A hybrid clampless technique for aortic anastomoses

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ABSTRACT

Background and Purpose: In various circumstances of aortic repairs (heavy circumferential calcifications or shaggy aorta with extensive thrombus), open and endovascular techniques are at high risk. In addition to a likelihood of emboli, aortic clamping can be complicated by rupture and endovascular techniques may not be successful. We here describe a simple and reproducible hybrid technique that allows performing an aortic anastomosis without clamping in these situations.

Methods: After a limited exposure of the anterior aortic wall in a healthy segment, a prosthetic graft is sutured without any arteriotomy or clamping (adventitial suture), mimicking the final aspect of an end-to-side anastomosis. The graft and the anastomosis site are punctured using a long needle, allowing a guidewire to be positioned in the aorta under fluoroscopic guidance. Protected covered stenting of the anastomosis site opens the anastomosis without aortic clamping. After tunneling the graft to the target artery, the distal anastomosis is performed in a usual fashion.

Results: This technique was successfully used in 10 challenging consecutive cases with a sustained patency.

Conclusions: This hybrid clampless technique for aortic anastomosis represents a useful alternative for challenging lesions unsuitable for a simple open or endovascular treatment. (J Vasc Surg Cases and Innovative Techniques 2021;7:137-41.)

In various circumstances of aortic repairs such as heavily circumferential calcifications or shaggy aorta with extensive thrombus, open and endovascular techniques are highly risky. In addition to a likelihood of emboli, aortic clamping can be complicated by rupture and endovascular techniques may not be successful.[1-3] These situations can be complicated by emergent settings where cardiac and pulmonary[4] functions cannot be meticulously assessed, precluding extensive approaches.

We describe a hybrid technique that allows performing an aortic anastomosis without clamping, thereby avoiding these risks.

TECHNIQUE

The principle is to perform an adventitial aortic anastomosis with a prosthetic graft after a limited dissection of the anterior aortic wall, mimicking the final aspect of an end-to-side anastomosis. The anastomosis is then opened and stabilized using a covered stent, which provides a pulsatile flow into the graft. An educational video will allow vascular physicians to reproduce the technique (Video). All patients provided written informed consent before procedures. Institutional review board approval was not necessary for the present publication.

Indications. Data from all patients with a contraindication to aortic clamping who underwent this technique of hybrid aortic clampless anastomosis were reviewed. These patients were considered poor candidates for endovascular treatment (Fig 1) based on preoperative computed tomography angiography revealing a highly calcified lesion beginning at the arteries ostia or a shaggy aorta. Preoperative, intraoperative, and follow-up data were reviewed based on medical records and imaging modalities. Contraindications to aortic clamping are detailed in Table I.

Technical approach. Procedures were performed under general anesthesia with a conventional angiographic C-arm (Veradius Unity, Philips Healthcare, Amsterdam, the Netherlands) (Video). The anastomosis technique was standardized. A limited exposure of a healthy anterior aortic wall without major calcifications or thrombus was obtained (Fig 2, *A*). A beveled prosthetic graft (Fusion, Maquet, Rastatt, Germany, or ringed PTFE Gore, Newark, Del, or Gelsoft, Vascutek, Inchinnan, UK) was quickly sutured to the aorta using 4/0 polypropylene sutures without any arteriotomy or clamping (adventitial running suture), mimicking the final aspect of an end-to-side anastomosis (Fig 2, *B*). The angulation of the constructed anastomosis anticipated the final aspect of the bypass. The distal graft and the anastomosis site were

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Fig 1. Sagittal computed tomography (CT) scan of a heavily calcified aorta with a ostial and long calcified lesion of superior mesenteric artery.

both punctured using a unique 18G 18-cm long needle (AND-18-18.0, Cook, Bloomington, Ind) (Fig 2, *C*). A 180-cm long 0.035" Amplatz wire (Boston Scientific, Marlborough, Mass) with a distal J tip was introduced in the aorta through the cannula provided with the needle. The cannula was retrieved and a 7F 45-cm introducer (Flexor, Cook) was positioned over the wire through the surgical graft. It was pushed into the aortic lumen thereby enlarging the hole made by the needle. A balloon-expandable covered stent (Advanta V12, Getinge, Gothenburg, Sweden, or Lifestream, Bard, New Providence NJ, or BeGraft, Bentley, Exton, Pa) was advanced protected into the sheath at the anastomosis level in a way that the proximal part of the stent was at least 10 mm in the aorta. The stent diameter was chosen with an oversizing of 1 mm compared with the graft. In small diameter aortas, another possibility was to push the stent further in the aorta in a way that the proximal part of the stent was placed on the posterior aortic wall, similar to the shape of a chimney stent.[5] The stent was inflated over the balloon under fluoroscopic control for secure positioning. After deflating the balloon, a pulsatile flow was observed into the graft (Fig 2, *D*). Completion angiography was performed to assess the morphology and the patency of the anastomosis site. The graft was then tunneled to the distal anastomosis level. Care was given not to stretch the graft too much to avoid a kink at the distal part of the stent. Finally, the graft was distally anastomosed to the target artery in a conventional fashion with a running polypropylene suture (Fig 2, *E*).

Outcomes. Ten patients were operated using this technique. Results are provided with median and ranges. Details regarding the donor sites, target arteries, surgical grafts and stents used are provided in Table I. Target artery was determined by clinical indication; superior mesenteric artery for mesenteric arterial disease (n = 4, 2 acute ischemia) and femoral artery (common or deep) for aortoiliac occlusive disease (n = 5, 2 acute ischemia). One patient benefited from this technique for vertebrobasilar insufficiency related to complex aortic trunk lesions. The total operative time was 310 minutes (range, 175-380 minutes). Fluoroscopy time and total radiation dose were 155 seconds (range, 106-185 seconds) and 6.34 Gy/cm^2 (range, 3.41-13.5 Gy/cm^2), respectively. Intraoperative technical success (patent bypass without >30% stenosis and/or flow-limiting lesion) was 100%. No leak was observed at the proximal anastomosis, and no stent migration was seen. There were no early deaths. Two early reinterventions were necessary. The first reintervention was a fasciotomy 12 hours after revascularization for acute limb ischemia owing to postoperative compartment syndrome. The second reintervention was total graft replacement by a cryopreserved allograft at postoperative day 14 owing to a severe postoperative infection after a redo aortic surgery. No embolic event was reported. Hospital stay was 9 days (range, 6-21 days). Within the 14-month follow-up (range, 6-51 months), one patient was lost, but all other patients were alive and healthy. All bypasses were patent and no ischemic symptom was noted.

DISCUSSION

We present a simple and reproducible technique of hybrid aortic clampless anastomosis for challenging situations. It represents an alternative in case of surgical or anesthetic contraindications to conventional aortic surgery and/or unsuitable lesions for endovascular treatment. In addition to its feasibility, our results show satisfactory midterm results with a 100% primary patency and no morbidity related to the technique.

Previous techniques to overcome challenges associated to anastomosis have been reported in various settings. These techniques can be classified according to their anastomosis site (proximal or distal) and anastomosis technique (clampless and/or sutureless). We summarized some of them in the Table II. Interestingly, porcelain or shaggy ascending aortas are also considered challenging in cardiac surgery despite the availability of cardiopulmonary bypass and hybrid aortic arch debranching[11] or

Table I. Characteristics of patients, lesions, and procedures

	Age /sex	Donor site	Target artery	Contraindication to aortic clamping		Prosthetic graft	Covered stent	Last follow-up
				Surgical	Anesthetic			
1	77/ Female	Coeliac aorta	SMA	Heavily calcified aorta		Fusion 7 mm	Begraft 7/57	13
2	66/Male	Infrarenal abdominal aorta	CFA	Heavily calcified aorta		Fusion 10 mm	Fluency 13.5/100	13
3	55/Male	Thoracic descending aorta	CCA	Heavily calcified aorta		Ringed PTFE 8 mm	Advanta V12 9/58	16
4	61/Male	Infrarenal abdominal aorta	SMA	Heavily calcified aorta		Fusion 7 mm	Lifestream 8/37	51
5	81/Female	Infrarenal abdominal aorta	CFA		Unstable ischemic heart disease	Fusion 8 mm	Lifestream 8/37	21
6	66/Male	Infrarenal abdominal aorta	CFA		Unstable ischemic heart disease	Polyester 8 mm	V12 9/38	7
7	64/Male	Coeliac aorta	SMA		Unstable ischemic heart disease	Fusion 7 mm	Begraft 8/57	15
8	81/Male	Coeliac aorta	SMA	Heavily calcified aorta		Fusion 7 mm	Begraft 8/37	6
9	57/Male	Infrarenal abdominal aorta	DFA		Low pulmonary function	Ringed PTFE 7 mm	V12 8/38	7
10	63/Male	Coeliac aorta	CFA	Heavily calcified aorta		Fusion 8 mm	V12 8/38	6

CCA, Common carotid artery; *CFA*, common femoral artery; *DFA*, deep femoral artery; *SMA*, superior mesenteric artery.

endoclamping[13] have also been described in these situations. For shaggy ascending aortas, atherosclerotic material flushing[14] can limit shower embolisms, but requires an extracorporeal circulation to avoid blood loss. The present technique is clampless but not sutureless. However, the suture does not mandate the usual level of caution since it is further opened and covered by a stent-graft. It has the advantage to use off-the-shelf materials without substantially increasing the complexity and the cost of the procedure.

An interesting point of the technique is to avoid large aortic approaches. It can therefore be beneficial for patients who underwent previous aortic surgery. It avoids the potential morbidity of extensive adhesiolysis during an abdominal approach,[4] and replace it by a localized approach of a healthy aortic wall segment.

We offered special considerations in case of a planned lung surgery after the aortic procedure. Lung cancer surgery after aortic repair is not rare owing to similar risk factors[15] and some patients have a heavily calcified abdominal aorta and a healthy clamping zone in the thorax. This was the case for two patients of the present series. The present technique avoided a proximal anastomosis on the thoracic aorta and left the primary thoracic approach for a later lung surgery.

After a complex proximal aortic anastomosis, the treating surgeon can also face a challenging distal anastomosis owing to extensive lesions on the target artery. The VORTEC technique[6] is based on a sutureless transluminal distal stenting of the target artery. However, it needs a distal seal in the target artery limiting its use in bifurcations. The POSE technique is an hybrid alternative using an open stenting before a manual suture.[12] These techniques can be associated with the technique described here, and one patient in this study underwent a proximal clampless aortic anastomosis and distal anastomosis on the superior mesenteric artery using the POSE technique.

CONCLUSIONS

The present technique of hybrid aortic clampless anastomosis is feasible and safe. It represents an alternative in case of lesions unsuitable to an endovascular treatment and when aortic clamping is deemed at risk owing to surgical or anesthetic considerations.

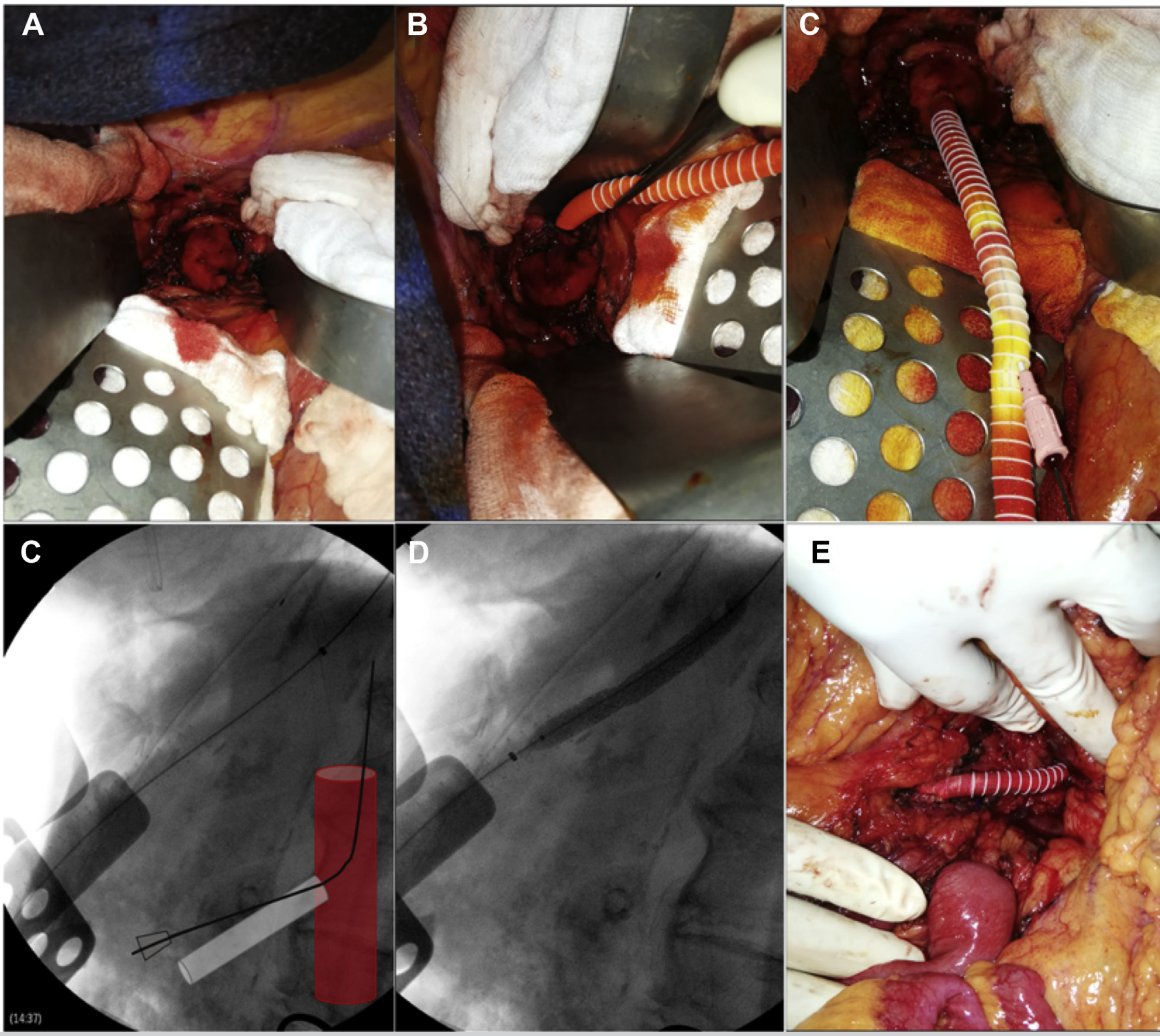

Fig 2. **A**, Surgical exposure of a healthy anterior aortic wall. **B,** Adventitial running suture mimicking the final aspect of a side-to-end anastomosis. **C,** Puncture of the graft and the proximal anastomosis site. **D,** Covered stent deployment providing a pulsatile flow into the graft. **E,** Conventional anastomosis to the distal target artery.

Table II. Overview of anastomosis alternatives

	Technique	Anastomosis site	Clampless	Sutureless
Lachat et al[6] 2008	VORTEC	Distal	√	√
Alimi et al[7] 2009	Experimental	Proximal Abdominal aorta	√	√
Bonvini et al[8] 2011	ViPS	Distal	√	√
Abou Taam et al[9] 2012	Experimental	Distal	–	√
Chiesa et al[10] 2014	GHVG	Distal	√	√
Kato et al[11] 2015	Real chimney	Proximal Ascending aorta	√	–
Coscas et al[12] 2016	POSE	Distal	√	–
Current technique		Proximal Thoracoabdominal aorta	√	–

GHVG, Gore Hybrid Vascular Graft; *POSE*, Primary Open Stenting following by Endarterectomy; *ViPS*, Viabahn Padova Sutureless; *VORTEC*, Viabahn Open Revascularization TEChnique.

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