

## . 论 著 .

## 椎动脉 V4 段夹层动脉瘤的个体化治疗

徐 军 李海校 毛崇丹 吕成林 徐宝占 崔玉光 丰育功

【摘要】目的 探讨椎动脉 V4 段夹层动脉瘤的临床特点、治疗方法及其疗效。方法 回顾性分析 2017 年 1 月至 2023 年 6 月收治的 10 例椎动脉 V4 段夹层动脉瘤的临床资料。结果 10 例均发生急性出血,术前 Hunt-Hess 分级 I 级 1 例,II 级 5 例,III 级 4 例 1 例。单纯弹簧圈栓塞治疗 3 例,支架辅助弹簧圈栓塞治疗 2 例,弹簧圈栓塞+载瘤动脉闭塞治疗 5 例;术后即刻造影显示动脉瘤完全或次全闭塞率为 100%,随访期间未发现动脉瘤复发。1 例因术后支架内急性血栓形成死亡,其余 9 例术后恢复良好(GOS 评分 4~5 分)。结论 椎动脉 V4 段夹层动脉瘤为中青年脑卒中的重要病因,临床表现各异。对于有手术指征的病人,首选血管内治疗,具体治疗方案需根据病人具体情况进行个体化选择。

【关键词】颅内夹层动脉瘤;椎动脉 V4 段;临床特征;血管内治疗

【文章编号】1009-153X(2024)09-0522-05 【文献标志码】A 【中国图书资料分类号】R 743.9; R 815.2

**Individualized therapy for patients with dissecting aneurysms of the V4 segment of the vertebral artery**

XU Jun<sup>1</sup>, LI Hai-xiao<sup>1</sup>, MAO Chong-dan<sup>1</sup>, LÜ Cheng-lin<sup>1</sup>, XU Bao-zhan<sup>1</sup>, CUI Yu-guang<sup>1</sup>, FENG Yu-gong<sup>2</sup>. 1. Department of Neurosurgery, Weifang Medical College Affiliated Qingdao 8th People's Hospital, Qingdao 266100, China; 2. Department of Neurosurgery, Affiliated Hospital of Qingdao University, Qingdao 266000, China

【Abstract】Objective To explore the clinical characteristics, treatment methods, and therapeutic effects of dissecting aneurysms of the V4 segment of the vertebral artery. Methods The clinical data of 10 patients with dissecting aneurysms of the V4 segment of the vertebral artery admitted from January 2017 to June 2023 were retrospectively analyzed. Results All 10 patients presented with acute hemorrhage. Before the operation, 1 patient was classified as Hunt-Hess grade I, 5 as grade II, and 4 as grade III. Three patients were treated with simple coil embolization, 2 with stent-assisted coil embolization, and 5 with coil embolization plus occlusion of the parent artery. Immediate postoperative angiography showed that the complete or near-complete occlusion rate of aneurysms was 100%. No recurrence of aneurysms was found during the follow-up period. One patient died due to acute thrombosis within the stent after the operation, and the remaining 9 patients recovered well after the operation (GOS score of 4~5). Conclusions Dissecting aneurysms of the V4 segment of the vertebral artery are an important cause of stroke in young and middle-aged people, with diverse clinical manifestations. For patients with surgical indications, endovascular treatment is the preferred option, and the specific treatment plan needs to be individualized based on the patient's specific situation.

【Key words】Intracranial dissecting aneurysms; V4 segment of vertebral artery; Clinical characteristics; Endovascular therapy

椎动脉夹层动脉瘤是由各种原因导致的血管壁撕裂而形成的动脉瘤。椎动脉 V4 段因独特的解剖学和血流动力学特征更易导致局部结构的完整性破坏,从而形成夹层动脉瘤<sup>[1]</sup>。椎动脉 V4 段夹层动脉瘤(intracranial vertebral artery dissecting aneurysms, IVDAD)是导致中青年脑卒中的重要原因,年发病率在(1~1.5)/10 万<sup>[2]</sup>,其临床表现多样且不具特异性,为临床诊断带来一定难度。未经处理的 IVADA 易导致蛛网膜下腔出血,发生率高达 83%<sup>[3]</sup>。本文回顾性分析 2017 年 1 月至 2023 年 6 月收治的 10 例

IVDAD 的临床资料,总结诊治经验,旨在提高对 IVADA 的认识。

## 1 资料与方法

1.1 一般资料 10 例中,男性 7 例,女性 3 例;年龄 39~73 岁,平均(56±11)岁。10 例均以急性出血发病,以突发剧烈头痛并意识障碍入院,其中 1 例因突发头痛 3.5 h 入院,途中频繁恶心呕吐并误吸、肢体抽搐,呼吸心跳骤停后 120 心肺复苏成功,既往有甲亢病史 4 年,曾服药治疗,入院前已停药(图 1)。术前 Hunt-Hess 分级 I 级 1 例,II 级 5 例,III 级 4 例。10 例病人的基线资料见表 1。

1.2 影像学资料 10 例术前均行 DSA 检查确诊,其中 2 例同时行 MRI 及 MRA 检查,9 例同时行 CTA 检查。动脉瘤位于小脑后下动脉(posterior inferior cer-

ebellar artery, PICA)远端 3 例, PICA 起始部 5 例, PICA 近端 2 例。对侧椎动脉发育良好 7 例, 对侧发育差或不发育(或闭塞)3 例。

1.3 治疗方法

1.3.1 直接弹簧圈栓塞 全麻后, 经股动脉穿刺置入 6F 动脉鞘, 全身肝素化。在路图下, 将微导管头端置入动脉瘤体内, 选择弹簧圈行栓塞治疗。

1.3.2 动脉瘤栓塞+闭塞载瘤动脉 穿刺双侧股动脉, 患侧椎动脉行闭塞试验, 对侧椎动脉造影, 分析可耐受后, 微导管送入动脉瘤体内行弹簧圈部分栓塞, 再在动脉瘤近端载瘤动脉(椎动脉)内填入弹簧圈将其闭塞。闭塞时, 注意确保 PICA 可从同侧或对侧椎动脉获得足够血供。

1.3.3 支架辅助弹簧圈栓塞 术前常规抗血小板药物准备, 采用支架半释放及后释放技术辅助弹簧圈栓塞动脉瘤, 支架完全覆盖动脉瘤颈远、近端各 3 mm 以上。

1.3.4 术后处理 术后均给予腰椎穿刺术或腰大池置管引流术, 脑室内出血量大者行脑室外引流术。常规尼莫地平抗血管痉挛, 同时给予“3H”治疗。支架辅助栓塞者, 给予常规抗血小板聚集治疗, 并根据服用情况或复查后调整用药。

2 结果

10 例中, 3 例行直接弹簧圈栓塞术, 5 例行动脉瘤栓塞+闭塞载瘤动脉, 2 例行支架辅助弹簧圈栓塞术; 术后即刻造影显示完全或次全闭塞率为 100%, 随访期间未发现动脉瘤复发。2 例动脉瘤栓塞+闭塞载瘤动脉术后未见明显后遗症, 预后良好(图 2); 1 例支架辅助弹簧圈栓塞术后支架内急性血栓形成

死亡; 另外 7 例术后遗留不同程度的后遗症, 包括额颞、后枕及颈部疼痛, 头晕、行走不稳, 肢体无力等, 其中 1 例双侧椎动脉夹层动脉瘤择期行对侧支架辅助弹簧圈栓塞术(图 1), 仅存右侧上眼睑轻度下垂, 随访期间右侧上眼睑下垂逐渐改善。存活 9 例末次随访, GOS 评分 4~5 分。

3 讨论

椎动脉夹层动脉瘤是各种原因导致的血管壁撕裂而形成的动脉瘤。根据撕裂位置的不同, 血管损伤的程度及形态各异。若撕裂损伤位于血管内膜与中膜之间, 继发性血肿形成可产生与原管腔平行的假腔, 这种情况轻者以缺血症状为主, 重者可同时出现缺血、闭塞及出血症状; 若是血管中膜和外膜损伤, 则更易导致管壁瘤样凸起, 从而形成夹层动脉瘤, 若瘤体进一步扩张、破裂, 则可出现蛛网膜下腔出血等<sup>[4]</sup>。

IVADA 是后循环动脉瘤中常见的类型, 好发于 40~50 岁, 占有后循环动脉瘤的 28%, 占颅内动脉瘤的 3.8%<sup>[5]</sup>。因病变部位不同, IVADA 的临床表现各异, 除常见症状外, 因血管壁撕裂、牵拉缺血、瘤样扩张、血肿压迫等因素, 也可出现较为少见的脑干及小脑症状<sup>[6,7]</sup>。也有文献报道突然破裂的椎动脉夹层动脉瘤可首先出现下腰部疼痛、下肢麻木、便秘等不典型马尾神经综合征, 随后再出现典型的蛛网膜下腔出血表现<sup>[8]</sup>。

对于椎动脉夹层动脉瘤的治疗, 尚缺乏统一的治疗方案。Kim 和 Lim<sup>[9]</sup>报道未破裂的 IVADA 可自愈, 可能与女性、不吸烟、无小脑后下动脉受累、基底动脉弯曲较少等有关。本 1 例双侧椎动脉夹层动脉

表 1 椎动脉 V4 段夹层动脉瘤的临床资料  
Table 1 Clinical data of patients with dissecting aneurysms of the V4 segment of the vertebral artery

病例	年龄 (岁)	性别	入院 GCS 评分(分)	术前 Hunt- Hunter 分级	术前改良 Fisher 分级	治疗方式	随访时间 (月)	GOS 评分 (分)
病例 1	39	女	14	Ⅱ级	1 级	支架辅助栓塞	6	5
病例 2	45	男	13	Ⅲ级	3 级	栓塞+载瘤动脉闭塞	8	4
病例 3	64	男	14	Ⅲ级	2 级	单纯弹簧圈栓塞	8	4
病例 4	52	男	15	Ⅰ级	1 级	单纯弹簧圈栓塞	9	5
病例 5	45	女	13	Ⅱ级	2 级	栓塞+载瘤动脉闭塞	12	5
病例 6	73	男	13	Ⅲ级	2 级	支架辅助栓塞	0	1
病例 7	53	女	14	Ⅱ级	2 级	单纯弹簧圈栓塞	18	5
病例 8	64	男	13	Ⅲ级	3 级	栓塞+载瘤动脉闭塞	15	5
病例 9	67	女	14	Ⅱ级	2 级	栓塞+载瘤动脉闭塞	12	4
病例 10	58	女	14	Ⅱ级	2 级	栓塞+载瘤动脉闭塞	8	5

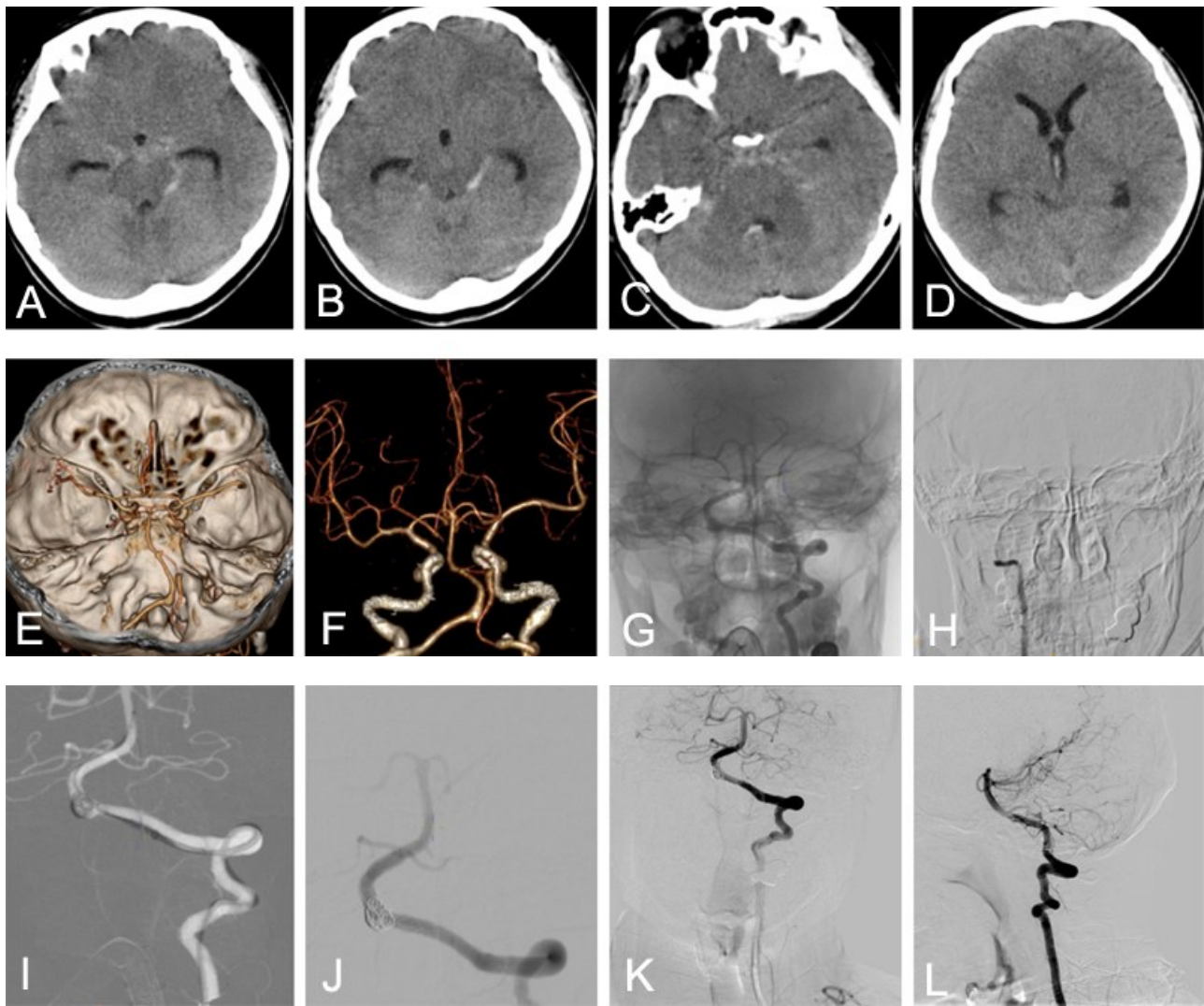


图 1 双侧椎动脉 V4 段夹层动脉瘤支架辅助弹簧圈栓塞术前后影像  
A-D. 术前头颅 CT 示鞍上池、环池、四叠体池、左侧桥前池及第三、四脑室高密度影,考虑蛛网膜下腔出血;E、F. 术前 CTA 显示双侧椎动脉 V4 段夹层动脉瘤,右侧相对优势;G-J. DSA 显示左侧椎动脉 V4 段局部梭型扩张,形态较规则,右侧椎动脉 V3 段以远未见显影,考虑右侧椎动脉闭塞;K、L. 术后半年复查 DSA,未见动脉瘤复发

**Figure 1 Pre- and post-operative images of a patient with bilateral dissecting aneurysms of the V4 segment of the vertebral artery undergoing stent-assisted coil embolization**

A-D: Preoperative CT shows high-density shadows in the suprasellar cistern, ambient cistern, quadrigeminal cistern, left anterior pontine cistern, and the third and fourth ventricles, suggesting subarachnoid hemorrhage. E-F: Preoperative CTA reveals bilateral dissecting aneurysms of the V4 segment of the vertebral artery, with the right side being relatively dominant. G-J: DSA shows local fusiform dilation of the left vertebral artery V4 segment with a relatively regular shape, and no visualization of the right vertebral artery beyond the V3 segment, suggesting right vertebral artery occlusion. K-L: Re-examination of DSA half a year after the operation shows no recurrence of the aneurysm.

瘤,左侧为非责任动脉瘤,行支架辅助弹簧圈栓塞治疗,对侧动脉瘤先行保守治疗,择期再用支架辅助弹簧圈栓塞治疗对侧动脉瘤。

当夹层动脉瘤进展或破裂时,可行血管内介入或开放手术治疗。防止 IVADA 再出血、保证 PICA 血流通畅是治疗的关键点<sup>[1]</sup>。Moon 等<sup>[10]</sup>认为药物治疗失败亦是需要进一步手术治疗的指征,其术后脑卒中或短暂性脑缺血发作的发生率每年仅 0.27%。由于显微手术风险较大,目前血管内治疗已成为

IVADA 的首选治疗方式<sup>[11]</sup>,主要包括载瘤动脉闭塞术和血流重建术,具有创伤小、恢复快、并发症少、病死率和致残率低等优点。闭塞载瘤动脉主干是血管内治疗的可选方法,但闭塞载瘤动脉的缺点值得关注<sup>[12,13]</sup>,术前血流动力学评估非常重要,比如需行球囊闭塞试验,观察健侧椎动脉对基底动脉及患侧 PICA 代偿供血情况等。Schob 等<sup>[1]</sup>认为在侧支血管良好的前提下,血管内闭塞载瘤动脉是治疗颅内破裂椎动脉夹层动脉瘤的最佳方式,如果可能,应该避



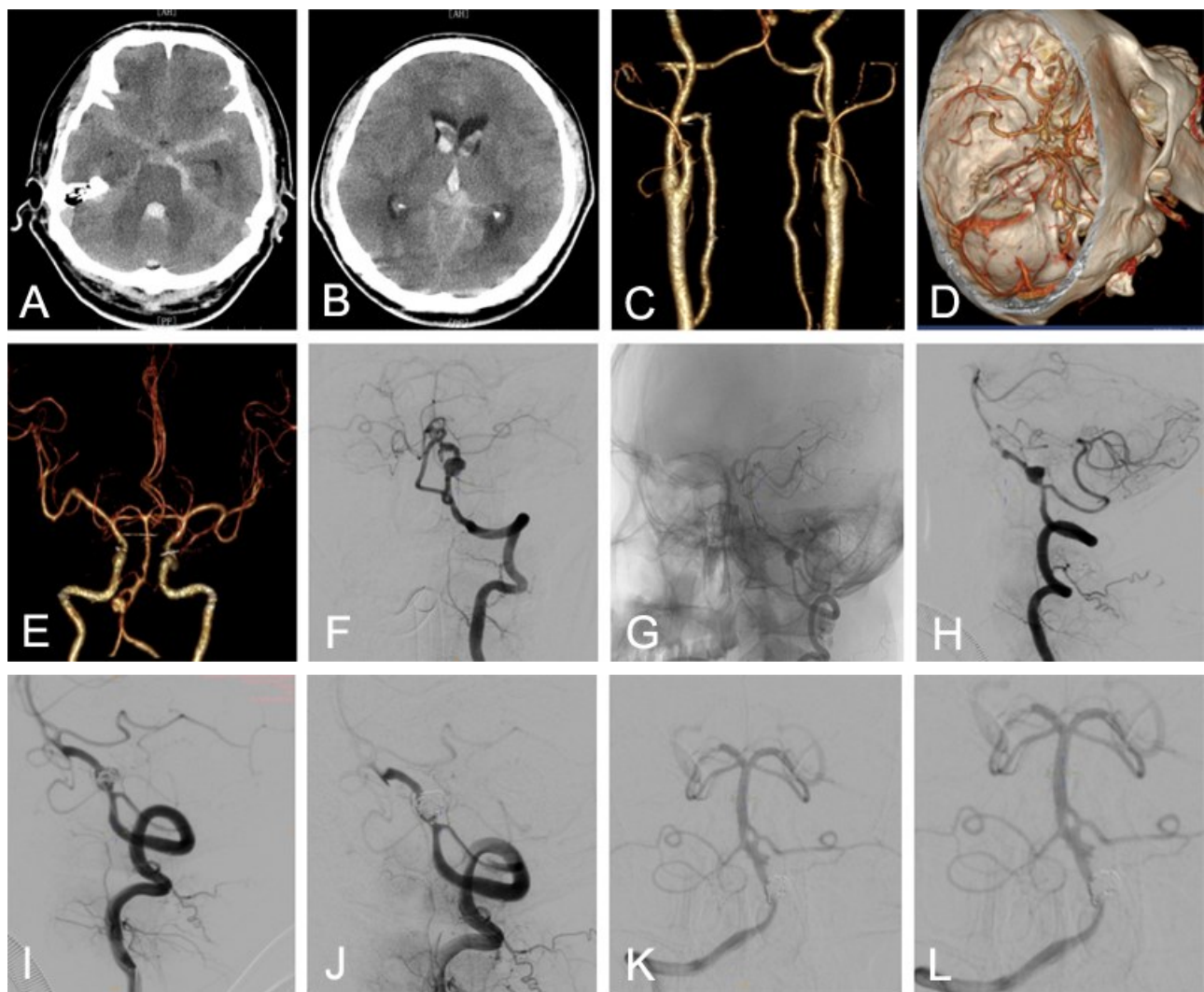


图2 左侧椎动脉V4段夹层动脉瘤单纯弹簧圈栓塞术前后影像  
A、B. 术前头颅CT示部分脑池、双侧脑室及第三、四脑室高密度影，双侧脑沟显示不清，中线结构居中，考虑蛛网膜下腔出血、脑室积血；C-E. 术前CTA显示左侧椎动脉V4段较对侧纤细，局部呈囊状扩张征象，长径约7.8 mm，右侧椎动脉V4段相对优势，基底动脉、双侧大脑后动脉走行自然，管腔未见狭窄与扩张；F-K. DSA显示左侧椎动脉夹层动脉瘤，动脉瘤不规则，起自小脑后下动脉发出点远端，大小约6.5 mm×5 mm；L. 术后半年复查DSA未见动脉瘤复发

**Figure 2 Pre- and post-operative images of a patient with a left dissecting aneurysm of the V4 segment of the vertebral artery undergoing simple embolization**

A-B: Preoperative CT shows high-density shadows in some cerebrospinal fluid cisterns, bilateral ventricles, and the third and fourth ventricles; the bilateral cerebral sulci are not clearly displayed, and the midline structure is centered, suggesting subarachnoid hemorrhage and intraventricular hemorrhage. C-E: Preoperative CTA reveals that the left vertebral artery V4 segment is thinner than the contralateral side, with a local cystic dilation sign, with a long diameter of approximately 7.8 mm; the right vertebral artery V4 segment is relatively dominant; the basilar artery and bilateral posterior cerebral arteries have a natural course, and there is no stenosis or dilation of the lumen. F-K: DSA shows a dissecting aneurysm of the left vertebral artery; the aneurysm is irregular, originating from the distal end of the posterior inferior cerebellar artery, with a size of approximately 6.5 mm × 5 mm. L: No recurrence of the aneurysm was observed on DSA reexamination six months after the operation.

免PICA的闭塞,但权衡到椎动脉夹层动脉瘤破裂的极大风险,极端情况下,即使是PICA近端闭塞也是必要的,由于远端可以出现逆向血流,近端闭塞可以改变夹层动脉瘤处的血流动力学特征,在一定程度上可以阻止病变的进展,但逆向充盈亦可能会导致复发和再出血风险增加,现临床上较少单独使用。

栓塞夹层动脉瘤联合闭塞载瘤动脉术是治疗

IVADA比较可靠的技术,术前仍需评估对侧血流代偿<sup>[14]</sup>。若病变累及PICA等重要分支,或病变位于优势侧椎动脉、基底动脉干等,则闭塞载瘤动脉的治疗方式不适合。本文1例左侧椎动脉颅内段夹层动脉瘤,左侧椎动脉管腔较对侧细,为非优势侧椎动脉,动脉瘤起自PICA发出点远端,术前评估对侧血流代偿好,遂行夹层动脉瘤栓塞+载瘤动脉闭塞术,取得

可靠治疗效果。

对于主干动脉不能闭塞的病人,应行血管内重建治疗<sup>[15]</sup>,包括支架辅助弹簧圈栓塞术和单纯支架植入术(自膨式支架、覆膜支架、血流导向装置等),其中支架辅助弹簧圈栓塞术是血管内治疗最常用的重建性手术方式,既可以闭塞夹层动脉瘤,又能保持载瘤动脉及其分支的通畅<sup>[16]</sup>。本文 1 左侧 IVADA 即采用该术式,支架植入后既可改变血管内的血流动力学,促进瘤腔内血栓形成,使夹层动脉瘤闭塞,还可促进血管内皮修复,使夹层动脉瘤达到解剖愈合<sup>[14,17]</sup>。另外,支架还可防止弹簧圈逸出和移位。术中使用弹簧圈不一定必须致密填塞,因为致密填塞有可能会引起支架变形、塌陷、导致穿支血管闭塞或夹层动脉瘤破裂等。但对已破裂的夹层动脉瘤,应尽量对动脉瘤、尤其出血点实施致密栓塞。

单纯支架植入术主要用于未破裂椎动脉夹层动脉瘤的治疗,尤其适用于累及 PICA 且对侧椎动脉发育差的椎动脉夹层动脉瘤。亦可采用多支架重叠放置技术,从而提高支架的金属覆盖率,以增加血流导向,提高支架治疗夹层动脉瘤的疗效<sup>[16]</sup>。但多支架置入可能会影响支架的正常展开、贴壁,术后需要严格的抗血小板药物治疗,这会增加围手术期血管狭窄、梗塞及出血的风险。本文 1 例采用双 LVIS 支架重叠放置技术,因术后支架内血栓形成而死亡,值得进一步总结。

覆膜支架、血流导向装置、药物涂层及生物降解支架等相比于其他介入材料起步较晚,因其特定的适应证和使用权限、费用、穿支事件、远期疗效等问题受到较大限制,目前临床还难以常规使用值得进一步积累经验。

总之,IVADA 为中青年脑卒中的重要病因,临床表现各异。对于有手术指征的病人,首选血管内治疗,具体治疗方案需根据病人具体情况进行个体化选择。本文 11 例 IVADA 的临床资料进行汇总分析,旨在提高对 IVADA 的认识,但病例数偏少,对于影响 IVADA 的预后因素尚需进一步深入研究。

**【伦理学声明】:**本研究遵循《赫尔辛基宣言》,所有病人和/或家属均签署知情同意书。本研究方案于 2024 年 8 月 1 日经青岛市第八人民医院伦理委员会审批,批号为 QBYLL-KY-2024-020。

**【利益冲突声明】:**本文不存在任何利益冲突。

**【作者贡献声明】:**徐军负责手术计划的制定及实施、拟定论文的的思路及论文的框架;李海校、毛崇丹、

吕成林、徐宝占负责收集病例资料、撰写论文、修改论文;崔玉光、丰育功参与修改论文及最后定稿。

【参考文献】

[1] SCHOB S, BECHER A, BHOGAL P, *et al.* Segment occlusion vs. reconstruction—a single center experience with endovascular strategies for ruptured vertebrobasilar dissecting aneurysms [J]. *Front Neurol*, 2019, 10: 207.

[2] ZENG QW. Progress in interventional treatment of vertebral artery dissection aneurysms [J]. *Chin J Pract Nerv Dis*, 2018, 21(15): 1629–1633.  
曾庆威. 椎动脉夹层动脉瘤的介入治疗进展[J]. *中国实用神经疾病杂志*, 2018, 21(15): 1629–1633.

[3] AKAMATSU Y, SATO K, ENDO H, *et al.* Ruptured vertebral artery dissecting aneurysm concurrent with spontaneous cervical internal carotid artery dissection: a report of three cases and literature review [J]. *World Neurosurg*, 2017, 107: 1048.e1–1048.e6.

[4] ZHONG X, LI X, SHAO S, *et al.* A case of infectious intracranial dissecting aneurysm [J]. *Neurol India*, 2017, 65(2): 405.

[5] ZHAO X, WANG H, LIU J, *et al.* Endovascular treatment of vertebral artery dissecting aneurysm: a single-center experience [J]. *Exp Ther Med*, 2019, 18(6): 4838–4844.

[6] WANG Y, CHENG W, LIAN Y. The headache and neck pain in ischemic stroke patients caused by cervicocerebral artery dissection: a case-control study [J]. *J Stroke Cerebrovasc Dis*, 2019, 28(3): 557–561.

[7] AKDAL G, ÖZÇELİK P, KIRKIM G, *et al.* Vertebral artery dissection from neck self-manipulation presenting with acute severe bilateral hearing loss [J]. *J Neurol*, 2020, 267(1): 285–287.

[8] LLOYD S, HASAN RM, RICHARD P, *et al.* Subarachnoid haemorrhage due to intracranial vertebral artery dissection presenting with atypical cauda equina syndrome features: case report [J]. *BMC Neurol*, 2019, 19: 262.

[9] KIM MK, LIM YC. Conservative management of unruptured spontaneous intracranial vertebral artery dissection [J]. *World Neurosurg*, 2019, 126: e402–e409.

[10] MOON K, ALBUQUERQUE FC, COLE T, *et al.* Stroke prevention by endovascular treatment of carotid and vertebral artery dissections [J]. *J Neurointerv Surg*, 2017, 9(10): 952–957.

[11] LEE HJ, CHO WC, CHOI JH, *et al.* Comparison of parent artery occlusion and stent-assisted treatments in ruptured vertebral artery dissecting aneurysms [J]. *World Neurosurg*, 2022, 167: e533–e540.

[10] GAO B, KANG K, ZHANG J, *et al.* Clinical characteristics and long-term outcome of headaches associated with moyamoya disease in the chinese population—a cohort study [J]. *Front Neurol*, 2020, 11: 605–636.

[11] LEE JY, CHOI YH, CHEON JE, *et al.* Delayed posterior circulation insufficiency in pediatric moyamoya disease [J]. *J Neurol*, 2014, 261 (12): 2305–2313.

[12] KAWABORI M, KURODA S, NAKAYAMA N, *et al.* Effective surgical revascularization improves cerebral hemodynamics and resolves headache in pediatric Moyamoya disease [J]. *World Neurosurg*, 2013, 80(5): 612–619.

[13] KAWAGUCHI S, SAKAKI T, MORIMOTO T, *et al.* Characteristics of intracranial aneurysms associated with moyamoya disease: a review of 111 cases [J]. *Acta Neurochir (Wien)*, 1996, 138(11): 1287–1294.

[14] SEWELL RA, JOHNSON DJ, FELLOWS DW. Cluster headache associated with moyamoya [J]. *J Headache Pain*, 2009, 10(1): 65–67.

[15] KATANO H, NISHIKAWA Y, YAMADA H, *et al.* Association of superficial temporal artery dilatation with headache after revascularization in adult moyamoya disease [J]. *World Neurosurg*, 2019, 129: e594–e606.

[16] AL-WAILI NS, BUTLER GJ, BEALE J, *et al.* Hyperbaric oxygen in the treatment of patients with cerebral stroke, brain trauma, and neurologic disease [J]. *Adv Ther*, 2005, 22(6): 659–678.

[17] SCHIAVO S, DEBACKER J, DJAIANI C, *et al.* Mechanistic rationale and clinical efficacy of hyperbaric oxygen therapy in chronic neuropathic pain: an evidence-based narrative review [J]. *Pain Res Manag*, 2021, 2021: 8817504.

[18] MIJAJLOVIC MD, ALEKSIC V, MILOSEVIC N, *et al.* Hyperbaric oxygen therapy in acute stroke: is it time for Justitia to open her eyes [J]. *Neurol Sci*, 2020, 41(6): 1381–1390.

[19] FISCHER BR, PALKOVIC S, HOLLING M, *et al.* Rationale of hyperbaric oxygenation in cerebral vascular insult [J]. *Curr Vasc Pharmacol*, 2010, 8(1): 35–43.

[20] ESCHENFELDER CC, KRUG R, YUSOFI AF, *et al.* Neuroprotection by oxygen in acute transient focal cerebral ischemia is dose dependent and shows superiority of hyperbaric oxygenation [J]. *Cerebrovasc Dis*, 2008, 25(3): 193–201.

[21] FUJIMURA M, TOMINAGA T, KURODA S, *et al.* 2021 Japanese guidelines for the management of moyamoya disease: guidelines from the research committee on moyamoya disease and Japan Stroke Society [J]. *Neurol Med Chir (Tokyo)*, 2022, 62(4): 165–170.

[22] AIHARA Y, KASHIWASE S, CHIBA K, *et al.* Aspirin use and platelet aggregation in ischemic onset-type pediatric moyamoya patients with intractable headaches (moya-ache) [J]. *Childs Nerv Syst*, 2021, 37(5): 1649–1657.

(2023-07-05 收稿, 2024-01-12 修回)

(上接第 526 页)

[12] AIHARA M, NAITO I, SHIMIZU T, *et al.* Predictive factors of medullary infarction after endovascular internal trapping using coils for vertebral artery dissecting aneurysms [J]. *J Neurosurg*, 2018, 129 (1): 107–113.

[13] KANEMATSU Y, SATOMI J, KORAI M, *et al.* Flow alteration therapy for ruptured vertebral artery dissecting aneurysms involving the posterior inferior cerebellar artery [J]. *Neurol Med Chir (Tokyo)*, 2018, 58(8): 341–349.

[14] MASAHIRO H, TOSHINORI M, KOJI S, *et al.* Stent-assisted coil embolization for ruptured intracranial dissecting aneurysms involving essential vessels [J]. *World Neurosurg*, 2018, 119: e728–e733.

[15] URASYANANDANA K, SONGSANG D, AURBOONYAWAT T, *et al.* Treatment outcomes in cerebral artery dissection and literature review [J]. *Interv Neuroradiol*, 2018, 24(3): 254–262.

[16] IMAHORI T, SHOSE H, OKAMURA Y, *et al.* Deploying 5 overlapping Enterprise stents and coiling for treating hemorrhagic vertebral artery dissecting aneurysm [J]. *World Neurosurg*, 2019, 132: 177–181.

[17] RYOSUKE M, ICHIRO N, KOJIO, *et al.* Stent-assisted coil embolization of unruptured vertebral artery dissecting aneurysms with the low-profile visualized intraluminal support stent, with five techniques: technical note and case report [J]. *Surg Neurol Int*, 2019, 10: 105.

(2023-12-16 收稿, 2024-04-16 修回)