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Insights into Angiographic Recanalization of Large Arterial Occlusion: Institutional Experience with Mechanical Thrombectomy for Acute Ischemic Stroke

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Abstract

Stroke is a leading cause of morbidity and mortality in humans. Most strokes are ischemic in nature and early recanalization of occluded vessels determines good outcomes. Recanalization of occluded vessels depends on many angiographic and demographic features. These factors need to be identified for better patient overall outcomes. Better preoperative knowledge of factors can help in customizing our treatment approach and explaining the prognosis to the guardians of the patients. We aim to share our institutional experience with mechanical thrombectomy (MT) for stroke and studied factors that affect an angiographic recanalization of vessels. A retrospective single-center study was conducted involving 104 patients who underwent MT at our institution between January 2016 and December 2019. Patient demographics, baseline characteristics, pre- and postprocedural imaging findings, and other clinical data were meticulously reviewed. We divided patients into successful recanalization (modified thrombolysis in cerebral ischemia [mTICI] 2b or 3) and unsuccessful recanalization (mTICI 2a or 1) groups and various factors were analyzed to evaluate their impact on recanalization rates. In the univariate analysis, a significant association was observed between successful recanalization and several factors: the absence of rheumatic heart disease (RHD) as a risk factor ($p = 0.035$), the presence of a hyperdense vessel sign ($p = 0.003$), and the use of treatment methods including aspiration ($p = 0.031$), stent retriever ($p = 0.001$), and Solumbra ($p = 0.019$). However, in the multivariate analysis, none of these factors exhibited statistical significance. The presence of RHD is a risk factor associated with poor angiographic recanalization in all three MT treatment modalities. Based on the above variables we can guide the patients/relatives prior to MT procedure for their better outcome and risk–benefit ratio.

Keywords
- mechanical thrombectomy
- stroke
- recanalization

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Introduction

Stroke is a leading cause of morbidity and mortality worldwide.[1,2] In the United States, 87% of all strokes are ischemic,[2] caused by thromboembolic occlusion of intracranial arteries. The most critical determinant of recovery from ischemia is the early restoration of impaired blood flow. Thrombolytic therapy with intravenous tissue-type plasminogen activator (IV t-PA) has been recommended as the standard of care in an appropriate patient[3] but the rate of successful recanalization with intravenous thrombolysis (IVT) was lower with occlusion of a major artery (30% in basilar artery occlusions, 30% in the proximal, middle cerebral artery (MCA) occlusions, and 6% in terminal carotid artery occlusions).[4] Endovascular treatment (EVT) has a relatively longer time window, up to 24 hours in the study done in 2018 by Nogueira et al,[5] and markedly improved the treatment scope of EVT. Current EVT approaches include pharmacologic thrombolysis and mechanical thrombectomy (MT) (aspiration thrombectomy, and most recently, stent retriever [SR] technology). MT has become a norm for large vessel occlusion (LVO).[6] With the continued development of devices for MT, the recanalization rate has significantly improved, reaching approximately 80% in recent trials.[6,7] However, recanalization of occluded vessels depends not just on the treatment approach used, but also on a plethora of patient and imaging factors. These variables can be crucial for patient selection, appropriate treatment selection, and prognostication. Several studies have separately evaluated angiographic features like collaterals, clot burden, recanalization, number of device passes, and the presence of intracranial atherosclerotic disease (ICAD) in predicting the outcome after MT.[8] Evaluation of variables related to good angiographic recanalization can help with better patient triage and treatment and portend a better prognosis. The study aims to investigate the notable factors that affect the angiographic recanalization during MT after LVO in patients with acute ischemic stroke.

Materials and Methods

Study design: We conducted a single-centered retrospective study of prospectively collected data. We identified all the consecutive patients who underwent MT in our institution from January 1, 2016 to December 31, 2019 from our imaging repository (Radiology Information System-Picture Archiving and Communication System).

Patient selection: We included both in-hospital and emergency patients who presented with symptoms of acute ischemia. All patients who were more than 18 years old and suffered from occlusion of the internal carotid artery (ICA) terminal, M1 or M2, or basilar artery were included.

Data Analysis

Noncontrast Computed Tomography and Computed Tomography Angiography Evaluation

Noncontrast computed tomography (NCCT) (128 slice CT Scanner, Siemens, Erlangen, Germany) was evaluated for the presence of hyperdense vessel signs, Alberta Stroke Program Early CT Score (ASPECTS), and involved territory. CT acquisition timing was accurately noted to calculate the onset to NCCT time (we lacked a database for patient entry time into the hospital). ASPECTS was not calculated for a posterior circulation stroke, due to beam hardening artifacts. Triple-phase CT angiography (CTA) was evaluated for the LVO, vessels involved, subtype of involved vessels (like proximal middle or distal segment, "T" occlusion), presence of ICAD changes, collateral grading (1–3 = poor, 4–5 = good), tandem occlusion, type of arch, and clot length. Clot length was measured in the third phase of CTA where the proximal and distal ends of the filling defect were seen. The collateral score was calculated after comparison in the three phases. Few patients underwent magnetic resonance imaging stroke protocol to calculate ASPECTS and diffusion-weighted imaging-fluid-attenuated inversion recovery mismatch.

Characteristics: We collected all details on demographics, clinical presentation, time of symptoms onset (ictus), risk factors and preexisting morbidity, National Institutes of Health Stroke Scale (NIHSS) score, thrombolysis status, and emergency treatment from medical records. Other details including procedural techniques on digital subtraction angiography (DSA) (Biplane DSA, Philips, Netherlands) (SR type, use of intermediate catheter, number of passes, and rescue techniques), recanalization thrombolysis in cerebral ischemia (TICI) perfusion grades, complications associated with MT, the reason for unsuccessful recanalization, immediate procedure complication like dissection, subarachnoid hemorrhage (SAH), ICA, 24-hour CT ASPECTS, recanalization or procedure completion time, and NCCT to recanalization time were evaluated. We divided stroke etiology into two groups. The rheumatic heart disease (RHD) group included all cases of RHD such as stuck valve thrombolysis or prosthetic heart valve thrombolysis, and mitral stenosis (MS)/mitral regurgitation. The non-RHD group included other risk factors like hypertension, diabetes, ICAD, and cardioembolic other than RHD.

Mechanical Thrombectomy Protocol

MT was performed by the SR technique (►**Fig. 1**) or aspiration technique (►**Fig. 2**), or a combination of the two (SA, Solumbra technique) (►**Fig. 3**). In our institute, MT procedures were performed by three independent senior neurointervention physicians (experience of 25, 15, and 13 years). All devices and methods for recanalization therapy were selected at the discretion of each neurointerventionist after taking into consideration the patient's clinical status, technical difficulty, location and size of the clot, the expertise of the physician, consent of patients and their families for probable postoperative complications, logistical considerations as in Indian setting many patients were unable to purchase material as Solumbra procedure cost around 5 lakh rupees, and availability of equipment in an emergency; therefore, bias may have been present.

1. SRs are particularly useful for large or stubborn clots and clot located in larger vessels.

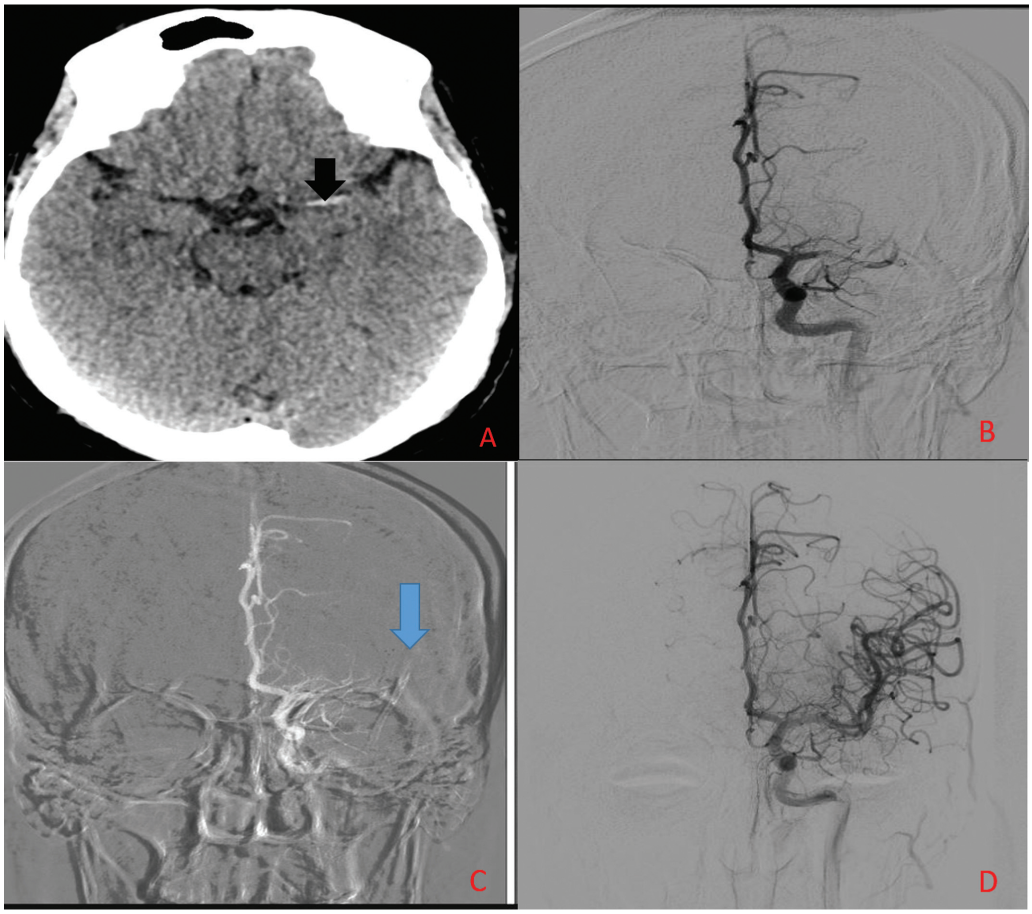

Fig. 1 A known case of rheumatic heart disease (RHD), post-mitral valve replacement (MVR), and post-stuck valve thrombolysis, presented with sudden onset right-sided weakness persisting for 1 hour. On examination, National Institutes of Health Stroke Scale (NIHSS) was 20. (**A**) Noncontrast computed tomography (NCCT) axial image shows dense left M1 middle cerebral artery (MCA) (shown by black arrow). (**B**) Selective digital subtraction angiography (DSA) of left internal carotid artery (ICA) shows cutoff in left mid-M1 MCA. (**C**) Roadmap image showing deployment of stent retriever in left M2 MCA (shown by the thick blue arrow). (**D**) Anterior-posterior view of the left ICA DSA run after a single pass of stent retriever shows complete recanalization (modified thrombolysis in cerebral ischemia [mTICI] = 3).

2. Aspiration can be effective for smaller clots or when the clot is located in vessels where the use of SRs may be challenging.
3. Combined Solumbra allows for more effective clot removal and improves the chances of successful recanalization.

If recanalization failed despite multiple attempts with the first-line device, rescue treatment was tried by switching to another method, in most cases Solumbra (combined method) or aspiration method. Vascular access was obtained using an 8F short vascular sheath. ICA/vertebral artery access was subsequently obtained using a long sheath and an intermediate catheter. MT was performed using a SR (Trevo, Stryker; Solitare, Medtronic) and aspiration (ACE68 Reperfusion Catheter, Penumbra). Many cases were converted to the Solumbra procedure after failing the initial stand-alone SR/aspiration thrombectomy.

Outcome: The primary outcome of our study was modified TICI (mTICI) recanalization status, which we divided into two arbitrary groups: successful recanalization (mTICI 2b, mTICI 3) and unsuccessful recanalization (mTICI1, mTICI2a).

Statistical analysis: Data were presented as mean and standard deviation for continuous variables and as percentages for categorical variables. In univariable analysis, an unpaired *t*-test was done to compare two group means and a paired *t*-test for paired means within the group. The chi-square test was done to find the association between categorical variables and the Fisher's exact test was done if the expected cell count was less than 5. A *p*-value of less than 0.05 was considered significant. A multivariate analysis was performed of variables which were found to be statistically significant on univariable analysis to define independent predictive variables of successful recanalization by using a binary logistic regression. Statistical analyses were performed using SPSS software version 25 for Windows (SPSS, IBM Corp, Armonk, New York, United States).

Results

A total 104 patients were enrolled for the study. The mean age of the study population (56 males, 48 females) was 50 years. In our study, the successful recanalization rate (mTICI2b and mTICI3) was 62.5% and the unsuccessful recanalization rate was 37.5%, irrespective of the thrombectomy modality used (►**Table 1**). Demographic and baseline characteristics are detailed in ►**Table 2**. Multiple variables

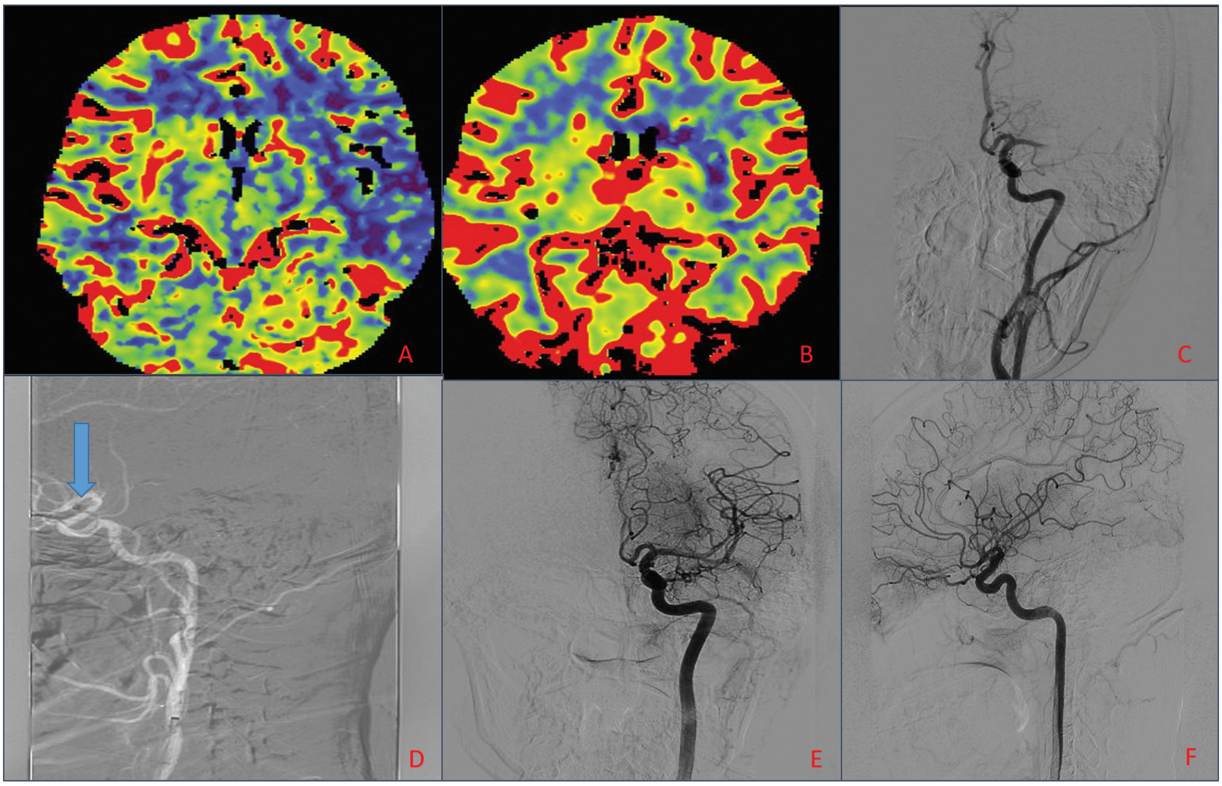

Fig. 2 A known case of rheumatic heart disease (RHD) with severe mitral stenosis (MS) and mitral regurgitation (MR) status post-mitral valve replacement (MVR) presented with acute onset right-sided weakness persisting for 2 hours and 40 minutes. On examination, National Institutes of Health Stroke Scale (NIHSS) was 4, with E4V5M6. Mechanical thrombectomy was performed under local anesthesia. (**A** and **B**) Cerebral blood flow (CBF) and cerebral blood volume (CBV) map showing perfusion deficit in left middle cerebral artery (MCA) territory indicating penumbra. (**C**) Selective digital subtraction angiography (DSA) of left internal carotid artery (ICA) shows left distal M1 MCA cutoff. (**D**) Penumbra aspiration catheter ACE68 (marked by the thick blue arrow) taken up to proximal M1 MCA. (**E** and **F**) After a single pass of aspiration, complete recanalization was noted (modified thrombolysis in cerebral ischemia [mTICI] = 3).

were compared to identify the factors that contribute to successful or unsuccessful recanalization. The significance of these factors was determined based on their *p*-value. No significant correlation was noted between the two groups with age, gender of the patient, vascular territory involved, vessel involved, type of anesthesia employed, baseline NIHSS and ASPECTS score, CTA collateral score, clot length, presence of tandem lesions, and pre-MT intravenous thrombolysis (►**Tables 2** and **3**). Further, overall complications were found to be similar in incidence, irrespective of recanalization (►**Tables 2** and **3**). We found that the most common risk factor for LVO was the cardioembolic event, in which half the patients (48 of 104) suffered from an underlying RHD (MS, postthrombolysis for stuck valve, post-mitral valve replacement). Out of 104 patients, 8 patients did not have any known risk factors. Overall successful recanalization rate was significantly higher among those without the RHD as a risk factor. The failure rate (47.9%) was significantly ($p = 0.035$) higher among those with RHD risk factors than those without (27.1%) on univariate analysis. The success rate of recanalization is significantly more successful using aspiration (84.2%) (►**Fig. 2**) ($p = 0.031$), followed by Solumbra (78.8%) ($p = 0.019$) (►**Fig. 3**) and least with SRs (44.2%) ($p = 0.001$) (►**Fig. 1**) (►**Table 2**). The failure rate was lowest with aspiration and highest with SRs. Hyperdense vessel signs (►**Figs. 1** and **3**) have the more possibility of successful recanalization and the result was statistically significant on univariate analysis ($p = 0.003$) (►**Table 2**).

All the variables which were significant in univariate analysis (►**Tables 2** and **3**) were included for multiple logistic regression analysis. From ►**Table 4**, it is evident that none of the variables acts as a significant independent predictor ($p < 0.05$) of poor recanalization. The absence of aspiration as a treatment method for clot retrieval has higher odds of failed recanalization.

Demonstration of Solumbra technique with mTICI = 3 recanalization (►**Fig. 3A–H**), hyperdense MCA sign (►**Figs. 3A** and **1A**), SR techniques with mTICI = 3 recanalization (►**Fig. 1A–D**), aspiration (a direct aspiration first-pass technique [ADAPT]) technique with mTICI = 3 recanalization (►**Fig. 2A–F**), case of RHD with no hyperdense MCA sign on NCCT (►**Fig. 4A**), and failure of recanalization with mTICI = 0 (►**Fig. 4A–F**), and ICAD with reocclusion in ►**Fig. 5A–D**.

Discussion

Stroke is the second most common cause of death and the fourth most common cause of disability in world.[9] In the existing studies (PROACT, IMS, MERCI, and Multi MERCI), a high mortality rate up to 50% and a significant functional improvement (modified Rankin score: < 2 at 3 months) was noted in only 10% patients with LVO, irrespective of

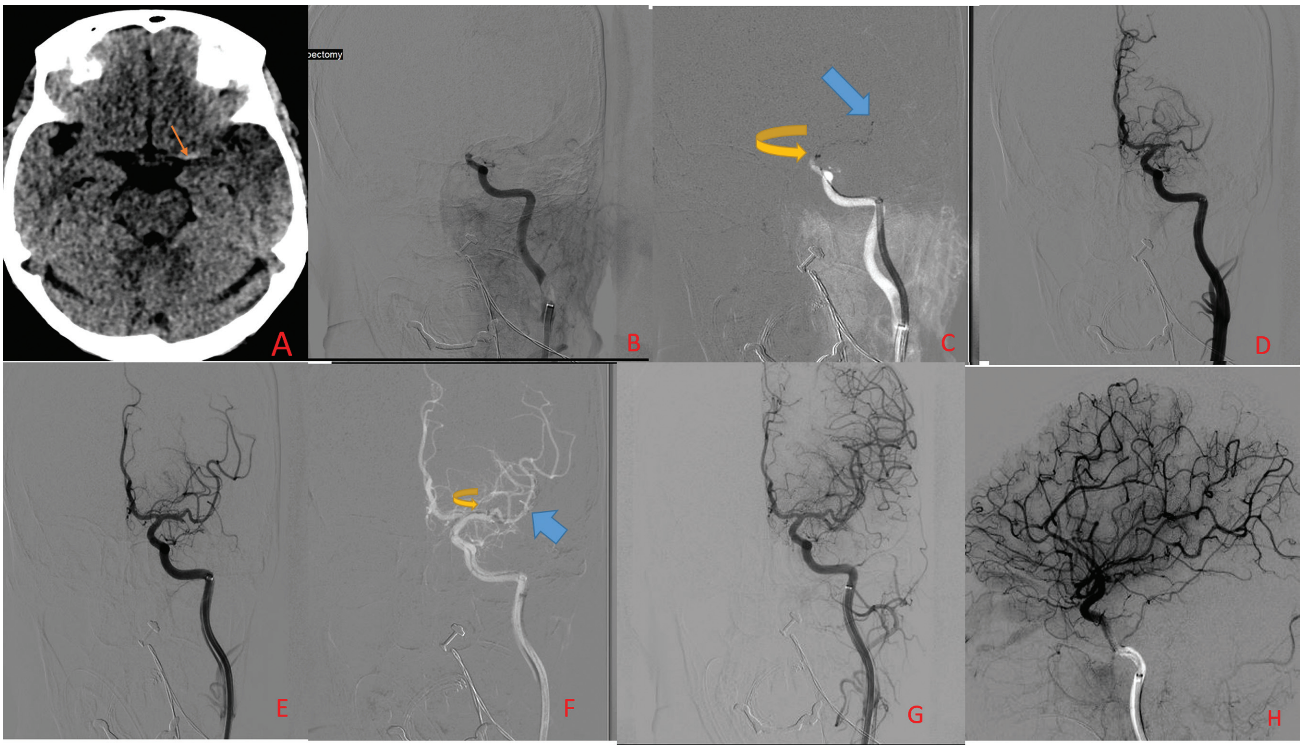

Fig. 3 A patient with an ictus of 6 hours presented in casualty with sudden onset right hemiparesis, slurring of speech, and restlessness. On examination, the National Institutes of Health Stroke Scale (NIHSS) score was 15. The patient had diabetes mellitus (DM) and hypertension (HTN) with no cardiac comorbidities. The patient was taken for mechanical thrombectomy under general anesthesia. (**A**) Noncontrast computed tomography (NCCT) axial image showing dense middle cerebral artery (MCA) sign on the left side (shown by arrow). (**B**) Digital subtraction angiography (DSA) anterior-posterior (AP) image of left internal carotid artery (ICA) run shows T occlusion. (**C**) (Demonstration of Solumbra technique) Roadmap of left ICA angiogram, long sheath, aspiration catheter (yellow curved arrow), the stent (thick blue arrow Trevo 4 × 30 mm). (**D**) Left ICA run after 1st Solumbra pass showing minimal improvement in recanalization (modified thrombolysis in cerebral ischemia [mTICI] = 1). (**E**) DSA of left ICA after 2nd Solumbra pass showing recanalization of the superior division of M2 MCA and left M1 MCA (mTICI = 2a). (**F**) Roadmap image of left ICA demonstrating 3rd pass of Solumbra technique with stent retriever (shown by thick blue arrow) in the inferior division of M2 MCA with the good opening of struts, aspiration catheter (shown by yellow curved arrow) at left MCA bifurcation level. (**G** and **H**) AP and lateral view of left ICA run show complete left MCA territory recanalization (mTICI = 3).

recanalization status.[10,11] For better outcomes, patient selection strategies with knowledge of factors that can predict good recanalization are of utmost importance. In recent years, endovascular intervention treatments have been the preferred modality in patients with ischemic stroke due to LVO due to higher recanalization rate[12] as comparison with IV recombinant t-PA (rt-PA), as rt-PA alone have low rate of recanalization.[13–15] A meta-analysis of 53 different trials, encompassing 2,066 stroke patients, documented a significantly high recanalization rate with endovascular therapy (46% for IVT, 63% for intra-arterial thrombolysis [IAT], 68% for combined IVT/IAT, and 84% for MT).[16,17] In our study, the highest rate of recanalization is noted in aspiration (84.2%, $p < 0.031$) (►**Fig. 2**), followed by the Solumbra technique (78.8%, < 0.019) (►**Fig. 3**) and least in SR (44.2%, < 0.001) (►**Fig. 1**) (►**Table 2**). A multicentric study done by McCarthy et al[18] reveals a higher recanalization rate in Solumbra comparing aspiration and SR (ADAPT 85%, SR 84%, Solumbra 86%) which is favoring our result.

Table 1 Subdivision of the mTICI recanalization grade with the number of patients in each grade

Final mTICI grade	*N*	%
0	8	7.7
1	15	14.4
2a	16	15.4
2b	20	19.2
3	45	43.3
Total	104	100.0

Abbreviation: mTICI, modified thrombolysis in cerebral infarction.

In univariate analysis absence of RHD risk factor and hyperdense MCA signs were significantly associated with good recanalization, but in multivariate regression analysis (►**Table 4**), none of these were significant enough to call them as independent predictor.

In our study, we observed low angiographic recanalization rates in patients with RHD risk factors across all three modalities: SR, aspiration, or Solumbra (►**Fig. 4A–F**). Clots in patients with RHD are hard in consistency, composed mainly of fibrin and lack red blood cells. Clots in RHD patients exhibit firm consistency, primarily composed of fibrin and lacking in red blood cells. They form due to intense inflammatory responses rich in mononuclear cells, fibrosis, and

Table 2 Success of thrombectomy evaluated with demographic characteristics, mechanical thrombectomy procedure, and imaging details

Variables (*N* = total number of patients included in the study)		Recanalization				Chi-square test (*p*-Value)
		Successful (2B/3)		Unsuccessful		
		N (65)	% (62.5)	*N* (39)	% (37.5)	
Gender (104)	Male	34	60.7	22	39.3	0.685
	Female	31	64.6	17	35.4	
Vascular territory (104)	Anterior	58	63.7	33	36.3	0.548
	Posterior	7	53.8	6	46.2	
Vessels involved (104)	MCA	44	62.9	26	37.1	0.750
	ICA	14	66.7	7	33.3	
	Basilar	7	53.8	6	46.2	
Anesthesia (104)	LA	44	62.0	27	38	0.948
	GA	19	61.3	12	38.7	
NIHSS (96)	< 10	14	66.7	7	33.3	0.655
	≥ 10	46	61.3	29	38.7	
RHD risk factor (96)	Yes	25	52.1	23	47.9	**0.035**
	No	35	72.9	13	27.1	
Treatment method: aspiration (19)	Yes	16	84.2	3	15.8	**0.031**
	No	49	57.6	36	42.4	
Treatment method: stent retriever (52)	Yes	23	44.2	29	55.8	< **0.001**
	No	42	80.8	10	19.2	
Treatment method: Solumbra (33)	Yes	26	78.8	7	21.2	**0.019**
	No	39	54.9	32	45.1	
Baseline ASPECTS (100)	< 7	9	60	6	40	0.66
	≥ 7	56	65.9	29	34.1	
Hyperdense vessel sign (55)	Yes	27	69.2	12	30.8	**0.003**
	No	4	25	12	75	
CTA collateral score (104)	Good	37	66.1	19	33.9	0.416
	Poor	28	58.3	20	41.7	
Tandem lesions (103)	Yes	7	50	7	50	0.314
	No	57	64	32	36	
IV thrombolysis (104)	Yes	41	64.1	23	35.9	0.677
	No	24	60	16	40	
Overall (104) complications (SAH/ICH/others)	Yes	18	27.7	12	30.8	0.737
	No	47	72.3	27	69.2	

Abbreviations: ASPECTS, Alberta Stroke Program Early Computed Tomography Score; CTA, computed tomography angiography; GA, general anesthesia; ICA, internal carotid artery; ICH, intracerebral hemorrhage; IV, intravenous; LA, local anesthesia; MCA, middle cerebral artery; NIHSS, National Institutes of Health Stroke Scale; RHD, rheumatic heart disease; SAH, subarachnoid hemorrhage.
Note: $p < 0.005$ indicates a significant correlation.

calcifications.[19] These clots typically demonstrate high rigidity, low deformability, and lack hyperdensity on NCCT scans (►**Fig. 4A**). Negotiating these hard clots with a microcatheter and microwire, as well as engaging them with a SR, proves challenging. Our study revealed a significantly higher rate of unsuccessful recanalization in RHD patients (►**Fig. 4**). Some literature suggests that up to 8 to 11% of stroke may be attributable to underlying RHD.[20–22] In our study almost 50% (48 out of 96 patient with knows risk) patients have RHD as a risk factor. Individuals with RHD face an elevated risk of atrial fibrillation, with strokes occurring at a younger age, being more prevalent in females, and associated with higher NIHSS scores, poorer recanalization rates, and increased mortality and disability (2 times) compared with strokes of other etiologies.[20,21,23] Studies indicate underutilization of anticoagulants in ischemic stroke patients with atrial fibrillation

Table 3 Success of thrombectomy evaluated with thrombectomy times, collaterals score, clot length, and ASPETCS of the patients

Variables (*N*)	Recanalization						Unpaired *t*-test (*p*-Value)
	Successful (2B/3)			Unsuccessful			
	N	Mean	SD	*N*	Mean	SD	
Age (104)	65	50.277	12.52	39	49.6	15.32	0.826
Ictus to NCCT time (min)	65	181.969	130.36	39	214.69	145.85	0.239
NCCT to procedure completion time (min)	65	162.35	60.74	39	194.4	63.02	**0.012**
Puncture to procedure completion time (min)	65	65.4	45.4	39	101.78	42.96	< **0.001**
CTA collateral score	65	3.56	0.84	39	3.30	0.89	0.138
Clot length (mm) (100)	**63**	12.81	6.72	**37**	14.10	6.23	0.34
Baseline ASPECTS	**65**	7.84	1.52	**39**	7.48	1.37	0.24

Abbreviations: ASPECTS, Alberta Stroke Program Early Computed Tomography Score; CTA, computed tomography angiography; NCCT, noncontrast computed tomography; SD, standard deviation.

Table 4 Multiple logistic regression analysis for variable associated with failed recanalization

Variables	*p*-Value	Odds ratio	95% CI for Exp(B)	
			Lower	Upper
Presence of cardioembolic (RHD as risk factor)	0.052	0.046	0.002	1.025
Without the use of the aspiration method	0.456	3.521	0.129	96.404
Use of stent retriever alone	0.054	0.035	0.001	1.052
Absence of hyperdense vessel sign	0.069	0.118	0.012	1.181

Abbreviations: CI, confidence interval; RHD, rheumatic heart disease.

and/or RHD, particularly observed in Chinese populations.[24,25] Notably, in our study, all RHD patients had a history of irregular or discontinued anticoagulant use, resulting in stroke.

Hyperdense MCA vessel signs on NCCT are indicative of clots rich in erythrocyte (hemoglobin) content (►**Figs. 1** and **3**). These clots are friable and easily navigable during MT procedures.[26] We observed significantly higher recanalization in patients who have hyperdense MCA. Our findings were consistent with a study conducted by Froehler et al,[27] wherein successful recanalization was achieved in 79% of patients with the hyperventilation syndrome (HVS) (33/42), compared with only 36% (9/25) of patients without HVS ($p = 0.001$). The absence of a hyperdense MCA sign is associated with poor functional outcomes following MT.[28]

Tandem lesions pose challenges in accessing the occlusion site and prolong the procedure duration. Our approach involved initially addressing the extracranial lesion through balloon angioplasty, followed by MT using a SR. Surprisingly, the presence of tandem lesions did not significantly increase the likelihood of unsuccessful recanalization in our study. A study by Feil et al[29] reported successful perfusion in 88.3% of cases when treating acute extracranial ICA lesions, compared with 62.8% when no acute extracranial ICA treatment was performed before MT.

We did not observe any significant difference in recanalization rates between patients treated with intravenous thrombolysis and those without it. This contrasts with the findings of Suzuki et al,[30] who achieved better recanalization success (93.2%) in the MT + IV t-PA group compared with those without IV t-PA (90.1%). This discrepancy may stem from a lack of randomization or established protocols at the time of our study.

The successful recanalization rate was higher in the NIHSS < 10 group, with vice versa for NIHSS scores of 10 or higher, although this difference was not statistically significant. Our findings align with those of Aoki et al,[31] where the successful recanalization rate correlated with NIHSS grade: 100% in the NIHSS 0 to 8 group, 88% in 9 to 16, 81% in 17 to 24, and only 60% in > 24. High NIHSS scores were associated with longer clots and poorer collateral scores.

ICAD is a major cause in the elderly who are smokers. Simple clot retrieval would not be effective and reocclusion will appear in most cases (►**Fig. 5**). A detachable stent with an antiplatelet is required in many cases to keep the patent of occluded vessels. However, there will be an increased chance of hemorrhage if the infarct area is large. In our institute before 2021, we have not performed MT for ICAD. So in our study, ICAD cases are very few. Acute basilar occlusions related to ICAD showed a tendency for a higher rate of 90-day mortality compared with non-ICAD occlusions.[32]

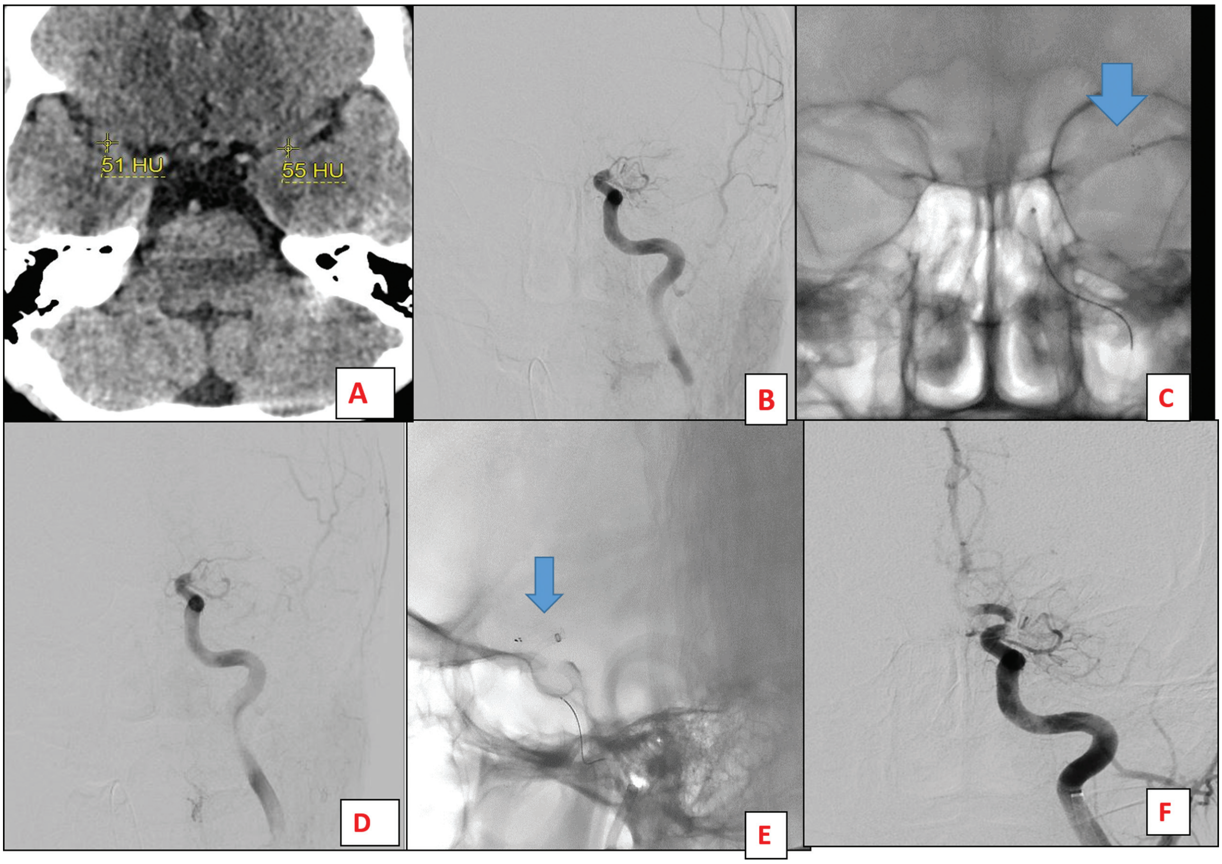

Fig. 4 A known case of rheumatic heart disease (RHD), post-mitral valve replacement (MVR), and post-stuck valve thrombolysis, presented with sudden onset right-sided weakness persisting for 1 hour. On examination, National Institutes of Health Stroke Scale (NIHSS) was 20. (**A**) Noncontrast computed tomography (NCCT) shows similar density or no hyperdense sign in left middle cerebral artery (MCA). (**B**) Anterior-posterior (AP) view of left internal carotid artery (ICA) digital subtraction angiography (DSA) run shows cutoff at left terminal ICA level. (**C**) The stent retriever was deployed in the left MCA and terminal ICA (as shown by the thick blue arrow). (**D**) After two passes of stent retriever recanalization was not established, T occlusion persisted (modified thrombolysis in cerebral ischemia [mTICI] = 0). (**E**) Lateral view shows stent and aspiration catheter assembly (Solumbra) as shown by blue arrow. (**F**) AP view of the left ICA run after 2 Solumbra technique attempts shows persistent MCA occlusion (mTICI = 0). No recanalization happened after 4 retrieval attempts.

Overall, our time intervals were longer. This disparity may be attributed to manpower issues and limited awareness among patients in low-income countries.[33,34] Factors contributing to delays in starting the procedure at our institute included difficulties in obtaining consent from, illiterate patient guardians, poor public awareness, and financial constraints. Cases requiring general anesthesia, challenging vascular anatomy, and other technical difficulties also resulted in longer elapsed times. Consistent with the findings of Goda et al,[33] our study identified female gender and longer time from groin puncture to recanalization as significant factors associated with unsuccessful recanalization. In our study, the average duration from groin puncture to successful recanalization was approximately 65 minutes.

SAH (10.6%) and intraparenchymal hemorrhage (21.2%) were two common complications during the periprocedural period up to 24 hours. Multiple complications were present in the same patient. Complications are more common in cases of successful recanalization and may be due to injury by the microwire, searing injury to small perforator branches during Solumbra assembly pooling, and possibly reperfusion injury. Complex anatomy, such as a coiled loop in the cervical ICA and an acute bend at the cavernous segment of the ICA, posed major resistance to the use of the aspiration catheter in the procedure. Five cases had ICAD in the MCA, leading to vessel reocclusion and failed recanalization.

Limitations

This was a retrospective, single-center study with a small number of patients. We did not have any clinical follow-up of the patients after thrombectomy to assess the long-term efficacy outcome of recanalization. Pathological findings in the thrombus were not examined, and door-to-imaging time data are not available. Future studies should include pathological examination to further investigate predictors of recanalization

Conclusion

The absence of RHD as a risk factor, the presence of erythrocyte-rich hyperdense clot, and the use of aspiration modality are associated with chances of successful recanalization.

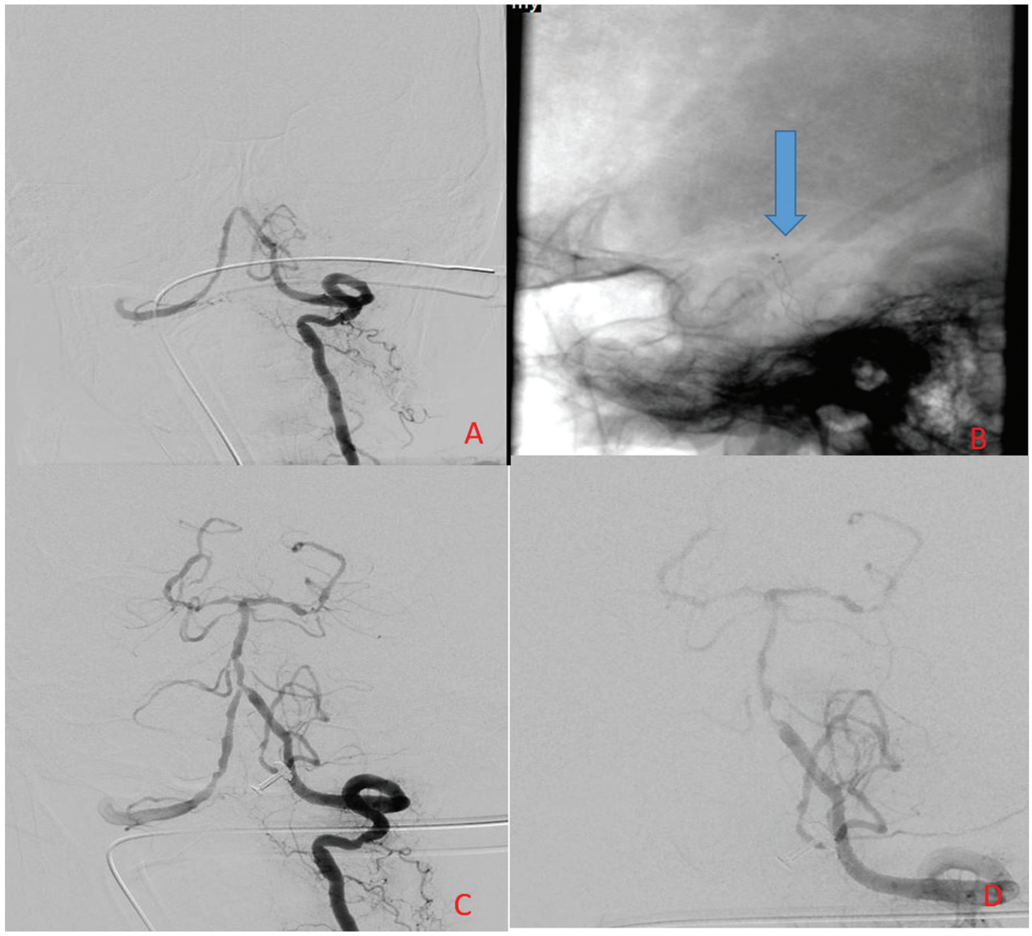

Fig. 5 An elderly patient with a known history of smoking and long-standing hypertension presented with symptoms of posterior circulation stroke that had been ongoing for 20 hours. Computed tomography (CT) angiography revealed proximal occlusion of the basilar artery with multiple calcified plaques. (**A**) Left vertebral artery digital subtraction angiography (DSA) run in anterior-posterior (AP) view shows nonvisualization of the basilar artery. (**B**) A stent retriever (arrow) was deployed across the occlusion in the basilar artery. (**C**) Check run after the first pass shows complete recanalization of the basilar artery with visualization of bilateral posterior cerebral artery (PCA). There are multifocal areas of long-segment focal narrowing and lumen irregularity in the basilar artery suggestive of intracranial atherosclerotic disease (ICAD) changes. (**D**) Check the DSA run after 10 minutes showing reclusion appearing in the proximal basilar artery. After that, it was completely occluded again.

Authors' Contributions

B.D.C., S.B.G., S.J., A.G., and L.J.D.S. contributed to the acquisition, analysis, conception, design, and drafting of the work. M.V.P.S., R.B., A.K.P., S.S.K., B.D.C., S.B.G., S.J., A.G., and L.J.D.S. contributed to the final draft, revisions, upload, and submission of final revised work. All authors have agreed to be personally accountable for their contributions and ensured that questions related to the accuracy or integrity of any part of the work, even those in which one was not personally involved, are appropriately investigated, resolved, and documented in the literature.

Ethical Approval

This work has been approved by the Institute Ethical Committee (IEC).

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Conflict of Interest

None declared.

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