

急性大脑中动脉 M2 段闭塞致缺血性卒中 支架取栓术与直接抽吸取栓术对比分析

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【摘要】 目的 对比分析支架取栓术与直接抽吸取栓术治疗急性大脑中动脉 M2 段闭塞致缺血性卒中的有效性和安全性。方法 纳入 2016 年 3 月至 2021 年 3 月在湖北省武汉市第一医院行血管内治疗的 44 例急性大脑中动脉 M2 段闭塞致缺血性卒中患者, 分别行支架取栓术(支架组, 22 例)和直接抽吸取栓术(抽吸组, 22 例), 详细记录发病至手术结束时间、术后即刻血管再通率(改良脑梗死溶栓血流分级 $\geq 2b$ 级)、术后 90 d 预后良好率(改良 Rankin 量表评分 ≤ 2 分)和病死率、症状性颅内出血和无症状性颅内出血发生率。结果 共 44 例患者, 血管再通率为 77.27%(34/44), 其中支架组为 68.18%(15/22), 抽吸组为 86.36%(19/22) 但有 5 例血管再通欠佳改行支架取栓术。两组患者穿刺至手术结束时间($t = 0.978$, $P = 0.334$)、血管再通率($\chi^2 = 2.071$, $P = 0.150$)、术后 90 d 预后良好率($\chi^2 = 0.364$, $P = 0.546$)和病死率($\chi^2 = 0.193$, $P = 0.660$)、症状性颅内出血($\chi^2 = 0.524$, $P = 0.469$)和无症状性颅内出血($\chi^2 = 0.275$, $P = 0.600$)发生率差异均无统计学意义。结论 支架取栓术和直接抽吸取栓术治疗急性大脑中动脉 M2 段闭塞致缺血性卒中安全、有效, 尚待多中心大样本随机对照试验进一步验证。

【关键词】 动脉闭塞性疾病; 大脑中动脉; 支架; 抽吸; 血栓切除术

A comparative study of stent thrombectomy and direct aspiration thrombectomy in the treatment of ischemic stroke caused by acute middle cerebral artery M2 segment occlusion

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【Abstract】 **Objective** To analyze the effectivity and safety of stent thrombectomy and direct aspiration thrombectomy in the treatment of ischemic stroke caused by acute middle cerebral artery (MCA) M2 segment occlusion. **Methods** A total of 44 patients with ischemic stroke caused by acute MCA M2 segment occlusion who received endovascular therapy in Wuhan No.1 Hospital from March 2016 to March 2021 were selected, including 22 patients with stent thrombectomy and 22 patients with direct aspiration thrombectomy. Time from onset to the end of surgery, postoperative immediate recanalization rate [modified Thrombolysis in Cerebral Infarction Score (mTICI) $\geq 2b$], postoperative 90-day good prognosis rate [modified Rankin Scale (mRS) ≤ 2], mortality, rate of symptomatic intracranial hemorrhage (sICH) and asymptomatic intracranial hemorrhage (asICH) were recorded. **Results** The postoperative recanalization rate in the total 44 patients was 77.27% (34/44), while 68.18% (15/22) in the stent group and 86.36% (19/22) in the aspiration group. Five patients in the aspiration group had poor result with aspiration and were remedied with stent thrombectomy. There was no statistic difference in the time from puncture to the end of the surgery ($t = 0.978$, $P = 0.334$), recanalization rate ($\chi^2 = 2.071$, $P = 0.150$), postoperative 90-day good prognosis rate ($\chi^2 = 0.364$, $P = 0.546$), mortality ($\chi^2 = 0.193$, $P = 0.660$), incidence of sICH ($\chi^2 = 0.524$, $P = 0.469$) and asICH ($\chi^2 = 0.275$, $P = 0.600$). **Conclusions** This preliminary study showed that stent thrombectomy and

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direct aspiration thrombectomy in patients with ischemic stroke caused by acute MCA M2 segment occlusion are safe and effective, but further exploration of multicentre, large-sample randomised controlled trials is needed.

【Key words】 Arterial occlusive diseases; Middle cerebral artery; Stents; Suction; Thrombectomy

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Conflicts of interest: none declared

影像学将大脑中动脉(MCA)M2段定义为侧位 DSA 或冠状位 CT、MRI 显示的外侧裂内缘垂直段血管。相较于颈内动脉(ICA)和 M1 段, M2 段位置较远, 血管走行迂曲, 直径较细且管壁较薄, 其闭塞导致的梗死灶虽相对较小, 但病残率较高, 特别是优势半球 M2 段闭塞可导致严重的神经功能障碍如偏瘫、完全性失语等, 而成功的血管再通可以增加良好临床结局之可能^[1]。rt-PA 静脉溶栓是治疗急性 M2 段闭塞致缺血性卒中的有效方案, 但仍存在治疗时间窗短、血管再通率低等不足, 而对于发病时间 ≤ 6 小时的急性前循环大动脉闭塞患者, 血管内治疗的有效性优于单纯静脉溶栓^[2-5]。支架取栓术(SR)是血管内机械取栓术治疗急性缺血性卒中的主要取栓方式, 近年出现的直接抽吸取栓术(ADAPT)因大口径导管的应用可更完整地抽吸血栓, 提高血管再通率, 引起越来越多的关注。ASTER(Contact Aspiration vs Stent Retriever for Successful Revascularization)研究^[6]和 COMPASS(Aspiration Thrombectomy versus Stent Retriever Thrombectomy as First-Line Approach for Large Vessel Occlusion)研究^[7]均提示直接抽吸取栓术与支架取栓术治疗急性前循环缺血性卒中的有效性和安全性无显著差异, 且前者可缩短手术时间、节省治疗费用。然而关于急性 M2 段闭塞致缺血性卒中取栓方式的相关研究证据等级较低, 尚无定论。本研究以近 5 年在湖北省武汉市第一医院行血管内机械取栓术的急性大脑中动脉 M2 段闭塞致缺血性卒中患者为研究对象, 初步比较支架取栓术与直接抽吸取栓术的有效性和安全性, 以为临床优化治疗方案提供指导。

资料与方法

一、临床资料

1. 纳入标准 (1)急性缺血性卒中的诊断符合《中国急性缺血性脑卒中诊治指南 2018》^[8]的标准。(2)经头部 MRA、CTA 或 DSA 证实 M2 段闭塞; 或者

行机械取栓桥接静脉溶栓的患者溶栓过程中直接取栓, 但取栓支架或抽吸导管到位前溶栓药物滴注完毕, 经 DSA 确定 M2 段仍闭塞。(3)发病至就诊时间 ≤ 12 h。(4)年龄 > 18 岁。(5)入院时美国国立卫生研究院卒中量表(NIHSS)评分 ≥ 6 分且存在明显神经功能缺损。(6)均行血管内机械取栓术, 并于术前评估其闭塞部位和侧支代偿^[9]。(7)随访至术后 90 d 且资料完整。

2. 排除标准 (1)头部 CT 显示颅内出血、颅内肿瘤。(2)动脉夹层、烟雾病等导致的缺血性卒中, 或者慢性 M2 段闭塞致缺血性卒中。(3)合并近端颈动脉闭塞串联病变。(4)合并其他恶性疾病, 严重心、肺、肾功能障碍。

3. 一般资料 选择 2016 年 3 月至 2021 年 3 月在我院卒中中心接受血管内机械取栓术的急性大脑中动脉 M2 段闭塞致缺血性卒中患者共 44 例, 男性 24 例, 女性 20 例; 年龄 42 ~ 87 岁, 平均(67.80 ± 11.22)岁; 发病至就诊时间 60 ~ 720 min, 中位时间 210(120, 300) min; 既往有高血压病史占 47.73%(21/44)、糖尿病占 22.73%(10/44)、房颤占 61.36%(27/44), 吸烟史占 27.27%(12/44); 入院时 NIHSS 评分为 4 ~ 28 分, 平均(13.86 ± 5.58)分; 13 例(29.55%)桥接 rt-PA 静脉溶栓; 发病至股动脉穿刺时间为 91 ~ 945 min, 中位时间 263.50(180.00, 363.50) min。

二、研究方法

1. 血管内机械取栓术 患者平卧位, 气管插管全身麻醉, 采用改良 Seldinger 穿刺法穿刺右股动脉, 置入 8F 动脉鞘(美国 Cordis 公司), 静脉滴注肝素生理盐水, 经 125 单弯导管(美国 Cordis 公司)将 8F 导引导管(美国 Cordis 公司)或 Neuron Max 6F 长鞘(美国 Penumbra 公司)置于颈内动脉 C1 段远端, 行正位、侧位和同侧 45°斜位选择性 DSA, 必要时行 3D-DSA 以寻找最佳操作体位。(1)支架取栓术: 在 0.014 in Synchro 微导丝(长度 200 cm, 美国 Boston Scientific 公司)和 Rebar-18 微导管(美国 Covidie 公

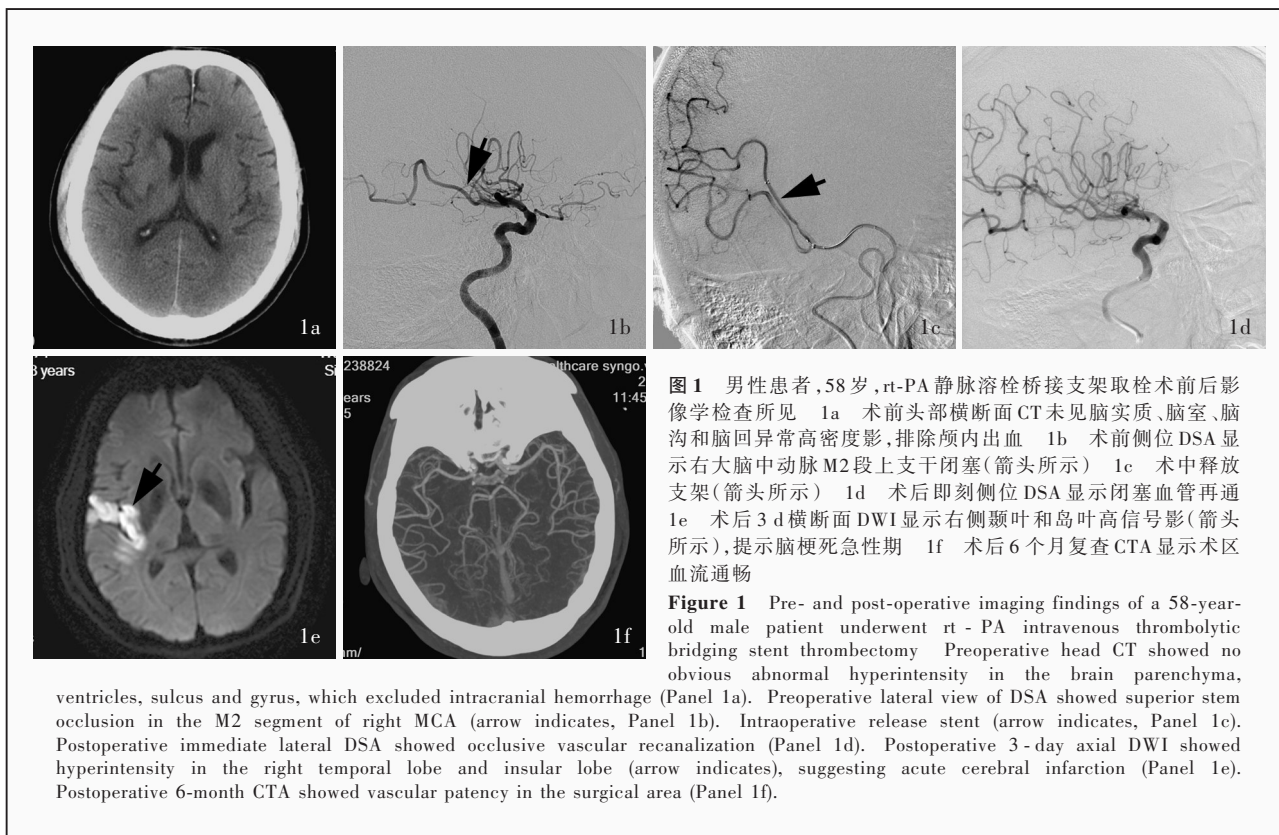


图 1 男性患者, 58 岁, rt-PA 静脉溶栓桥接支架取栓术前后影像学检查所见 1a 术前头部横断面 CT 未见脑实质、脑室、脑沟和脑回异常高密度影, 排除颅内出血 1b 术前侧位 DSA 显示右大脑中动脉 M2 段上支干闭塞(箭头所示) 1c 术中释放支架(箭头所示) 1d 术后即刻侧位 DSA 显示闭塞血管再通 1e 术后 3 d 横断面 DWI 显示右侧颞叶和岛叶高信号影(箭头所示), 提示脑梗死急性期 1f 术后 6 个月复查 CTA 显示术区血流通畅

Figure 1 Pre- and post-operative imaging findings of a 58-year-old male patient underwent rt - PA intravenous thrombolytic bridging stent thrombectomy. Preoperative head CT showed no obvious abnormal hyperintensity in the brain parenchyma, ventricles, sulcus and gyrus, which excluded intracranial hemorrhage (Panel 1a). Preoperative lateral view of DSA showed superior stem occlusion in the M2 segment of right MCA (arrow indicates, Panel 1b). Intraoperative release stent (arrow indicates, Panel 1c). Postoperative immediate lateral DSA showed occlusive vascular recanalization (Panel 1d). Postoperative 3 - day axial DWI showed hyperintensity in the right temporal lobe and insular lobe (arrow indicates), suggesting acute cerebral infarction (Panel 1e). Postoperative 6-month CTA showed vascular patency in the surgical area (Panel 1f).

司)支撑下将 Navien 058 中间导管(美国 EV3 公司)头端置于 C4 段,微导丝穿过闭塞段后将微导管末端置于 M2 段远端,回撤微导丝,微导管“冒烟”证实位于血管真腔内,将 Solitaire AB 支架(4 mm × 20 mm, 美国 EV3 公司)准确定位后释放,静置 5 min,将 Navien 导管尽量到位至闭塞段近端,采用 SWIM 技术^[10]取栓,边抽吸、边回撤支架,尽量减少支架对血管的牵拉(图 1)。取栓后即刻复查 DSA,改良脑梗死溶栓血流分级(mTICI) ≥ 2b 级证实血管成功再通,结束手术。为减少血管损伤和颅内出血风险,取栓操作不超过 3 次。(2)直接抽吸取栓术:根据术前 DSA 结果选择适宜的抽吸导管如 5F Sofia(美国 MicroVention 公司)、4MAX 或 3MAX(美国 Penumbra 公司),在微导丝和微导管支撑下将抽吸导管引导至闭塞段并接触血栓近端,连接 50 ml 注射器持续负压抽吸 90 s,再保持负压缓慢回撤导管,全程不弯曲导管(图 2)。取栓后即刻复查 DSA, mTICI 分级 ≥ 2b 级证实血管成功再通,结束手术。若 3 次抽吸后 mTICI 分级仍 < 2b 级,则改行支架取栓术。

2. 有效性及安全性评价 (1)穿刺至手术结束时间:记录穿刺至手术结束时间。(2)术后即刻血管再通率:采用 mTICI 分级评价血管再通情况, mTICI

分级 ≥ 2b 为血管成功再通。(3)术后 90 d 预后:术后 90 d 采用改良 Rankin 量表(mRS)^[11]评价预后, mRS 评分 ≤ 2 分为预后良好、> 2 分为预后不良; mRS 评分 6 分为死亡,并计算病死率。(4)颅内出血发生率:主要包括症状性颅内出血(sICH)和无症状性颅内出血(asICH)。术后 72 h 内头部 CT 提示颅内出血,并存在以下 3 项中 1 项,即 NIHSS 评分增加 > 4 分、单项评分增加 > 2 分、临床症状突然恶化需行去骨瓣减压术或气管插管呼吸机辅助通气等辅助治疗,诊断为症状性颅内出血^[12];其余颅内出血为无症状性颅内出血。

3. 统计分析方法 采用 SPSS 22.0 统计软件进行数据进行处理与分析。计数资料以相对数构成比(%)或率(%)表示,采用 χ^2 检验。服从或近似服从正态分布的计量资料以均数 ± 标准差($\bar{x} \pm s$)表示,采用两独立样本的 *t* 检验;服从非正态分布的计量资料以中位数和四分位数间距 [$M(P_{25}, P_{75})$] 表示,采用 Mann-Whitney *U* 检验。以 $P \leq 0.05$ 为差异具有统计学意义。

结 果

据取栓方式分为支架取栓术组(支架组, 22 例)

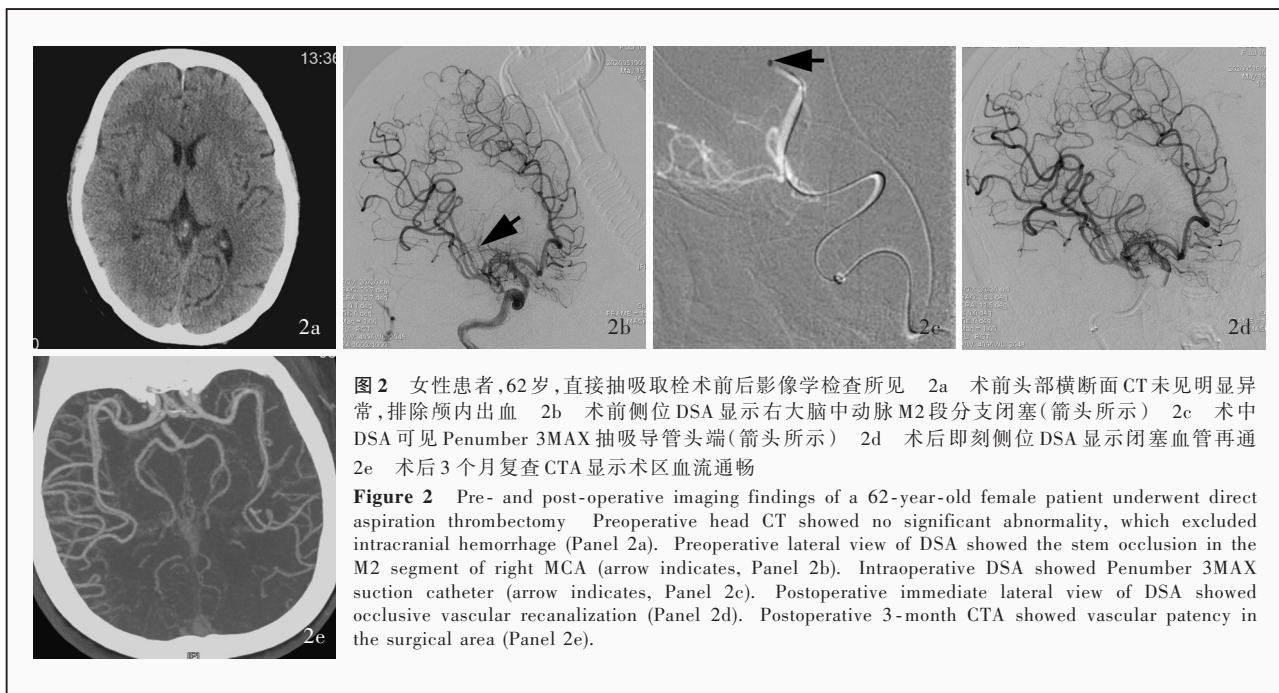


图2 女性患者,62岁,直接抽吸取栓术前后影像学检查所见 2a 术前头部横断面CT未见明显异常,排除颅内出血 2b 术前侧位DSA显示右大脑中动脉M2段分支闭塞(箭头所示) 2c 术中DSA可见Penumbra 3MAX抽吸导管头端(箭头所示) 2d 术后即刻侧位DSA显示闭塞血管再通 2e 术后3个月复查CTA显示术区血流通畅

Figure 2 Pre- and post-operative imaging findings of a 62-year-old female patient underwent direct aspiration thrombectomy. Preoperative head CT showed no significant abnormality, which excluded intracranial hemorrhage (Panel 2a). Preoperative lateral view of DSA showed the stem occlusion in the M2 segment of right MCA (arrow indicates, Panel 2b). Intraoperative DSA showed Penumbra 3MAX suction catheter (arrow indicates, Panel 2c). Postoperative immediate lateral view of DSA showed occlusive vascular recanalization (Panel 2d). Postoperative 3-month CTA showed vascular patency in the surgical area (Panel 2e).

和直接抽吸取栓术组(抽吸组,22例),两组患者性别,年龄,发病至就诊时间,高血压、糖尿病、房颤,吸烟史,入院时NIHSS评分,术前桥接静脉溶栓,发病至股动脉穿刺时间等资料比较,差异均无统计学意义($P>0.05$,表1),均衡可比。

支架组血管再通率为68.18%(15/22),抽吸组为86.36%(19/22),但抽吸组有5例血管再通欠佳改行支架取栓术,组间差异无统计学意义($P=0.150$,表2)。此外,两组穿刺至手术结束时间、术后90d预后良好率和病死率、症状性颅内出血和无症状性颅内出血发生率差异亦无统计学意义(均 $P>0.05$,表2)。

讨 论

本研究结果显示,对于急性大脑中动脉M2段闭塞,支架取栓术与直接抽吸取栓术的有效性和安全性均无明显差异,直接抽吸取栓术的血管再通率并不劣于支架取栓术,且手术相关并发症风险无增加。此外,本研究有13例(29.55%)患者桥接rt-PA静脉溶栓,此类患者在溶栓过程中直接取栓,但取栓支架或抽吸导管到位前溶栓药物滴注完毕。尽管有学者认为,静脉溶栓效果可能影响桥接治疗的远期预后^[13];但多中心随机对照试验DEVT(Direct Endovascular Treatment)试验^[14]和DIRECT-MT(Direct Mechanical Thrombectomy)试验^[15]则显示,直接机械取栓与静脉溶栓桥接机械取栓疗效相当,

故本研究对比分析支架组与抽吸组远期疗效时,未考虑静脉溶栓的影响。

大脑中动脉M2段管径较细、供血区相对较少,但供血重要功能区的血管如中央沟动脉闭塞仍可导致严重的神经功能障碍^[16]。未行血管再通治疗的急性M2段闭塞患者预后较差,病死率较高^[17],早期开通闭塞血管可减少梗死面积,改善预后。目前关于M2段单纯静脉溶栓疗效的研究多为回顾性研究,缺少前瞻性随机对照试验且样本量有限:M2段单纯rt-PA静脉溶栓的血管再通率为27.3%~68.4%,临床预后良好率为48%~81%,症状性颅内出血发生率为1.7%~8.8%;而桥接血管内治疗可以进一步提高血管再通率^[18-20]。2018年,美国心脏病协会(AHA)/美国卒中协会(ASA)发布的《急性缺血性卒中患者早期管理指南》指出,大脑中动脉M1段或颈内动脉颅内段急性闭塞性缺血性卒中采取血管内治疗为I级推荐A级证据^[21]。关于M2段闭塞性缺血性卒中的血管内治疗方式目前尚无定论,一项基于5项随机对照临床试验的Meta分析显示,血管内机械取栓术并无明显获益($OR=1.280$,95%CI:0.510~3.210; $P=0.170$),但由于样本量较小,其结论存在偏倚^[22]。本研究44例急性大脑中动脉M2段闭塞致缺血性卒中患者分别行支架取栓术或直接抽吸取栓术,血管再通率为77.27%(34/44),与刘舒鑫和李迪^[16]报告的血管再通率77%~93.3%相一致;其中,支架组血管再通率为68.18%(15/22),抽

表 1 支架组与抽吸组患者临床资料的比较

Table 1. Comparison of clinical data between stent group and aspiration group

观察指标	支架组 (n = 22)	抽吸组 (n = 22)	统计量值	P 值
性别[例(%)]			0.367	0.545
男性	11(50.00)	13(59.09)		
女性	11(50.00)	9(40.91)		
年龄($\bar{x} \pm s$, 岁)	65.82 ± 11.19	69.77 ± 11.16	-1.174	0.247
发病至就诊时间[$M(P_{25}, P_{75})$, min]	210.00(82.50, 277.50)	210.00(120.00, 300.00)	-0.426	0.670
高血压[例(%)]	9(40.91)	12(54.55)	0.820	0.365
糖尿病[例(%)]	6(27.27)	4(18.18)	0.518	0.472
房颤[例(%)]	11(50.00)	16(72.73)	2.397	0.122
吸烟史[例(%)]	5(22.73)	7(31.82)	0.458	0.498
入院时 NIHSS($\bar{x} \pm s$, 评分)	13.36 ± 6.11	14.36 ± 5.09	-0.590	0.558
术前桥接静脉溶栓[例(%)]	8(36.36)	5(22.73)	0.983	0.322
发病至股动脉穿刺时间[$M(P_{25}, P_{75})$, min]	248.00(159.00, 337.50)	311.00(206.25, 407.25)	-1.456	0.146

Two-independent-sample *t* test for comparison of age and NIHSS at admission, Mann-Whitney *U* test for comparison of time from onset to attendance and time from onset to puncture of the femoral artery, and χ^2 test for comparison of others, 年龄和入院时 NIHSS 评分的比较行两独立样本的 *t* 检验, 发病至就诊时间和发病至股动脉穿刺时间的比较行 Mann-Whitney *U* 检验, 其余指标的比较行 χ^2 检验。NIHSS, National Institutes of Health Stroke Scale, 美国国立卫生研究院卒中量表

表 2 支架组与抽吸组患者有效性和安全性的比较

Table 2. Comparison of effectivity and safety of patients between stent group and aspiration group

组别	例数	穿刺至手术结束时间($\bar{x} \pm s$, min)	血管再通[例(%)]	预后良好[例(%)]	病死[例(%)]	sICH[例(%)]	asICH[例(%)]
支架组	22	120.00 ± 49.09	15(68.18)	10(45.45)	4(18.18)	2(9.09)	3(13.64)
抽吸组	22	106.91 ± 39.16	19(86.36)	12(54.55)	2(9.09)	0(0.00)	1(4.55)
χ^2 或 <i>t</i> 值		0.978	2.071*	0.364	0.193*	0.524*	0.275*
P 值		0.334	0.150	0.546	0.660	0.469	0.600

*adjusted χ^2 value, 校正 χ^2 值。Two-independent-sample *t* test for comparison of the time from puncture to the end of the surgery, and χ^2 test for comparison of others, 穿刺至手术结束时间的比较行两独立样本的 *t* 检验, 其余指标的比较行 χ^2 检验。sICH, symptomatic intracranial hemorrhage, 症状性颅内出血; asICH, asymptomatic intracranial hemorrhage, 无症状性颅内出血

吸组为 86.36% (19/22), 虽然两组血管再通率无明显差异, 但抽吸组血管再通例数相对较多, 可能与机械取栓术存在学习曲线, 而抽吸组病例入组时间相对靠后、操作相对成熟有关; 此外, 抽吸组有 5 例血管再通欠佳改行支架取栓术, 进一步提高血管再通率。

在本研究中, 支架组术后 90 天预后良好率为 45.45% (10/22), 与多项研究报道的术后 90 天预后良好率不超过 53.3% 相一致^[23-25]; 抽吸组为 54.55% (12/22), 略高于意大利一项单中心临床研究 (45.72%)^[26], 两组术后 90 天预后良好率无明显差异, 提示直接抽吸取栓治疗急性 M2 段闭塞致缺血性卒中的疗效与支架取栓相当。本研究支架组 2 例 (9.09%) 发生症状性颅内出血, 推测是由于 M2 段特殊的解剖位置和生理特点, 微导管或微导丝通过较为困难, 易导致动脉穿孔, 若动脉走行迂曲, 回撤支

架易损伤血管, 增加颅内出血的风险^[27]; 此外, 机械取栓术后再灌注损伤、血-脑屏障损害、凝血功能异常也可能导致颅内出血^[28-30]。两组症状性颅内出血和非症状性颅内出血发生率均无明显差异, 表明支架取栓术和直接抽吸取栓术治疗急性 M2 段闭塞致缺血性卒中的安全性相当, 但从取栓技术对操作者的要求考虑, 可选择直接抽吸取栓术, 必要时行支架取栓术予以补救, 如果 3 次支架取栓仍无法成功再通、手术时间过长等, 应果断放弃。

本研究为回顾性研究且样本量较小, 不同术者对取栓方式的选择、取栓过程的操作、术后管理水平不同, 均可导致研究结果存在偏倚; 加之未对研究对象的发病机制进行分类, 也有可能影响研究结果^[31]。今后尚待进一步扩大样本量, 进行多中心前瞻性随机对照试验, 以进一步探讨两种术式的有效性和安全性。

利益冲突 无

参 考 文 献

- [1] Khatri P, Yeatts SD, Mazighi M, Broderick JP, Liebeskind DS, Demchuk AM, Amarenco P, Carrozzella J, Spilker J, Foster LD, Goyal M, Hill MD, Palesch YY, Jauch EC, Haley EC, Vagal A, Tomsick TA; IMS III Trialists. Time to angiographic reperfusion and clinical outcome after acute ischaemic stroke: an analysis of data from the Interventional Management of Stroke (IMS III) phase 3 trial[J]. *Lancet Neurol*, 2014, 13:567-574.
- [2] Ciccone A, Valvassori L, Nichelatti M, Sgoifo A, Ponzio M, Sterzi R, Boccardi E; SYNTHESIS Expansion Investigators. Endovascular treatment for acute ischemic stroke[J]. *N Engl J Med*, 2013, 368:904-913.
- [3] Goyal M, Demchuk AM, Menon BK, Eesa M, Rempel JL, Thornton J, Roy D, Jovin TG, Willinsky RA, Sapkota BL, Dowlatshahi D, Frei DF, Kamal NR, Montaner WJ, Poppe AY, Ryckborst KJ, Silver FL, Shuaib A, Tampieri D, Williams D, Bang OY, Baxter BW, Burns PA, Choe H, Heo JH, Holmstedt CA, Jankowitz B, Kelly M, Linares G, Mandzia JL, Shankar J, Sohn SI, Swartz RH, Barber PA, Coutts SB, Smith EE, Morrish WF, Weill A, Subramaniam S, Mitha A, Wong JH, Lowerison MW, Sajobi TT, Hill MD; ESCAPE Trial Investigators. Randomized assessment of rapid endovascular treatment of ischemic stroke[J]. *N Engl J Med*, 2015, 372:1019-1030.
- [4] Saver JL, Goyal M, Bonafe A, Diener HC, Levy EI, Pereira VM, Albers GW, Cognard C, Cohen DJ, Hacke W, Jansen O, Jovin TG, Mattle HP, Nogueira RG, Siddiqui AH, Yavagal DR, Devlin TG, Lopes DK, Reddy V, du Mesnil de Rochemont R, Jahan R; SWIFT PRIME Investigators. Solitaire™ with the Intention for Thrombectomy as Primary Endovascular Treatment for Acute Ischemic Stroke (SWIFT PRIME) trial: protocol for a randomized, controlled, multicenter study comparing the Solitaire revascularization device with IV tPA with IV tPA alone in acute ischemic stroke[J]. *Int J Stroke*, 2015, 10:439-448.
- [5] Campbell BC, Mitchell PJ, Kleinig TJ, Dewey HM, Churilov L, Yassi N, Yan B, Dowling RJ, Parsons MW, Oxley TJ, Wu TY, Brooks M, Simpson MA, Miteff F, Levi CR, Krause M, Harrington TJ, Faulder KC, Steinfort BS, Priglinger M, Ang T, Scroop R, Barber PA, McGuinness B, Wijeratne T, Phan TG, Chong W, Chandra RV, Bladin CF, Badve M, Rice H, de Villiers L, Ma H, Desmond PM, Donnan GA, Davis SM; EXTEND-IA Investigators. Endovascular therapy for ischemic stroke with perfusion - imaging selection [J]. *N Engl J Med*, 2015, 372:1009-1018.
- [6] Lapergue B, Blanc R, Gory B, Labreuche J, Duhamel A, Marnat G, Saleme S, Costalat V, Bracard S, Desal H, Mazighi M, Consoli A, Piotin M; ASTER Trial Investigators. Effect of endovascular contact aspiration vs stent retriever on revascularization in patients with acute ischemic stroke and large vessel occlusion: the ASTER randomized clinical trial[J]. *JAMA*, 2017, 318:443-452.
- [7] Turk AS 3rd, Siddiqui A, Fifi JT, De Leacy RA, Fiorella DJ, Gu E, Levy EI, Snyder KV, Hanel RA, Aghaebrahim A, Woodward BK, Hixson HR, Chaudry MI, Spiotta AM, Rai AT, Frei D, Almandoz JED, Kelly M, Arthur A, Baxter B, English J, Linfante I, Fargen KM, Mocco J. Aspiration thrombectomy versus stent retriever thrombectomy as first-line approach for large vessel occlusion (COMPASS): a multicentre, randomised, open label, blinded outcome, non-inferiority trial [J]. *Lancet*, 2019, 393:998-1008.
- [8] Neurology Branch, Chinese Medical Association; Cerebral Vascular Diseases Group, Neurology Branch, Chinese Medical Association. Chinese guidelines for diagnosis and treatment of acute ischemic stroke 2018[J]. *Zhonghua Shen Jing Ke Za Zhi*, 2018, 51:666-682.[中华医学会神经病学分会, 中华医学会神经病学分会脑血管病学组. 中国急性缺血性脑卒中诊治指南 2018[J]. *中华神经科杂志*, 2018, 51:666-682.]
- [9] Wang J, Xia S, Qi ZY, Feng XQ. Advances on the application research of cerebral collateral circulation assessment for acute ischemic stroke mechanical thrombectomy [J]. *Zhongguo Xian Dai Shen Jing Ji Bing Za Zhi*, 2019, 19:720-725.[王健, 夏爽, 祁子禹, 冯学泉. 脑侧支循环评估在急性缺血性卒中机械取栓中的应用进展[J]. *中国现代神经疾病杂志*, 2019, 19:720-725.]
- [10] Li Q, Zhu LF, Zhou TF, Guan M, Wu LH, He YK, Li TX. The application of SWIM technology in the treatment of acute occlusion of middle cerebral artery [J]. *Jie Ru Fang She Xue Za Zhi*, 2019, 28:717-720.[李强, 朱良付, 周腾飞, 管民, 吴立恒, 贺迎坤, 李天晓. SWIM技术在大脑中动脉急性闭塞治疗中的应用[J]. *介入放射学杂志*, 2019, 28:717-720.]
- [11] van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJ, van Gijn J. Interobserver agreement for the assessment of handicap in stroke patients[J]. *Stroke*, 1988, 19:604-607.
- [12] von Kummer R, Broderick JP, Campbell BC, Demchuk A, Goyal M, Hill MD, Treurniet KM, Majoie CB, Marquering HA, Maza MV, San Román L, Saver JL, Strbian D, Whiteley W, Hacke W. The heidelberg bleeding classification: classification of bleeding events after ischemic stroke and reperfusion therapy [J]. *Stroke*, 2015, 46:2981-2986.
- [13] Turc G, Tsivgoulis G, Audebert HJ, Boogaarts H, Bhogal P, De Marchis GM, Fonseca AC, Khatri P, Mazighi M, Pérez de la Ossa N, Schellinger PD, Strbian D, Toni D, White P, Whiteley W, Zini A, van Zwam W, Fiehler J. European Stroke Organisation: European Society for Minimally Invasive Neurological Therapy expedited recommendation on indication for intravenous thrombolysis before mechanical thrombectomy in patients with acute ischaemic stroke and anterior circulation large vessel occlusion [J]. *Eur Stroke J*, 2022, 7: I - X X VI.
- [14] Zi W, Qiu Z, Li F, Sang H, Wu D, Luo W, Liu S, Yuan J, Song J, Shi Z, Huang W, Zhang M, Liu W, Guo Z, Qiu T, Shi Q, Zhou P, Wang L, Fu X, Liu S, Yang S, Zhang S, Zhou Z, Huang X, Wang Y, Luo J, Bai Y, Zhang M, Wu Y, Zeng G, Wan Y, Wen C, Wen H, Ling W, Chen Z, Peng M, Ai Z, Guo F, Li H, Guo J, Guan H, Wang Z, Liu Y, Pu J, Wang Z, Liu H, Chen L, Huang J, Yang G, Gong Z, Shuai J, Nogueira RG, Yang Q; DEVT Trial Investigators. Effect of endovascular treatment alone vs intravenous alteplase plus endovascular treatment on functional independence in patients with acute ischemic stroke: the DEVT randomized clinical trial [J]. *JAMA*, 2021, 325:234-243.
- [15] Yang P, Zhang Y, Zhang L, Zhang Y, Treurniet KM, Chen W, Peng Y, Han H, Wang J, Wang S, Yin C, Liu S, Wang P, Fang Q, Shi H, Yang J, Wen C, Li C, Jiang C, Sun J, Yue X, Lou M, Zhang M, Shu H, Sun D, Liang H, Li T, Xing P, Ke K, Yuan H, Wang G, Yang W, Shi H, Li T, Li Z, Xing P, Zhang P, Zhou Y, Wang H, Xu Y, Huang Q, Wu T, Zhao R, Li Q, Fang Y, Wang L, Lu J, Li Y, Fu J, Zhong X, Wang Y, Wang L, Goyal M, Dippel DWJ, Hong B, Deng B, Roos YBWEM, Majoie CBML, Liu J; DIRECT-MT Investigators. Endovascular thrombectomy with or without intravenous alteplase in acute stroke [J]. *N Engl J Med*, 2020, 382:1981-1993.
- [16] Liu SX, Li D. Advances in recanalization of M2 segment occlusion in middle cerebral artery [J]. *Zhongguo Zu Zhong Za Zhi*, 2019, 14:400-403.[刘舒鑫, 李迪. 大脑中动脉 M2 段闭塞

- 血管再通研究进展[J]. 中国卒中杂志, 2019, 14:400-403.]
- [17] Lima FO, Furie KL, Silva GS, Lev MH, Camargo EC, Singhal AB, Harris GJ, Halpern EF, Koroshetz WJ, Smith WS, Nogueira RG. Prognosis of untreated strokes due to anterior circulation proximal intracranial arterial occlusions detected by use of computed tomography angiography[J]. *JAMA Neurol*, 2014, 71:151-157.
- [18] Bhatia R, Hill MD, Shobha N, Menon B, Bal S, Kochar P, Watson T, Goyal M, Demchuk AM. Low rates of acute recanalization with intravenous recombinant tissue plasminogen activator in ischemic stroke: real-world experience and a call for action[J]. *Stroke*, 2010, 41:2254-2258.
- [19] Rai AT, Carpenter JS, Raghuram K, Roberts TD, Rodgers D, Hobbs GR. Endovascular therapy yields significantly superior outcomes for large vessel occlusions compared with intravenous thrombolysis: is it time to randomize [J]? *J Neurointerv Surg*, 2013, 5:430-434.
- [20] Rahme R, Yeatts SD, Abruzzo TA, Jimenez L, Fan L, Tomsick TA, Ringer AJ, Furlan AJ, Broderick JP, Khatri P. Early reperfusion and clinical outcomes in patients with M2 occlusion: pooled analysis of the PROACT II, IMS, and IMS II studies[J]. *J Neurosurg*, 2014, 121:1354-1358.
- [21] Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, Biller J, Brown M, Demaerschalk BM, Hoh B, Jauch EC, Kidwell CS, Leslie - Mazwi TM, Ovbiagele B, Scott PA, Sheth KN, Southerland AM, Summers DV, Tirschwell DL; American Heart Association Stroke Council. 2018 Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association[J]. *Stroke*, 2018, 49:e46-110.
- [22] Goyal M, Menon BK, van Zwam WH, Dippel DW, Mitchell PJ, Demchuk AM, Dávalos A, Majoie CB, van der Lugt A, de Miquel MA, Donnan GA, Roos YB, Bonafe A, Jahan R, Diener HC, van den Berg LA, Levy EI, Berkhemer OA, Pereira VM, Rempel J, Millán M, Davis SM, Roy D, Thornton J, Román LS, Ribó M, Beumer D, Stouch B, Brown S, Campbell BC, van Oostenbrugge RJ, Saver JL, Hill MD, Jovin TG; HERMES Collaborators. Endovascular thrombectomy after large - vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials[J]. *Lancet*, 2016, 387:1723-1731.
- [23] Zhao W, Zhao LH, Hou YW, Zhang HL, Li B, Wang JH, Guo ZY. Stent thrombectomy for middle cerebral artery M2 segment and anterior cerebral artery occlusion [J]. *Zhonghua Lao Nian Xin Nao Xue Guan Bing Za Zhi*, 2017, 19:536-538.[赵伟, 赵莲花, 侯延伟, 张合亮, 李博, 王景华, 郭再玉. 大脑中动脉M2段和大脑前动脉闭塞的支架取栓治疗[J]. 中华老年心脑血管病杂志, 2017, 19:536-538.]
- [24] Xing PF, Li ZF, Li Q, Zhao R, Fang YB, Zhao KJ, Dai DW, Yang PF, Zhang YW, Liu JM. Efficacy of mechanical thrombectomy with stent-retriever for anterior circulation distal vessel occlusion [J]. *Di Er Jun Yi Da Xue Xue Bao*, 2018, 39:997-1002.[邢鹏飞, 李子付, 李强, 赵瑞, 方亦斌, 赵开军, 戴冬伟, 杨鹏飞, 张永巍, 刘建民. 支架取栓器械取栓治疗前循环远端血管闭塞的疗效观察[J]. 第二军医大学学报, 2018, 39:997-1002.]
- [25] Zhang CY, Yang B, Zhao SJ, Shi QY. Clinical efficacy of stent embolectomy in treatment of middle cerebral artery M2 occlusion [J]. *Zhongguo Jie Ru Ying Xiang Yu Zhi Liao Xue*, 2019, 16:250-252.[张春阳, 杨斌, 赵士军, 石秋艳. 支架取栓术治疗大脑中动脉M2段闭塞的临床效果[J]. 中国介入影像与治疗学, 2019, 16:250-252.]
- [26] Romano DG, Casseri T, Leonini S, Tassi R, Cioni S, Vallone IM, Gennari P, Acampa M, Martini G, Bracco S. Single-center experience using the 3MAX or 4MAX reperfusion catheter for the treatment of acute ischemic stroke with distal arterial occlusions in patients not eligible for intravenous fibrinolysis [J]. *Radiol Med*, 2019, 124:408-413.
- [27] Mokin M, Fargen KM, Primiani CT, Ren Z, Dumont TM, Brasiliense LBC, Dabus G, Linfante I, Kan P, Srinivasan VM, Binning MJ, Gupta R, Turk AS, Elijovich L, Arthur A, Shallwani H, Levy EI, Siddiqui AH. Vessel perforation during stent retriever thrombectomy for acute ischemic stroke: technical details and clinical outcomes [J]. *J Neurointerv Surg*, 2017, 9:922-928.
- [28] Jin R, Yang G, Li G. Molecular insights and therapeutic targets for blood - brain barrier disruption in ischemic stroke: critical role of matrix metalloproteinases and tissue - type plasminogen activator [J]. *Neurobiol Dis*, 2010, 38:376-385.
- [29] Vandelli L, Marietta M, Gambini M, Cavazzuti M, Trenti T, Cenci MA, Casoni F, Bigliardi G, Pentore R, Nichelli P, Zini A. Fibrinogen decrease after intravenous thrombolysis in ischemic stroke patients is a risk factor for intracerebral hemorrhage [J]. *J Stroke Cerebrovasc Dis*, 2015, 24:394-400.
- [30] Feldman MJ, Roth S, Fusco MR, Mehta T, Arora N, Siegler JE, Schrag M, Mittal S, Kirshner H, Mistry AM, Yaghi S, Chitale RV, Khatri P, Mistry EA. Association of asymptomatic hemorrhage after endovascular stroke treatment with outcomes [J]. *J Neurointerv Surg*, 2021, 13:1095-1098.
- [31] Liu YC, Zheng MM, Li Y, Xie SW, Wang JY, Liu QR. Analysis of prognostic factors of mechanical thrombectomy in patients with acute ischemic stroke with large vessel occlusion [J]. *Zhongguo Xian Dai Shen Jing Ji Bing Za Zhi*, 2020, 20:407-412.[刘永昌, 郑明明, 李严, 谢松旺, 王俊勇, 刘庆冉. 急性大血管闭塞性缺血性卒中患者机械取栓术后预后影响因素分析[J]. 中国现代神经疾病杂志, 2020, 20:407-412.]

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· 小词典 ·

中英文对照名词词汇(七)

Roussel Uclaf 因果关系评估法

Roussel Uclaf Causality Assessment Method(RUCAM)

荧光定量聚合酶链反应

fluorescent quantitative polymerase chain reaction(FQ-PCR)

营养不良线丝 dystrophic neurites(DN)

原发性错配修复缺陷型 IDH 突变型星形细胞瘤

primary mismatch repair deficient IDH-mutant astrocytoma

(PMMRDIA)

早发型视神经脊髓炎谱系疾病

early-onset neuromyelitis optica spectrum disorders

(EO-NMOSDs)

症状性颅内出血

symptomatic intracranial hemorrhage(sICH)

知觉组织 perceptual organization(PO)