· 专题报道 ·

颅内动脉机械取栓联合颈动脉支架植入治疗颈内动脉串联病变所致急性缺血性脑卒中的疗效分析

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［摘要］　**目的**　评价颅内动脉机械取栓联合颈动脉支架植入治疗颈内动脉串联病变所致急性缺血性脑卒中的疗效及安全性。**方法**　回顾性纳入 2019 年 1 月至 2020 年 12 月在聊城市人民医院脑科医院神经外科就诊的颈内动脉串联病变所致急性缺血性脑卒中患者 55 例，其中采取先行颅内动脉闭塞处机械取栓、后行颈内动脉起始部重度狭窄或闭塞段支架植入手术策略的患者 43 例（由远及近组），采用先行颈内动脉起始部重度狭窄或闭塞段支架植入、后行颅内动脉闭塞处机械取栓手术策略的患者 12 例（由近及远组）。比较两组患者发病至股动脉穿刺时间，入院时、术后 24 h、术后 7 d 美国国立卫生研究院卒中量表（NIHSS）评分，术中 1 次取栓成功率，股动脉穿刺至血管再通时间，术后即刻血管成功再通（改良脑梗死溶栓分级≥2b 级）率，术后症状性颅内出血发生率，以及术后 90 d 预后良好（改良 Rankin 量表评分≤2 分）率、死亡率。**结果**　55 例患者均顺利完成颅内动脉闭塞处机械取栓及颈内动脉起始部重度狭窄或闭塞段支架植入术。由远及近组患者 1 次取栓成功率高于由近及远组［67.4%（29/43）vs 33.3%（4/12）］，股动脉穿刺至血管再通时间短于由近及远组［（68.77±17.65）min vs （100.08±38.38）min］，差异均有统计学意义（P 均＜0.05）。两组患者发病至股动脉穿刺时间，入院时、术后 24 h、术后 7 d NIHSS 评分，术后即刻血管成功再通率，术后症状性颅内出血发生率，以及术后 90 d 预后良好率和死亡率差异均无统计学意义（P 均＞0.05）。**结论**　颅内动脉机械取栓同期颈动脉支架植入治疗颈内动脉串联病变所致急性缺血性脑卒中是安全、有效的，但采取由远及近的手术策略比由近及远手术策略有更高的 1 次取栓成功率且能更快地达到血管再通。

［关键词］　急性缺血性脑卒中；颈动脉串联病变；机械取栓术；颈动脉支架植入

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Mechanical thrombectomy of intracranial artery combined with carotid stent implantation in treatment of acute ischemic stroke caused by tandem lesions of internal carotid artery: an analysis of efficacy

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［Abstract］　**Objective**　To evaluate the efficacy and safety of mechanical thrombectomy of intracranial artery combined with carotid stent implantation in the treatment of acute ischemic stroke caused by tandem lesions of internal carotid artery. **Methods**　A total of 55 patients with acute ischemic stroke caused by tandem lesions of internal carotid artery treated in Department of Neurosurgery of Liaocheng People's Hospital (Brain Hospital) from Jan. 2019 to Dec. 2020 were retrospectively included. Among them, 43 patients (distal-to-proximal group) were treated with mechanical thrombectomy for the occluded lesion of intracranial artery, followed by stent implantation for the severe stenotic/occluded lesions of initial internal carotid artery, and 12 patients (proximal-to-distal group) were treated with stent implantation for the severe stenotic/occluded lesions of initial internal carotid artery, followed by mechanical thrombectomy for the occluded lesion of intracranial artery. Onset-to-puncture time, National Institutes of Health stroke scale (NIHSS) scores on admission, and 24 h and 7 d after operation, the success rate of 1-time thrombectomy during operation, puncture-to-recanalization time, rate of successful recanalization immediately after operation (modified thrombolysis in cerebral infarction grade≥2b), incidence of postoperative symptomatic intracranial hemorrhage, and good prognosis (modified Rankin scale score≤2) rate and mortality 90 d after operation were compared between the 2 groups. **Results**　All patients successfully received mechanical

thrombectomy of intracranial artery and stent implantation of initial internal carotid artery. The success rate of 1-time thrombectomy in the distal-to-proximal group was significantly higher than that in the proximal-to-distal group (67.4%［29/43］ vs 33.3%［4/12］, $P<0.05$), and the puncture-to-recanalization time was significantly shorter than that in the proximal-to-distal group (［68.77±17.65］min vs［100.08±38.38］min, $P<0.05$). There were no significant differences in the onset-to-puncture time, NIHSS scores on admission, 24 h and 7 d after operation, successful recanalization rate immediately after operation, incidence of postoperative symptomatic intracranial hemorrhage, or good prognosis rate and mortality 90 d after operation between the 2 groups (all $P>0.05$). **Conclusion**　Mechanical thrombectomy of intracranial artery combined with carotid stent implantation is safe and effective in the treatment of acute ischemic stroke caused by tandem lesions of internal carotid artery. The distal-to-proximal strategy has a higher success rate of 1-time thrombectomy than the proximal-to-distal strategy, and can achieve successful recanalization much faster.

［**Key words**］　acute ischemic stroke; carotid artery tandem lesions; mechanical thrombectomy; carotid artery stent implantation

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　　颈内动脉串联病变是指颅内大血管闭塞合并同侧颈内动脉颅外段重度狭窄或闭塞病变,此类患者占急性缺血性脑卒中的 10%～15%[1]。与单纯的急性颅内大血管闭塞相比,颈内动脉串联病变患者的预后更差、致残率和死亡率更高,若闭塞血管不能及时、有效再通,总死亡率可达 55%[2]。颈内动脉串联病变的手术策略根据病变处理的先后次序分为优先远端取栓和优先颈动脉支架植入 2 种,采用哪种治疗方式的患者临床预后更优存在一定争议[3]。先处理颅内动脉闭塞病变能最大限度地缩短血管再通时间,但是在治疗颈内动脉颅外段病变的时候有可能发生颅内动脉再次闭塞;若优先处理颈内动脉颅外段病变则延长了血管再通时间。本研究回顾性分析接受颅内动脉机械取栓同期颈动脉支架植入治疗的颈内动脉串联病变所致急性缺血性脑卒中患者资料,观察其治疗效果。

1　资料和方法

1.1　研究对象　回顾性选择 2019 年 1 月至 2020 年 12 月在聊城市人民医院脑科医院神经外科就诊的前循环急性缺血性脑卒中患者 376 例。纳入标准:(1)急性缺血性脑卒中的诊断符合《中国急性缺血性脑卒中诊治指南 2018》[4]中诊断标准,且术中全脑血管造影检查证实前循环颅内动脉闭塞合并同侧颈内动脉起始部重度狭窄或闭塞;(2)年龄≥18 岁;(3)发病至股动脉穿刺时间<6 h;(4)入院时美国国立卫生研究院卒中量表(National Institutes of Health stroke scale,NIHSS)评分≥6 分;(5)发病前改良 Rankin 量表(modified Rankin scale,mRS)评分<2 分;(6)患者或其家属对手术方案及治疗风险充分知情并签署手术知情同意书。

1.2　研究方法　将入组患者根据血管内治疗处理策略分为由远及近组和由近及远组。

1.2.1　血管内治疗　(1)由远及近组:患者取仰卧位,予经口气管插管全身麻醉。经股动脉置入 8 F 短动脉鞘(日本 Terumo 公司),泥鳅导丝导引 8 F 导引导管(美国 Boston Scientific 公司)、5 F 中间导管(美国 EV3 公司)到达患侧颈总动脉分叉附近。首先尝试将中间导管通过颈内动脉起始部重度狭窄或闭塞段,若未成功,则在路图下由微导管辅助微导丝通过颈内动脉起始段重度狭窄或闭塞段,然后沿微导丝送入球囊扩张导管,扩张颈内动脉起始段狭窄或闭塞段。球囊扩张后将中间导管通过颈内动脉起始段到达颈内动脉颅内段,由 Traxcess 14 微导丝(美国 MicroVention 公司)辅助 Rebar-18 微导管(美国 EV3 公司)通过颅内动脉闭塞段到达远端正常管腔。释放 Solitaire FR 取栓支架(美国 EV3 公司)覆盖闭塞病变处,停留 5 min 后,在支架锚定装置协助下操作 Navien 导管继续前进并保持负压抽吸,缓慢回撤取栓支架及中间导管至导引导管内。机械取栓操作结束后立即行患侧颈内动脉造影,若血管未开通则重复上述取栓操作。确认远端血管通畅后,将 Navien 导管置于颈内动脉岩段垂直部分,沿 Navien 导管释放 Spider FX 5.0 远端栓塞保护装置(美国 EV3 公司),根据颈内动脉起始部狭窄程度决定是否需要行球囊预扩张。然后置入 Protege RX 颈动脉支架

（美国 EV3 公司），根据支架形态及支架植入术后颈内动脉起始部残余狭窄的严重程度决定是否予球囊再扩张。最后进行造影检查，采用改良脑梗死溶栓（modified thrombolysis in cerebral infarction，mTICI）分级评估血管再通情况，结束手术（图 1）。
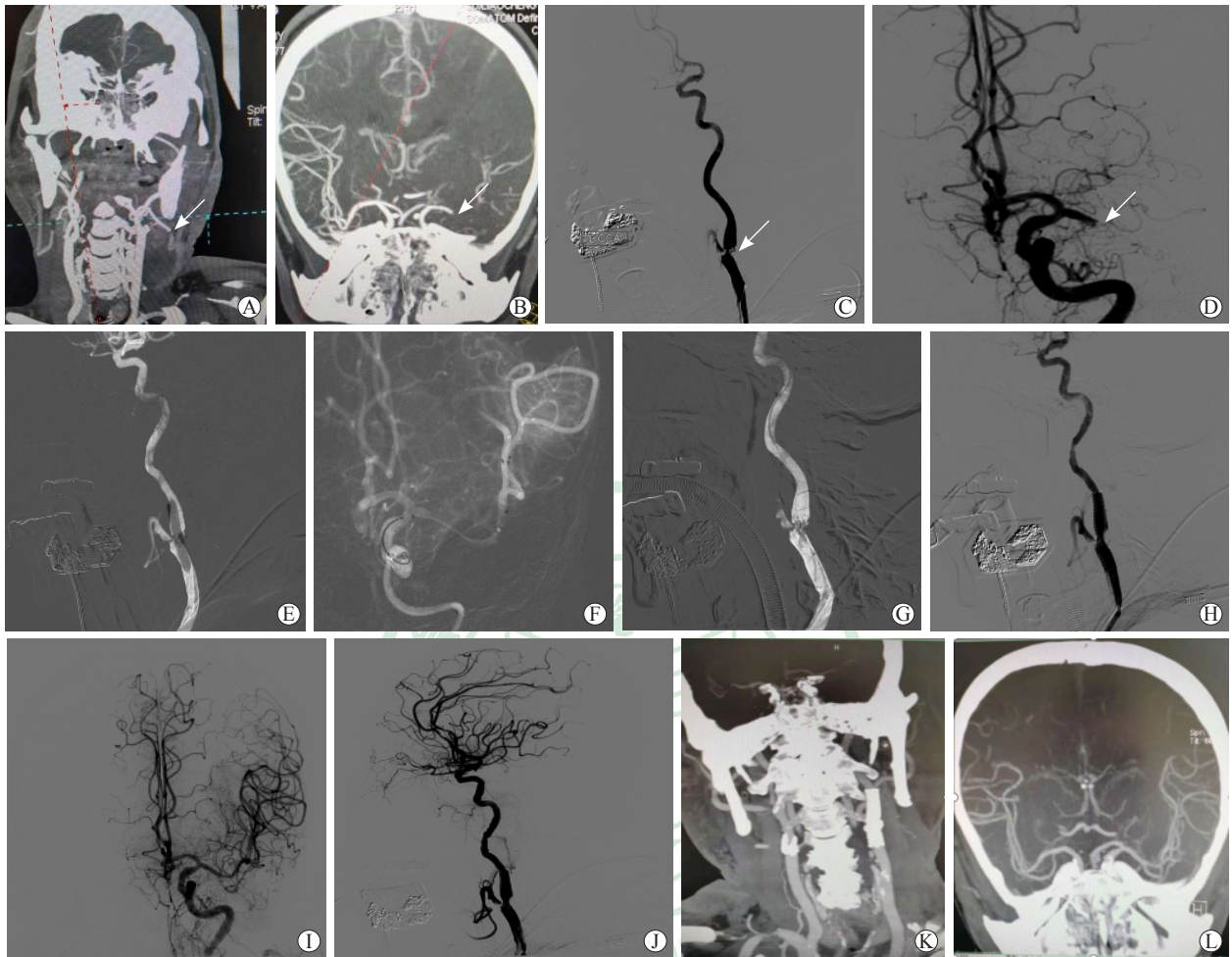

图 1　1 例采用由远及近行机械取栓＋支架植入术的左侧颈内动脉串联病变患者的影像学资料

Fig 1　Imaging data of a patient with tandem lesions of left internal carotid artery undergoing mechanical thrombectomy＋stent implantation from distal to proximal

A 62-year-old male patient suffered from a sudden aphasia and was unable to move his right limbs for 2 h. The pre-onset modified Rankin scale score was 0, and the baseline National Institutes of Health stroke scale score was 19. A: Preoperative CTA confirming the left internal carotid artery occlusion (arrow); B: Preoperative CTA showing occlusion of the M1 segment of left middle cerebral artery (arrow); C: Intraoperative angiography showing extremely severe stenosis of the left internal carotid artery (arrow); D: Intraoperative angiography showing occlusion of the left middle cerebral artery (arrow); E: Balloon dilation of the carotid bulb; F: Stent thrombus removal in the left middle cerebral artery; G: Balloon dilation of the start of internal carotid artery under the distal protection device; H: Carotid stent implantation; I: Angiography showed that the left middle cerebral artery was unobstructed; J: Angiography showed that the left internal carotid artery was unobstructed; K: Postoperative CTA showed that the left internal carotid artery was unobstructed; L: CTA after operation showed that the left middle cerebral artery was unobstructed. CTA: Computed tomography angiography.

（2）由近及远组：患者先在颈内动脉起始部重度狭窄或闭塞段植入支架，然后应用取栓支架在颅内动脉闭塞处行机械取栓操作，支架植入和取栓具体操作同由远及近组。

1.2.2　围手术期药物治疗　（1）静脉溶栓：对于发病 4.5 h 内的患者，由术者决定是否予阿替普酶静脉溶栓治疗，剂量为 0.9 mg/kg；发病 4.5～6 h 的患者直接行血管内治疗。（2）术后用药情况：对于术中 Dyna-CT 检查未见明显造影剂渗出或渗出较少的患者，术后予替罗非班 0.25～0.3 mg/L 静脉

泵入,停用替罗非班 4 h 前口服负荷剂量双联抗血小板聚集药物(阿司匹林 300 mg＋硫酸氢氯吡格雷 300 mg),之后予阿司匹林 100 mg＋硫酸氢氯吡格雷 75 mg 口服,每天 1 次,3 个月后根据血栓弹力图结果调整为单药终身服用。术后 24 h 复查头颅 CT,如发生症状性颅内出血则立即停用抗血小板聚集药物。

1.2.3 疗效、评价指标及随访 主要评价指标为术中 1 次取栓成功率、术后 90 d 预后良好(mRS 评分≤2 分)率,次要评价指标包括血管成功再通(mTICI 分级≥2b 级)率、术后 24 h NIHSS 评分、术后 7 d NIHSS 评分、发病至股动脉穿刺时间、股动脉穿刺至血管再通时间、术后症状性颅内出血发生率、术后 90 d 死亡率等。除住院期间临床死亡患者外,其余均完成术后 90 d 随访。

1.3 统计学处理 应用 SPSS 22.0 软件进行统计学分析。符合正态分布的计量资料以 $\bar{x}\pm s$ 表示,两组间比较采用独立样本 t 检验;计数资料以例数和百分数表示,两组间比较采用 χ^2 检验或 Fisher 确切概率法。检验水准(α)为 0.05。

2 结 果

2.1 两组患者基线资料比较 共 55 例颈内动脉串联病变所致急性缺血性脑卒中患者入组,其中男 35 例、女 20 例,年龄为 35～82 岁,平均年龄为(63.17±10.40)岁。合并糖尿病患者 11 例,合并高血压患者 17 例,合并高脂血症患者 28 例,有吸烟史患者 23 例。55 例患者发病前 mRS 评分均＜2 分。31 例接受静脉溶栓桥接血管内治疗,24 例直接行血管内治疗。由远及近组 43 例,由近及远组 12 例,两组患者性别、年龄、脑卒中危险因素、入院时 NIHSS 评分、行静脉溶栓患者占比、血管闭塞部位、发病至股动脉穿刺时间差异均无统计学意义(P 均＞0.05)。见表 1。

表 1 两组颈内动脉串联病变所致急性缺血性脑卒中患者的基线资料比较

Tab 1 Comparison of baseline data of patients with acute ischemic stroke caused by internal carotid artery tandem lesions between 2 groups

Index	Distal-to-proximal group N＝43	Proximal-to-distal group N＝12	Statistic	P value
Age/year, $\bar{x}\pm s$	63.42±10.90	62.67±8.29	$t=0.221$	0.826
Male, n (%)	30 (69.8)	5 (41.7)	$\chi^2=2.102$	0.147
Diabetes mellitus, n (%)	9 (20.9)	2 (16.7)	$\chi^2=0.000$	1.000
Hyperlipidemia, n (%)	23 (53.5)	5 (41.7)	$\chi^2=0.525$	0.469
Hypertension, n (%)	13 (30.2)	4 (33.3)	$\chi^2=0.000$	1.000
Smoking, n (%)	18 (41.9)	5 (41.7)	$\chi^2=0.000$	0.990
NIHSS score on admission, $\bar{x}\pm s$	18.12±4.11	18.50±3.92	$t=0.289$	0.774
Intravenous thrombolysis, n (%)	24 (55.8)	7 (58.3)	$\chi^2=0.024$	0.876
Occlusion site, n (%)			Fisher exact test	1.000
MCA-M1	40 (93.0)	11 (91.7)		
MCA-M2	3 (7.0)	1 (8.3)		
OPT/min, $\bar{x}\pm s$	213.28±57.91	186.83±48.60	$t=1.444$	0.155

　　Distal-to-proximal group: Mechanical embolectomy was performed for the occluded lesion of intracranial artery, followed by stent implantation for the stenotic/occluded internal carotid artery; Proximal-to-distal group: Stent implantation was performed for the stenotic/occluded internal carotid artery, followed by mechanical embolectomy for the occluded lesion of intracranial artery. NIHSS: National Institutes of Health stroke scale; MCA: Middle cerebral artery; OPT: Onset-to-puncture time.

2.2 两组患者治疗效果比较 所有患者均顺利完成颅内动脉闭塞处机械取栓及颈内动脉起始部重度狭窄或闭塞段支架植入术。由远及近组患者 1 次取栓成功率高于由近及远组,股动脉穿刺至血管再通时间短于由近及远组,差异均有统计学意义(P 均＜0.05)。而两组患者术后即刻血管成功再通率、术后症状性颅内出血发生率、术后 24 h NIHSS 评分、术后 7 d NIHSS 评分、术后 90 d 预后良好率和死亡率差异均无统计学意义(P 均＞0.05)。见表 2。

表 2　两组颈内动脉串联病变所致急性缺血性脑卒中患者的治疗效果比较

Tab 2　Comparison of therapeutic effects of patients with acute ischemic stroke caused by internal carotid artery tandem lesions between 2 groups

Index	Distal-to-proximal group $N=43$	Proximal-to-distal group $N=12$	Statistic	P value
Times of mechanical thrombectomy, n (%)			Fisher exact test	0.040
1	29 (67.4)	4 (33.3)		
2	13 (30.2)	6 (50.0)		
3	1 (2.3)	2 (16.7)		
mTICI grade≥2b, n (%)	43 (100.0)	12 (100.0)	$\chi^2=0.026$	1.000
PRT/min, $\bar{x}\pm s$	68.77±17.65	100.08±38.38	$t=2.747$	0.017
sICH, n (%)	6 (14.0)	2 (16.7)	$\chi^2=0.000$	1.000
NIHSS score 24 h after operation, $\bar{x}\pm s$	11.56±6.20	11.58±7.53	$t=0.012$	0.991
NIHSS score 7 d after operation, $\bar{x}\pm s$	8.47±3.32	8.36±4.02	$t=0.011$	0.892
mRS score 90 d after operation, $\bar{x}\pm s$	2.19±1.79	2.58±1.62	$t=0.693$	0.491
90 d mRS score≤2, n (%)	29 (67.4)	6 (50.0)	$\chi^2=0.595$	0.441
90 d mortality, n (%)	4 (9.3)	1 (8.3)	Fisher exact test	1.000

　　Distal-to-proximal group: Mechanical embolectomy was performed for the occluded lesion of intracranial artery, followed by stent implantation for the stenotic/occluded internal carotid artery; Proximal-to-distal group: Stent implantation was performed for the stenotic/occluded internal carotid artery, followed by mechanical embolectomy for the occluded lesion of intracranial artery. mTICI: Modified thrombolysis in cerebral infarction; PRT: Puncture-to-recanalization time; sICH: Symptomatic intracranial hemorrhage; NIHSS: National Institutes of Health stroke scale; mRS: Modified Rankin scale.

3　讨　论

　　急性颈内动脉串联病变患者同时存在近端颈内动脉病变和远端颅内动脉病变,是急性缺血性脑卒中的一个较为复杂的类型,此类患者行单纯静脉溶栓治疗的血管成功再通率仅为 9%,预后良好率仅为 20%,而死亡率高达 55%[5],可能是因为血栓负荷较大、顺行血流量较少,使溶栓药物难以到达颅内血栓处。HERMES 研究表明颈内动脉串联病变导致的急性缺血性脑卒中行静脉溶栓联合机械取栓术的治疗效果优于单纯静脉溶栓[6],还有多项研究详细分析了血管内治疗串联病变的有效性和安全性,但对于串联病变血管内治疗的手术策略尚无统一意见[7-9]。

　　目前针对颈内动脉串联病变的手术策略分为优先处理近端病变(由近及远)和优先处理远端病变(由远及近),2 种方式各有优缺点。由近及远的手术策略先行颈内动脉起始部支架植入使颈内动脉血流恢复后,再行颅内动脉闭塞机械取栓术,该术式的优点是可以建立良好的血管通路,能避免在颅内动脉取栓后进行颈内动脉手术操作时出现颅内血管再次闭塞的可能,但是也存在近端血流恢复后远端栓子逃逸的风险,并且近端病变优先处理使远端血管再通时间延长,可能会引起更大面积的梗死灶。而优先处理远端病变即先开通颅内动脉闭塞段,如果颈内动脉起始部闭塞或重度狭窄,中间导管无法通过时,可先予球囊扩张,待颈内动脉血流恢复后再行颈内动脉支架植入,这一方式能使远端血管快速再通,但是手术难度相对较高,在建立血管通路时可能会导致血液进入血管壁甚至发生动脉夹层和血管穿孔。一篇 meta 分析显示 2 种手术方案在血管成功再通率、术后症状性颅内出血发生率、术后 90 d 预后良好率方面差异均无统计学意义[10];也有研究表明先处理颅内动脉病变再处理颈内动脉颅外段病变的手术方案在血管成功再通率、并发症发生率方面优于先处理颈内动脉颅外段病变再处理颅内动脉病变[11]。针对颈内动脉串联病变的手术策略,有学者总结提出了 PEARS(protect-expand-aspiration-revascularization-stent)技术[12]和 Double PT(pass-thrombectomy-protective thrombectomy)技术[13],但是针对串联病变的最佳手术方案仍未达成共识[14]。本研究中多数患者采取先远后近的逆向开通策略,即采用球囊扩张颈内动脉起始部闭塞或重度狭窄段后推送导引导管通过狭窄或闭塞段,此时颈内动脉无正向血流,起到了防止远端栓子逃逸的作用,且 Navien 导管跟进后予负压抽吸能有效地清除颈内动脉起始部脱落的栓子和血栓组织;然后予颅内动脉机械取栓操作,取栓后撤除微导丝微导管级取栓支架、保留 Navien 导管,沿 Navien 导管输送保护伞到达颈内

动脉岩段垂直部分保护伞到位后撤除 Navien 导管,再沿保护伞推送杆送入球囊,予狭窄处预扩张;最后释放颈动脉支架,若支架打开不良、残余狭窄较严重,可再次予球囊扩张。

颈内动脉串联病变所致急性缺血性脑卒中患者行血管内治疗时,无论由远及近开通还是由近及远开通,缺血再灌注时间都是影响预后的主要因素,越短的再灌注时间意味着更好的预后。在一项纳入 25 例颈内动脉串联闭塞患者的研究中,优先处理颅内病变组血管再通时间较优先处理颅外病变组短[(43±31)min vs(111±43)min,$P<0.001$],但是两组患者的预后差异无统计学意义,这可能和样本量较小、存在抽样误差有关[15]。本研究中两组患者术中均未发生远端血管开通后再闭塞,但与由近及远组相比,由远及近组患者的 1 次取栓成功率更高、股动脉穿刺至血管再通时间更短,能更快地达到血管再通。

远端血管机械取栓成功后否需要同期植入颈动脉支架存在争议,因为急性期支架植入后,为避免支架内血栓形成需立即给予负荷剂量抗血小板聚集药物治疗,这可能会增加颅内出血的风险,尤其当患者在接受静脉溶栓治疗后。Heck 和 Brown[16]研究报道急诊颈内动脉支架植入术后患者应用抗血小板聚集药物治疗,其症状性颅内出血发生率高达 22%。然而有研究提示,对于急性缺血性脑卒中患者动脉内溶栓后行急诊支架植入术是安全、有效的[17]。Broeg-Morvay 等[18]研究表明,急诊支架植入术治疗颈内动脉串联闭塞并未增加症状性颅内出血的发生率。也有研究显示同期植入颈动脉支架的患者预后良好率较分期植入者更高,但是在术后死亡率和症状性颅内出血发生率方面无明显差异[19]。中国 ACTUAL 注册研究中症状性颅内出血发生率为 16.0%[20]。白永杰等[21]回顾性分析了 124 例颈内动脉串联闭塞患者资料,机械取栓术后症状性颅内出血发生率为 15.3%。本研究中由远及近组术后症状性颅内出血发生率为 14.0%(6/43),由近及远组为 16.7%(2/12),总体病例症状性颅内出血发生率为 14.5%(8/55),与上述研究结果相近,提示前循环颈内动脉串联病变患者行机械取栓同期颈动脉支架植入不会增加术后出血风险。

颈内动脉串联病变患者行血管内治疗围手术期的药物治疗方案目前也存在争议,TITAN 研究纳入 369 例行机械取栓术的颈内动脉串联闭塞患者,

发现接受抗血小板药物治疗的患者术后 90 d 死亡率更低,血管成功再通率更高,但术后脑出血发生率并未增加[1],Pop 等[22]研究发现联合应用阿司匹林和硫酸氢氯吡格雷双重抗血小板药物能显著降低支架植入术后支架内血栓形成的发生率,且对于颈动脉支架植入术后患者,大部分临床中心均给予双联抗血小板药物治疗。本研究入组患者术后 24 h 均行头颅 CT 检查,无颅内出血给予双联抗血小板药物治疗(阿司匹林 100 mg＋硫酸氢氯吡格雷 75 mg 每天 1 次口服),发生非症状性颅内出血的患者的一般情况下采取单一抗血小板药物,术后若发生症状性颅内出血则立即停用抗血小板药物。

同期在我院行机械取栓治疗的非串联闭塞患者共 321 例,218 例行静脉溶栓桥接机械取栓治疗,1 次取栓成功率为 75%,发病至股动脉穿刺时间为(231.26±60.20)min,股动脉穿刺至血管再通时间为(52.34±20.60)min,术后即刻血管成功再通率为 93%,术后 90 d 预后良好率为 56%、死亡率为 12%,症状性颅内出血发生率为 15%(未发表资料),与本研究中串联病变病例的治疗效果相当。本研究中血管成功再通率、症状性颅内出血发生率、术后 90 d 预后良好率也与文献[23-24]报道相近,但术后死亡率更低,这可能和入组病例数少、取栓评估剔除了一部分症状严重的病例有关。

综上所述,颅内动脉机械取栓联合颈动脉支架植入治疗颈内动脉串联病变所致急性缺血性脑卒中时,不论采取由近及远还是由远及近手术策略都是安全、有效的,但采取由远及近的手术策略能获得更高的 1 次取栓成功率且能更快地实现血管再通。但本研究采取回顾性分析,病例数较少且缺少随机化对照,结果有一定局限性,对急性颈内动脉串联病变患者的最佳治疗方案仍需进一步探索。

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