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Effect of supraglottic airway devices versus endotracheal intubation general anesthesia on outcomes in patients undergoing mechanical thrombectomy

A prospective randomized clinical trial

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Abstract

Background: There are still controversies about the optimal anesthesia protocol for patients with acute ischemic stroke (AIS) undergoing mechanical thrombectomy (MT). The aim of this study was to explore the effect of supraglottic airway device (SAD) versus endotracheal intubation (EI) general anesthesia on clinical and angiographic outcomes in patients with AIS undergoing MT.

Methods: One hundred sixteen patients with large-vessel occlusion stroke were randomized to receive either SAD or EI general anesthesia. The primary outcome was the rate of occurrence of >20% fall in mean arterial pressure (MAP). Secondary outcomes included hemodynamics, successful recanalization, time metrics, satisfaction score of neurointerventionalist, number of passes performed, the conversion rate from SAD to EI, the National Institutes of Health Stroke Scale score, and Alberta Stroke Program Early CT Score before and 24 hours after surgery, length of stay in the stroke unit and hospital, complications and functional independence at discharge, and 90 days after stroke.

Results: Both the lowest systolic blood pressure and lowest diastolic blood pressure were significantly lower in the EI group ($P = .001$). The consumption of vasoactive agents, the occurrence of >20% reduction in MAP and time spent with >20% fall in MAP were significantly higher in the EI group ($P < .05$). Compared with the EI group, the time for door-to-puncture was significantly shorter in the SAD group ($P = .015$). There were no significant differences with respect to puncture-to-reperfusion time, number of passes performed, rates of successful recanalization, National Institutes of Health Stroke Scale score, and Alberta Stroke Program Early CT Score 24 hours after surgery. The satisfaction score of neurointerventionalist was significantly lower in the EI group ($P = .043$). Conversion rate from SAD to EI was 7.41%. There were no significant differences with respect to complications, mortality, and mean Modified Rankin Scale scores both at discharge and 90-day after stroke. However, length of stroke unit and hospital stays were significantly shorter in the SAD group ($P < .05$).

Conclusion: AIS patients undergoing MT with SAD general anesthesia led to more stable hemodynamics, higher satisfaction score of neurointerventionalist, shorter door-to-puncture time, length of stroke unit, and hospital stay. However, there were no significant differences between the 2 groups on the angiographic and functional outcomes both at discharge and 90 days after stroke.

Abbreviations: AIS = acute ischemic stroke, ASA = American society of anesthesiologists, ASPECTS = alberta stroke program early CT score, CS = conscious sedation, EI = endotracheal intubation, GA = general anesthesia, LA = local anesthesia, LVO = large-vessel occlusion, MAC = monitored anesthesia care, MAP = mean arterial pressure, mEICI = Modified Thrombolysis in Cerebral Infarction, mRS = modified rankin scale, MT = mechanical thrombectomy, NIHSS = national institutes of health stroke scale, SAD = supraglottic airway device, S_PO_2 = blood oxygen saturation.

Keywords: acute ischemic stroke, endotracheal intubation, general anesthesia, mechanical thrombectomy, supraglottic airway devices

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The data analyzed in this article are not publicly available. Information will be available on request to the corresponding author by email.

The study was approved by Institutional Review Board of Liaocheng People's hospital. The study was one part of the overall project which has been registered at chictr.org (ChiCTR-IPR-16008494). Informed consent was obtained from capable patients or their legal representatives.

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1. Introduction

Acute ischemic stroke (AIS) due to large-vessel occlusion (LVO) is a leading cause of long-term disability and mortality around the world, especially in aging societies such as China.[1] The traditional therapeutic time window is limited to 4.5 hours after the onset of stroke by intravenous thrombolysis. In addition, there are a significant proportion of patients who present contraindications to intravenous thrombolysis such as taking oral anticoagulants.[2,3]

Mechanical thrombectomy (MT) has been one of the standard surgical treatment approaches for AIS patients especially with LVO.[4] Studies have suggested that anesthetic management during MT may have a substantial effect on the patient's clinical outcome.[5,6] However, a subset of patients does not experience ideal clinical outcomes despite successful recanalization (Modified Thrombolysis in Cerebral Infarction [mEICI] ≥2b), which suggests that the outcome after AIS is determined by many factors.[7,8] Among which, time from stroke onset to recanalization has been considered crucial for salvaging the ischemic penumbra and improving the neurological outcomes. As a result, an important component of the optimal anesthesia scheme is to start MT as quickly and safely as possible.[9,10]

General anesthesia (GA), conscious sedation (CS), local anesthesia (LA), and monitored anesthesia care (MAC) are the most common anesthesia regimens during MT. However, the optimal anesthetic management of AIS patients undergoing MT remains controversial.[11] Potential advantages of GA include improved control of the airway and a reduction in patient movement. The disadvantages of GA include the increased delay time and fluctuation of hemodynamics which could impair cerebral perfusion.[12] CS, LA, and MAC may be associated with less time metrics, fewer hemodynamic fluctuations, and ability to assess neurological function during the procedure. However, patients with excessive uncontrolled movements and loss of airway control are the most common reasons for converting to GA during MT.[13–15] GA with supraglottic airway device (SAD) may reduce both the patient movement and fluctuation of hemodynamics. As a result, it might be a valid compromise among endotracheal intubation (EI) GA, CS, LA, and MAC in the management of AIS patients undergoing MT especially for fasted patients.[16,17] However, there has been no relevant prospective study investigating the effect of GA with SAD in AIS patients undergoing MT. This study was to explore the effect of SAD versus EI GA on clinical and angiographic outcomes in AIS patients undergoing MT.

2. Methods

2.1. Patients

The study was approved by Institutional Review Board of Liaocheng People's hospital. The study was one part of the overall project which has been registered at chictr.org (ChiCTR-IPR-16008494). Informed consent was obtained from capable patients or their legal representatives. All findings are reported in accordance with the Consolidated Standards of Reporting Trials guidelines.

Patients were recruited between August 2018 and December 2020 if they met the following criteria: American Society of Anesthesiologists (ASA) grades I to III; fasted; National Institutes of Health Stroke Scale (NIHSS) score ≤ 10; ≥50 years; suitable for MT up to 6 hours from onset of stroke; received intravenous rt-PA; and arterial occlusion in the anterior circulation (carotid artery, M1 or M2 segments of the middle cerebral artery, or anterior cerebral artery). Patients were excluded if the presented prestroke modified Rankin Scale (mRS) score > 2, intracranial hemorrhage, a difficult airway, hypoxemia due to aspiration and regurgitation (blood oxygen saturation [SpO_2] < 90%), or body mass index >30 kg/m^2. Among 116 patients, 24 (20.69%) patients were admitted to our centers from other hospitals and 92 (79.31%) patients were directly admitted to our centers. Patients were parallel, simple randomized with an allocation ratio of 1:1 into the 2 groups using sealed, opaque envelopes generated by a computer randomization list with an independent nurse anesthetist.

2.2. Intervention

GA has been the standard practice for AIS patients undergoing MT at our centers according to the results of a previous study since 2018.[18] All patients receive ASA standard monitoring included electrocardiography , heart rate , noninvasive BP, SpO_2, end tidal partial pressure of carbon dioxide, and bispectral index. BP was recorded at 3-minutes intervals.[19] Patients in the EI group were induced with 1 to 2 mg/kg propofol, 1 to 2 μg/kg fentanyl, and 0.2 mg/kg cisatracurium, while patients in the SAD (ATB11–3.0/4.0, Jiancheng Medical Technology Co, Ltd, Zhejiang, China) group were induced with 1 to 2 mg/kg propofol, 1 to 2 μg/kg fentanyl without any muscle relaxants. Anesthesia was then maintained with sevoflurane, remifentanil, and dexmedetomidine based on both bispectral index (40–60) and hemodynamics. All patients were maintained normocapnia with end tidal partial pressure of carbon dioxide levels of 35 to 40 mm Hg and the head was immobilized with a standard cervical collar. Systolic BP (SBP) was controlled between 140 and 180 mm Hg and diastolic BP was controlled to < 105 mm Hg before successful recanalization (mEICI ≥2b) with both intravenous fluid and vasoactive agents according to the recommendations of the Society for Neuroscience in Anesthesia and Critical Care Expert Consensus Statement. SBP was maintained between 140 and 180 mm Hg if patients had not achieved successful recanalization. SBP was maintained between 100 and 140 mmHg to avoid hyperperfusion and intracranial hemorrhage after successful recanalization, while mean arterial pressure (MAP) was maintained ≥70 mm Hg at all times.[19] All patients were extubated in the intervention room and then transferred to the specialized stroke care unit as recommended by the American Heart Association/ASA.[20] Computed tomography scans were routinely obtained 6 hours after MT.

2.3. MT procedure

MT procedures were carried out by the experienced neurointerventionalists as in our previous study.[18] The MT approach was decided at the discretion of the neurointerventionalist based on the occlusion site, vascular tortuosity, and clot burden. In brief, a 5-F femoral sheath was introduced into the right femoral artery with Seldinger technique after local infiltration with 2% lidocaine. After cerebral digital subtraction angiography confirmed the site of occlusion, a 6-F or 8-F femoral sheath was used to replace the 5-F femoral sheath. A microcatheter was then placed in the artery distal to the thrombus, and the MT device (tent retriever, aspiration, or a combination of both) was deployed distal to the thrombus. Both the MT device and microcatheter were removed through the guide catheter and suction was applied during withdrawal. All patients were assessed for procedural complications in the end of MT with computed tomography scans.

2.4. Outcomes

The primary outcome was the rate of occurrence of >20% fall in MAP. Secondary outcomes included hemodynamics (recorded at the following time points: arrival at room (T0); immediately after EI/SAD (T1); 1 minutes (T2), 3 minutes (T3), 5 minutes (T4), 10 minutes (T5) after EI/SAD; extubation (T6); 1 minutes (T7), 3 minutes (T8), 5 minutes (T9), 10 minutes (T10) after extubation), successful recanalization (mEICI ≥ 2b; 0, no reperfusion; 1, penetration of affected vascular territory with minimal reperfusion; 2a, reperfusion of <50% of the territory of the occluded vessel; 2b, reperfusion ≥50% but slower than expected filling of the territory of the occluded vessel; 3, complete reperfusion),[21] time metrics (stroke onset-to-door, door-to-puncture, and puncture-to-reperfusion), satisfaction score of the neurointerventionalist (10-point scale: 0, poorest; 10, excellent), number of passes performed, the conversion rate from SAD to EI, NIHSS score and Alberta Stroke Program Early CT Score before and 24 hours after surgery, functional independence assessed at 90-day after MT (mRs score ≤ 2: 0, no symptoms; 1, no significant disability; 2, slight disability; 3, moderate disability; 4, moderately severe disability; 5, severe disability; 6, death),[22] length of stroke unit and hospital stays, mortality at discharge, and 90-day after stroke and complications.[23] All the postoperative dates were recorded by a blinded nurse of the acute pain service team.

2.5. Sample size

Sample size was calculated to provide 80% power ($\alpha = 0.05$, $\beta = 0.2$) to detect a difference of 10% in the rate of occurrence of >20% fall in MAP according to our preliminary study (PASS 11.0; NCSS Statistical Software, Kaysville, UT). This calculation indicated that 52 patients were required in each group. Assuming a dropout rate of 10%, at least 58 patients were recruited in each group.

2.6. Statistical analysis

Statistical analysis was performed with SPSS for Windows version 22.0 (SPSS Inc, Chicago, IL). The Kolmogorov–Smirnov and Levene tests were used to assess data distribution and homogeneity of variance. Continuous data were expressed as mean and standard deviation or median and interquartile range. Repeated-measures analysis of variance was performed between the 2 groups. The Kolmogorov–Smirnov Z test was used if continuous data were not normally distributed. Categorical data were expressed as frequency and percentage and analyzed using χ^2 tests or Fisher exact tests when appropriate. $P < .05$ was considered statistically significant.

3. Results

3.1. Patient baseline characteristics

Figure 1 illustrated the patient enrolment according to the consolidated standards of reporting trials diagram. In total, 239 patients undergoing MT for AIS were recruited between August 2018 and December 2020. Of these, 123 patients were excluded: 67 patients with prestroke mRS score >2; 21 patients with intracranial hemorrhage; 6 patients with difficult airway; 14 patients with hypoxemia ($SpO_2 < 90\%$); 15 patients with the body mass index >30 kg/m^2. One hundred sixteen patients were divided into 2 groups, among which 10 patients were excluded because lost-to-follow-up (6 patients in the EI group, 4 patients in the SAD group). Ultimately, 52 patients were recruited in the EI group and 54 patients were recruited in the SAD group. Patients' baseline demographic and radiographic characteristics were comparable between the 2 groups ($P > .05$, Table 1).

3.2. Hemodynamics

Compared with the EI group, both heart rate and MAP were significantly lower from T1 to T3 and from T6 to T10 in the SAD group ($P < .05$, Fig. 2). Both lowest SBP and lowest diastolic BP before successful recanalization were significantly lower in the EI group ($P = .001$, Table 2). The consumption of vasoactive agents, the occurrence of >20% fall in MAP and time spent with >20% fall in MAP were significantly higher in the EI group ($P < .05$, Table 2).

3.3. Procedure time metrics

Compared with the EI group, time of door-to-puncture was significantly shorter in the SAD group ($P = .015$, Table 2). However, the puncture-to-reperfusion time was comparable between the 2 groups ($P = .248$, Table 2). There were no significant differences in terms of rates of successful recanalization, time of stroke onset-to-door, and the number of passage attempts during the MT ($P > .05$, Table 2). The conversion rate from SAD to EI was 7.41% (Table 2).

3.4. Postoperative date

There were no significant differences between the 2 groups with respect to the mean mRS scores at discharge and 90-day after stroke rate, NIHSS score and Alberta Stroke Program Early CT Score at 24 hours after surgery ($P > .05$, Table 3). The satisfaction score of neurointerventionalist was significantly lower in the EI group ($P = .043$, Table 3). Mortality rates at discharge and 90-day after stroke were comparable between the 2 groups although the length of stroke unit stay and hospital stay were significantly shorter in the SAD group ($P < .05$, Table 3). There was no statistical difference with respect to postprocedural asymptomatic or symptomatic intracranial hemorrhage or procedural and anesthetic complications between the 2 groups ($P > .05$, Table 4).

4. Discussion

In this prospective randomized study, AIS patients undergoing MT with SAD GA led to more stable hemodynamics, higher satisfaction score of neurointerventionalist, shorter door-to-puncture time, length of stroke unit, and hospital stay. However, there were no significant differences between the 2 groups on the angiographic and functional outcomes both at discharge and 90 days after stroke.

Our study only recruited patients with minor or mild stroke (NIHSS ≤ 10) as a previous study reported that AIS with a low NIHSS score appeared to be accompanied with LVO and patients more likely to experience poorer functional outcomes

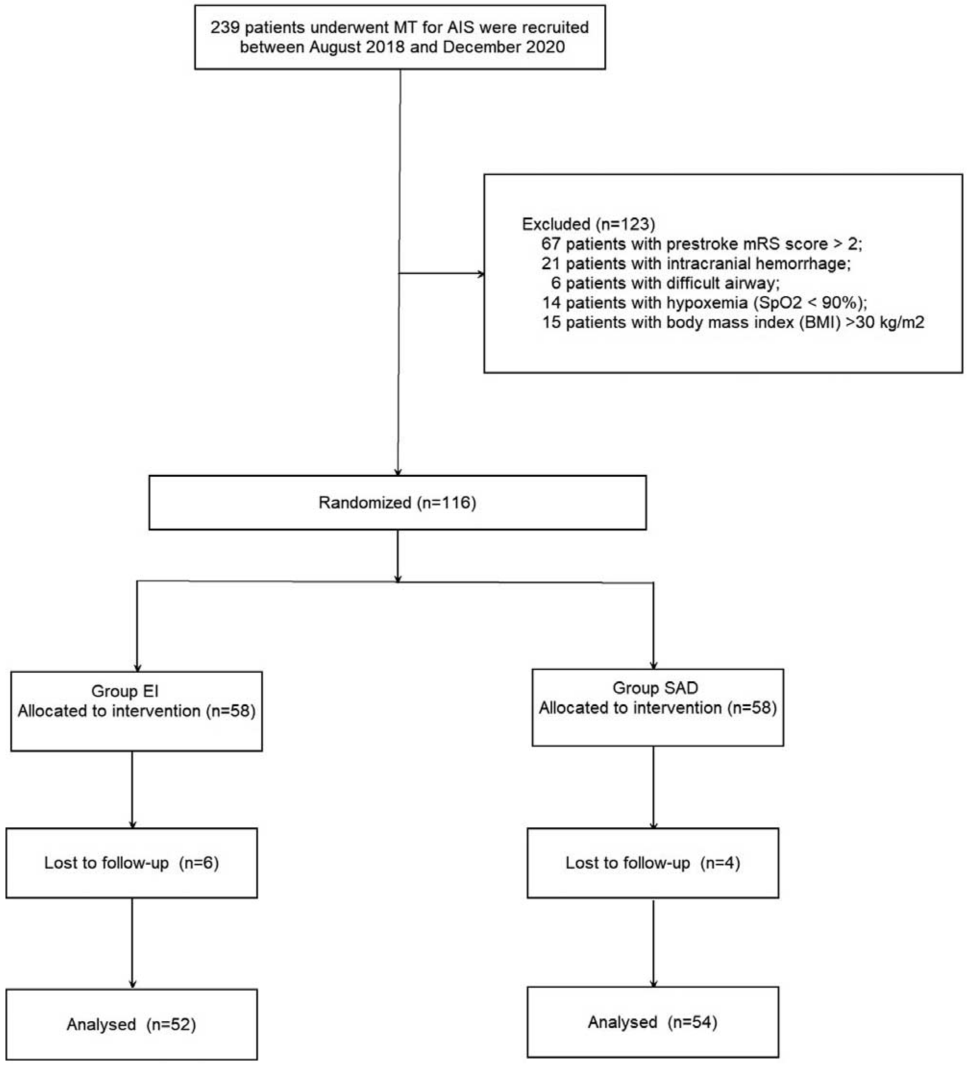

Figure 1. Patient enrollment flow diagram.

and higher rate of mortality if not treated in time.[24] A previous meta-analysis suggested that close monitoring, strictly controlling hemodynamics, and a trained team consisting of a vascular neurologist, neuroradiologist, and anesthesiologist may be more important than the choice of agents and anesthetic technique.[25] However, the optimal anesthesia method is equally important during MT for there are still great difficulties in some clinical applications such as how to avoid radiation and minimize the number of operation interruptions. One of the most important requirements of patients undergoing MT was a stable head position, which is commonly subjected to movements during balloon inflation and wire manipulation. Even tiny movements of the head can affect visibility of cerebral vessels, increase the risk of complications, and eventually increase the procedural time, and even lead to intracranial hemorrhage.[26] Thus, GA may be considered one of the most common anesthetic approaches for improving control of the airway and reducing patient movements.

Previous systematic reviews and meta-analysis indicate that AIS patients who received GA experienced worse functional outcome and higher rates of mortality and respiratory complications compared with patients in the CS group.[27] A main reason is the delay in time metrics in the GA group, whereby each hour of delay in door-to-puncture times was associated with a 19% reduction in good functional outcomes.[28] However, reliability of these results may be limited by selection bias, intervention heterogeneity, and use of different generation thrombectomy devices. More importantly, the duration and impact of this delay varies between different stroke centers. Recently, 3 RCTs with 368 patients have shown that GA achieved a slight superiority over CS in terms of higher rates of successful recanalization at 24 hours and functional independence at 90 days after AIS. At the same time, mortality and symptomatic intracranial hemorrhage were similar between the 2 groups.[29–31] Several factors such as an experienced stroke team and emergency room management may contribute to the shorter recanalization times. The anesthesia team is available 24 hours per day in our hospitals and they are present 30 minutes before patients arrive at the emergency department. This may minimize the delay for patients who are to receive GA.[32] As a result, we favor GA as the main anesthesia protocol at our centers. A prior study found that delays mainly occurred at

Table 1

Baseline demographic and radiographic characteristics between the 2 groups.

Variable	Group EI (n=52)	Group SAD (n=54)	*P* values
Age (yrs)	63.37±5.93	65.22±6.05	.115
Sex (male/female)	33/19	29/25	.308
Body weight (kg)	67.78±5.72	70.36±8.57	.067
BMI (kg/m^2)	23.52±4.52	24.31±5.46	.416
NIHSS	7.87 (6.75–9.48)	8.34 (6.89–9.52)	.238
ASPECTS	12.67 (10.95–13.67)	12.04 (11.28–13.51)	.461
ASA I/II/III (n)	5/32/15	6/29/19	.715
Location (left/right)	38/14	35/19	.358
Comorbidity, n (%)			.949
Hypertension	18 (34.62%)	22 (40.74%)	
Diabetes	6 (11.54%)	5 (9.26%)	
Coronary heart disease	7 (13.46%)	8 (14.81%)	
Atrial fibrillation	6 (11.54%)	9 (16.67%)	
Hyperlipidemia	8 (15.38%)	7 (12.96%)	
Previous stroke	3 (5.77%)	2 (3.70%)	
Prestroke mRS, n (%)			.825
0	6 (11.54%)	5 (9.26%)	
1	24 (46.15%)	28 (51.85%)	
2	22 (42.31%)	21 (38.89%)	
Occluded segment, n (%)			.860
M1	20 (38.46%)	25 (46.30%)	
M2	9 (17.31%)	10 (18.52%)	
ICA	18 (34.62%)	16 (29.63%)	
ACA	3 (5.77%)	2 (3.70%)	
Tandem	2 (3.85%)	1 (1.85%)	

Variables presented as mean±SD, median (interquartile range) or number of patients n (%). ACA=anterior cerebral artery, ASA=American Society of Anesthesiology, ASPECTS=Alberta Stroke Program Early CT Score, BMI=body mass index, ICA=internal carotid artery, mRS=modified Rankin Scale, NIHSS=National Institute of Health Stroke scale.

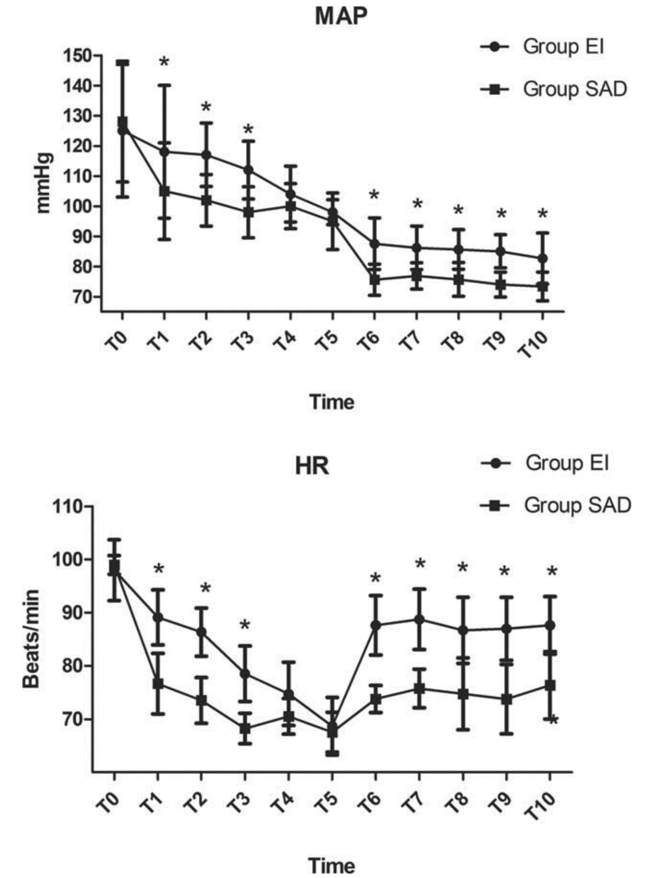

Figure 2. Comparison of hemodynamic changes between the 2 groups. *$P<.05$ vs group SAD. SAD = supraglottic airway device.

Table 2

Procedural time metrics and hemodynamics between the 2 groups.

Variable	Group EI (n=52)	Group SAD (n=54)	*P* values
Duration of surgery (min)	125.83±18.22	135.08±24.62	.063
Duration of anesthesia (min)	147.11±25.93	146.51±27.48	.809
Lowest SBP before successful recanalization (mm Hg)	117.84±23.87	135.24±13.45*	.001
Lowest DBP before successful recanalization (mm Hg)	67.81±12.92	87.61±14.59*	.001
Rate of occurrence of >20% fall in MAP, n (%)	15 (28.85%)	7 (12.96%)*	.044
Time spent with >20% fall in MAP (min)	17.31 (7.84–25.74)	7.63 (4.88–17.31) *	.001
Time of stroke onset-to-door (min)	255.84 (98.81–404.14)	275.92 (87.82–472.72)	.318
Time of door-to-puncture (min)	12.47±4.62	8.53±3.23*	.015
Time of puncture-to-reperfusion (min)	35.62 (15.04–48.53)	28.94 (16.74–54.11)	.248
Successful recanalization (mTICI≥2b), n (%)	45 (86.54%)	46 (85.19%)	.842
Consumption of vasoactive agents, n (%)			.044
Atropine	7 (13.46%)	4 (7.41%)	
Ephedrine	12 (23.08%)	8 (14.81%)	
Phenylephrine	32 (61.54%)	9 (16.67%)	
Urapidil	9 (17.31%)	4 (7.41%)	
Number of passage attempts, n (%)			.533
1st	19 (36.54%)	15 (27.78%)	
2nd	22 (42.31%)	28 (51.85%)	
3rd	7 (13.46%)	6 (11.11%)	
>3rd	4 (7.69%)	5 (9.26%)	
Convert to EI, n (%)	–	4 (7.41%)	–

Variables presented as mean±SD, median (interquartile range) or number of patients n (%). DBP=diastolic blood pressure, MAP=mean arterial pressure, mTICI=modified Thrombolysis in Myocardial Infarction, SBP=systolic blood pressure, TI=tracheal intubation.

* $P<.05$ vs group EI.

Table 3

Postoperative variables between the 2 groups.

Variable	Group EI (n = 52)	Group SAD (n = 54)	*P* values
Neurointerventionalist satisfaction score	8.35 (7.67–9.35)	9.16 (8.06–9.76)*	.043
length of stroke unit	2.23 (1.27–3.42)	1.37 (0.78–2.31) *	.022
length hospital stay	12.58 (7.60–15.62)	9.31 (7.62–13.52) *	.032
NIHSS at 24 h postintervention	6.65 (5.34–9.24)	6.94 (4.82–9.41)	.759
ASPECTS at 24 h postintervention	13.26 (10.51–13.87)	12.87 (10.22–13.35)	.162
Mortality, n (%)			
At discharge	5 (9.62%)	2 (3.70%)	.266
90-d after stroke	6 (11.54%)	2 (3.70%)	.157
Mean mRS score, n (%)			
At discharge	1.26 (0.53–1.76)	1.35 (0.45–1.83)	.506
90-d after stroke	1.09 (0.35–1.64)	1.15 (0.54–1.76)	.683

Variables presented as median (interquartile range) or number of patients n (%). ASPECTS = Alberta Stroke Program Early CT Score, mRS = modified Rankin Scale, NIHSS = National Institute of Health Stroke scale.
* $P < .05$ vs group EI.

initiation of MT even with the fast-track intubation protocol.[33] To further shorten this delay to GA, we have adopted the protocol of GA with SAD since 2017, which is likely faster than GA with EI because of the shorter anesthesia induction time. Door-to-reperfusion time was ultimately equivalent between the 2 groups though door-to-groin puncture time was significantly shorter in the SAD group. These differences may be due to both the relatively longer door-to-reperfusion time during MT and the well-organized workflow of the scheme of GA with EI. In our study, door-to-reperfusion time was longer than previous study, which may be attributed to the fact that the occurrence of in situ thrombus is much more common among Asians and given the tertiary referral nature of our region there is a higher incidence of atherosclerosis.[34]

One crucial aspect of MT is how to minimize the influence anesthesia on the timely reperfusion of occluded blood vessels. Recently, GA with SAD has been applied in the interventional neuroradiology procedures given its hemodynamic stability, especially during induction and end of anesthesia.[35] Previous studies reported that even slight BP fluctuations before recanalization may be harmful in patients with AIS for whom cerebral blood flow is highly dependent on cerebral perfusion pressure and cerebral autoregulation is seriously damaged during MT.[36,37] We recorded both stable hemodynamics and higher lowest diastolic blood pressure and lowest systolic blood pressure during MT in the SAD group in our study as well as less consumption of vasoactive agents. Previous studies have reported that lower periprocedural lowest diastolic blood pressure, high BP variability, and higher cumulative dose of norepinephrine were independently associated with poorer outcome because of its deleterious impact on the collateral circulation with no improved blood flow to the ischemic penumbra.[38,39] Inconsistent with the results of previous studies was that we observed the infarct volume was similar at 24 hours after surgery. Besides, both mortality at discharge and good clinical outcome at 90 days after stroke were similar between the 2 studies, which may be due to the differences in recruited patients, targeted blood pressure control, and vasopressors adopted between the 2 studies. MAP was adopted in our study for it is the most used BP parameter during MT and is associated with intracranial pressure and cerebral perfusion.[40–42] Ischemia and reperfusion injury induce the production of both inflammatory cytokines and pro-inflammatory cytokines in animal models which may be detrimental on functional outcomes.[43] However, there was no significant difference in terms of the functional outcome both at discharge and at 90 days after stroke, although hemodynamics were more stable in the SAD group. The explanation may lie with other mechanisms that could influence the functional outcomes of patients with AIS, such as activation of microglia, macrophages, or peripheral leukocytes, and integrity and functionality of the blood-brain barrier.[44]

Volatile anesthetics were used to maintain the depth of anesthesia in this study as previous studies have reported that sevoflurane can potentially offer neuroprotective benefits on ischemic brain tissue in animal models up to 2 to 4 weeks after ischemia.[45] The possible mechanisms include inhibition of excitatory glutamatergic neurotransmission, ischemia-induced intracellular calcium release and the brain's metabolism, potentiation of inhibitory GABAergic neurotransmission, and antioxidant activity.[46] In addition, a previous study found that patients receiving volatile anesthetics achieved functional independence after controlling for BP variation.[43] Our study recruited patients up to 6 hours from onset of stroke as a previous study reported that patients subjected to MT with CS in the extended time window (6–16 hours after onset of stroke)

Table 4

Postoperative adverse effects of patients between the 2 groups.

Variable	Group EI (n = 52)	Group SAD (n = 54)	*P* values
Procedural complications	4 (7.69%)	6 (11.11%)	.742
Symptomatic intracerebral haemorrhage	5 (9.62%)	5 (9.26%)	1.000
Asymptomatic intracerebral haemorrhage	13 (25.00%)	15 (27.78%)	.827
Anesthetic complications	2 (3.85%)	3 (5.56%)	1.000

Variables presented as number of patients n (%).

experienced a higher likelihood of functional independence at 90 days and a lower NIHSS score at 24 hours compared with patients with GA.[47]

Previous studies have reported that SAD can be used safely without gastric tube implantation even with positive-pressure ventilation at volumes of less 10 mL/kg and ventilation pressures lower than 20 cm H_2O with duration longer than 120 minutes.[48] However, all AIS patients were placed a gastric tube immediately after SAD placement for both fixing the laryngeal mask and prevention of aspiration by gastrointestinal decompression. In our study, 4 (7.41%) patients in the SAD group still needed to convert to tracheal intubation during surgery (2 patients with air leak, and 2 patients with increased airway pressure because of excessive secretion and aspiration). However, the neurointerventionalist satisfaction score was significantly higher in the SAD group partly because of the reduced delay to puncture. Furthermore, the length of stay at both the stroke unit and hospital was significantly shorter in the SAD group. As a result, it is reasonable to favor GA with SAD during MT for anterior AIS-LVO when immediate conversion to GA with EI is possible. Previous studies have reported that anesthetic complications, such as aspiration and mechanical ventilation, were associated with postprocedural pneumonia. Contrary to a previous study, the incidence of both anesthetic and procedural complications was significantly reduced partly because our study sample included patients with fasted, minor or mild stroke, smaller sample size, and shorter mechanical ventilation in our study.[31] The incidence of symptomatic intracerebral hemorrhage and asymptomatic intracerebral hemorrhage were also similar between the 2 groups. Observational studies may be more appropriate to evaluate safety because of the possibility of larger sample sizes.

Our study had following limitations. First, procedural anesthesia management required a trained team composed of a vascular neurologist, neuroradiologist, and anesthesiologist, which may limit the generalizability of this study for some grass-roots hospitals. Second, hemodynamic variables were documented at 3-minutes intervals in this study as in a previous study, which may have resulted in missing more significant hemodynamic fluctuations.[18] Third, because of the obviously different in appearance between supraglottic airway devices and endotracheal intubation, we did not adopt the completely blind method in this study which might be selection bias. The results of this study need to be confirmed in larger randomized controlled studies.

5. Conclusions

AIS patients undergoing MT with SAD general anesthesia led to more stable hemodynamics, higher satisfaction score of neurointerventionalist, shorter door-to-puncture time, length of stroke unit, and hospital stay. However, there were no significant differences between the 2 groups on the angiographic and functional outcomes both at discharge and 90 days after stroke.

Author contributions

JZ, JJL, WCZ, GJX, and YYQ conceived and designed the trial; JZ, GJX, and YYQ collected the data; LL, and WCZ analyzed the data; JZ, JJL, WCZ, and YYQ wrote this paper. All authors have read and approved the manuscript.

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Data curation: Jingjing Liu.
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