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REVIEW ARTICLE

Descending Thoracic Aorta as inflow for primary revascularization of aorto-iliac occlusive disease – review of the last 30 years

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ABSTRACT

INTRODUCTION: The descending thoracic aorta (DTA) has been used as inflow mostly as a secondary option for revascularization after either graft failure/infection or other intra-abdominal pathologies contraindicating a standard abdominal aortic approach. The objective of this review is to summarize current evidence on the use of this inflow site for revascularization procedures.

METHODS: A comprehensive electronic literature search was performed, using PubMed and Embase databases. All literature published in English in the last 30 years was considered. The main goal was to assess the feasibility and practicality of implementing this approach in cases of severe and complex aortoiliac lesions.

RESULTS: Our review comprised 11 articles. DTA has been used predominately as a secondary option. The 30-day mortality rate was 4% (9/222). Secondary graft patency at 5-years was generally high across all studies. The use of DTA as inflow has been shown to be a safe and effective option for aorto-iliac reconstruction.

CONCLUSION: DTA can be used safely as an inflow for lower-limb revascularization and it remains an important tool in the vascular surgeon's armamentarium.

Keywords: Descending thoracic aorta bypass; descending Thoracic Aorta; visceral aorta; coral reef aorta; open surgery; chronic limb ischemia;

INTRODUCTION

In 1961, Stevenson et al reported the first use of descending thoracic aorta (DTA) inflow for aorto-iliac reconstruction,[1] but at the time, axillo(bi)femoral bypass was more popular due to its simplicity with reasonable outcomes, overshadowing the DTA as inflow. Currently, endovascular treatment is the preferred method for most aorto-iliac lesions, including complex cases, due to the development of successful new techniques.[2] The standard aortobifemoral bypass (AbFB) is now generally applied when endovascular treatment is not feasible. In some cases, however, AbFB is not suitable due to circumferential aortic calcification or complex lesions involving the mid-visceral aorta precluding safe clamping of the abdominal aorta. Bypass procedures using the DTA as inflow have been described as alternative interventions in patients with hostile abdomen or as an alternative inflow source when graft failure/infection has occurred with past published studies reporting reasonable outcomes. The study aims to assess the current state of research on DTA inflow, its advantages, and limitations to guide clinical decision-making.

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METHODS

The authors performed a thorough electronic search of the literature using PubMed and Embase databases. The key words used in the search strategy were the following: (descending thoracic aorta) AND (bypass OR inflow) AND (aortoiliac lesions).

Only articles in English published in the last 30 years were included. After duplicates removal, titles and abstracts were screened and all potentially relevant articles were included for full text assessment. Only original research was included, but case reports and case series were allowed.

REVIEW

The authors selected 11 articles to compose the review (Table 1).[3-12]

Table 1. Summary of publications reporting on revascularization with inflow from the descending thoracic aorta, included in the literature review.

Authors (year)	Type of study	N	Main outcomes	Primary vs Secondary Revascularization
Hentgen et al (2022)	Retrospective	27	30-day mortality	Primary: 14 Secondary: 3
Li et al (2021)	Case Report	1	-	Primary: 1
Wistuba et al (2015)	Case Series	4	-	Primary: 2 Secondary: 1
Reppert et al (2014)	Retrospective	13	Perioperative morbidity and mortality	Primary: 6 Secondary: 7
Fukui et al (2003)	Case Report	1	-	Secondary: 1
Koksal et al (2002)	Case series	5	-	Primary: 5
Passmal et al (1999)	Retrospective	50	Primary and secondary patency, limb salvage and survival rates	Primary: 31 Secondary: 19
Sapienza et al (1997)	Retrospective	41	Morbidity and mortality rates and long term outcomes	Primary: 14 Secondary: 27
Criado et al (1993)	Retrospective	32	Perioperative and long term results Patency (meta-analysis)	Primary: 19 Secondary: 13
McCarthy et al (1993)	Retrospective	21	Perioperative morbidity, patency	Primary: 2 Secondary: 19
Branchereau et al (1992)	Retrospective	27	Perioperative morbidity, patency	Primary: 4 Secondary: 23

Demographic data analysis showed that the majority of patients (68.6%) were male, with an average age of 58.1 years. Prevalent comorbidities included smoking history, high blood pressure, coronary disease, dyslipidemia, diabetes, and chronic renal disease (Table 2).

Table 2. Summary of demographic data of patients with revascularization procedures using the descending thoracic aorta as inflow, included in the review

Mean age - years	58.1
Male: Female ratio	2.19:1
Smoking History – n (%)	128/170 (75.3)
High Blood Pressure – n (%)	73/170 (42.9)
Coronary Disease – n %)	56/170 (33)
Dyslipidemia – n (%)	36/170 (21)
Diabetes – n (%)	23/170 (13.5)
Chronic Renal Disease – n (%)	15/170 (8.8)

DTA inflow was used as primary revascularization in 99 patients (44.6%) and as a secondary option in 123 patients (55.4%). From the latter group, the indication for surgery were as follows: aortic graft infection in 24, aortoenteric fistula in 5, aortic pseudoaneurysm in 2, failure of previous endovascular procedure in 10, and failure of previous open surgery in 82 patients (Table 3).

Table 3. Causes for secondary revascularization procedures using the descending thoracic aorta as inflow, included in the review (N=123).

Causes for Secondary revascularization		n (%)
Graft infection		24 (19.5)
Aortoenteric fistula		5 (4.1)
Aortic pseudoaneurysm (graft)		2 (1.6)
Endovascular failure		10 (8.2)
Open Surgery failure	Aortic reconstructions (not specified)	27 (22.0)
	Aortobifemoral bypass	44 (35.8)
	Aortic endarterectomies	3 (2.4)
	Femoral crossover	3 (2.4)
	Iliofemoral bypass	2 (1.6)
	Axillofemoral bypass	3 (2.4)

Surgical technique details (Table 4) were gathered, and side bite clamping was the preferred method for proximal aortic control. The graft, either unigraft or a bifurcated one, is usually tunneled through the retroperitoneal space in a partly blind way and anastomosed distally to the femoral arteries. A lumbar flank counter incision is suggested by some authors to help guiding the graft and avoid intra-abdominal organ injury.

Table 4. Summary of surgical technical details used in patients with revascularization procedures using the descending thoracic aorta as inflow, included in the review

Author (year)	Proximal clamping	Tunelization	Bypass configuration
Hentgen et al (2022)	Cross Clamping	Retroperitoneal – partly blind	One limb graft + femoral crossover
Li et al (2021)	Side bite Clamp	Retroperitoneal – partly blind	Bifurcated graft
Wistuba et al (2015)	Side bite Clamp	Retroperitoneal – partly blind with flank incision	Bifurcated graft
Reppert et al (2014)	Side bite Clamp	Retroperitoneal – partly blind with flank incision	Bifurcated graft
Fukui et al (2003)	Side bite Clamp	Retroperitoneal Videoassisted;	One limb graft; Previous Femoral crossover
Koksal et al (2002)	Side bite Clamp	Retroperitoneal – partly blind	Bifurcated graft
Passmal et al (1999)	Side bite Clamp	Retroperitoneal – partly blind	One limb graft + femoral crossover
Sapienza et al (1997)	Side bite Clamp	Retroperitoneal – partly blind with flank incision	One limb graft + femoral crossover (when needed)
Criado et al (1993)	Side bite Clamp	Retroperitoneal – partly blind	One limb graft + femoral crossover
McCarthy et al (1993)	Side bite Clamp	Retroperitoneal – partly blind	One limb graft + femoral crossover
Branchereau et al (1992)	Cross Clamping	Retroperitoneal – partly blind with flank incision	Bifurcated graft

The 30-day mortality rate was 4% (9/222) and fourteen patients (6%) needed reintervention due to a thrombosis event in 8 and bleeding events in four. Thirty-one per cent of the complications were lung-related, the most frequent acute complication (Table 5). Graft thrombosis and infection were the most reported long-term complications reported (Table 6). Secondary graft patency at 5-years was reported to be higher than 86%, except in Branchereau et al who reported a 72.6% of graft patency. At 10 years, Sapienza et al reported a primary and secondary of 64% and 76%, respectively (Table 6).

Table 5. Complications and cause of reintervention in patients with revascularization procedures using the descending thoracic aorta as inflow, included in the review.

Causes for Secondary revascularization		n (%)
Pulmonary (pneumonia and lung collapse)		15 (6.7)
Myocardial Infarction		4 (1.8)
Intestinal Ischemia		4 (1.8)
Acute renal Failure		3 (1.3)
Cerebrovascular event		4 (1.8)
Intrabdominal organ injury		2 (0.9)
Retroperitoneal hematoma		1 (0.4)
Paraplegia		1 (0.4)
Related to reintervention	Limb/femoral crossover occlusion	4 (1.8)
	Aortic Graft thrombosis	4 (1.8)
	Proximal anastomosis bleeding	4 (1.8)
	Acute intestinal ischemia	1 (0.4)
	Popliteal embolism	1 (0.4)

Table 6. Graft patency and late related complications in patients with revascularization procedures using the descending thoracic aorta as inflow, included in the review.

Autor (year)	N	Medium Follow up	Graft Patency	Late complications
Hentgen et al (2022)	27	26m	At 4 Years - Primary and Secondary of 95.5% and 88.9%, respectively.	Graft Infection -1 False Aneurysm -1 Femoral Crossover occlusion - 1
Li et al (2021)	1	5m	Patent at 5 Mo.	N/A
Wistuba et al (2015)	4	61m	100%	N/A
Reppert et al (2014)	13	18m	Secondary Patency of 86% at 6 Mo.	N/A
Fukui et al (2003)	1	N/A	N/A	N/A
Koksal et al (2002)	5	3m	100% at 3 Mo.	N/A
Passmal et al (1999)	50	39m	At 5 Years - Primary and Secondary of 79% and 84%, respectively.	Limb Occlusions – 6 Graft Occlusion – 1 Graft Infection – 2 False Aneurysm -1
Sapienza et al (1997)	41	55m	At 5 Years - Primary and Secondary of 80% and 86%, respectively. At 10 Years - Primary and Secondary of 64% and 76%, respectively.	Limb Occlusions – 9 Graft Infection – 3 False Aneurysm -1
Criado et al (1993)	32	22m	At 2 Years – Primary patency 85.9%	Graft Occlusion – 2 Graft Infection – 2
McCarthy et al (1993)	21	44m	At 4 Years - Primary and Secondary of 86.4% and 100%, respectively.	Graft Infection – 1 Mesenteric ischemia -1
Branchereau et al (1992)	27	26.3m	At 5 Years – Secondary patency of 72.6%	Graft Occlusion – 3 Graft Infection – 1

N/A Not available.

DISCUSSION

In an era where endovascular approach has become progressively the first option even for TASC D lesions, we should always keep in mind the durability of open surgical reconstruction. There are three specific situations where DTA inflow should be thought thoroughly: severe circumferential juxtarenal/suprarenal aortic calcification, failed aortofemoral bypass or endovascular first approach with no favorable anatomy for direct reconstruction and when concomitant visceral atherosclerotic disease is present and in need for revascularization.

This review shows favorable results of DTA bypass with similar mortality, morbidity rates, and graft patency compared to AbFB. Arguments against DTA inflow source are the invasiveness and the higher risk of complications. Even though, DTA bypass has evolved over time, with the possibility of performing it with minimal invasive techniques such as minimal thoracotomy or even using videoendoscopic. These advancements can potentially reduce the most frequent and feared pulmonary related complications. Ultimately, the decision to use it should be made on a case-by-case basis, considering the patient's individual functional status, age, comorbidities and the expertise and resources available at the medical center. These advancements can potentially reduce the most frequent and feared pulmonary related complications.

Even though DTA inflow is typically used as an alternative, this paper highlights the low perioperative morbimortality and good long-term patency rates, supporting its use not only as an alternative but also for primary revascularization in selected cases. The DTA is less prone to atherosclerotic disease and its approach avoids intrabdominal organ injury. Moreover, spinal cord, mesenteric, and renal ischemia are less likely given that partial clamping is a viable option. While the DTA inflow technique can be an effective treatment for aorto-iliac occlusive disease, it is a complex and technically demanding procedure that requires significant surgical skill and experience. Recent data on this procedure are lacking. Therefore, more studies to compare other endovascular and direct open surgical options are needed in order to define the indication for a DTA inflow use.

In conclusion, DTA can be used safely as an inflow for lower-limb revascularization and it remains an important tool in the vascular surgeon's armamentarium.

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REFERENCES

1. Stevenson JK, Sauvage LR, Harkins HN. A bypass homograft from thoracic aorta to femoral arteries for occlusive vascular disease. Am Surg. 1961;27:632-7

2. Szilagyi DE, Elliott JP Jr, Smith RF, Reddy DJ, McPharlin M. A thirty-year survey of the reconstructive surgical treatment of aortoiliac occlusive disease. J Vasc Surg. 1986;3:421–36

3. Hentgen B, Davaine JM, Jayet J, Verscheure D, Couture T, Koskas F. Extra Anatomic Aorto-Iliac Revascularization Using Descending Thoracic Aorta to Bifemoral Bypass in Selected Cases. Ann Vasc Surg. 2022;86:210-8.

4. Li W, Santana D, Rivas E, Huynh J, Olivas R, Edwards A. Descending thoracic aorta to bilateral femoral artery bypass and thoracic endovascular aortic repair in the management of atypical aortoiliac occlusive disease. J Vasc Surg Cases Innov Tech. 2021;7:718-24

5. Wistuba MR, Alonso-Pérez M, Al-Sibbai AZ, González-Gay M, Alvarez Marcos F, Camblor LA, et al. Lower limbs revascularization from supraceliac and thoracic aorta. Ann Vasc Surg. 2015;29:1035-9

6. Reppert AE, Jazaeri O, Babu A, Greenberg JI, Deluka E, Nehler MR, et al. Minimal thoracotomy thoracic bifemoral bypass in the endovascular era. Ann Vasc Surg. 2014;28:1420-5

7. Fukui S, Paraskevas N, Soury P, Gigou F, Petit MD, Laurian C. Totally videoendoscopic descending thoracic aorta to femoral artery bypass. J Vasc Surg. 2003;37:191-3

8. Köksal C, Sarikaya S, Zengin M. Thoracofemoral bypass for treatment of juxtarenal aortic occlusion. Asian Cardiovasc Thorac Ann. 2002;10:141-4

9. Sapienza P, Mingoli A, Feldhaus RJ, Napoli F, Marsan A, Franceschini M, et al. Descending thoracic aorta-to-femoral artery bypass grafts. Am J Surg. 1997;174:662-6

10. Criado E, Keagy BA. Use of the descending thoracic aorta as an inflow source in aortoiliac reconstruction: indications and long-term results. Ann Vasc Surg. 1994;8:38-47

11. McCarthy WJ, Mesh CL, McMillan WD, Flinn WR, Pearce WH, Yao JS. Descending thoracic aorta-to-femoral artery bypass: ten years' experience with a durable procedure. J Vasc Surg. 1993;17:336-47

12. Branchereau A, Magnan PE, Moracchini P, Espinoza H, Mathieu JP. Use of descending thoracic aorta for lower limb revascularisation. Eur J Vasc Surg 1992;6:255-62