

# Mechanical thrombectomy for vertebral and basilar artery occlusions: Our institutional experience with 17 patients

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## Research Article

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# Abstract

**Introduction:** Acute ischemic stroke of the posterior circulation as a result of vertebrobasilar artery occlusions are often associated with severe morbidity and mortality rates. Vertebrobasilar artery occlusions retrieval via mechanical thrombectomy (MT) is a new treatment modality for occlusive strokes. Nevertheless, factors associated with good outcome have not been investigated adequately. Thus, our study focuses on factors associated with good prognosis.

**Method:** We retrospectively analyzed a series of 17 patients with acute vertebral artery occlusions (VAOs) and basilar artery occlusions (BAOs) treated via mechanical thrombectomy. In all patients, information such as sex and age, time from admission to onset of femoral artery access, number of thrombus removed, time of femoral artery access to recanalization, pre- and post-operative National Institutes of Health Stroke Scale (NIHSS), pre- and post-operative thrombolysis in cerebral infarction as well as modified Rankin Scale were documented and analyzed.

**Results:** Our analysis comprised of 11 patients with BAOs and 6 patients with VAOs. We achieved 70.6 % recanalization rate with over all good prognosis of 58.8% at 90 days. Statistically, there was significant improvement in outcome comparing the NIHSS before operations to the NIHSS one week after the operations ( $t=2.735$ ,  $P=0.008$ ). Nevertheless, we did not find any significant correlation between time from admission to onset of femoral artery puncture, time from femoral artery puncture to recanalization and prognosis.

**Conclusion:** Lower NIHSS score before MT could be a good prognostic factor. An average time of about 5.5 hours from patients' arrival to recanalization with 70.6 % recanalization rate with over all good prognosis of 58.8% at 90 days means that, patients who operations are carried out within 5 hours still have hope for recanalization compared to initial 1.5 hours average time for recanalization.

## Introduction

Acute ischemic stroke (AIS) is one of the primary triggers of disability as well as mortality worldwide with substantial burden on health systems and families[1–3]. AIS of posterior circulation as a result of vertebrobasilar artery occlusions (VBAO) constitutes about 10–20% of all large vessel occlusions (LVO) with a mortality rate of nearly 90% and most frequently affecting the basilar artery (BA)[4–8]. The posterior circulation mainly provides blood supply to important parts such as the brainstem, thalamus and cerebellum[9].

Intravenous tissue plasminogen activator (t-PA) given within 4.5 hours is currently the recommend treatment for patients with thrombolytic ischemic strokes[10, 11]. Most recently, mechanical thrombectomy (MT) for the treatment of acute thrombolytic ischemic stroke has shown favorable outcomes in both anterior and posterior LVOs[5, 12–17]. Almost all studies involving acute VBAO focused primarily on prognostic factors such as the severity of neurologic deficits, time of onset to treatment, location of the occlusion, the state of collaterals, treatment or management options, as well as timely reperfusion[18–21].

Prognosis is often bad with a high mortality rate when early reperfusion is not achieved in patients with basilar artery occlusion (BAO)[19, 22]. Thus, MT in patients with BAO has shown good clinical outcomes with a wide

range of functional attainments[13, 22]. Although a few studies have shown that, flow reversal as well as patency of the vertebral arteries (VA) may also affect recanalization success, very few studies have reported MT in vertebral artery occlusions (VAOs)[5, 7, 23, 24]. Factors associated with good outcome have not been investigated adequately. Our study focuses on factors associated with good prognosis.

Specifically, the precise correlation between reperfusion and outcome is not fully established in BAO and VAO patients. Thus, we present our institutional experience on MT for VAOs as well as BAOs.

## Method And Materials

We retrospectively analyzed a series of 17 patients with acute VAOs and BAOs treated via MT at the departments of neurosurgery, Jiangyin Hospital from January 2017 to December 2020. This study was approved by our hospital's Research Committee. Patients as well as relatives were made aware our intention to include them in a study during follow-up visits at outpatient department. Written informed consents as well as concerns for publication were obtained from all the patients and the hospital. In all patients, information such as sex and age, time from admission to onset of femoral artery access, number of thrombus removed, time of femoral artery access to recanalization, pre- and post-operative National Institutes of Health Stroke Scale (NIHSS), pre- and post-operative thrombolysis in cerebral infarction (TICI) as well as modified Rankin Scale (mRS) were documented and analyzed.

## Indications And Contraindications

Indications for MT included: (1) Clinical diagnosis is in line with acute ischemic stroke in the posterior circulation, hospitalized within 24 hours of onset, and neurological deficits related to posterior circulation ischemia such as dizziness, gaze disturbance, visual field defect, visual impairment, coma, etc.; (2) If cerebrovascular evaluation with computer tomographic angiography (CTA) showed that the BA and/or VA was occluded, and a head computer tomography (CT) scan ruled out intracranial hemorrhage; (3) If the patient's family agreed to an informed consent and signed the surgical consent form.

Contraindications for MT: (1) If a head CT indicates the presence of intracranial hemorrhage or large-area cerebral infarction in the posterior circulation (> 2/3 of the pons or midbrain volume or cerebellar hemisphere infarction); (2) If there was a history of active bleeding or a tendency to hemorrhage; (3) Severe disability, mRS > 2 points; (4) Severe renal insufficiency; (5) If the patient had a clear history of contrast agent allergy.

## Preoperative Evaluation

After the patient was admitted in the hospital, a neurologist will complete the physical examination, neurological functional assessment as well as the NIHSS score in the emergency room. The emergency physician will also perform a head CT scan to rule out intracranial hemorrhage, as well as a head and neck CTA to identify BAO (Fig. 1A&B) and/or VAO. Also, preoperative magnetic resonance images (MRIs) were performed in all patients to detection brainstem infarction. In all patients, preoperative CTA revealed the

presence of great vessel occlusion such as the arteries above. Time from admission to onset of femoral artery puncture/accesses were documented before the commencement of endovascular operations.

## Anatomical Divisions Of The Vertebrobasilar Artery

The VA is characteristically divided into 4 segments such as V1-V4[25, 26]: V1; also denoted as the pre-foraminal segment (starts from the subclavian artery to the transverse foramen of C6), V2; also denoted as the foraminal segment (starts from the transverse foramen of C6 to the transverse foramen of C2), V3; also denoted as the atlantic, extradural or extraspinal segment (starts from C2, where the artery loops, turns lateral and upwards into the transverse foramen and progress via C1 to penetrate the dura, V4; also denoted as the intradural or intracranial segment (starts from the dura at the lateral border of the posterior atlanto-occipital membrane to their convergence on the medulla to constitute the BA).

## Endovascular Procedures

All procures were carried out under general anesthesia. The entire operations were carried out strictly as previously described by Luo et al[8]. After securing the femoral artery access, a 6F/8F guide catheters were maneuvered into the BA or the VAs via the subclavian arteries and initial angiographies performed to determine the locations of the occlusions (Fig. 1C). Using a coaxial system, we advance 0.21 inch microcatheters (Rebar microcatheter; Covidien, California, USA) and 0.014 inch microguide wires (Transend; Stryker, Kalamazoo, Michigan) into the thrombi as far as the distal ends of the occluded vessels. Angiographies were then performed to confirm that the distal vasculars were patent and no pathology were found in the lumens.

In all patients, solitaire Abs or FRs (ev3, Irvine, California) were utilized for the MT. The Solitaire devices were carefully maneuvered to the occluded segments via the microcatheters and the stent retrievers unsheathed to allowed for complete expansion through the thrombi. The devices often created bypasses that restored blood flow across the occluded segments. Again, we performed angiography to determine patency of the distal arteries, after which we resheathed fully deployed the solitaire devices. Thrombectomies were done via the withdrawal of the solitaire devices and the delivery microcatheters as a single unit. If the angiography showed that the occluded arteries were patent (Fig. 1D), and blood flow rates were basically normal (TICI 2b and above), then the procedures were completed.

If the angiography still showed stenosis of the BA or VA and the anterior blood flow does not meet a TICI score of 2b, then balloon angioplasty (Gateway™, Boston Scientific Place, Natick, MA) was first performed. If angiography still showed no patency, the stent placements were performed to ensure that, the flow rates met TICI score of 2b or above. In all patients who underwent the MTs, the number of thrombus removed were documented. Also, the time from femoral artery puncture/access to recanalization of the occluded arteries were documented.

# Post Procedure Management, Efficacy Evaluation And Follow-up

Heparin infusion was used during and immediately after the operation. Intravenous tirofiban used during the operation was also maintained after the operation. Aspirin 300 mg and clopidogrel 300 mg were inserted in the anus immediately after the operation. All the patients were admitted to the intensive care unit (ICU) for monitoring and treatment, and transferred to the general ward after their conditions were stable. In all patients, immediate postoperative CT scans were performed to rule bleeding 24hours after the operation. CTAs were also performed to confirm recanalization (Fig. 1E). Also, post-operative MRIs were performed to assess infarctions after the procedure (Fig. 1F).

Also in all patients, TICI grade were scored as follows[22, 27]: 0 ; no recanalization (no perfusion or anterograde flow beyond the occlusion site) 1; minimal recanalization (contrast medium passes the area of occlusion but fails to opacify the entire cerebral bed distal to the obstruction during the angiographic run), 2 ; partial recanalization (2a: partial filling, < 50% of territory visualized, 2b: partial filling,  $\geq$  50% of territory visualized) and 3; complete recanalization (total reperfusion with normal filling). At the ICU, NIHSS of all the patients were assessed 7 days after the operation.

Also, mRS was used to evaluate the prognosis of patients up to 90 days after the operation.

The mRS scores were assessed as follows[22, 28]: 0; no symptoms, 1; no clinically relevant disability, 2; slight disability (able to look after own affairs without aid but not to a full extent), 3; moderate disability (requires some aid but able to walk unaided), 4; moderately severe disability (unable to attend to own bodily needs or to walk without aid); 5, severe disability (requires constant nursing care); and 6, dead.

## Statistical Analysis

SPSS 17.0 statistical software was used to analyze the data. Normally distributed data were analyzed into  $X \pm S$ . Data comparison before and after surgery was performed by paired t-test. Non-normally distributed data were analyzed into medians, and  $P < 0.05$  was considered statistically significant.

## Results

### Demographic and preoperative evaluations

In all, a total of 17 patients were included in our analysis. Among them, 13 were males while 4 were females. Their ages ranged from 34–75 years old, with an average age of 60 years. The time from onset of admission to the femoral artery puncture/access was 3.0–8.0 hour, with an average time of 5.5 hours. We did not find any significant correlation between time from admission to onset of femoral artery puncture/access and prognosis. This could be due to factors such as collateral compensation and/or the small sample size of study. The basic clinical data of 17 patients is as shown in Table 1. In all patients, preoperative MRIs did not show brainstem infarction subsequent to their operations.

Table 1

Clinical data of 17 patients with acute ischemic stroke in the posterior circulation who received emergency stent mechanical thrombectomy.

No.	Sex	Age (Yrs.)	Location of Lesion	NTR	DNT (Min)	TAR (Min)	mTICI Score		NIHSS Score		mRS (90 days)
							PreOp	PostOp	PreOp	PostOp (1wk)	
1	M	46	Basilar Artery	4	43	135	0	2b	10	6	2
2	M	65	Left Vertebral Artery (V1)	5	57	310	0	3	10	2	1
3	M	60	Left Vertebral Artery (V2)	4	47	340	0	1	25	-	6
4	M	54	Basilar Artery	5	58	300	0	2a	17	-	6
5	M	56	Left Vertebral Artery (V1)	3	42	100	0	1	12	-	6
6	F	75	Basilar Artery	2	97	100	0	3	25	8	3
7	F	74	Basilar Artery	3	52	245	0	2a	20	-	6
8	M	64	Basilar Artery	4	115	170	0	3	20	10	3
9	M	64	Left Vertebral Artery (V4)	2	31	180	0	3	16	3	2
10	M	75	Basilar Artery	3	29	156	0	3	26	6	2
11	F	74	Basilar Artery	3	51	188	0	3	19	3	1
12	M	47	Left Vertebral Artery (V1)	1	29	65	0	3	4	2	1
13	M	70	Basilar Artery	3	361	135	0	3	16	2	1
14	M	57	Basilar Artery	4	61	285	0	2a	17	10	4

No.	Sex	Age (Yrs.)	Location of Lesion	NTR	DNT (Min)	TAR (Min)	mTICI Score		NIHSS Score		mRS (90 days)
							PreOp	PostOp	PreOp	PostOp (1wk)	
15	M	54	Basilar Artery	2	81	105	0	3	9	1	0
16	M	34	Right Vertebral Artery (V1)	3	21	120	0	3	15	4	1
17	F	52	Basilar Artery	2	43	91	0	3	12	3	1

**Abbreviation list:** DNT = Time from admission to onset of femoral artery access (puncture), NTR= Number of thrombus removed, TAR = Time of femoral artery access (puncture) to recanalization, National Institutes of Health Stroke Scale = NIHSS, mRS = modified Rankin Scale, mTICI = modified Thrombolysis in Cerebral Ischemia. Yrs = Years, WK = Week, Min = Minutes. PreOp = Preoperative, PostOp = Postoperative

### Anatomical distribution of lesions.

Out of the 17 patients, 11 patients had BAOs while six patients had VAOs (Table 2). Also, out of the six patients with VAOs, five occlusions were seen at left side while one occlusion was observed at the right side. Furthermore, out of the out of the six patients with VAOs, four occlusions were observed at V1 segment of the VA, one at V2 segment and one at the V4 segment. Thus, we observed more patients with BAOs than VAOs. More patients had V1 occlusions compare to V2 and V4. No patient had V3 segment occlusion.

Table 2

Stratification of patients as per the type of artery occluded, recanalization rate and function outcome of patients.

Artery Occluded	No. of patients	mTICI score		mRS score at 90 days		
		1-2a	2b or 3	0-2	3-5	6
BA	11	3	8	6	3	2
VA	6	2	4	4	-	2
Total	17	5	12	10	3	4

Abbreviation: BA = Basilar artery, VA = Vertebral artery, mTICI = modified Thrombolysis in Cerebral Ischemia, mRS = modified Rankin Scale.

## Operative Outcome

After 1–7 times of MT with Solitaire AB, 70.6% (12/17) patients achieved good recanalization (TICI 2b or 3); 17.4% (3/17) achieved partially recanalization (TICI 2a); while 11.7% (2/17) of the patients achieved very little recanalization (TICI 1). Out of the 11 patients with BAOs, 72.7% (8/11) achieved an effective recanalization (TICI 2b or 3) while out of the six patients with VAOs, 66.7% (4/6) achieved an effective recanalization (mTICI 2b or 3). There was no significant difference in recanalization (TICI 2b or 3) between BAO and VAOs (Table 2). The average time from femoral artery puncture/access to recanalization was 172 minutes. We did not find any significant correlation between time from femoral artery puncture/access to recanalization and prognosis. This could be due to the small sample size of study. All the 12 patients who achieved successful recanalization of the arteries (TICI 2b or 3) survived after their operation. Out of the three patients who achieved partial recanalization (TICI 2a), one patient had severe stenosis of the BA with acute occlusion and balloon dilation at the stenotic portion resulted in rupture and bleeding of the BA and subsequently death after the operation.

The other 2 patients had larger areas of cerebral infarctions after the operation, and decompressive craniostomies were performed to allow for brain expansion as well as brain hernias, and one died. The two patients with TICI 2a who died had occlusions in the BA. All the two patients who achieved very little recanalization (TICI 1) died immediately after their operations. These two patients had occlusions in V1 and V2 segments of the VA. All the deceased patients died immediately after the operations (> 24 hours). The average number of thrombi removed was 3. Also, the average time from femoral artery puncture/access to recanalization was 178 minutes. Thus, an average time of about 5.5 hours from patients' arrival to recanalization with 70.6% recanalization rate with overall good prognosis of 58.8% at 90 days means that patients whose operations are carried out within 5 hours still have hope for recanalization compared to initial 1.5 hours average time for recanalization.

## Efficacy Evaluation And Follow-up Outcomes

The average NIHSS score before operations was 15.3 while the average NIHSS score one week after the operations was 4.5. Statistically, there was significant improvement in outcome comparing the NIHSS before operations to the NIHSS one week after the operations ( $t = 2.735$ ,  $P = 0.008$ ). The prognoses of the patients were assessed up to 90 days mRS score follow-up after operations. A good prognosis was defined as mRS  $\leq 2$  grade (Table 2). We observed that (Table 1) 41.17% (7/17) of had mRS score of 0&1 (good prognosis). Also, 29.41% (5/17) had mRS scores of 2&3 (mild to moderate disability). Furthermore, 5.8% (1/17) had mRS score of 4&5 (severely disability). 23.53% (4/17) had mRS score of 6 (Dead).

Out of the 11 patients with BAO, 54.5% (6/11) achieved a good functional outcome (mRS 0–2) while out of the six patients with VAO, 66.7% (4/6) achieved a good functional outcome (mRS 0–2). We did not observe any significant difference in good functional outcome (mRS 0–2) between BAO and VAOs. The overall good functional outcome in our patients was 58.8% (10/17) as per the mRS score range of 0–2 (Table 2). Also, we observed a mortality rate of 23.53%. We did not observe any significant difference between patients with BAO and VAO (Table 2). Two years follow-ups of patients with favorable outcomes revealed no further neurological deficits and massive improvements in the lives. No patients were lost during follow-ups.

## Discussion

The effectiveness of MT in posterior circulation stroke is still confronted with uncertainty notwithstanding the successful outcomes in large vessel anterior circulation stroke[6, 12, 15, 16, 18, 29]. Over all, out of the 17 patients, we observed BAOs in 64.7% (11/17) patients while in 35.3% (6/17) patients had VAOs. Furthermore, 70.6% of our patients achieved recanalization (TICI 2b-3) with 41.17%, 29.41% and 29.41% of the patients attaining good prognosis, mild to moderate disability and severely disability respectively as per our mRS scores. The overall good functional outcome in our patients was 58.8% (10/17) as per the mRS score range of 0–2. Our patients were predominantly males with a mean age of 60 years.

Sonig et al reported a series of 12 BAO treated with retrievable MT and achieved an effective recanalization (TICI 2b or 3) of 91.7% (11/12) of their patients with a median mRS scores 2 at discharge and 1 at last follow-up[30]. Also, Kang et al demonstrated successful reperfusion of 90.3% in patients with acute BAO who underwent MT with retrievable stents and achieved a favorable functional outcome of 46.9% (mRS 0–2) of their patients[31]. Furthermore, Gory et al attained 72.2% effective recanalization (TICI 2b or 3) or reperfusion in their patients with favorable functional outcome of 34% (mRS 0–2) and 2–5% risk of hemorrhage[22]. Baik et al achieved an overall successful reperfusion rate of 78% with a favorable clinical outcome of 37% in their patients[18].

Out of the 11 patients with BAO, 72.7% (8/11) achieved an effective recanalization (TICI 2b or 3) with a good functional out of 54.5% (6/11) as per the mRS score range of 0–2. Also, out of the six patients with VAO, 66.7% (4/6) achieved an effective recanalization (TICI 2b or 3) with a functional out of 66.7% (4/6) as per the mRS score range of 0–2. We did not observe any significant difference in recanalization (TICI 2b or 3) between BAO and VAOs may be because of the small sample sizes. Furthermore, we did not observe any significant difference in good functional outcome (mRS 0–2) between BAO and VAOs may be because of the small sample sizes. None of our patients presented with bilateral VAO or tandem VA-BA occlusions. Tandem VA-BA occlusions although rare, have been reported in about 16–20 patients with acute VBAO[6, 18, 32].

The initial symptomatology of our patients where neurological deficits related to posterior circulation ischemia such as dizziness, gaze disturbance, visual field defect, visual impairment, coma. CT scan and CTA were the initial radiological modalities use in assessing the patient at the emergency after clinical assessments. CT scan was used to rule out intracranial hemorrhage while CTA was used to detect the BA and VA occlusions. Nevertheless, magnetic resonance diffusion weighted image is often the “gold standard” radiological modality for the detection of ischemic changes in patients with LVO in the posterior circulation[5, 33]. Intraoperatively, utilized angiographies to confirm occlusions as well as assess patency of distal vasculars.

The NIHSS is a beneficial as well as realistic means of assessing stroke patients[5, 34]. It is devised to evaluate stroke symptoms associated with the anterior circulation with more emphasis on the limb as well as speech impairments and less focus on cranial nerve symptomatology[5, 35]. Nevertheless, patients with LVO in the posterior circulation can have an NIHSS score of 0, with symptoms like headache, vertigo, as well as nausea only in prodromal period. Furthermore, the baseline NIHSS signify a clinical evaluation of the collateral state as well as thrombus severity[5, 19]. Thus, low NIHSS score at admission could be due small thrombus or good collaterals leading to good outcomes after MT[5]. Gory et al observed that, patients who present with a

high NIHSS had poorer prognosis compared to patients with mild-to-moderate deficit at the time of treatment notwithstanding recanalization and thus, they proposed an NIHSS cutoff value of 13[36]. Our study revealed that, the average NIHSS score before operations was 15.3 while the average NIHSS score one week after the operations was 4.5. Thus, there was significant improvement in outcome comparing the NIHSS before operations to the NIHSS one week after the operations. Our findings are therefore consistent with early studies above.

Solitaire thrombectomy for acute ischemic stroke treatment is instinctively practical, very auspicious, and already used in several institutions[37–39]. Miteff et al revealed that, Solitaire thrombectomy attained a high rate of recanalization which translated into good prognosis patients with acute strokes caused by proximal occlusion within the cerebral arteries[37]. Using Solitaire AB, Luo et al achieved an overall recanalization rate of 89.9% and 36.2% of their patients achieved favorable outcome at 90 days[8]. Also, studies have shown that, averagely, about 81% of patients often attain recanalization rate with about 30% attaining favorable outcomes at 90 days[13, 37, 40]. We used Solitaire AB or FR to treat 17 patients with BAOs and VAOs and attained 70.6% recanalization rate with over all good prognosis of 58.8% at 90 days which is comparable to early studies above. The average number of thrombi removed in our case series was 3.

Luo et al indicated that, collateral status before MT as well as baseline NIHSS score were independent predictors of mortality at 90 days in patients with acute posterior circulation stroke who underwent Solitaire AB thrombectomy[8]. Studies have shown that, reperfusion time is one of the key predictors of good prognosis in the anterior circulation as well as posterior circulation strokes[5, 12–14, 41]. Nevertheless, other studies did not find any link between reperfusion time and good prognosis in the posterior circulation strokes[5, 19, 42, 43]. Baik et al observed poor outcome despite the good recanalization rate may be because of the longer procedural time[18]. We did not find any significant correlation between time from femoral artery puncture/access to recanalization and prognosis. Furthermore, we did not find any significant correlation between time from admission to onset of femoral artery puncture/access and prognosis.

Baik et al observed a mortality rate of 21%[18]. Luo et al observed a mortality rate of 24.6% at 90 days[8]. Similar studies observed mortality rates ranging from 21–33% at 90 days[5, 22, 30, 31]. We observed a mortality rate of 23.53%. We did not observe any significant difference in mortality between patients with BAO and VAO. We anticipated better prognosis and less or no mortality in patients VAOs because the VA are two and the patent one could compensate the occluded one as compare to BAO. Comparatively, MT often results in higher recanalization rates than t-PA therapy, but better outcomes with MT are not always exhibited [12, 18, 44]. Our study had limitations because it was a retrospective type with small case series which does not allow for satisfactory conclusions because detailed statistical analysis could not be perform in most variables. Also, the study was conducted in a single hospital. Thus, prospective studies with large samples and several hospitals are warranted to arrive at satisfactory conclusions.

## Conclusion

We observed significant improvement in outcome comparing the NIHSS before operations to the NIHSS one week after the operations. Thus, Lower NIHSS score before MT could be a good prognostic factor. We attained 70.6% recanalization rate with over all good prognosis of 58.8% at 90 days which is comparable to early

studies. An average time of about 5.5 hours from patients' arrival to recanalization with 70.6% recanalization rate with over all good prognosis of 58.8% at 90 days means that, patients who operations are carried out within 5 hours still have hope for recanalization compared to initial 1.5 hours average time for recanalization.

## Abbreviations

Acute ischemic stroke = AIS, Basilar artery = BA, Basilar artery occlusion = BAO, Computer tomography = CT, Computer tomographic angiography = CTA, Large vessel occlusions = LVO, Modified Rankin Scale = mRS, Mechanical thrombectomy = MT, National Institutes of Health Stroke Scale = NIHSS, Tissue plasminogen activator = t-PA, Thrombolysis in cerebral infarction = TICI, Vertebrobasilar artery occlusions = VBAO, Vertebral arteries = VA, Vertebral artery occlusion = VAO.

## Declarations

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**Availability of Data:** The data used in this paper is not publicly available but will be made available on reasonable demand from the corresponding author because of patients' confidentiality.

**Author contributions:** Study concepts and design: XY, YF, JJ, ZX, WM and SAR; Data acquisition and follow-up: XY, YF, JJ, ZX, WM and SAR; Statistical analysis: XY, YF, JJ, ZX, WM and SAR; Manuscript preparation: SAR; Manuscript editing XY, YF, JJ, ZX, WM and SAR. All authors carefully reviewed the manuscript and approved the final version.

**Ethics approval and consent to participate:** This study was approved by the Ethic Committee of Jiangyin Hospital and written informed consent was obtained from all participants. All methods were performed in **accordance** with the relevant guidelines and regulations.

**Consent for publication:** Not applicable

**Competing interests:** All the authors have no competing interest to disclose.

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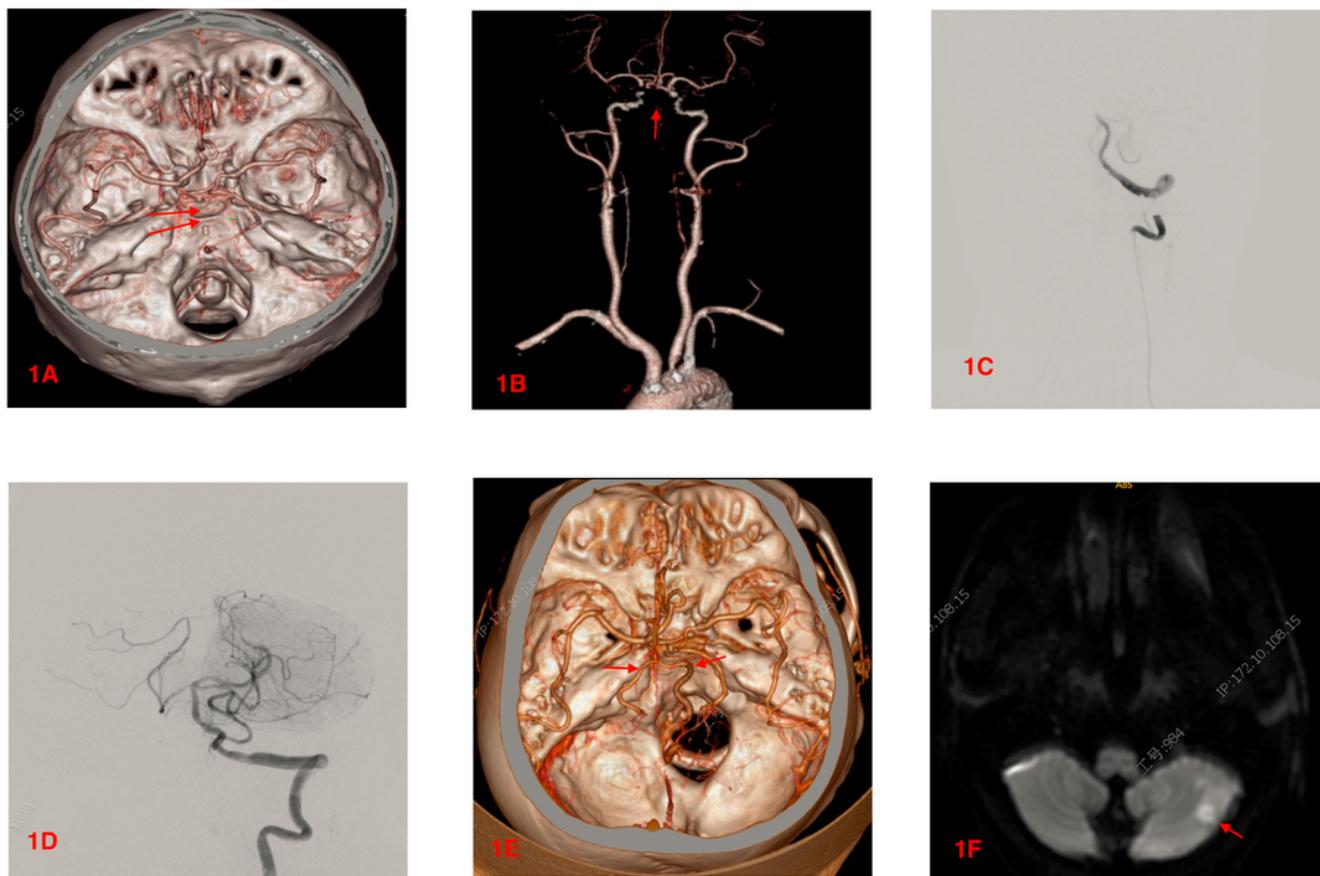
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## Figures



**Figure 1**

Are pre-, intra- and postoperative images of one on the patients with Basilar artery stenosis.

**A&B:** Are preoperative CTA images showing now no basilar artery. Red arrow = No basilar artery.

**C:** Is an intraoperative DSA showing acute occlusion of the basilar artery.

**D:** Is an intraoperative DSA after thrombectomy showing recanalization of the basilar artery.

**E:** Is a Postoperative CTA showing the recanalized basilar artery. Red arrows = basilar artery.

**F:** Is a postoperative MRI showing an acute infarct in the cerebellar hemisphere. Red arrows = infarction

