

急性Stanford B型主动脉夹层腔内修复术后远端 主动脉负性重塑危险因素分析*

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【摘要】 目的 应用计算机断层扫描及影像分析软件评估Stanford B型主动脉夹层腔内修复术(thoracic endovascular aortic repair, TEVAR)后支架远端主动脉形态学变化,探讨术后发生支架远端主动脉负性重塑的危险因素。**方法** 回顾性分析2005年10月至2015年12月于我院接受TEVAR手术的急性Stanford B型主动脉夹层患者的临床资料和影像学数据,结合既往Criadol分区原则将主动脉归纳分为胸降主动脉区、肾上腹主动脉区、肾下腹主动脉区及髂动脉区,评估不同区域主动脉真假腔形态及破口分布情况。利用单因素和多元logistic回归分析发生支架远端主动脉负性重塑的危险因素。**结果** 共完整收集216例于我院进行定期随访的患者资料,平均随访(3.9±2.1)年,随访期内47例(21.8%)患者支架远端主动脉出现负性重塑。单因素logistic线性回归分析发现主动脉壁结构异常(马凡综合征病史)和假腔持续通畅(远端破口存在、假腔血栓化不全)是本组患者TEVAR术后支架远端主动脉负性重塑的危险因素;多元logistic回归分析显示,胸降主动脉区破口多[比值比(OR)=1.36, 95%可信区间(CI)=1.12-1.58, P=0.005]以及肾下腹主动脉区破口少(OR=0.49, 95%CI=0.22-0.71, P<0.001)是患者术后支架远端主动脉负性重塑的独立危险因素。**结论** 主动脉壁结构异常、假腔持续通畅、胸降主动脉区破口多及肾下腹主动脉区破口少是急性Stanford B型主动脉夹层患者TEVAR术后支架远端主动脉负性重塑的独立危险因素。

【关键词】 主动脉夹层 腔内修复 主动脉重塑 破口

Risk Factors for Adverse Aortic Remodeling in Post-TEVAR Patients with Acute Stanford B Aortic Dissection

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【Abstract】 Objectives To assess morphological changes of distal aorta and the risk factors for adverse aortic remodeling in post-TEVAR(thoracic endovascular aortic repair) patients with acute Stanford B aortic dissection. **Methods** We retrospectively investigated the patients who underwent TEVAR for a type B dissection between October 2005 and December 2015. CT angiogram (CTA) was obtained for each patients preoperatively, postoperatively and during the post-operational follow-up. Based on Criadol partition principle, we divided the aorta into descending thoracic aorta area, suprarenal abdominal aorta area, infrarenal abdominal aorta area and iliac artery area, and evaluated the distribution of aortic tears and the form of true and false lumen in different aortic partition. Univariate and multivariate logistic regression analyses were used to analyze the risk factors affecting distal aortic remodeling. **Results** Of 216 patients[(mean follow-up (3.9±2.1) years] who were regularly followed up in our center, 47 patients (21.8%) occurred adverse remodeling in distal aorta. Univariate logistic regression indicated that abnormal aortic wall structure (Marfan's syndrome) and patent false lumen (existence of distal tears, decreased complete false lumen thrombosis) were associated with distal aortic adverse remodeling. Multivariate logistic regression showed that more tears in descending thoracic aorta area (OR=1.36, 95%CI=1.12-1.58, P=0.005) and less tears in infrarenal abdominal aorta area (OR=0.49, 95%CI=0.22-0.71, P<0.001) were independent risk factors affecting remodeling in distal aorta after TEVAR. **Conclusions** Aortic wall structure abnormalities, a patent false lumen, more tears in descending thoracic aorta area, less tears in infrarenal abdominal aorta area are independent risk factors for adverse aortic remodeling in post-TEVAR patients with acute Stanford B aortic dissection.

【Key words】 Aortic dissection Endovascular repair Aortic remodeling Tears

胸主动脉腔内修复手术(thoracic endovascular

aortic repair, TEVAR)已成为复杂性Stanford B型主动脉夹层的首选治疗方法,近期也有研究证实非复杂性Stanford B型主动脉夹层患者接受TEVAR术后远期临床结局优于传统药物治疗^[1-3]。真腔扩大、假腔缩减及

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假腔内血栓形成被认为是TEVAR术后主动脉远端良性重塑改变,其与术后患者远期临床获益密切相关^[4-5]。因此,本研究通过回顾性分析我中心近十年来接受TEVAR手术治疗的急性Stanford B型主动脉夹层患者临床资料和影像学数据,探讨影响此类患者TEVAR术后远端主动脉良性重塑的危险因素,为进一步制定合理的初次手术范围和策略提供参考依据。

1 材料与方法

1.1 资料收集

收集2005年10月至2015年12月于我院接受TEVAR手术的急性Stanford B型主动脉夹层患者临床资料和影像学数据。结合本研究需要,将患者的B型主动脉夹层累及区域按照Criadol分区法^[6]分为胸降主动脉区(4~5区),肾上腹主动脉区(6~8区),肾下腹主动脉区(9区)及髂动脉区(10~11区),术后随访观察患者主动脉各区段形态学变化和远端破口数量及位置分布。排除随访期内失访、I型内漏及死亡患者,最终将包括末次随访在内至少3次随访CT的患者资料纳入统计学分析。

1.2 随访

所有患者术后1、3、6、12月定期复查夹层动脉瘤CT增强扫描加三维重建检查,1年后每年复查1次(范围自头颈动脉至双侧腹股沟区),经3Mensio Medical Imaging(3mensio Medical Imaging BV, Bilthoven, The Netherlands)心脏和血管内结构性检查软件完成各项统计指标的测量。主动脉真假腔测量方法:真假腔短径取轴位像上垂直于内膜片的最大长度,所有数值均取小数点后2位,单位均为mm。

统计指标包括:①TEVAR术后1年夹层长度、假腔血栓化/未血栓化长度、支架远端不同主动脉平面真/假腔直径及比例,真/假腔血供分支数目、双腔血供分支数目。②破口总数量及不同主动脉区段破口数量。患者术后发生支架远端主动脉负性重塑标准:主动脉直径>正常直径1.5倍或主动脉直径增长率>10 mm/年。

1.3 统计学方法

连续变量组间比较使用独立样本 t 检验比较,分类变量组间比较使用Chi-square检验和Fisher确切概率法比较。通过单因素logistic线性回归分析,明确发生主动脉远端负性重塑的危险因素,运用多因素logistic多元回归分析筛选出破口对TEVAR术后主动脉远端负性重塑的独立危险因素, $P<0.05$ 为差异有统计学意义。

2 结果

2.1 患者资料

2005年10~12月间,共有345例急性Stanford B型主动脉夹层患者于本中心接受TEVAR手术。随访期内失访123例。排除术后早期出现I型内漏及围术期死亡患者6例,最终共完整收集到216例于我院至少完成3次术后影像学随访的患者资料,平均随访 (3.9 ± 2.1) 年。随访期内共47例(21.8%)患者术后发生支架远端主动脉负性重塑。根据患者术后是否发生支架远端主动脉负性重塑分为良性重塑组($n=169$)和负性重塑组($n=47$)。两组患者术前资料见表1。

表1 TEVAR术前患者既往病史/例数
Table 1 Past medical history of patients before TEVAR/case

Variables	Advantaged remodeling ($n=169$)	Adversed remodeling ($n=47$)	P
Female	34	10	0.8523
Male	135	37	0.1101
Age(≥ 60 yr.)	87	24	0.0001
Age(<60 yr.)	82	23	0.1321
Hypertension			
I	35	9	0.1213
II	60	7	0.2085
III	49	11	0.4443
Arrhythmia	26	4	0.4235
Chronic obstructive pulmonary disease	31	3	0.3286
Diabetes	15	2	0.4874
Chronic renal insufficiency	30	3	0.5382
Hepatic cyst	104	20	0.4823
Cholecystitis	27	2	0.3827
Lumbar disc protrusion	33	4	0.2511
Marfan syndrome	5	8	<0.0001
Autoimmune diseases	6	1	0.6625
History of aortic disease	21	1	0.0624
Atherosclerosis	38	11	0.9234
History of interventional surgery	1	5	0.0096
Other surgical history	17	10	0.0095
Cigarette smoking	137	38	0.3637
Alcohol consumption	97	23	0.5333
Length of descending thoracic aorta covered by covered stent	76	21	<0.0001
Number of covered stents	139	38	0.545

2.2 主动脉形态学变化

TEVAR术前患者既往病史统计见表1, 术后主动脉夹层形态学变化见表2, 单因素logistic线性回归分析发现主动脉壁结构异常(马凡综合征病史)[比值比(OR)=6.98, 95%可信区间(CI)=3.78~12.9, $P<0.0001$]是患者发生术后支架远端主动脉负性重塑的危险因素。远端存在残余破口, 假腔持续通畅, 使TEVAR术后良性重塑组假腔血栓化明显优于负性重塑组(140.9±94.3

VS 98.9±59.9, $P<0.001$), 单因素logistic线性回归分析显示假腔持续通畅是TEVAR术后远端主动脉负性重塑的危险因素。

2.3 术后破口数量和位置分布

急性Stanford B型主动脉夹层经过TEVAR术封闭第一破口以后绝大多数的患者支架远端仍然存在破口, 其中约80%左右的患者破口数量超过三个。破口分布各异, 主动脉各个分区均可见, 以肾上腹主动脉区

表2 术后一年主动脉夹层形态学变化

Table 2 Morphological changes of aortic dissection one year after operation

Variables	Advantaged remodeling (n=169)	Adversed remodeling (n=47)	P
Length of dissection/mm	366.6±91.8	428.9±96.8	<0.001
Length of false lumen thrombosis/mm	140.9±94.3	98.9±59.9	<0.001
Length of patent false lumen/mm	13.2±25.0	36.4±52.5	<0.001
Distance from complete proximal thrombosis to LSA/mm	90.0±68.7	68.2±53.3	<0.001
Number of branches supplied blood by TL	2.5±0.7	2.2±1.0	0.007
Number of branches supplied blood by FL	0.7±0.4	0.8±0.9	0.654
Number of branches supplied blood by TL and FL	0.7±0.7	1.0±1.1	0.006
FL wraps TL/case(%)	0(0%)	5(10.6%)	<0.001
Position of the widest TL plane	213.4±84.4	190.5±94.9	0.038
Distribution of the widest TL/case(%)			0.877
Infrarenal abdominal aorta	23(13.6)	7(14.9)	
Suprarenal abdominal aorta	56(33.1)	11(23.4)	
Thoracic descending aorta	90(53.3)	29(61.7)	
T/F of the widest TL plane	1.0±0.6	1.0±1.6	0.916
Position of minimal T/F	311.7±89.3	316.8±100.3	0.661
T/F of minimal plane	0.4±0.2	0.2±0.2	<0.001
Position of maximal T/F	261.3±91.1	231.4±112.7	0.014
T/F of the widest plane	1.6±1.7	1.4±1.8	0.168
Position of the widest plane of aorta	171±61	163.8±65	0.366
Distribution of the widest plane of aorta/case(%)			0.07
Infrarenal abdominal aorta	6(3.6)	3(6.4)	
Suprarenal abdominal aorta	60(35.5)	6(12.8)	
Thoracic descending aorta	103(60.9)	38(80.8)	
Number distribution of tears			0.04
Infrarenal abdominal aorta	186	22	
Suprarenal abdominal aorta	119	29	
Thoracic descending aorta	6	24	
Total aortic diameter of the most narrow TL plane	25.3±4.3	28.2±7.0	<0.001
Short diameter of TL on the most narrow TL plane	8.0±3.2	6.8±2.8	0.002
T/F of the most narrow TL plane	0.4±0.5	0.2±0.1	<0.001

FL: False lumen; TL: True lumen; LSA: Left subclavian artery; T/F: Ratio of TL Diameter to FL

和肾下腹主动脉区较为常见。多因素logistic多元回归分析显示胸降主动脉区破口多($OR=1.36$, $95\% CI=1.12\sim1.58$, $P=0.005$)以及肾下腹主动脉区破口少($OR=0.49$, $95\% CI=0.22\sim0.71$, $P<0.001$)是患者术后支架远端主动脉负性重塑的独立危险因素,胸降主动脉区破口数量每增加一个,远端主动脉发生负性重塑的风险为1.36倍,肾下腹主动脉区破口数量每减少一个,远端主动脉发生负性重塑的风险为2.0倍(表3)。

表3 术后夹层破口数量Logistic多元线性回归分析

Table 3 Logistic multiple linear regression analysis of post-operative number of tears

Model	Crude	Adjust*
Number of thoracic descending aorta	1.21(1.08,1.41)	1.36(1.14,1.58)
Number of Suprarenal abdominal aorta	0.96(0.79,1.18)	1.23(0.79,1.89)
Number of infrarenal abdominal aorta	0.44(0.25,0.66)	0.49(0.22,0.71)
Number of iliac artery	0.93(0.68,1.28)	0.74(0.39,1.40)

*Adjust age, Rypertension and marfan syndrom

3 讨论

本研究发现主动脉壁结构异常、假腔持续通畅、胸降主动脉区破口多及肾下腹主动脉区破口少是发生急性Stanford B型主动脉夹层患者TEVAR术后支架远端主动脉负性重塑的独立危险因素。此外,初次手术范围以及对远端破口的不同手术策略可能也会支架远端主动脉良性重塑产生一定影响。

急性Stanford B型主动脉夹层患者TEVAR术后的主动脉良性重塑程度与患者长期预后有着密切关系。既往研究结果显示夹层范围及累及分支情况、破口数量及假腔血栓化等均是影响远端主动脉良性重塑的危险因素^[7-13]。本研究通过对比患者术前夹层总长度及TEVAR术后假腔血栓化/未血栓化长度和分析主动脉各区段破口数量及分布,发现胸降主动脉区破口多及支架远端存在破口均会影响支架远端主动脉良性重塑。因此,本研究结果表明主动脉夹层存在多个破口,导致TEVAR术封闭了主要破口后仍有部分血流通过远端破口与假腔相通,导致假腔血栓化减少,进而影响远端主动脉良性重塑,此为影响急性Stanford B型主动脉夹层腔内修复术后远端主动脉良性重塑的独立危险因素。此外,TOLENAAR等^[8]研究发现术前夹层范围广,累及分支动脉亦会影响远端主动脉良性重塑,本研究结果进一步证实了这一观点。

胸降主动脉区破口多、夹层范围广以及累及分支

均可影响TEVAR术后假腔血栓化,导致主动脉远端负性重塑。部分研究结果表明支架远端主动脉负性重塑,使经典TEVAR术后具有较高的再次手术率^[14-16]。故有学者认为只要真假腔之间仍有破口连通,假腔内就有血流灌注;而无论是保守治疗、开放手术还是TEVAR手术,只要假腔内持续血流存在,就会继续导致主动脉增粗并存在破裂风险。因而主张应把消除全部破口作为TEVAR治疗急性Stanford B型夹层的核心要求,以期获得“根治”的效果^[17]。本研究中有7例患者在一期手术时同时封闭了肾下腹主动脉区破口,患者术后早期影像学随访数据显示主动脉整体形态重塑良好,但腹主动脉及髂动脉存在残余夹层,术后4年腹腔干平面主动脉假腔直径测量结果较术后早期明显增大,肾上腹主动脉区呈现明显的负性重塑,双侧髂总动脉假腔明显扩大,形成巨大假性动脉瘤。这也说明如果肾上腹主动脉区存在破口时,盲目先处理肾下腹主动脉区破口可能导致远端主动脉假腔压力持续增大,内膜片持续撕裂,增加远端主动脉负性重塑的风险^[9]。因此,首次手术尽可能完全封闭胸降主动脉区域,且对于远端破口的处理应遵循由近至远的原则,肾上腹主动脉区存在破口时,不宜盲目先处理肾下腹主动脉区。

此外,远端破口的治疗比近端破口更困难。既往国内外研究有破膜技术、覆膜支架开窗、开槽技术或结合使用弹簧圈、封堵器、小型覆膜支架、分支型覆膜支架、多层裸支架、栓塞子等处理远端破口或受累分支动脉的少数报道^[18-19]。对远端破口的治疗方式多样,且具有个体化特征,目前还无法在破口位置、血管解剖状况不同的情况下完全消除远端所有破口。因此,对于远端破口,重在根据患者个体化的位置分布及解剖特性评估是否需要全部处理,严密随访远端主动脉重塑^[20]。

本研究中所有患者均使用同一品牌的支架,可排除不同品牌支架之间自身特性的差异对研究结果的影响;然而本研究尚存在一定不足:首先,作为一项单中心回顾性研究,各种选择性偏倚或患者合并因素都可能对研究结果产生影响。其次,本研究分析了多个因素对远端主动脉良性重塑的影响,但各因素之间的相互作用可能对研究结果产生影响;最后,部分患者缺乏连续时间点的影像学随访资料,数据的缺失可能会对研究结果的解读带来负面影响。

TEVAR已成为急性Stanford B型主动脉夹层患者的首选治疗方法,主动脉壁先天结构异常、支架远端存在破口、胸降主动脉区破口多及肾下腹主动脉区破

口少是影响急性Stanford B型主动脉夹层患者TEVAR术后支架远端主动脉良性重塑的独立危险因素。对主动脉夹层破口的处理应遵循由近至远的原则,首次手术时应尽量完善处理胸降主动脉段破口,肾上腹主动脉区存在破口时不宜盲目先处理肾下腹主动脉区破口。对支架远端破口的处理时机及策略还需要更进一步的研究探索。

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