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Endovascular Therapy for Acute Ischemic Stroke: A Comprehensive Review of Current Status

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A B S T R A C T

Stroke remains among the leading causes of disability and death worldwide. Fibrinolytic therapy is associated with poor patency and functional outcomes. Recently, multiple randomized trials have been published that have consolidated the role of endovascular therapy for ischemic stroke due to large vessel occlusion in the anterior cerebral circulation. This manuscript reviews the current understanding of the endovascular management of acute stroke including technical aspects and current evidence base.

Contents

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1. Background

Stroke, a growing global healthcare burden, remains one of the leading causes of disability and death in the Western world [1]. Ischemic stroke accounts for nearly 80% of all strokes. Rapid restoration of blood flow to ischemic tissue salvages the ischemic penumbra and reduces the final infarct area. Prompt intravenous fibrinolytic treatment with tissue plasminogen activator (tPA) within 4.5 h of the onset of symptoms has been the standard of care in the management of acute ischemic strokes. Nonetheless, limitations of the tPA therapy, including the low incidence of vessel recanalization in large vessel ischemic strokes have led to the evolution of endovascular approaches devised for a greater reduction of clot burden in larger vessels [2,3]. While previous studies failed to demonstrate the benefits of endovascular intervention over tPA therapy multiple recent, multicenter randomized control trials and their subsequent meta-analyses have demonstrated the superiority of early intra-arterial treatment with stent retrievers over standard intravenous thrombolysis for the management of ischemic strokes, caused by a documented large artery occlusion in the proximal anterior circulation. These results have led to updates of the acute stroke guidelines and consensus documents, with new recommendations favoring stent retrievers after IV fibrinolysis in the treatment of strokes in selected settings [4,5].

While evolving research on the optimization of endovascular stroke interventions is in process, there is an important variation nationwide in the availability of interventional neurologists and acute stroke centers offering those procedures. Interventional cardiology heart teams in collaboration with well-organized emergency medical response services have been at the forefront of ensuring timely reperfusion in patients with acute myocardial infarction for the past several decades. This legacy underlines the potential for involving interventional cardiologists in stroke teams in joint efforts, using the established acute MI networks to manage acute strokes. We [6], as well as other groups [7], have demonstrated the possibility of attaining similar outcomes of stroke interventions performed by cardiologists, to those achieved by neurointerventional centers. Such collaborative interactions may extend services to a larger group of patients and improve post-stroke outcomes by ensuring rapid and successful recanalization rates [8,9]. This article aims to introduce acute stroke intervention to interventional cardiologists interested in extending their practice to this field.

2. Initial management and patient selection

The importance of the effective stroke teams cannot be overemphasized. Immediate medical attention is warranted from the onset of acute stroke, in order to prevent additional brain damage. Such actions and the decision to proceed to endovascular treatment are most effective when performed by a multidisciplinary stroke team (Table 1). The members of this team vary depending on the needs of the hospital and may include the emergency department, radiology, neurosurgery, neurology, cardiology and anesthesiology departments.

Once a stroke is identified, the initial goals are ensuring medical stability, with particular attention to airway, breathing, and circulation, a rapid neurologic evaluation as well as the management of concomitant issues such as high blood pressure and hyperglycemia. Elevated blood pressure is frequent; however, the management can differ in the acute stroke setting [10]. An electrocardiography can detect signs of concomitant acute cardiac ischemia or arrhythmias. History and neurologic evaluation should establish the time of onset; as well as the National Institutes of Health Stroke Scale (NIHSS) score at presentation.

Imaging is necessary to exclude underlying hemorrhage and determine whether the patients with acute ischemic stroke are candidates for thrombolytic or endovascular therapy. Both computed tomography (CT) and magnetic resonance imaging (MRI) can be used; however, longer scan times of MRI and incompatibility of certain medical equipment with the magnetic field deem CT a more practical option. In most instances, non-enhanced CT will provide the necessary information needed to make decisions regarding emergency management, however, according to recent guidelines, if endovascular therapy is considered, a non-invasive intracranial vascular study is strongly recommended during the initial imaging evaluation of acute stroke patients, without delaying intravenous r-tPA [5].

A CT angiogram (CTA) can provide essential information regarding the culprit vessel, the presence of collaterals and possibly the underlying pathophysiology (e.g., atherosclerotic stenosis) as well as the aortic arch and great vessel anatomy [11]. History, neurological evaluation, and imaging studies determine which patients qualify for endovascular intervention. Recommendations of the latest guidelines regarding patient selection are shown in Table 1.

3. General anesthesia vs. conscious sedation

General anesthesia (GA) and conscious sedation are frequently used during endovascular therapy for acute ischemic stroke. GA allows a completely motionless procedure but may be associated with significant disadvantages including hemodynamic fluctuations in cerebral perfusion pressures and time delays [12]. A strong data from a recent meta-analysis [13] and several other studies [14–18] indicate that GA had poorer outcomes compared with conscious sedation which might be safer and more effective than GA in the setting of endovascular therapy for stroke. *However, the common point of all studies is the choice of anesthesia or sedation should be individualized* based on individual clinical characteristics. An expert consensus document states that GA may be preferable in uncooperative or agitated patients, for airway protection, including most patients with posterior circulation stroke, depressed level of consciousness, and respiratory compromise [19].

4. Access site

The standard access route for percutaneous neurointerventions is the common femoral artery. However, femoral access in some patient subsets, including patients with severe systemic atherosclerosis with bilateral iliofemoral artery occlusions, thoracic aortic dissection, extreme tortuosity, ostial stenosis of the proximal cervical vasculature or unfavorable anatomy of the aortic arch pose a challenge, which can delay or even preclude the intervention. Considering the patient population requiring acute stroke intervention is older and more likely to have above-mentioned problems, utilization of alternative routes may be needed.

Trans brachial or trans-radial approaches are alternative routes; however, such access is technically difficult for catheterization of a non-bovine left carotid take-off, due to its sharp angle [20,21]. Finally, the direct carotid approach is an alternative access, particularly for such challenging cases.

5. Cerebral angiography

The cerebral blood supply consists of the anterior and posterior circulation which derive from the internal carotid arteries (ICA) a branch of the common carotid artery and the vertebral arteries; branching from the subclavian arteries, respectively. An important and unique component of the cerebral vessels is the circle of Willis. This anastomotic circulation permits the maintenance of cerebral perfusion via collaterals, if an occlusion of one of the main arteries occurs.

In addition to the intracranial vascular anatomy, appreciation of anatomy of the arch of the aorta and proximal extracranial neck vessels is crucial. Use of the standard Judkins right (JR4) catheter or angled glide catheter can be utilized to selectively engage the great vessels in most patients with a type 1 arch. More challenging arches (type II and III) can be engaged using Vitek (Cook Medical, Bloomington, IN) or Simmons type catheters (Angiodynamics, Latham, NY) [22].

After engaging the carotid arteries, digital subtraction angiography (DSA) performed to visualize the vessels should reflect both the true anteroposterior and lateral projections focusing on the target cerebral artery distribution and their distal branches. Oblique views can be acquired as needed to allow clear documentation of the location, extent, and vessel caliber at the occlusion site [23]. The extent of collateral circulation predicts outcomes and the clinical aftermath [24]. Collaterals, which can originate from the circle of Willis, the external carotid artery via the ophthalmic artery, and rarely from the persistent trigeminal artery [22] should be assessed using the American Society of Interventional and Therapeutic Neuroradiology (AITN) collateral grading (ACG) system [23,25]. After the procedure, the degree of revascularization should be quantified. There is currently lack of consensus on the definitions of revascularization. Revascularization is a broader term implying all treatment-related improvements in blood flow, including both recanalization and reperfusion [23]. Although recanalization and reperfusion are often used interchangeably, these terms have different meanings [26]. Recanalization infers opening of an occluded artery, while reperfusion restoration of flow in the distal arterial bed and in the tissue. Because they establish different dimensions of revascularization, they should be both obtained and reported. On the other hand, reperfusion is assessed visually by anterograde restoration of a capillary blush on DSA and modified TICI scale, a cerebral analogous of TIMI grading, should be used to assess the tissue reperfusion [25,27,28].

Table 1
Recommendations of current AHA/ASA guidelines for patient selection for endovascular treatment of stroke.
Reprinted from Powers et al. [5] with permission from American Heart Association. Copyright 2015. Stroke.

1) Patients should receive ET with a stent retriever if they meet all the following criteria (*Class I; LoE: A*)
   a) prestroke mRS score 0 to 1
   b) acute ischemic stroke receiving intravenous r-tPA within 4.5 h of onset according to guidelines from professional medical societies
   c) causative occlusion of the internal carotid artery or proximal MCA (M1)
   d) age ≥ 18 years
   e) NIHSS score of ≥6
   f) ASPECTS of ≥6
   g) treatment can be initiated (groin puncture) within 6 h of symptom onset
2) In carefully selected patients with anterior circulation occlusion who have contraindications to IV r-tPA, ET with stent retrievers completed within 6 h of stroke onset is reasonable (*Class IIa; LoE: C*).
3) Although the benefits are uncertain, use of ET with stent retrievers may be reasonable for carefully selected patients with AIS in whom treatment can be initiated (groin puncture) within 6 h of symptom onset and who have causative occlusion of the M2 or M3 portion of the MCAs, anterior cerebral arteries, vertebral arteries, basilar artery, or posterior cerebral arteries (*Class IIb; LoE: C*).
4) ET with stent retrievers may be reasonable for some patients <18 years of age with acute ischemic stroke who have demonstrated large vessel occlusion in whom treatment can be initiated (groin puncture) within 6 h of symptom onset, but the benefits are not established in this age group (*Class IIb; LoE: C*).
5) Although the benefits are uncertain, use of ET with stent retrievers may be reasonable for patients with acute ischemic stroke in whom treatment can be initiated (groin puncture) within 6 h of symptom onset and who have prestroke mRS score of >1, ASPECTS <6, or NIHSS score < 6 and causative occlusion of the internal carotid artery or proximal MCA (M1) (*Class IIb; LoE: B-R*).
6) Observing patients after intravenous r-tPA to assess for clinical response before pursuing ET is not required to achieve beneficial outcomes and is not recommended. (*Class III; LoE: B-R*).

Abbreviations: AIS: Acute ischemic stroke, ET: Endovascular therapy, IV: intravenous, LoE: Level of Evidence, MCA: middle cerebral artery, mRS: modified Rankin Score, NIHSS: National Institute of Health Stroke Scale.

6. Methods for revascularization in acute ischemic stroke

Endovascular stroke interventions offer theoretical advantages over intravenous fibrinolysis, including speed and rate of recanalization, reduced risk of hemorrhage and longer time window for use [29] (Fig. 1). Ultrasound energy can be used to disrupt the clot and facilitate the diffusion of fibrinolytics. The EKOS MicroLys US infusion catheter (EKOS Corporation, Bothell, WA) functions as a microinfusion conduit through its distal port and creates a microenvironment of ultrasonic vibration to facilitate thrombolysis [30].

Mechanical thrombus disruption can be achieved by repeated probing of the thrombus by a micro guide wire, microcatheter or snares [31–33], which can increase the surface area on which fibrinolytic agents can act. One important concern is embolization secondary to clot fragmentation, therefore it is usually performed in conjunction with intra-arterial or systemic thrombolysis. Percutaneous angioplasty of a thrombus is no longer recommended due to the thrombus breakdown and distal embolization.

Anterograde flow can additionally be restored with mechanical thrombectomy. The Merci Retrieval System (Stryker, Kalamazoo, MI, USA); a device developed for endovascular intracranial embolectomy, was the first stroke device to be approved by the FDA and has been remodeled ever since. The device is advanced through the occlusion using a micro-catheter and deployed distally to the thrombus. This is followed by withdrawal of the Merci retriever with the thrombus captured by its helical loops, alongside the micro-catheter, using manual aspiration with a large syringe to reverse the flow and further aspirate any clot debris [34]. However, the non-stent retriever devices are no longer recommended for stroke thrombectomy in modern neurointerventional practice [5].

Stenting of the occluded segment results in recanalization, by compressing the thrombus against the vessel wall. Self-expanding stents are preferable in the context of acute stroke. This is because the embolic nature of the occlusion differs from those in most coronary lesions, which are almost exclusively atherosclerotic and require higher atmospheres to deploy the stent [35]. However, limitations of the permanent stent implantation include the need for long-term antiplatelet therapy and the risk of restenosis. These pitfalls have been addressed with the development of re-sheathable and re-constrainable self-expanding stents permanently mounted to a delivery wire (known as retrievable stents). These devices combine fast recanalization effect of an intracranial stent and the capability of extracting the thromboembolus offered by mechanical thrombectomy devices [29]. The occlusion is crossed with a micro-catheter and subsequently, the stent retriever is deployed covering the thrombus.

By compressing the thrombus, the retrievable stent's radial force is able to immediately create a channel allowing restoration of the blood flow. Leaving the device in place, for up to 5 min, promotes engagement of the device with thrombus. The micro-catheter and stent are, then, gently retrieved back under continuous aspiration using a large syringe through the guiding-catheter to prevent the development of an embolism [6]. Repeated passes are frequently needed; however, we have set a maximum of 4 passes in our clinical practice. Examples of the first-generation stent retrievers include the Solitaire FR (Medtronic, Minneapolis, MN, USA) and Trevo (Stryker) (Table 2). Among the second-generations, EmboTrap II [36] (Johnson and Johnson, New Brunswick, NJ, USA) and Trevo XP ProVue (Stryker) recently approved by the FDA. Aperio (Acandis GmbH, Pforzheim, Germany) and some other devices can only be found in the European Market.

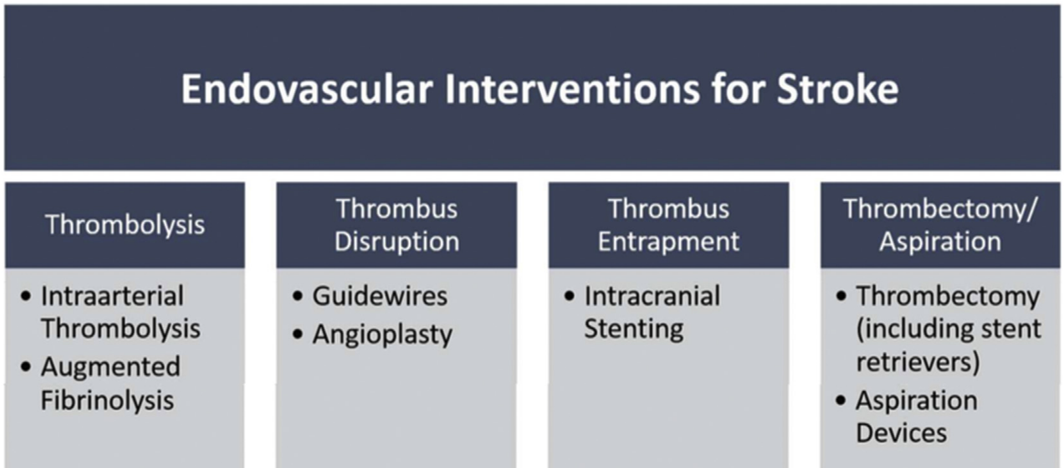

Fig. 1. Endovascular recanalization strategies for acute ischemic stroke.

Potential device-related risks include stent distal embolization and stent detachment. Guidelines recommend stent retrievers over coil retrievers such as Merci for mechanical thrombectomy. Mechanical thrombectomy devices, excluding stent retrievers, may be indicated in certain situations [5].

Recent advances in catheter technology have made available large, easily trackable, aspiration catheters that can now easily and reliably navigate the cerebrovasculature. Consequently, a novel technique, namely ADAPT technique has recently been reported. This technique involves passing a large guide catheter distal into the cervical or proximal petrous ICA as possible. The largest caliber aspiration catheter possible, which can be exemplified as the ACE 68, 5MAX, 5MAX ACE (Penumbra Inc., Alameda, CA, USA), AXS Catalyst 6 (Stryker), Sofia 6F (MicroVention, Aliso Viejo, CA, USA), or PHENOM PLUS (Medtronic) is advanced to the level of the thrombus, over a micro-wire and micro-catheter and is used to aspirate the thrombus using a syringe or aspiration pump. The absence of flow within the aspiration system confirms engagement with the thrombus at which point, the catheter is gently advanced for 1–2 mm to ensure solid engagement with the thrombus. Aspiration is applied for approximately 20 s, and if no flow through the system is found then the catheter is slowly withdrawn.

Table 2
Toolbox for endovascular stroke intervention.

Guide wires
Proximal/distal emboli protection devices • MOMA • Filters
Micro catheters
Guiding catheters (Neuron 088; Penumbra, Oakland, California, USA)
Angioplasty balloons
Intracoronary stents
Stent retrievers • Solitaire (Medtronic) • Trevo (Stryker)
Aspiration catheters • ACE 68, 5MAX, 5MAX ACE (Penumbra Inc., Alameda, CA, USA), • AXS Catalyst 6 (Stryker), • Sofia 6F (MicroVention, Aliso Viejo, CA, USA) • PHENOM PLUS (Medtronic)
Snares

7. Complications

Endovascular stroke interventions are associated with complications that can be linked to the intervention procedure or to the stroke. It is important to be able to identify these complications and subsequently manage appropriately. While some of these complications and their management are naturally similar to those encountered by cardiologists during vascular intervention procedures, others differ significantly in management.

The brain is surrounded by the noncompliant skull and in the event of hemorrhage intracranial pressure rises rapidly, potentially leading catastrophic outcomes. Spontaneous hemorrhagic transformation and edema formation can be observed in large strokes due to major artery occlusions or reperfusion injury; however, it can also be a result of vessel damage from endovascular manipulations, in tissue already prone to bleed, because of the thrombolytics and disruption of the blood-brain barrier [37]. The characteristics of cerebral arteries also arteries have no external elastic lamina, and the adventitia is very thin compared with vessels of similar luminal diameter in other parts of the body. Intracranial arteries have a lower wall: lumen ratio than extracranial arteries, which makes these vessels relatively fragile [38].

Although the time to perfusion is a major factor, there are additional risk factors associated with spontaneous hemorrhagic transformation [39] (Table 3). In a study of 222 consecutive patients, the hemorrhagic transformation was more common in patients with poor collaterals and recanalization, indicating that poor baseline collaterals may result in clinically significant hemorrhagic complications, probably due to an increase in infarct size [24]. Prevention involves careful patient selection and meticulous management of blood pressure and glucose during and following the interventions.

During the procedure, intracranial hemorrhage can be recognized by contrast extravasation or mass effect. For the former, however, leakage of contrast medium from vessels into extracellular spaces can also be due to varying degrees of injury to microvascular permeability and integrity [40]. Once a significant hemorrhage occurs, the management is challenging, and involves the reversal of anticoagulation and/or antiplatelet effects of medications, while controlling blood pressure without inducing hypotension [37]. Urgent neurosurgical evacuation might also be needed signifying the need for a comprehensive stroke team.

Table 3
Factors associated with hemorrhagic transformation in ischemic stroke patients.
Modified from Jickling et al. [39] with permission from SAGE publishing. Copyright 2014. Journal of Cerebral Blood Flow and Metabolism.

	Factors associated with hemorrhagic transformation in ischemic stroke patients
Clinical	Age
	Stroke severity/NIHSS
	Systolic blood pressure
	Hypertension history
	Glucose
	Diabetes
	Body weight
	Gender
	Congestive heart failure
	Atrial fibrillation
	Renal impairment
	Antiplatelet use
	Platelet count
	Anticoagulant/international normalized ratio/partial thromboplastin time time to reperfusion
Neuroimaging	Infarct size/diffusion weighted imaging infarct volume
	Early infarct size
	Dense cerebral artery sign
	Leukoaraiosis
	MRI enhancement pattern
	BBB permeability (perfusion CT)
	Hyperintense Acute Injury Marker (HARM) (presence of gadolinium enhancement of CSF)
	Apparent diffusion coefficient value (MRI)
	Collateral flow (MRI)
	Cerebral blood flow or volume (MRI)

Abbreviations: NIHSS: National Institute of Health Stroke Scale, BBB: Blood Brain Barrier, CSF: Cerebrospinal Fluid, CT: Computed Tomography, MRI: Magnetic Resonance Imaging.

Instrumentation and manipulations in the vessels can result in intra or extracranial dissections, with a possibility of the loss of flow. Similar to coronary interventions, the treatment of ischemic stroke is also plagued by no-reflow indicating a failure to achieve adequate tissue level reperfusion [41]. Vasospasms can occur and usually resolves by nitrate administration. Distal embolization can occur due to the manipulation of the thrombus, or due to inadequately flushed catheters. Device-related complications, such as stent dislocation have also been reported in the literature [42,43].

8. Clinical evidence

Three previously reported studies in 2013 [44–46] failed to demonstrate a clinically meaningful benefit of endovascular therapy over thrombolysis alone. Several characteristics of the previous studies have been proposed for this discrepancy: 1) prolonged onset-to-treatment times; 2) low recanalization rates; 3) insufficient confirmation of initial arterial occlusion in a significant percentage of patients, and 4) limited use of current stent-retriever devices [47–49]. Despite the fact that these studies were technically negative, they were, nevertheless, significant because they failed to show worsening with endovascular treatment and underscored the need for use of newer retrieving devices and confirmation of large-vessel occlusion.

The recent 5 randomized trials, all published in 2015, comparing stent retrievers and thrombolytic therapy compared to thrombolytic therapy alone have consolidated the role of endovascular therapy as the standard of care for acute stroke patients with occlusion of proximal anterior circulation [50–54]. Subsequently, multiple meta-analyses have assimilated these results to show the advantage of endovascular stent therapy [55,56].

The HERMES collaborators (Highly Effective Reperfusion evaluated in Multiple Endovascular Stroke Trials) pooled individual patient level data from MR CLEAN, ESCAPE, SWIFT, PRIME, REVASCAT, and EXTEND IA trial [56]. 1287 patients (mean age, 66.5 years; women, 47%) with stroke were randomly assigned to receive thrombectomy (N = 634) or usual care alone (N = 653). The most frequent culprit occlusion was the M1 segment of the middle cerebral artery, followed by the intracranial internal carotid artery. The median time from onset to the randomization was 3 h 16 min (IQR 2 h 22 min to 4 h 27 min). The prespecified primary outcome in these trials was the degree of disability on the modified Rankin Scale (mRS) at 90 days. The score on mRS ranges from normal (0) to death (6). The frequency of a low 90-day modified Rankin Score (0 to 2) (functional independence) in the intervention group was 42.6% compared with 26.1% in the control group (odds ratio: 2.43; 95% confidence interval [CI]: 1.9 to 3.09; $p < 0.0001$) with number needed to treat of 5 for functional independence and NNT 2.6 for a less disabled outcome with endovascular therapy. There was no difference in the frequency of intracranial bleeding (4.2% vs. 4.3%; $p = 0.78$) and 90-day mortality (15.1% vs. 18.7%; $p = 0.19$). Another important observation from the HERMES collaboration was that among the 15% patient's ineligible for alteplase, the magnitude of benefit was similar to endovascular therapy compared to those who received ET + alteplase [55,56].

Among the 549 patients who underwent an endovascular thrombectomy intervention and had resulting mTICI scores documented, substantial reperfusion was achieved in 390 (71.0%) [56]. This is an important breakthrough in stroke treatment, in fact, the most important breakthrough since the NINDS (National Institute of Neurological Disorders and Stroke) t-PA trial that established the use of IV thrombolysis for ischemic stroke 20 years ago [57].

Several current or planned studies including PISTE [Pragmatic Ischaemic Stroke Thrombectomy Evaluation], THERAPY [Assess the Penumbra System in the Treatment of Acute Stroke], THRACE [Trial and Cost Effectiveness Evaluation of Intra-arterial Thrombectomy in Acute Ischemic Stroke], and THRILL [Thrombectomy in Patients Ineligible for IV tPA] studies may provide high-level evidence for the efficacy of endovascular treatment in different patient populations and subgroups. Further advances are expected with the refinement of retrieving devices and selection criteria that may allow the time window to be extended even further, up to 15 h in the anticipated DEFUSE-3 trial, or even up to 24 h in the DAWN trial [58–60].

When it comes to the comparison of the contact aspiration and stent retriever as a first-line revascularization technique, on the contrary to some retrospective studies [61–63] a recent randomized trial ASTER [The Contact Aspiration vs Stent Retriever for Successful Revascularization] [64] showed that thrombectomy with contact aspiration was not superior to the stent retriever in terms of the successful revascularization rate among the patients with ischemic stroke in the anterior cerebral circulation. Although adequate evidence found, this study was not designed to detect the non-inferiority of both techniques to each other. Therefore, new RCT's should be designed for the first-line technique selection. According to current evidence, the operator should avoid the prejudiced approach.

9. Symptom onset to revascularization timelines ("Time is the brain")

The HERMES collaborators recently published their findings from the pooled 5 RCTs to evaluate the impact of time to treatment windows on the primary outcome (functional independence) [60]. Among the 607 patients who had an arterial access puncture, the median time from symptom onset to arterial puncture was 238 min (~4 h) (IQR, 180–302) and from symptom onset to reperfusion 301 min (~5 h) (IQR, 226–384) The investigators found a linear relationship between time delays to reperfusion and outcomes. The magnitude of benefit nominally declined with longer times from symptom onset to arterial puncture: such that at 3 h the absolute risk difference (ARD) in endpoint for lower disability scores was 39.2%; 30.2% at 6 h and 15.7%; at 8 h. The time at which the lower 95% CI for estimated treatment benefit first crossed 1.0 and was no longer statistically significant was at a symptom

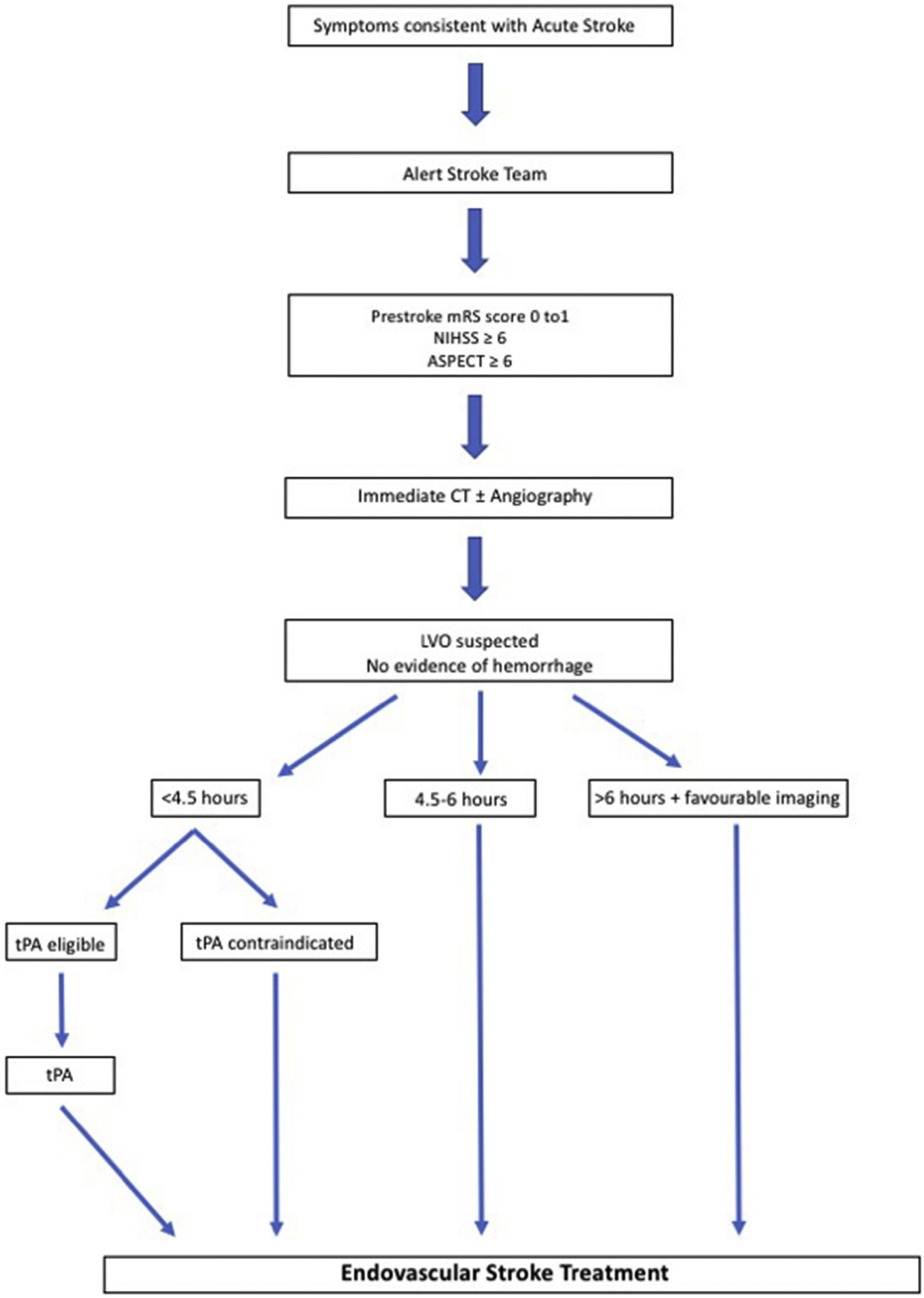

Fig. 2. Flow diagram summarizing clinical approach to endovascular stroke; ASPECT: Alberta Stroke Program Early CT Score, NIHSS: National Institute of Health Stroke Scale, mRS: modified Rankin Score, CT: Computed Tomography, tPA: Tissue Plasminogen Activator.

onset–to–expected arterial puncture time of 7 h and 18 min. The probability of functional independence (mRS 0–2) at 3 months declined from 64.1% with symptom onset–to-reperfusion time of (3 h)180 min to 46.1% with symptom onset–to-reperfusion time of 480 min (8 h).

National guidelines and consensus statements in the United States, Europe, and Canada recommend endovascular recanalization up until 6 h after symptom onset, but most of the thrombectomy devices are cleared by the US Food and Drug Administration (FDA) for use up to 8 h after symptom onset except the Trevo device which is recently approved by the FDA up to 24 h, and the Canadian guidelines additionally recommend thrombectomy for selected patients up to 12 h after symptom onset. The DAWN trial investigators recently reported that extending the thrombectomy window to patients within 6 to 24 h after stroke onset, the rate of functional independence was 49% at 3 months compared to the control group (13%) [60]. Moreover, this was similar to the rate reported in the pooled analysis of five trials of thrombectomy, in which patients predominantly received treatment within 6 h after stroke onset (49% and 46%, respectively) [56] (Fig. 2).

10. Conclusions

Endovascular interventions, in acute ischemic stroke, are subject to continuous advancements and progression. Moreover, studies on modern devices and other imaging techniques have the potential to broaden the horizons of stroke interventions. We believe in the potential role of experienced and skilled interventional cardiologists in helping expand these services and alongside highly organized STEMI networks and institutions. While coronary and cerebral reperfusion strategies share many universal fundamentals in terms of catheter-based should familiarise with, prior to participating in stroke interventions, as skills may not be directly transferable and require a solid understanding of the underlying anatomy and physiology.

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Declaration of conflict of interests and disclosures

The authors declare that they have no conflict of interest and they alone are responsible for the content and writing of the paper.

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