From the Society for Vascular Surgery

Management of visceral aortic patch aneurysms after thoracoabdominal repair with open, hybrid, or endovascular approach

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ABSTRACT

Objective: The objective of this study was to investigate the outcomes of patients with visceral aortic patch (VAP) aneurysms after open repair of thoracoabdominal aortic aneurysm (TAAA) treated with three different approaches: open, hybrid, and endovascular repair.

Methods: Between 1993 and 2016, there were 29 cases treated for VAP aneurysm after initial TAAA open repair (median time interval, 6.2 years; interquartile range, 4-8 years). Three different treatment modalities were employed: redo open repair (O group) in 14 cases (48.3%), hybrid repair (H group) in 10 cases (34.5%), and endovascular custom-made fenestrated endograft repair (E group) in 5 cases (17.2%). Early (30-day) and midterm results were recorded. The primary end point was a composite major adverse event score: any 30-day death plus any grade ≥2 postoperative complications plus any surgical revision classified according to the Society for Vascular Surgery/American Association for Vascular Surgery reporting standards. Patients were evaluated with computed tomography scans in the outpatient clinic at 3, 6, and 12 months and annually thereafter.

Results: The composite major adverse event score significantly differed among groups (O group, 79%; H group, 60%; E group, 0%; $P = .009$). Two cases (6.9%) of temporary delayed spinal cord ischemia (grade 1) were observed in both the E and H groups. The treatment modality employed was differently associated with blood loss ≥1000 mL (O group, 79%; H group, 40%; E group, 0%; $P = .007$), number of packed red blood cells transfused ≥3 units (O group, 100%; H group, 90%; E group, 40%; $P = .003$), intensive care unit stay >1 day (O group, 71%; H group, 70%; E group, 0%; $P = .014$), and length of hospital stay ≥7 days (O group, 79%; H group, 80%, E group, 20%; $P = .034$). At short term (6 months), we observed one endovascular reintervention in the E group and one fatal visceral graft thrombosis in the H group. At a median follow-up of 30 months (interquartile range, 15-75 months), we observed another aneurysm-related death in the H group due to graft infection and four unrelated deaths (one case in the H group and two cases in the O group).

Conclusions: This retrospective study confirms that repair of VAP aneurysms that develop after open repair of TAAAs can be performed with open, hybrid, and endovascular techniques. Current practice favors endovascular repair if possible, but a conclusion that it is superior to any other technique requires validation in a larger sample or a randomized trial. (J Vasc Surg 2018;67:1360-71.)

Revascularization of splanchnic and renal arteries is one of the critical steps in open repair of thoracoabdominal aortic aneurysm (TAAA). Several techniques are currently employed, but the most common is the inclusion technique proposed by Stanley Crawford in the early 1970s. It consists of a side-to-end anastomosis aimed at reimplantation, on a side opening in the synthetic Dacron graft, of an island of aortic wall from which the visceral arteries arise.[1] The main drawback of this technique is that the retained portion of the diseased aorta might be prone to further dilation, thus giving rise to a visceral aortic patch (VAP) aneurysm. The prevalence of VAP aneurysm (>5 cm) is currently underestimated; it ranges from 1.1% to 7.7% after median follow-up times ranging from 7 months to 16 years.[2-5]

Different authors[2,3,6-21] have published case reports and one small series regarding both redo open and hybrid TAAA repair, with high mortality and morbidity rates. Only two authors proposed a fenestrated or branched approach for two single cases.[22-25]

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The aim of this study was to investigate the outcomes of three different treatment modalities (open, hybrid, and endovascular) of VAP aneurysm after previous TAAA open repair managed in a single center.

METHODS

Patients. Between January 1993 and December 2016, there were 29 cases (Table I) referred to the Division of Vascular Surgery of the San Raffaele Hospital of Milan for VAP aneurysm with a median diameter of 64 mm (interquartile range [IQR], 58-69 mm). Nineteen patients had undergone prior TAAA repair in our institution by means of open repair with a VAP performed by the standard inclusion technique (872 were treated in the same study with the same technique, and 77 received separate reimplantation of all vessels with a presewn four-branch Dacron graft). The median time interval from the index procedure of the 29 cases was 6.2 years (IQR, 4-8 years). The patients' aortic history at the index procedure is summarized in Table II. During the study period, 14 cases (48.3%) fit for open redo thoracoabdominal repair were managed with conventional open repair (O group), whereas high-risk surgical candidates were treated by means of a hybrid approach (H group) in 10 cases (34.5%) and, since 2013, by means of endovascular repair (E group) with custom-made fenestrated or branched endograft in 5 cases (17.2%). The preoperative workup included a complete physical examination, aortic and coronary imaging, respiratory function tests, and routine blood tests. All preoperative imaging was analyzed on an Aquarius three-dimensional workstation (TeraRecon, San Mateo, Calif), and the treatment modality was evaluated considering both clinical and anatomic suitability (hybrid or endovascular repair) of the patients.

Operative technique. The O group (between 1993 and 2016) underwent an open repair with reinclusion technique through a thoracophrenolaparotomy in 12 cases (85.7%). All the visceral vessels were separately reimplanted with quadrifurcated branched Dacron graft (Vascutek Ltd, Renfrewshire, Scotland, UK) in the most recent seven cases (50%; Fig 1); in the other cases, a combination of undersized VAP and separate bypasses was used.[12] No extracorporeal circulation was used, and intraoperative hypothermic selective perfusion of the splanchnic vessels with cold crystalloid (lactated Ringer solution at 4°C) and of the renal arteries with cold enriched crystalloid solution (Custodiol 4°C; Dr Franz-Köhler Chemie GmbH, Bensheim, Germany) was administered through 9F Pruitt-Inahara occlusion and perfusion catheters (Le Maitre Vascular, Burlington, Mass).[26]

The H group (between 1998 and 2012) underwent a single staged repair with retrograde splanchnic and renal debranching with Dacron graft (6-8 mm in diameter) from the previous infrarenal graft or from the common iliac artery (Fig 2) and VAP aneurysm exclusion using a commercially available endograft (Zenith TX2 Graft [Cook Medical, Bloomington, Ind] in six cases, Valiant Thoracic Stent Graft [Medtronic, Minneapolis, Minn] in three cases, and Bolton Relay [Bolton Medical, Sunrise, Fla] in one case).[12] We aborted the revascularization of two renal arteries because of dense adhesions that made the preparation of the vessel too complex. Moreover, we planned to intentionally cover without revascularization two celiac trunks. The stent graft was inserted from the common femoral artery surgically exposed, and the ballooning was performed according to the instructions for use of the device. The procedures were performed in a standard operating room with a portable C-arm (Ziehm Vision RFD Hybrid Edition; Ziehm Imaging, Nürnberg, Germany). More details of open and hybrid repair techniques have been previously described.[12]

The E group (between 2013 and 2016) underwent a custom-made fenestrated or branched endograft (Cook Medical) repair that was designed on the basis of the individual's anatomy and the physician's planned procedural strategy (Figs 3 and 4). The oversizing of the aortic sealing stent within the previous surgical graft was limited to a maximum of 4 mm to avoid infolding of the endograft. The median planning, production, and sterilization time of the custom-made graft was 42 ± 13 days. In two cases, a proximal tubular stent graft deployment was planned to create an adequate proximal neck, and the procedure was performed as a staged step under local anesthesia with a percutaneous femoral approach (Abbott Vascular, Santa Clara, Calif). The five custom-made steps were performed in a standard angiographic suite (Philips Allura Xper FD10 single-plane C-arm with Flat Panel Detector technology; Philips Medical, Best, The Netherlands), under local anesthesia in three cases receiving a bilateral percutaneous approach. An upper limb access was required in four cases (two brachial open access cases and two transaxillary percutaneous access cases[27]). For fenestrations, balloon-expandable LifeStream stents (Bard, Murray Hill, NJ) were routinely used and positioned protruding 3 to

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective cohort study
- **Take Home Message:** Twenty-nine patients were treated for visceral patch aneurysms that developed after open thoracoabdominal aortic aneurysm repair. Treatments with open, hybrid, or endovascular repair were effective at a median of 30 months after repair.
- **Recommendation:** Current practice favors endovascular repair, but the superiority of endovascular repair of visceral patch aneurysm over open or hybrid repair needs validation in a larger sample of patients.