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# Mechanical thrombectomy for acute stroke complicating cardiac interventions

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## Abstract:

**INTRODUCTION:** Acute ischemic stroke (AIS) complicating cardiac interventions (CI) is well described. The use of mechanical thrombectomy (MT) for treatment of emergent large vessel occlusion (ELVO) in this setting, however, is not widely reported.

**METHODS:** Cases of patients undergoing MT for AIS with ELVO at a single institution were reviewed. Cases preceded by recent CI were investigated retrospectively. Data was collected for patient demographics, type of cardiac intervention, stroke characteristics, neurovascular intervention, and patient outcomes.

**RESULTS:** Between 2008 and 2017, registry analysis identified nine patients treated with MT for AIS complicating recent CI. Patients were more commonly male with a mean age of 67 years. A large majority had a known cardiac arrhythmia. Coronary artery bypass graft surgery (CABG) was the most identified CI, followed by valve repair, and cardiac ablations. Mean presenting NIHSS was 18. Most presented with hemiplegia. Seven cases were found to have MCA occlusions. Stent-retrievers were used in 6 cases with excellent recanalization in five MCA cases (TICI 2c or 3) and in two basilar cases. Despite immediate improvements in NIHSS scores in most cases, functional outcomes were poor in 7 cases (mRS of 4-6). Three cases were complicated by hemorrhage and three cases ended in mortality.

**CONCLUSION:** AIS with ELVO following recent CI is associated with high rates of mortality and poor functional outcomes despite MT. Further work is needed to understand the key drivers to poor outcomes in this ELVO subgroup.

## Keywords:

Coronary artery bypass graft surgery, emergent large vessels occlusions, mechanical thrombectomy, stroke

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## Introduction

Acute ischemic stroke (AIS) complicating cardiac interventions (CI) is well described. Predisposing factors include aortic surgery, prior stroke history, advanced age, poor left ventricle function, and female gender.<sup>[1]</sup> In patients undergoing CIs complicated by stroke, high levels of mortality have been reported.<sup>[1,2]</sup> Management of these

patients is further complicated by the recent use of heparinization, surgery, and other factors that preclude the use of intravenous thrombolytics. Recently, modern techniques in performing mechanical thrombectomy (MT) have dramatically changed the management of ischemic strokes presenting with emergent large vessel occlusion (ELVO).<sup>[3]</sup> The specific use of MT for treatment of ELVO in the setting of recent CI has not been widely reported, particularly in the stent-retriever era. Here we report our experience with MT in patients suffering AIS following CIs.

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## Methods

Institutional review board approval with a waiver for individual consent was obtained. Patients undergoing MT for AIS with ELVO at a single center between 2008 and 2017 were reviewed. Cases preceded by recent cardiac surgery or transcatheter cardiac procedures were investigated retrospectively. AIS occurred either intraoperatively or during the postoperative hospitalization period of the CI. Cases of AIS complicating CI without ELVO were not reviewed. Data was collected for patient demographics, type of CI, stroke characteristics, neurovascular intervention, and patient outcomes. A literature search was performed on PubMed and MEDLINE regarding the treatment of AIS complicating CI. Search terms included combinations of “thrombectomy” and “acute stroke,” “large-vessel occlusion,” “CI,” “cardiac surgery,” “valve replacement.” Statistical analysis was performed in GraphPad Prism (La Jolla, California).

## Results

Between 2008 and 2017, registry analysis identified nine patients treated with MT for AIS complicating recent CI. Patients were largely male ( $n = 7$ ) with a mean age of 67 years. A large majority had a known cardiac arrhythmia ( $n = 6$ ). None of the patients had a history of prior stroke. All nine patients were fully competent in their activities of daily living before their CI with modified Rankin Scale (mRS) scores of 0. Hypertension, diabetes, and peripheral vascular disease were commonly identified comorbidities [Table 1]. CABG was the most identified CI ( $n = 4$ ), followed by valve repair ( $n = 2$ ), and cardiac ablations ( $n = 2$ ). One-third of patients were on aspirin and a large majority received heparinization during their CI [Table 1].

Mean presenting NIHSS was 18, and in 6 of 9 cases presented with moderate to severe (NIHSS 16–20) or severe (NIHSS 21–42) symptoms at onset [Table 2]. Most patients presented with hemiplegia ( $n = 8$ ). One patient who underwent cardiac pacemaker placement did receive intravenous thrombolytics after developing AIS and before undergoing MT. Catheter angiography demonstrated MCA occlusions in seven cases with most of these cases revealing occlusions within the M1 or M2 segments. The remaining two cases demonstrated occlusions of the basilar circulation. In all cases, last seen normal to puncture time was below 7 h with most cases ( $n = 7$ ) achieving puncture below 4 h from last seen normal time.

In six cases, stent-retrievers were used and in all six of these cases, excellent recanalization was achieved. Thrombus aspiration was used either alone, with stent-retrievers, or with a self-expanding stent in five cases. A self-expanding

**Table 1: Demographics and stroke**

	<i>n</i>
Mean age (SD)	67 (8.3)
Male	7
HTN	6
DM	4
PVD/CAD	6
Cardiac arrhythmia	
Atrial fibrillation	6
Aflutter	2
No history	3
Prior stroke	0
Unstable angina	1
Preoperative ejection fraction	
>60	1
50-60	5
40-50	2
Unknown	2
Cardiac intervention	
CABGs	4
Other bypass	1
Valve repairs	2
Catheterizations	1
Ablation	2
Pacemaker	1
Aspirin	3
Clopidogrel	0
Heparin	6
Time from CI to AIS	
<60 min	2
1-3 h	1
3-24 h	1
1-3 days	0
3-5 days	5
NIHSS at presentation	
0-4 (minor)	0
5-15 (moderate)	3
16-20 (moderate to severe)	4
21-42 (severe)	2
Signs and symptoms	
Aphasia	4
Hemiplegia or hemiparesis	8
Somnolent, not waking	3
tPa given	1
Occlusion by angiogram	
M1	4
M2	2
M3	1
Basilar	2

SD: Standard deviation, PVD: Peripheral vascular disease, CAD: Coronary artery disease, DM: Diabetes mellitus, HTN: Hypertension, CABG: Coronary artery bypass graft, AIS: Acute ischemic stroke, CI: Cardiac interventions, tPA: Tissue plasminogen activator

stent was used in a single case [Table 3]. Overall rates of excellent recanalization were high ( $n = 7$ ) with TICI 2b/c or 3 achieved in five MCA occlusion cases and successful recanalization of the basilar artery TICI 2b or 3 achieved in the two cases of vertebrobasilar occlusion. The two cases

**Table 2: Stroke intervention and outcomes**

	<i>n</i>
Last seen normal to puncture time (h)	
<2	3
2-3	1
3-4	3
4-7	2
Devices used	
Solitaire	5
Trevo	1
Penumbra aspiration	5
Enterprise	1
Stent-retriever used	6
Intra-arterial thrombolytics used	2
Groin puncture to revascularization time (min)	
<60	4
60-90	1
90-120	2
>120	2
End TICl for MCA occlusions	
TICl 1	1
TICl 2a	1
TICl 2b/c	3
TICl 3	2
Best NIHSS within 72 h of MT	
0-4	2
5-15	3
16-20	3
21-42	1
Immediate change in NIHSS	
Improved >10 points	1
Improved 6-10 points	2
Improved 1-5 points	4
Unchanged	1
Worsened 1-5 points	1
Hemorrhagic transformation	3
Mortality	3
mRS at discharge	
0-3	2
4-5	4
6	3

TICl: Thrombolysis in cerebral infarction, MCA: Middle cerebral artery, NIHSS: National Institutes of Health Stroke Scale, MT: Mechanical thrombectomy, mRS: Modified Rankin Scale

of MCA occlusion achieving poor recanalization (TICl 1 or 2a) were performed before 2011.

Despite immediate improvements in NIHSS scores in most cases ( $n = 7$ ), functional outcomes were poor (mRS of 4–6) at the time of discharge [Table 2]. Change in NIHSS did not significantly correlate with discharge mRS (Spearman's  $r$  coefficient = 0.5921;  $P = 0.09299$ ). Three cases were complicated by post-MT intracranial hemorrhage (ICH), two were symptomatic and three mortalities occurred in the immediate post-MT hospitalization period. Two of these three mortalities involved large post-MT symptomatic ICHs

associated with midline shift of at least one cm. In both cases of large post-MT ICH, MT was performed during active anticoagulation therapy. In all three cases of mortality, MT failed to improve NIHSS by more than 2 points.

### Case example

A 69 year-old with renal impairment and chronic insulin-dependent diabetes presented with chest discomfort and shortness of breath. Workup revealed pulmonary edema secondary to a non-ST segment myocardial infarction. The patient eventually underwent quintuple coronary artery bypass graft surgery after cardiac catheterization revealed the severe multi-vessel coronary disease. Following cardiac surgery, the patient was extubated and initially did well with no arrhythmias on telemetry. On the fifth postoperative day, however, the patient collapsed to the floor when attempting to mobilize. Examination revealed unresponsiveness, left-sided hemiplegia, right-sided hemiparesis, and right-sided gaze preference. NIHSS was 25. Atrial fibrillation was noted by telemetry. Emergent diagnostic angiography revealed an occlusive thrombus at the basilar apex extending into the right posterior cerebral artery (PCA). Intravenous thrombolytics were contraindicated due to the recent cardiac surgery. The patient subsequently underwent MT using a stent-retriever deployed between the mid-basilar trunk and right PCA. Posttreatment angiography demonstrated excellent recanalization of the basilar apex and right PCA [Figure 1] 4 h and 52 min after symptom onset.

Post-MT, the patient improved neurologically, was extubated, and had an NIHSS of 9 3 days after the stroke. Post-MT imaging revealed intraventricular hemorrhage within the right temporal horn. This was managed observantly with serial scans, but complicated management of cardiac arrhythmias which were felt to require anticoagulation. After serial imaging indicated stability in the intraventricular hemorrhage, the patient was eventually started on heparin anticoagulation and would later undergo placement of a cardiac pacemaker. Due to persistent paraparesis and severe dysphagia, the patient remained bedridden and would eventually require placement of a percutaneous endoscopic gastrostomy tube. The patient was eventually discharged with ongoing needs of constant nursing care.

### Discussion

Stroke is a well-known complication of cardiac surgeries and transcatheter cardiac procedures.<sup>[1,2,4-7]</sup> AIS complicating CI is associated with significantly higher rates of mortality.<sup>[1,2,5]</sup> Patients undergoing cardiac surgery, for example, were six times more likely to die if

**Table 3: Summary of previous series**

Study (year)	n	Mean age	Endovascular CI (%)	ET (%)	Successful revascularization (%)	Death (%)
Al Mubarak <i>et al.</i> (2002)	8	72	63	88	50	13
Zaidat <i>et al.</i> (2005)	21	72	48	100	48	19
De Marco <i>et al.</i> (2007)	6	61	83	66	50	17
Khatri <i>et al.</i> (2008)	12	72	83	42	30	25
Arnold <i>et al.</i> (2008)	12	60	50	100	50	-
Salinas <i>et al.</i> (2013)	1	88	100	100	100	0
Madeira <i>et al.</i> (2016)	3	45	0	100	100	0
Thomas <i>et al.</i> (2018)	1	69	0	100	100	0
Sheriff <i>et al.</i> (2018)	6	59	0	100	57	33

CI: Cardiac interventions, ET: Endovascular therapy

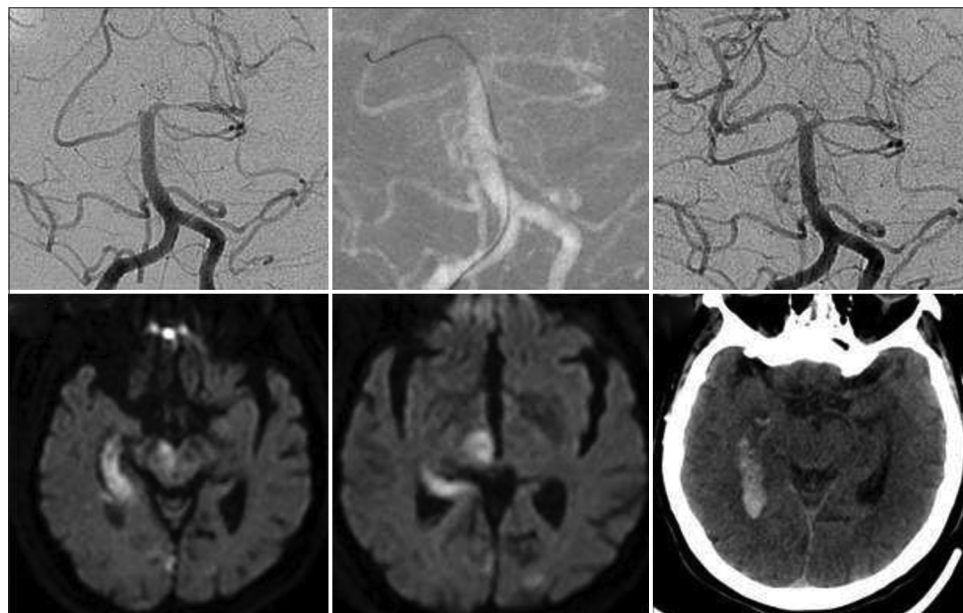


Figure 1: Panel

their surgery was complicated by stroke.<sup>[1,2]</sup> While some of these patients are predisposed to mortality due to the presence of systemic comorbidities such as sepsis and low cardiac output, some patients with low preoperative risk factors demonstrate excess mortality in the setting of AIS complicating CI.<sup>[1]</sup> Stroke, therefore, likely drives mortality in CI cases that would have otherwise been tolerated without major complication.

It is unclear what percentage of AISs complicating CIs are due to ELVOs. Many of the studies reviewing the epidemiology of AIS complicating CI are from the cardiothoracic surgery and cardiology literature and do not specify the type of ischemic stroke [Table 3]. In addition, much of this work was performed before the recognition of the ELVO concept. Intra-arterial thrombolysis for AIS complicating cardiac catheterization, for example, has been described by multiple authors.<sup>[8-12]</sup> As reviewed by Hamon *et al.*,<sup>[5]</sup> rates of successful recanalization approximated 50%. Rates of hemorrhagic conversion ranged from 14% to 25% with rates of mortality ranging from 8% to 19%.

Multiple recent randomized control trials have firmly established the efficacy of MT with stent-retrievers for the management of AIS with ELVO.<sup>[3,13-16]</sup> Accordingly, more recent publications have described successful use of MT with stent-retrievers in four cases of AIS with ELVO complicating three cases of cardiac surgery and one case of transcatheter aortic valve implantation.<sup>[17-20]</sup> All four patients demonstrated complete recanalization with improved clinical status.

In contrast, outcomes at discharge were largely poor in the present series. Despite excellent rates of recanalization, use of stent-retrievers in two-thirds of the cases, and post-procedure improvement in NIHSS scores in most patients, only two out of nine patients had a mRS at the discharge of 3 or less. Improvement in NIHSS generally correlates with functional improvement as measured by mRS.<sup>[21,22]</sup> The failure of improvement in NIHSS score following MT to significantly correlate with discharge mRS may reflect the significant burden of comorbidities in this population. Despite the relative improvement in NIHSS, the surviving patients were

frequently noted to have significant difficulty mobilizing and gaining functional independence in the setting of multiple comorbidities and recovery from major cardiac and neurological organ system insults and corrective interventions. In the highlighted case, for example, significant cardiac, renal, and pulmonary comorbidities combined with persistent neurologic deficits following MT resulted in a poor overall functional outcome at discharge.

Interestingly, the one patient who received intravenous tPA had the best functional outcome with an mRS of 0 at discharge, but this patient also had the lowest NIHSS on presentation and it is challenging to draw meaningful conclusions from one case. Recent work has demonstrated the efficacy of MT without IV tPA in selected patients outside the 6-h tPA window.<sup>[23]</sup> Contraindications for tPA treatment in the remaining eight patients included recent surgery and anticoagulant therapy.

Anticoagulation therapy can significantly challenge management in these patients. Recent work has suggested that patients undergoing MT while on recent anticoagulation may have a generally higher risk of spontaneous ICH after MT.<sup>[24]</sup> Indeed the rate of ICH following MT in this series (33%) far exceeds reported numbers from previous randomized trials (4.4%).<sup>[25]</sup> This might reflect the preceding use of anticoagulants during cardiac procedures, challenging blood pressure management in this population, or again highlight the burden of comorbidities in these cases. In addition, initiation of anticoagulants for management of cardiac issues can be made difficult in patients who in fact develop post-MT ICH as was highlighted in the presented case example. Recent authors have argued the safety of anticoagulant therapy if no ICH is identified on a control head computed tomography 1 day after MT.<sup>[24]</sup>

A larger and ideally prospective series is needed to determine the proportion of ELVO amongst AIS complicating CI and to better ascertain the role of preoperative risk factors in influencing functional outcomes. It is possible that different types of CI are more prone to developing ELVO as their primary mechanism of AIS and that preventative strategies could then be appropriately designed specifically to the intervention.<sup>[26]</sup> Limitations of the study include the retrospective, single-center design as well as the small number of subjects. However, this represents the largest published experience to date studying MT treatment of ELVO complicating CI.

## Conclusions

AIS with ELVO following recent CI is associated with high rates of mortality and poor functional outcomes

despite MT recanalization. Further work is needed to understand the key drivers to poor outcomes in this subgroup.

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## Conflicts of interest

There are no conflicts of interest.

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