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# The Role and Outcomes of Thoracodistal Bypass

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A B S T R A C T

*Objectives:* Endovascular procedures for lower extremity revascularization are becoming more commonplace due to low morbidity, mortality, and shorter length of stay. The role of open bypass must be reconsidered. Aortobifemoral bypass is the gold standard for extensive aortoiliac occlusive disease (AIOD); however, thoracodistal bypass holds a niche position. We investigate indications and outcomes of thoracodistal bypass.

*Methods:* Medical records of five patients who underwent thoracodistal bypass at Thomas Jefferson University Hospital (TJUH) between 2012 and 2019 were reviewed. Contemporary and historical literature was reviewed.

*Results:* Indications included calcified paravisceral pathology, previous failed or infected bypass grafts, and prior abdominal operations. Thirty-day mortality at our institution was 0%. Four out of five patients had patent grafts at one year. Complications included pulmonary, renal, bleeding, and wound complications in addition to need for reintervention.

*Conclusions:* Despite high complication rates associated with thoracodistal bypass, longterm patency and longterm survival rates are also high. Thoracodistal bypass continues to be a useful tool in select patients.

## Introduction

The approach to lower limb revascularization has changed as endovascular procedures become more common. Open bypass continues to be a viable option, especially for patients with extensive occlusion such as aortoiliac occlusive disease (AIOD). Among the options for open procedures, aortofemoral bypass (AFB) is first line treatment for lower limb revascularization; however, thoracofemoral or thoracodistal bypass continues to play an important role in patients meeting certain criteria.[1]

First described in 1961, thoracodistal bypass involves exposure of the left groin, followed by anterolateral thoracotomy at the 7$^{th}$ or 8$^{th}$ intercostal space and graft tunneling through the retroperitoneal space until it is anastomosed to its distal target (Figure 1).[2–5] This procedure is considered secondary revascularization for remediation of previous graft failure or graft infection.[6] It can serve as primary revascularization in the setting of abdominal pathology precluding AFB, as well as in the setting of aortoiliac occlusive disease.[7,8] Reviews of early literature show low perioperative mortality and excellent primary and secondary patency.[8–12] Despite the versatility of this procedure, few reports exist in the literature.[7]

## Methods

We present five cases of thoracodistal bypass at Thomas Jefferson University Hospital (TJUH) performed between 2012 and 2019. The medical records were reviewed to identify demographic data and post-operative outcomes. Primary post-operative outcomes included graft patency at three months, six months, and one year, as well as 30-day mortality. Secondary outcomes included major and minor surgical complications. Demographic data included patient comorbidities and indications for the procedure. Contemporary and historical literature was reviewed. Consent to publish details from the cases was obtained from the patients.

## Case reports

### *Case 1*

A 69-year-old female with lower extremity claudication, hyperlipidemia, and hypertension secondary to renovascular disease. Abdominal aortogram revealed coral reef calcific lesion, including bilateral renal artery calcification (Figure 2). Proximal anastomosis was made at the descending thoracic aorta; distal anastomoses were created at left renal and left external iliac arteries (Figure 3). Complications included blood loss anemia, pleural effusion, and an apical pneumothorax. At six months follow-up, she was without claudication. Computed tomography scan at six months and two years post-operative showed a patent graft (Figures 4 & 5).

### *Case 2*

A 38-year-old male with mid-aortic syndrome, abdominal aortic aneurysm, hypertension, hyperlipidemia, and mitral valve prolapse. Surgical history included aorto-aortic bypass with reimplantation of bilat-

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**Figure 1.** Incision through the seventh intercostal space.

eral renal arteries with saphenous vein grafts. He presented with 5.5 cm pseudoaneurysm of left renal artery vein graft and claudication. He underwent thoracic aorta to bilateral common iliac artery bypass with Hemashield Gold (Dacron 14x7 mm) graft, left renal aneurysm stenting with tapered Viabahn graft, and embolization of prior aorto-aorto bypass with Amplatzer occlusion device. There were no complications. The graft was patent and pseudoaneurysm had decreased to 3.4 x 3.2 cm at one year. He was without claudication three years postoperatively.

*Case 3*

A 61-year-old female with hypertension, hyperlipidemia, and tobacco use. Past surgical history included AFB, removal of right femoral graft and re-do with CryoVein due to infection, and bilateral axillary-femoral artery bypass. Graft occlusion necessitated bypass from descending thoracic aorta to profunda femoris arteries with 14x7 mm Gore PTFE graft and jump grafts (8 mm Gore Propaten) to mid-bilateral superficial femoral arteries. Complications included groin wound seroma. At forty-six months, she required right graft limb and right femoral-popliteal artery bypass graft thrombectomies. Thoraco-distal bypass graft and right femoral-popliteal graft were patent fourteen months after reintervention.

*Case 4*

A 60-year-old female with AIOD, peripheral arterial disease, hyperlipidemia, and tobacco use. Past surgical history included AFB, graft infection necessitating graft removal, and creation of axillary-bifemoral artery bypass. Subsequent graft occlusion necessitated thoracic aorta to bilateral profunda femoris artery bypass (Gore 14 x 7 mm PTFE graft) and jump graft to superficial femoral artery. Complications included post-op bleeding, open thrombectomies of right graft limb and right leg arteries at six and nine months, open thrombectomy of bilateral graft limbs at sixteen and nineteen months, and excision and reconstruction of bilateral femoral grafts at twenty-one months. Repeated occlusion led to left above knee amputation and discharge to hospice.

*Case 5*

57-year-old female with extensive cardiovascular history presented with claudication. Infrarenal aortic occlusion with calcification of paravisceral aorta necessitated descending thoracic aorta to bilateral common femoral artery bypass and bilateral iliofemoral endarterectomy. Complications included limb thrombosis requiring thrombectomy and four-compartment fasciotomy, acute kidney injury, rhabdomyolysis, blood loss anemia, and SIRS. At six months she had 2-3 block calf claudication. At fifteen months, bypass was patent.

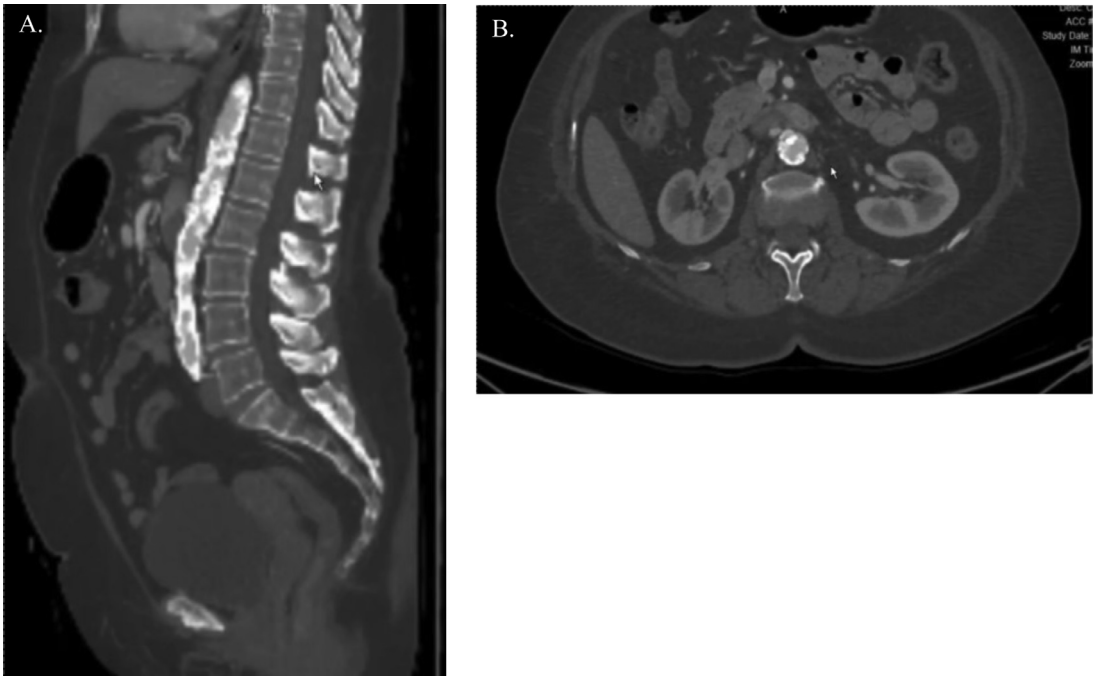


**Figure 2.** A. Extensively calcified aorta. B. Aortic calcification at level of renal arteries.

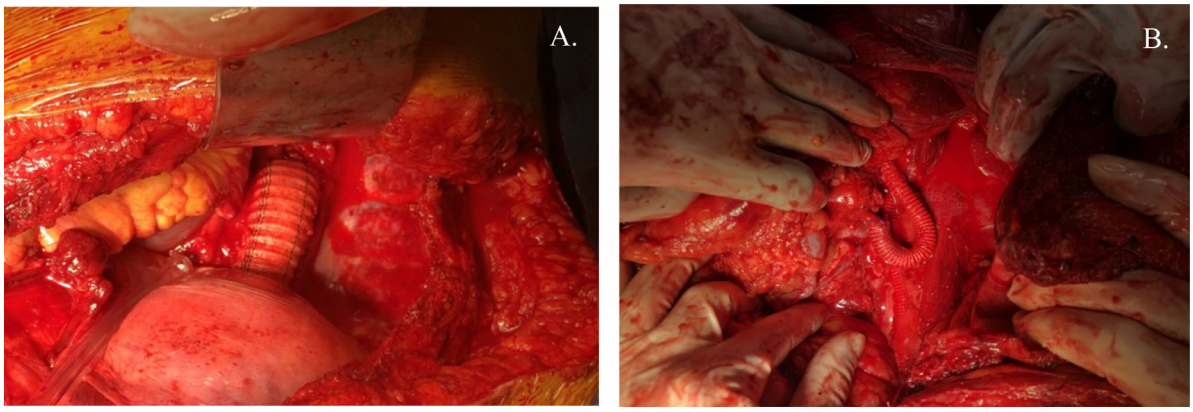


**Figure 3.** A. Proximal anastomosis at thoracic aorta. B. Distal anastomosis between the graft and renal artery.

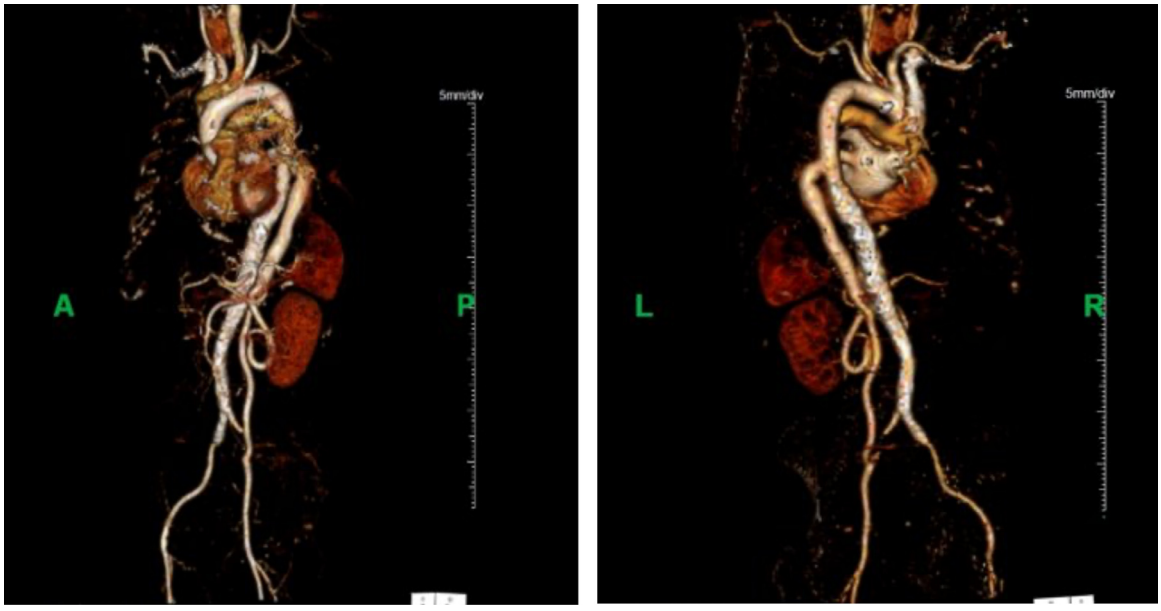


**Figure 4.** 3D reconstruction CT of graft from descending thoracic aorta to left external iliac artery and left renal artery.

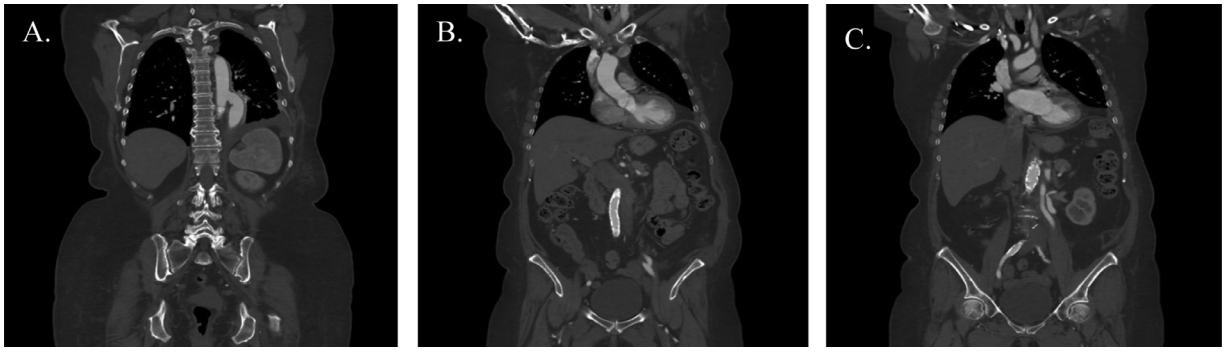


**Figure 5.** A. proximal anastomosis of graft at thoracic aorta. B. Distal anastomosis of graft at left external iliac artery. C. Distal anastomosis of graft at left renal artery.

## Results

Among TJUH patients, ages ranged from 38 to 69 years old. Indications for thoracodistal bypass included previous failed bypass graft and complex or calcified paravisceral pathology. Comorbidities included coronary artery disease, hypertension, hyperlipidemia, fatty liver disease, renovascular disease, aortic coarctation, atrial fibrillation, diabetes, and tobacco use. Thirty-day mortality was 0%. Perioperative complications were limited to minor complications, and included pulmonary, bleeding, renal, and wound complications, as well as the need

for vascular reintervention. All five TJUH patients had patent grafts at three and six months; four out of five patients had patent grafts at one year.

## Discussion

Blaisdell and Sauvage were the first to use the descending thoracic aorta as a source of inflow to the iliofemoral region.[2,5,10,12] Today, thoracodistal bypass is reserved for secondary revascularization following graft failure.[13] Aortofemoral bypass from the abdominal aorta is preferred; however thoracodistal bypass can serve as an alternative extra-anatomic bypass with satisfactory results.[1,7,14] Thoracodistal bypass is rarely used in the modern era, as endovascular procedures are more commonly used to treat AIOD. Lower complication rates and shorter length of stay associated with endovascular procedures make stenting the more desirable option.[15] Despite the popularity of endovascular techniques, there is still a role for extra-anatomic bypass, including thoracodistal bypass.

Vascular surgeons must reserve thoracodistal bypass for patients meeting certain criteria. Prior pelvic or abdominal radiation, intra-abdominal infection, or adhesions from previous abdominal surgery can create a hostile abdomen. The intra-abdominal pathology associated with a hostile abdomen precludes access of abdominal aorta.[3,16,17] Inflow from the descending thoracic aorta is often necessary in patients with extensive AIOD and calcification of the juxtrarenal, infrarenal, and suprarenal aorta.[1,10,18–22] Previous graft failure, due to graft occlusion or infection, is another indication for thoracodistal bypass as a means of secondary revascularization.[23–25]

Complications of thoracodistal bypasss are high, and range from 31.2% to 34.8%.[6] Complications include myocardial infarction, splenectomy, stroke, paraplegia, occlusion and need for reintervention or amputation, renal failure requiring new dialysis, surgical site infection or seroma, multiple organ failure, pulmonary, and bleeding complications.[1,6,7,18–21,26] Pulmonary complications include transfusion related lung injury, postoperative respiratory distress, pleural effusion, lung collapse, postoperative pneumonia, and pulmonary embolism.[1,18,19,21,26] Bleeding complications include need for transfusion and gastrointestinal bleed.[1,18,21]

Despite high complication rates associated with thoracodistal bypass, studies have shown impressive patency.[1,6,25] Feldhaus et al. reported patency of 96 ± 3.9% at one year and 85 ± 8.1% at five years.[1,25] Crawford et al. reported one- and three-year limb patency of 94 ± 4% and 80 ± 10%, respectively.[1] Stewart et al reported primary patency of 89.0% at one year, and a freedom from major amputation at one year of 97.1% ± 2.2%.[6] Perioperative mortality ranges from 0% to 12.5%.[1,6,8,10,12] Some studies report long-term survival rates of 92.7 ± 2.2% or 93 ± 4% at one year, and 93.5% at five years.[1,6]

In the endovascular era, there are few contemporary studies describing outcomes of thoracodistal bypass, and no centers perform this procedure routinely. With the use of techniques like covered endovascular reconstruction of aortic bifurcation (CERAB), some infrarenal lesions can be treated endovascularly with reduced risk of fracturing calcified vessels or causing bleeding.[15] Despite the potential utility of procedures like CERAB, there is still a role for open surgery in treating AIOD. The Trans-Atlantic Inter-Society Consensus Document of Peripheral Arterial Disease (TASC II) continues to recommend open revascularization as a first-line treatment for type II D aortoiliac lesions including Leriche Syndrome.[27,28] Although aortofemoral bypass from the abdominal aorta is the gold standard method of extra-anatomic bypass, thoracodistal bypass can serve as an alternative procedure in patients with pathology or anatomy inhibiting access to the abdominal aorta.[6]

## Conclusion

In the endovascular age, thoracodistal bypass serves a method of secondary revascularization in patients requiring remedial procedures for previous failed or infected aortofemoral bypass and axillofemoral bypass grafts. It continues to serve as an important option for primary revascularization in patients with complex or calcified paravisceral pathology or hostile abdomen. The long-term patency rates identified in our patients and in the literature, are excellent. The rate of complications at our institution were limited to minor complications. Although it will have a niche position, thoracodistal bypass remains a valuable tool in the armamentarium of the vascular surgeon.

## Disclaimers

None.

## Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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