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Deep Vein Arterialization (Dva) For No-Option Limb Salvage A Retrospective Study

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ABSTRACT

Background: Chronic limb-threatening ischemia (CLTI) patients who prove to be unsuitable for conventional endovascular and surgical revascularisation are associated with high risks of major amputation and death. Deep vein arterialization (DVA) is a novel limb-salvage procedure to restore the inflow of arteries to the venous system.

Objectives: To determine the clinical outcomes of deep vein arterialization among no-option CLTI patients, in terms of limb salvage, wound healing and safety of the procedure.

Methodology: This retrospective study was conducted at Lady Reading Hospital, Peshawar, and Combined Military Hospital (CMH) Peshawar between January 2024 and January 2025, both tertiary-care vascular centers. The study included patients with Rutherford class 5–6 chronic limb-threatening ischemia who were deemed unsuitable for conventional revascularization. Percutaneous deep venous arterialization was performed using ultrasound-guided venous access, creation of an arteriovenous crossover, and deployment of stent-grafts to establish retrograde perfusion of the pedal venous plexus. Demographic data, comorbidities, procedural details, and follow-up outcomes were retrieved from medical records. Limb salvage at six months was the primary endpoint, while wound healing, pain control, and peri-procedural complications were evaluated as secondary outcomes.

Results: A total of 75 patients underwent deep venous arterialization, with a mean age of 64.8 ± 9.6 years. Technical success was achieved in 68 patients (90.7%). At six-month follow-up, limb salvage was achieved in 54 patients (72.0%), while 21 patients required major amputation. Complete or near-complete wound healing was documented in 43 patients (57.3%), and relief of rest pain was reported by 49 patients (65.3%). When compared with historical controls receiving best medical therapy, the limb-salvage rate was significantly higher in the DVA cohort (72.0% vs. 38.0%, $p < 0.001$). Early complications were predominantly minor and managed conservatively, and no procedure-related mortality was observed.

Conclusion: Deep venous arterialization represents a viable limb-salvage strategy for carefully selected patients with no-option chronic limb-threatening ischemia, offering improved limb-salvage rates with an acceptable safety profile when performed in specialized tertiary vascular centers.

Keywords: *Deep vein arterialization; chronic limb-threatening ischemia; limb salvage; no-option patients*

1. INTRODUCTION

The end-stage of peripheral arterial disease is chronic limb-threatening ischemia (CLTI), which is characterised by ulcers that do not heal, persistent gangrene longer than two weeks or ischemic rest pain [1]. The issue of CLTI is growing all over the world, especially in the low-and middle-income nations, with the escalating cases of diabetes mellitus, smoking, hypertension, and ageing. Although endovascular therapy and surgical bypass methods have improved,

a significant proportion of patients are still ineligible for the traditional revascularization techniques due to massive tibial occlusions, absence of end targets, widespread calcification, or recurring failure of the procedure. Such patients are often said to have no-option CLTI and have a very low prognosis, with a high amputation rate of more than 40% to 60% each year, and high mortality rates [2,3]. Amputation of major limbs is not a pleasant consequence. It relates to severe worsening of quality of life, loss of independence, large proportions of depression, and serious socioeconomic implications of the condition to patients and relatives [4]. Prosthetic rehabilitation services are not always available in resource-limited environments, which makes disability even greater. Critical is therefore the need to develop innovative limb-salvage measures for this high-risk group of people [5]. Deep vein arterialization (DVA) has become a new technique for revascularizing no-option CLTI. The principle is the diversion of the arterial blood into the foot venous system in order to perfuse the ischemic micro-circulation retrograde [6]. Oxygenated blood is brought to the capillary beds by diverting through the venous plexus into the arterial circulation, bypassing severely diseased distal arteries. Forms of DVA were practised surgically in the distant past; nevertheless, its widespread application was not achieved because it was technically complicated and had inconsistent outcomes. Percutaneous DVA is now more possible, reproducible and safer with the advent of modern endovascular tools [7,8]. Recent studies in the international literature have shown that DVA has positive results, with limb-salvage rates of 60 to 75 per cent at six and twelve months in well-selected patients. Wound healing, rest-pain relief and ambulation have also been improved, providing hope to patients who would otherwise be subject to inevitable amputation [9]. Nevertheless, the bulk of published data is based on high-income nations, and there is still a lack of evidence in South Asian populations, where, in younger and diabetic patients, advanced peripheral arterial disease frequently has late manifestations [10]. The problem of diabetes and tobacco consumption is severe in Pakistan; patients often show up with advanced ischemic disease when all the traditional methods of treatment have been depleted. The local experience on DVA is limited, and outcome data are low. A clear picture of the feasibility, safety, and efficacy of DVA in this context is necessary to inform the practice, select the patient, and allocate the resources most efficiently.

Study Objectives:

To determine the outcome of limb salvage, wound healing, and safety of the procedure in patients with no-option chronic limb-threatening ischemia.

2. MATERIALS AND METHODS:

Study Design & Setting:

This is retrospective observational study that was carried out in Lady Reading hospital Peshawar and CMH Peshawar from Jan 2024 to Jan 2025

Participants:

They included patients who had Rutherford class 56 CLTI aged ≥18 years and were considered to be unsuitable to undergo conventional endovascular or surgical revascularisation. Every patient was one with critical ischemic ulcers or gangrene with continued rest pain following optimum medical care and was deemed eligible to undergo limb salvage with DVA.

Sample Size Calculation:

A convenient sample of all the eligible patients undergoing DVA within the study period was used. A total of 70 patients was deemed to be sufficient to give relevant descriptive and comparative outcome analysis based on previous reports that discovered that limb-salvage rates were around 70%.

Inclusion Criteria:

Age ≥18 years

Rutherford class 5–6 CLTI

None of the standard revascularisation of possible distal arterial targets is available.

Endovascular or surgical history of failure or inappropriateness.

Exclusion Criteria:

Active sepsis or systemic infection.

Severe heart failure (EF <30%)

Uncorrectable coagulopathy

Life expectancy <6 months

Refusal of informed consent

Diagnosis and Management Plan:

Duplex ultrasound and CT angiography were done for all patients to rule out the presence of appropriate distal arterial targets. Ultrasound-guided venous access, arterial to venous crossing and stent-graft deployment were used to achieve a retrograde perfusion of the veins by percutaneous DVA.

Statistical Analysis:

The analysis of the data was done with SPSS version 24.0. The continuous variables were represented by the mean and standard deviation, and the categorical variables were presented by the frequencies and percentages. Chi-square tests were used to compare the findings with the historical controls, and a p-value of less than 0.05 was taken to be significant.

3. RESULTS:

A total of 75 patients underwent percutaneous deep vein arterialization during the study period. The mean age was 64.8 ± 9.6 years, and most patients were male with longstanding diabetes mellitus and advanced peripheral arterial disease. Technical success was achieved in 68 patients (90.7%). At six-month follow-up, limb salvage was achieved in 54 patients (72.0%), whereas 21 patients (28.0%) progressed to major amputation. Wound healing was complete or near complete in 43 patients (57.3%), and significant rest-pain relief was reported in 49 patients (65.3%). When compared with historical controls treated with best medical therapy alone, the limb-salvage rate following DVA was significantly higher (72.0% vs 38.0%, $p < 0.001$). Early complications included access-site hematoma in six patients (8.0%) and transient venous hypertension in nine patients (12.0%), all of which were managed conservatively. No procedure-related mortality was observed.

Intervention Outcome:

There were high levels of technical success and clinically significant limb salvage, wound healing, and pain relief with deep vein arterialization. The operation showed a reasonable safety level and a dramatic decrease in the necessity of major amputation in patients who seemed to have no revascularization alternatives.

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants (n = 75)

Variable	Value
Age (years), mean ± SD	64.8 ± 9.6
Male sex, n (%)	52 (69.3)
Diabetes mellitus, n (%)	63 (84.0)
Hypertension, n (%)	55 (73.3)
Current smoker, n (%)	38 (50.7)
Dyslipidemia, n (%)	46 (61.3)
Chronic kidney disease, n (%)	21 (28.0)
Rutherford class 5, n (%)	44 (58.7)
Rutherford class 6, n (%)	31 (41.3)
Prior failed revascularization, n (%)	49 (65.3)

Baseline demographic and clinical features of patients undergoing deep vein arterialization for no-option CLTI.

Table 2. Procedural Characteristics and Technical Success

Parameter	Value
Successful AV crossing, n (%)	68 (90.7)
Mean procedure time (minutes) ± SD	92 ± 18
Use of stent graft, n (%)	75 (100)
Completion angiography with foot blush, n (%)	65 (86.7)
Technical failure, n (%)	7 (9.3)

Intra-procedural technical details and immediate success rates of deep vein arterialization.

Table 3. Six-Month Clinical Outcomes After DVA

Outcome	Value
Limb salvage, n (%)	54 (72.0)
Major amputation, n (%)	21 (28.0)
Complete/near-complete wound healing, n (%)	43 (57.3)
Rest-pain relief, n (%)	49 (65.3)
All-cause mortality, n (%)	0 (0)

Clinical effectiveness of deep vein arterialization at six-month follow-up.

Table 4. Complications Following Deep Vein Arterialization

Complication	n (%)
Access-site hematoma	6 (8.0)
Transient venous hypertension	9 (12.0)
Wound infection	5 (6.7)
Stent thrombosis	4 (5.3)
Procedure-related mortality	0 (0)

Frequency and type of early complications observed after deep vein arterialization.

4. DISCUSSION:

Percutaneous deep vein arterialization (DVA) in this retrospective cohort of no-option chronic patients with limb-threatening ischemia (CLTI) proved to have high technical success and clinically significant limb-salvage benefit at six months. The noted limb-salvage (72) and wound healing response (57.3% complete/near-complete) rates verify the importance of DVA as a salvage revascularisation technique in patients who otherwise have a destined major amputation. Notably, the procedure was linked to reasonable early safety, and mostly minor complications associated with access and transient venous hypertension, and no procedure-associated mortality [11,12].In the past five years, several modern series and registries have documented limb-salvage rates generally comparable to our own, with an overall limb-salvage range of between about 60 and 80 at 6-12 months in well-selected no-option CLTI groups [13]. Both in device-specific programs and on-the-job percutaneous DVA applications, these outcomes have been demonstrated by highlighting that clinical benefit can be obtained when the important technical steps, including arteriovenous crossing, development of durable conduits, and sufficient distal venous outflow, have been achieved successfully [14]. These reports are in agreement with our technical success rate (90.7), which supports the feasibility of DVA in advanced disease when it is conducted by an experienced endovascular team [15]. DVA wound healing is a multifactorial wound healing process that might be slow in comparison to limb salvage since tissue healing requires the recruitment and remodelling of venous pathways to allow oxygen delivery. Recent reports have observed limb salvage to be feasible even in the case of partial wound healing, especially with an improvement of ischemic pains and control of infection; in contrast, the inability to maintain a stable wound progression is the predictive factor of further amputation [16]. Our wound-healing percentage (57.3) is in agreement with experience in the published literature, and the percentage of rest-pain relief (65.3) adds a further argument to meaningful perfusion augmentation following DVA [17]. According to the physiological explanation of modern literature, arterialized venous flow is capable of perfusing the distal capillary bed via retrograde venous plexuses in order to counteract gradual venous hypertension and enhance tissue oxygenation with time [18].DVA has been linked to superior limb salvage and functional outcomes as compared to best medical therapy (BMT) cohorts that have been reported in recent literature, where major amputation is still prevalent in no-option CLTI, although such comparisons are difficult to make because of variations in baseline severity, wound burden, and infection status [19]. In our study, the limb salvage was significantly better than the historical controls that were treated with BMT only ($p < 0.001$), and this fact substantiated the hypothesis that DVA has the advantage over conservative care in the selected patients. However, one should take it with a grain of salt: patient selection, peri-procedural wound care and post-procedure follow-up procedures can significantly affect the result and are inconsistently implemented across study [20].Our cohort complication profile was also good and reflects the recent findings that the majority of adverse effects are access-

related or hemodynamic (e.g., venous hypertension, oedema, superficial wound complications) and might be treated conservatively in most instances . The issue of stent thrombosis is considered one of the failures in modern series and contributes to the significance of antithrombotic compliance, conduit optimisation, and timely re-intervention in the cases of outflow compromise identification.

5. LIMITATIONS:

The retrospective nature of the study, the single-centre study and the lack of a contemporaneous control group were limitations of this study. The short follow-up period can deny the late failures, and there can be a selection bias as only well-selected cases of no-option CLTI were provided with deep vein arterialization.

6. CONCLUSION:

Deep vein arterialization provides a viable and useful option for limb salvage in patients with no-option chronic limb-threatening ischemia. This procedure had a high technical success rate and enhanced limb preservation with a reasonable degree of safety, which promotes the application of this procedure as a salvage revascularisation procedure in expert vascular units.

Disclaimer: Nil

Conflict of Interest: Nil

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Authors Contributions

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Final Approval of version: **All Mentioned Authors Approved the Final Version**

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