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ORIGINAL RESEARCH

Outcome of balloon angioplasty in occlusion of small and medium sized arteries of the limbs

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ABSTRACT

Background: Peripheral arterial disease (PAD) is a progressive atherosclerotic condition characterized by narrowing or blockage of arteries that supply the limbs, leading to ischemia and functional impairment. These vessels are crucial for maintaining distal blood flow, and their obstruction can lead to critical limb ischemia (CLI), increasing the risk of ulceration, gangrene, and limb loss.[1]

Objective: To assess the outcomes of balloon angioplasty in patients with occlusive diseases of small and medium sized arteries of limbs

Material and method: it's a prospective observational study of 35 patients of PAD ,who were referred to interventional radiology for angioplasty. Angioplasty/ stenting was done under DSA guidance after preoperative evaluation by CT angiography.

Result: Complete resolution was observed in short-segment occlusions at 3 months, with only minor recurrence (2.9%) at 6 months. Long-segment occlusions also showed a significant reduction, with single-segment cases decreasing from 71.4% preoperatively to 20.0% at 6 months. PSV increased significantly across all infrapopliteal arteries, particularly in the Dorsalis Pedis artery ($p<0.001$), indicating improved perfusion.

Conclusion: This study highlights the efficacy of balloon angioplasty in managing occlusions in small and medium-sized arteries of the limbs, demonstrating significant improvements in arterial patency and clinical outcomes.

Keywords: Angioplasty, Peripheral arterial disease (PAD), Digital Subtraction Angiography (DSA), CT Angiography, Lower Limb Doppler USG, Critical limb ischemia (CLI)

INTRODUCTION

Peripheral arterial disease (PAD) is a progressive atherosclerotic condition characterized by narrowing or blockage of arteries that supply the limbs, leading to ischemia and functional impairment. It mainly affects the lower extremities and is linked to significant morbidity and mortality, particularly in patients with cardiovascular risk factors such as diabetes, hypertension, dyslipidemia, and smoking. PAD prevalence is rising globally, yet a significant portion remains underdiagnosed and undertreated. Occlusion of small and medium-sized arteries, particularly those distal to the popliteal artery, presents unique therapeutic challenges due to their anatomical and physiological features. These vessels are crucial for maintaining distal blood flow, and their obstruction can lead to critical limb ischemia (CLI), increasing the risk of ulceration, gangrene, and limb loss.[1] The pathophysiology of PAD is mainly driven by atherosclerosis, where endothelial dysfunction, lipid accumulation, and chronic inflammation lead to plaque formation, progressively narrowing arteries and reducing blood flow. Balloon angioplasty has become a key endovascular treatment for PAD, especially for small and medium-sized arterial occlusions.[2,3,4] In percutaneous transluminal angioplasty (PTA), a balloon catheter is inserted into the occluded artery and inflated to compress the plaque, restoring artery patency. Unlike surgery, PTA preserves native vasculature and can be performed under local anesthesia, making it ideal for high-risk patients. PTA is indicated for symptomatic PAD with

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significant arterial stenosis or occlusion, particularly when surgical options are not viable. It has shown positive results in improving vessel patency and alleviating symptoms, although long-term success is limited by restenosis.[5,6,7]

Despite the progress in endovascular therapy, there are gaps in knowledge regarding the effectiveness of balloon angioplasty for small and medium-sized arteries. While it is feasible and generally safe, long-term data on outcomes such as restenosis, the need for repeat procedures, and functional improvements are limited. The variability of these arteries, including differences in location, lesion length, and calcification, complicates the prediction of outcomes. Additionally, factors such as diabetes and renal insufficiency may affect procedural success. This study aims to evaluate the clinical outcomes of balloon angioplasty in small and medium-sized limb arteries, addressing the need for real-world clinical data on its durability.[8,9]

AIMS AND OBJECTIVES

Aim

To assess the outcomes of balloon angioplasty in patients with occlusive diseases of small and medium sized arteries of limbs.

Objectives

Primary objective:

- To evaluate the clinical and imaging parameters at 3 and 6 months after balloon angioplasty in acute and chronic arterial occlusive diseases of limbs.

Secondary objective:

- To compare the clinical and radiological outcome at 3 and 6 months after treatment with clinical and the angiographic pattern in patients with symptomatic arterial occlusive disease undergoing balloon angioplasty.

MATERIALS AND METHODS

- **Study design**: Prospective observational study.
- **Study duration**: May 2023 to November 2024 (18 months).
- **Source of study**: This study was conducted in intervention unit of Radiodiagnosis department of Dr. Ram Manohar Lohia Institute Of Medical Sciences, Lucknow.
- **Machines used:** Toshiba DSA, Philips 64 slice CT scanner and Supersonic AIXPLORER Ultrasound machine/Doppler machine
- **CT SCAN MACHINE:** make- PHILIPS
  Model- CT brilliance 64
  Sr no.- 95581
- **DSA;** make - TOSHIBA, Japan
  Model- INFX 8000V
- **DOPPLER ULTRASOUND MACHINE**: Supersonic AIXPLORER Multiwave Version 12.2.0808 USG scanner using 2-18 MHz probe linear array transducers.

Inclusion criteria

- Patients of acute arterial thrombosis.
- Patients of chronic claudication
- Patients with ischemic pain of limbs/rest pain.
- Patients with pregangrenous and gangrenous changes.
- Patients with limb ulcers.

Exclusion criteria

- Patients with deranged coagulation profile.
- Patients who refuse to give consent for the scan.
- Unstable patients
- Currently pregnant patients.
- Iodine and other contrast allergy.

Methodology

Patients were included in the study if they were able to return for follow up every 3 months. The decision to perform intervention was made in consultation between referring physician and vascular radiologist.

Doppler ultrasound and CT angiography were done prior to intervention to check the flow velocity and patency of diseased artery segment and to look for atherosclerotic plaques, stenosis or any collateral supply.

Antithrombotics and anticoagulants were given prior to intervention and after intervention as needed and as per guidelines.

Specifically, the intervention was considered a success if the clinical grade improved by at least one level (i.e., asymptomatic, mild claudication, disabling claudication, ischemic night pain or rest pain, or ulceration or gangrene) and one or more of the following vascular laboratory measurements improved: ankle/brachial systolic pressure ratio increased by at least 0.10, monophasic Doppler frequency analysis recordings became biphasic or triphasic.

Outcomes that were be included are restenosis, primary patency, reintervention (w/PTA or bypass), amputation, procedural complications, wound healing, and survival.

OBSERVATIONS AND RESULTS

This Prospective observational study conducted at Department of Radiodiagnosis, DR. RMLIMS, Lucknow, aimed to evaluate the clinical outcomes of balloon angioplasty in patients with peripheral artery disease (PAD) affecting small and medium-sized peripheral arteries. A total of 35 patients meeting the inclusion criteria were enrolled, with a mean age of 54.86 years. The majority were male (88.6%), and key risk factors included smoking (82.9%), diabetes mellitus (60.0%), and hypertension (62.9%). Data analysis was conducted using SPSS 22 software, with categorical variables presented as frequencies and proportions, and continuous variables as mean and

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standard deviation. Graphical representations were generated using MS Excel and MS Word.

Crosstabulation analysis revealed varying clinical severity, with 62.9% of patients experiencing ischemic rest pain (Rutherford Grade 4) and 40.0% presenting with gangrenous changes. Doppler studies indicated significant infrapopliteal arterial involvement, predominantly affecting the Dorsalis Pedis and Anterior Tibial arteries. Long-segment occlusions (>5 cm) were most common, observed in 80.0% of cases. Pre-procedural ankle-brachial pressure index (ABPI) confirmed arterial insufficiency, with 97.1% of patients exhibiting an ABPI $\leq$0.90.

Post-procedural assessments at 3 and 6 months demonstrated substantial improvements in occlusion resolution, peak systolic velocity (PSV), and ABPI. Complete resolution was observed in short-segment occlusions at 3 months, with only minor recurrence (2.9%) at 6 months. Long-segment occlusions also showed a significant reduction, with single-segment cases decreasing from 71.4% preoperatively to 20.0% at 6 months. PSV increased significantly across all infrapopliteal arteries, particularly in the Dorsalis Pedis artery ($p<0.001$), indicating improved perfusion. Although the resistive index (RI) remained largely unchanged, Doppler waveform analysis revealed a shift toward monophasic patterns in distal arteries, suggesting persistent hemodynamic compromise in some patients. However, overall clinical improvement was significant, with a marked reduction in Rutherford Grade 4 and 5 cases over six months.In summary, balloon angioplasty provides substantial short-term benefits in restoring arterial patency and improving clinical outcomes in PAD patients with small and medium-sized arterial involvement. However, continued long-term monitoring remains essential due to the potential risk of restenosis and persistent distal perfusion challenges.

DISCUSSION

Balloon angioplasty has become a cornerstone in the treatment of occlusions in small and medium-sized arteries, particularly in the peripheral vasculature. The advent of this minimally invasive procedure has transformed the management of limb ischemia, providing an effective alternative to surgical bypass and endarterectomy in certain patient populations. Balloon angioplasty utilizes controlled inflation of a balloon catheter to dilate stenotic or occluded vessels, thereby restoring patency and improving blood flow. This technique has demonstrated significant clinical benefits in improving limb salvage, reducing symptoms of claudication, and enhancing overall quality of life in patients with peripheral artery disease (PAD). [10,11,12]

The analysis of clinical severity in the study cohort, based on the Rutherford classification, revealed a predominant distribution in higher-grade categories, reflecting the advanced stage of arterial occlusion among participants. The most frequently observed grade was Rutherford Grade 4, accounting for 62.9% of cases, indicating a significant proportion of patients experiencing ischemic rest pain. Grades 3 and 5 were equally prevalent, each representing 17.1% of the study population, suggesting a mix of patients with moderate claudication and those with minor tissue loss. Notably, Grade 6, the most severe category associated with major tissue loss, was observed in only 2.9% of cases. The absence of Grade 2 cases suggests that no individuals presented with the mildest form of claudication, further emphasizing the predominance of advanced disease within the study cohort.[13,14]

These findings align with previous research highlighting the prevalence of advanced PAD stages in clinical settings. A study by **Abu Dabrh et al.** reported that a significant proportion of patients presented with critical limb ischemia, corresponding to Rutherford Grades 4 to 6, underscoring the severe nature of PAD in referred populations.[15,16]

The distribution of limb involvement among the study participants demonstrates a notable predominance of right-limb affection, observed in 68.6% of cases. In contrast, left-limb involvement was documented in 42.9% of individuals. This asymmetrical distribution suggests a potential laterality predisposition in the manifestation of arterial occlusive disease, which may be influenced by anatomical, hemodynamic, or lifestyle-related factors. The relatively higher prevalence of right-limb involvement aligns with findings in vascular pathology, where dominant-limb usage and mechanical stress are considered contributory factors in disease progression.

The observed predominance of right-limb involvement aligns with findings from previous research. A study by **Doraiswamy VA et al**. reported a similar trend, noting a higher incidence of peripheral artery disease (PAD) in the right limb among patients with premature peripheral arterial disease.[18,19,20]

The distribution of arterial occlusions in the present study cohort reveals a predominance of long-segment occlusions exceeding 5 cm, which were observed in 80.0% of participants. Single-segment long occlusions accounted for 71.4% of cases, while multiple-segment long occlusions were noted in 8.6%. In contrast, short-segment occlusions measuring less than 5 cm were less frequently encountered, with single-segment occlusions in 14.3% and multiple-segment occlusions in only 5.7% of the cohort. These findings suggest a significant burden of extensive arterial occlusions, which have important implications for disease severity and treatment strategies.

In contrast, a study by **Nelson MR et al**. evaluated Ankle-Brachial Index measurements in 250 high cardiovascular risk patients using an oscillometric blood pressure device in primary care settings. They reported a mean ABI of 1.02 ± 0.10, indicating generally normal arterial perfusion, with only 22% of participants diagnosed with peripheral arterial disease.

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This lower prevalence of arterial occlusions may be attributed to differences in study populations and diagnostic methodologies, as their cohort was drawn from a primary care setting and utilized oscillometric devices, which may have lower sensitivity for detecting PAD compared to Doppler-based assessments.

POST-PROCEDURE DOPPLER EVALUATION (AFTER 3 MONTHS AND 6 MONTHS)

Post-procedural Doppler assessments at 3 and 6 months demonstrate a significant reduction in occlusion rates, highlighting the effectiveness of the intervention in improving arterial patency. Short-segment occlusions (<5 cm), which were present in 14.3% (single-segment) and 5.7% (multiple-segment) of cases preoperatively, showed complete resolution at the 3-month follow-up (0.0% for both). At the 6-month evaluation, there was a slight recurrence, with 2.9% of single-segment occlusions reappearing, but multiple-segment occlusions remained absent. The improvement in short-segment occlusions was statistically significant (p=0.018), indicating a durable response to the procedure.

For long-segment occlusions (>5 cm), which comprised the majority of preoperative cases (71.4% single-segment and 8.6% multiple-segment occlusions), a remarkable improvement was noted. At 3 months, single-segment occlusions reduced to 17.1%, while multiple-segment occlusions decreased to 2.9%. By 6 months, the occlusion rate for single-segment cases remained relatively stable at 20.0%, while multiple-segment occlusions resolved completely (0.0%). These reductions were highly statistically significant (p<0.001), suggesting substantial revascularization success.

The findings of our study align with the prospective cohort study by **Vieira IÍF et al.** which investigated the prognostic value of the resistive index (RI) in predicting revascularization outcomes in critical limb ischemia (CLI) patients. Vieira et al. found that while the difference in preoperative RI between patent and occluded revascularizations was not statistically significant (p=0.658), there was a trend suggesting that lower preoperative RI values correlated with greater post-procedure patency at 30 days. Our study builds on these results, demonstrating that the benefits of revascularization extend beyond the short-term period, with sustained patency improvements at 3 and 6 months.[21,22]

Conversely, the study by **Crutchley et al.** on renal artery stenosis (RAS) found that a high resistive index (RI ≥0.8) was associated with poor post-procedure outcomes, including significant renal function decline and increased mortality. Unlike our study, which shows sustained arterial patency with minimal recurrence rates, Crutchley et al. observed that despite successful interventions, high RI values predicted worse long-term outcomes. This contrast suggests that while Doppler parameters like RI may be useful for predicting outcomes in both PAD and RAS, their prognostic significance varies between vascular territories due to differences in hemodynamic and pathophysiological factors.[22]

The infrapopliteal arteries demonstrated significant changes in waveform morphology. The anterior tibial artery exhibited an increase in monophasic waveforms from 25.7% to 28.6% (p=0.007), while the posterior tibial artery showed a similar trend, with monophasic waveforms rising from 25.7% to 28.6% (p=0.005). Notably, the dorsalis pedis artery experienced a significant increase in monophasic waveforms from 22.9% to 40.0% (p<0.001), suggesting a potential decline in distal arterial perfusion.

These findings of our study align with prior studies conducted by **Kim et al.**and **Nuffer Z et al**.[23,24]

CONCLUSION

This study highlights the efficacy of balloon angioplasty in managing occlusions in small and medium-sized arteries of the limbs, demonstrating significant improvements in arterial patency and clinical outcomes.

Pre-procedural Doppler assessments confirmed a substantial burden of infrapopliteal arterial occlusions, with long-segment occlusions being the most prevalent. Post-procedural evaluations at three and six months demonstrated marked improvements in arterial patency, with a significant reduction in occlusion rates, particularly for short-segment lesions.

REFERENCES

1. CDC. About Peripheral Arterial Disease (PAD). Heart Disease. May 20, 2024. Accessed January 30, 2025. https://www.cdc.gov/heart-disease/about/peripheral-arterial-disease.html
2. Zemaitis MR, Boll JM, Dreyer MA. Peripheral Arterial Disease. In: StatPearls. StatPearls Publishing; 2025. Accessed January 30, 2025. http://www.ncbi.nlm.nih.gov/books/NBK430745/
3. Holder TA, Gutierrez JA, Aday AW. Medical Management of Peripheral Artery Disease. Cardiol Clin. 2021;39(4):471-482. doi:10.1016/j.ccl.2021.06.001
4. Thiruvoipati T, Kielhorn CE, Armstrong EJ. Peripheral artery disease in patients with diabetes: Epidemiology, mechanisms, and outcomes. World J Diabetes. 2015;6(7):961-969. Do
5. Hong H, Park UJ, Roh YN, Kim HT. Predictive factors of severe dissection after balloon angioplasty for femoropopliteal artery disease. Ann Vasc Surg. 2021;77:109-115.
6. Schmidt A, Ulrich M, Winkler B, et al. Angiographic patency and clinical outcome after balloon-angioplasty for extensive infrapopliteal arterial disease. Catheter Cardiovasc Interv. 2010;76(7):1047-1054.
7. Söderström MI, Arvela EM, Korhonen M, et al. Infrapopliteal percutaneous transluminal angioplasty versus bypass surgery as first-line strategies in critical leg ischemia: a propensity score analysis. Ann Surg. 2010;252(5):765-773.
8. CDC. About Peripheral Arterial Disease (PAD). Heart

DOI: 10.69605/ijlbpr_14.5.2025.133

Disease. May 20, 2024. Accessed January 30, 2025. https://www.cdc.gov/heart-disease/about/peripheral-arterial-disease.html
9. Zemaitis MR, Boll JM, Dreyer MA. Peripheral Arterial Disease. In: StatPearls. StatPearls Publishing; 2025. Accessed January 30, 2025. http://www.ncbi.nlm.nih.gov/books/NBK430745/
10. Holder TA, Gutierrez JA, Aday AW. Medical Management of Peripheral Artery Disease. Cardiol Clin. 2021;39(4):471-482. doi:10.1016/j.ccl.2021.06.001
11. Endarterectomy - an overview | ScienceDirect Topics. Accessed January 31, 2025. https://www.sciencedirect.com/topics/medicine-and-dentistry/endarterectomy
12. Gul F, Janzer SF. Peripheral Vascular Disease. In: StatPearls. StatPearls Publishing; 2025. Accessed January 30, 2025. http://www.ncbi.nlm.nih.gov/books/NBK557482/
13. Eguchi K, Murakami A, Horaguchi T, Kato M, Miyashita H, Kario K. Percutaneous transluminal angioplasty for peripheral artery disease confers cardiorenal protection. J Hum Hypertens. 2014;28(1):51-55. doi:10.1038/jhh.2013.37
14. Gouëffic Y, Brodmann M, Deloose K, Dubosq-Lebaz M, Nordanstig J. Drug-eluting devices for lower limb peripheral arterial disease. doi:10.4244/EIJ-D-23-01080
15. Thiruvoipati T, Kielhorn CE, Armstrong EJ. Peripheral artery disease in patients with diabetes: Epidemiology, mechanisms, and outcomes. World J Diabetes. 2015;6(7):961-969. doi:10.4239/wjd.v6.i7.961
16. Criqui MH, Aboyans V. Epidemiology of peripheral artery disease. Circ Res. 2015;116(9):1509-1526. doi:10.1161/CIRCRESAHA.116.303849
17. Doraiswamy VA, Giri J, Mohler E. Premature peripheral arterial disease – difficult diagnosis in very early presentation. Int J Angiol Off Publ Int Coll Angiol Inc. 2009;18(1):45-47.
18. Patel A, Irani FG, Pua U, et al. Randomized Controlled Trial Comparing Drug-coated Balloon Angioplasty versus Conventional Balloon Angioplasty for Treating Below-the-Knee Arteries in Critical Limb Ischemia: The SINGA-PACLI Trial. Radiology. 2021;300(3):715-724. doi:10.1148/radiol.2021204294
19. Hong H, Park UJ, Roh YN, Kim HT. Predictive factors of severe dissection after balloon angioplasty for femoropopliteal artery disease. Ann Vasc Surg. 2021;77:109-115.
20. Schmidt A, Ulrich M, Winkler B, et al. Angiographic patency and clinical outcome after balloon-angioplasty for extensive infrapopliteal arterial disease. Catheter Cardiovasc Interv. 2010;76(7):1047-1054. doi:10.1002/ccd.22658
21. Söderström MI, Arvela EM, Korhonen M, et al. Infrapopliteal percutaneous transluminal angioplasty versus bypass surgery as first-line strategies in critical leg ischemia: a propensity score analysis. Ann Surg. 2010;252(5):765-773. doi:10.1097/SLA.0b013e3181fc3c73
22. Vieira IÍF, Silva ETAGB de BE, Buril G de O, Silva CHND da, Lins EM. Resistance Index as a Prognostic Factor for Patency in Distal Lower Limb Arterial Revascularization. Ann Vasc Surg. 2025;111:360-366. doi:10.1016/j.avsg.2024.10.019
23. Kim ES, Sharma AM, Scissons R, et al. Interpretation of peripheral arterial and venous Doppler waveforms: A Consensus Statement from the Society for Vascular Medicine and Society for Vascular Ultrasound.
24. Nuffer Z, Rupasov A, Bekal N, Murtha J, Bhatt S. Spectral Doppler ultrasound of peripheral arteries: a pictorial review. Clin Imaging. 2017;46:91-97. doi:10.1016/j.clinimag.2017.07.007