



doi:10.7659/j.issn.1005-6947.2024.12.017
http://dx.doi.org/10.7659/j.issn.1005-6947.2024.12.017
China Journal of General Surgery, 2024, 33(12):2077-2082.

· 文献综述 ·

腹主动脉瘤腔内修复术后并发症相关危险因素研究进展

王玉竹, 张帅, 周雨, 金怡, 赵子赫, 潘朝晖, 付东升, 韩月雪, 胡健航, 热亚古丽·柯尤木, 刘昭, 李晓强

(南京大学医学院附属鼓楼医院 血管外科, 江苏 南京 210008)

摘要

腹主动脉瘤腔内修复术 (EVAR) 因手术时间短、术后恢复快、术后早期病死率低等优势, 已经成为腹主动脉瘤重要的治疗方法, 但其并发症发生率和术后再干预率均高于开放手术。EVAR 术后并发症主要包括入路血管损伤、植入后综合征、支架移位、内漏、内脏分支动脉闭塞及下肢缺血和支架感染, 这些也是造成再干预的主要原因。近年来, 有关EVAR各术后并发症产生的原因和相关危险因素引起广泛关注和讨论, 对临床医生完善手术方式和术后监测, 改善患者预后意义重大。笔者就目前EVAR后的并发症、相关危险因素及处理方式作一综述。

关键词

主动脉瘤, 腹; 血管内操作; 手术后并发症; 危险因素; 综述

中图分类号: R654.3

Research progress on risk factors associated with postoperative complications of endovascular repair for abdominal aortic aneurysms

WANG Yuzhu, ZHANG Shuai, ZHOU Yu, JIN Yi, ZHAO Zihe, PAN Chaohui, FU Dongsheng, HAN Yuexue, HU Jianhang, REYAGULI·Keyoumu, LIU Zhao, LI Xiaoqiang

(Department of Vascular Surgery, Affiliated Drum Tower Hospital, Medical School of Nanjing University, Nanjing 210008, China)

Abstract

Endovascular Aneurysm Repair (EVAR) has become an important treatment method for abdominal aortic aneurysms due to its advantages of shorter operative time, faster postoperative recovery, and lower early postoperative mortality. However, the incidence of complications and the postoperative reintervention rates are higher than those of open surgery. The main complications after EVAR include access vessel injury, post-implantation syndrome, stent migration, endoleaks, visceral branch artery occlusion, lower limb ischemia, and stent infection, which are also the primary causes of reintervention. In recent years, the causes and associated risk factors of various postoperative complications of EVAR have attracted widespread attention and discussion, which are of great significance for improving surgical techniques, enhancing postoperative monitoring, and improving patient outcomes. This paper provides a review of the current complications, associated risk factors, and management strategies after EVAR.

Key words

Aortic Aneurysm, Abdominal; Endovascular Procedures; Postoperative Complications; Risk Factors; Review

CLC number: R654.3

收稿日期: 2024-06-27; 修订日期: 2024-07-11。

作者简介: 王玉竹, 南京大学医学院附属鼓楼医院博士研究生, 主要从事血管外科临床方面的研究。

通信作者: 刘昭, Email: liuzhao@nju.edu.cn; 李晓强, Email: flytsg@126.com

腹主动脉瘤是老年人中常见的主动脉疾病，伴随致命的破裂风险，既往以开放手术为主要治疗方式。自30年前Parodi等首次完成腹主动脉瘤腔内修复术（endovascular aneurysm repair, EVAR）以来，该技术已逐渐成为腹主动脉瘤重要的治疗方式。与开放手术相比，EVAR具有手术时间短、术后恢复快、术后早期病死率低等优势，但在中长期随访中，EVAR则表现出更高的并发症发生率和再干预率。目前对于EVAR术后并发症的讨论已不局限于统计描述，很多相关研究旨在阐述各并发症的产生原因和相关危险因素，这有助于在临床治疗过程中完善手术方法以及术后监测，降低术后风险，提高患者预后。本文现结合近年文献，就EVAR的常见并发症及相关危险因素进行分析。

1 入路血管损伤

通过股动脉、髂动脉等建立好血管通路是EVAR手术成功的关键因素之一，但在支架输送过程中可能会对入路血管造成损伤。目前建立血管入路的方式有动脉切开和经皮穿刺两种，其中经皮穿刺建立入路手术时间更短，且术后相关并发症的发生率更低^[1-2]。有统计^[3]表明，年龄大、有吸烟史、消瘦以及女性患者发生入路血管损伤的概率更大。另有研究^[4]发现，直径小、发生钙化或严重扭曲的髂动脉更容易发生损伤，损伤结果常表现为髂动脉破裂或髂动脉夹层。髂动脉破裂可能延长患者的住院时间或直接导致患者死亡，而夹层则可能导致髂动脉闭塞。

2 植入后综合征

植入后综合征是EVAR术后的一种非感染性炎症反应，当患者出现持续发热（ $>38\text{ }^{\circ}\text{C}$ ）1 d以上，伴有白细胞增多、C-反应蛋白和白介素6升高，且血培养阴性时，即可诊断为植入后综合征^[5]。目前对于植入后综合征的诊断标准尚不统一，其发生率在15.8%~34%之间^[6]。植入后综合征的产生可能与EVAR术中血管内皮损伤、动脉瘤腔内血栓形成、肠道短暂缺血引起的细菌易位等因素有关^[7-8]。相比于标准的肾下EVAR，涉及内脏分支动脉的复杂EVAR术后患者发生植入后综合征的风险显著增加^[9]。另外，特定类型的支架材料，尤其是聚酯纤

维制成的覆膜支架，术后更容易出现植入后综合征，而采用聚四氟乙烯制成的覆膜支架术后发生植入后综合征的概率则较低^[10]。不过植入后综合征常为良性病程，常规仅需使用阿司匹林等非甾体抗炎药控制炎症反应并进行临床监测，无需使用抗生素^[7,11]。

3 支架移位

支架从原始固定位置移动5~10 mm即为支架移位^[11]。近端支架移位会导致I型内漏，动脉瘤可能因此扩张而有破裂的风险。支架移位通常与动脉瘤颈的进行性扩张、主动脉扭曲、主动脉壁退行性病变、支架大小不合适有关^[12]。反锥形动脉瘤颈更易发生支架移位，对于该类患者可以预防性使用内锚定将支架固定在主动脉壁上。而正常形态的动脉瘤颈，通过在术中选择更大尺寸支架，或使用大球囊扩张支架至贴合主动脉壁，也可以降低支架移位发生的可能^[13-14]。

4 内漏

内漏是EVAR术后最常见的并发症，其定义为动脉瘤腔内持续存在血流灌注，导致治疗失败、动脉瘤持续生长或破裂。根据血流的来源可以将内漏分为五种类型。I型内漏：由于覆膜支架近端或远端锚定区与血管贴合不紧密，血流经支架和血管间的缝隙持续进入动脉瘤腔，包括近端内漏（Ia型）和远端内漏（Ib型）。II型内漏：持续的血流通过动脉瘤体上单个（IIa型）或多个（IIb型）分支血管灌注到瘤腔内，常见于肠系膜下动脉和腰动脉。III型内漏：是支架本身的结构破坏，可分为支架断裂（IIIa型）或覆膜撕裂（IIIb型）。IV型内漏：覆膜支架的覆膜针孔渗漏或其他质量原因造成的内漏。V型内漏：指存在持续的动脉瘤囊扩张，但不见造影剂渗漏。II型内漏是最常见的内漏类型，IV型和V型内漏很少见^[15-16]。

与Ia型内漏形成相关的危险因素包括不良动脉瘤颈形态、瘤颈部血栓、应用烟囱支架等，而髂动脉形态不良和使用“喇叭腿”支架则会增加Ib型内漏发生的风险^[17]。对于不良动脉瘤颈形态，相关研究^[18-21]表明，肾动脉上型腹主动脉瘤瘤颈角度更大或肾下型腹主动脉瘤瘤颈曲率更大的患者，

容易发生晚期Ia型内漏。另外一项单中心回顾性研究^[22]表明,高密度脂蛋白升高会增加I型内漏的发生风险,但其机制尚不明确。I型内漏会使瘤腔变成“只进不出”的高压型瘤腔,破裂风险升高,因此要尽量避免其发生,需要根据术前对动脉瘤颈的测量选择合适的支架尺寸和固定方式。而如果发生I型内漏,其治疗方式与支架移位相同。除非腔内修复无法纠正,否则不建议转为开放手术进行处理^[23]。

有研究^[24]表明, EVAR 术后发生II型内漏患者的瘤体最大直径、肠系膜下动脉直径和腰动脉数量相较未发生内漏的患者均有明显增大,且在这些患者中长期吸烟和患有高血压的比例更高。除此之外,术后血小板水平降低的II型内漏患者,其瘤腔增大更为明显,更需要定期检测和及时干预^[25]。II型内漏的再干预方式通常为栓塞相应的分支动脉和动脉瘤腔,少数使用手术结扎分支动脉以达到同样的效果。值得注意的是,栓塞肠系膜下动脉有发生缺血性结肠炎的风险^[26-27]。

随着支架工艺的进步, III型内漏的发生率明显降低,但其危险性仍然不可忽视^[28]。III型内漏同样会造成主动脉瘤破裂,需要通过在支架破裂处额外植入支架进行修复^[29-30]。

IV型内漏极少见,且通常为自限性,一般无需特殊处理^[31]。但如果出现动脉瘤的持续扩张,可以采用腔内修复或开放手术的方式进行治疗。

V型内漏具体发生机制和危险因素不明,但可能与移植物孔隙度增加导致的血液渗出和血栓及组织降解导致的囊内容物积累有关^[32]。对于V型内漏,大多不进行处理,仅当瘤腔直径因内漏出现明显增大(>1 cm)时行手术修复^[31]。

5 内脏分支动脉闭塞

接受EVAR治疗的患者可能会在术后出现内脏分支动脉闭塞,继而发生肾、肠、盆腔脏器缺血以及骨髓缺血的症状。闭塞的原因包括分支支架尺寸过大、支架放置位置偏差、支架移位、支架扭曲以及支架植入后血流动力学变化等^[29,33-34]。支架植入后动脉的血流动力学均会发生改变,但临床治疗过程中常常忽略这一因素的影响。有报道^[35]称,低血流速度、低壁面切应力、高相对停留时间、高振荡剪应力指数等条件会促进血小板

的聚集,进而产生血栓。不恰当的分支支架植入条件可能会使分支动脉处于容易产生血栓的血流动力学状态下,导致闭塞的发生。对于可能由血流动力学变化引起的栓塞,需要在术中注意分支支架释放的位置、深度以及角度,尽可能保证分支动脉的血流通畅,以达到预防的目的。

肾缺血的原因包括肾动脉栓塞、夹层或支架覆盖了肾动脉入口^[36-37]。瘤颈过短、瘤颈附壁血栓较多都会增加堵塞肾动脉的风险,术中释放支架时需格外谨慎^[38]。如果术后发生肾功能持续恶化,可能需要搭桥手术以重建受累肾脏的血运。

EVAR 术后约有1%~3%患者会发生肠缺血,最常累及结肠,其原因是支架覆盖了肠系膜下动脉入口^[39-40]。此时肠系膜交通动脉发育不良,便可能发生左结肠缺血。假如支架覆盖了肠系膜上动脉和腹腔干,患者将会出现缺血性结肠炎,表现为术后30 d内的腹痛和便血。对于出现了覆膜刺激征和严重感染的患者,应当及时行剖腹手术切除坏死肠段^[11]。

盆腔脏器缺血常继发于髂内动脉栓塞后的患者,症状包括跛行、直肠缺血、勃起功能障碍和皮肤坏死,往往会随着时间的推移而改善,无需干预。然而双侧髂内动脉栓塞的患者,其症状可能会持续存在^[41]。针对髂内动脉栓塞的问题,目前有多种策略正在研究,包括髂内动脉外科血管重建、医师自行改良支架、放置平行内移植物等。

单纯EVAR术后很少出现脊髓缺血,但其出现往往伴随着截瘫的风险。相关危险因素包括支架覆盖范围过大、围手术期低血压、手术时间长、髂内动脉闭塞、既往肾下主动脉手术史和肾功能不全^[41-43]。

6 下肢缺血

在接受EVAR治疗的患者中,有0.4%~11.9%会出现术后急性下肢缺血^[11,15,29,33,44]。尽管发生率随着支架的迭代不断降低,但其仍是EVAR术后导致再干预、延长住院时间和增加病死率的主要并发症之一^[45]。原因包括髂动脉弯曲角度过大($\geq 60^\circ$)、支架扭曲、支架远端口径放大率过大($>15\%$)髂动脉狭窄($\geq 50\%$)、髂外动脉钙化严重以及下肢动脉入路损伤^[29,33,46-47]。支架的品牌和结构设计,对术后髂动脉闭塞的发生率同样存在影响^[48-49]。急性

下肢缺血的血管腔内修复方式包括腔内取栓或溶栓、对髂支狭窄部位进行球囊扩张成形或再植入增强支架纠正支架扭曲^[50]。开放手术有股—股搭桥、腋—股搭桥和开放取栓等选择。

7 支架感染

据统计^[11]，0.3%~3.6%的患者会在EVAR术后出现支架感染^[15]，病死率在25%~50%之间。早期的支架感染可能与术中污染有关，支架远端污染可能是延迟性支架感染的原因。发热、白细胞增多、支架周围软组织浸润、主动脉肠瘘、假性动脉瘤等均为支架感染的诊断依据^[51]。另外有研究^[52-54]表明，及时手术对于支架感染的治疗十分重要，包括支架切除、感染组织清创和动脉血流重建以保留远端血流。根据临床情况给予抗生素，给药时间几周至几年不等。有时需要终生抗生素治疗。

8 展望

EVAR已经成为腹主动脉瘤的重要治疗方法，随着设备以及血管腔内技术的不断进步，即使对于复杂的腹主动脉瘤，通过EVAR也能取得良好的治疗效果，这也使得EVAR的适应证越来越广泛。与此同时，EVAR的术后并发症也越来越受关注。临床医生需要充分了解各并发症的危险因素和处理方式，谨慎评估患者的主动脉瘤解剖特征和基础情况，以取得更好的手术结果。

利益冲突：所有作者均声明不存在利益冲突。

作者贡献声明：王玉竹负责搜集文献，撰写稿件；张帅、周雨、金怡、赵子赫、潘朝晖、付东升、韩月雪、胡健航、热亚古丽·柯尤木负责协助搜集文献；刘昭、李晓强负责稿件审核、修改意见。

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(本文编辑 熊杨)

本文引用格式: 王玉竹, 张帅, 周雨, 等. 腹主动脉瘤腔内修复术后并发症相关危险因素研究进展[J]. *中国普通外科杂志*, 2024, 33(12): 2077–2082. doi: 10.7659/j.issn.1005-6947.2024.12.017

Cite this article as: Wang YZ, Zhang S, Zhou Y, et al. Research progress on risk factors associated with postoperative complications of endovascular repair for abdominal aortic aneurysms[J]. *Chin J Gen Surg*, 2024, 33(12): 2077–2082. doi: 10.7659/j.issn.1005-6947.2024.12.017