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Thrombolysis in endovascular management of chronic aortic occlusions: A narrative review

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ABSTRACT

INTRODUCTION: Revascularisation of chronic juxtarenal aortic occlusions can present a complex challenge. While open repair remains the gold standard, endovascular therapy is increasingly used in high-risk patients. The role of catheter-directed thrombolysis (CDT) in chronic aortic occlusions remains unclear and might be underestimated in patients unfit for open revascularisation.

METHODS: We conducted a narrative review of PubMed/MEDLINE and Embase for English-language studies from January 1, 2000, to January 31, 2025. Using MeSH and free-text terms for thrombolysis (e.g., catheter-directed thrombolysis, fibrinolysis, urokinase, tissue plasminogen activator) and chronic aortic/aortoiliac occlusion (including juxtarenal/infrarenal anatomy), we included native chronic aortic or aortoiliac occlusions treated with CDT in revascularisation studies reporting technical and/or clinical outcomes. Case reports (<5 patients) were excluded. Outcomes assessed included technical success (thrombus reduction enabling definitive endovascular therapy), patency, and major complications.

RESULTS: Five retrospective series were included, comprising 54 patients treated with CDT (urokinase or tPA) before endovascular aortoiliac revascularisation. All studies used CDT as an adjunct to endovascular revascularisation. Technical success rates ranged from 80–100%, with no 30-day mortality and low complication rates. Reported primary patency after definitive endovascular reconstruction was generally 85–100% at 1 year (83% at 18 months in one series), with limited longer-term follow-up.

CONCLUSION: CDT may serve as a useful adjunct in the endovascular treatment of chronic juxtarenal aortic occlusions, particularly in high-risk patients. However, further prospective studies are needed to define its long-term efficacy and safety.

Keywords: CERAB; Bare-metal stent; Aortoiliac occlusive disease; Peripheral arterial disease; Catheter-directed thrombolysis.

INTRODUCTION

Chronic juxtarenal aortic occlusion poses a challenge in vascular practice, particularly because of the lesion's proximity to vital visceral branches. While open surgical bypass remains the traditional standard,[1,2] the evolution of endovascular therapy has broadened the treatment landscape, especially for patients at high surgical risk.

Catheter-directed intra-arterial thrombolysis (CDT) was first described by Dotter et al. in 1974.[3] Its use is well documented in the acute and subacute stages of thrombosis. However, the use of thrombolysis and thrombolytic agents is scarce in the chronic setting, and vascular surgeons generally consider it unhelpful.

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The Surgery versus Thrombolysis for Ischemia of the Lower Extremity (STILE) trial aimed to clarify the roles of surgical intervention versus CDT in acute and chronic limb ischemia. The investigators found that when treatment was initiated within 14 days of symptom onset, thrombolysis was associated with a lower rate of major amputation than surgery (11% vs 30%). However, when treatment was delayed beyond 14 days, thrombolysis resulted in a higher amputation rate than surgery (12% vs 3%).[4] These findings significantly tempered enthusiasm for using thrombolysis in chronic settings over time. It is important to note that 55.8% of patients randomised to CDT in the study experienced a significant reduction in the extent of their initially planned revascularisation following thrombolytic therapy. Moreover, substantial advances in endovascular technology have emerged since the trial's publication.

CDT and thrombolytic agents might have a valuable, yet underappreciated, role in treating select cases of chronic aortic occlusion. This review explores a possible new role for thrombolysis in the endovascular treatment of chronic JRAO.

METHODS

We performed MEDLINE (via PubMed) and Embase searches to identify relevant studies published between January 1, 2000, and January 31, 2025. The search strategy employed a combination of Medical Subject Headings (MeSH) terms and free-text keywords including: "catheter-directed thrombolysis," "thrombolysis," "fibrinolysis," "chronic aortic occlusion," "juxtarenal aortic occlusion," "infrarenal aortic occlusion," "aortoiliac occlusive disease," "urokinase," "tissue plasminogen activator," "tPA," and "endovascular therapy".

The search strategy was designed to capture studies evaluating the use of thrombolytic agents in the treatment of chronic aortic and aortoiliac occlusions. To supplement the electronic database search, we manually reviewed the reference lists of all retrieved articles and relevant review articles to identify additional studies that may have been missed in the initial search.

Studies were eligible for inclusion if they met the following criteria: (1) involved patients with chronic aortic or aortoiliac occlusion; (2) utilized CDT as part of the treatment strategy; (3) reported technical and/or clinical outcomes; (4) included at least 5 patients to reduce risk of bias from very small case series; and (5) were published in English.

Exclusion criteria included: (1) case reports with fewer than five patients; (2) studies focusing exclusively on acute thrombosis (<14 days); (3) studies of graft occlusions without native vessel involvement; (4) review articles, editorials, and commentaries without original data; (5) duplicate publications reporting on the same patient cohort (in which case the most recent or comprehensive publication was retained); and (6) studies that did not report outcomes specific to CDT.

Screening and data extraction were performed by a single reviewer (the author). Titles and abstracts for potential eligibility. Full-text articles were then retrieved and assessed against the inclusion and exclusion criteria.

Primary outcomes evaluated included technical success of CDT (defined as achieving flow channel and sufficient thrombus reduction to permit subsequent endovascular intervention) and primary patency at one year. Secondary outcomes included 30-day mortality, bleeding complications (major and minor), and other procedure-related complications.

RESULTS

Only seven articles reported the direct use of lysis to treat chronic aortic juxtarenal occlusions between 2000 and 2025. One of the articles was a case report, and in the other, the authors used only lysis to treat distal thrombus embolisation after an endovascular approach;[5] thus, both were excluded. The remaining five studies were retrospective series, Table 1.

In 2009, Moise et al. reported 31 patients with chronic infrarenal aortic occlusion. Nine of them underwent CDT (urokinase) before endovascular stenting. All patients were TASC D. Three of the nine patients underwent percutaneous mechanical thrombectomy as an adjunct. A flow channel was obtained in all nine lytic cases, but complete thrombus resolution was not achieved in any. Lysis effectively facilitated safe subsequent endovascular interventions in all 9 patients.

The mean thrombolysis duration was 34.5 hours (range 12–60 hours). There were no mortalities in the 30-day postoperative period, and no patient required amputation. Regarding complications, they reported one brachial haematoma during lysis and three patients with significant post-operative renal dysfunction, one of whom required haemodialysis.[6]

In 2014, Zhang et al. reported a retrospective study of 20 patients with chronic lower-limb ischemia treated with CDT using urokinase, followed by angioplasty with or without stenting.

Of these patients, 18 had native vessel occlusion, 11 had aortoiliac occlusive disease, and only two had bilateral iliac occlusive disease. According to the TASC II classification, 11 patients had type C lesions and seven had type D lesions. The patients reported a median symptom duration of 19 months before intervention.

Technical success was achieved in 100% of cases. In this series, adjuvant thrombolysis reduced the mean length of the occlusive lesions from 150 mm to 30 mm, with 16 of the 20 patients experiencing an improvement in their TASC classification. The mean time of thrombolysis was 48 hours, and the thrombolytic agent was urokinase in 16 patients and rt-PA in four. The strategy translated to a 95% primary patency at one year. There was significant symptomatic improvement post-treatment. No major bleeding complications occurred, though a few minor hemorrhagic events were reported.[7]

Table 1. Summary of the five articles concerning CDT in chronic aortic occlusions, included in this literature review.

	Moise et al. (2009)	Zhang et al. (2014)	Yuan et al. (2014)	Zhao et al.	Clinical Success (%)
N Patients	9	20	5	14	6
Anatomic Regions	Aorto-iliac	Aorto-iliac and Infra-inguinal	Aorto-iliac	Aorto-iliac	Aorto-iliac
Agent	Urokinase	Urokinase and tPA	Urokinase	Urokinase	tPA
Thrombolysis duration (in hours)	34.5 (mean)	48 (mean)	27 (mean)	48-120 (range)	12-72 (range)
Thrombus reduction	100%	100%	80%	100%	100%
30-day mortality	0%	0%	0%	0%	0%
Adjunct procedures	Stenting and angioplasty	Stenting, angioplasty, bypass graft	Stenting and angioplasty	Stenting	CERAB
Primary patency of revascularization	85% (at one year)	95% (at one year)	83% (at 18 months)	86% (at one year)	100% (at one year)
Adverse outcomes	- Renal dysfunction - Access haematoma - Artery rupture	None	Retroperitoneal haematoma	- Transient pain; - Two late asymptomatic re-occlusions - Haemorrhage	Access haematoma

Yuan et al. in 2014 reported endovascular treatment of long-segment (>10 cm) atherosclerotic aortoiliac occlusion in 20 patients; five of those patients underwent adjunctive CDT before angioplasty and stent reconstruction. Proximal aortic occlusion at the renal artery level was the most common indication for thrombolysis. Urokinase was delivered via infusion catheter using continuous and pulse-spray techniques at 30,000 IU/h. The mean thrombolysis duration was 27 hours (range 20-38 hours), with angiographic thrombus resolution in four of five cases. A single major bleeding complication (retroperitoneal haemorrhage) was reported in the CDT subgroup; no distal embolisation or in-hospital mortality was recorded. Primary patency reported was 93.3% at 6 months, 83% at 18 months, and 66.4% at 24 months.[8]

In 2020, Zhao et al. reported a retrospective series of 14 patients with juxtarenal aortic occlusion treated with urokinase-based CDT for two to six days. This study includes acute aortic occlusions, and the authors do not specify how many patients had chronic aortic occlusions. The lysis catheter was laced with 500,000 IU of urokinase and then infused at 20,000 IU/h, in combination with low-molecular-weight heparin (100 IU/kg), with daily laboratory monitoring and interval angiography to assess progress. The reported duration of disease was 30.8±24.7 months (range 1–72 months). CDT was successful in all patients, with significant symptom relief and no perioperative visceral embolisation reported. At one year, two patients had asymptomatic re-occlusion.[9]

More recently, in 2023, Minion D et al. reported six patients with chronic juxtarenal aortic total occlusion treated using tPA-based CDT, followed by the covered endovascular repair of the aortic bifurcation (CERAB) technique. Thrombolysis successfully reduced the thrombus in all patients, enabling safer stent placement. There were no reported perioperative deaths, myocardial infarctions, strokes, or major complications. A temporary increase in serum creatinine was seen in 3 patients. The primary patency reported is 100% at early follow-up up to 15 months. This study supports the use of thrombolysis as a preparatory step in anatomically complex endovascular reconstructions. It describes the lysis and CERAB technique, termed the LA CERAB technique, as a safe alternative for treating chronic juxtarenal aortic occlusions.[10]

DISCUSSION

This review examines a potential emerging role of CDT as an adjunctive therapy in the endovascular management of chronic juxtarenal aortic occlusions, a clinical scenario traditionally considered outside the therapeutic window for thrombolytic agents. The findings from the limited available literature suggest that CDT could facilitate safer and more effective endovascular interventions in highly selected patients, challenging the conventional wisdom about the utility of thrombolysis in chronic occlusive disease.

The use of thrombolysis in chronic arterial occlusions has historically been limited, largely due to the influential findings of the STILE trial, which demonstrated that when treatment was initiated beyond 14 days of symptom onset, thrombolysis resulted in higher amputation rates than surgery (12% vs. 3%).[4] However, the STILE trial also revealed that 55.8% of patients randomized to CDT experienced a substantial reduction in the extent of their initially planned revascularization, suggesting potential benefits that may have been underappreciated.

The five retrospective studies reviewed collectively demonstrate that CDT can create a flow channel in the majority of chronic juxtarenal aortic occlusions, despite not achieving complete thrombus resolution in most cases.[6-10] CDT can reduce thrombus burden in the juxtarenal aortic

segment, thereby reducing embolic risk and improving visualization of the true lumen and of the underlying arterial anatomy, making endovascular approaches in these cases safer.

In the series by Zhang et al, adjuvant CDT improved TASC classification. This substantial reduction in lesion complexity has important implications for procedural planning, potentially enabling less extensive stenting, lower costs, and shorter procedure times—all factors that may improve outcomes in this high-risk patient population.

Since the STILE trial, endovascular technology has advanced significantly. Today's CDT protocols employ lower doses of fibrinolytic agents, shorter infusion durations, and combine with mechanical thrombectomy devices. These improvements lead to fewer bleeding complications and better outcomes compared to past data.[11]

The integration of CDT with advanced endovascular techniques, such as CERAB (Covered Endovascular Reconstruction of Aortic Bifurcation), represents a novel approach to anatomically complex chronic juxtarenal occlusions. Minion's series of six patients treated with the "LA CERAB" technique (lysis-assisted CERAB) reported 100% technical success, no perioperative deaths, and 100% primary patency at early follow-up. While these results are promising, they must be interpreted cautiously given the small sample size and short follow-up duration.

This review is constrained by limited evidence, comprising only five small retrospective studies with 54 patients undergoing CDT for chronic aortic occlusions. The absence of control groups, standardised protocols, and long-term follow-up hampers the ability to draw definitive conclusions regarding safety and efficacy. Moreover, publication bias may lead to an overrepresentation of successful cases, possibly inflating the actual success rates.

The heterogeneity in thrombolytic agents (urokinase vs. tPA), dosing regimens, infusion durations, and adjunctive procedures makes comparison across studies difficult. The absence of standardised reporting of outcomes, including definitions of technical success, methods for assessing patency, and grading of complications, further complicates interpretation.

Future research should focus on prospective studies with standardised protocols that compare CDT-assisted endovascular revascularisation with endovascular approaches without CDT and with open surgical repair.

CONCLUSION

Although historically underutilized in chronic occlusive disease, thrombolysis is a potentially valuable adjunctive therapy in endovascular management of chronic juxtarenal aortic occlusions. These recent retrospective studies demonstrate that thrombolysis may facilitate safer, more effective endovascular interventions in highly selected patients, and its role may be re-evaluated not as a standalone therapy but as a preparatory or adjunctive tool. Future prospective studies with longer follow-up and larger cohorts are needed to better define the role of thrombolysis in the management of chronic aortoiliac occlusive disease.

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