# Protective Effects of HITH-4 Far-Infrared Therapy Combined with Heparinoid on Arteriovenous Fistula Function in Diabetic Dialysis Patients: A Postprint

**Authors:** Hu Chunyan, Yajing Li, Geng Tonghui, Zhang Dongxue, Zhang Dongxue

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## Abstract

Background Functional maintenance of arteriovenous fistula is crucial for diabetic hemodialysis patients. Infrared irradiation can significantly improve the poor condition of arteriovenous fistula function in diabetic hemodialysis patients; however, there are few reports on the effectiveness evaluation of the protective effect of HITH-4 far-infrared therapeutic apparatus combined with Hirudoid on fistula function in diabetic hemodialysis patients.

Objective To investigate the protective effect of HITH-4 far-infrared therapeutic apparatus combined with Hirudoid cream on fistula function in diabetic hemodialysis patients.

Methods Sixty diabetic hemodialysis patients using autologous arteriovenous fistula were selected. The patients were randomly divided into two groups (n=30 each): the control group received topical application of Hirudoid cream; the intervention group received irradiation of the fistula-side limb with HITH-4 far-infrared therapeutic apparatus combined with topical application of Hirudoid cream. After six months of intervention, needle puncture wound healing time, blood scab disappearance time, dialysis blood flow, arterial pressure, brachial artery blood flow, and arteriovenous fistula vascular complications were compared between the two groups.

Results There was no statistically significant difference in general conditions between the two groups ($P>0.05$). The needle puncture wound healing time and blood scab disappearance time in the intervention group were significantly shorter than those in the control group, and the dialysis blood flow, arterial pressure, and brachial artery blood flow after treatment were significantly higher than those in the control group ($P<0.05$). The incidence rates of skin hematoma,

local bleeding, and fistula thrombosis in the intervention group were lower than those in the control group (P<0.05).

Conclusion HITH-4 far-infrared therapeutic apparatus combined with Hirudoid for arteriovenous fistula maintenance can reduce the risk of vascular stenosis and the incidence of vascular complications, effectively maintaining arteriovenous fistula function in diabetic hemodialysis patients.

## Full Text

# Protective Effect of HITH-4 Far Infrared Therapy Combined with Hirudoid on Arteriovenous Fistula Function in Diabetic Dialysis Patients

**HU Chunyan, LI Yajing, GENG Tonghui, ZHANG Dongxue**
Department of Nephrology, The Fourth Hospital of Hebei Medical University, Shijiazhuang 050011, China
*Corresponding author: ZHANG Dongxue, Nurse-in-charge; E-mail: 125657481@qq.com*

### Abstract

**Background:** The maintenance of autogenous arteriovenous fistula (AVF) is crucial for diabetic hemodialysis patients. While far infrared therapy (FIR) can significantly improve AVF dysfunction in this population, few studies have reported on the protective effectiveness of combining FIR using a HITH-4 type apparatus with topical Hirudoid application for AVF in diabetic patients.

**Objective:** To investigate the protective effect of HITH-4 far infrared therapy combined with Hirudoid cream on AVF function in diabetic hemodialysis patients.

**Methods:** Sixty diabetic patients undergoing maintenance hemodialysis via AVF were selected and randomly divided into two groups of 30 patients each. The control group received topical Hirudoid cream alone, while the intervention group received both HITH-4 far infrared irradiation of the fistula limb and topical Hirudoid cream. After a six-month intervention, we compared puncture site healing time, scab disappearance time, dialysis blood flow, arterial pressure, brachial artery blood flow, and AVF complications between the groups.

**Results:** The two groups showed no significant differences in baseline demographics (P>0.05). The intervention group demonstrated significantly shorter puncture site healing time and scab disappearance time compared with the control group (P<0.05). Dialysis blood flow, arterial pressure, and brachial artery blood flow were all significantly higher in the intervention group (P<0.05). The incidence of complications—including cutaneous hematoma, local hemorrhage, and fistula thrombosis—was significantly lower in the intervention group (P<0.05).

**Conclusion:** The combination of HITH-4 far infrared therapy and Hirudoid effectively protects and maintains AVF function while reducing the risk of vascular stenosis and related complications in diabetic hemodialysis patients.

**Keywords:** HITH-4 far infrared; Hirudoid; Diabetes mellitus; Arteriovenous fistula; Brachial artery blood flow

## Introduction

The prevalence of diabetes mellitus continues to rise globally, with projections estimating that 642 million people (10.4% of the population) will be affected by 2040 [1]. Diabetic patients with uremia require renal replacement therapy, and autogenous arteriovenous fistula (AVF) serves as the preferred vascular access for maintenance hemodialysis, often referred to as the "lifeline" for these patients [2]. The quality of vascular access directly impacts both survival and quality of life in hemodialysis patients. However, hemodialysis patients frequently present with comorbidities such as hypertension and coronary artery disease [3], which can lead to complications throughout AVF maturation and use, resulting in AVF dysfunction that severely compromises dialysis efficacy and patient safety. Therefore, maintaining optimal vascular access function is essential for improving patient outcomes.

Both far infrared therapy and topical Hirudoid application can promote local blood circulation and facilitate AVF maturation [4-5]. Previous studies have demonstrated that infrared irradiation significantly improves AVF dysfunction in diabetic hemodialysis patients, thereby enhancing dialysis quality [6]. However, limited literature exists evaluating the combined use of HITH-4 far infrared therapy and Hirudoid for protecting AVF function in this population. This study investigated the protective effects of this combination therapy on AVF function in diabetic hemodialysis patients.

## Methods

**1.1 Patient Selection and Inclusion/Exclusion Criteria** We enrolled diabetic patients undergoing maintenance hemodialysis via autogenous AVF in the Department of Nephrology at the Fourth Hospital of Hebei Medical University between January 1, 2020, and June 1, 2020. All participants received comprehensive information about the purpose and methodology of Hirudoid and far infrared therapy, including treatment parameters, potential adverse effects, and costs, before providing informed consent. A total of 60 eligible patients were ultimately recruited, comprising 36 males and 24 females with a mean age of $(59.9\$\pm14.6) years and mean dialysis duration of (5.6\pm\$2.7)$ years.

**Inclusion criteria:** (1) Diabetic hemodialysis patients using autogenous AVF; (2) Glomerular filtration rate <15 ml/min; (3) Age 18-75 years; (4) Undergoing maintenance hemodialysis for >3 months with regular thrice-weekly sessions at

our institution; (5) Provided informed consent and demonstrated good compliance.

**Exclusion criteria:** (1) Severe cardiopulmonary disease or other organ complications; (2) Life expectancy <1 year; (3) Consciousness disorders or inability to cooperate.

This study was approved by the Ethics Committee of the Fourth Hospital of Hebei Medical University (approval number: 2020KY189), and all participants signed informed consent forms.

**1.2 Intervention Protocol** To minimize bias and ensure validity, this randomized controlled trial strictly adhered to inclusion/exclusion criteria and implemented blinding of data collection personnel. Patients were randomly allocated into two groups of 30 using a random number table. All participants received maintenance hemodialysis with FX80 dialyzers and 17G needles thrice weekly for 4 hours per session.

**Routine care for both groups** included admission education to enhance AVF awareness and cooperation, standard post-dialysis dressing, and patient counseling to wear loose clothing, avoid lifting heavy objects or blood draws with the fistula arm, and refrain from scratching scabs or excessively stimulating puncture sites.

**Control group:** Received topical Hirudoid cream applied to the AVF and surrounding skin 24 hours after each dialysis session, with gentle massage for 15-20 minutes until fully absorbed.

**Intervention group:** Received combined therapy comprising HITH-4 far infrared irradiation and Hirudoid application. Far infrared therapy was administered approximately 0.5 hours after dialysis initiation using a HITH-4 apparatus (Anhui Aerospace Biotechnology Co., Ltd.) positioned 25-30 cm from the limb at <40°C to ensure comfortable warmth without burning, for 40 minutes per session [7]. Hirudoid cream was applied as in the control group 24 hours post-dialysis. The intervention period lasted six months.

**1.3 Outcome Measures** After six months, we compared: (1) Puncture site healing time; (2) Scab disappearance time; (3) Dialysis blood flow; (4) Arterial pressure; (5) Brachial artery blood flow; and (6) AVF complications. Dialysis blood flow $ $200 ml/min was considered adequate, and arterial pressure >-180 mmHg was deemed acceptable. Vascular access complications including hematoma, local hemorrhage, and fistula thrombosis were recorded. Previous research indicates brachial artery blood flow helps identify AVF dysfunction [8]; according to Chinese vascular access consensus guidelines [9], brachial artery flow was categorized as normal (500-1,500 ml/min), low (<500 ml/min), or high (>1,500 ml/min).

**1.4 Statistical Analysis** Data were analyzed using SPSS 19.0 software. Normally distributed continuous variables are expressed as mean±standard deviation and compared between groups using t-tests. Categorical data are presented as counts or percentages and analyzed using $^2$ tests. Statistical significance was set at $P<0.05$.

## Results

**2.1 Baseline Characteristics** The two groups showed no significant differences in age, sex, mean dialysis duration, or body mass index ($P>0.05$), confirming comparability .

**2.2 Puncture Site Healing and Scab Disappearance Time** The intervention group exhibited significantly shorter puncture site healing time and scab disappearance time compared with the control group ($P<0.05$) .

**2.3 Dialysis Blood Flow and Arterial Pressure** Post-treatment dialysis blood flow and arterial pressure were significantly higher in the intervention group than in the control group ($P<0.05$) .

**2.4 Brachial Artery Blood Flow** Brachial artery blood flow was significantly higher in the intervention group compared with the control group ($P<0.05$) .

**2.5 AVF Complications** The incidence of cutaneous hematoma, local hemorrhage, and fistula thrombosis was significantly lower in the intervention group ( $^2=4.81$, $P<0.05$) .

## Discussion

AVF represents the "lifeline" for maintenance hemodialysis patients, directly affecting dialysis quality and quality of life. Repeated punctures can cause vascular endothelial injury and inflammatory responses, leading to calcification, thrombosis, and stenosis that reduce AVF blood flow and compromise dialysis efficacy [10-11]. Diabetic hemodialysis patients are particularly vulnerable due to poor vascular elasticity and increased risk of sclerosis, stenosis, and infection [12], making it crucial to identify effective nursing interventions to improve AVF function. Conventional nursing methods are often inadequate for optimizing outcomes in all patients.

Hirudoid cream, which contains mucopolysaccharide polysulfate, is widely used clinically to promote blood circulation and protect vascular endothelium [4-5]. Non-invasive and convenient far infrared therapy represents a novel physical treatment that effectively improves fistula blood flow and treatment efficiency. However, limited data exist on the combined use of HITH-4 far infrared therapy

and Hirudoid in diabetic hemodialysis patients. Our results demonstrate that this combination is superior to Hirudoid alone.

The combined therapy significantly reduced puncture site healing time and scab disappearance time while increasing dialysis blood flow, arterial pressure, and brachial artery blood flow, accompanied by lower complication rates—collectively indicating improved vascular function. Hirudoid' s active ingredient, mucopolysaccharide polysulfate, is rapidly absorbed through the skin and acts on the fibrinolytic and coagulation systems to inhibit hyaluronidase and protease activity, exerting anti-inflammatory effects, promoting local circulation and tissue regeneration, and preventing scar formation while maintaining vascular elasticity and accelerating healing [13]. These mechanisms align with our observed reductions in healing times.

Far infrared therapy, an electromagnetic wave, enhances fistula blood flow through both thermal and non-thermal effects while promoting puncture site healing, improving circulation, and reducing bruising and swelling [14]. The thermal effect occurs when far infrared irradiation causes irregular particle motion, generating localized heat that increases blood flow [15], dilates AVF diameter, and maintains fistula function—consistent with our findings of increased blood flow and arterial pressure. Notably, diabetic patients often develop peripheral neuropathy with impaired temperature sensation [16], necessitating careful control of irradiation time and temperature to prevent burns.

The non-thermal effects include promoting nitric oxide synthase expression, increasing nitric oxide production in vascular endothelial cells, which plays a key role in maintaining endothelial integrity and reducing vascular tone [17]. Far infrared also induces heme oxygenase-1 (HO-1) expression, promoting hemoglobin metabolism into biliverdin and bilirubin—potent antioxidants that reduce oxidative stress-induced vascular injury [18]. Additionally, HO-1 inhibits tumor necrosis factor-$\alpha$ (TNF-$\alpha$)-mediated inflammation and vascular proliferation [19], explaining the improved brachial artery blood flow observed in our intervention group.

Furthermore, the significantly lower rates of cutaneous hematoma, local hemorrhage, and fistula thrombosis in the intervention group demonstrate that combined HITH-4 far infrared and Hirudoid therapy effectively maintains AVF function while reducing treatment costs, offering a cost-effective approach.

## Conclusion

Combined HITH-4 far infrared therapy and Hirudoid application for AVF care in diabetic hemodialysis patients effectively dilates blood vessels, promotes local circulation and tissue regeneration, and inhibits scar formation, thereby reducing the risk of vascular stenosis and complications. However, careful control of irradiation temperature and duration is essential to prevent burns. Despite strict adherence to inclusion criteria and efforts to minimize bias, this study is limited by its small sample size and short follow-up period. Future research

should expand the sample size and extend follow-up to systematically evaluate long-term AVF outcomes. Nevertheless, our findings provide evidence supporting the combined use of HITH-4 far infrared therapy and Hirudoid for protecting AVF function in diabetic hemodialysis patients.

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## Author Contributions

HU Chunyan: Conceptualization, methodology, data analysis, interpretation, manuscript drafting and revision. LI Yajing: Conceptualization, methodology, statistical analysis, data interpretation, manuscript drafting and revision. GENG Tonghui: Data collection and manuscript revision. ZHANG Dongxue: Conceptualization, methodology, quality control, manuscript review, and supervision.

## Conflict of Interest

The authors declare no conflict of interest.

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*Note: Figure translations are in progress. See original paper for figures.*