

临床研究

DOI: 10.13406/j.cnki.cyx.002048

Pipeline 血流导向装置在治疗颈内动脉大型或巨大型宽颈动脉瘤中的初步应用

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【摘要】目的:初步探讨 Pipeline 血流导向装置(pipeline embolization device, PED)治疗颈内动脉大型或巨大型宽颈动脉瘤的临床效果。**方法:**回顾性分析我院神经外科 2016 年 4 月至 2018 年 4 月应用 PED 治疗的 14 例颈内动脉大型或巨大型宽颈动脉瘤的临床资料,采用 Kamran 分级、改良 Rankin 量表(modified Rankin scale, mRS)评分及影像学方法评估临床疗效。**结果:**14 例患者共 15 个动脉瘤,均为颈内动脉大型或巨大型宽颈未破动脉瘤,单纯 PED 置入 2 例,联合弹簧圈栓塞 12 例,其中 13 例 PED 顺利到位释放,1 例失败, PED 疝入瘤腔。PED 成功置入术中即刻造影显示瘤腔内对比剂明显滞留。术后并发症 2 例(14%),1 例颅神经麻痹症状加重,1 例为血栓性事件。出院时 mRS 评分 0 分 12 例,1 分 2 例,术后 6 个月 14 例患者均行数字减影血管造影(digital subtraction angiography, DSA)检查,13 例动脉瘤完全或近完全闭塞,1 例 PED 疝入瘤腔的患者载瘤动脉闭塞,患者仅遗留眼睑下垂,临床随访 6~21 个月,余 13 例均未出现神经功能缺损症状。**结论:**PED 置入治疗颈内动脉大型或巨大型宽颈动脉瘤短期评估疗效好,且安全,联合弹簧圈治疗可提高闭塞率,有可能减少术后动脉瘤破裂出血风险,但其远期疗效仍需进一步评价。

【关键词】颈内大或巨大型动脉瘤;宽颈动脉瘤;Pipeline 支架;弹簧圈

【中图分类号】R816.2

【文献标志码】A

【收稿日期】2019-01-16

Preliminary application of pipeline embolization device in the treatment of large or giant wide-necked aneurysms of the internal carotid artery

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【Abstract】Objective: To preliminarily explore the clinical effect of pipeline embolization device in the treatment of large or giant wide-necked aneurysms of the internal carotid artery. **Methods:** A retrospective analysis was performed on the clinical data of 14 patients with large or giant wide-necked aneurysms of the internal carotid artery who were treated with PED from April 2016 to April 2018 in the neurosurgery department of our hospital. And the clinical efficacy was evaluated by Kamran grading, modified Rankin Scale(mRS), and radiological examination. **Results:** There were 15 aneurysms in 14 patients, all of which were large or giant wide-necked unruptured aneurysms of the internal carotid artery. Two cases were implanted with PED alone, while in the other 12 cases PED was given concurrently with coil embolization. Among these cases, PED was successfully released in 13 cases but failed in 1 case whose PED herniated into the lumen of the aneurysm. Immediately after the successful placement of PED, the contrast agent showed obvious retention in the lumen of the aneurysm. Postoperative complications occurred in 2 cases(14%), cranial nerve palsy worsened in 1 case, and thrombotic events happened in 1 case. At discharge, mRS score was 0 in 12 cases and 1 in 2 cases. At 6 months after surgery, 14 patients underwent digital subtraction angiography. Thirteen patients had complete or nearly complete occlusion of aneurysm, and one with PED hernia into the lumen of the aneurysm had occlusion of the artery with aneurysm, and only blepharoptosis was left in this patient. During follow-up at 6 to 21 months, no symptoms of neurological defects were found in the remaining 13 patients. **Conclusion:** PED in the treatment of large or giant wide-necked aneurysms of the internal carotid artery has good therapeutic efficacy and safety in short-term evaluation. PED combined with coil embolization can improve the occlusion rate and may reduce the risk of postoperative aneurysm rupture and bleeding, but its long-term efficacy still needs further evaluation.

【Key words】 large or giant wide-necked aneurysms of the internal carotid artery; wide-necked aneurysms; pipeline embolization device; coil embolization

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优先出版: <http://kns.cnki.net/kcms/detail/50.1046.R.20190529.1434.014.html>

(2019-05-29)

颅内支架技术在脑动脉瘤介入治疗中应用广泛,对颈内动脉段大型或巨大宽颈动脉瘤,因其高复发率,传统的介入治疗面临着巨大的挑战^[1]。自 Pipeline 血流导向装置(Pipeline embolization device, PED)于 2008 年获得 CE 认证以来,其带来全新的“血流导向”理念,从常规的动脉瘤栓塞治疗发展到以改变血流动力学方向,重建载瘤动脉壁,达到治疗目的^[2]。PED 已逐渐成为治疗复杂动脉瘤的重要方法。然而在临床应用中,依然是获益与风险并存。本文回顾性分析 14 例应用 PED 治疗的颈内动脉大型或巨大宽颈动脉瘤的临床资料,现将结果报道如下。

1 临床资料

1.1 一般资料

14 例患者中,男 4 例,女 10 例;年龄 45~65 岁(53±8)岁。均为颈内动脉未破裂动脉瘤。临床表现为头痛 3 例,头昏 3 例,眼睑下垂 2 例,视物模糊 2 例,视野缺失 1 例,激素水平异常 1 例,体检发现 2 例。见表 1。

1.2 影像学检查

患者均行数字减影血管造影(digital subtraction angiography, DSA)及三维成像数字减影血管造影(three-dimensional digital subtraction angiography, 3D-DSA)检查。动脉瘤特征:13 例单发动脉瘤,1 例多发动脉瘤,动脉瘤最大直径 8~28 mm (17±6) mm,均为宽颈动脉瘤(颈体比>1/2 或瘤颈宽度≥4 mm)。术前 DSA 了解动脉瘤同侧侧枝循环均有不同程度的代偿。

1.3 治疗方法

1.3.1 抗血小板治疗 术前口服阿司匹林 100 mg+氯吡格雷 75 mg 3~5 d,行氯吡格雷基因、血小板聚集试验检测,使花生四烯酸(AA)抑制率>50%,二磷酸腺苷(ADP)抑制率>30%,未达标者改服替格瑞洛 90 mg/d。术后继续口服阿司匹林 100 mg+氯吡格雷 75 mg。6 个月后复查 DSA,之后继续口服阿司匹林 1 年。

1.3.2 手术治疗过程(以左侧颈内动脉床突上段动脉瘤为例) 采用 SELDINGER 技术行双侧股动脉穿刺,右侧置入 8F、左侧 6F 导管鞘。将 8F 导引导管升入左侧颈内动脉起始端,Navien 颅内支撑导管送至颈内动脉海绵窦段。全身肝素化,在路途下先经 Navien 支撑导管将支架导管在瘤腔内成袢后升入左侧大脑中动脉 M1 段以远,整体回撤释放张力将瘤腔内支架导管成袢部分捋直。再经左侧导引导管将微导管超选至瘤囊内。经支架导管跨瘤颈释放 PED,远心端锚定在 M1 中段,近心端锚定在海绵窦。再向瘤腔内输送弹簧圈填塞。术后即刻造影,动脉瘤致密填塞,载瘤动脉通畅。

1.4 随访方法

出院前采用改良 Rankin 量表(modified Rankin scale, mRs)对患者临床症状进行评分,记录围手术期出现的临床症状;术后 6 个月行 DSA,评价动脉瘤闭塞、载瘤动脉、PED 覆盖分支血管情况。根据 Kamran 分级方法评估:1 级完全栓塞(瘤腔、瘤颈均未见造影剂充盈);2 级瘤颈残留(见瘤颈有造影剂充盈);3 级瘤腔残留(瘤颈和瘤腔内均有造影剂充盈)。

表 1 患者的临床资料

特征	例数
性别	
男	4
女	10
临床症状	
无症状	2
SAH	0
头痛	3
头昏	3
脑神经麻痹	5
垂体功能低下	1
首次检查方法	
MR/MRA	12
CT/CTA	2
动脉瘤位置	
海绵窦段	5
床突上段	8
眼段	2
动脉瘤大小(mm)	
<10	2
<20	6
≥20	7
动脉瘤形状	
囊状	14
其他	1

2 结果

2.1 动脉瘤栓塞后即刻表现

13 例患者均顺利完成置入 PED, PED 辅助弹簧圈栓塞 12 例,术后即刻 DSA 示瘤腔未见显影(图 1、图 2)。单纯置入 PED 2 例,1 例 PED 疝入瘤腔,术后即刻见对比剂明显滞留,无即刻闭塞,6 个月复查瘤体未显影。PED 覆盖眼动脉 7 例,覆盖脉络膜前动脉 1 例,其中术后 1 例眼动脉未显影。

2.2 临床并发症及随访结果

14 例患者有 1 例术中支架疝入瘤腔,术后右眼下垂症状加重,6 个月复查计算机断层扫描(computed tomography, CT)检查示载瘤动脉闭塞,患者并无严重并发症。1 例术后 2 d 出现手术对侧下肢肌力下降,欣维宁小剂量泵入后第 2 天症状缓解,其余患者均无并发症发生。2 例眼睑下垂患者症状无改善,2 例头昏症状无改善。其余患者症状得到减轻好转。术后 Kamran 分级 I 级 11 例、II 级 1 例、III 级 2 例。平均随访 9 个月复查 DSA,结果显示 PED 联合弹簧圈栓塞的动脉瘤均完全闭塞,载瘤动脉通畅。随访 12 个月 mRS 评分 13 例 0 分,1 例 1 分。

典型病例:女,63 岁,因头昏 7 个月就诊,术前 DSA 左侧颈内动脉床突段、海绵窦段可见 2 枚动脉瘤串联,其中近心端大动脉瘤囊袋状,约 5.0 mm×6.9 mm,瘤颈 5.0 mm,远心端小动脉瘤约 3.2 mm×2.6 mm(图 3A)。采用单纯 PED 置入,手术过程:Marksmen 支架导管跨瘤颈超选至 M1 段,输送 PED(图 3B)。支架过弯展开后,为避免支架尾端降落于第 2 处转弯膨大部,加力推送支架,支架后部向内反折突入形成套叠(图 3C),部分回收支架以防支架意外解脱,将支架及支架导管整体回拉,将套叠反折部分支架改出,尾端仍将降落于转弯膨大部(图 3D),当完全释放支架后,为使支架更为贴壁,将支架导管及支撑导丝于支架腔内进行“按摩”(图 3E),撤出支架导管后行 3D 了解最终效果(图 3F~H)。

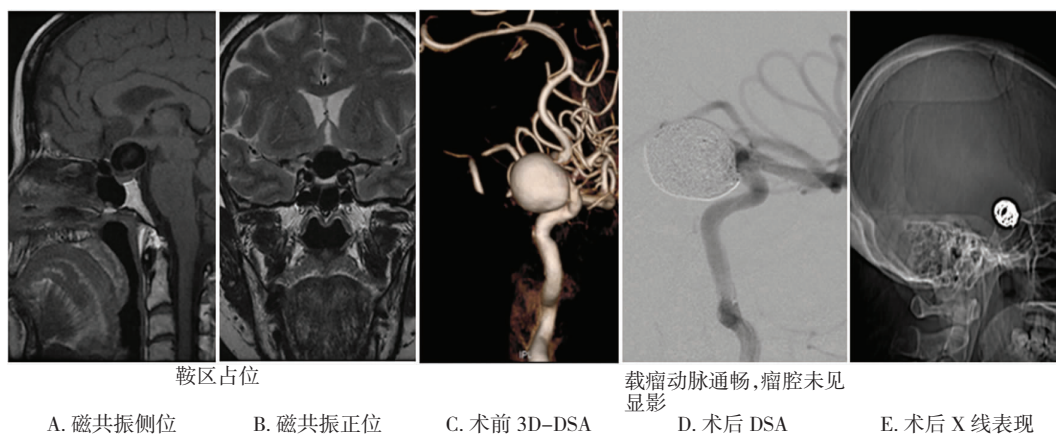


图 1 左侧床突段动脉瘤的术前、术后影像学资料

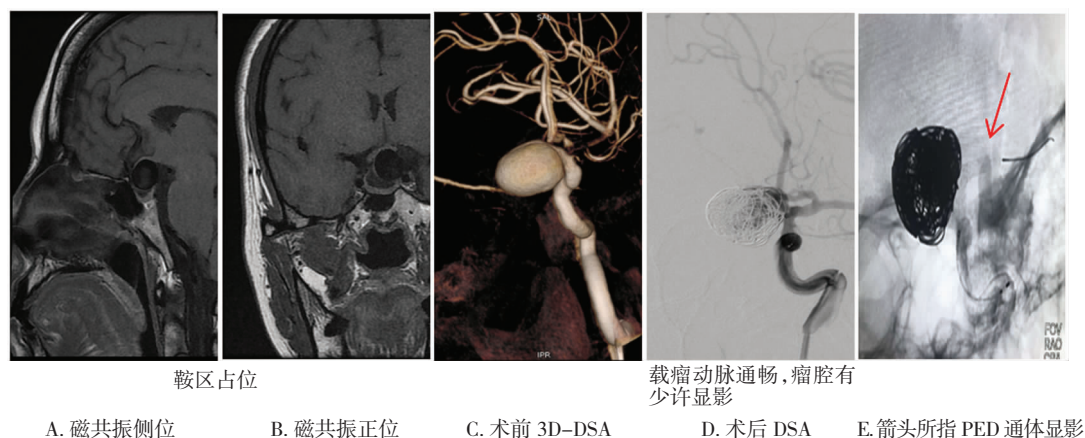


图 2 右侧床突段动脉瘤的术前、术后影像学资料

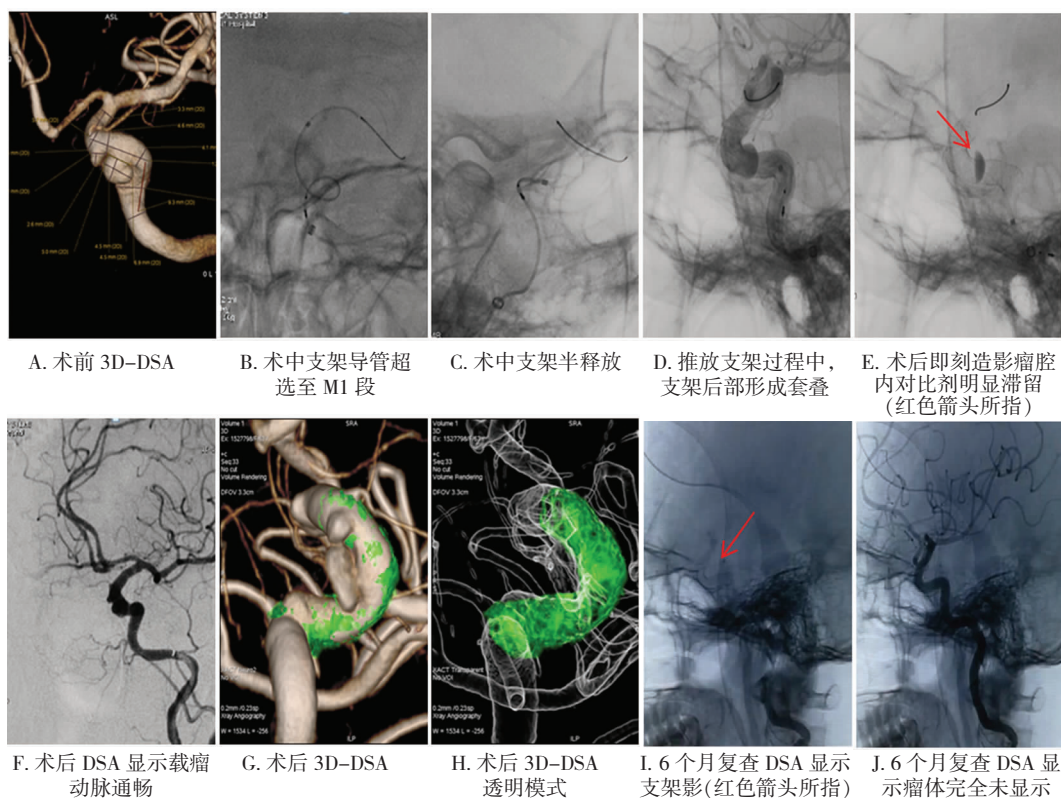


图 3 左侧床突段、海绵窦段动脉瘤的术前、术中、术后影像学资料

3 讨论

颅内复杂动脉瘤的治疗一直以来都是临床治疗的难点,特别是 ICA 大型或巨大型宽颈动脉瘤,开颅夹闭治疗难度大、手术风险高,传统介入治疗存在高复发率、低闭塞率^[3]。尽管这些年支架技术的应用,但对此类动脉瘤,血管内治疗仍存在诸多挑战。

PED 以载瘤动脉重建为理念,能显著减少动脉瘤内血流,将血流导向远端血管以促进动脉瘤内血栓形成^[4],通过瘤颈处支架的内膜化使载瘤动脉得到修复重建,从而促使动脉瘤闭塞。与传统血管内治疗相比,PED 治疗 ICA 大或巨大宽颈动脉瘤具有较高的闭塞率^[5]和较低并发症^[6],越来越受神经介入工作者的青睐。Lylyk 等^[7]、Nelson 等^[8]及 Saatci 等^[9]报道,PED 治疗术后 6 个月动脉瘤的闭塞率分别为 93%、93.3%和 91.2%。由上可见,PED 术后 6 个月的闭塞率多超过了 90%,并随时间的延长而逐年提高^[10],除此之外,PED 治疗 ICA 巨大动脉瘤可以显著节省成本^[11]。随着使用 PED 经验和技术的积累,其有效性及安全性得到广泛认同,在大或巨大动脉瘤治疗中显示出显著的优越性。然而,PED 治疗此类动脉瘤是一个渐进过程,需要较长的时间才能达到完全闭塞,故在完全闭塞之前仍有破裂的风险。Hampton 等^[12]报道了 1 例巨大 ICA 动脉瘤在 PED 平稳治疗 5 d 后出现致死性动脉瘤破裂;1 项对英国中心经验的回顾性分析显示对 1 例直径 30 mm ICA 动脉瘤置入 PED 2 d 发生急性动脉瘤破裂^[13];Yu 也报道了 2 例迟发性破裂^[14],均造成严重的临床后果。事实上,治疗后动脉瘤破裂已成为 PED 治疗最担忧和最严重的并发症,其具体机制不明,倾向于炎症理论和血流动力学 2 种学说。PED 置入后引起瘤腔内红色血栓形成,其含有蛋白水解酶和白细胞,可促进炎症反应,最终导致动脉瘤破裂^[15]。有人通过术后给予激素治疗可能减轻炎性反应,从而降低出血性的并发症^[5]。血流动力学理论认为,PED 降低入瘤的血流,瘤腔内血流动力学发生改变,可能使瘤壁受力不均而导致破裂^[16]。在 IntrePED 研究中,认为所有与动脉瘤破裂相关的均为大或巨大动脉瘤^[17],由于此类动脉瘤行 PED 治疗后瘤腔闭塞是个慢性过程,PED 置入后仍存在破裂出血的可能。为此,有人提出联合弹簧圈可能会加速闭塞的过程,以避免发生迟发性动脉瘤破裂^[14,18-20]。但是目前为止并无证据表明联合弹簧圈治疗后可以避免动脉瘤破裂,而且已有文献报道 PED 联合弹簧圈治疗后出现动脉瘤破裂的病例^[18,21],认为联合弹簧圈不

能消除甚至不能降低术后动脉瘤破裂的风险。另外,与单纯的 PED 置入,填塞弹簧圈会增加操作难度,增加手术风险。而且会进一步加重瘤体的占位效应,增加血栓的发生。尽管有人认为在大型动脉瘤治疗中低密度弹簧圈填塞很有必要^[22],但是否需要联合弹簧圈栓塞一直存在争议,对弹簧圈填塞的数量仍无定论,也无科学客观指导。

然而,经过近十年的应用,从早期单纯 PED 治疗到认为联合弹簧圈治疗可以提高疗效,对大或巨大 ICA 动脉瘤的联合治疗得到越来越多的报道^[20,23]。本研究中 85%的患者选择联合弹簧圈治疗,可以达到术后即刻瘤腔不显影,6 个月闭塞率几乎为 100%,未出现 1 例破裂出血,仅 1 例出现术后对侧下肢肌力下降,CT 未见明显出血梗死灶,欣维宁小剂量泵入后 12 h 内缓解,PED 联合弹簧圈治疗安全有效,并发症无明显增加^[24];相反,在单纯 1 例海绵窦段巨大动脉瘤 PED 置入中发生支架短缩陷入瘤腔,事后分析此类巨大动脉瘤,可先在不增加占位效应情况下弹簧圈疏松填塞,二期置入 PED,避免释放后因无支撑而发生短缩移位。对于如何选择弹簧圈的使用尚无客观评价指标。床突上段动脉瘤位于硬膜内,一旦破裂出血后果严重,均选择 PED 联合弹簧圈疏松填塞。本课题组认为通过联合弹簧圈治疗可以加速瘤腔内血栓形成,瘤内形成“成篮”保护,平衡腔内压力,从而预防破裂,并在提高闭塞率同时减少复发率。另外,本课题组认为瘤颈口有明显喷射症、单纯 PED 有短缩或陷入瘤腔风险、形态不规则、有子瘤或者已经破裂出血的动脉瘤的情况下应该考虑联合弹簧圈治疗。

PED 的使用是一个系统工程,除了是否填充弹簧圈,与所有血管内技术一样,围手术期双抗体的使用、PED 本身手术技巧的掌握,这些要点均需充分考虑。PED 置入之前需口服双抗(阿司匹林缓释片+氯吡格雷),在已发表的一系列血栓栓塞并发症中,支架内血栓形成发生在停用氯吡格雷时,甚至在随访 3 个月后^[25]。本组所有患者均术前术后口服双抗,术前行 ADP 抑制率低于 30%,则改服替格瑞洛。而对宽颈巨大型动脉瘤,PED 尺寸的选择及支架远端的放置至关重要,原则上尽量接近血管直径、长度多于瘤颈至少 6 mm,Marksman 放置在动脉瘤远端至少 20 mm 的位置。对存在血管迂曲,瘤颈远近段血管直径差异大,拟释放支架的血管直径差异大的患者,可以先以远端血管直径选择一个支架,近端血管直径选第二枚支架,以套叠技术解决问题。在释放早期 PED 会出现“雪茄形状”(Pipeline 部分打开,形状拉长),因 PED 具有通体显影,边释放边观

察其释放情况,需警惕支架的短缩效应,可能会导致支架陷入瘤腔,严重的造成动脉瘤破裂^[26],在支架完全释放后,一定要做好术后处理,适度推送微导管,促进其更好地贴壁。

总之,PED 治疗颈内动脉大或巨大宽颈动脉瘤安全有效,术中联合疏松弹簧圈栓塞可提高闭塞率,有可能减少术后动脉瘤破裂出血风险。然而对是否需要辅助弹簧圈、弹簧圈的填塞密度均缺乏科学证据,如何减少并发症,提高疗效,提升 PED 的性能及其使用技巧,精准的个体化治疗,仍是以后研究的重点。此外,本组病例数不多,其远期疗效有待进一步随访。

参 考 文 献

- [1] Nanda A, Sonig A, Banerjee AD, et al. Microsurgical management of giant intracranial aneurysms: a single surgeon experience from Louisiana State University, Shreveport[J]. *World Neurosurgery*, 2014, 81(5-6): 752-64.
- [2] Shankar JJ, Tampieri D, Iancu D, et al. SILK flow diverter for complex intracranial aneurysms: a Canadian registry[J]. *Journal of NeuroInterventional Surgery*, 2016, 8(3): 273-278.
- [3] Ferns SP, Sprengers ME, Van Rooij WJ, et al. Coiling of Intracranial aneurysms: a systematic review on initial occlusion and reopening and retreatment rates[J]. *Stroke*, 2009, 40(8): e523-529.
- [4] Fiorella D, Lylyk P, Szikora I, et al. Curative cerebrovascular reconstruction with the Pipeline embolization device: the emergence of definitive endovascular therapy for intracranial aneurysms[J]. *J Neurointerv Surg*, 2018, 10(1): i9-18.
- [5] Rexiati N, Aikeremu RX, Kadeer K, et al. Short-term efficacy of pipeline embolization device for treating complex intracranial aneurysms[J]. *Bio-Medical Materials and Engineering*, 2018, 29(2): 137-146.
- [6] Kallmes DF, Brinjikji W, Cekirge S, et al. Safety and efficacy of the Pipeline embolization device for treatment of intracranial aneurysms: a pooled analysis of 3 large studies[J]. *Journal of Neurosurgery*, 2017, 127(4): 775-780.
- [7] Lylyk P, Miranda C, Ceratto R, et al. Curative endovascular reconstruction of cerebral aneurysms with the pipeline embolization device: the Buenos Aires experience[J]. *Neurosurgery*, 2009, 64(4): 642-643.
- [8] Nelson PK, Lylyk P, Szikora I, et al. The pipeline embolization device for the intracranial treatment of aneurysms trial[J]. *AJNR Am J Neuroradiol*, 2011, 32(1): 34-40.
- [9] Saatci I, Yavuz K, Ozer C, et al. Treatment of intracranial aneurysms using the pipeline flow-diverter embolization device: a single-center experience with long-term follow-up results[J]. *AJNR Am J Neuroradiol*, 2012, 33(8): 1436-1446.
- [10] Becske T, Brinjikji W, Potts MB, et al. Long-term clinical and angiographic outcomes following pipeline embolization device treatment of complex internal carotid artery aneurysms: five-year results of the pipeline for uncoilable or failed aneurysms trial[J]. *Neurosurgery*, 2017, 80(1): 40-48.
- [11] Colby GP, Lin LM, Paul AR, et al. Cost comparison of endovascular treatment of anterior circulation aneurysms with the pipeline embolization device and stent-assisted coiling[J]. *Neurosurgery*, 2012, 71(5): 944-948.
- [12] Hampton T, Walsh D, Tolias C, et al. Mural destabilization after aneurysm treatment with a flow-diverting device: a report of two cases[J]. *Journal of NeuroInterventional Surgery*, 2018, 10(1): i51-55.
- [13] Yang SH, Hampton T, Kandasamy, et al. Outcome study of the pipeline embolization device for treatment of intracranial aneurysms at a single UK institution[J]. *British journal of neurosurgery*, 2017, 31(6): 661-667.
- [14] Yu SC, Kwok CK, Cheng PW, et al. Intracranial aneurysms: midterm outcome of pipeline embolization device—a prospective study in 143 patients with 178 aneurysms[J]. *Radiology*, 2012, 265(3): 893-901.
- [15] Kulcsár Z, Houdart E, Bonafé A, et al. Intra-aneurysmal thrombosis as a possible cause of delayed aneurysm rupture after flow-diversion treatment[J]. *Am J Neuroradiol*, 2011, 32(1): 20-25.
- [16] Cebal JR, Mut F, Raschi M, et al. Aneurysm rupture following treatment with flow-diverting stents: computational hemodynamics analysis of treatment[J]. *Am J Neuroradiol*, 2011, 32(1): 27-33.
- [17] Kallmes DF, Hanel R, Lopes D, et al. International retrospective study of the pipeline embolization device: a multicenter aneurysm treatment study[J]. *Am J Neuroradiol*, 2015, 36(1): 108-115.
- [18] Fischer S, Vajda Z, Aguilar Perez M, et al. Pipeline embolization device (PED) for neurovascular reconstruction: initial experience in the treatment of 101 intracranial aneurysms and dissections[J]. *Neuroradiology*, 2012, 54(4): 369-382.
- [19] Arrese I, Sarabia R, Pintado R, et al. Flow-diverter devices for intracranial aneurysms: systematic review and meta-analysis[J]. *Neurosurgery*, 2013, 73(2): 193-199.
- [20] Park MS, Nanaszko M, Sanborn MR, et al. Re-treatment rates after treatment with the Pipeline Embolization Device alone versus Pipeline and coil embolization of cerebral aneurysms: a single-center experience[J]. *Journal of Neurosurgery*, 2016, 125(1): 137-144.
- [21] Kan P, Siddiqui AH, Veznedaroglu E, et al. Early postmarket results after treatment of intracranial aneurysms with the pipeline embolization device: a U.S. multicenter experience[J]. *Neurosurgery*, 2012, 71(6): 1080-1087.
- [22] Siddiqui AH, Kan P, Abila AA, et al. Complications after treatment with pipeline embolization for giant distal intracranial aneurysms with or without coil embolization[J]. *Neurosurgery*, 2012, 71(2): E509-513.
- [23] Lin N, Brouillard AM, Krishna C, et al. Use of coils in conjunction with the pipeline embolization device for treatment of intracranial aneurysms[J]. *Neurosurgery*, 2015, 76(2): 142-149.
- [24] Sweid A, Atallah E, Herial N, et al. Pipeline-assisted coiling versus pipeline in flow diversion treatment of intracranial aneurysms[J]. *Journal of Clinical Neuroscience*, 2018, 58: 20-24.
- [25] De Vries J, Boogaarts J, Van Norden A, et al. New generation of flow diverter (surpass) for unruptured intracranial aneurysms: a prospective single-center study in 37 patients[J]. *Stroke*, 2013, 44(6): 1567-1577.
- [26] Kühn AL, Dabus G, Kan P, et al. Flow-diverter stents for endovascular management of non-fetal posterior communicating artery aneurysms—analysis on aneurysm occlusion, vessel patency, and patient outcome[J]. *Interv Neuroradiol*, 2018, 24(4): 363-374.

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