Case Report

Endovascular Septotomy During Thoracic Endovascular Aortic Repair for Chronic Dissection-Related Aneurysm: All That Glitters Is Not Gold

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Although endovascular repair is preferred over open techniques for chronic dissection-related thoracoabdominal aneurysms, specific adjunctive maneuvers are frequently required to optimize the distal landing zone of the thoracic endovascular aortic repair (TEVAR) or to enlarge the narrowed true lumen to deploy a branched endograft. Recently, transcatheter endovascular septotomy (TES) has gained attention as an evolving minimally invasive technique to optimize complex TEVAR procedures creating a better apposition of the endograft to the native aortic wall with the primary aim to block the retrograde perfusion of the false lumen. Initial results have been described satisfactory, but not negligible rates of intraprocedural complications in the form of lamella prolapse/migration leading to branch vessels occlusion have been described too. Herein we describe a complication that occurred after TEVAR with TES, causing static malperfusion of the reno-visceral vessels.

Keywords: thoracic endovascular aortic repair; transcatheter endovascular septotomy; case report

Introduction

Chronic post-dissection aortic aneurysms (PD-AAs) represent a challenging scenario [1]. The high aortic remodeling obtained with the complete false lumen (FL) thrombosis supports the concept of distal FL occlusion as an adjunct in the treatment of PD-AAs [2]. Various endovascular procedures have been described to induce FL thrombosis as an adjunct to thoracic endovascular aortic repair (TEVAR), such as embolization by means of coils, plugs, or glue, and the candy plug technique [3,4]. Originally described for the management of structural valvular diseases, recently transcatheter endovascular septotomy (TES) has gained attention as an evolving minimally invasive technique to incise or fenestrate the dissection septum with the primary aim to optimize aortic luminal diameter and ameliorate the distal sealing zone [5–7]. Despite TES techniques have been associated with enthusiasm, notable complications have been described too including distal embolization, free-flap migration, and prolapsing intimal flap tissue leading to branch vessel occlusion and even infrarenal aortic obliteration. These complications have been reported in the range of 5-to-33% depending on the TES technical variant and in particular after the use of a pull-through technique [1,6]. Up so far, TES has been reported to be safe and effective in chronic PD-AAs with the only caution when employing this technique only in acute dissection owing to the elevated risk of malperfusion syndromes due to the dislodgement of large portions of intima and lamella determined by the obliteration of side branches and the aortic bifurcation [6–8]. Herein, we report on the case of an unexpected intraoperative, iatrogenic reno-visceral malperfusion after TES during "zone 2" TEVAR for a chronic PD-AA.

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Case Report

The ethical permission was waived by the Ethics Committee of University of Insubria since it is based on retrospective analysis of anonymized data.She is a 71-year-old woman with a medical history of hypertension. Ascending aortic graft replacement with additional aortic valvuloplasty by leaflet resuspension was performed five years earlier for an acute aortic syndrome determined by a DeBakey type 1 acute aortic dissection. That postoperative course was uneventful, and she entered a follow-up surveillance program that showed a slow but progressive enlargement of the residual type B dissection. In 2024, she remained asymptomatic, but the descending thoracic aorta increased of >1 cm with a maximum diameter of 61 mm at the distal aortic arch level, and the FL was larger than 22 mm in diameter (Fig. 1). The primary, residual, entry tear was located 28 mm beyond the take-off of the left subclavian artery, with a re-entry tear >10 mm at the level of the celiac trunk that originated along with the left renal artery from the FL. Aneurysmal extent was type C in agreement with the Estrera classification [8]. The European System for Cardiac Operative Risk Evaluation-II (EuroSCORE-II) was 5.32%, and the aortic size index was 4.12. After a detailed discussion on the risks/benefits of an open intervention or an endovascular alternative, informed consent was obtained to proceed with thoracic endovascular aortic repair TEVAR and TES. We used short-term antibiotic prophylaxis (cefazolin, 2 gr *b.i.d.*; Cefamezin; Pfizer; Milan, Italy) and intravenous heparinization (50 UI/kg) targeting the activated clotted time value >200 throughout the entire procedure with standardized periodic monitoring every thirty minutes. We performed a left common carotid-to-left subclavian artery bypass using a 6 mm armed heparin-bonded expanded polytetrafluoroethylene graft bypass (Propaten®, W.L. Gore; Flagstaff, AZ, USA). Through a right femoral surgical cutdown, we used permissive hypotension to deploy the first TEVAR component (CTAG® 34 mm × 200 mm, W.L. Gore; Flagstaff, AZ, USA) in "zone 2". Afterward, we performed TES under intravascular examination (VOLCANO Visions PV .035, Philips; Amsterdam, Netherlands) control [9]. TES was advanced up to the level of the renal arteries. Then, a second TEVAR component (CTAG® 45 mm × 150 mm, W.L. Gore; Flagstaff, AZ, USA) was then deployed at the level of the celiac trunk. To achieve a perfect endograft-to-wall apposition, we ballooned the distal edge of the second component to obtain a "knickerbocker"-like remodeling [10]. At the subsequent angiography, a static malperfusion was observed potentially due to the lamella dislodgement that occluded the origin of the celiac trunk as well as the superior mesenteric artery and the left renal artery (Fig. 2). To resolve the malperfusion we attempted to obtain a re-alignement of the lamella through a STABILISE technique (ZDES® 46 mm × 180 mm, Cook Inc.; Bloomington, IN, USA), but we failed to restore the vessels' patency [11]. Therefore, sequential selective catheterization of the visceral and renal vessels was required, starting from the superior mesenteric artery. Once the lumen gained into this native vessel, the selective angiography showed an embolus at the level of the first branch which was resolved with manual thromboaspiration and local selective bolus of thrombolytic agent (Urokinase, 100.000 IU, Pfizer; Milan, Italy). The superior mesenteric artery was finally stented (VBX® 7 mm × 59 mm, W.L. Gore; Flagstaff, AZ, USA) along with the celiac trunk (VBX® 7 mm × 39 mm, W.L. Gore; Flagstaff, AZ, USA) and the left renal artery (VBX® 6 mm × 29 mm, W.L. Gore; Flagstaff, AZ, USA). Final control angiography confirmed the complete exclusion of the FL in the descending thoracic aorta, the relamination of the reno-visceral segment, and the patency of all reno-visceral vessels (Fig. 2). We concluded the procedure with the embolization of the left subclavian artery using an endovascular plug (Amplatzer-II, Abbott Cardiovascular; Chicago, IL, USA). The total time of intervention was 496 minutes with a visceral ischemic time of 62 minutes, and left renal ischemic time of 104 minutes. The postoperative course was uneventful; the increase of the renal and visceral enzymes did not develop into definitive ischemic complications (Fig. 3). To reduce the thrombotic risk, she was discharged on postoperative day 13th starting oral anticoagulant with warfarin (Coumadin®, Bristol-Myers Squibb; New York, NY, USA) with a target international normalized ratio (INR) value between 2 and 3, plus cilostazol (Fripass®, Italfarmaco; Cinisello Balsamo, Italy). She was last seen 15 months after the intervention, alive and well: no bleeding events were observed. During the follow-up, she underwent computed tomography angiography at 1, 6 and 12 months which demonstrated the complete exclusion of the descending thoracic dissection-related aneurysm, the relamination of the reno-visceral aorta, and the patency of the stented vessels (Fig. 4, 12-months follow-up).

This case has been reported in line with the case report guidelines: Case Report (CARE) Guidelines to ensure the accuracy and completeness of the report **(Supplementary Material)**.

Discussion

The differential of pressure between FL and TL is widely accepted as the main mechanism responsible for the aneurysmal dilatation after aortic dissection. Therefore, it has been intuitive to think about the possibility that equally distributing the pressures between the TL and FL through fenestration may mitigate the condition that prompts the development of a dissection-related aneurysm [12]. While historically the aim of the open fenestration was to resolve the malperfusion by creating a single aortic lumen, in this endovascular era the concept of TES aims to obtain different outcomes [13,14]. In dissection-related thoracoabdominal aneurysms TES is aimed to enlarge aortic luminal diameter in patients with narrowing or compressed TL thus facilitating branch vessel catheterization [1]. We opted for TES instead of alternative embolization techniques because, in patients with PD-AAs confined to the descending thoracic aorta, the advantage of using TES is twofold: first, it creates a more appropriate distal landing zone thus favoring a better apposition of the endograft to the native aortic wall with the primary aim to block the retrograde perfusion of the false lumen. Secondly, TES allows for a reduced extent of aortic coverage which may mitigate the risk of spinal cord ischemia.

Available evidence from high volume centers suggests that TEVAR with TES in appropriately selected patients with PD-AAs appears to be safe with low peri-operative mortality and morbidity rates [1,9]. Nevertheless, lamella dislodgement and intima invagination causing target vessel oc-

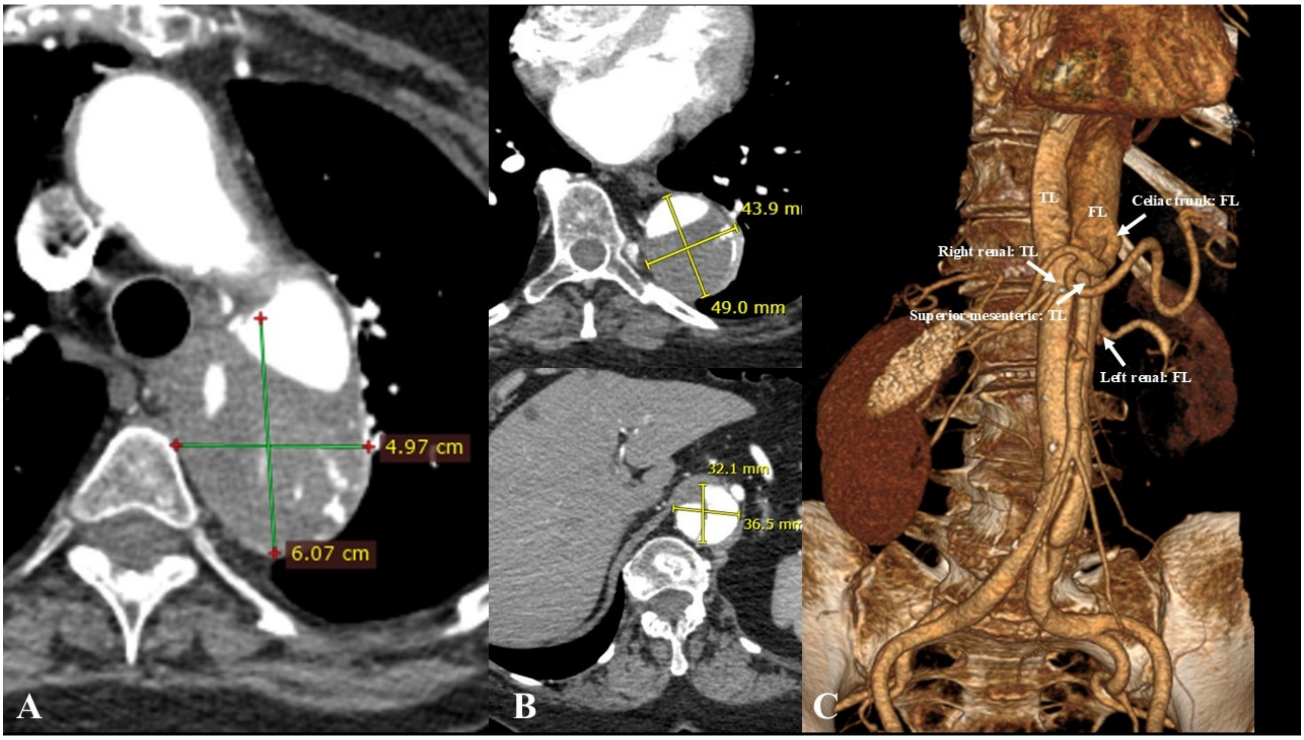


Fig. 1. Preoperative work-up. Follow-up, preoperative computed tomography angiography showing the evolution of a chronic post-dissection aneurysm (A). Aortic disease extent was type C (B), with the celiac trunk, the left renal artery and the inferior mesenteric artery originating from the false lumen (FL), and the superior mesenteric artery as well as the right renal artery from the true lumen (TL) (C).

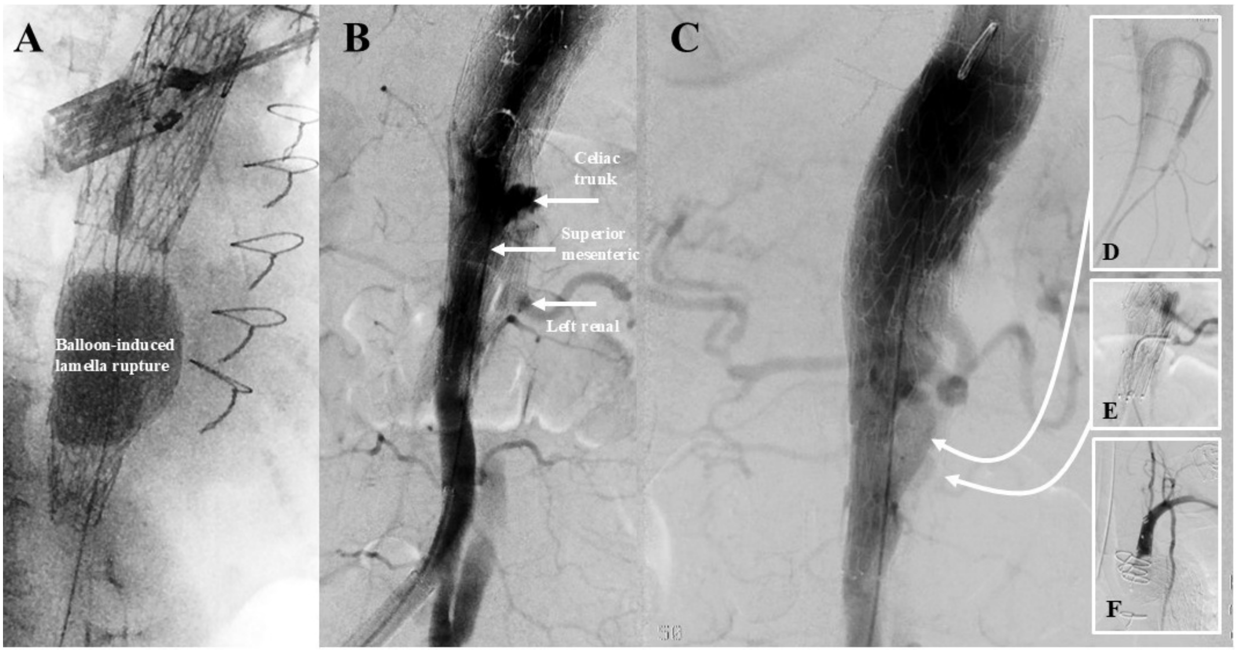
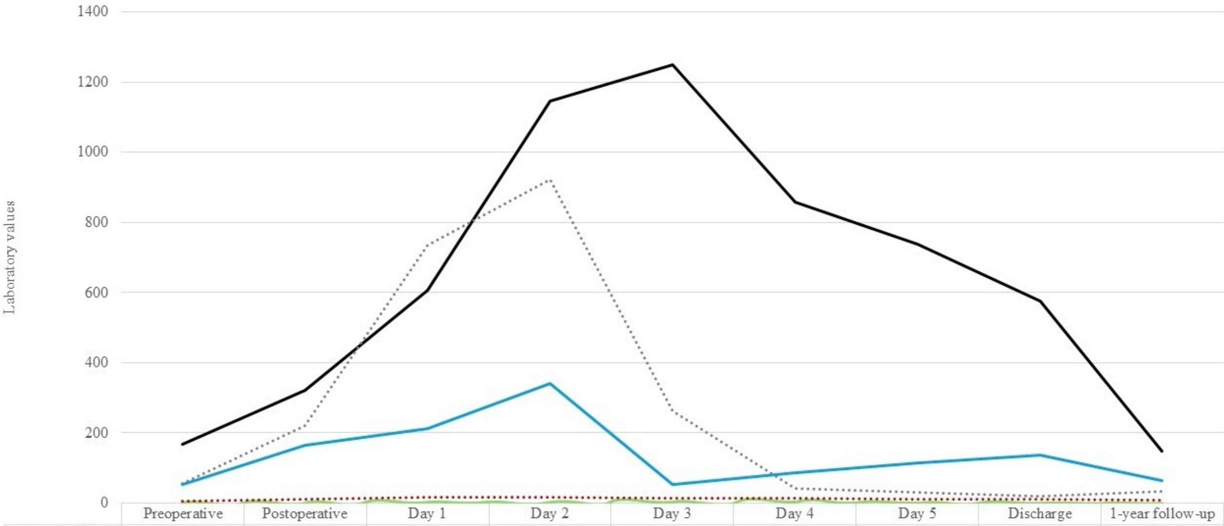


Fig. 2. Operative procedure. Intraoperative findings: the "knickerbocker" molding of the second endograft component (A), the reno-visceral malperfusion (white arrows) which persistent after the relamination with the dissection stent (B), curved white arrows indicate the direction of catheter manipulation during selective catheterization, completion angiography after stenting on the celiac trunk, superior mesenteric artery and left renal artery (C) after their selective catheterization of the superior mesenteric artery (D) and of the left renal artery (E), as well as the final left subclavian artery embolization using a endovascular plug (F).



	Preoperative	Postoperative	Day 1	Day 2	Day 3	Day 4	Day 5	Discharge	1-year follow-up
creatinine	0,69	0,91	1,57	1,75	1,86	1,46	1,22	1,04	1,12
LDH	168	322	605	1146	1250	859	739	575	147
CPK	56	221	734	922	263	43	31	20	32
Amilase	54	164	211	342	54	86	115	137	64
Leucocytes	6,76	11,52	15,22	16,69	12,79	12,47	11,39	12,14	7,74

Unit of reference: creatinine, mg/dL; LDH/CPK/Amilase, U/L; Leucocytes, 10^9/L

Fig. 3. Panel of blood tests showing the trends of different biomarkers from the perioperative period to the 1-year follow-up. LDH, Lactate Dehydrogenase; CPK, Creatine Phosphokinase.

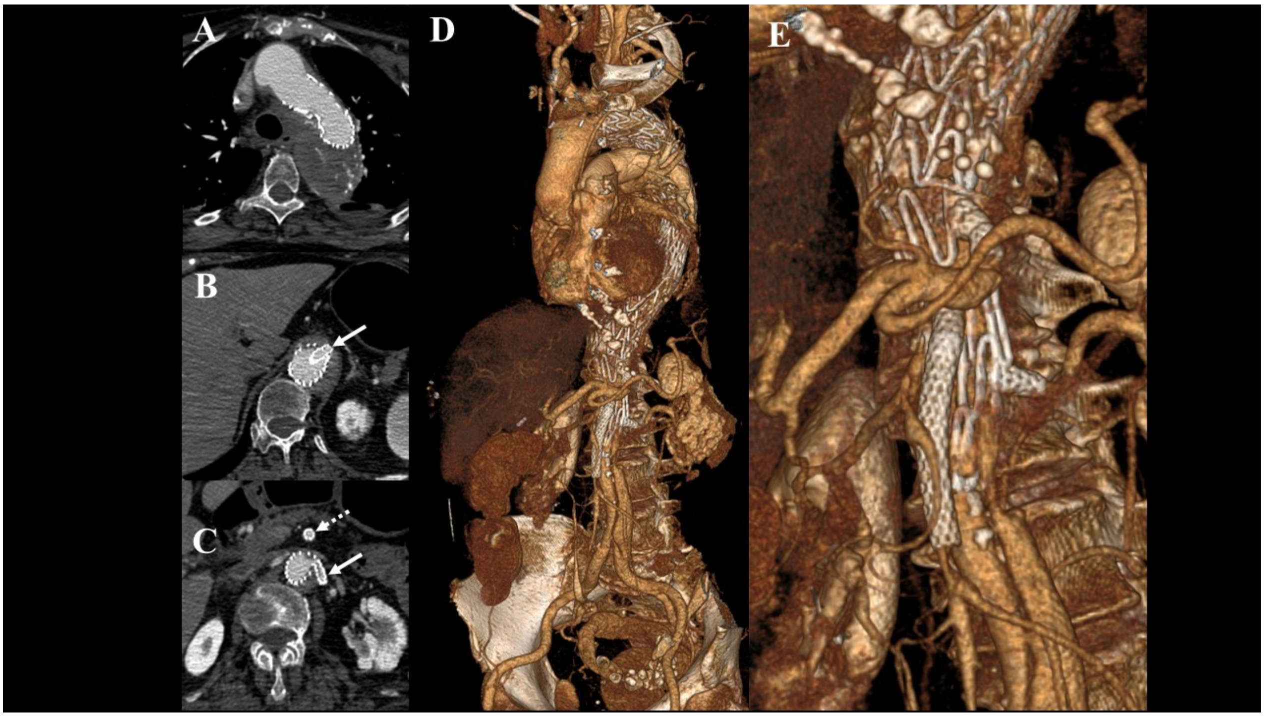


Fig. 4. Postoperative control. Follow-up computed tomography angiography at 12 months confirmed the exclusion of the aneurysm and the complete thrombosis of the descending thoracic false lumen with a positive remodeling (A), and the patency of the bridging stent-graft of the celiac trunk (arrow) (B), of the superior mesenteric artery (C, dotted arrow) as well as that one of the left renal artery (C, full arrow). 3D volume rendering reconstructions demonstrated the extent of the reconstruction with the complete abolishment of the false lumen reperfusion across the reno-visceral vessels (D) and their patency (E).

clusion and the risk of distal embolization have been described [15]. The exact mechanism that developed in our case could not be fully ascertained, but can find a possible explanation in the observations made by Berguer *et al*. [12] in their experimental work on endovascular septectomy. They considered pertinent to evaluating whether the septotomy should be carried out by antegrade, starting at the proximal tear, or retrograde from the distal tear. They observed that a septotomy that begins at the proximal tear could cause sudden distention of the FL with further extension of the dissection and collapse of the TL [12]. A retrograde septotomy involving the visceral segment of the aorta may also correct an existing visceral malperfusion. In our case we had vessels originating partly from the TL and partly from the FL, so that we might hypothesize a combination of mechanisms that may have occurred: the dislodgement of fragments of lamella as a consequence of the endograft ballooning along with the sudden distension of the TL that may have caused the collapse of the distal part of the lamella determining a flow-limiting static obstruction. That said, even the most recent guidelines suggested that the use of TES should currently be confined to clinical study settings since the technology remains in its early stages, and definitive conclusions about its role in clinical practice cannot yet be established [16,17].

Conclusions

Case reports do not allow us to draw definitive conclusions; however, this catastrophic intraoperative event offered us some food for thought. First, despite the unexpected occurrence and the correlated extensive endovascular maneuvers, we should recognize that septotomy may be a valuable adjunctive tool in the endovascular armamentarium to make TEVAR simpler in complex anatomies. Secondly, while a procedure can be performed, it does not necessarily mean it must be performed. Third, TEVAR and TES were successful without technical difficulties, but clinical indication and anatomical criteria are still to be refined. Therefore, considering the unexpected, this case suggests TES should be performed at centers capable of rapid conversion to open surgery and composite procedures.

Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

Author Contributions

GP conceptualized the research study, performed the research, and analyzed the data. MF, LB, FM, and FF conceptualized the research study and collected data. GP, MF, LB, FM, and FF drafted the manuscript. All authors have been involved in revising the manuscript critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

The ethical permission was waived by the Ethics Committee of University of Insubria since it is based on retrospective analysis of anonymized data. Informed consent was obtained. The study was conducted in accordance with the Declaration of Helsinki.

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Conflict of Interest

Gabriele Piffaretti is serving as one of the Editorial Board members of this journal. We declare that Gabriele Piffaretti had no involvement in the peer review of this article and has no access to information regarding its peer review. Other authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.62713/aic.4521.

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