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· 专题报道 ·

## 创伤性颈内动脉夹层血管内治疗的安全性和有效性分析

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**[摘要]** **目的** 探讨血管内介入治疗对创伤性颈内动脉夹层(TICAD)的安全性和有效性。**方法** 回顾性纳入2014年1月至2019年11月海军军医大学(第二军医大学)长海医院脑血管病中心收治的经DSA证实为TICAD、采取血管内介入治疗且随访时间≥6个月的16例患者,分析患者一般资料、术后即刻结果、围手术期并发症、临床和影像学随访结果。**结果** 16例TICAD患者中男14例,女2例,年龄为16~63岁,中位年龄为37岁。患者致伤原因包括车祸伤(11例)、拳击伤(1例)、摔伤(1例)、颈部扭伤(1例)、高压水枪伤(1例)、高处坠落伤(1例)。术前影像学检查示14例患者表现为颈内动脉夹层动脉瘤,其中1例患者有2枚夹层动脉瘤。该15枚夹层动脉瘤中5枚接受血流导向装置治疗,8枚接受支架辅助弹簧圈栓塞治疗,1枚接受球囊辅助弹簧圈栓塞治疗,1枚接受单纯支架植入治疗;术后即刻造影见7枚夹层动脉瘤不显影,1枚瘤颈显影,7枚瘤体少量显影。2例患者表现为单纯颈内动脉夹层,均接受单纯支架植入治疗,术后即刻造影均见夹层血管通畅。16例患者均未发生手术相关并发症。16例患者接受临床随访,15例格拉斯哥结局量表评分为5分,1例3分。14例患者接受影像学随访,13例治愈,1例好转。

**结论** 血管内治疗对TICAD安全性高,且能有效改善患者临床预后,但该结论尚待大规模前瞻性临床试验证实。

**[关键词]** 创伤; 颈内动脉夹层; 血管内治疗; 治疗结果

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### Safety and efficacy of endovascular treatment for traumatic internal carotid artery dissection

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**[Abstract]** **Objective** To explore the safety and efficacy of endovascular interventional therapy for traumatic internal carotid artery dissection (TICAD). **Methods** Sixteen patients with TICAD confirmed by digital subtraction angiography (DSA), who received endovascular interventional therapy in the Stroke Center of Changhai Hospital of Naval Medical University (Second Military Medical University) from Jan. 2014 to Nov. 2019 and followed up for at least 6 months, were retrospectively included. The general characteristics, immediate postoperative outcomes, perioperative complications, and clinical and imaging follow-up data were analyzed. **Results** There were 14 males and 2 females with a median age of 37 years (range, 16-63 years). The causes of TICAD included traffic accident (11 cases), boxing (1 case), falling (1 case), neck sprain (1 case), high-pressure water gunshot (1 case) and high falling (1 case). Preoperative imaging examination showed

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internal carotid artery dissecting aneurysms in 14 patients, including 1 patient with 2 dissecting aneurysms. Of the 15 dissecting aneurysms, 5 were treated with flow diverter, 8 with stent-assisted coil embolization, 1 with balloon-assisted coil embolization, and 1 with simple stent implantation. Immediate postoperative angiography showed that 7 dissecting aneurysms were completely occluded, 1 had residual contrast agent in aneurysm neck, and 7 had residual contrast agent in aneurysm body. Two patients, with imaging examination showing simple internal carotid artery dissection, received simple stent implantation and had resumed blood flow immediately after operation. No operation-related complications developed in the 16 patients. During the clinical follow-up, the Glasgow outcome scale (GOS) score was 5 in 15 patients, and 3 in 1 patient. The follow-up imaging results of 14 patients showed that 13 of them were cured, and 1 was improved. **Conclusion** Endovascular treatment is safe for TICAD and can effectively improve the clinical prognosis of the patients, but this conclusion needs to be confirmed by large-scale prospective clinical trials.

[Key words] trauma; internal carotid artery dissection; endovascular treatment; treatment outcome

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创伤性颈内动脉夹层 (traumatic internal carotid artery dissection, TICAD) 是在外伤暴力作用下颈内动脉内膜发生撕裂使血液进入血管假腔而形成的壁内血肿, 其进一步进展可造成颈内动脉狭窄、闭塞、蛛网膜下腔出血或形成假性动脉瘤样改变等。研究表明, 颈动脉夹层的发病率为 2.5/10 万~5.0/10 万, 而颈内动脉夹层约占颈动脉夹层的 70%<sup>[1-2]</sup>。随着社会经济的发展, 交通事故和工业生产中意外事件造成 TICAD 的概率越来越大<sup>[3]</sup>, 及时诊断和早期处置 TICAD 是避免疾病进展的有效手段。影像学及血管介入技术的发展为 TICAD 的诊治提供了新的可能。本研究总结了 2014 年 1 月至 2019 年 11 月海军军医大学 (第二军医大学) 长海医院脑血管病中心诊治的 TICAD 病例资料, 旨在分析血管内介入治疗 TICAD 的安全性和有效性。

## 1 资料和方法

1.1 研究对象 回顾性纳入 2014 年 1 月至 2019 年 11 月在海军军医大学 (第二军医大学) 长海医院脑血管病中心接受血管内治疗、随访时间 ≥6 个月的所有 TICAD 患者。本研究通过海军军医大学 (第二军医大学) 长海医院伦理委员会审批。

1.2 患者资料收集 (1) 临床资料, 包括年龄、性别、致伤原因、受伤至发病时间、症状、病变部位、治疗策略、术后即刻结果。(2) 影像学资料, 包括术前、术后即刻及随访时的数字减影血管造影 (digital subtraction angiography, DSA) 或计算机断层扫描血管造影 (computed tomography angiography, CTA) 检查结果。(3) 术后即刻

及随访结果: 采用格拉斯哥结局量表 (Glasgow outcome scale, GOS) 评价患者术后恢复情况, 其中死亡计 1 分, 植物状态计 2 分, 严重残疾计 3 分, 中度残疾计 4 分, 恢复良好计 5 分。

1.3 手术方案与抗血小板治疗方案 手术方法: 患者取仰卧位, 常规消毒、铺单, 全身麻醉后采用改良 Seldinger 技术行股动脉穿刺, 置入动脉鞘, 全身肝素化 (肝素首次剂量为 0.67 mg/kg, 静脉注射 1 h 后追加首次剂量的半量, 2 h 后再追加首次剂量的 1/4, 之后每隔 1 h 追加前次剂量的 1/4, 当 1 次追加肝素总剂量减至 10 mg 时平均隔 1 h 予 10 mg 肝素)。行双侧锁骨下动脉和颈动脉造影明确颈内动脉夹层诊断后退出造影导管, 将导引导管置于颈内动脉夹层责任血管近端, 测量颈内动脉夹层远端直径和夹层血管长度。选择尺寸合适的血流导向装置、支架或弹簧圈, 通过标准的手术策略植入。如果术中出现急性血栓形成, 即刻采用替罗非班进行溶栓治疗。术后严密监测患者生命指征和股动脉穿刺点有无出血。

抗血小板治疗方案: 所有接受血管内治疗的患者于术前 2 h 接受各 300 mg 负荷剂量氯吡格雷和阿司匹林。接受支架植入治疗的患者术后每天服用阿司匹林 (100 mg/d) 和氯吡格雷 (75 mg/d), 服药 6 周后停用氯吡格雷, 阿司匹林则终身服用; 接受单纯弹簧圈栓塞治疗的患者术后无须服用氯吡格雷和阿司匹林。

1.4 术后即刻效果与随访观察指标 采用 GOS 评价患者术后即刻效果与临床随访时患者恢复情况, 术后 6 个月行 DSA 或头颈部 CTA 检查评价夹层血管的影像学结局。围手术期并发症包括患者住院期

间发生的缺血性事件（术中急性支架内血栓形成、术后早期支架内血栓形成）、出血性事件（术中动脉瘤破裂、术后早期再破裂）和症状性脑血管痉挛（经 DSA 证实且存在临床症状）。临床随访截至 2020 年 8 月 1 日，影像学结局评价采用患者最后 1 次检查结果。

1.5 统计学处理 应用 SPSS 22.0 软件进行统计学分析。呈正态分布的计量资料以  $\bar{x} \pm s$  表示，呈偏态分布的计量资料以中位数表示，计数资料以例数和百分数表示。

## 2 结果

2.1 患者基本资料 2014 年 1 月至 2019 年 11 月在海军军医大学（第二军医大学）长海医院脑血

管病中心接受血管内治疗且随访时间  $\geq 6$  个月的 TICAD 患者共 16 例，男 14 例，女 2 例，年龄为 16~63 岁，中位年龄为 37 岁。患者致伤原因包括车祸伤（11 例）、拳击伤（1 例）、摔伤（1 例）、颈部扭伤（1 例）、高压水枪伤（1 例）、高处坠落伤（1 例）。受伤至发病时间为 1 h~3 个月，中位时间为 1 个月。5 例患者表现为头颈部疼痛，2 例视物不清，3 例意识不清伴蛛网膜下腔出血，3 例鼻出血，3 例无明显症状。术前即刻影像学检查示，14 例患者表现为颈内动脉夹层动脉瘤，其中 1 例为颈内动脉交通段夹层动脉瘤合并颈内动脉颈段夹层动脉瘤（图 1）；2 例患者表现为颈内动脉夹层双腔征。见表 1。

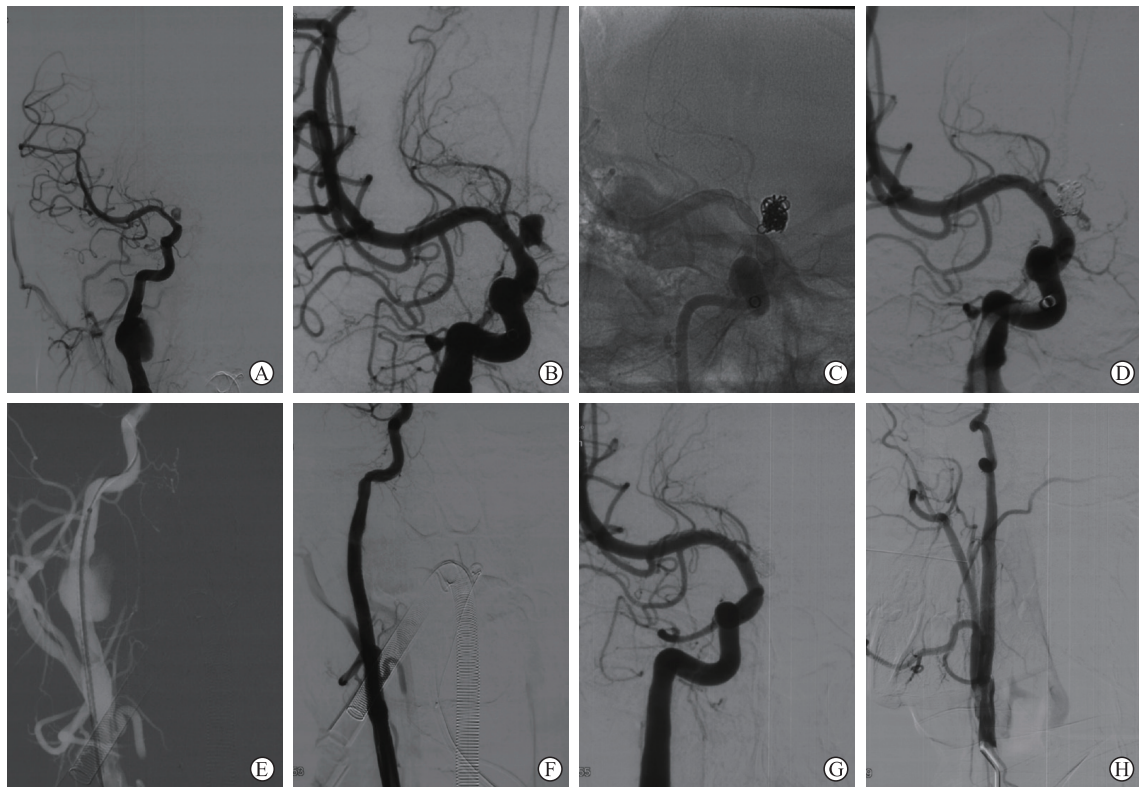


图 1 1 例右侧颈内动脉交通段夹层动脉瘤合并颈内动脉颈段夹层动脉瘤患者的 DSA 资料

Fig 1 DSA results of a patient with right internal carotid artery communicating and cervical segment dissecting aneurysms

Male, 16 years, injured from traffic accident for 2 months. A: DSA showing dissecting aneurysms in communicating and cervical segments of right internal carotid artery. B-D: The dissecting aneurysm (maximum diameter 5 mm, B) in communicating segment of right internal carotid artery was covered using 4/15 mm Tubridge flow diverter and embolized using HydroCoil (C); and after the treatment, the artery was patent with a small amount of contrast agent remnant from the aneurysm (D). E, F: The dissecting aneurysm (maximum diameter 2.5 cm, E) in cervical segment of right internal carotid artery was treated using 6/10 mm GORE peripheral stent, and the artery was patent and aneurysm disappeared after the stent release (F). G, H: Six months after endovascular treatment, the artery was patent, and dissecting aneurysms in communicating segment (G) and cervical segment (H) of right internal carotid artery disappeared. DSA: Digital subtraction angiography.



表1 16例创伤性颈内动脉夹层患者资料

Tab 1 Data of 16 patients with traumatic internal carotid artery dissection

No.	Gender	Age/ year	Injury cause	Time interval <sup>a</sup>	Clinical manifestation	Lesion location	Treatment strategy	Immediate postoperative		Last follow-up	
								GOS score	DSA	GOS score	DSA
1	Male	16	Traffic accident	2 months	No	C1 (R) C7 (R)	Stent implantation Flow diverter	5	Complete embolization	5	Cured
2	Male	47	Traffic accident	1 week	No	C1-C4 (L)	Stent implantation	3	Blood flow improvement	3	—
3	Male	63	Falling	1 month	Headache	C2 (L)	Flow diverter	5	Aneurysm body remnant	5	Cured
4	Male	32	Traffic accident	1 month	Blurred vision of left eye	C4 (L)	Flow diverter	4	Aneurysm body remnant	5	Cured
5	Male	16	Traffic accident	3 months	Epistaxis, cerebrospinal fluid rhinorrhea, intracranial murmur	C5 (L)	Balloon- assisted coiling	5	Aneurysm body remnant	5	Cured
6	Male	38	Traffic accident	3 weeks	Blind of right eye	C6 (R)	Stent-assisted coiling	5	Complete embolization	5	Improved
7	Male	18	Traffic accident	2 weeks	Unconsciousness, SAH	C5 (L)	Flow diverter	3	Complete embolization	5	—
8	Male	43	Boxing	4 weeks	Headache, dizziness	C2 (B)	Stent-assisted coiling	5	Aneurysm body remnant	5	Cured
9	Male	59	Traffic accident	2 weeks	No	C5 (R)	Stent-assisted coiling	5	Aneurysm body remnant	5	Cured
10	Female	53	Traffic accident	3 weeks	Headache, dizziness	C4 (L)	Stent-assisted coiling	5	Aneurysm body remnant	5	Cured
11	Male	17	Traffic accident	2 weeks	Epistaxis	C5 (L)	Stent-assisted coiling	5	Complete embolization	5	Cured
12	Male	38	Traffic accident	1 month	Headache, dizziness	C4 (R)	Flow diverter	5	Aneurysm neck remnant	5	Cured
13	Female	53	Traffic accident	1 week	Epistaxis	C4 (L)	Stent-assisted coiling	5	Complete embolization	5	Cured
14	Male	28	Neck sprain	12 d	Neck pain, right limb weakness	C2 (L)	Stent-assisted coiling	5	Aneurysm body remnant	5	Cured
15	Male	36	High- pressure water gunshot	3 h	Unconsciousness, SAH	C5 (L)	Stent-assisted coiling	4	Complete embolization	5	Cured
16	Male	18	High falling	1 h	Unconsciousness, SAH	C1-C7 (B)	Stent implantation	3	Blood flow improvement	5	Cured

The lesions in case 2 and 16 showed a double chamber sign before endovascular treatment, and all the others showed dissecting aneurysms. <sup>a</sup>: Time from injury to onset. —: No DSA follow-up data. GOS: Glasgow outcome scale; DSA: Digital subtraction angiography; SAH: Subarachnoid hemorrhage; C1: Cervical segment; C2: Petrous segment; C3: Lacerum segment; C4: Cavernous segment; C5: Clinoidal segment; C6: Ophthalmic segment; C7: Communicating segment; R: Right; L: Left; B: Bilateral.

2.2 术后即刻结果 16例TICAD患者均成功接受血管内治疗,包括颈内动脉夹层动脉瘤14例(共15枚夹层动脉瘤,1例患者颈内动脉颈段和交通段各有1枚夹层动脉瘤),单纯颈内动脉夹层2例。15枚夹层动脉瘤中5枚接受血流导向装置治疗,8枚行支架辅助弹簧圈栓塞治疗,1枚行球囊辅助弹

簧圈栓塞,1枚行单纯支架植入治疗;术后即刻造影见7枚夹层动脉瘤不显影、1枚瘤颈显影、7枚瘤体少量显影。2例单纯颈内动脉夹层患者均接受单纯支架植入,术后即刻造影均见夹层血管通畅。术后即刻3例患者临床GOS评分为3分,2例为4分,11例为5分。16例患者均无手术相关并发症。

见表1。

2.3 随访结果 16例患者均接受临床随访,随访时间为9~78个月,平均(35±9)个月,最后1次随访时15例患者GOS评分为5分,1例为3分。14例患者接受影像学随访,随访时间为6~70个月,平均(26±8)个月,最后1次随访时13例治愈,1例好转。见表1。

### 3 讨论

头颈动脉夹层在临床上是一种少见的脑血管疾病,目前国内尚缺乏针对头颈部动脉夹层的大规模流行病学研究。颈内动脉夹层根据发病因素分为自发性颈内动脉夹层和TICAD,自发性夹层通常与常染色体显性遗传病埃勒斯-当洛综合征(Ehlers-Danlos syndrome, EDS)、血管退行性病变、高同型半胱氨酸血症、动脉粥样硬化、血管发育不良、感染等密切相关<sup>[4-5]</sup>。对于TICAD,研究表明多种外伤因素可导致其发生,轻至咳嗽、打喷嚏、突然转头、按摩、长时间打电话,重至颈部穿透伤或钝器伤、严重的车祸外伤、坠楼等。值得注意的是,医源性损伤因素如介入操作不当等也可能造成TICAD<sup>[6]</sup>。部分TICAD患者合并血管组织结构异常。本组16例TICAD患者的致伤因素包括车祸伤、拳击伤、摔伤,头部扭伤、高压水枪伤、高处坠落伤,其中车祸伤为最常见的致伤原因。

TICAD的典型临床表现是一侧头面颈部疼痛、Horner综合征、受伤数小时后视网膜或脑缺血三联征。另有临床研究指出TICAD的临床表现还包括颈动脉杂音、后组颅神经麻痹、黑矇、晕厥、颈部肿胀等<sup>[7]</sup>。本组16例患者中5例表现为头颈部疼痛,2例视物不清,3例意识不清伴蛛网膜下腔出血,3例鼻出血,3例无明显症状。除临床表现外,TICAD的诊断很大程度上依赖影像学手段,如彩色多普勒超声、CTA、磁共振血管成像、DSA等。影像学检查中颈动脉夹层造成的血管狭窄和动脉瘤样扩张可呈现出不同特征,动脉狭窄弦线征、火焰征、动脉闭塞、血管壁双腔征、血管内膜瓣、动脉壁不规则褶皱等是血管狭窄性颈动脉夹层的典型影像学特征,囊状动脉瘤、梭形动脉瘤是颈动脉夹层动脉瘤样扩张的典型影像学特征<sup>[8]</sup>。本组16例TICAD患者术前都接受了DSA

检查,其中14例表现为颈内动脉夹层动脉瘤,2例表现为颈内动脉夹层双腔征。

由于缺乏大型循证医学证据,TICAD的治疗多采用症状相关疾病的治疗策略。对影像学表现为血管狭窄的TICAD患者,应避免受损内膜表面血栓形成和动脉栓塞;对表现为动脉瘤样改变的患者,应积极干预动脉瘤以避免发生蛛网膜下腔出血。临床针对TICAD的治疗包括药物治疗和外科手术治疗2种方案,既往多项研究对2种治疗方案进行了回顾性总结,认为药物治疗多适用于症状轻微、影像学表现稳定的TICAD患者,但需要密切的临床监测和随访;而外科手术治疗更多适用于临床症状明显、影像学表现不稳定者<sup>[9-10]</sup>。药物治疗通过使用不同的抗凝(阿司匹林、氯吡格雷、双嘧达莫等)和抗血小板(低分子肝素、华法林等)方案预防缺血性脑卒中。Lyrer和Engelter<sup>[11]</sup>研究指出,抗血小板和抗凝在治疗颈动脉夹层患者中远期生存率差异无统计学意义。既往研究表明传统外科开放手术治疗TICAD安全有效,手术策略包括病变动脉切除、血管补片技术、血栓部位血管内膜剥脱术等<sup>[12]</sup>。

近年来,介入技术逐渐被用于颈动脉夹层的治疗。Pham等<sup>[13]</sup>回顾了140例支架治疗颈动脉夹层患者的资料,支架植入术的成功率为99%,手术并发症发生率为1.3%。Moon等<sup>[14]</sup>通过回顾分析93例颈动脉夹层患者的资料指出,支架植入可有效改善患者的临床结局。Latacz等<sup>[15]</sup>采用了双密网支架策略治疗颈动脉夹层,影像学随访结果显示治疗后病变动脉血流通畅,夹层和假性动脉瘤完全被支架覆盖。国内刘娟等<sup>[16]</sup>研究表明,颈动脉夹层动脉瘤支架植入后94.9%的病变血管完全恢复正常,89.7%的患者症状消失或好转。本组16例TICAD患者均接受了血管内治疗,手术成功率为100%,介入治疗策略有血流导向装置、支架辅助弹簧圈栓塞、球囊辅助弹簧圈栓塞、单纯支架植入,所有患者均无手术相关并发症,且临床和影像学结局较佳(临床随访15例患者GOS评分为5分,1例为3分;影像学随访13例治愈,1例好转)。

综上所述,血管内介入策略对TICAD安全性高,且能有效改善患者临床预后。本研究限于样本量小和回顾性研究设计,所得结论需大规模临床随机对照试验进一步证实。

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