doi:10.11659/jjssx.01E020088

·临床研究·

一站式杂交手术与全弓置换治疗主动脉弓病变的疗效分析

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[摘 要] **目的** 探讨一站式杂交手术与全弓置换处理主动脉弓部病变的疗效。**方法** 回顾性分析2017年1月至2019年4月我院收治的29例累及主动脉弓部病变患者的临床资料,将13例行一站式杂交手术的患者纳入杂交手术组,16例行全弓置换联合支架象鼻的患者纳入全弓置换组。比较2组患者肺部感染、胸腔积液、肾损伤、神经系统损伤、心功能不全、截瘫、切口感染、用血量和住院时间等情况。**结果** 所有患者均成功完成手术。术后2组患者肺部感染、胸腔积液、一过性肾功能损伤、切口感染、一过性意识障碍、截瘫、脑梗死/脑出血、心功能不全、移植旁路血管再发狭窄、再发主动脉夹层等术后并发症发生率比较,差异无统计学意义($P>0.05$);2组患者住院时间比较,差异无统计学意义($P>0.05$);杂交手术组患者用血量平均(3.69±2.89)U,全弓置换组平均(12.38±3.14)U,组间比较差异有统计学意义($P<0.05$)。杂交手术组围手术期因突发心跳骤停,成功复苏后脑死亡1例,全弓置换组无围手术期死亡病例。随访1~26个月,随访期间杂交手术组出现1例覆膜支架远端夹层扩张破裂死亡病例,全弓置换组出现1例脑血管意外导致呼吸功能衰竭死亡病例,其余患者恢复良好。**结论** 一站式杂交手术与全弓置换治疗弓部病变效果均满意,其中一站式杂交手术用血量较全弓置换组明显减少,无需深低温停循环,对年龄大、一般情况差的患者更为有利;而全弓置换组用血量更大,需要停循环、创伤大,但象鼻支架材料利于二次手术根治远端病变,适用于年轻、术前一般情况良好的患者。

[关键词] 主动脉夹层;主动脉弓;杂交手术;全弓置换

[中图分类号] R654.3 [文献标识码] A [收稿日期] 2020-01-16

Curative effect analysis of one-stop hybrid surgery and total arch replacement in the treatment of aortic arch disease

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Abstract: Objective To explore the efficacy of one-stop hybrid surgery and total arch replacement for aortic arch disease. **Methods** The clinical data of 29 patients with aortic arch disease admitted to our hospital from January 2017 to April 2019 were analyzed retrospectively. Thirteen cases of one-stop hybrid surgery technique were included in the hybrid surgery group, and 16 patients who underwent total arch replacement combined with stent elephant trunk technology were included in the total arch replacement group. The pulmonary infection, pleural effusion, kidney injury, nervous system injury, cardiac insufficiency, paraplegia, incision infection, blood volume and length of hospital stay were compared between the two groups. **Results** All patients successfully completed the operation. There was no statistically significant difference in the incidence of postoperative complications such as pulmonary infection, pleural effusion, transient renal dysfunction, incision infection, transient consciousness, paraplegia, cerebral infarction/cerebral hemorrhage, cardiac insufficiency, restenosis of graft bypass vessels, and reoccurrence of aortic dissection between the two groups ($P>0.05$). The length of hospital stay were not statistically significant different between the two groups ($P>0.05$). The blood volume in hybrid surgery group and the total arch replacement group were (3.69±2.89)U and (12.38±3.14)U respectively, the difference was statistically significant ($P<0.05$). In the hybrid operation group, there was 1 case of brain death after successful resuscitation due to sudden cardiac arrest in the perioperative period, and there was no perioperative death in the total arch replacement group. The patients were followed up for 1 to 26 months. One patient in hybrid surgery group died of expansion and rupture of the distal dissection of the stent graft; one patient in the total arch replacement group died of cerebrovascular accidental respiratory failure; the rest of the patients recovered well. **Conclusion** The one-stop hybrid surgery and total arch replacement are equally satisfactory for the treatment of aortic arch disease. One-stop hybrid surgery has significantly less blood volume than the total arch replacement group, and it does not require deep hypothermic circulatory arrest, which is more beneficial to older patients with poor general conditions. In the total arch replacement group, the blood volume was significantly increased and it requires circulatory arrest which results in great trauma. The elephant trunk stent material is beneficial to the radical treatment of distal lesions in the second operation, and is suitable for young patients with good preoperative general conditions.

Keywords: aortic dissection; aortic arch; hybrid surgery; total arch replacement

[基金项目] 安徽省重点研究与开发计划项目(1704f0804010)

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主动脉夹层是一种病死率极高的大血管疾病,未经治疗的患者每小时病死率为1% ~2%[1]。因主动脉弓部解剖结构特殊,涉及重要分支血管,对主动脉弓的病变一般不宜单独行腔内隔绝治疗。全弓置换联合支架象鼻手术使主动脉弓部病变的治疗效果明显改善,并且随着支架象鼻手术的广泛应用及改良,患者病死率已逐年下降[2],但其仍然具有手术创伤大、深低温停循环等缺点[3]。近十年来随着血管支架技术的成熟,杂交手术应运而生,其具有创伤小、恢复快的特点[4]。因杂交手术和全弓置换均可用于弓部病变的处理,但手术方式的差别,结果可能存在差异,本文回顾性分析了2017年1月至2019年4月于我院行杂交手术或全弓置换手术的主动脉弓部病变患者的临床资料,通过对比两者的预后,以期为患者术式的选择提供参考。

1 资料与方法

1.1 临床资料

回顾性分析2017年1月至2019年4月我院收治的29例累及主动脉弓部病变患者的临床资料,其中男27例,女2例,年龄32 ~75岁;将采用一站式杂交手术的13例患者纳入杂交手术组,采用全弓置换联合支架象鼻手术的16例患者纳入全弓置换组。杂交手术组男12例,女1例,年龄43 ~75岁;全弓置换组男15例,女1例,年龄32 ~58岁。高血压、马凡氏综合征、弓部动脉瘤、外伤、主动脉溃疡、主动脉夹层、肾功能不全、胸腔积液等情况比较,2组差异无统计学意义($P>0.05$),具有可比性,见表1。

纳入标准:①术前均经大血管CTA诊断为主动脉弓病变;②既往未行其他心脏外科手术。排除标准:①术前严重肝功能损害,凝血功能障碍;②术前口服阿司匹林、氯吡格雷等抗凝药物;③术前合并严重肢体灌注不良、严重胃肠道灌注不良、昏迷或截瘫。

1.2 手术方法

杂交手术组:右股动脉及正中开胸,游离头臂血管各分支,静脉肝素化(activated clotting time,ACT)480 s以上,行右股动脉、右心房插管,建立体外循环,升主动脉阻断灌注心脏停跳液,先行主动脉瓣置换/升主动脉置换/Bentall手术。升主动脉使用侧壁钳部分阻断,尖刀片开孔,使用直径为18 mm×9 mm×9 mm的Y形人工血管(Maquet)或直径为18 mm×10 mm×9 mm×9 mm的四分支人工血管(Maquet),将人工血管主干18 mm端与升主动脉/人工血管右前壁行端侧吻合,吻合完成后将人工血管9 mm端分别与左颈总动脉、左锁骨下动脉行端侧吻合,人工血管10 mm端与无名动脉行端侧吻合。完毕后使用0#丝线结扎左颈总动脉、左锁骨下动脉近端,切断无名动脉近端并采用5-0prolene线缝闭残端,完成升主动脉 - 左颈总动脉 - 左锁骨下动脉 - 无名动脉的重建。经股动脉入路造影明确转流血管通畅情况,明确弓部病变位置,根据术前CT与术中造影的结果选择合适支架,夹层按瘤体近端直径加0 ~5%、动脉瘤按近端瘤体直径加15% ~20%选择支架,释放支架时将收缩压控制在90 mmHg以下。杂交手术间内同时完成降主动脉腔内隔绝术,见图1a。再次造影检查支架有无移位、内漏,评价手术效果。

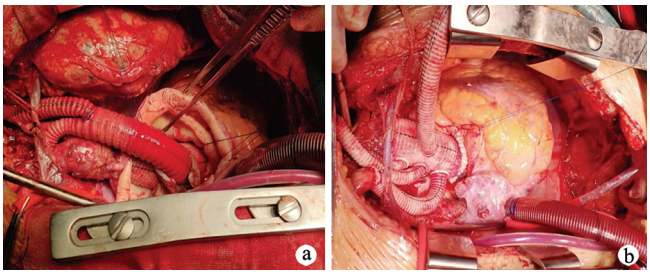
表1 患者术前合并症情况[例(%)]

合并症		杂交手术组	全弓置换组	P
高血压	有	11(84.6)	13(81.2)	0.811
	无	2(15.4)	3(18.8)	
马凡综合征	有	0(0)	1(6.3)	0.359
	无	13(100)	15(93.8)	
弓部动脉瘤	有	2(15.4)	2(12.5)	0.823
	无	11(84.6)	14(87.5)	
外伤	有	1(7.7)	1(6.3)	0.879
	无	12(92.3)	15(93.8)	
主动脉溃疡	有	0(0)	0(0)	
	无	13(100)	16(100)	
主动脉夹层	有	11(84.6)	14(87.5)	0.823
	无	2(15.4)	2(12.5)	
肾功能不全	有	1(7.7)	1(6.3)	0.879
	无	12(92.3)	15(93.8)	
胸腔积液	有	1(7.7)	2(12.5)	0.672
	无	12(92.3)	14(87.5)	

全弓置换组:在右锁骨下、右股动脉及胸骨正中做切口,行右腋动脉、右股动脉插管建立体外循环,鼻咽温及肛温均低于25 ℃停循环,使用Cronus术中支架置入真腔内,封闭破口,四分支人工血管远端与术中支架吻合完成后,经四分支血管另一分支灌注,再依次将四分支血管其余分支分别与左颈总动脉、升主动脉、左锁骨下动脉、无名动脉吻合,完成左颈总动脉重建后复温,完成升主动脉近端吻合口后心脏复跳(图1b)。温度恢复正常后停止体外循环,仔细止血,使用鱼精蛋白中和肝素,常规关胸。

1.3 术后观察及随访

所有患者手术均成功,术后送入重症监护室,严密观察生命体征及相关并发症,如:肺部感染、胸腔积液、一过性肾功能损伤、切口感染、一过性意识障碍、截瘫、



a:一站式杂交手术;b:全弓置换联合支架象鼻手术

图1 主动脉弓部病变患者手术情况

脑梗死/脑出血、心功能不全、移植旁路血管再发狭窄、再发主动脉夹层。术后均采用美托洛尔、尼卡地平、厄贝沙坦等控制心率和血压。出院前统计患者围手术期用血量及住院时间。出院后门诊随访观察1~26个月,术后1、3、6、12个月定期行薄层增强CT扫描,出院1年后每年门诊复查1次,了解支架周围有无内漏、降主动脉段支架内血栓形成情况、是否形成新发主动脉夹层和转流血管是否通畅等。

1.4 统计学处理

采用SPSS 22.0软件对数据进行统计分析,计量资料以均数±标准差($\bar{x} \pm s$)表示,采用独立样本t检验。计数资料以率表示,组间比较采用卡方χ^2检验或Fisher精确检验,$P<0.05$为差异有统计学意义。

2 结果

2.1 手术后情况

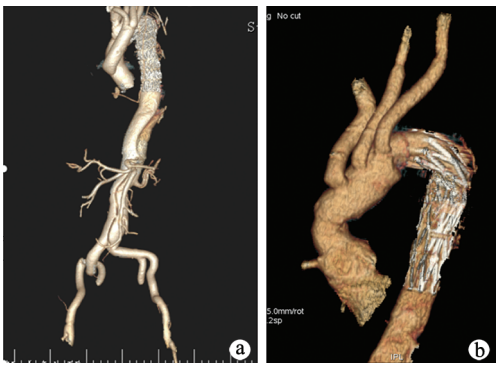
患者肺部感染、胸腔积液、一过性意识障碍、一过性肾功能损伤、切口感染、截瘫、脑梗死/脑出血、心功能不全、移植旁路血管再发狭窄、再发主动脉夹层等术后并发症发生率,2组比较差异无统计学意义($P>0.05$),见表2。杂交手术组1例患者围手术期突发心跳骤停,经抢救后神经系统永久损害,家属放弃治疗,宣布临床死亡;4例患者出现一过性肾功能不全,肌酐均轻度增高,经补液、利尿等内科治疗后肾功能均恢复。全弓置换组3例患者术后早期发生肾功能衰竭,其中1例患者经血液透析治疗后肾功能恢复至正常水平,另2例患者经保守治疗,出院前肾功能自愈;1例患者术后出现截瘫,经脑脊液引流、抗凝、激素治疗后,肌力由0级恢复至1级,后转入康复科继续治疗,随访复查时肌力恢复。杂交手术组患者围手术期用血量少于全弓置换组,差异有统计学意义($P<0.05$);2组患者住院时间组间比较差异无统计学意义($P>0.05$)。

表2 患者术后情况

项目	杂交手术组	全弓置换组	P
用血量(U)	3.69±2.89	12.38±3.14	0.000
住院时间(d)	29.69±8.71	27.44±8.88	0.499
肺部感染[例(%)]	3(23.1)	2(12.5)	0.453
胸腔积液[例(%)]	4(30.8)	5(31.3)	0.978
一过性肾损伤[例(%)]	4(30.8)	3(18.8)	0.452
一过性意识障碍[例(%)]	1(7.7)	4(25.0)	0.220
心功能不全[例(%)]	0(0)	0(0)	
截瘫[例(%)]	0(0)	1(6.25)	0.359
切口感染[例(%)]	0(0)	2(12.5)	0.186
脑并发症[例(%)]	1(7.7)	0(0)	0.259
移植物再狭窄[例(%)]	0(0)	0(0)	
再发夹层[例(%)]	1(7.7)	0(0)	0.259

2.2 出院后随访资料

术后随访1~26个月。杂交手术组出现1例轻度Ⅰ型内漏,未进一步处理,患者无特殊不适;术后1年,1例患者(7.7%)再发升主动脉吻合口夹层,再次行全弓置换联合支架象鼻手术后康复出院;12例患者(92.3%)降主动脉段假腔内血栓形成(图2a);随访中1例患者因覆膜支架远端夹层扩张,新发破裂死亡。全弓置换组14例患者(87.5%)假腔内血栓形成(图2b);随访中1例患者出现脑血管意外,因呼吸功能衰竭死亡。存活的26例患者术后恢复良好,未出现支架移位、新发内漏、支架断裂等相关并发症,重建血管通畅率100%。



a:杂交手术组;b:全弓置换组

图2 三维CTA重建

3 讨论

主动脉夹层累及主动脉弓部可能会导致神经系统及远端假腔的快速扩张等并发症。Umana等[5]报道,相对于夹层局限于降主动脉的患者,夹层累及弓部的患者病死率更高。Tsukube等[6]也报道A型夹层的病死率极高,一经诊断必须立即手术。而主动脉弓部病变涉及众多重要脏器分支血管,操作复杂,手术方式选择多,目前的主要方法有一站式杂交手术和全弓置换术。

一站式杂交手术因结合开胸与介入手术的优点,

有以下优势:①杂交手术不需要深低温停循环,手术创伤相对更小[7-8];②一般患者手术的近中期效果与传统手术无明显差距,对于高危高龄患者的效果更优[9];③增加了近心端的锚定区,使腔内隔绝的适应证更广[10]。一站式杂交手术技术因具有创伤小及非体外循环的优势,成为主动脉弓部夹层手术的主要选择之一。部分患者甚至可采用胸部上段小切口,因其能够保证胸廓的完整性,更利于减轻患者痛苦及促进术后恢复。故对于 B 型主动脉夹层累及主动脉弓部病变,弓部的杂交技术是可行的。但具备上述优势的同时,杂交手术也伴随相关并发症,如脑梗死、内漏形成、新发夹层[11-12]、肾功能损伤等[13],尤其当杂交手术涉及近端 Z0 区时,需要完全弓部去分支化,其病死率和脑并发症明显增高[14]。

Borst 等[15]在 1983 年首先报道了全弓置换象鼻手术技术,但手术后极易出现肾功能损伤、肺功能损伤、神经系统损伤等一系列的严重并发症[16]。特别是软象鼻容易发生打扭、梗阻、喉返神经损伤、软象鼻难以植入真腔等问题一直难以解决。近年来随着此类手术的逐渐应用,手术者经验积累、技术提高及手术方式的改进(如采用中低温选择性脑保护及使用改良支架象鼻等),相关并发症发生率逐年下降,且病变根治彻底,远期疗效确切,随访效果满意,支架象鼻手术已经逐步成为治疗 A 型夹层累及主动脉弓部的标准术式[2]。

全弓置换手术采用深低温停循环易致凝血功能障碍,需要大量输血,而输血会导致心脏手术风险增加[17]。有学者认为输血是心血管术后死亡事件的独立危险因素,会影响患者的预后[17]。此外,全弓置换手术创伤大,患者出血量多,易产生因低血压引起的肾灌注不足;同时,深低温和长时间下半身停循环也易产生因肾缺血导致的肾损伤[18]。而杂交手术避免了深低温停循环的缺点,创伤相对较小。本研究比较了杂交手术与全弓置换手术的近中期结果,用血量上杂交手术组明显少于全弓置换组,表明杂交手术的手术创伤相对于传统手术小,有利于高危、高龄患者的恢复以及减少患者因大量输血造成的相关并发症。本研究中杂交手术患者取得的疗效确切,围手术期死亡 1 例,随访期间 1 例夹层复发,考虑由患者术前合并升主动脉增宽、肾功能不全、肾性高血压、升主动脉条件差、术后血压控制不理想等导致。经全弓置换手术治疗的患者随访期间死亡 1 例,近期随访效果满意,2 组患者的近中期病死率及主要并发症发生率并无明显差异。

综上所述,与全弓置换手术相比,一站式杂交手术避免了停循环造成的脏器损伤,手术创伤小,用血量减少,恢复迅速,但可能会再发夹层形成,且使用的覆膜支架材料其远端不利于二次根治手术,因此,本研究认为一站式杂交手术对高龄、高危等不能耐受传统手术的患者可能更加有利。需要强调的是,全弓置换术创伤较大,用血量明显增多,需要停循环,不宜用于高龄、高危患者,但与杂交手术组相比其近期并发症发生率无明显差异,随访效果满意,对于年轻、术前一般情况良好、升主动脉条件差的不利于杂交手术转流的患者可能更为适用。

[参考文献]

[1] Joanna G, Felix S, Aranold VE. Acute aortic dissection: pathogenesis, risk factors and diagnosis[J]. Swiss Med Wkly, 2017, 147: w14489. doi: 10.4414/smw.2017.14489.

[2] Sun L, Qi R, Zhu J, et al. Total arch replacement combined with stented elephant trunk implantation: a new "standard" therapy for type a dissection involving repair of the aortic arch? [J]. Circulation, 2011, 123(9): 971 - 978. doi: 10.1161/CIRCULATIONAHA.110.015081.

[3] Kazimierczak A, Jedrzejczak T, Rynio P, et al. Favorable remodeling after hybrid arch debranching and modified provisional extension to induce complete attachment technique in type A aortic dissection: a case report[J]. Medicine (Baltimore), 2018, 97(37): e12409. doi: 10.1097/MD.0000000000012409.

[4] Gaudino M, Bakaeen F, Davierwala P, et al. New strategies for surgical myocardial revascularization[J]. Circulation, 2018, 138(19): 2160 - 2168. doi: 10.1161/CIRCULATIONAHA.118.035956.

[5] Umana JP, Lai DT, Mitchell RS, et al. Is medical therapy still the optimal treatment strategy for patients with acute type B aortic dissections? [J]. J Thorac Cardiovasc Surg, 2002, 124(5): 896 - 910. doi: 10.1067/mtc.2002.123131.

[6] Tsukube T, Haraguchi T, Okada Y, et al. Long-term outcomes after immediate aortic repair for acute type A aortic dissection complicated by coma[J]. J Thorac Cardiovasc Surg, 2014, 148(3): 1013 - 1019. doi: 10.1016/j.jtcvs.2014.06.053.

[7] Wang R, Weng GX, Xie Q, et al. Hybrid aortic arch replacement for aortic arch disease[J]. Chin J Thorac Cardiovasc Surg, 2017, 33(6): 347 - 350. doi: 10.3760/cma.j.issn.1001 - 4497.2017.06.007.

[8] Sultan I, Bianco V, Yazji I, et al. Hemiarch reconstruction versus clamped aortic anastomosis for concomitant ascending aortic aneurysm [J]. Ann Thorac Surg, 2018, 106(3): 750 - 756. doi: 10.1016/j.athoracsur.2018.03.078.

[9] Sood V, Patel HJ, Williams DM, et al. Open and endovascular repair of the nontraumatic isolated aortic arch aneurysm [J]. J Vase Surg, 2014, 60(1): 57 - 63. doi: 10.1016/j.jvs.2014.01.066.

[10] Lin FY, Tseng YH, Huang JW, et al. Fate of distal aorta after acute type A aortic dissection repair: change and persistency of postoperative false lumen status [J]. Int J Cardiol, 2018, 266: 50 - 55. doi: 10.1016/j.ijcard.2018.01.010.

[11] Chou HW, Chan CY, Chang CH, et al. Comparisons of aortic remodelling and outcomes after endovascular repair of acute and chronic complicated type B aortic dissections[J]. Interact Cardiovasc Thorac Surg, 2018, 27(5): 733 - 741. doi: 10.1093/icvts/ivy167.

doi:10.11659/jjssx.12E019109

·临床研究·

神经内镜额部锁孔手术与显微手术治疗基底节区出血的临床疗效

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[摘 要] **目的** 探讨神经内镜额部锁孔手术与显微手术治疗基底节区出血的治疗效果。**方法** 回顾性分析徐州医科大学附属医院神经外科2017年8月至2019年6月收治的34例经手术治疗基底节区出血患者的临床资料。根据手术方式分为内镜额部锁孔手术组(观察组)14例和显微手术组(对照组)20例,比较2组患者术前、术中和术后的病情变化及手术并发症发生情况,总结两种手术方式的临床应用效果。**结果** 观察组平均血肿清除率、手术时间均少于对照组,差异均有统计学意义($P<0.05$);2组患者术后并发症发生率比较,差异无统计学意义($P>0.05$);观察组术后不同时间GCS评分及术后3个月ADL评分均优于对照组,差异有统计学意义($P<0.05$)。**结论** 与显微手术相比,神经内镜额部锁孔手术具有手术时间短、血肿清除率高、术后并发症少、患者预后较好等优点。

[关键词] 基底区;高血压脑出血;神经内镜;显微手术;血肿清除术;小骨窗开颅

[中图分类号] R743.34 [文献标识码] A [收稿日期] 2019-12-20

Clinical study of neuroendoscopic frontal keyhole surgery and microsurgery for basal ganglia hemorrhage

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Abstract: Objective To explore the therapeutic effect of neuroendoscopic frontal keyhole surgery and microsurgery in the treatment of basal ganglia hemorrhage. **Methods** The clinical data of patients with hemorrhage in basal ganglia treated by surgery from August 2017 to June 2019 in neurosurgery department of affiliated hospital of Xuzhou medical university were retrospectively analyzed. According to the operation approaches, they were divided into the endoscopic frontal keyhole operation group (study group, 14 cases) and the microsurgery group (control group, 20 cases). The preoperative, intraoperative and postoperative disease changes and the occurrence of surgical complications in the two groups were compared, and the clinical application effects of the two surgical approaches were summarized. **Results** The average hematoma clearance rate and operation time in the study group were lower than those in the control group, and the differences were statistically significant ($P<0.05$). There was no significant difference in the incidence of postoperative complications between between the two groups ($P>0.05$). The GCS scores at different time after operation and ADL scores 3 months after operation in the study group were better than those of the control group, the differences were statistically significant ($P<0.05$). **Conclusion** Compared with microsurgery, neuroendoscopic frontal keyhole surgery has the advantages of short operation time, high hematoma clearance rate, less postoperative complications and better prognosis.

Keywords: basal ganglia region; hypertensive cerebral hemorrhage; neuroendoscopy; microsurgery; hematoma removal; small bone window craniotomy

[基金项目] 江苏省科技厅社会发展项目(BE2016646)

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[12] Law Y, Koelbe T, Schirmer J, et al. Transapical access for antegrade catheterization of the inner branches of an arch stent-graft deployed distal to an ascending arch stent-graft[J]. J Endovasc Ther, 2018, 25(5):542-546. doi:10.1177/1526602818792042.

[13] Chiu P, Goldstone AB, Schaffer JM, et al. Endovascular versus open repair of intact descending thoracic aortic aneurysms[J]. J Am Coll Cardiol, 2019, 73(6):643-651. doi:10.1016/j.jacc.2018.10.086.

[14] Cao P, De Rango P, Czerny M, et al. Systematic review of clinical outcomes in hybrid procedures for aortic arch dissections and other arch diseases[J]. J Thorac Cardiovase Surg, 2012, 144(6):1286-1300. doi:10.1016/j.jtcvs.2012.06.013.

[15] Borst HG, Walterbusch G, Schaps D. Extensive aortic replacement using "elephant trunk" prosthesis[J]. Thorac Cardiovasc Surg, 1983, 31(1):37-40. doi:10.1055/s-2007-1020290.

[16] Gong M, Ma WG, Guan XL, et al. Moderate hypothermic circulatory arrest in total arch repair for acute type A aortic dissection: clinical safety and efficacy[J]. J Thorac Dis, 2016, 8(5):925-933. doi:10.21037/jtd.2016.02.75.

[17] Robertson CA, Gourlay T. Development of a diagnostic sensor for measuring blood cell concentrations during haemoconcentration[J]. Perfusion, 2016, 32(2):126-132. doi:10.1177/0267659116667806.

[18] 杨晓梅,王春生,刘 岚,等.成人体外循环心脏手术后急性肾损伤的危险因素分析[J].中华胸心血管外科杂志,2013,29(3):147-150. doi:10.3760/cma.j.issn.1001-4497.2013.03.007.

(编辑:刘 艺)