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Research Article

Hemorrhagic Complications of Mechanical Thrombectomy for Acute Ischemic Stroke: A Single-Center Study of Related Factors

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Abstract

Background: Mechanical thrombectomy (MT) is an effective treatment for acute ischemic stroke with large vessel occlusions (LVO). However, MT also carries a risk of hemorrhagic complications (HC). In this study, we analyzed factors associated with HC at a single center, with particular attention to intraoperative factors.

Methods: We identified 312 patients (193 males, 119 females) that underwent MT at our center. The average age was 75.2 years. Clinical and technical complications were retrospectively identified and related factors were extracted from surgical records and examined in relation to bleeding complications.

Results: Of all identified cases, 38 cases (14.5%) experienced HC. The HC group was older than the non-HC group (77.9 years vs. 74.8 year), although this difference was not statistically significant ($p = 0.158$). No significant associations were found between site of occlusion, infarct breakdown, National Institutes of Health Stroke Scale (NIHSS) score, Alberta Stroke Program Early computed tomography (CT) Score (ASPECTS), MT method, or time to recanalization factors. The modified Thrombolysis In Cerebral Infarction (mTICI) score showed a significantly large proportion of TICI 2B in the HC group and TICI 3 in the non-HC group.

Conclusions: The only factor associated with HC was the degree of recanalization, specifically mTICI 2B or less. Patients with a longer recanalization time-especially cases where the procedure was terminated at mTICI 2B-may require more rigorous postoperative management.

Keywords: Mechanical Thrombectomy; Hemorrhagic Complications; Modified Thrombolysis in Cerebral Infarction; Intraprocedural Bleeding; Post Thrombectomy Control

Abbreviations

MT: Mechanical Thrombectomy; HC: Hemorrhagic Complication, NIHSS: National Institutes of Health Stroke Scale, ASPECTS: Alberta Stroke Program Early CT Score, mTICI: Modified Thrombolysis in Cerebral Infarction, ICA: Internal Carotid Artery, BA: Basilar Artery, ICH: Intracerebral Hemorrhage, SAH: Subarachnoid Hemorrhage, BP: Blood Pressure, SICH: Symptomatic Intracranial Hemorrhage

Introduction

The effectiveness of mechanical thrombectomy (MT) for acute ischemic stroke with large vessels occlusion (LVO) is well established [1,2]. However, postoperative cerebral bleeding is a challenging adverse event and difficult to improve outcomes [3]. Prognosis after MT is related to early recanalization as well as postoperative management to avoid hemorrhagic sequela [4]. Vascular injuries due to the use of clot-retrievers or aspiration devices may also be responsible for hemorrhagic complications (HC), which cannot be ignored [5]. Detailed knowledge of these outcomes is essential for all stroke physicians. In this study, we analyzed factors associated with HC and reviewed the underlying pathophysiology and strategies for early recognition and treatment, with particular attention to intraoperative factors.

Materials and Methods

Clinical and technical complications were retrospectively collected for 312 patients (193 males, 119 females) treated at Saitama Medical University International Medical Center from April 2017 to March 2022. The average patient age was 75.2 years. The sample included 209 cardiogenic embolization cases, 78 atherothrombosis cases, 1 dissociation case, and 17 other cases. The site of occlusion was the internal carotid artery (ICA) in 84 cases (26%), proximal M1 in 58 cases (18%), distal M1 in 86 cases (27%), M2 in 45 cases (14%), and basilar artery (BA) in 25 cases (8%). MT was performed by stent retriever alone, aspiration [10], or a combination of both methods [11], according to the surgeon's judgment.

Intraoperative factors, such as National Institutes of Health Stroke Scale (NIHSS) score [6] at presentation, Alberta Stroke Program Early CT Score (ASPECTS) [7], various time factors from onset to reopening, modified Thrombolysis In Cerebral Infarction (mTICI) grading system [8], and MT method were examined. The major intracranial procedural complications were defined as symptomatic intracranial hemorrhage (SICH), subarachnoid hemorrhage (SAH), and vessel perforation [9]. A clinical or technical event was judged to be procedure- or treatment-related when there was a strong temporal relationship with the procedure. Related factors were extracted from surgical records and examined in relation to bleeding complications.

Statistical analysis was performed using SPSS (v28, IBM, USA). The chi-square test was used to explore the relationship between qualitative variables. The Mann–Whitney U test was used to compare differences between two independent groups when the dependent variable was either ordinal or continuous, but not normally distributed. Results with $p < 0.05$ were considered statistically significant.

Results

The HC group consisted of 38 cases (14.5%). The HC group had a higher mean age than the uncomplicated (non-HC) group (77.9 years vs. 74.8 years), but the difference was not statistically significant ($p = 0.158$). No significant association was found among site of occlusion, infarct breakdown, NIHSS, ASPECT, or time to recanalization factors. The mTICI score showed a significantly high number of TICI 2B in the HC group and TICI 3 in the non-HC group (chi-square test, $p < 0.001$). There were no significant differences in retrieval clot method. The complication rates by site of occlusion were as follows: ICA: 10 (11.9%), M1 proximal: 6 (10.3%), M1 distal: 7 (8.1%), M2: 8 (17.7%), and BA: 5 (10%). The frequency of M2 was slightly higher, but not statistically significant ($p = 0.79$). Of the 38 cases with HC, 24 cases (63.1%) were related to intraoperative procedures. There were six fatal cases. Five cases were considered to be procedure-related; one was associated with postoperative fatal cerebral hemorrhage, and most were transient. Intraoperative extravasation of contrast material was observed in three cases.

Discussion

There are two main aspects of HC: one is related to complications of the intraoperative procedures, e.g., injury to the vessel associated with manipulations of devices, while the other is postoperative sequelae of hemorrhagic cerebral infarction associated with reperfusion of cerebral blood flow [3]. The latter aspect may be secondary to the pathologic process, as hemorrhagic infarction is not necessarily considered the HC. However, as it is difficult to strictly distinguish between the two, both are included in the HC

	Intracranial hemorrhage (n = 38)		No intracranial hemorrhage (n = 274)		*p*
Age, years	77.9		74.8		0.158
Female, n (%)	14/38	36.8	105/274	38.3	0.86
Etiology, n					0.583
Atherothrombosis	13		65		
Cardiogenic embolism	23		186		
others	2		15		
Occlusion site, n					0.789
BA	5		20		
cervical	1		3		
ICA	10		74		
M1 distal	7		79		
M1 proximal	6		52		
M2	8		37		
Orthers	1		9		
NIHSS, median	19		18		0.916
ASPECTS, median	7		8		0.633
IV-tPA, n (%)	13/38	34	122/274	44.5	0.229
mTICI score, n (%)					<0.001
0	0/30	0	8/272	2.9	
1	2/30	6.6	4/272	1.4	
2a	6/30	20.0	34/272	12.5	
2b	16/30	53.3	97/272	35.6	
2c	1/30	3.3	0/272	0	
3	5/30	16.6	129/272	65.8	
Methods					1.09
ADAPT, n (%)	5/33(15.1)		54/263(20.5)		
Stent retriever, n(%)	7/33(21.2)		74/263(28.1)		
Combined, n(%)	21/33 (63.6)		134/263(50.9)		
Time factors					
Time from arrival to puncture, mean	66		69		0.432
Time from arrival to recanalization	124		124		0.589
Time from puncture to reperfusion	60		55		0.300
Time from onset to reperfusion	249		308		0.114

Table 1: Factors associated with HC after thrombectomy for acute ischemic stroke.

category in this paper. Although predictors of HC have been widely reported, they are not clearly established. Previously reported predictors include preprocedural arterial hypertension, worse initial NIHSS score, and poor collaterals [12-14].

In the present study, the degree of recanalization was one of intraoperative factors associated with hemorrhagic complications. The HC group had significantly higher frequency of mTICI 2B, while the non-HC group had a higher frequency of mTICI 3. A difference in prognosis between mTICI 2B and mTICI 3 cases has been reported, with improved clinical outcome in patients with a final TICI score of 3 vs. those with a final score of 2B [15]. While there are reports suggesting that thrombectomy should aim for mTICI 2C or higher, the number of passes is also important. As the frequency of bleeding complications increases with more passes [16], it is often necessary to stop with mTICI 2B. It has also been reported that the prognosis related to time factor does not differ from that of TICI 3 if TICI 2B recanalization is achieved early [17]. Regarding the number of passes, some reports suggest aiming for TICI3 if the number of passes is three or less [18]. The increased risk of HC with further retrieval attempts, with a decline in good outcomes in late recanalization, must therefore be considered.

Postoperative management, especially blood pressure (BP) control, is important. In the present study, the high prevalence of mTICI 2B in the HC group suggests that this situation is more likely to induce a complication of hemorrhagic stroke. More rigorous postoperative management, especially BP control, is thus considered essential to prevent HC when mTICI 2B is completed [19]. In cases of intracerebral hemorrhage (ICH) on computed tomography (CT), aggressive BP control is often recommended beyond current post thrombectomy guidelines to prevent further ICH expansion. At our center, we recommend maintaining systolic BP between 140 and 160 mm Hg and diastolic pressure less than 90 mm Hg in patients with SICH [14].

Although this procedure is highly effective, the risk of HC is always present. Particular attention should be paid to rare cases of major hemorrhage after reopening. One such case was observed in this series. Of the 38 cases of bleeding complications associated with thrombectomy at our institution, 24 (63.1%) were procedure-related bleeding disorders and 6 (63.1%) were fatal, suggesting that intraoperative procedural complications may be a factor that worsens prognosis. Although the occurrence of SAH was somewhat conspicuous in 14 cases (36.6%), the majority of cases were transient and it did not have a major impact on postoperative management. Nevertheless, careful postoperative management is essential, including BP control and refraining from anticoagulation [20]. The technique of recanalization should be standardized by institution, which might reduce complications.

Conclusion

In this study, the factor associated with HC was the degree of recanalization, namely mTICI 2B. The findings suggest that mTICI 3 should be the aim in order to reduce bleeding complications. Patients who had a longer recanalization time-especially if the procedure was terminated at mTICI 2B-are considered to require more rigorous postoperative management.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

All procedures in this study were approved by the Ethical Committee of International University of Health and Welfare (23-Nr-010) and International Medical Center, Satima Medical University (14-196).

Submission Statement

This manuscript is original and has not been submitted elsewhere in part or in whole

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