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# Is Mechanical Embolectomy Performed in Nonanesthetized Patients Effective?

**BACKGROUND AND PURPOSE:** In centers performing endovascular treatment for patients with AIS, there is variability in placing patients under general anesthesia. Nonanesthetized patients might move during the procedure leading to complications and prolonging the time to revascularization due to lack of cooperation. However, general anesthesia can lead to a delay of the procedure, an inability to assess the patient during the procedure, and fluctuations of blood pressure. Our center does not routinely either use general anesthesia or sedate patients. We report our experience with nonanesthetized patients undergoing emergent mechanical embolectomy.

**MATERIALS AND METHODS:** We performed a retrospective analysis of 66 consecutive patients enrolled in the MERCI Registry at our center from June 2007 to June 2009. A univariate statistical analysis was performed by using the Fisher exact test for categorical variables and the Student *t* test for continuous variables in comparing use of general anesthesia with nonanesthetized patient demographics, procedural times, procedural complications, good outcome, and mortality.

**RESULTS:** Nine patients (13.6%) were placed under general anesthesia, and 57 (86.4%) were awake. Higher baseline NIHSS scores and older age were statistically associated with general anesthesia. No significant difference occurred between groups in the time to groin puncture or procedural times. Revascularization rates were 77% for general anesthesia patients and 70% for nonanesthetized patients ( $P = .331$ ). The nonanesthetized group had better outcomes, but we did not control these outcomes for other factors. Complications were much more frequent in the general anesthesia patients (22%) than in the nonanesthetized patients (3.5%) ( $P = .0288$ ).

**CONCLUSIONS:** Performing mechanical embolectomy in nonanesthetized patients at our institution does not prolong procedure time, decrease revascularization rates, increase complication rates, or decrease good outcome. Mechanical embolectomy in nonanesthetized patients is effective and should be considered an option in the treatment of the patient with AIS.

**ABBREVIATIONS:** AIS = acute ischemic stroke; AS = angiosuite; ED = emergency department; GA = general anesthesia; IQR = interquartile range; L = left; MCA = middle cerebral artery; MI = myocardial infarction; MERCI = Mechanical Embolus Removal in Cerebral Ischemia; mRS = modified Rankin Scale; NIHSS = National Institutes of Health Stroke Scale; TIMI = Thrombolysis in Myocardial Infarction

Endovascular treatments, including mechanical embolectomy and intra-arterial administration of thrombolytic agents, have been shown to be effective in vessel revascularization of patients with AIS in randomized trials.<sup>1</sup> Additionally, registries have examined how other factors such as a combination of endovascular treatment, patient demographics, vessel revascularization, and coadministration of pharmacologic agents affect clinical outcome.<sup>2-14</sup>

However, many questions still remain regarding the appropriate medical management of patients with AIS during endovascular treatment. For instance, in centers using mechanical embolectomy, there is variation in placing patients under general anesthesia. Nonanesthetized patients might move during the procedure, leading to complications or prolonging the time to revascularization and completeness of revascularization due to lack of cooperation. However, general anesthesia

can lead to delay of the procedure, inability to assess the patient during the procedure, and fluctuations of blood pressure. Our center does not routinely either use general anesthesia or sedate patients. Instead, we use a system of physical restraints to the head, wrists, and legs and occasionally light sedation (low-dose fentanyl or midazolam). We report our experience with nonintubated patients with AIS undergoing emergent endovascular treatment.

## Materials and Methods

After approval from our institutional review board, we performed a retrospective analysis of consecutive endovascular treatment cases in our center enrolled in the MERCI Registry from June 2007 to June 2009. Inclusion criteria were patients with AIS who underwent endovascular treatment within 8 hours from symptom onset.

From our prospectively collected institutional stroke data base, we retrieved and analyzed the following variables: demographics (de-identified), NIHSS score, intravenous tissue plasminogen activator usage, general anesthesia use, time to first groin puncture, location of the thrombus, technical aspects of the procedure (devices and pharmacologic agents used), length of the procedure, recanalization grade, time to revascularization, procedural complications, mortality, and 90-day outcome. The length of time from arrival in our emergency department to the first groin puncture defined the time to groin

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**Table 1: Characteristics of nonintubated and intubated patients treated with MERCI**

	Nonintubation (n = 57)	Intubation (n = 9)	P Value
Age (mean ± SD)	65.9 ± 15.5	78.3 ± 11.4	.025 <sup>a</sup>
Baseline NIHSS score (mean ± SD)	17.1 ± 7.4	28.3 ± 5.0	<.001 <sup>a</sup>
Internal carotid	22 (38.6%)	3 (33.3%)	.155
Middle cerebral	35 (61.4%)	5 (55.6%)	
Vertebrobasilar	0 (0.0%)	1 (11.1%)	
Good outcome	29 (50.9%)	1 (11.1%)	.033 <sup>a</sup>
Mortality	17 (29.8%)	5 (55.6%)	.147

<sup>a</sup>  $P < .05$ .

puncture. The time from arrival in the angiography suite to the last angiogram defined the total length of the procedure. Revascularization was graded by using the TIMI score. Patients with a TIMI score of 2 or 3 were defined as having successful revascularization.<sup>12</sup> Procedural complications were defined as vessel perforation or vessel dissection. A 90-day mRS score of 0–2 represented a good outcome.

A univariate statistical analysis was performed by using the Fisher exact test for categorical variables and the Student *t* test for continuous variables in comparing patients under general anesthesia with non-anesthetized patients. Additionally, univariate analyses were performed in a similar fashion comparing revascularization, dichotomized outcome (good versus poor), and mortality. Finally, the Wilcoxon rank sum test was used to compare median times.

## Results

A total of 66 patients, 39 men and 27 women, met inclusion criteria. The mean age for the entire cohort was  $68 \pm 15$  years with a median NIHSS score of 18.5 (mean, 19; range, 5–36). Successful revascularization was achieved in 75% of patients, with 45% of patients having a good outcome. The overall complication rate was 7%, and the overall mortality rate was 18%.

A total of 9 (14%) patients were placed under general anesthesia before the procedure. All general anesthesia patients were placed under general anesthesia for respiratory compromise either before arrival to the hospital or in the emergency department. Comparison of baseline characteristics among general anesthesia and nonanesthetized patients is outlined in Table 1. The general anesthesia patients were more likely to be older and have higher baseline NIHSS scores than the non-anesthetized patients.

There were no differences between groups in the time to groin puncture, the length of the procedure, or revascularization rates (Table 2). Good outcome was significantly better in the nonanesthetized patient group (50.9% versus 11.1%,  $P = .155$ ) but was not controlled for other factors. Mortality was not significantly different between groups (29.8% versus 55.6%,  $P = .147$ ). Procedural complications occurred in 2 patients in each group (Table 3).

## Discussion

The use of general anesthesia in endovascular procedures of patients with AIS is highly variable between interventionalists and institutions. Additionally, many of the current registries and previous trials do not have guidelines for the use of general anesthesia during endovascular treatment.<sup>2,3</sup> In our institution, the lack of general anesthesia does not adversely affect

patient outcome or procedural complications; in fact, our results are compatible with those reported in previous trials and in registry data.

For example, in Prolyse in Acute Cerebral Thromboembolism II, a prospective study to determine the clinical efficacy and safety of intra-arterial recombinant prourokinase in patients with acute stroke of <6 hours' duration caused by MCA occlusion, a 66% recanalization rate, 40% good outcome rate, and 25% mortality rate were reported.<sup>1</sup> In the Multi MERCI registry trial, a trial of thrombectomy in patients with large-vessel stroke treated within 8 hours of symptom onset, a 69.5% revascularization rate, 5.5% procedural complication rate, 36% good outcome rate, and 34% mortality rate were reported.<sup>2</sup> In the Penumbra Pivotal Stroke trial, an examination of the safety and effectiveness of the Penumbra System (Penumbra, Alameda, California) in the revascularization of patients presenting with AIS secondary to intracranial large-vessel occlusive disease, an 81.6% revascularization rate, 12.8% procedural event rate, 25% good outcome rate, and 33% mortality rate were reported.<sup>3</sup> Our revascularization rate in nonanesthetized patients of 70% (by MERCI criteria), procedural complications of 4%, good outcome of 50%, and mortality rate of 29% are compatible with these other studies.

Many of the effects of both the induction and recovery from general anesthesia on the ischemic brain and the outcome of patients with acute stroke are unknown. Some inhaled anesthetics, such as isoflurane, can lead to increases in intracranial pressure, while others can induce changes in the cerebral autoregulatory response to cardiac output, which is already impaired in the patient with AIS.<sup>13</sup> Furthermore, both the induction and recovery periods are often associated with severe variations in blood pressure and heart rate, which can further decrease cerebral perfusion.<sup>14,15</sup> In combination, these direct and indirect actions of anesthetic agents may have negative effects on the outcomes of patients with AIS.

Another disadvantage of general anesthesia in the patient with AIS is the time needed to induce anesthesia. When 1.9 million neurons are destroyed every minute, any delay is costly.<sup>16</sup> In our institution, there was not a significant difference between patients under general anesthesia and nonanesthetized patients; however, this may vary across institutions. Additionally, general anesthesia eliminates the ability to interact with the patient during the procedure, which may add an additional safety factor during endovascular treatment.<sup>17</sup> We were able to treat 86% of our patients with AIS with minimal or no conscious sedation, preserving our ability to gain useful information from the patient during our endovascular treatment. For example, because intracranial vessels are very sensitive to stretching, we could alter endovascular treatment techniques on the basis of the patient's pain level, to reduce the risk of vessel perforation and intracerebral hemorrhage. Additionally, we were able to constantly assess their neurologic status both during the procedure and in the immediate period following the procedure, the period of highest risk for vessel reocclusion. In the acutely worsening patient, this ability allowed us to quickly reassess arterial reocclusion or intracerebral hemorrhage and alter medical management, such as anticoagulation reversal and blood pressure control, immediately.

In the nonanesthetized patient with AIS, lack of coopera-

**Table 2: Endovascular treatment times and outcomes<sup>a</sup>**

	Nonintubation (n = 57)	Intubation (n = 9)	P Value
Median onset to ED arrival time (IQR)	106.0 (50.0–231.0)	70.0 (40.0–140.0)	.270
Median onset to AS arrival time (IQR)	235.0 (185.0–340.0)	250.0 (205.0–309.0)	.802
Median symptom onset to groin puncture time (IQR)	260.0 (212.0–372.0)	271.0 (237.0–335.0)	.802
Median time to groin puncture (IQR)	143.0 (105.0–174.0)	167.0 (120.0–195.0)	.504
Median time of procedure (IQR)	111.0 (80.0–147.0)	97.0 (75.0–109.0)	.583
Revascularization ( $\geq$ TIMI 2)	43 (70%)	6 (77%)	.331
Good outcome	29 (50.9%)	1 (11.1%)	.033 <sup>b</sup>
Mortality	17 (29.8%)	5 (55.6%)	.147

<sup>a</sup> All times are in minutes.<sup>b</sup>  $P < 0.05$ .**Table 3: Complications in patients with and without GA**

GA	Artery	Baseline NIHSS Score	Complication	Outcome
No	MCA	19	MCA rupture	mRS 2
No	MCA	28	MCA rupture	Death (stroke + M1)
Yes	MCA	28+	MCA rupture	Death (stroke)
Yes	Basilar	26	L subclavian dissection	mRS 4

tion during the procedure could be a major disadvantage, prolonging time to revascularization and leading to procedural complications. In our study, this was not the case, with no significant differences found in procedural times and with a lower percentage of procedural complications. This may be due to our use of a standard method of restraint placement, if needed, which helps significantly to decrease patient movement during endovascular treatment.

The major limitations of our study are retrospective analysis and nonrandomized enrollment. Also, our populations were quite small, and comparison groups were not equal because our patients who underwent general anesthesia were significantly older and had more severe strokes. Finally, many factors that affect clinical outcomes were not controlled for, such as patient comorbidities, difference in techniques among operators, patient collateral characteristics, and differences in medical management.

## Conclusions

Endovascular treatment in nonanesthetized patients with AIS in our institution is as effective as endovascular treatment in patients placed under general anesthesia, and our results equal those in national studies. Further prospective investigation should be conducted to better understand the effects of general anesthesia, or lack thereof, on clinical outcomes of patients with AIS undergoing endovascular treatment.

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