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· 文献综述 ·

## 胸腹主动脉瘤外科治疗现状及进展

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### 摘要

胸腹主动脉瘤(TAAA)自然预后不良,常累及多条内脏动脉,给外科治疗带来挑战。目前外科治疗方式包括:开放手术、杂交手术和全腔内技术。开放手术是TAAA的标准治疗方法,远期疗效好,但技术复杂、创伤大、并发症高。近年发展的杂交手术和全腔内技术各显示其优势,但仍有不足。TAAA的外科治疗选择应遵循个体化原则,多学科协作可最大限度降低手术风险,并维持持久疗效。

### 关键词

主动脉瘤,胸;主动脉瘤,腹;血管外科手术;血管内操作;杂交技术;综述

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## Current status and progress of surgical treatment of thoracic-abdominal aortic aneurysm

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### Abstract

The natural prognosis of thoracic-abdominal aortic aneurysm (TAAA) is poor. Multiple visceral arteries are often involved, which brings challenges to safe surgical treatment. The current surgical treatment of TAAA include: open repair, hybrid surgery and total endovascular repair. Open repair is the standard approach with satisfactory long-term efficacy, but it is also a surgically complex and highly invasive procedure with high incidence of complications. Hybrid procedure and endovascular repair developed in recent years have shown their advantages, but there are still shortcomings. The surgical treatment options for TAAA should follow the principle of individualization. Multidisciplinary collaboration can minimize the risk of surgery and maintain long-term durable outcomes for TAAA patients.

### Key words

Aortic Aneurysm, Thoraci; Aortic Aneurysm, Abdominal; Vascular Surgical Procedures; Endovascular Procedures; Hybrid Technique; Review

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胸腹主动脉瘤(thoracoabdominal aortic aneurysm, TAAA)是指同时累及主动脉胸腔段和腹腔段的动脉瘤,约占所有主动脉瘤的10%<sup>[1]</sup>,该疾病自然病死率高。据统计,当TAAA瘤体直径达到7 cm时,如未经治疗有40%以上的可能性会破裂,2年病死率为76%,5年病死率超过95%<sup>[1-2]</sup>。目前TAAA采用公认的Crawford分型<sup>[3]</sup>:I型动脉瘤

从左锁骨下动脉起点延伸至腹主动脉近端;II型累及范围最广,从锁骨下动脉到主髂动脉分叉处;III型累及远端胸主动脉并延伸至主髂动脉分叉处;IV型仅限于膈下主动脉;V型从胸主动脉远端向下延伸,终止于肾动脉上方(图1)。TAAA的外科治疗难点在于涉及内脏动脉的重建,因此对任一外科医生都极具挑战。

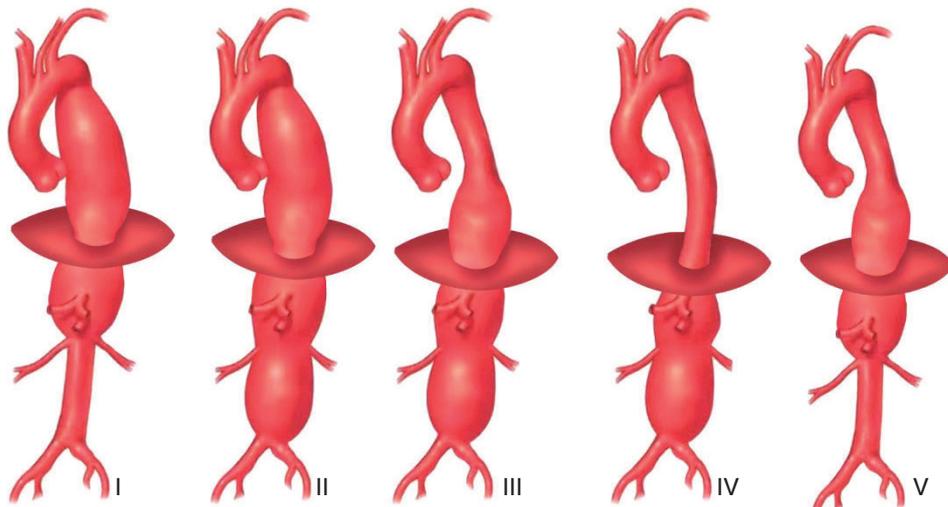


图1 TAAA分型

Figure 1 Classification of TAAA

## 1 TAAA的常见病因

目前对于TAAA的发病原因尚未明确,与AAA相似,吸烟、高血压、COPD和外周血管疾病等是此病的危险因素<sup>[4]</sup>。TAAA也可能继于主动脉夹层,其后期的自然进化或腔内治疗后仍有假腔扩张导致的夹层动脉瘤。但大多数TAAA是退行性的,可能与动脉粥样硬化有关<sup>[5]</sup>。另外,感染性疾病如梅毒和真菌等,自身免疫性疾病Takayasu动脉炎和巨细胞动脉炎等也会导致此病发生<sup>[6-7]</sup>。

部分已知先天性遗传性疾病,如结缔组织病Marfan综合征、Ehler-Danlos综合征和Loeys-Dietz综合征,常因先天的动脉中层结缔组织发育缺陷、胶原纤维薄弱致血管脆弱,容易发生TAAA。截至目前,已有29个已鉴定的基因被证明与TAAA的发生相关,如ACTA2, BGN, COL1A2, EFFEMP2、FBN1及ELN等<sup>[8]</sup>。这些基因通常编码细胞外基质成分(ECM),即转化生长因子途径(TGF- $\beta$ ),或参与平滑肌细胞(SMC)的功能<sup>[9-10]</sup>。

## 2 治疗

TAAA病变累及范围广,自然预后差,尤其涉及到多支内脏动脉,给治疗带来极大难度。目前对于TAAA尚无有效的治疗药物,保守治疗的目的在于控制血压,缓解疼痛等对症治疗<sup>[11]</sup>。其手术治疗方式主要有3种:传统开放手术、腔内修复术和杂交手术治疗。

TAAA手术治疗的适应证仍然存在一些争议,特别是对于无症状的动脉瘤。根据Laplace定律,破裂的风险与动脉瘤的直径直接相关,超过5 cm的TAAA每增长1 cm每年破裂的风险就会翻倍<sup>[12]</sup>。鉴于其不良的自然预后,虽手术治疗有很高的风险,但大多学者仍支持对TAAA进行外科治疗。目前一般对以下情况建议外科干预:(1)破裂或有破裂前兆的TAAA;(2)出现急性夹层并有灌注不良或其他并发症;(3)有症状的TAAA;(4)每年瘤体直径增长>1 cm;(5)虽直径<6.0 cm,但合并有结缔组织疾病者<sup>[13]</sup>。

### 2.1 开放手术修复

1955年, Etheredge等<sup>[14]</sup>在美国首次进行了

TAAA开放手术, 随后DeBakey等<sup>[15]</sup>采用主动脉置换技术证实外科方法治疗TAAA, 后续并对该术式进行改良并证实治疗TAAA的可行性。因当时相关辅助技术及器械、材料的限制, 采用近远端分流方式, 采用人工血管行降主动脉与腹主动脉或髂动脉的吻合, 切除瘤体并重建腹腔动脉、肾动脉等重要分支, 未对肋间动脉和腰动脉进行重建, 不过, 该手术时间长, 出血多, 术后病死率较高, 截瘫风险大<sup>[16-17]</sup>。

随着对TAAA认识增加及器械材料的进展, 1978年Crawford等<sup>[18]</sup>报导采用改良手术治疗82例TAAA, 首次通过主动脉内吻合完成近端重建, 并采用脑脊液引流、体外循环、深低温停循环等现代技术, 依次完成主动脉和分支血管片的吻合。该术式不切除瘤体, 重建或保留了肋间动脉和腰动脉, 降低了病死率6%, 截瘫率6%, 是现代胸腹主动脉外科手术方式的基石。国内Wang等<sup>[19]</sup>对Crawford术式进行改良, 降低了手术创伤, 提高了手术安全性。

Coselli等<sup>[16]</sup>报导近30年共3 346例通过传统开放手术治疗胸腹主动脉瘤的数据资料, <50岁组的手术病死率和并发症发生率较低。Kahlberg等<sup>[17]</sup>报导TAAA采用开放手术治疗患者382例, 住院期间病死率和截瘫率分别为7.6%和8.1%, 5年随访内脏动脉均保持很高的通畅率(腹腔干98%、肠系膜上动脉100%、右肾动脉96%、左肾动脉82%), 显示TAAA的开放手术具有理想的中远期疗效。

TAAA经典开放手术对医生的技术要求较高, 同时Crawford分型也与术后并发症相关, II型和III型术后不良事件最高, 达20%, 其中III型有高达7.6%的永久性截瘫发生率<sup>[20]</sup>。随着外科技术和术后监护技术的发展, 手术病死率和后期并发症发生率已经降到了最低点, 预后一般良好。在技术成熟的医生和中心手中, 可接受的手术病死率应低于5%, 截瘫发生率低于5%。对于较为年轻的TAAA患者推荐开放手术治疗<sup>[21]</sup>, 这些患者能良好耐受手术创伤术后并发症相对较低, 远期效果好, 但仍建议这类患者集中在手术量较大的中心进行治疗。

## 2.2 腔内修复术

近50年血管腔内技术发展迅速, TAAA的腔内治疗已成为重要治疗手段, 随着技术进步及器具改进, TAAA的全腔内治疗取得越来越好的效果<sup>[22-24]</sup>。腔内修复与开放手术相比有两个优势<sup>[25]</sup>: 第一, 避免创伤很大的胸腹大切口, 对心肺影响小;

第二, 无需阻断主动脉, 避免重建过程中的内脏缺血等情况。不过, 采用全腔内治疗也有其不足, 如无法对大的肋间动脉进行血运重建, 长段肋间动脉的覆盖意味着TAAA全腔内修复可能有更高的脊髓缺血率<sup>[26]</sup>。另外, 全腔内治疗的远期疗效尚有待更多数据证实。

目前, TAAA的腔内治疗主要包括开窗、分支支架及平行支架技术<sup>[27]</sup>。开窗支架有商品化订制和医生台上自制, 商品化订制开窗支架对主动脉解剖也有较高要求, 解剖不良的TAAA订制开窗支架置入时同样也会遇到诸多问题。且订制支架价格高昂, 时限一般也需要4~6周。另外, 许多医生会在手术台上根据血管状况现场制作开窗支架, 国内刘昭等<sup>[28-31]</sup>采用3D打印技术引导支架开窗位置, 提高了手术安全性及疗效, 但对于明显主动脉扭曲病变, 在分支动脉的精准对位上仍存在挑战。一旦支架置入定位的不够精准, 不仅导致内脏动脉缺血或脏器丢失, 或远期分支支架闭塞, 也可能因内漏导致封堵失败。

与开窗支架相同, 分支支架也需要在术前进行定制或台上自制。一般来说分支支架比开窗支架具有更低的内漏发生率, 它可以根据瘤体管腔大小、分支动脉位置调整分支长度和路径, 也可以设计为内嵌式分支支架, 以更好适应解剖形态, 减少内漏发生。但同样要求分支支架对位精准, 对主动脉及分支动脉的解剖形态也有一定要求<sup>[32]</sup>。

鉴于商品化的开窗或分支支架存在的时效问题, 以及台上自制支架存在破坏产品构造、潜在伦理因素、无统一标准等不足, 而平行支架技术则利用现有支架, 通过八爪鱼、烟囱、潜望镜等技术, 为腔内治疗TAAA提供了另外一种选择<sup>[33-35]</sup>, 相对而言, 平行支架更为简便易施, 但采用平行支架治疗TAAA, 存在的缝隙造成的Ia型内漏是其天生之不足, “八爪鱼”技术因桥接的分支支架较多, 暴露在瘤腔内多段支架在血流冲击下的摆动, 可能导致后期的III型内漏发生率增加, 甚至桥接支架脱落。王文闻等<sup>[36]</sup>回顾开窗分支支架治疗共16例, 结果显示: 临床技术成功率100%, 1例患者术后发生近端I型内漏, 二期腔内处理后内漏消失。Gallitto等<sup>[37]</sup>报道了腔内治疗的33例TAAA, I型、II型、III型和IV型的比例分别为4%、21%、57%和18%。分别采用开窗或分支支架技术, 无术中死亡, 术后30 d病死率为6.6%, 内脏动脉通畅率为97%, 术后6、12个月和24个月生存率分别为90%、85%和68%, 内脏动脉

在术后3、6个月和24个月的通畅率分别为95%、90%和90%，术后没有出现内漏，无TAAA相关死亡。Spanos等<sup>[29]</sup>报道42例分支支架治疗先兆破裂或破裂TAAA，内脏动脉分支支架成功重建率为97%。术后脊髓缺血的发生率为21%，术后肾功能不全发生率为23%，其中包括2例需要永久性透析；30 d病死率为14%，没有发生术中死亡；术后1个月，I型、II型内漏发生率分别为0和43%；分支支架通畅率为99%。该报道提示全腔内治疗TAAA同样有不低的并发症和病死率，应值得重视。

完全性的腔内治疗还存在不足，如可能需要较多的对比剂用量，患者和术者可能接受较长时间的辐射暴露<sup>[38]</sup>，其远期治疗效果仍需验证，可能存在更高的再次干预几率<sup>[39-41]</sup>。另外，目前还缺乏腔内治疗与开放治疗两者疗效的对照研究，且该技术多集中于高度专业的大中心实施，以及高昂的耗材价格，限制了该技术的广泛应用。总的来说，腔内治疗应选择外科手术的高危患者，以及解剖形态适合行腔内治疗的患者，对于脊髓缺血的高危患者，围术期选择性做好预防性脑脊液引流、维持良好的脊髓灌注压等措施，以尽可能减少脊髓缺血的发生。另外，推荐TAAA的腔内治疗技术，在拥有足够病例的大中心实施，无疑对减少并发症、提高疗效是大有裨益的。

### 2.3 杂交手术修复

通过杂交手术治疗TAAA由Quiñones-Baldrich在1999年首次报道等<sup>[42]</sup>。杂交技术结合腔内修复术及开放手术，其通过开放手术重建内脏分支动脉，介入技术完成主动脉支架植入。为开放手术的高危患者提供了更多的治疗机会和选择。杂交手术避免了开胸带来的巨大创伤、以及主动脉阻断带来的缺血损害。而且，对于需要大范围覆盖节段动脉的TAAA，手术可以分期完成，有利于降低脊髓损伤风险<sup>[2, 43]</sup>。

TAAA杂交治疗的早期结果令人鼓舞，在单中心报告中，手术病死率为8.6%~13.5%，5年生存率为62%，截瘫和肾衰竭率接近或优于开放手术组<sup>[44-45]</sup>。但也有部分作者认为，TAAA的杂交手术与开放手术相比，并未体现出明显的优势<sup>[46]</sup>，杂交技术同样有较大的创伤、不低的并发症。患者选择杂交手术而未选择开放手术，常因合并症或其他开放手术的高危患者，或是TAAA破裂与灌注不良的需要紧急手术的病例，目前还缺乏随机或对比研究来证实杂交技术相对于开放手术的优势。因此目前杂交手术尚不能作为TAAA治疗的标

准方式，仍需要技术和器材的进步，以及长期的随访结果评价。

## 3 总结

TAAA的自然预后差，累及范围广泛，涉及重要的内脏动脉，外科开放手术仍是标准治疗方式，手术相关风险较高，但具有可靠的持久性疗效。杂交手术和全腔内介入手术可以减少开放手术带来的损伤，并显示出其良好的近期效果，是有效的治疗选择。随着技术提高及器具的改进，全腔内技术显示出良好的发展前景。针对TAAA的治疗选择，应根据患者的个体化原则，选择最佳的治疗方案。但目前国内各专业之间的协作机制尚不完善有效，对不同术式的选择，大多并非基于患者整体状况或病变解剖的评估，更多是基于各自专科技术的限制。因此，完善的多科协作机制，对提高TAAA的手术安全性和持久疗效，是至关重要的。

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