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急性缺血性卒中血管内治疗临床 预后因素研究进展

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摘要: 血管内介入治疗是当前急性缺血性卒中的主要治疗手段,但部分患者仍未获得神经功能独立。分析各种因素对术后神经功能改变的预测价值,可为适宜的接受患者群体及治疗方案提供更多参考。

关键词: 急性缺血性卒中; 血管内治疗; 机械取栓; 临床预后

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Research advances in clinical prognostic factors for acute ischemic stroke treated with endovascular therapy

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Abstract: Endovascular interventional therapy is currently the main treatment for acute ischemic stroke, but some patients still have not achieved neurological function independence. Analysis of the predictive value of various factors for postoperative neurological function changes can provide more reference for selecting appropriate patient groups and treatment plans.

Key words: Acute ischemic stroke; Endovascular therapy; Mechanical thrombectomy; Clinical prognosis

最新的全球疾病负担研究显示,从1990—2021年,卒中仍然是全球非传染性疾病中第二大常见死亡原因(仅次于缺血性心脏病)^[1]。近年来,急性缺血性脑卒中(acute ischemic stroke, AIS)的治疗模式已经从单纯的药物治疗转变为药物和血管内介入治疗(endovascular therapy, EVT)。尽管机械取栓(mechanical thrombectomy, MT)在AIS治疗中的循证安全性和有效性已被证实,但无效再通仍是当前面临的挑战^[2]。美国心脏协会推荐将在90 d时达到改良Rankin评分量表(modified Rankin scale, mRS)评分0~2分(即功能独立)作为神经功能恢复的早期获益指标。临床观察到通过MT获得血管成功再通后,仍有部分患者的未取得早期获益,现将临床预后预测因素的研究现状进行综述。

1 一般特征

发病年龄是一个预测因素,研究发现对于卒中发作超过6 h的AIS患者,年龄<80岁的患者MT治疗后的3个月临床预后较好^[3]。对于大面积核心梗死[Alberta卒中项目早期CT评分(Alberta Stroke Program Early Ct Score, ASPECTS) 0~2分],≤69岁的患者更易从血管内治疗中获益^[4]。同时,在≥16岁的急性M2闭塞儿童患者中也观察到了血栓切除术带来的良好结局^[5]。性别之间也存在差异,通过对MT之前的CT灌注成像(computed tomography perfusion imaging, CTP)观察发现,相较于男性,女性AIS患者的早期梗死体积较小,半影体积较小,但预后比男性患者差,这可能源于早期梗死体积对女性患者的预

后影响更显著^[6]。关于不同种族之间的差异研究较少,有研究发现接受MT的非西班牙裔黑人患者的3个月和6个月功能预后都比非西班牙裔白人患者差,其中可能包含一些社会经济因素^[7]。尽管肥胖是卒中高危因素之一,但其与MT预后关系尚不明确。在前循环大血管闭塞接受MT的患者未观察到体重指数与临床结局的关联^[8]。而另一项回顾性分析发现,体重指数≤23.62 kg/m²患者的总生存期和90 d mRS量表评分均明显低于体重指数高于此阈值的患者,提示体重过轻患者术后的生存和功能预后较差,建议进一步研究优化营养状况能否带来神经保护益处^[9]。

2 卒中病因

椎基底动脉闭塞性卒中患者血管介入治疗后的功能预后可能与脑卒中病因有关,相较于大动脉粥样硬化型和心源性栓塞型卒中,来源不明的栓塞型卒中与更差的临床结果有关^[10]。前循环的大血管闭塞性卒中观察到,相较于心源性栓塞型,大动脉粥样硬化型预后较好^[11]。

3 基线临床神经功能和神经放射学特征

3.1 美国国立卫生研究院卒中量表评分

在≥80岁的前循环大血管闭塞患者中观察到仅较低的入院美国国立卫生研究院卒中量表(National

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Institute of Health Stroke Scale, NIHSS)评分与术后良好的预后显著相关^[12]。虽然NIHSS评分更偏重前循环的病变情况,但仍与后循环梗死预后具有相关性。在一项通过多元逻辑回归建立的后循环闭塞患者临床预后预测模型中显示,越高的基线NIHSS评分预示着术后预后不良^[13]。日本一项包含536例急性后循环大血管闭塞患者的调查发现,就诊时NIHSS评分 ≤ 20 分是MT后预后良好的唯一独立因素^[14]。

3.2 术前影像学评估

3.2.1 ASPECTS评分 ASPECTS评分主要基于CT平扫,可评价缺血性卒中患者的早期缺血改变。在接受机械取栓术的前循环大血管闭塞AIS患者中发现,较高的ASPECTS值(6~10)预示着临床结果明显更好;ASPECTS值 ≤ 5 则明显降低了患者长期功能独立的可能性,表现出较差的长期功能改善(mRS评分 >2),并增加了MT后症状性颅内出血(symptomatic intracranial hemorrhage, sICH)和死亡的风险^[15]。对于大面积核心梗死患者(ASPECTS值0~2),年龄 >69 岁的患者出现不良结局风险增加,故应优先考虑较年轻患者采用MT^[4]。

3.2.2 其他放射学特征 通过对入院时的CT血管造影进行评估,发现不良的静脉流出[皮质静脉混浊评分(COVES ≤ 2)]与MT后不明原因的早期神经功能恶化(MT后的前24 h内NIHSS评分增加 ≥ 4 ,随访影像学检查无实质出血)相关,而后者与90 d时的不利的功能结局独立相关^[16]。CTP上的时间密度曲线(time attenuation curve, TAC)可确定血栓通透性,是一种在预测AIS患者MT预后评价中较具前景的影像学标志物,其中单峰分布的TAC与富含纤维蛋白和血小板的凝块相关,且与不良结局独立相关^[17]。

对于中度远端血管闭塞引起的AIS患者,血管内治疗是否有益尚不清楚,一项针对该类患者的国际、多中心、随机对照、双臂、评估者盲法试验正在进行^[18]。先前已有研究发现,对于成功再通的大脑中动脉远端中等血管闭塞患者而言,脑血容量(cerebral blood volume, CBV)指数 ≥ 0.7 与MT术后预后良好独立相关^[19]。刷状征是指磁共振序列中磁敏感上可见到扩大的深髓静脉,这种现象与血液脱氧血红蛋白浓度增加有关,一项单中心前瞻性研究发现,治疗前刷状征的存在与3个月时的良好功能独立性独立相关,故其可被视为对脑缺血的生理适应的生物标志物^[20]。脑白质疏松症是源于不同原因导致的微血管病变影像学表现,入院时使用van Swieten量表对CT平扫评估脑白质疏松症等级,中度至重度的脑白质疏松症具有较高的MT术后90 d不良功能结局及死亡比例^[21]。

4 血管介入治疗

4.1 围手术期管理

脑自动调节是防止脑组织低灌注或过度灌注的主要方法,当血压在一定范围内波动时,机体通过调整脑小血管的直径来维持相对恒定的脑血流量^[22],但是术中及术后血压波动较大仍可能出现不良功能结局^[23, 24]。现对血管内治疗术中血压控制无统一意见,关于全身麻醉下EVT期间不同术中血压水平(SBP 140~180 mmHg vs SBP 110~140 mmHg)对大血管闭塞性AIS患者的影响的随机对照试验已经开展(CHEC2023-015)^[25]。与此同时,在一项前瞻性研究中观察到机械取栓成功再通后24 h内严格控制血压($\leq 160/90$ mmHg)与神经元损伤增加有关,表现为较高的神经丝轻链 sNfL水平和较差的功能结果^[26]。而术后强化血压控制治疗(收缩压 <140 mmHg)对接受EVT治疗并成功实现再灌注的AIS患者有害^[27]。另外,术中体温降低可降低脑需氧量,MT期间低体温患者(最高体温小于 36°C)在3个月随访时表现出更好的神经功能结局^[28]。

4.2 桥接疗法

在机械血栓切除术之前使用静脉溶栓的桥接疗法与并发症的风险增加及良好功能结局的关联尚有争议。一项来自22个卒中综合中心的国际队列研究表明,在非房颤(atrial fibrillation, AF)患者中,桥接治疗提高了90 d功能预后良好的几率,且未增加出血性并发症风险;但在AF患者中,桥接治疗不仅导致症状性颅内出血和2型实质血肿的出现概率显著增加,且无法改善90 d功能结局^[29]。一项通过对入院时计算机断层扫描血管造影的血栓衰减后增强值(thrombus attenuation increase, TAI)量化血栓渗透性程度,分为高通透性和低通透性,在血栓渗透性较低的患者中,桥接治疗组比单独取栓组更易获得良好预后,而在血栓渗透性较高的患者中,两种治疗组的长期预后无显著差异,故血栓渗透性较低的患者建议静脉注射阿替普酶后血管内取栓,而血栓渗透性较高的患者可单独取栓^[30]。

4.3 手术过程

初始DSA中的血管闭塞外观也被关注到。截断征(+)组的预后相对较差,可能源于手术时间较长^[31]。半月板征的存在与心源性栓塞病因显著相关,更适合接触抽吸技术,但不能预测临床结果^[32, 33]。MT可采用支架取栓装置和(或)接触式抽吸术,在前循环大血管闭塞中使用抽吸技术和支架取栓技术的首过再通率及90 d后功能结局无明显差异^[34],但在 ≥ 80 岁以上患者观察到使用血栓抽吸术与较高的再灌注结果相关^[35]。在抽吸技术中观察到较大的抽吸导管内径与较高的首次通过效应发生率

相关,导管尺寸也是其中一个变量^[36]。机械取栓过程中偶尔会发生出血性并发症,自限性出血一般预后良好,而球囊填塞能有效阻止血液外渗,可降低90 d内的死亡率^[37]。替罗非班可抑制血小板聚集,国内一项前瞻性多中心研究发现,相较于静脉给药或不使用替罗非班,经动脉注射替罗非班对接受EVT治疗的急性大血管闭塞伴颅内动脉粥样硬化性疾病患者的预后有不良影响^[38]。

现将改良脑梗死溶栓分级(modified Thrombolysis in Cerebral Infarction Score, mTICI)达2b/3级再通被定义为血管内治疗成功,但在ASPECTS值2~5的AIS患者中发现,MT后达到mTICI 2c/3评分与更良好的90 d预后相关,故在低ASPECTS患者中,mTICI 2c/3可能是更合适的MT目标^[39]。微循环功能障碍在急性大血管闭塞性卒中也常见,再通后利用DSA立即进行微血管脑循环时间(microvascular cerebral circulation time, mCCT)测量,mCCT延长与不良结局显著相关^[40]。较短的动脉穿刺至再通时间、MT持续时间在预测预后中也起着重要作用,尤其是在后循环卒中患者中^[41, 42]。

5 合并症/并发症

心房颤动(atrial fibrillation, AF)是大血管闭塞性AIS的常见合并症,一项Meta分析发现,AF患者MT术后90 d时mRS评分为0~2分的比例显著降低,同时发现AF组与非AF之间的再灌注成功率及sICH发生率相似,但房颤组死亡率显著高于非房颤组^[43]。入院时肾小球滤过率 $<60 \text{ ml}/(\text{min} \cdot 1.73 \text{ m}^2)$ 定义为肾功能损害,其是术后神经功能独立性较差和90 d死亡率较高的独立预测因子^[44]。在接受MT治疗的老年卒中患者中,女性和卒中相关肺炎是3个月时结局较差的独立预测因子^[45]。出血转化是接受MT患者的已知并发症,根据海德堡出血分类将实质血肿(parenchymal hematoma, PH)进行分级,PH2型的发生预示着不良结局,在前循环大面积缺血核心缺血(ASPECTS ≤ 5)患者中发现,MT期间较多的通过次数和非全麻下进行的手术与PH 2型发生率升高相关,这对临床结果产生负面影响^[46]。入院时血糖、凝血酶时间和术后NIHSS评分水平较高、再灌注时间较长的患者更易出现sICH^[47, 48],而后者对EVT的预后不良有很好的预测作用^[13]。高血糖会加重氧化应激、炎症反应和内皮细胞损伤。可通过葡萄糖与糖化血红蛋白比值(glucose-to-glycated hemoglobin ratio, GAR)指数来表示应激性高血糖,GAR >24.8 则徒劳再通的风险较高^[49]。而无论是否合并糖尿病,入院时血糖 $\geq 7.8 \text{ mmol/L}$ 都对卒中发作后1周的神经功能恢复有负面影响^[50]。在前循环缺血性脑卒中患者中观察到,早期脑水肿加重和功能结局恶化与

短期血糖水平升高相关,但与HbA1c水平无关,且认为血糖水平通过介导早期水肿形成而对功能结局产生影响^[51]。恶性脑水肿被定义为中线移位 $\geq 5 \text{ mm}$,伴有局部脑肿胀征象。低基线ASPECT评分、高密度大脑中动脉征象缺失、血管造影侧支循环不良和较差的血运重建与MT后恶性脑水肿独立相关,且恶性脑水肿的90 d临床预后不良率显著升高^[52]。脑卒中MT术后新发严重贫血(血红蛋白低于 10 g/dl)存在预后不良的风险^[53]。有研究将MT后24 h内血红蛋白浓度分为无贫血,轻度贫血,中重度贫血,发现无论基线血红蛋白浓度如何,中重度贫血组(男性 $<11 \text{ g/dl}$,女性 $<10 \text{ g/dl}$)获得良好临床结果的频率较低^[54]。同时,另一项包含974例缺血性卒中患者的研究发现,与血小板计数正常组相比,血小板减少组MT术后有着较低的神经功能独立率和更高的死亡率,但两组之间的sICH发生率接近^[55]。

6 炎症因子/循环生物标志物

炎症反应参与卒中脑损伤过程,并影响MT术后临床结局。研究发现入院时C反应蛋白/白蛋白比值较高,术后临床预后较差^[56],而术后hs-cTnI上升的动态变化是90 d内死亡的独立影响因素^[57]。中性粒细胞、嗜酸性粒细胞、中性粒细胞与淋巴细胞比率(neutrophil to lymphocyte ratio, NLR)与预后不良独立相关^[58, 59],且高水平的NLR与sICH相关,后者会加重神经功能缺损,增加死亡率^[60]。同样地,一些参与调控的炎症因子如可溶性细胞间黏附分子可通过增加sICH趋势而降低临床预后^[61]。多配体蛋白聚糖-1(Syndecan-1)是一种能够参与血管生成、创伤愈合等生理过程的炎症反应调控因子,机械取栓术后第一天外周血中低水平的Syndecan-1预示着临床预后较差^[62]。腱糖蛋白-C(tenascin-C)参与神经元凋亡和血脑屏障破坏,凝溶胶蛋白则与微循环障碍有关,有研究同样发现它们可作为MT无效再通及早期并发症的独立预测因子^[63]。卒中急性期的抗炎治疗具有重要意义,通过对脑卒中大鼠的颈动脉内给予抗炎反应药物BMX-001可显著改善大鼠机械取栓术后的神经功能缺损症状和梗死体积^[64]。

7 总结与展望

尽管AIS患者行机械取栓是安全的,但其临床疗效受到多种复杂因素的影响,部分患者接受治疗后较易出现术后并发症,且无法获得良好的远期预后。预后因素评估有利于筛选出更适宜的目标患者群体,并为治疗细节提供更多重要指导。

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[参考文献]

- [1] 2021 Stroke Risk Factor Collaborators GBD. Global, regional, and national burden of stroke and its risk factors, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021[J]. *Lancet Neurol*, 2024, 23(10): 973-1003.
- [2] Goda T, Oyama N, Kitano T, et al. Factors associated with unsuccessful recanalization in mechanical thrombectomy for acute ischemic stroke[J]. *Cerebrovasc Dis Extra*, 2019, 9(3): 107-113.
- [3] Gok DU, Kim SY, Na YC, et al. Extended time window (>6 hour) mechanical thrombectomy; good clinical outcome in the younger age population in thrombectomy cases: Relationship between age and prognosis[J]. *J Pers Med*, 2023, 14(1): 2.
- [4] Li Z, Li L, Peng Z, et al. Combined effect of ASPECTS and age on outcome of patients with large core infarction treated with mechanical thrombectomy[J]. *J Neurointerv Surg*, 2025, 17(4): 341-345.
- [5] Bhatia KD, Pulcine E, Andrews I, et al. Mechanical thrombectomy for pediatric arterial ischemic stroke from acute M2 occlusion[J]. *AJNR Am J Neuroradiol*, 2024, 45(5): 588-591.
- [6] Wróbel D, Wrona P, Homa T, et al. Sex alters the effect of perfusion deficits on functional outcome in patients with acute ischemic stroke undergoing mechanical thrombectomy[J]. *Cerebrovasc Dis*, 2024; 1-10.
- [7] Srinivas T, Ran K, Nair SK, et al. Racial disparities in functional outcomes following mechanical thrombectomy in a cohort of patients with ischemic stroke [J]. *J Neurointerv Surg*, 2024, 16(9): 857-863.
- [8] Hoffman H, Cote JR, Wood J, et al. The influence of body mass index on outcomes in patients undergoing mechanical thrombectomy for anterior circulation large vessel occlusion: Institutional experience and meta-analysis [J]. *Neurocrit Care*, 2024, 40(2): 654-663.
- [9] Fecker AL, Shahin MN, Sheffels S, et al. Low body mass index patients have worse outcomes after mechanical thrombectomy [J]. *J Neurointerv Surg*, 2024, 16(11): 1194-1199.
- [10] Abdelrady M, Derraz I, Dargazanli C, et al. Outcomes following mechanical thrombectomy in different etiological subtypes of acute basilar artery occlusion: Stroke etiology and outcome after EVT in BAO[J]. *Clin Neuroradiol*, 2023, 33(2): 361-374.
- [11] Marnat G, Gory B, Sibon I, et al. Mechanical thrombectomy failure in anterior circulation strokes: Outcomes and predictors of favorable outcome[J]. *Eur J Neurol*, 2022, 29(9): 2701-2707.
- [12] Mitsuhashi T, Teranishi K, Tokugawa J, et al. Prognostic determinants of anterior large vessel occlusion in acute stroke in elderly patients[J]. *Geriatrics (Basel)*, 2024, 9(1): 13.
- [13] Liu Z, Zhang R, Ouyang K, et al. Predicting functional outcome in acute ischemic stroke patients after endovascular treatment by machine learning[J]. *Transl Neurosci*, 2023, 14(1): 20220324.
- [14] Takano Y, Koyanagi M, Takamatsu T, et al. Clinical evaluation of mechanical thrombectomy for patients with posterior circulation occlusion: A retrospective study [J]. *Clin Neurol Neurosurg*, 2024, 237: 108133.
- [15] Li J, Duan J, Zhang L, et al. Low (0-5) Alberta Stroke Program Early Computed Tomography Score on admission predictive of worse functional outcome after mechanical thrombectomy for anterior circulation large vessel occlusion [J]. *Eur J Med Res*, 2023, 28(1): 266.
- [16] Heitkamp C, Winkelmeier L, Heit JJ, et al. Early neurological deterioration in patients with acute ischemic stroke is linked to unfavorable cerebral venous outflow[J]. *Eur Stroke J*, 2024, 9(1): 162-171.
- [17] Wei J, Jiang J, Zhu Y, et al. Clot-based time attenuation curve as a novel imaging predictor of mechanical thrombectomy functional outcome in acute ischemia stroke[J]. *Eur Radiol*, 2024, 34(4): 2198-2208.
- [18] Marios-Nikos P, Alex B, Jens F, et al. Endovascular therapy plus best medical treatment (BMT) versus BMT alone for medium distal vessel occlusion stroke (DISTAL): an international, multicentre, randomized-controlled, two-arm, assessor-blinded trial [J]. *Eur Stroke J*, 2024, 9(4): 1083-1092.
- [19] Yedavalli V, Koneru M, Hamam O, et al. Pretreatment CTP collateral parameters predict good outcomes in successfully recanalized middle cerebral artery distal medium vessel occlusions [J]. *Clin Neuroradiol*, 2024, 34(2): 341-349.
- [20] Hua VT, Benhammida S, Nguyen TP, et al. Brush sign on pre-treatment imaging is associated with good functional outcome in stroke patients treated with mechanical thrombectomy: A prospective monocentric study[J]. *J Neuroradiol*, 2024, 51(4): 101186.
- [21] Göthel-Ezzeiani A, Jansen O, Austein F, et al. Impact of leukoaraiosis or blood pressure on clinical outcome, mortality and symptomatic intracerebral hemorrhage after mechanical thrombectomy in acute ischemic stroke[J]. *Sci Rep*, 2022, 12(1): 21750.
- [22] Jafari M, Desai A, Damani R. Blood pressure management after mechanical thrombectomy in stroke patients [J]. *J Neurol Sci*, 2020, 418: 117140.
- [23] Xu C, Jin T, Chen Z, et al. Increased blood pressure variability during general anaesthesia is associated with worse outcomes after mechanical thrombectomy: A prospective observational cohort study[J]. *BMJ Open*, 2022, 12(10): e059108.
- [24] Lu Y, Shen R, Lin W, et al. Association between blood pressure variability and clinical outcomes after successful recanalization in patients with large vessel occlusion stroke after mechanical thrombectomy[J]. *Front Neurol*, 2022, 13: 967395.
- [25] Li B, Niu T, Dai Y, et al. Intraoperative intensive blood pressure management strategy and the outcome of patients who had an acute ischaemic stroke undergoing endovascular treatment under general anaesthesia: Study protocol for a prospective randomised controlled trial[J]. *BMJ Open*, 2024, 14(4): e079197.
- [26] Hahn M, Hayani E, Bitar L, et al. Strict blood pressure control following thrombectomy is associated with neuronal injury and poor functional outcome[J]. *Ann Clin Transl Neurol*, 2023, 10(12): 2255-2265.
- [27] da Silva Neto EP, Ferreira LF, de Cardozo Hernandez ALC, et al. Blood pressure targets after successful reperfusion in mechanical thrombectomy for acute ischemic stroke: An updated systematic review and meta-analysis of randomized clinical trials [J]. *Neurol Sci*, 2024, 45(8): 3879-3886.
- [28] Xu R, Nair SK, Kilgore CB, et al. Hypothermia is associated with improved neurological outcomes after mechanical thrombectomy [J]. *World Neurosurg*, 2024, 181: e126-e132.
- [29] Akbik F, Alawieh A, Dimisko L, et al. Bridging thrombolysis in atrial fibrillation stroke is associated with increased hemorrhagic complications without improved outcomes[J]. *J Neurointerv Surg*, 2022, 14(10): 979-984.
- [30] Shang K, Zhu W, Ye L, et al. Effect of mechanical thrombectomy with and without intravenous thrombolysis on the functional outcome of patients with different degrees of thrombus perviousness [J]. *Neuroradiology*, 2023, 65(11): 1657-1663.
- [31] Zhang W, Zhang W, Liu T, et al. Angiographic demonstration of a cutoff sign as an unfavorable prognostic indicator for patients with acute ischemic stroke undergoing mechanical thrombectomy [J]. *J Stroke Cerebrovasc Dis*, 2024, 33(5): 107672.
- [32] Miranda A, Abdelnaby R, Araújo A, et al. Meniscus sign in patients with anterior circulation large vessel occlusion stroke does not predict outcome[J]. *Clin Neuroradiol*, 2023, 33(1): 65-72.
- [33] Nie C, Kang Z, Tu M, et al. Clot meniscus sign is associated with

- thrombus permeability and choice of mechanical thrombectomy technique in acute middle cerebral artery occlusion[J]. *Front Neurol*, 2022, 13: 850429.
- [34] Huang CM, Hong YF, He WC, et al. Aspiration thrombectomy versus stent-retriever thrombectomy for the first-pass therapy of intracranial atherosclerosis-related large vessel occlusion: A post hoc analysis of the endovascular treatment with versus without tirofiban for patients with large vessel occlusion stroke trial[J]. *World Neurosurg*, 2024, 183: e366-e371.
 - [35] D'Anna L, Barba L, Foschi M, et al. Safety and outcomes of different endovascular treatment techniques for anterior circulation ischaemic stroke in the elderly: Data from the Imperial College Thrombectomy Registry [J]. *J Neurol*, 2024, 271 (3) : 1366-1375.
 - [36] Scharzt D, Ellens N, Kohli GS, et al. Impact of aspiration catheter size on clinical outcomes in aspiration thrombectomy [J]. *J Neurointerv Surg*, 2023, 15(e1): e111-e116.
 - [37] Wang C, Shi M, Li C, et al. Rescue strategy for hemorrhagic complication during mechanical thrombectomy and the clinical outcome [J]. *J Endovasc Ther*, 2023: 15266028231218880.
 - [38] Bu Z, Sun D, Ma G, et al. The impact of intraarterial, intravenous, and combined tirofiban on endovascular treatment for acute intracranial atherosclerotic occlusion [J]. *Front Neurol*, 2024, 15: 1336098.
 - [39] Elawady SS, Saway BF, Matsukawa H, et al. Thrombectomy in stroke patients with low Alberta stroke program early computed tomography score: Is modified thrombolysis in cerebral infarction (mTICI) 2c/3 superior to mTICI 2b? [J]. *J Stroke*, 2024, 26(1): 95-103.
 - [40] Ji Y, Shi B, Yuan Q, et al. Effect of prolonged microcirculation time after thrombectomy on the outcome of acute stroke[J]. *J Neurointerv Surg*, 2023, 15(11): 1078-1083.
 - [41] Alhazmi H, Ameen OK, Almalki Z, et al. Endovascular thrombectomy for acute ischemic stroke in Saudi Arabia: A single-center experience[J]. *J Stroke Cerebrovasc Dis*, 2024, 33(4): 107552.
 - [42] Borończyk M, Kuźniak M, Borończyk A, et al. Efficacy and safety of mechanical thrombectomy in the posterior cerebral circulation-a single center study[J]. *Sci Rep*, 2024, 14(1): 7700.
 - [43] Kobeissi H, Ghozy S, Seymour T, et al. Outcomes of patients with atrial fibrillation following thrombectomy for stroke: A systematic review and meta-analysis [J]. *JAMA Netw Open*, 2023, 6(1): e2249993.
 - [44] Hu W, Shen H, Tao C, et al. Effect of renal impairment on the efficacy and safety of intra-arterial treatment: A post-hoc analysis of DIRECT-MT study[J]. *Int J Stroke*, 2022, 17(7): 746-752.
 - [45] Xue J, Zhang XG, Zhang D, et al. Predictors of very poor outcome after mechanical thrombectomy in older patients with acute ischemic stroke[J]. *World Neurosurg*, 2024, 185: e1224-e1229.
 - [46] Alexandre AM, Scarcia L, Brunetti V, et al. Predictors of parenchymal hematoma and clinical outcome after mechanical thrombectomy in patients with large ischemic core due to large vessel occlusion: A retrospective multicenter study [J]. *J Neurointerv Surg*, 2024, 17(e1): e87-e95.
 - [47] Shen H, Ma Q, Jiao L, et al. Prognosis and predictors of symptomatic intracranial hemorrhage after endovascular treatment of large vessel occlusion stroke [J]. *Front Neurol*, 2022, 12: 730940.
 - [48] Hung A, Ejimogu E, Ran K, et al. Clinically asymptomatic hemorrhagic conversion is associated with need for inpatient rehabilitation after mechanical thrombectomy for anterior circulation ischemic stroke[J]. *World Neurosurg*, 2024, 186: e181-e190.
 - [49] Merlino G, Romoli M, Ornello R, et al. Stress hyperglycemia is associated with futile recanalization in patients with anterior large vessel occlusion undergoing mechanical thrombectomy [J]. *Eur Stroke J*, 2024, 9(3): 613-622.
 - [50] Lasek-Bal A, Żak A, Binek Ł, et al. Relevance of admission hyperglycaemia and diabetes mellitus to efficacy and safety of mechanical thrombectomy in stroke patients [J]. *Neurol Neurochir Pol*, 2022, 56(6): 472-479.
 - [51] Klapproth S, Meyer L, Kniep H, et al. Effect of short- versus long-term serum glucose levels on early ischemic water homeostasis and functional outcome in patients with large vessel occlusion stroke[J]. *Eur J Neurol*, 2024, 31(3): e16166.
 - [52] Zhang L, Li J, Yang B, et al. The risk and outcome of malignant brain edema in post-mechanical thrombectomy: Acute ischemic stroke by anterior circulation occlusion[J]. *Eur J Med Res*, 2023, 28(1): 435.
 - [53] Chen H, Ahmad G, Phipps MS, et al. Peri-procedural decrease in hemoglobin following mechanical thrombectomy for ischemic stroke [J]. *Interv Neuroradiol*, 2023: 15910199231205627.
 - [54] Inui R, Koge J, Tanaka K, et al. Detrimental effect of Anemia after mechanical thrombectomy on functional outcome in patients with ischemic stroke[J]. *Front Neurol*, 2023, 14: 1299891.
 - [55] Toruno MA, Al-Janabi OM, Ghozy S, et al. Outcomes of mechanical thrombectomy in patients with acute ischemic stroke and thrombocytopenia: Systematic review and meta-analysis [J]. *J Neurol*, 2024, 271(7): 4383-4391.
 - [56] Akpınar CK, Kocaturk O, Aykac O, et al. Can C-reactive protein/albumin ratio be a prognostic factor in acute stroke patients undergoing mechanical thrombectomy? [J]. *Clin Neurol Neurosurg*, 2023, 231: 107856.
 - [57] Chen F, Bai X, Wang X, et al. Impact of high-sensitivity troponin elevation and dynamic changes on 90-day mortality in patients with acute ischemic stroke after mechanical thrombectomy: Results from an observational cohort [J]. *J Neurointerv Surg*, 2023, 15(11): 1142-1147.
 - [58] Yu S, Huang ZC, Wang HS, et al. Eosinophil: a new circulating biomarker for risk of poor outcome in stroke patients undergoing mechanical thrombectomy[J]. *Clin Interv Aging*, 2023, 18: 523-531.
 - [59] 张晓鸽, 吴敏, 高旸, 等. 中性粒细胞/淋巴细胞比值对急性大血管闭塞性卒中血管内治疗后症状性颅内出血的影响[J]. *中风与神经疾病杂志*, 2023, 40(4): 357-361.
 - [60] Chen S, Cheng J, Ye Q, et al. Day 1 neutrophil-to-lymphocyte ratio (NLR) predicts stroke outcome after intravenous thrombolysis and mechanical thrombectomy[J]. *Front Neurol*, 2022, 13: 941251.
 - [61] Zhang X, Zhou F, Wang W, et al. Levels of adhesion molecules and clinical outcomes in patients with ischemic stroke after mechanical thrombectomy[J]. *Front Neurol*, 2022, 13: 1024162.
 - [62] Xu B, Yin T, Sun T, et al. Peripheral blood syndecan-1 levels after mechanical thrombectomy can predict the clinical prognosis of patients with acute ischemic stroke[J]. *Acta Neurochir (Wien)*, 2024, 166(1): 153.
 - [63] Zang N, Lin Z, Huang K, et al. Biomarkers of unfavorable outcome in acute ischemic stroke patients with successful recanalization by endovascular thrombectomy [J]. *Cerebrovasc Dis*, 2020, 49(6): 583-592.
 - [64] Li X, Duan W, Du L, et al. Intracarotid infusion of redox-active manganese porphyrin, MnTnBuOE-2-PyP⁵⁺, following reperfusion improves long-term, 28-day post-stroke outcomes in rats[J]. *Antioxidants (Basel)*, 2023, 12(10): 1861.

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