Retrograde Recanalization of Occluded Radial Artery via Distal Radial Access: Experience from a Single-Center Prospective Study (Post-Print)

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Abstract

Background: The incidence of radial artery occlusion (RAO) after transradial access for coronary interventional diagnosis and treatment is relatively high. Objective: This study evaluated the feasibility of retrograde recanalization of RAO via distal transradial access (dTRA). Methods: From June 2019 to December 2021, 44 patients who developed RAO after coronary interventional diagnosis and treatment and had corresponding symptoms underwent retrograde recanalization of RAO via dTRA. Adverse events during hospitalization were recorded, and duplex ultrasonography was performed at 3, 6, and 12 months postoperatively to examine the patency rate of the radial artery. Results: RAO was successfully recanalized in 39 patients, while 5 patients failed, with a procedural success rate of 88.6%. Compared with the success group, the failure group had a significantly higher proportion of smoking and/or diabetes (80.0% vs. 33.3%, P=0.046), a higher proportion of having undergone at least 3 previous coronary interventional procedures (60.0% vs. 12.8%, P=0.011), and a higher proportion of chronic occlusion (100.0% vs. 51.28%, P=0.041). Each group had 1 patient with minor bleeding at the puncture site and 1 patient with hematoma. At 3, 6, and 12 months postoperatively, the radial artery patency rates in the success group were 48.7%, 43.6%, and 35.9%, respectively. Conclusion: Retrograde recanalization of RAO via dTRA has a relatively high success rate, but the patency rate at follow-up is below 50%.

Full Text

Preamble

Retrograde Recanalization of Radial Artery Occlusion via Distal Transradial Access: A Single-Center Prospective Study

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Abstract

Background: Radial artery occlusion (RAO) frequently occurs following transradial artery access (TRA) for coronary procedures. **Objective:** This prospective study evaluated the feasibility of retrograde recanalization of RAO via distal transradial artery access (dTRA). **Methods:** From June 2019 to December 2021, 44 consecutive patients who developed RAO after coronary interventions underwent attempted retrograde recanalization via dTRA. In-hospital adverse events were recorded, and radial artery patency was assessed by Doppler ultrasound at 3, 6, and 12 months post-procedure. **Results:** RAO was successfully recanalized in 39 patients, with 5 failures, yielding a procedural success rate of 88.6%. Compared to the successful group, the failed group had significantly higher rates of smoking and/or diabetes (80.0% vs. 33.3%, P=0.046), prior coronary interventions ($ $3 procedures) (60.0% vs. 12.8%, P=0.011), and chronic total occlusion (100.0% vs. 51.28%, P=0.041). One patient in each group experienced minor bleeding at the puncture site, and one in each group developed hematoma. Patency rates in the successful group were 48.7%, 43.6%, and 35.9% at 3, 6, and 12 months, respectively. **Conclusion:** Retrograde recanalization of RAO via dTRA demonstrates high procedural success but yields patency rates below 50% at follow-up.

Keywords: Distal transradial artery; Retrograde recanalization; Radial artery occlusion; Coronary angiography; Percutaneous coronary intervention

Introduction

Compared with the femoral approach, transradial artery access (TRA) has become the preferred method for over 90% of coronary interventions due to fewer associated complications [1]. However, TRA carries the significant drawback of radial artery occlusion (RAO), with the PROPHET study reporting RAO rates of 12% at 24 hours and 7% at 30 days post-procedure [2]. Once RAO occurs, the radial artery can no longer serve as an access site for future interventions,

nor can it be used as an arterial graft for coronary artery bypass surgery or as a conduit for arteriovenous fistula creation in hemodialysis patients. Recent research [3] has demonstrated that distal transradial artery access (dTRA), defined as access distal to the superficial palmar branch, is equally safe and effective for coronary procedures, offering enhanced patient comfort and significantly reduced compression time, bleeding complications, and occlusion rates. Due to the dual blood supply of the palm via the superficial and deep palmar arches, blood can reach the distal radial artery even after proximal RAO, enabling successful puncture and recanalization. In 2018, Balaban et al. [4] reported a clinical study of 25 patients undergoing coronary angiography via dTRA after retrograde RAO recanalization. Subsequently, Shi et al. [5] confirmed the safety and efficacy of this approach in a 15-patient cohort in 2021. Nevertheless, large-scale studies with long-term follow-up data remain limited. We therefore conducted this prospective clinical study to evaluate the success rate of retrograde RAO recanalization via dTRA, identify potential predictors of failure, and assess 12-month outcomes.

Methods

Study Design

This single-center prospective study was registered with ClinicalTrials.gov (NCT04861389) and approved by the Ethics Review Committee of Shenzhen People' s Hospital (LL-ZLJS-2021082).

Patient Selection

From June 2019 to December 2021, we consecutively enrolled 44 patients in the Department of Cardiology at Shenzhen People' s Hospital. Inclusion criteria were: (1) RAO following previous TRA coronary procedures; (2) associated symptoms such as arm weakness or severe pain; and (3) need for further coronary evaluation due to chest pain. Exclusion criteria included: (1) acute coronary syndrome requiring emergency intervention; (2) non-palpable ulnar artery pulse; and (3) cardiogenic shock. Patients were categorized into successful (n=39) or failed (n=5) groups based on procedural outcomes. Successful recanalization was defined as restoration of antegrade radial artery flow confirmed by angiography and Doppler ultrasound, while failure was defined as persistent absence of antegrade flow.

Procedural Details

All procedures were performed by a single experienced operator (Dr. Xin Sun) using Cordis Avanti radial artery puncture kits. The distal radial artery was palpated in the anatomical snuffbox and Hegu acupoint region, with the strongest pulsation point selected for puncture. After local anesthesia with 2-3 ml lidocaine, a modified Seldinger technique was employed. Following successful puncture, a skin incision was made and the sheath advanced 2-3 cm into the

artery [Figure 1: see original paper]A. Heparin (70-100 IU/kg) was administered intra-sheath. Radial angiography was performed to evaluate arterial anatomy, occlusion characteristics, thrombus burden, and collateral circulation [Figure 1: see original paper]B and C. For acute occlusions or chronic occlusions with high thrombus burden, thrombus aspiration was performed directly through the sheath (preferably a 7F thin-walled sheath) or via an aspiration catheter [Figure 1: see original paper]D. For chronic occlusions without significant thrombus burden or when aspiration was unsuccessful, balloon angioplasty was performed, assisted if necessary by 0.014-inch or 0.025-inch guidewires [Figure 1: see original paper]E. Patients with acute or chronic occlusions with high thrombus burden received continuous urokinase infusion via microcatheter (Terumo, Japan) for 6-12 hours post-recanalization [Figure 1: see original paper]F. Final angiography confirmed restoration of antegrade flow [Figure 1: see original paper]G. In-hospital complications including bleeding and hematoma were monitored, and Doppler ultrasound (Handydop Pro, Medisound Medical Device) assessed radial artery patency before discharge and at 3, 6, and 12 months.

Study Endpoints

The primary endpoint was procedural success rate of retrograde RAO recanalization, defined as restoration of antegrade radial flow confirmed by angiography and Doppler ultrasound. Secondary endpoints included predictors of failure, procedural complications, and radial artery patency rates during follow-up (3, 6, and 12 months).

Statistical Analysis

Data were analyzed using SPSS 22.0. Continuous variables are presented as mean ± standard deviation, and categorical variables as counts and percentages. Intergroup differences in continuous variables were analyzed using t-tests for normally distributed data. Categorical variables were compared using chi-square or Fisher' s exact tests. A P-value <0.05 was considered statistically significant.

Results

Procedural Success and Baseline Characteristics

Among 44 patients, RAO was successfully recanalized in 39 cases, yielding a success rate of 88.6% . The failed group had significantly higher rates of smoking and/or diabetes (80.0% vs. 33.3%, P=0.046), prior coronary interventions ($ $3 procedures) (60.0% vs. 12.8%, P=0.011), and chronic total occlusion (100.0% vs. 51.28%, P=0.041). No other significant between-group differences were observed.

Procedural and Post-Procedural Characteristics

Except for balloon angioplasty rates, no significant differences existed between groups in procedural characteristics . Procedure time in the successful group ranged from 15 to 66 minutes (mean 43.79 ± 9.40 minutes). Thirty-seven patients (84.09%) in the successful group underwent immediate coronary angiography or intervention following radial recanalization. Minor bleeding at the puncture site and hematoma each occurred in one patient per group, with no statistically significant differences.

Follow-Up Patency Rates

In the successful group, Doppler ultrasound follow-up revealed patency rates of 48.7% (19/39) at 3 months, 43.6% (17/39) at 6 months, and 35.9% (14/39) at 12 months.

Discussion

This prospective study demonstrates that retrograde recanalization of procedure-induced RAO via dTRA is feasible, with a high procedural success rate of 88.6%. However, long-term patency remains suboptimal, falling below 50% within 12 months. RAO represents a common complication of TRA, with reported incidence ranging from 0.8% to 38% [6-7]. Risk factors include body mass index, diabetes, sheath size, anticoagulation use, and compression time [6,8]. While severe hand ischemia is rare due to dual blood supply via the palmar arches, RAO can impair arm function and cause severe pain from acute occlusion. It also eliminates the radial artery as a future access route, forcing reliance on femoral access with its higher complication rates and reduced patient comfort [9]. Furthermore, in patients with renal insufficiency, RAO precludes use of the radial artery for arteriovenous fistula creation [10].

Since 2017, dTRA has gained attention among interventional cardiologists as a novel approach for coronary procedures [3,11-12]. Several studies have explored retrograde RAO recanalization via dTRA. Sheikh et al. [13] reported a single case of successful left RAO recanalization in a patient with prior bypass surgery, multiple interventions, and severe peripheral vascular disease. Li et al. [14] described successful radial recanalization via dTRA following emergency PCI. Small clinical series have confirmed the safety and efficacy of this approach, reporting success rates of 88-93% [4-5]. Our 88.6% success rate aligns with these findings.

We identified diabetes, smoking, chronic occlusion, and prior coronary interventions ($ $3) as significant predictors of failure, likely related to radial artery spasm, calcification, and poor collateral circulation. The most common complications were access site bleeding and hematoma [4,15], though rates were lower than with conventional radial access [16]. Several technical considerations are crucial: operators must be highly experienced in dTRA puncture, with ultrasound guidance improving success rates [17-18]; sheath insertion should be

limited to 2-3 cm depth; if sheath aspiration yields no blood, position within the occluded segment rather than subintimal dissection must be confirmed; and balloon tracking techniques can facilitate guidewire passage through chronic occlusions.

Long-term outcomes of retrograde RAO recanalization remain poorly defined. Balaban et al. [4] reported a 33.4% patency rate at one month among 14 patients treated with drug-coated balloons. Our study achieved higher patency rates (48.7%, 43.6%, and 35.9% at 3, 6, and 12 months, respectively) without drug-coated balloons. This discrepancy may reflect different pathophysiological mechanisms of stenosis formation. While drug-coated balloons effectively prevent atherosclerotic restenosis, they show limited efficacy in dysfunctional dialysis access or procedure-induced RAO [19-20]. Randomized controlled trials are needed to clarify the role of drug-coated balloons in maintaining radial artery patency after recanalization.

Given the modest long-term patency rates, dTRA retrograde recanalization may be most appropriate for patients with RAO who require elective coronary interventions, as it allows reuse of access materials for subsequent procedures and reduces costs. Conversely, in asymptomatic patients without anticipated coronary procedures within one year, retrograde recanalization may not be justified.

This study has several limitations. The small number of patients in the failed group precluded multivariate logistic regression or propensity-matched analysis to identify independent predictors of failure. We did not compare drug-coated versus conventional balloons for RAO treatment. Additionally, we did not analyze serial ultrasound-derived vascular parameters such as radial artery diameter. Finally, as a single-center study, these findings require validation in larger multicenter randomized trials.

Conclusion

Retrograde recanalization of RAO via dTRA is feasible with a high procedural success rate of 88.6%, but long-term patency remains below 50%.

Author Contributions

Xin Sun conceived the study and established overall research objectives. Mingpei Yuan performed the research and drafted the manuscript. Yaowang Lin, Weijie Bei, Huadong Liu, and Shaohong Dong collected data.

Conflict of Interest

The authors declare no conflicts of interest.

References

[1] Agostoni P, Biondi-Zoccai GG, de Benedictis ML, Rigattieri S, Turri M, Anselmi M, et al.: Radial versus femoral approach for percutaneous coronary diagnostic and interventional procedures; Systematic overview and meta-analysis of randomized trials. J Am Coll Cardiol 2004, 44(2):349-356.

[2] Pancholy S, Coppola J, Patel T, Roke-Thomas M: Prevention of radial artery occlusion-patent hemostasis evaluation trial (PROPHET study): a randomized comparison of traditional versus patency documented hemostasis after transradial catheterization. Catheter Cardiovasc Interv 2008, 72(3):335-340.

[3] Kiemeneij F: Left distal transradial access in the anatomical snuffbox for coronary angiography (ldTRA) and interventions (ldTRI). EuroIntervention 2017, 13(7):851-857.

[4] Balaban Y, Elevli MG: It is both possible and safe to perform coronary angiography through the same radial artery, after retrograde recanalization of radial artery occlusion, following a previous coronary angiography. J Interv Cardiol 2018, 31(6):957-963.

[5] Shi G, Li F, Zhang L, Gong C, Xue S, Song Y, et al.: Retrograde Recanalization of Occluded Radial Artery: A Single-Centre Experience and Literature Review. J Endovasc Ther 2022:15266028211067732.

[6] Rashid M, Kwok CS, Pancholy S, Chugh S, Kedev SA, Bernat I, et al.: Radial Artery Occlusion After Transradial Interventions: A Systematic Review and Meta-Analysis. J Am Heart Assoc 2016, 5(1).

[7] Hahalis G, Aznaouridis K, Tsigkas G, Davlouros P, Xanthopoulou I, Koutsogiannis N, et al.: Radial Artery and Ulnar Artery Occlusions Following Coronary Procedures and the Impact of Anticoagulation: ARTEMIS (Radial and Ulnar ARTEry Occlusion Meta-AnalysIS) Systematic Review and Meta-Analysis. J Am Heart Assoc 2017, 6(8).

[8] Garg N, Madan BK, Khanna R, Sinha A, Kapoor A, Tewari S, et al.: Incidence and predictors of radial artery occlusion after transradial coronary angioplasty: Doppler-guided follow-up study. J Invasive Cardiol 2015, 27(2):106-112.

[9] J.-H. Roh and J.-H. Lee. Distal radial approach through the anatomical snuff box for coronary angiography and percutaneous coronary intervention. Korean Circulation Journal, vol. 48, no. 12, pp. 1131–1134, 2018.

[10] Huang Jiajun, Zhang Zhenjian, Wang Neng. Clinical application of distal radial artery approach in the treatment of arteriovenous fistula stenosis. Journal of Cardiovascular and Cerebrovascular Disease Prevention and Treatment, 2022, 22(2):85-87. DOI:10.3969/j.issn.1009-816x.2022.02.022.

[11] Amin MR, Banerjee SK, Biswas E, Paul N, Mahabub EE, Ahmed SF, et al.: Feasibility and Safety of Distal Transradial Access in the Anatomical

Snuffbox for Coronary Angiography and Intervention. Mymensingh Med J 2019, 28(3):647-654.

[12] Koutouzis M, Kontopodis E, Tassopoulos A, Tsiafoutis I, Katsanou K, Rigatou A, et al.: Distal Versus Traditional Radial Approach for Coronary Angiography. Cardiovasc Revasc Med 2019, 20(8):678-680.

[13] Sheikh AR, Abdelaal E, Sastry S, Karim S, Zeb M: Novel Distal Left Radial Artery Access in Anatomical Snuffbox for Recanalization of Proximal Radial Artery Total Occlusion and Percutaneous Coronary Intervention Through Left Internal Mammary Artery. Circulation: Cardiovascular Interventions 2018, 11(7):e006579.

[14] Li F, Shi G-W, Zhang B-F, Yu X-L, Huang H-M, Xiao J-Q, et al.: Recanalization of the occluded radial artery via distal transradial access in the anatomic snuffbox. BMC Cardiovasc Disord 2021, 2021 Feb 2;21(1):67.

[15] Schulte-Hermes M, Klein-Wiele O, Vorpahl M, Seyfarth M: Feasibility of Transradial Access for Coronary Interventions Via Percutaneous Angioplasty of the Radial Artery in Cases of Functional Radial Occlusion. J Invasive Cardiol 2018, 30(10):355-359.

[16] Zhao Mingming, Xue Yueqin, Wang Yan, Wang Yingzhi, Zhou Jixing, Zhao Meng. Meta-analysis of feasibility and safety of coronary intervention via distal radial artery. Chinese Circulation Journal, 2021, 36(12):1173-1179. DOI:10.3969/j.issn.1000-3614.2021.12.005.

[17] Naito T, Sawaoka T, Sasaki K, Iida K, Sakuraba S, Yokohama K, et al.: Evaluation of the diameter of the distal radial artery at the anatomical snuff box using ultrasound in Japanese patients. Cardiovasc Interv Ther 2019, 34(4):312-316.

[18] Hadjivassiliou A, Kiemeneij F, Nathan S, Klass D: Ultrasound-guided access to the distal radial artery at the anatomical snuffbox for catheter-based vascular interventions: a technical guide. EuroIntervention 2021, 16(16):1342-1348.

[19] Maleux G, Vander Mijnsbrugge W, Henroteaux D, Laenen A, Cornelissen S, Claes K, et al.: Multicenter, Randomized Trial of Conventional Balloon Angioplasty versus Paclitaxel-Coated Balloon Angioplasty for the Treatment of Dysfunctioning Autologous Dialysis Fistulae. J Vasc Interv Radiol 2018, 29(4):470-475.e473.

[20] Kitrou P, Parthipun A, Diamantopoulos A, Padayachee S, Karunanithy N, Ahmed I, et al.: Paclitaxel-coated balloons for failing peripheral bypass grafts: the BYPACS study. J Cardiovasc Surg (Torino) 2014, 55(2):217-224.

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