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Hans汉斯

Stanford B型主动脉夹层假腔血栓形成影响因素的研究进展

海依娜尔·赛力克汗，赛力克·马高维亚*

新疆医科大学第一附属医院消化血管中心血管甲状腺外科，新疆 乌鲁木齐

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摘　要

随着腔内技术的日益完善，TEVAR已经成为Stanford B型主动脉夹层的主要治疗方法，但TEVAR术后可能因假腔通畅或假腔部分血栓形成导致主动脉不良事件，影响患者预后。早期发现血管重塑预测因素有助于选择适合的技术避免相关并发症发生，本文对假腔血栓形成的影响因素研究进展作一综述。

关键词

Stanford B型主动脉夹层，胸主动脉腔内修复术，假腔血栓形成

Research Progress on the Influencing Factors of Pseudoluminal Thrombosis in Stanford Type B Aortic Dissection

Sailikehan·Haiyinaer, Magaoweiya·Sailike*

Department of Vascular Thyroid Surgery, Digestive Vascular Center, The First Affiliated Hospital of Xinjiang Medical University, Urumqi Xinjiang

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Abstract

With the increasing improvement of Intravascular techniques, TEVAR has become the main treatment for Stanford type B aorticdissection, but TEVAR may lead to adverse aortic events due to pseudolumen patent or partial thrombosis of the pseudolumen after TEVAR, which affects patient

*通讯作者。

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prognosis. Early detection of predictors of aortic pseudoluminal thrombosis can help to select the appropriate technique to avoid related complications. This article reviews the progress of research on the influencing factors of pseudoluminal thrombosis.

Keywords

Stanford Type B Aorticdissection, Thoracic Endovascular Aortic Repair, Pseudoluminal Thrombosis

1. 引言

主动脉夹层是指各种原因(如高血压、高龄、动脉粥样硬化、先天性瓣膜病、结缔组织病、外伤及应激等)导致主动脉内膜破裂，血液从内膜撕裂口进入主动脉壁中层，造成主动脉管壁出现真假腔的一种临床少见而凶险的大血管急症。其中，根据国际急性主动脉夹层登记处(IRAD)的数据，急性 B 型夹层患者(Acute Type B Aortic Dissection)约占所有夹层患者的 33% [1]。临床上，TBAD 分为复杂性与单纯性，与难治性疼痛、难治性高血压、快速动脉瘤形成、灌注不良综合征、破裂或即将破裂相关的夹层被归类为复杂性，无上述并发症归为单纯性 TBAD，在发病期间症状和体征趋于稳定。随着对 TBAD 了解的加深，出现了多种针对的治疗方法，主要有最佳药物治疗(OMT)、开放性手术治疗以及胸主动脉腔内修复术(TEVAR)。因为其发病率和死亡率与开放手术结果相比相对较低，目前一致认为将 TEVAR 作为复杂性疾病管理的首选治疗方法[1]。TEVAR 的关键在于封堵主动脉近端破口，使主动脉真腔扩大、假腔内血栓形成，所以假腔是否完全血栓化已成为评估主动脉重塑的良好指标[2]。不过并不是所有行 TEVAR 的患者都可以获得主动脉良性重塑，部分患者可能会导致术后假腔通畅或假腔部分血栓形成，这可能与远期主动脉不良事件相关。本综述就主动脉假腔血栓形成的影响因素进行归纳总结，提出是否需要在早期根据这些因素预防不良事件的发生。

2. 手术方式

TEVAR 在发病率和死亡率方面，相比较于开放性手术，有较高的成功率，且有利于主动脉重塑。Liu D [3]等的荟萃分析显示 TEVAR 有利于 30 天/住院死亡率，且显著增加了假腔完全血栓形成率，但出现了更高的截瘫率，这需要选择更合适的腔内技术来进行治疗。Lou X [4]等回顾性研究了 146 名 TBAD 患者，证实 TEVAR 组 72.1%，OMT 组 20.0%的患者获得完全假腔血栓形成($P < 0.001$)。与 OMT 相比，TEVAR 治疗提供了良好的主动脉重塑，这可能与长期生存率的改善有关。可以看出，在假腔完全血栓形成方面，TEVAR 更具优势，并且因形态学差异衍生出很多新型治疗方式[5]。在 TEVAR 时，需根据夹层累及近端主动脉弓及远端分支血管的情况选择合适的腔内技术。根据 2019 年发布的欧洲心胸外科协会(EACTS)和欧洲血管外科学会(ESVS)专家共识[6]，累及主动脉弓的 B 型夹层被归类为非 A 非 B 主动脉夹层，其发生率在所有主动脉夹层患者中占 11%。随着腔内技术的发展，0 区被引为一种新的近端着陆区分类，但要保证主动脉直径 ≤38 mm 及升主动脉稳定，在逆撕风险较高的情况：升主动脉 > 38 mm、主动脉瓣膜疾病、升主动脉延长等，仍应考虑开放性手术治疗。因主动脉弓腔内修复主要问题是脑卒中，术中须保护弓上分支保证脑中枢供血。根据目前数据主动脉弓腔内技术成功率为 84.2%~100% [7]，现有的平行支

架技术、开窗技术以及分支支架技术等成为了处理弓上分支的主流方法，并且在一些临床研究中显示了良好的生存率及主动脉重塑[8] [9]，不过需要注意术后 I 型内漏发生和再干预率，积极进行影像学随访评估。TEVAR 是利用覆膜支架覆盖夹层的近端破口，部分患者的远端破口可持续存在，导致假腔通畅或部分血栓形成，是影响主动脉重塑的不利因素[10] [11]。理论上在进行 TEVAR 时，有必要处理远端破口。在此基础上，一些技术被发明出来以促进主动脉夹层远端主动脉重塑，提高远期预后，如 PETTICOAT、STABILISE、开窗或分支支架、假腔栓塞、多层血流调节器(MFM)等技术[12]。将这些技术运用到临床中，为 TBAD 患者提供了一种安全可行的介入选择，技术成功率高，促进主动脉假腔血栓化[13] [14] [15] [16] [17]。

3. 手术干预时机

目前针对 TBAD 分期，急性发作至发病后 2 周为急性期，发病 2 周至 3 个月为亚急性期，3 个月之后为慢性期[6]。TEVAR 已是复杂 TBAD 的首选治疗方式，对于单纯 TBAD 更多是以 OMT 治疗为主，不过当患者具有高风险因素时(主动脉总直径 ＞44 mm、假腔直径 ＞22 mm、假腔通畅或部分血栓形成、初级入口撕裂直径 ＞10 mm 和年龄 ＞70 等)，则建议进行腔内治疗[12]。Hsu H L [13]等研究发现当在症状发作后 36 天内进行 PETTICOAT 技术时，可能会实现更好的假腔血栓形成。另外一项研究发现与慢性期相比，在最初 90 天内干预可改善生存结局和主动脉重塑，与急性期相比，处于亚急性期的 TEVAR 后早期并发症的风险低[18]。Lee S J [19]等发现急性/亚急性组的主动脉最大直径和假腔直径小于慢性组，随访 1 年时，急性/亚急性和早期慢性组的主动脉最大直径减小，晚期慢性组主动脉最大直径增加。由于随着时间的推移，可能导致夹层顺应性降低，从而对主动脉重塑产生不利影响。根据目前的研究亚急性期是 TEVAR 干预的最佳时间窗口，在未来的研究需要将主动脉血栓形成状态及时间纳入设计方法中，以提高文献中关于干预时机的证据质量。

4. 支架移植相关因素

支架移植相关的并发症有 I 型内漏、逆行 A 型夹层、主动脉扩张和支架移植物诱导的新裂口(SINE)等主动脉事件，可能导致主动脉不良重塑，故需考虑到介入支架的长度、扩张率等因素，由此选择合适的支架及腔内技术，预防并发症的发生。Ma T [20]等发现使用 1 个<165 mm 的支架是逆行 A 型夹层和 SINE 的独立预测因素。Kan X [21]等发现根据生物力学研究远端着陆区的壁应力随支架长度而减小。Lombardi J V [22]等发现近端密封长度与相关的不良结局之间存在反比关系。当支架覆盖于主动脉弓内侧弯时，其与主动脉壁之间会产生间隙，称为鸟喙结构，鸟喙结构与 Ia 型内漏的风险相关，影响假腔血栓形成[23]。在近端适当选择腔内技术将主体支架置于健康主动脉时，需考虑到鸟喙结构的影响，同时避免覆盖弓上分支影响中枢血供。另外，在行 TEVAR 时为了固定支架，一般需要扩张支架管径 ＞ 主动脉腔。Rychla M [24]等发现近端着陆区支架扩张率 ≤10%可减少高达 50%的主动脉事件。远端着陆区的支架管径过大会导致 SINE，有研究表明使用远端限制性支架或锥形支架有助于预防 SINE 发生[25]。

5. 主动脉几何形态

主动脉弓：升主动脉和主动脉弓扩大，主动脉弓角度、主动脉曲率和主动脉弓型是影响 TBAD 发病的几何危险因素[26]。研究显示主动脉曲率、角度大小影响术后鸟喙结构，从而导致内漏的风险，>59.15˚的角度可能意味着内漏的风险更高。影响假腔血栓形成[27]。Li D [28]等在主动脉角度和曲率的基础上，发现主动脉问号程度可能是 TEVAR 后假腔完全血栓形成的良好预测因子。TEVAR 后多比较术前主动脉形态与血栓的关系，证明期可行性，针对风险较高的患者积极定期行影像学检查，尽早治疗远端撕裂口，促进血栓形成。

主动脉破口大小及位置：TBAD 近端原发裂口及远端再入裂口的大小、位置及数量等均会影响到主动脉假腔血栓形成。Sun W [29]等发现裂口面积大、再入裂口多、原发裂口位于足弓近端等导致阴性重塑风险较高。Zhang S [30]等发现腹主动脉再入裂口多，肾下腹主动脉裂口少，原发裂口与左锁骨下动脉距离小，裂口之间的距离大，残留裂口面积大等因素会导致远端主动脉扩大。Armour C H [31]等发现在主体支架远端与第一次再入裂口距离较大的患者中，假腔流量减少，壁应力降低导致胸部假腔血栓形成更快。主动脉再入裂口的远端越远，假腔血栓形成的可能性就越大。理论上在主动脉腔内治疗时，根据现有技术，对于远端裂口修复能够促进假腔完全血栓形成。

降主动脉形态：Rylski B [32]等在多中心研究中发现主动脉夹层发生后改变了降主动脉的几何形状，增加了其直径，长度和体积。一项荟萃分析发现最大降主动脉直径和最大假腔直径是晚期不良结局的预测指标[33]。Zhou M [34]等的机器学习预测真腔塌陷和假腔分支多是 TBAD 远端主动脉扩大的危险因素。一项国内多中心研究显示术前腹部假腔灌注分支数量影响假腔血栓形成，与 TEVAR 后腹主动脉扩大风险呈正相关[35]。Wang X [36]等发现夹层与降主动脉长度比值(Length-to-Descending Thoraco-Abdominal Aorta Length Ratio, LLR)是 TEVAR 术后腹主动脉扩大的独立预测因素，当 LLR ≥ 1 时，TEVAR 术后腹主动脉扩大的风险最高。这些研究表明降主动脉形态一定程度上影响 TEVAR 术后假腔血栓形成，术前若能预测到这些影响因素，将有效帮助到临床医生制定治疗方案，选用合适的腔内技术。

6. 总结与展望

TEVAR 术后主动脉假腔通畅及部分血栓形成，是晚期主动脉不良事件的危险因素，影响患者的远期生存率。故早期识别及预测假腔血栓形成的影响因素很有必要。TEVAR 有利于主动脉假腔完全血栓形成，且随着不断深入的研究，也衍生出更多新颖的腔内治疗方式。所以在现有技术的基础上，提前评估假腔血栓形成的影响因素，将帮助临床医生选择适合的支架及腔内技术，减少相关的并发症，有助于改善患者的预后。目前关于 TBAD 的研究多为回顾性，单中心研究，在证明力度上较局限。随着机器算法的出现及不断进步[37] [38]，未来还需使用更高级的机器算法来根据患者的主动脉形态因素及计算流体力学测量进行多中心、大样本、前瞻性的高质量研究，验证假腔血栓形成的预测因素。帮助临床医生成功预测负性重塑的风险，根据 TBAD 患者的个体化差异，优化治疗方案。

参考文献

[1] Evangelista, A., Isselbacher, E.M., Bossone, E., *et al*. (2018) Insights from the International Registry of Acute Aortic Dissection: A 20-Year Experience of Collaborative Clinical Research. *Circulation*, **137**, 1846-1860. https://doi.org/10.1161/CIRCULATIONAHA.117.031264

[2] 张红刚, 乔彤. Stanford B 型主动脉夹层腔内修复术后主动脉重塑研究进展[J]. 中华外科杂志, 2018, 56(6): 477-480. https://doi.org/10.1161/10.3760/cma.j.issn.0529-5815.2018.06.018

[3] Liu, D., Luo, H., Lin, S., *et al*. (2020) Comparison of the Efficacy and Safety of Thoracic Endovascular Aortic Repair with Open Surgical Repair and Optimal Medical Therapy for Acute Type B Aortic Dissection: A Systematic Review and Meta-Analysis. *International Journal of Surgery*, **83**, 53-61. https://doi.org/10.1016/j.ijsu.2020.08.051

[4] Lou, X., Chen, E.P., Duwayri, Y.M., *et al*. (2022) Early Results of Thoracic Endovascular Aortic Repair for the Management of Acute Uncomplicated Type B Aortic Dissection. *Seminars in Thoracic and Cardiovascular Surgery*. https://doi.org/10.1053/j.semtcvs.2021.12.014

[5] Kumar, S., Choinski, K.N. and Tadros, R.O. (2020) Thoracic Aortic Endografts: Past, Present, and Future. *Surgical Technology International*, **37**, 232-236.

[6] Czerny, M., Schmidli, J., Adler, S., *et al*. (2019) Current Options and Recommendations for the Treatment of Thoracic Aortic Pathologies Involving the Aortic Arch: An Expert Consensus Document of the European Association for Cardio-Thoracic Surgery (EACTS) and the European Society for Vascular Surgery (ESVS). *European Journal of Cardio-Thoracic Surgery*, **55**, 133-162. https://doi.org/10.1093/ejcts/ezy383

[7] Brown, J.A., Arnaoutakis, G.J., Szeto, W.Y., *et al*. (2021) Endovascular Repair of the Aortic Arch: State of the Art.

Journal of Cardiac Surgery, **36**, 4292-4300. https://doi.org/10.1111/jocs.15920

[8] Li, J., Xue, Y., Li, S., *et al*. (2022) Outcomes of Thoracic Endovascular Aortic Repair with Chimney Technique for Aortic Arch Diseases. *Frontiers in Cardiovascular Medicine*, **9**, Article ID: 868457. https://doi.org/10.3389/fcvm.2022.868457

[9] Zhao, Z., Qin, J., Yin, M., *et al*. (2020) *In Situ* Laser Stent Graft Fenestration of the Left Subclavian Artery during Thoracic Endovascular Repair of Type B Aortic Dissection with Limited Proximal Landing Zones: 5-Year Outcomes. *Journal of Vascular and Interventional Radiology*, **31**, 1321-1327. https://doi.org/10.1016/j.jvir.2020.02.025

[10] Tanaka, A., Sakakibara, M., Ishii, H., *et al*. (2014) Influence of the False Lumen Status on Clinical Outcomes in Patients with Acute Type B Aortic Dissection. *Journal of Vascular Surgery*, **59**, 321-326. https://doi.org/10.1016/j.jvs.2013.08.031

[11] Li, D., Ye, L., He, Y., *et al*. (2016) False Lumen Status in Patients with Acute Aortic Dissection: A Systematic Review and Meta-Analysis. *Journal of the American Heart Association*, **5**, e003172. https://doi.org/10.1161/JAHA.115.003172

[12] Spanos, K. and Kölbel, T. (2020) Role of Endoluminal Techniques in the Management of Chronic Type B Aortic Dissection. *CardioVascular and Interventional Radiology*, **43**, 1808-1820. https://doi.org/10.1007/s00270-020-02566-7

[13] Hsu, H.L., Huang, C.Y., Lu, H.Y., *et al*. (2022) Aortic Remodeling of the Provisional Extension to Induce Complete Attachment Technique in DeBakey Type IIIb Aortic Dissection. *Journal of the Formosan Medical Association*, **121**, 1748-1757. https://doi.org/10.1016/j.jfma.2022.01.006

[14] Vecchini, F., Haupert, G., Baudry, A., *et al*. (2022) Risk Factors for Incomplete Aortic Remodeling with Stent-Assisted Balloon-Induced Intimal Disruption and Relamination in Aortic Dissection Repair for Complicated Aortic Dissection: Results of a Multicenter Study. *Journal of Endovascular Therapy*. https://doi.org/10.1177/15266028221111984

[15] Marques de Marino, P., Ibraheem, A., Tesinsky, P., *et al*. (2022) Fenestrated and Branched Stent Grafts for the Treatment of Post-Dissection Thoracoabdominal Aortic Aneurysms. *Seminars in Vascular Surgery*, **35**, 312-319. https://doi.org/10.1053/j.semvascsurg.2022.06.002

[16] Li, H.L., Chan, Y.C., Jia, H.Y., *et al*. (2022) Methods and Outcomes of Endovascular False Lumen Embolization for Thoracic Aortic Dissection. *Annals of Vascular Surgery*. https://doi.org/10.1016/j.avsg.2022.03.020

[17] Costache, V.S., Meekel, J.P., Costache, A., *et al*. (2021) One-Year Single-Center Results of the Multilayer Flow Modulator Stents for the Treatment of Type B Aortic Dissection. *Journal of Endovascular Therapy*, **28**, 20-31. https://doi.org/10.1177/1526602820950720

[18] Jubouri, M., Bashir, M., Tan, S.Z.C.P., *et al*. (2022) What Is the Optimal Timing for Thoracic Endovascular Aortic Repair in Uncomplicated Type B Aortic Dissection? *Journal of Cardiac Surgery*, **37**, 993-1001. https://doi.org/10.1111/jocs.16190

[19] Lee, S.J., Kang, W.C., Ko, Y.G., *et al*. (2020) Aortic Remodeling and Clinical Outcomes in Type B Aortic Dissection According to the Timing of Thoracic Endovascular Aortic Repair. *Annals of Vascular Surgery*, **67**, 322-331. https://doi.org/10.1016/j.avsg.2020.03.022

[20] Ma, T., Dong, Z.H., Fu, W.G., *et al*. (2018) Incidence and Risk Factors for Retrograde Type A Dissection and Stent Graft-Induced New Entry after Thoracic Endovascular Aortic Repair. *Journal of Vascular Surgery*, **67**, 1026-1033.e2. https://doi.org/10.1016/j.jvs.2017.08.070

[21] Kan, X., Ma, T., Dong, Z., *et al*. (2021) Patient-Specific Virtual Stent-Graft Deployment for Type B Aortic Dissection: A Pilot Study of the Impact of Stent-Graft Length. *Frontiers in Physiology*, **12**, Article ID: 718140. https://doi.org/10.3389/fphys.2021.718140

[22] Lombardi, J.V., Famularo, M., Kratzberg, J., *et al*. (2021) Effect of Proximal Fixation Length on Complications after Endovascular Repair of Type B Aortic Dissection. *Journal of Vascular Surgery*, **73**, 1189-1196.e3. https://doi.org/10.1016/j.jvs.2020.07.087

[23] Shahbazian, N., Romero, D.A., Forbes, T.L., *et al*. (2022) Identification of Geometric and Mechanical Factors Predictive of Bird-Beak Configuration in Thoracic Endovascular Aortic Repair Using Computational Models of Stent Graft Deployment. *JVS-Vascular Science*, **3**, 259-273. https://doi.org/10.1016/j.jvssci.2022.05.056

[24] Rychla, M., Dueppers, P., Meuli, L., *et al*. (2022) Influence of Measurement and Sizing Techniques in Thoracic Endovascular Aortic Repair on Outcome in Acute Complicated Type B Aortic Dissections. *Interdisciplinary CardioVascular and Thoracic Surgery*, **34**, 628-636. https://doi.org/10.1093/icvts/ivab300

[25] Li, X., Zhang, Y., Sun, Z., *et al*. (2022) Prevention of Distal Stent Graft-Induced New Entry after Endovascular Repair for Type B Aortic Dissection: A Retrospective Cohort Study. *The Journal of Thoracic and Cardiovascular Surgery*. https://doi.org/10.1016/j.jtcvs.2022.01.042

[26] Sun, L., Li, X., Li, Q., *et al*. (2021) Morphological Features of Aortic Arch Predicting the Risk for Acute Type B Aortic Dissection. *World Journal of Surgery*, **45**, 3458-3466. https://doi.org/10.1007/s00268-021-06247-5

[27] Cao, L., Ge, Y., He, Y., *et al*. (2020) Association between Aortic Arch Angulation and Bird-Beak Configuration after Thoracic Aortic Stent Graft Repair of Type B Aortic Dissection. *Interdisciplinary CardioVascular and Thoracic Surgery*, **31**, 688-696. https://doi.org/10.1093/icvts/ivaa171

[28] Li, D., Peng, L., Wang, Y., *et al*. (2020) Predictor of False Lumen Thrombosis after Thoracic Endovascular Aortic Repair for Type B Dissection. *The Journal of Thoracic and Cardiovascular Surgery*, **160**, 360-367. https://doi.org/10.1016/j.jtcvs.2019.07.091

[29] Sun, W., Xu, H., Xiong, J., *et al*. (2021) 3D Morphologic Findings before and after Thoracic Endovascular Aortic Repair for Type B Aortic Dissection. *Annals of Vascular Surgery*, **74**, 220-228. https://doi.org/10.1016/j.avsg.2020.12.026

[30] Zhang, S., Chen, Y., Zhang, Y., *et al*. (2018) Should the Distal Tears of Aortic Dissection Be Treated? The Risk of Distal Tears after Proximal Repair of Aortic Dissection. *International Journal of Cardiology*, **261**, 162-166. https://doi.org/10.1016/j.ijcard.2018.01.028

[31] Armour, C.H., Menichini, C., Milinis, K., *et al*. (2020) Location of Reentry Tears Affects False Lumen Thrombosis in Aortic Dissection Following TEVAR. *Journal of Endovascular Therapy*, **27**, 396-404. https://doi.org/10.1177/1526602820917962

[32] Rylski, B., Muñoz, C., Beyersdorf, F., *et al*. (2018) How Does Descending Aorta Geometry Change When It Dissects? *European Journal of Cardio-Thoracic Surgery*, **53**, 815-821. https://doi.org/10.1093/ejcts/ezx292

[33] Nugraha, R.A., Amshar, M., Batubara, E.A.D., *et al*. (2022) Descending Aorta Diameters as Predictor of Late Adverse Outcomes in Patients with Uncomplicated Type B Aortic Dissection: A Systematic Review and Meta-Analysis. *Annals of Vascular Surgery*, **80**, 333-344. https://doi.org/10.1016/j.avsg.2021.10.033

[34] Zhou, M., Shi, Z., Li, X., *et al*. (2021) Prediction of Distal Aortic Enlargement after Proximal Repair of Aortic Dissection Using Machine Learning. *Annals of Vascular Surgery*, **75**, 332-340. https://doi.org/10.1016/j.avsg.2021.02.039

[35] Ge, Y., Lv, X., Ge, X., *et al*. (2021) The Number of Preoperative Abdominal False Lumen-Perfused Small Branches Is Related to Abdominal Aortic Remodeling after Thoracic Endovascular Aortic Repair for Type B Aortic Dissection. *Annals of Vascular Surgery*, **71**, 56-64. https://doi.org/10.1016/j.avsg.2020.09.007

[36] Wang, X., Ge, Y., Ge, X., *et al*. (2020) Dissection Length-to-Descending Thoraco-Abdominal Aorta Length Ratio Predicts Abdominal Aortic Enlargement after Thoracic Endovascular Aortic Repair for Type B Aortic Dissection Involving the Abdominal Aorta. *Interdisciplinary CardioVascular and Thoracic Surgery*, **31**, 680-687. https://doi.org/10.1093/icvts/ivaa184

[37] Dong, Y., Que, L., Jia, Q., *et al*. (2022) Predicting Reintervention after Thoracic Endovascular Aortic Repair of Stanford Type B Aortic Dissection Using Machine Learning. *European Radiology*, **32**, 355-367. https://doi.org/10.1007/s00330-021-07849-2

[38] Munshi, B., Parker, L.P., Norman, P.E., *et al*. (2020) The Application of Computational Modeling for Risk Prediction in Type B Aortic Dissection. *Journal of Vascular Surgery*, **71**, 1789-1801.e3. https://doi.org/10.1016/j.jvs.2019.09.032