



Is There an Optimal Time-Window for the Minimally Invasive Puncture Evacuation Surgery in Intracerebral Hemorrhage?

Yangyang Feng, Wenliang Guo, Gaigai Li, Chao Pan, Guangyu Guo, Hao Nie, Shuang Bai, Yanmin Chang, Jie Jing and Zhouping Tang*

Department of Neurology, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, China

Abstract

This article summarizes published studies on minimally invasive puncture evacuation surgery in cerebral hemorrhage and attempts to explore the best time point for MIPS in ICH from the perspective of pathophysiology and clinical treatment. We believe that 6 hrs to 12 hrs after cerebral hemorrhage may be the best time window for MIPS.

Keywords: Minimally invasive surgery; Intracerebral hemorrhage; Optimal time-window

Introduction

Intracerebral Hemorrhage (ICH) can be broadly defined as spontaneous and nontraumatic cerebral parenchyma hemorrhage [1-3]. Cerebral hemorrhage whose morbidity reaches about ten to thirty in one hundred thousand is consistently regarded as the intensive and critical disease in neurology on account of its high mortality and disability rate [4-6].

For intracerebral hemorrhage, the ongoing researches focus on evaluating the degree of efficiency in acute blood pressure controlling, hemostatic application, anti-inflammation therapy, Minimally Invasive Surgery (MIS) and neuro protection aspects etc [1,7]. Minimally invasive surgery is extensively applied in clinical practice since its characteristics of using local anesthesia, tiny surgical trauma, less operating time and smaller risks [8]. Minimally Invasive Surgery (MIS) can be categorized into Minimally Invasive Puncture Surgery (MIPS) and Endoscopic Surgery (ES) [2,9,10]. Compared with conventional therapy including drugs and craniotomy, endoscopic surgery and stereotactic thrombolytic therapy, patients profit more from minimally invasive puncture surgery [9].

Despite the existence of the time-window in mechanical thrombolysis and intravenous thrombolysis for acute cerebral ischemia attack is widely acknowledged in neuroscientists and educators, the confirmation of the optimal time point in minimally invasive puncture surgery for cerebral hemorrhage remains uncertain [9,11].

Seriously, is there really an optimal time-window in MIPS for ICH?

Surrounding hematomas, the cerebral tissue is characterized by inflammatory cells, oedema, apoptosis and necrosis [12]. Hematomas generate mechanical injuries or death of the neurons and glia cells, followed by oligemia or even ischemia for the regions around the hematomas within 1 hour [4,13,14]. Then there occurs the calcium influx, mitochondrial dysfunction, membrane depolarization, glutamate release and the injury ending dependent on the level of mitochondrial failure ranges from impermanent metabolic suppression after sodium accumulation to cellular swelling and necrosis within 4 hours [15]. In the period of 4 hrs to 7 days following the cerebral hemorrhage, as a starting point of the secondary injury cascade, the breakdown products of coagulation and hemoglobin such as thrombin, ferrous iron, heme and halo-transferrin, activate microglia, then release inflammatory cytokines in particular TNF- α and IL1 β , Matrix Metalloproteinases (MMP), complement factors and oxygen free radicals, induce Caspase activation, AQP4 expression in astrocytes, breakdown of connective tissue and expression of adhesion molecules, eventually lead to recruitment of PMNs and macrophages, increased Blood Brain Barrier permeability, vasogenic edema and apoptosis in neurons and glial cells [7,11,16,17]. Hematoma space-occupying effects exert powerful influence upon increasing intracranial pressure, squeeze the brain tissue, afterwards the

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*Correspondence:

Zhou Ping Tang, Department of Neurology, Tongji Hospital of Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei 430030, China;
E-mail: ddjtzp@163.com

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decreasing cerebral blood flow leads to secondary cerebral ischemia and aggravates brain damages as far as cerebral hernia [18,19]. The pathophysiological finding indicates that recovery from hematoma pressing as soon as possible could improve neurological function in patients at risk of ICH [20]. At the same time, domestic and foreign experiments testify that hematoma enlargement is an independent risk factor for neurological deterioration and poor prognosis as well as the enlarged volume of hematoma is positively correlated to the severity of outcome [18,19,21]. It is now well established from a variety of studies that the peak time for hematoma enlargement is 6 hours after the occurrence of ICH [22,23]. Therefore, it is fairly logical to speculate that MIPS earliest possible may result in indeterminate danger because of the coincidence between the peak time for hematoma enlargement and the time point for cascade of cerebral hemorrhage injury. While belated MIPS surely go against with the goal of surviving nerve function and life expectancy as much as possible [22-24]. Consequently, an appropriate time for performing MIPS is in a greatly urgent need in clinical practice [23,25,26].

One previous academic literature on MIPS for ICH has revealed that ultra-early stage (within 7 hrs of onset) MIPS has a significant effect on reducing the recurrence rate of patients with supratentorial ICH in 3 months, which thus advocates MIPS should be limited within 5 hrs to 7 hrs after ICH [27]. However, there is a large volume of published studies describing that intracranial hematoma in the ultra-early stage of ICH remains unstable [21]. Besides, hematoma space-occupying effects benefit to compress ruptured blood vessels and hemostasis [22,23]. Moreover, the diameter of ruptured vessels varies from 50 microns to 700 microns [23,24]. In MIPS operation, it is quite difficult to detect ruptured vessels for hemostasis. Vacuum aspiration may form new hemorrhagic points. The probability of postoperative rebleeding could increase [2,7-9,21,25].

There is a tremendous divergence in the timing of MIPS [22-25]. The timing choice in published prospective randomized controlled study varies hugely from 4 hrs to 96 hrs [7,9,25,28,29]. Among all of published researches, the statement that the pathophysiological time window of MIPS may be 6 hrs to 12 hrs after ICH is most convincing [9,21,25,29,30]. Relevant basic scientific studies have confirmed that in the rabbit cerebral hemorrhage model, glutamate level, blood-brain barrier permeability and brain leukocytes could decline significantly with statistical significance when taken MIPS at the point of 6 hrs to 12 hrs since ICH [21]. Relevant clinical scientific studies have found that in patients 6 hrs to 12 hrs after ICH can effectively bring down the glutamate level surrounding the hemorrhage focus and improve NIHSS and mRS scores 6 months later [25]. In addition, some researchers suggest that very early craniotomy within four hours of the onset appears to give rise to the risk of re-bleeding and death [9,25,28,29].

There are relatively small numbers of historical studies in the area of optimal time-window in the minimally invasive puncture evacuation surgery for intracerebral hemorrhage [9]. Among these studies, most investigated time points concentrate on the ultra-early phase therapy [9,25,28,29]. Despite the experimental programs and statistical approaches in a few of studies are not consummate, the analysis still extends our knowledge of time-window in MIPS and patients benefiting from MIPS still provide proof of great value for time window selection [4,9]. Over the past decade, most research in MIPS has emphasized the optimal time-window might be 6 hrs to 12 hrs and the safety of ultra-early (0h to 6h) MIPS remains to

be explored [4,9,21,25,30]. This conclusion is consistent with the pathophysiological mechanism of brain tissue after cerebral hemorrhage [21,25,30].

Above all, it is possible to hypothesize that the choice of an optimal time-window for MIPS in ICH is closely related to the lesion location (surface or core), combining with urokinase/rt-PA or not, hematoma volume and the degree of consciousness disturbance of patients [31,32]. We're looking forward to more relevant large-scale, scientifically and strictly designed, randomized controlled trials in the future to provide more evidence-based suggests for establishing a precise optimal time-window for MIPS in ICH.

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