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# 急性前循环大动脉闭塞性血管内治疗患者术中血压变异与远期预后相关性研究

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[摘要] **目的** 探究急性前循环大动脉闭塞性血管内治疗患者术中血压变异对患者卒中后3个月神经功能预后及术后颅内出血转化的影响。**方法** 回顾性分析2015年10月到2018年8月在浙江大学医学院附属杭州市第一人民医院神经内科收治的116例急性前循环大动脉闭塞血管内治疗患者,记录并分析患者术中血压。血压变异参数包括:分别计算收缩压及舒张压的最大值、最小值、平均值、极差、标准差、变异系数。患者发病90 d改良Rankin评分评价患者远期预后,0~2分提示预后良好。次要预后评价指标为血管内治疗术后1周内出血转化,包括出血性脑梗死、脑实质出血和症状性颅内出血。**结果** 在116例患者中,72例(62.1%)患者获得良好预后。44例患者(37.9%)术后1周内发生梗死后出血转化,其中27例患者表现为出血性脑梗死,17例表现为脑实质出血,9例(7.8%)患者术后发生症状性颅内出血。多因素回归分析结果显示:术中收缩压极差(*OR*:0.976,95%*CI*:0.943~0.992,*P*=0.010)、收缩压变异系数(*OR*:0.903,95%*CI*:0.823~0.992,*P*=0.033)、舒张压极差(*OR*:0.937,95%*CI*:0.894~0.985,*P*=0.01)、舒张压变异系数(*OR*:0.873,95%*CI*:0.785~0.970,*P*=0.012)与远期不良预后呈正相关;术中收缩压最大值(*OR*:1.037,95%*CI*:1.005~1.070,*P*=0.024)、收缩压平均值(*OR*:1.051,95%*CI*:1.013~1.091,*P*=0.009)、舒张压最大值(*OR*:1.088,95%*CI*:1.031~1.148,*P*=0.002)、舒张压平均值(*OR*:1.116,95%*CI*:1.041~1.196,*P*=0.002)与出血性梗死发生呈正相关。**结论** 急性前循环大动脉闭塞性脑梗死患者中,血管内治疗术中血压变异越大,远期预后越差,术后出血性脑梗死发生率越高。血管内治疗术中血压管理尤为重要。

[关键词] 血压变异;急性脑梗死;血管内治疗;预后
[中图法分类号] R443.5;R741.05;R743.33 [文献标志码] A

# Correlation of intraoperative blood pressure variability and long-term prognosis in patients with anterior circulation stroke undergoing endovascular therapy

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[**Abstract**] Objective To investigate the effects of blood pressure variability (BPV) during thrombectomy on functional outcomes and hemorrhagic transformation for anterior circulation stroke. Methods We enrolled 116 patients with acute ischemic stroke due to large-vessel occlusion who received endovascular therapy in Department of Neurology of Hangzhou First People's Hospital from October 2015 to August 2018 and analyzed their blood pressure (BP) records during thrombectomy. We calculated BPV: maximum (max), minimum (min), mean, range, standard deviation (SD), coefficient variation (CV) of systolic (SBP) and diastolic BP (DBP). Functional outcomes were evaluated using modified Rankin Scale (mRS)

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score in 90 d after surgery. Other outcomes were hemorrhagic infarction (HI), parenchymal hemorrhage (PH) and symptomatic intracerebral hemorrhage (sICH). **Results** Among the total 116 enrolled patients, 72 patients (62.1%) achieved good outcome. Forty-four patients (37.9%) developed hemorrhagic transformation (HT), among whom 27 were identified with HI and 17 with PH. Nine patients (7.8%) deteriorated to sICH. Multivariate regression analysis showed that larger intraoperative SBP range ($OR$=0.976, 95%$CI$: 0.943~0.992, $P$=0.010) and higher SBP CV ($OR$=0.903, 95%$CI$: 0.823~0.992, $P$=0.033), and DBP range ($OR$=0.937, 95%$CI$: 0.894~0.985, $P$=0.01) and DBP CV ($OR$=0.873, 95%$CI$: 0.785~0.970, $P$=0.012) were positively correlated with long-term adverse prognosis. While higher intraoperative maximum SBP ($OR$=1.037, 95%$CI$: 1.005~1.070, $P$=0.024) and DBP ($OR$=1.088, 95%$CI$: 1.031~1.148, $P$=0.002) and mean SBP ($OR$=1.051, 95%$CI$: 1.013~1.091, $P$=0.009) and mean DBP ($OR$=1.116, 95%$CI$: 1.041~1.196, $P$=0.002) had positive correlation with HI. **Conclusion** For the patients with acute ischemic stroke due to large-vessel occlusion, the greater the blood pressure variation during endovascular therapy, the worse the long-term prognosis, and the higher the incidence of postoperative HI. It is essential for intraoperative BP control during thrombectomy.

[**Key words**] blood pressure variability; acute ischemic stroke; thrombectomy; prognosis

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急性缺血性脑卒中(acute ischemic stroke, AIS)患者发病急性期外周血压与其功能预后显著相关[1]。急性大动脉闭塞性脑梗死患者血管内治疗(endovascular thrombectomy, EVT)术后24 h血压变异(blood pressure variability, BPV)可能影响患者临床功能预后[2-3]。部分研究发现AIS患者再灌注治疗术中血压下降可能加重梗死区域低灌,导致患者致残率增高[4-5]。目前大动脉闭塞性AIS患者EVT术中血压变异与预后相关性研究仍较少。不同研究者对血压变异参数的定义不尽相同,术中靶血管再通率不一致。有研究者认为术后24 h血压变异对闭塞血管不完全再通患者预后影响更大[6]。因此,我们主要纳入前循环大动脉闭塞性AIS患者,且患者EVT术后血流完全再通,推测此类患者术中血压变异可能影响远期临床预后,以期为提高AIS-EVT术后患者远期功能预后提供临床诊治思路。

## 1 资料与方法

### 1.1 研究对象

回顾性分析2015年10月到2018年8月在浙江大学医学院附属杭州市第一人民医院神经内科收治的急性前循环大动脉闭塞性缺血性脑卒中患者共116例。

1.1.1 入组标准 ①年龄≥18岁;②经头颅CT平扫确认的急性缺血性卒中;③急性起病,发病6小时内[7];④急性闭塞的大动脉包括:颈内动脉(C1-C7段)、大脑中动脉(M1及M2段)、大脑前动脉(A1段);⑤接受急诊血管内治疗,且术中最后一次造影提示血流完全再通,改良脑梗死溶栓分级(modified thrombolysis in cerebral infarction, TICI)评分2b-3级。

1.1.2 排除标准 ①急性卒中预后早期CT评分(acute stroke prognosis early CT score, ASPECTS)<6分;②术前或术中使用降压或升压药物;③术中血压记录不完整;④EVT治疗后靶血管未完全再通。

1.1.3 人口学基本信息 性别、年龄、吸烟、发病时美国国立卫生研究院卒中量表(National Institutes of Health Stroke Scale, NIHSS)评分、脑血管病危险因素(高血压病史,糖尿病史,冠心病史,心房颤动病史,高脂血症病史,既往卒中/短暂性脑缺血发作病史)、入院时血糖、静脉溶栓、入院时收缩压(systolic pressure, SBP)及舒张压(diastolic pressure, DBP)、发病到靶血管再通时间、麻醉方式、血管内治疗再通后mTICI分级、术前及术后1周内影像学资料、发病90 d改良Rankin(modified rankin scale, mRS)评分。

### 1.2 血压参数

术中每隔5~10 min测量血压,记录相应收缩压及舒张压。血压变异参数包括:血压最大值(max)、最小值(min)、平均值(mean)、极差(range)、标准差(standard deviation,SD)、变异系数(coefficient variation, CV)。

### 1.3 结局评价指标

主要评价指标:发病3个月时进行随访,改良Rankin量表评估远期神经功能预后,mRS评分0~2分者提示预后良好;3~6分者提示预后不良。次要评价指标:术后7 d内根据影像学资料评估患者梗死后出血转化(hemorrhagic transformation, HT)。梗死后出血转化包括:出血性脑梗死(hemorrhagic infarction, HI)、脑实质出血(parenchymal hemorrhage, PH)和症状性颅内出

血(symptomatic intracerebral hemorrhage, sICH)。NIHSS评分较基线增加≥4分者定义为症状性颅内出血。

1.4 统计学分析

使用SPSS 20.0软件进行统计学分析。基线数据中,分类变量(性别、高血压病史等)采用卡方检验,用百分数(%)表示;连续变量(如入院时血糖、NIHSS评分等)采用独立样本 $t$ 检验或 $U$ 检验,用 $\bar{x}\pm s$ 或中位数(四分位数)表示。二元回归模型Logistic回归模型检验术中血压与患者90 d神经功能预后相关性,检验术中血压与术后1周内颅内出血转化相关性。将性别、年龄、吸烟、基线NIHSS评分、发病到再通时间、既往病史等因素纳入回归模型进行校正分析。$P<0.05$ 提示差异具有统计学意义。

## 2 结果

2.1 基线分析

共194例患者诊断为急性大动脉闭塞性脑梗死,其中56例为后循环梗死,17例仅行脑血管造影术(digital subtraction angiography ,DSA),5例患者EVT术后靶血管未完全再通,最终纳入116例患者。所有患者中,男性58例,年龄(70.2 ± 12.6)岁,平均年龄70岁,基线NIHSS评分16(13,19)分。大动脉闭塞血管分布如下:颈内动脉颅内段闭塞17例(14.7%),颈内动脉颅外段闭塞13例(11.2%),T分叉闭塞8例(6.9%),大脑中动脉M1段闭塞56例(48.3%),大脑中动脉M2段闭塞21例(18.1%),大脑前动脉A1段闭塞1例(0.9%)。

72例患者(62.1%)获得远期良好预后(mRS评分,0~2),21例患者(18.1%)90 d内死亡(mRS评分6分)。预后良好组与预后不良组患者组间基线特征比较见表1。与预后不良组相比,预后良好组患者平均年龄更小,基线NIHSS评分更低,既往卒中/TIA发生率更低。另外,将患者根据是否颅内出血转化分组后(包括HI、PH及sICH),组间各基线因素无统计学差异。

**表1 不同预后患者基线特征比较[$\bar{x}\pm s$,中位数(四分位数),例(%)]**

| 因素 | 合计 | mRS评分0~2分 | | $P$值 |
|---|---|---|---|---|
| | | 是($n$=72) | 否($n$=44) | |
| 年龄/岁 | 70.2±12.6 | 66.4± 13.3 | 76.5±8.3 | <0.001 |
| 男性 | 58(50.0) | 39(54.2) | 19(43.2) | 0.251 |
| 基线NIHSS评分 | 16(13,19) | 15(12,18) | 17(14,20) | 0.008 |
| 入院血糖/mmol·$L^{-1}$ | 8.1±2.5 | 7.84±2.5 | 8.6±2.4 | 0.132 |
| 高血压病史 | 64(55.2) | 35(48.6) | 29(65.9) | 0.069 |
| 糖尿病病史 | 16(13.8) | 8(11.1) | 8(18.2) | 0.284 |
| 房颤病史 | 74(63.8) | 43(59.7) | 31(70.5) | 0.243 |
| 冠心病病史 | 16(13.8) | 9(12.5) | 7(15.9) | 0.605 |
| 高脂血症 | 17(14.7) | 11(15.3) | 6(13.6) | 0.808 |
| 既往卒中/TIA | 14(12.1) | 4(5.6) | 10(22.7) | 0.006 |
| 吸烟 | 24(20.7) | 19(26.4) | 5(11.4) | 0.053 |
| 静脉镇静麻醉 | 109(94.0) | 69(95.8) | 40(90.9) | 0.280 |
| 静脉溶栓 | 39(33.6) | 27(37.5) | 12(27.3) | 0.258 |
| 发病到再通时间/min | 351.8±164.2 | 369.2±185.5 | 323.3±118.0 | 0.145 |
| mTICI分级 | | | | |
| 2b | 16(13.8) | 5(6.9) | 11(25.0) | - |
| 3 | 100(86.2) | 67(93.1) | 33(75.0) | - |
| 颅内出血转化 | 44(37.9) | 19(26.4) | 25(56.8) | 0.001 |
| 症状性颅内出血 | 9(7.8) | 1(1.4) | 8(18.2) | 0.003 |
| 脑实质出血 | 17(14.7) | 3(4.2) | 14(31.8) | <0.001 |
| 出血性梗死 | 27(23.3) | 16(22.2) | 11(25.0) | 0.731 |
| 闭塞部位 | | | | |
| ICA | 30(25.9) | 20(27.8) | 10(22.7) | 0.547 |
| ACA | 1(0.9) | 0 | 1(2.3) | - |
| M1 MCA | 56(48.3) | 33(45.8) | 23(52.3) | 0.501 |
| M2 MCA | 21(18.1) | 13(18.1) | 8(18.2) | 0.986 |
| T分叉 | 8(6.9) | 6(8.3) | 2(4.5) | 0.686 |
| 入院时SBP/mmHg | 147.1±27.2 | 148.1±27.1 | 145.5±27.7 | 0.629 |
| 入院时DBP/mmHg | 81.0±14.6 | 82.1±14.2 | 79.1±15.0 | 0.288 |

NIHSS:美国国立卫生研究院卒中量表;TIA:短暂性脑缺血发作;BP:血压;ICA:颈内动脉;ACA:大脑前动脉;MCA:大脑中动脉;mTICI:改良脑梗死溶栓分级

### 2.2 术中血压变异与急性前循环大动脉闭塞性脑梗死患者3个月神经功能结局的关系

单因素分析提示,与预后不良组患者相比,预后良好组患者术中$SBP_{max}$更低[(146.9±18.2) *vs* (157.4±19.6)mmHg,$P=0.004$],$SBP_{range}$更小[(40.3±18.6) *vs* (52.7±26.5)mmHg,$P=0.008$],$SBP_{SD}$更小[(13.4±6.7) *vs* (16.4±7.7),$P=0.028$],$SBP_{CV}$更小[(10.8±5.3) *vs* (13.2±6.6), $P=0.032$]。分析组间舒张压血压变异结果同样显示,预后良好组患者$DBP_{range}$[(24.7±9.8) *vs* (31.1±12.6)mmHg, $P=0.005$],$DBP_{SD}$[(8.1±3.1) *vs* (9.5±4.3), $P=0.046$]及$DBP_{CV}$[(11.4±4.6) *vs* (13.8±6.8), $P=0.039$]均更低(表2)。

多因素回归分析提示,$SBP_{range}$、$SBP_{CV}$、$DBP_{range}$及$DBP_{CV}$是3个月神经功能预后独立危险因素(*OR*:0.967,95%*CI*:0.943~0.992,$P=0.010$;*OR*:0.903,95%*CI*:0.823~0.992,$P=0.033$;*OR*:0.937,95%*CI*:0.894~0.985,$P=0.010$;*OR*:0.873,95%*CI*:0.785~0.970,$P=0.012$)(表2)。$SBP_{range}$、$SBP_{CV}$、$DBP_{range}$及$DBP_{CV}$越高,不良预后风险更高。

**表2 血压变异参数与远期预后及出血性梗死相关性分析**

| 参数 | 合计 | mRS评分0~2 | | | 多因素分析 | |
|---|---|---|---|---|---|---|
| | | 是 | 否 | *P*值 | *OR*(95%*CI*) | *P*值 |
| $SBP_{max}$ | 150.9±19.3 | 146.9±18.2 | 157.4±19.6 | 0.004 | 0.979(0.951-1.007) | 0.144 |
| $SBP_{min}$ | 105.9±19.6 | 106.7±18.4 | 104.8±21.5 | 0.611 | 1.023(0.997-1.050) | 0.085 |
| $SBP_{mean}$ | 127.1±16.1 | 126.3±16.0 | 128.2±16.5 | 0.549 | 1.016(0.984-1.050) | 0.334 |
| $SBP_{range}$ | 45.0±22.6 | 40.3±18.6 | 52.7±26.5 | 0.008 | 0.967(0.943-0.992) | 0.010 |
| $SBP_{SD}$ | 14.6±7.2 | 13.4±6.7 | 16.4±7.7 | 0.028 | 0.931(0.864-1.003) | 0.061 |
| $SBP_{CV}$ | 11.7±5.9 | 10.8±5.3 | 13.2±6.6 | 0.032 | 0.903(0.823-0.992) | 0.033 |
| $DBP_{max}$ | 87.1±12.4 | 85.8±12.1 | 89.1±12.7 | 0.166 | 0.988(0.948-1.030) | 0.583 |
| $DBP_{min}$ | 60.0±10.8 | 61.2±11.1 | 58.0±10.0 | 0.122 | 0.993(0.952-1.036) | 0.750 |
| $DBP_{mean}$ | 72.5±9.9 | 73.2±10.2 | 71.3±9.3 | 0.336 | 1.049(0.990-1.113) | 0.105 |
| $DBP_{range}$ | 27.1±11.3 | 24.7±9.8 | 31.1±12.6 | 0.005 | 0.937(0.894-0.985) | 0.010 |
| $DBP_{SD}$ | 8.6±3.6 | 8.1±3.1 | 9.5±4.3 | 0.046 | 0.870(0.755-1.002) | 0.054 |
| $DBP_{CV}$ | 12.3±5.6 | 11.4±4.6 | 13.8±6.8 | 0.039 | 0.873(0.785-0.970) | 0.012 |

| 参数 | HI | | | 多因素分析 | |
|---|---|---|---|---|---|
| | 是 | 否 | *P*值 | *OR*(95%*CI*) | *P*值 |
| $SBP_{max}$ | 158.9±21.2 | 148.5±18.2 | 0.013 | 1.037(1.005-1.070) | 0.024 |
| $SBP_{min}$ | 110.4±16.0 | 104.6±20.4 | 0.173 | 0.190(0.016-2.306) | 0.192 |
| $SBP_{mean}$ | 132.3±16.1 | 125.4±15.9 | 0.052 | 1.051(1.013-1.091) | 0.009 |
| $SBP_{range}$ | 48.5±23.7 | 43.9±22.3 | 0.359 | 0.998(0.973-1.024) | 0.889 |
| $SBP_{SD}$ | 15.3±7.3 | 14.3±7.2 | 0.534 | 0.982(0.903-1.067) | 0.662 |
| $SBP_{CV}$ | 11.7±5.9 | 11.7±5.9 | 0.949 | 0.933(0.840-1.037) | 0.201 |
| $DBP_{max}$ | 93.6±13.0 | 85.1±11.6 | 0.001 | 1.088(1.031-1.148) | 0.002 |
| $DBP_{min}$ | 63.1±10.6 | 59.0±10.7 | 0.082 | 1.053(0.999-1.109) | 0.054 |
| $DBP_{mean}$ | 77.0±10.5 | 71.1±9.3 | 0.006 | 1.116(1.041-1.196) | 0.002 |
| $DBP_{range}$ | 30.5±12.6 | 26.1±10.8 | 0.078 | 1.036(0.991-1.083) | 0.121 |
| $DBP_{SD}$ | 9.1±4.2 | 8.5±3.5 | 0.437 | 1.042(0.908-1.195) | 0.559 |
| $DBP_{CV}$ | 12.0±6.1 | 12.4±5.5 | 0.767 | 0.968(0.885-1.059) | 0.479 |

Max 最大值, Min 最小值, SD 标准差, CV 变异系数;校正因素:房颤, 冠心病, 高血压, 性别, 年龄, 基线NIHSS评分, 发病到再通时间, 入院血糖, 入院血压, 吸烟, 麻醉方式, 糖尿病病史, 高脂血症, 静脉溶栓及既往卒中/TIA

2.3 术中血压变异与急性前循环大动脉闭塞性脑梗死患者术后1周内颅内出血转化的关系

44例患者(37.9%)发生梗死后出血转化,出血性梗死患者27例,脑实质出血患者17例。其中9例患者(7.8%)进展为sICH。单因素分析显示,与非HI患者相比,HI患者 $SBP_{max}$[(158.9±21.2) *vs* (148.5±18.2)mmHg,$P=0.013$]及 $SBP_{mean}$[(132.3±16.1) *vs* (125.4±15.9)mmHg,$P=0.052$]更大,$DBP_{max}$[(93.6±13.0) *vs* (85.1±11.6) mmHg,$P=0.001$)]及 $DBP_{mean}$[(77.0±10.5) *vs* (71.1±9.3)mmHg,$P=0.006$)]更大(表2)。

多因素回归分析提示,SBP及DBP最大值及平均值是出血性梗死发生的独立危险因素(*OR*:1.037,95%*CI*:1.005~1.070,$P=0.024$;*OR*:1.051,95%*CI*:1.013~1.091,$P=0.009$;*OR*:1.088,95%*CI*:1.031~1.148,$P=0.002$;*OR*:1.116,95%*CI*:1.041~1.196,$P=0.002$)(表2),SBP及DBP最大值及平均值越大,HI发生风险越高。另外,在PH患者及sICH患者中,未发现血压变异与相对应结局的关联性。

## 3 讨论

本研究显示经过EVT治疗后闭塞靶血管血流完全再通的急性前循环大动脉闭塞性脑梗死患者中,术中血压变异与术后1周内梗死后出血转化有关,尤其是出血性梗死有关。术中血压变异越大的患者,3个月神经功能恢复越差。

本研究部分结果与国内外其他学者研究结果一致,既往研究提示再灌注治疗中较大的血压变异可能导致患者不良预后[7-9]。一项回顾性分析显示,脉压差变异系数是90 d功能预后的独立预测因子[10]。一项meta分析显示,术中平均动脉压下降可能引起颅内低灌注,从而影响患者神经功能恢复[11]。

有学者进一步研究发现,血压变异可分为血压上升变异[12]及血压下降变异[13]。血压下降变异更容易导致颅内血流持续低灌注,从而引起梗死组织进一步扩大[14-15]。PETERSEN等[16]学者报道,急性颅内大动脉闭塞患者EVT术中闭塞血管血流再通前术中血压如较基线血压下降,可能增加不良预后发生风险。但也有研究者认为血压下降与预后无关。而CHO等[3]认为在完全再通患者中,术后平均收缩压增高及收缩压变异可能降低3个月良好预后率。围手术期血压对预后的影响复杂,术中、术后的血压变异对预后的影响机制可能有所不同。

既往研究结果中,AIS患者急性期血压变异与颅内出血转化相关性不尽相同。这可能与入组患者的异质性及血压变异参数的设置不同有关[17-18]。MAÏER等[10]用脉压作为血压变异参数,发现血压变异与梗死后出血转化无关。他们认为这个研究结果可能与闭塞血管治疗后血流完全再通有关。但也有学者持反对意见,ENCHANTED (the Enhanced Control of Hypertension and Thrombolysis Stroke Study)研究提示AIS静脉溶栓患者中,强化降压有助于降低颅内出血转化的发生[19-20]。也有部分研究者认为大动脉闭塞性AIS患者中较大的血压变异较为常见,这可能导致颅内血流灌注不稳定,颅内血流动态调节失衡,而此类变化在缺血组织尤为显著[21]。血压增高及更大的波动可能进一步破坏血脑屏障,引起短暂性脑组织血流灌注变化,继而出现梗死后出血转化[22]。同样有学者认为,EVT术中瞬间血流再通也是引起缺血再灌注损伤及梗死后出血转化的原因之一[5,23]。另外,本研究在PH患者及sICH患者中未发现血压变异与相对应结局的关联性。这个可能与血压变异水平有关。MISTRY等[24]认为,当平均收缩压大于170 mmHg时,可能增加患者sICH发生风险;当平均收缩压大于159 mmHg时,可能增加患者颅内出血转化风险。本研究中HI患者平均收缩压相对偏低,可能仍维持在相对安全范围之内,因此未关联更严重的不良事件。

本研究发现本研究中大约94%患者术中麻醉方式予静脉镇静。既往研究提示,相比全身麻醉,静脉镇静可能更易引起体内血流动力学波动[25-26]。但单因素分析组间未提示差异具有统计学意义,多因素回归分析将麻醉方式纳入回归模型后,结果类似,因此,我们考虑麻醉方式对研究结果的影响较小。本研究为回顾性单中心研究,样本量相对较少,可能有潜在的入组偏移。其次,尚未详细监测具体出血时间点。再次,本研究简单阐述血压变异与临床预后的关联,暂未进一步探索血压变异的相关机制。最后,由于血压变异受降压药物影响,本研究剔除了部分术中及术前使用降压药物的患者(可能存在血压过高的患者),可能存在一定的样本偏移。

综上所述,急性前循环大动脉闭塞性脑梗死患者中,血管内治疗术中血压变异与患者远期临床功能预后及术后1周内颅内出血转化密切相关,术中血压变异越大,远期预后越差,术后出血性脑梗死发生率越高。血管内治疗术中需严密监测血压,维持血压相对稳定有助于提高患者远期临床功能预后。

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