

Advances in Integrated Traditional Chinese and Western Medicine for Prevention and Treatment of Arteriovenous Fistula Thrombosis in Maintenance Hemodialysis Patients

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Abstract: *Autologous arteriovenous fistula (AVF) is the preferred permanent vascular access for maintenance hemodialysis (MHD) patients. Thrombosis is the leading critical complication causing AVF failure. Western medical interventions, including thrombolysis, endovascular procedures, and surgery, can rapidly restore blood flow in the acute phase but are associated with high rates of long-term restenosis and recurrent thrombosis. In traditional Chinese medicine (TCM), AVF thrombosis falls into the categories of “Mai Bi” (vessel impediment) and “Xue Bi” (blood impediment), with “qi deficiency and blood stasis” as the core pathogenesis throughout the entire disease course. TCM therapies, including oral herbal medicine, external fumigation, washing/soaking and wet compresses, moxibustion, massage, and rehabilitation exercises, can systematically improve the uremic hypercoagulable state, protect vascular endothelium, and maintain local microcirculatory homeostasis. Currently, integrated Chinese-Western medicine has evolved from simple superposition to a “stage-stratified, complementary advantages” model, i.e., Western medicine-dominated rapid recanalization in the acute phase, synergistic Chinese-Western intervention against restenosis in the recovery phase, and TCM-dominated long-term maintenance in the stable phase. This article systematically reviews the pathogenesis, therapeutic advances, and stratified management strategies for AVF thrombosis in end-stage renal disease (ESRD) patients, aiming to provide evidence-based references for standardized clinical prevention and treatment.*

Keywords: Hemodialysis, Arteriovenous Fistula, Thrombosis, Integrated Traditional Chinese and Western Medicine, Research Progress.

1. Pathogenesis: Perspectives from Western and Traditional Chinese Medicine

1.1 Pathological Mechanisms in Western Medicine

AVF thrombosis is the final outcome of the combined effects of Virchow's triad — vascular endothelial injury, hemodynamic abnormalities, and hypercoagulability.

Vascular endothelial injury serves as the initiating event. Repeated venipuncture causes direct mechanical damage; excessive ultrafiltration during dialysis induces transient hypotension and vascular collapse; vascular medial calcification in diabetic nephropathy patients and the microinflammatory environment induced by uremic toxins promote vascular smooth muscle cell proliferation and intimal hyperplasia through activation of inflammatory signaling pathways (e.g., NF- κ B). Clinical studies have demonstrated that high-flux hemodialysis combined with L-carnitine can significantly reduce the incidence of AVF complications while improving microinflammatory markers including high-sensitivity C-reactive protein (hs-CRP) and tumor necrosis factor- α (TNF- α), further supporting the role of microinflammation in AVF thrombosis pathogenesis [8]. Luminal stenosis generates turbulent and vortical flow, providing favorable conditions for platelet adhesion and aggregation [1,4].

Local blood flow stasis acts as a precipitating factor. Excessive single-session ultrafiltration volume (exceeding 5% of dry weight), cardiac dysfunction (particularly with reduced

ejection fraction), or decreased peripheral vascular compliance can all lead to significantly reduced AVF blood flow and diminished shear stress, forming a “slow flow–procoagulant” positive feedback loop at already stenotic segments [4].

Systemic hypercoagulability constitutes the predisposing background. Accumulated uremic toxins (such as indoxyl sulfate and p-cresyl sulfate) in ESRD patients persistently disrupt the coagulation-fibrinolysis balance by damaging the protein C system, elevating fibrinogen levels, and activating platelets. Furthermore, renal anemia, secondary hyperparathyroidism, and clinical use of erythropoietin (EPO) all increase blood viscosity and promote thrombotic tendency from various aspects [1]. Epidemiological data indicate that the annual incidence of AVF thrombosis in MHD patients ranges from 30% to 50%, with diabetes, recurrent intradialytic hypotension, and high hemoglobin levels confirmed as independent risk factors [4].

1.2 Etiology and Pathogenesis in Traditional Chinese Medicine

Based on clinical manifestations including limb swelling, local pain, cord-like hardness of the vessel, and abnormal skin temperature, AVF thrombosis can be classified within the TCM categories of “Mai Bi” (vessel impediment) and “Xue Bi” (blood impediment). Its core pathogenesis is characterized as root deficiency and branch excess, with qi deficiency and blood stasis as the fundamental pathology [2,3].

Root deficiency primarily involves spleen-kidney qi deficiency and dual deficiency of qi and yin. As chronic kidney disease persists, the qi of the spleen and kidney becomes progressively depleted, leading to insufficiency in the source of qi and blood production and weakened propulsive force. According to the TCM doctrine that “qi is the commander of blood” — when qi is deficient, blood moves sluggishly and stagnates to form stasis.

Branch excess mainly manifests as blood stasis obstructing the collaterals, often combined with cold congelation, phlegm turbidity, and damp-heat. External cold invasion causes vessel constriction (cold dominates contraction), leading to blood coagulation; phlegm turbidity attaches to the vessel wall, narrowing the lumen; damp-heat scorches and damages the vessels, forcing blood to extravasate and transform into stasis.

Core pathogenesis: Qi deficiency and blood stasis run through the entire process of AVF thrombosis formation, progression, and recurrence. This understanding is highly consistent with the pathological chain of “ESRD microinflammation – endothelial dysfunction – hypercoagulability” in modern medicine, providing a theoretical interface for integrated Chinese-Western intervention [2,4]. From the perspective of TCM holistic theory, vascular access dysfunction corresponds to the “blockage” of meridians and collaterals due to qi deficiency, blood stasis, and phlegm turbidity, which aligns with the Western pathophysiological mechanisms of vascular remodeling and neointimal hyperplasia, further reinforcing the theoretical basis for integrated therapeutic approaches [9].

2. Current Status and Limitations of Western Medical Treatment

2.1 Acute-Phase Pharmacological Thrombolysis and Anticoagulation

The first 6 hours after symptom onset constitute the golden window for pharmacological thrombolysis. Ultrasound - guided local targeted infusion of urokinase (100,000–250,000 U) or recombinant tissue plasminogen activator (rt-PA) can achieve a single-session recanalization rate of 65%–72% for fresh, non-organized thrombi, with a significantly lower systemic bleeding risk compared to intravenous systemic administration [7]. Sequential anticoagulation is required after successful thrombolysis, commonly with subcutaneous low-molecular-weight heparin; high-risk patients may receive combined aspirin or clopidogrel. However, for organized thrombi present for more than 7 days, the recanalization rate with pharmacological thrombolysis is less than 35%, and long-term anticoagulation therapy is often accompanied by adverse events such as puncture site oozing and gastrointestinal bleeding [4,7].

2.2 Minimally Invasive Endovascular Intervention

With the widespread availability of ultrasound and digital subtraction angiography (DSA), percutaneous endovascular intervention has become the first-line treatment for AVF thrombosis.

Mechanical thrombectomy combined with balloon angioplasty: After removing the intraluminal thrombus using

aspiration catheters or rotational devices, high-pressure balloon dilation is applied to residual stenotic lesions, achieving an immediate blood flow restoration success rate exceeding 90%, while maximizing preservation of the patient’s native vascular resources [4].

Drug-coated balloon (DCB): For stenosis-induced thrombosis where neointimal hyperplasia is the underlying mechanism, DCBs carrying antiproliferative agents (paclitaxel or sirolimus) can effectively inhibit neointimal hyperplasia, reducing the 6-month restenosis rate from 45% with conventional balloon angioplasty to approximately 18%, and significantly lowering long-term thrombosis recurrence [4]. Clinical evidence from non-randomized studies in patients with recurrent AVF dysfunction has demonstrated that following paclitaxel DCB angioplasty, 70% of patients achieve good thrill at 6 months, with 75% showing favorable bruit and adequate dialysis adequacy, confirming the safety and efficacy of DCB in reducing recurrent stenosis [10]. However, from a health economic perspective, Markov model-based analyses suggest that while DCB provides superior clinical outcomes, plain old balloon angioplasty (POBA) may be more cost-effective from the payer perspective in base-case models; sensitivity analyses indicate that DCB may achieve cost-effectiveness if the post-procedural mortality rate at 24 months increases by no more than 3.4% with DCB compared to POBA, highlighting the need for individualized device selection based on patient prognosis [11].

Hybrid technique: For long-segment organized thrombi, endovascular intervention alone is insufficient for complete clearance, necessitating combination with mini-incision open thrombectomy.

2.3 Open Surgical Procedures

Open thrombectomy combined with stenotic segment vascular reconstruction is currently reserved as a salvage treatment for failed endovascular recanalization or complete long-segment occlusion. Although it allows direct removal of the thrombus, it carries significant surgical trauma, pronounced postoperative limb edema, and the procedure itself may exacerbate neointimal hyperplasia due to vessel wall irritation, resulting in a relatively high early rethrombosis rate. Therefore, its application is becoming increasingly limited [4].

3. Advances in Traditional Chinese Medicine Treatment

3.1 Syndrome-Based Oral Herbal Medicine

Based on the therapeutic principles of “supplementing qi and activating blood, warming the meridians and unblocking collaterals, and resolving phlegm to eliminate stasis,” clinical practice commonly employs classic formulas such as Buyang Huanwu Decoction, Taohong Siwu Decoction (Four-Substance Decoction with Safflower and Peach Kernel), and Danggui Sini Decoction with modifications [2,3].

Qi deficiency and blood stasis pattern (most common): Heavy use of *Astragalus membranaceus* and *Codonopsis*

pilosula to supplement qi and promote blood movement, combined with *Salvia miltiorrhiza*, *Ligusticum chuanxiong*, *Carthamus tinctorius*, *Angelica sinensis*, and *Spatholobus suberectus* for blood activation and collateral unblocking. Modern pharmacological studies have shown that astragaloside IV can reduce endothelial injury, while ligustrazine can dilate peripheral microvessels and reduce whole blood viscosity and fibrinogen levels.

Cold congelation and blood stasis pattern: Add *Cinnamomum cassia* twig, *Artemisia argyi* leaf, and *Asarum sieboldii* to warm the meridians and disperse cold.

Phlegm-stasis intermingled pattern: Add *Atractylodes macrocephala*, *Poria cocos*, *Trichosanthes kirilowii* peel, and *Arisaema erubescens* processed with ginger and alum to strengthen the spleen, resolve phlegm, and soften hard masses.

A network pharmacology-based study confirmed that Taohong Siwu Decoction can protect AVF function through multi-target regulation of inflammatory responses, extracellular matrix remodeling, and shear stress-related signaling pathways [1]. Continuous syndrome-based oral administration for 3–6 months can improve patients' blood hyperviscosity status and reduce thrombus incidence [3].

3.2 External Herbal Therapy

External herbal therapy achieves transdermal absorption, avoiding hepatic first-pass metabolism, and is particularly suitable for dialysis patients with severely impaired liver and kidney function. Common methods include herbal fumigation, washing/soaking, wet compresses, and herbal plaster application [2,3].

Evidence-based data: Wei et al. [2] published a meta-analysis (including 26 randomized controlled trials with a total of 2,039 MHD patients) showing that adding blood-activating and stasis-resolving topical Chinese herbs to conventional treatment significantly reduced the incidence of fistula occlusion (RR=0.15, 95% CI: 0.07–0.32) and vascular stenosis (RR=0.32, 95% CI: 0.18–0.57), while also effectively treating subcutaneous hematoma and improving vascular elasticity. This constitutes the highest level of evidence available in this field to date.

3.3 Moxibustion, Acupoint Massage and Rehabilitation Training

Moxibustion: Acupoints including Quchi (LI11), Shousanli (LI10), Hegu (LI4), and Neiguan (PC6) are selected for mild or thunder-fire moxibustion. The warming effect of moxa fire unblocks meridians and improves local microcirculation of the upper limb [3]. The mechanism is thought to involve heat-induced vasodilation and regulation of local inflammatory mediators, which collectively counteract the cold congelation and blood stasis pathological state that predisposes to thrombosis [9].

Acupoint massage: Regular, gentle massage of the fistula-side limb from the distal end toward the anastomosis on non-dialysis days can promote venous return. The

four-step massage method reported by Lu Hua et al. provides a reference for specific clinical manipulation techniques. Comprehensive nursing strategies incorporating TCM techniques—including massage, moxibustion, and herbal compresses—have been systematically reviewed for their role in preventing AVF thrombosis, with proposed mechanisms involving improved local blood flow, reduced blood viscosity, and protection of vascular endothelial function [9].

Rehabilitation training: Grip strength ball exercises and upper limb elevation practice enhance blood flow shear stress through the muscle pump effect, counteracting blood stasis.

Clinical evidence: Lin et al. [3] published a randomized controlled trial (enrolling 120 MHD patients) showing that adding herbal fumigation and moxibustion to routine nursing care significantly reduced the incidence of fistula complications (11.1% vs. 36.7%) and prolonged AVF service life. Hou et al. [5] similarly confirmed that herbal fumigation combined with moxibustion reduces early AVF failure.

4. Stratified Integrated Chinese-Western Medicine Prevention and Treatment Strategy

Based on the dynamic evolution pattern of AVF thrombosis, a three-tier stratified integrated diagnostic and treatment model characterized by “Western medicine-dominated management in the acute phase, integrated Chinese-Western synergy in the recovery phase, and TCM consolidation in the stable phase” has now been established in clinical practice, embodying the core concept of “stage-based treatment with complementary advantages” [4]. This stratified approach is supported by the theoretical alignment between TCM collateral theory—which conceptualizes vascular access dysfunction as “meridian and collateral blockage” due to qi deficiency, blood stasis, and phlegm turbidity—and the Western pathophysiological framework of vascular remodeling and neointimal hyperplasia, providing a robust theoretical foundation for stage-specific integrated interventions [9].

4.1 Acute Phase (within 72 hours of thrombosis): Western Medicine-Dominated Rapid Recanalization with TCM Adjuvant Support

Core objective: To re-establish effective blood flow as rapidly as possible, reduce thrombolytic drug dosage, and minimize bleeding risk.

Intervention protocol:

- **Western medicine dominance:** Ultrasound-guided local thrombolysis or mechanical thrombectomy combined with balloon angioplasty, followed by sequential short-term standardized anticoagulation.
- **TCM adjuvant support:** Topical herbal wet compress (e.g., Ruyi Jinhuang San, a topical Chinese herbal compound for reducing swelling and dissipating nodules) to reduce swelling, dissipate nodules, and relieve vascular spasm; gentle massage to assist thrombus fragmentation and increase drug contact area.

Precautions: Massage manipulation must be performed with strict indication control; for fresh thrombi, the technique should be gentle to avoid forceful squeezing that could cause thrombus dislodgement and subsequent pulmonary embolism.

4.2 Recovery Phase (1–3 months post-recanalization): Integrated Chinese-Western Synergy to Inhibit Restenosis

Core objective: To inhibit neointimal hyperplasia and prevent early restenosis and thrombosis recurrence.

Intervention protocol:

- **Western medicine measures:** Individualized antiplatelet regimens (aspirin, clopidogrel, or cilostazol) based on thrombotic risk stratification; repeat DCB application for residual severe stenosis—while DCB has demonstrated superior efficacy in reducing restenosis, clinical decision-making should also consider individual patient prognosis and economic factors, as cost-effectiveness analyses have shown that the incremental benefit of DCB may not be justified across all patient populations [11]; strict control of blood pressure, blood glucose, blood lipids, and single-session ultrafiltration volume (not exceeding 5% of dry weight).
- **TCM measures:** Syndrome-based oral qi-supplementing and blood-activating formulas (e.g., Taohong Siwu Decoction); herbal fumigation 2–3 times per week; moxibustion therapy.

Synergistic advantages: Western medicine physically relieves local stenosis and implements targeted antithrombotic therapy, while TCM systemically corrects the qi deficiency and blood stasis constitution in the ESRD context and inhibits inflammation-mediated intimal hyperplasia. Together, they form a complementary pattern of “local + systemic” and “symptomatic + etiological” treatment. Han et al. [4] pointed out that integrated Chinese-Western intervention can compensate for the inability of Western medicine to reverse persistent hypercoagulability, leading to improvement in the 6-month primary patency rate. A randomized double-blind placebo-controlled trial published in 2023 further confirmed that topical application of Taohong Siwu Decoction significantly improves the 90-day maturation rate and long-term survival rate of AVF [6].

4.3 Stable Phase (beyond 3 months post-procedure): TCM-Dominated Long-Term Maintenance with Western Medicine Periodic Monitoring

Core objective: To reduce long-term thrombosis recurrence in high-risk populations and maximize AVF service life.

Target population: Patients with diabetic nephropathy, recurrent intradialytic hypotension, or a history of multiple AVF stenoses/thromboses.

Intervention protocol:

- **Western medicine:** Low-dose antiplatelet agents for long-term maintenance; AVF color Doppler ultrasound

follow-up every 3–6 months to assess blood flow and detect stenosis.

- **TCM:** Intermittent home-based herbal soaking (2–3 times per week); acupoint self-massage and grip strength ball rehabilitation training; intermittent oral administration of blood-activating and stasis-resolving Chinese patent medicines. Comprehensive nursing protocols integrating these TCM modalities have been shown to reduce blood viscosity, improve local microcirculation, and protect endothelial function through multi-target mechanisms [9].

Expected benefits: Long-term integrated management can significantly reduce the annual thrombosis recurrence rate in high-risk populations and effectively delay AVF failure.

5. Conclusion and Future Perspectives

Prevention and treatment of AVF thrombosis requires a transition from “acute recanalization” to “comprehensive long-term management.” Modern medicine possesses irreplaceable advantages in rapid acute-phase recanalization, but lacks persistently effective interventions for the long-standing “qi deficiency and blood stasis” pathological basis in ESRD patients, which is the root cause of recurrent thrombosis [1,4]. TCM, through diversified approaches including syndrome-based oral medication, external fumigation, moxibustion, and massage, systematically regulates systemic hypercoagulability, protects vascular endothelial function, and inhibits neointimal hyperplasia, demonstrating unique value in relapse prevention [2,3,5]. The theoretical integration of TCM collateral theory with Western vascular pathophysiology further supports a holistic understanding of AVF dysfunction and reinforces the rationale for combined therapeutic strategies [9].

The integrated Chinese-Western diagnostic and treatment model based on the concept of “stage stratification with complementary advantages” — namely, “Western medicine for rapid recanalization in the acute phase, integrated Chinese-Western synergy against stenosis in the recovery phase, and TCM for long-term consolidation in the stable phase” — has gradually become the mainstream strategy for AVF thrombosis prevention and treatment in MHD patients, showing superior clinical efficacy compared with monotherapy [4].

Future research should focus on the following directions:

- 1) Conducting multicenter, large-sample, randomized controlled trials to provide higher-level evidence-based medical support for integrated Chinese-Western regimens;
- 2) Utilizing network pharmacology and metabolomics technologies to elucidate the molecular mechanisms of “multi-component, multi-target, multi-pathway” actions of TCM formulas in preventing and treating AVF thrombosis;
- 3) Establishing standardized TCM external treatment protocols (temperature, duration, frequency, massage intensity, etc.) to facilitate clinical promotion and efficacy comparison;

4) Conducting health economic evaluations to assess the cost-effectiveness of integrated Chinese-Western regimens — given that economic analyses of DCB versus conventional angioplasty have demonstrated that cost-effectiveness is highly dependent on patient selection and long-term outcomes, underscoring the need for stratified economic modeling in integrated treatment strategies [11]—to provide evidence for clinical decision-making and healthcare policy formulation.

It is anticipated that with the continuous accumulation of high-quality evidence-based data and the gradual establishment of standardized protocols, integrated Chinese-Western strategies for preventing and treating AVF thrombosis will become more mature, thereby more effectively prolonging the survival of autogenous AVFs, reducing central venous catheter dependence, and providing robust support for improving the long-term quality of life of ESRD patients.

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