST elevation Myocardial infarction      | 2 (2.1%)                             |
| Non-Reported                                         | 5 (5.3%)                             |
| <b>Infarcted related artery (IRA)</b>                |                                      |
| Left anterior descending artery                      | 27 (28.7%)                           |
| Right coronary artery                                | 22 (23.4%)                           |
| Left circumflex artery                               | 4 (4.3%)                             |
| No significant stenosis                              | 3 (3.2)                              |
| Non reported                                         | 38 (40.4%)                           |
| <b>Culprit stenosis in cranial arteries</b>          |                                      |
| Middle cerebral artery                               | Right 18 (19.1%),<br>Left 29 (30.9%) |
| Basilar artery                                       | 10 (10.6%)                           |
| Internal carotid artery                              | Right 7(7.4%),<br>Left 5 (5.3%)      |
| Non reported                                         | 17 (18.1%)                           |
| No stenosis                                          | 4 (4.3%)                             |
| Anterior cerebral artery                             | 1 (1.1%)                             |
| Left common carotid artery                           | 2(2.1%)                              |
| Right vertebral artery                               | 1(1.1%)                              |

Table 3: Modified ranking scale (mRS) outcomes at hospital discharge and at 90 days after cardio-cerebral infarction.

|                                                                           |            |
|---------------------------------------------------------------------------|------------|
| <b>Modified ranking scale at hospital discharge (number: 72 patients)</b> |            |
| mRS 0-2 (mild disability)                                                 | 32 (44.4%) |
| mRS 3-5 (moderate to severe disability)                                   | 16 (22.3%) |
| mRS 6 (death)                                                             | 24 (33.3%) |
| <b>Modified ranking scale at 90 days (number 59 patients)</b>             |            |
| mRS 0-2 (mild disability)                                                 | 22 (37.3%) |
| mRS 3-5 (moderate to severe disability)                                   | 8 (13.5%)  |
| mRS 6 (death)                                                             | 29 (49.2%) |

Table 4: Mortality rate between combination intervention treatment and medical treatment.

|                           | <b>Intervention (PCI and MTE)</b> | <b>Medical treatment</b> | <b>P value</b> |
|---------------------------|-----------------------------------|--------------------------|----------------|
| <b>Hospital Mortality</b> | 13.30% (2/15)                     | 38.60% (22/57)           | 0.038          |
| <b>90 days Mortality</b>  | 23.50% (4/17)                     | 59.50% (25/42)           |                |

**Sex and in-hospital mortality**

The hospital mortality rate in male was 11 from 58 patients (18.9%) and in female 13 from 36 patients (35%) the p value is 0.063.

**Hospital and 90 days outcomes according to 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%). Interven-

tion's procedures: percutaneous coronary intervention (PCI) was used to treat 21 patients: 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%). treated via Mechanical thrombectomy of cerebral vessels in 21 patients (100%). The outcome of 21 patients, we can calculate modified ranking scale (mRS) at discharge from 15 patients: mRS 0-2: 8 (53.3%) patients, mRS 3-5: 7 (46.7%) patients, mRS 6: 2 (13.3%), the mRS at 90 days we reached from 17 patients, the

mRS was 0-2: 7 (41%) patients, 3-5: 6 (35%) patients and 6: 4 (23.5%) Patients.

#### **Difference 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). 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 4).

#### **Outcome according to first presentation symptoms**

First presentation myocardial infarction symptoms followed by acute ischemic stroke symptoms were reported in 18 (19.1%) patients. In those patients the most common stroke type (total: 18 cases, 14 cases were reported and 4 cases non reported) anterior circulation (86%) with right middle cerebral artery and right internal carotid artery occlusion (RMCA: 4 patients, LMCA: 2 patients, Basilar artery 2 patients, RICA:2), and this group had the highest mortality rate 33.3%.

The first acute ischemic stroke symptoms followed by acute myocardial infarction symptoms 50 (53.2%) patients. The type of MI: inferior STEMI 19 patients, anterior STEMI 17 patients, non-STEMI 13 patients and 1 patient high lateral STEMI. Coronary angiography to confirm culprit lesion were reported in 28 patients (13 patients RCA and 2 Patients LCX, 11 patients LAD and 2 patients' nonsignificant stenosis), the mortality rate in this patient was reported in 13 patients 26%.

The same time presentation of myocardial infarction and acute ischemic stroke symptoms in 26(27.7%) patients. the mortality rate in this patient was reported in 5 (19%).

#### **Discussion**

We present a total of 94 patients with concurrent cardio-cerebral infarction and we reported multiple causes which can be categorized into five types:

1. Embolic (left ventricle thrombus in patients with previous myocardial infarction or dilated cardiomyopathy, left atrial appendage thrombus in patients with atrial fibrillation).
2. Hypotensive (patients with cardiogenic shock and heart failure).
3. Atherosclerotic (patient with hypertension, smoking, diabetes mellitus and previous coronary artery disease).
4. Hyper coagulant states (COVID 19 infection, Polycythemia, malignancy and patent foramen ovale).
5. Mechanical complication (aortic dissection).

The left ventricle systolic dysfunction and atrial fibrillation are increasing the likelihood of embolic stroke due to thrombus formation in the left ventricle and left atrial appendage. These two phenomena have been commonly reported in this analysis. About half of the patients were presented with acute ischemic stroke symptoms followed by acute myocardial infarction symptoms 50 (53.2%). In this patient the most common MI type was inferior MI. First presentation myocardial infarction symptoms followed by acute ischemic stroke symptoms were reported in 18 (19.1%) patients. In this patient the most common stroke type anterior circulation with right middle cerebral artery or right internal carotid artery occlusion. The same time presentation of myocardial infarction and acute ischemic stroke symptoms in 26(27.7%) patients.

For alteplase medication forty-one patients were treated with intravenous alteplase (43.6%), percutaneous coronary inter-

vention (PCI) was used to treat 29 patients (30.8%). Mechanical thrombectomy of cerebral vessels in 24 patients (25.5%), only 21 (22.3%) were treated combination by both PCI and Mechanical thrombectomy of cerebral vessels. The main concerns about giving alteplase to patients with AIS and history of recent MI are (Beyond the bleeding):

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%. In-hospital mortality rate was higher in male (35%) than female (18.9%) and 78% of death related to cardiovascular causes. Lennie Lynn C. de Castillo et al, in case series involved 9 patients with concurrent CCI reported mortality rate 45% and cardiovascular death was 69% [8], In another metanalysis of 44 patients, ten patients died (23%), and nine (90%) of those were due to cardiac causes, [80]. The use of combination of intervention reduces hospital mortality to 13.3% and 90-days mortality to 25.3%. (P value: 0.038 and 0.012 respectively) the most common co-morbidities that patients presented with included hypertension, smoking, atrial fibrillation and diabetes mellitus. A greater number of male patients were noted but the mortality rate was higher in female patient. The combination intervention (PCI and MTE) treatment was significantly reduced mortality.

#### **Conclusion**

The occurrence of concurrent cardio cerebral infarction is to the best of our knowledge, this is the largest meta-analysis on the concurrent cardio cerebral infarctions, encompassing of 94 patients. rare with high risk of mortality rate especially in female patients. The intervention with PCI and MTE was significantly reduces the mortality rate. Further studies will need to examine the optimum treatment strategies.

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