

Left Versus Right Radial Access in Elderly Patients for Coronary Procedures: A Systematic Review and Meta-Analysis

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Abstract

Background: Radial artery access is widely used in coronary procedures, but the optimal choice between left (LRA) and right (RRA) radial access remains controversial, especially in older patients.

Objective: Compare LRA and RRA in patients ≥ 70 years undergoing coronary procedures.

Methods: This study conducted a systematic review and meta-analysis of observational studies and randomized clinical trials (RCTs), adopting a significance level of 5% for all statistical analyses. We searched PubMed, Embase, and Cochrane Central for studies comparing LRA and RRA in patients aged ≥ 70 years. The main outcomes were fluoroscopy time, contrast volume, and procedure difficulty.

Results: We included 1,094 patients from 4 studies, of which 3 were RCTs. Among them, 821 (75%) patients underwent the procedure via RRA. The LRA group showed a significantly shorter fluoroscopy time (standard mean difference [MD]: -0.41 ; 95% confidence interval [CI]: -0.67 to -0.42 ; $p < 0.01$; $I^2 = 80\%$), and there was a significant reduction in the contrast volume between the groups, favoring LRA (MD: -13.04 milliliters; 95% CI: -18.0 to -8.20 ; $p < 0.01$; $I^2 = 0\%$). However, there was no significant difference in the perceived difficulty level between the groups (risk ratio [RR]: 1.03; 95% CI: 0.61 to 1.73; $p = 0.92$; $I^2 = 0\%$).

Conclusion: LRA is associated with a significantly shorter fluoroscopy time, suggesting a greater efficiency in terms of radiation exposure. These findings imply that, while LRA may offer some efficiency benefits, the choice between LRA and RRA should consider other clinical and technical factors, such as operator preference and experience.

Keywords: Cardiology; Radial Artery; Aged.

Introduction

Coronary angiography and percutaneous coronary intervention are increasingly performed on elderly patients, who represent a growing segment of the cardiac patient population.¹ In recent years, transradial access has gained prominence due to its association with a significantly lower risk of access-related complications. Consequently, both the

American Heart Association and the European Society of Cardiology have endorsed it as the preferred access strategy for patients with acute coronary syndrome.^{2,3}

While the right radial approach has become the preferred vascular access route, it presents unique challenges in elderly patients. Aging is associated with a higher incidence of vascular tortuosity, particularly in the right subclavian artery, which may increase procedural difficulty and impact outcomes.⁴ These factors can potentially impact procedure difficulty and outcomes.

Given these considerations, there is a need to evaluate alternative access sites that may offer advantages in the elderly population. This meta-analysis aims to compare the efficacy and safety of left radial access (LRA) with right radial access (RRA) in elderly patients undergoing percutaneous coronary procedures. Specifically, we assessed these approaches in

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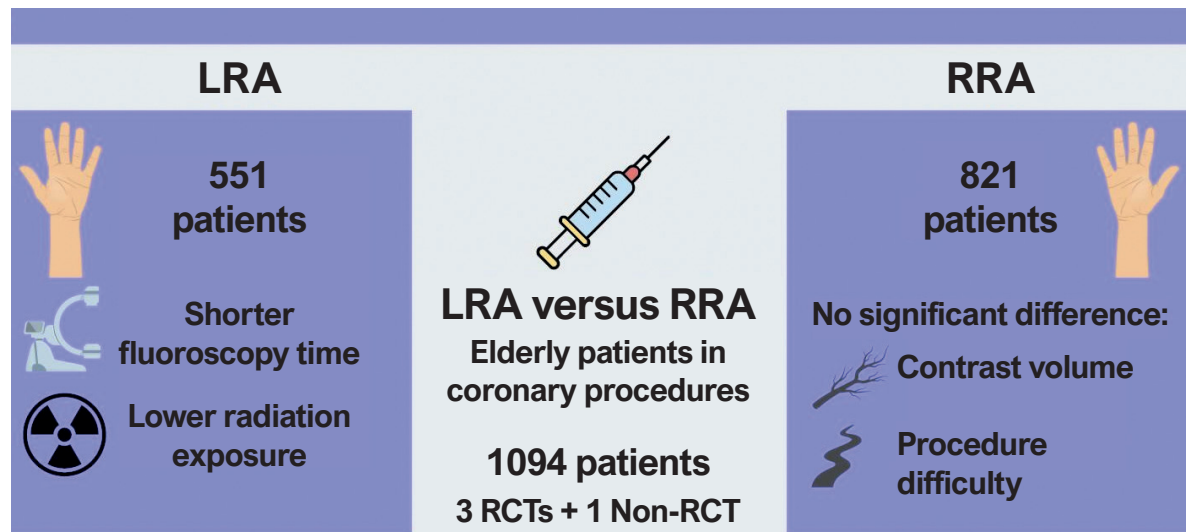
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**Central Illustration: Left Versus Right Radial Access in Elderly Patients for Coronary Procedures:
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LRA: left radial access; RCT: randomized controlled trial; RRA: right radial access.

relation to 3 key parameters: procedure difficulty, fluoroscopy time, and contrast volume.

Methods

This systematic review with meta-analysis was registered in the International Prospective Register of Systematic Reviews (PROSPERO) under protocol CRD42024564495. This study was designed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) reporting guideline.

Eligibility criteria and data extraction

Studies were included in this meta-analysis if they met all of the following criteria: (1) elderly patients (≥ 70 years) undergoing percutaneous coronary angiogram or percutaneous coronary intervention, (2) comparing RRA versus LRA, (3) randomized clinical trials (RCTs) or observational studies, and (4) reported at least one outcome of interest. We imposed no restrictions on publication date, publication status, or language. There was no minimum follow-up time requirement, as our primary outcomes were procedural and immediate postprocedural measures.

We excluded studies if (1) they reported outcomes from patients who crossed over to femoral access, and (2) they were duplicate reports of the same study population. In such cases, we selected the report with the largest number of patients which included our variables of interest.

Two independent reviewers screened 228 studies. After duplicate removal and title/abstract screening, 10 studies

underwent full-text review, and 4 were included. Discrepancies were resolved by discussion, with final decisions made by the senior author (O.D. Andrade).

Search strategy

Two authors (A.G and B.A.M) developed the initial search strategy, and we searched PubMed, Cochrane Central Register of Controlled Trials, and Embase from inception until July 2024. The search terms used were: "left," "right," "radial," "catheterization," "angioplasty," "angiography," "percutaneous coronary intervention," "elderly," and "old."

Quality assessment

We assessed risk of bias using the Cochrane Risk of Bias 2 (RoB 2) tool⁵ for randomized controlled trials and the Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) tool⁶ for observational studies. Two authors (A.G. and G.E.) independently evaluated each study, resolving disagreements through consensus.

RoB 2 assessed 5 domains (randomization, intervention deviations, missing data, outcome measurement, and result selection), while ROBINS-I evaluated 7 domains (confounding, participant selection, intervention classification, deviations, missing data, outcome measurement, and result selection).

To check for publication bias, we created funnel plots of study weights against point estimates. Egger's test was not performed due to the limited number of studies (< 10) in this meta-analysis.

Statistical and sensitivity analysis

We used risk ratios (RR) with 95% confidence interval (CI) for binary outcomes and mean differences (MD) or standardized mean differences (SMD) for continuous outcomes. Heterogeneity was assessed using the Cochrane Q-test and I^2 statistics, with p values > 0.10 and $I^2 > 25\%$ indicating significant heterogeneity.

Random-effects models with restricted maximum likelihood (REML) estimators were used for all analysis, following the Cochrane Handbook for Systematic Reviews of Interventions guidelines. The Wan and Luo methods were used to estimate means and standard deviations from medians and interquartile ranges.

For outcomes with at least 3 studies, we conducted leave-one-out sensitivity analysis. Skewed transformations were applied, and their impact was assessed through sensitivity analysis. All statistical analyses were performed using RStudio version 4.4.0.

Results

Study selection and characteristics

As detailed in Figure 1, 228 studies were identified overall. After the removal of duplicate reports and non-relevant studies by title and abstract reviews, 10 remained. These were thoroughly reviewed to satisfy the inclusion criteria. Four studies and 1,094 patients were included, of whom 821 (75%) patients underwent the procedure via RRA. Most participants were male (77.3%) (Table 1).

Pooled analysis of all studies

Our meta-analysis shows that LRA significantly reduced fluoroscopy time compared to RRA (SMD: -0.41 ; 95% CI: -0.67 to -0.42 ; $p < 0.01$; $I^2 = 80\%$; Figure 2). In absolute terms, fluoroscopy times were consistently lower with LRA across studies: 8.3 ± 6.7 min versus 8.9 ± 9.1 min in Freixa et al.,⁷ 3.7 min (2.4 to 6.3) versus 5.6 min (3.1 to 8.7) in Shah et al.,⁸ and 3.2 min (1.7 to 5.9) versus 4.4 min (2.4 to 7.8) in Will et al.⁹

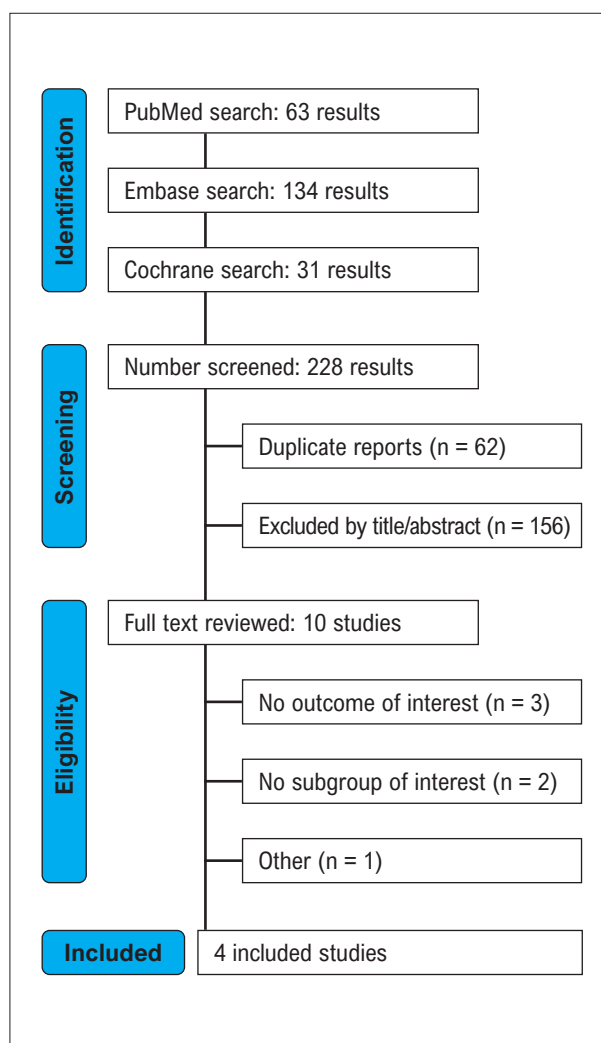


Figure 1 – PRISMA flow diagram of study screening and selection. The search strategy in Embase, PubMed, and Cochrane yielded 63 studies, of which 10 were fully reviewed for inclusion and exclusion criteria. Four studies were included in the meta-analysis.

Table 1 – Baseline characteristics of included studies

Study	Design	Patients > 70 years LRA/RRA	Male (%) LRA/RRA	Weight (kg) [†] LRA/RRA	HTN (%) LRA/RRA	DM (%) LRA/RRA	Creatinine (mg/dl) [†] LRA/RRA	ACS (%) LRA/RRA
Sciahbasi, 2011 ¹⁰	RCT	301/302	68/68	77±14	68/70	31/27	1.04±0.5/ 1.05±0.6	45/47
Freixa, 2012 ⁷	RCT	50/50	58/60	68±10.8/ 69.9±13.1	92/80	26/34	1.13±0.3/ 1.08±0.3	40/42
Shah, 2016 ⁸	RCT	24/38	06/12	72 [63-81]/ 71	90/94	40/54	0.8 [0.7-1.0]/ 0.8 [0.7-1.0]	NA
Will, 2022 ⁹	Non-RCT	2757/7682	73.9/76.1	NA	64.8/52.7	27.7/18.2	NA	53.8/65.3

* Data from the total study population, regardless of age. [†]Mean or median; ACS: acute coronary syndrome; DM: diabetes mellitus; HTN: hypertension; LRA: left radial access; NA: not available; RCT: randomized controlled trial; RRA: right radial access. Note: All included studies adopted a statistical significance level of 5%.

We also found a significant reduction in contrast volume favoring LRA (MD: -13.04 ml; 95% CI: -18.0 to -8.20 ; $p < 0.01$; $I^2 = 0\%$; Figure 3). In absolute terms, the mean contrast volumes were 95.8 ± 25.5 ml versus 105.4 ± 47.7 ml in Freixa et al.,⁷ 60 ± 22 ml versus 68 ± 31 ml in Shah et al.,⁸ and 77 ml (55 to 110) versus 94 ml (62 to 130) in Will et al.⁹ for LRA and RRA, respectively.

However, no significant difference was observed in perceived procedural difficulty between groups (RR: 1.03 ; 95% CI: 0.61 to 1.73 ; $p = 0.92$; $I^2 = 0\%$; Figure 4). Procedural difficulty occurred in 16% versus 24% in Shah et al.⁸ ($p = 0.45$) and 22% versus 22% in Freixa et al.⁷ of procedures performed through LRA and RRA, respectively.

Sensitivity analysis

With the removal of the Sciahbasi et al.,¹⁰ there was a significant reduction in heterogeneity among studies for the outcome of fluoroscopy time, from $I^2 = 80\%$ to $I^2 = 0\%$ (Figure 5). This was likely attributable to differences in study methodologies and patient populations. Additionally, there

was no change in the heterogeneity regarding the outcome of contrast volume (Figure 6).

Quality assessment

We assessed the risk of bias using the RoB2 tool⁵ for 3 studies and the ROBINS-I tool⁶ for one study, as illustrated in Supplementary Figures S1 and S2. The observational study by Will et al.⁹ was the only one classified as having a serious risk of bias, primarily due to potential confounding bias.

Among the RCTs, Freixa et al.⁷ raised some concerns due to potential bias in outcome measurement. Similarly, Shah et al.⁸ prompted concerns regarding bias in the randomization process and selection of reported results. In contrast, the RCT by Sciahbasi et al.¹⁰ was assessed as having a low risk of bias.

Discussion

The pooled analysis of all 4 studies included 1,094 patients and found that the fluoroscopy time and contrast volume were significantly lower in the LRA group compared

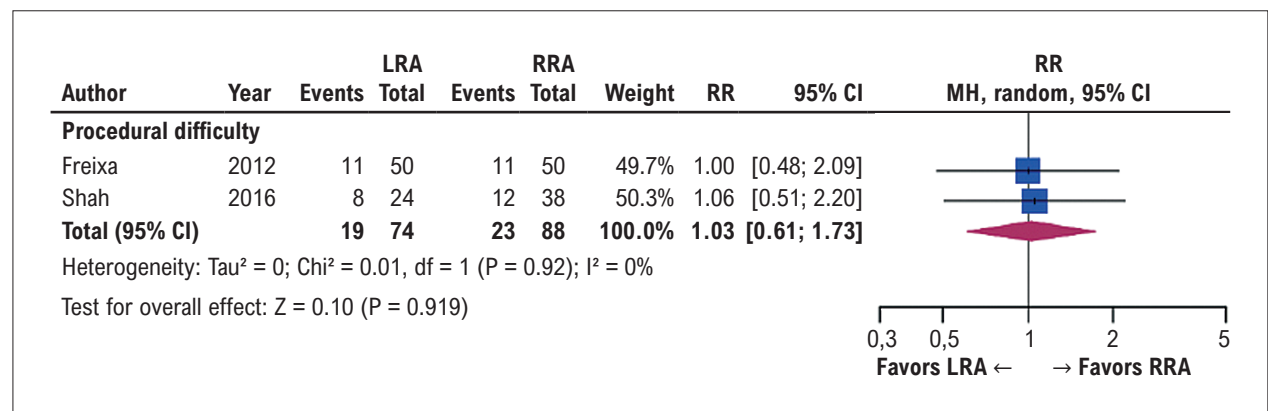


Figure 2 – The perceived difficulty of the procedure was similar between the groups. CI: confidence interval; LRA: left radial access; MH: Mantel-Haenszel; RR: risk ratio; RRA: right radial access.

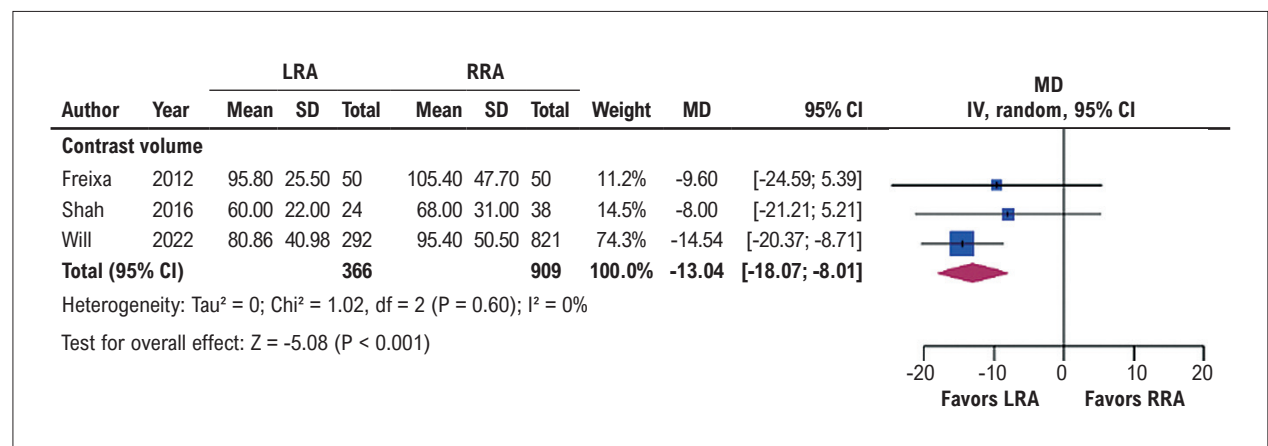


Figure 3 – The LRA group showed a significant reduction in the contrast volume. CI: confidence interval; IV: inverse variance; LRA: left radial access; RRA: right radial access; SD: standard deviation; MD: mean differences.

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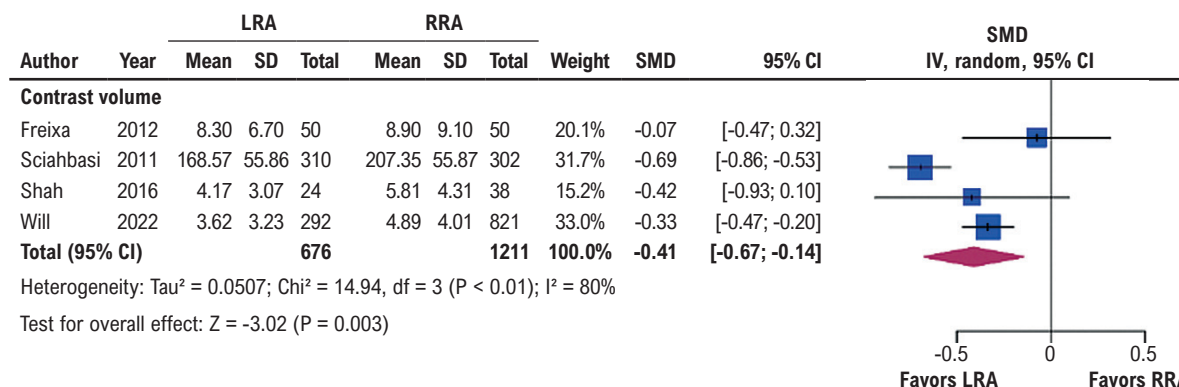


Figure 4 – The LRA group showed a significant shorter fluoroscopy time. CI: confidence interval; IV: inverse variance; LRA: left radial access; RRA: right radial access; SD: standard deviation; SMD: standardized mean difference.

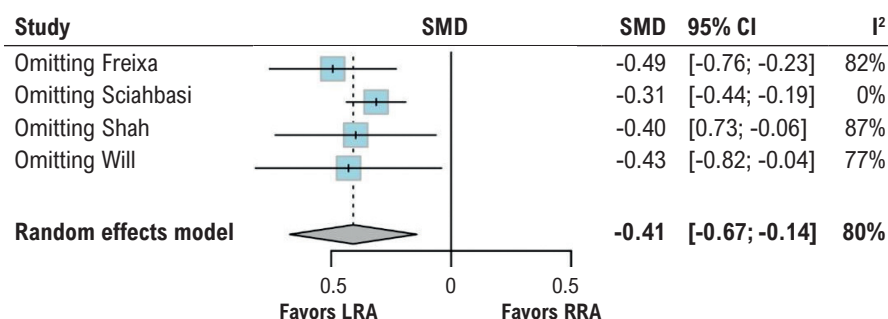


Figure 5 – Leave-one-out sensitivity analysis for the outcome of fluoroscopy time. CI: confidence interval; LRA: left radial access; RRA: right radial access; SMD: standardized mean difference.

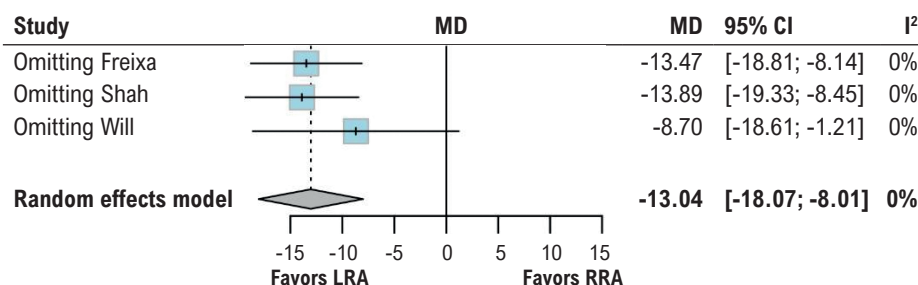


Figure 6 – Sensitivity Analysis for Contrast Volume. CI: confidence interval; LRA: left radial access; MD: mean difference; RRA: right radial access.

to the RRA group. Additionally, the procedural difficulty was slightly higher in the LRA group. Thus, the advantages of using the right radial approach seemed to be restricted to purely technical aspects, with no notable clinical implications.

Radial access is becoming increasingly common worldwide.¹¹ Despite evidence showing that RRA is associated with greater subclavian artery tortuosity compared to LRA, many clinicians still prefer RRA in practice.¹² A predefined subgroup analysis of the TALENT study revealed that the differences in radiation exposure between LRA and RRA were more pronounced in patients over 70 years old, with advanced age being an independent predictor of right subclavian artery tortuosity.¹³

Additionally, minimizing fluoroscopy time reduces radiation exposure for both patients and medical staff, which is associated with better long-term outcomes. This reduction in radiation is a key benefit, contributing to improved safety and long-term results for all involved.¹⁴

Also, the reduction in contrast volume with LRA may be due to the enhanced techniques or better visualization provided by the left radial approach, which is advantageous because it lowers the risk of contrast-related complications, such as allergic reaction and renal toxicity.^{15,16}

However, no significant difference was observed in the perceived difficulty of the procedure between the two groups. This suggests that the choice between LRA and RRA may be influenced mostly by other clinical factors or personal preferences than by the objective difficulty. Operator experience and familiarity with the technique likely play a significant role in this decision.^{17,18}

A crucial point is that the results obtained show that LRA has significant technical advantages over RRA in elderly patients undergoing coronary procedures, as summarized in the Central Illustration.

These outcomes have important clinical implications. Reducing fluoroscopy time and contrast volume with LRA can enhance patient safety and procedure efficiency, especially in settings where radiation exposure and contrast usage are major concerns.¹⁹ However, the lack of significant difference in perceived difficulty implies that operator experience and familiarity with the technique likely play a significant role in this decision.

Our findings align with a previous larger meta-analysis conducted by Shah et al. in 2016,²⁰ which also demonstrated that the left radial approach was associated with reductions in fluoroscopy time and contrast volume compared to the right radial approach. Although Shah et al.²⁰ included a broader and unselected patient population, our meta-analysis specifically focused on elderly patients (≥ 70 years), a subgroup at higher risk for procedural complications. By concentrating on this vulnerable population, our study provides more targeted evidence that may guide vascular access decisions in older adults undergoing coronary procedures.

Despite these positive results, there are limitations to this study. The high heterogeneity in fluoroscopy time suggests considerable variability between the included studies, likely due to differences in protocols and techniques. Additionally,

perceived difficulty was assessed subjectively, introducing potential bias and limiting the generalizability of the findings. The varying quality of the included studies, as well as differences in methodologies and sample sizes, may have contributed to the observed variability. Furthermore, the lack of detailed information about patient characteristics and procedural protocols limits the ability to conduct a more in-depth analysis.

Conclusion

In this study, we found that LRA access in elderly patients undergoing percutaneous coronary procedures is associated with a significantly shorter fluoroscopy time when compared to RRA. Additionally, LRA required a significantly lower contrast volume, suggesting a potential reduction in the risk of contrast-induced nephropathy in this vulnerable population. However, there was no significant difference in procedural difficulty between the two approaches. These results support that LRA might be a favorable option for elderly patients.

Author Contributions

Conception and design of the research: Gonçalves ALC, Guina OD; acquisition of data: Gonçalves ALC, Martins BAR, Bacca COF, Gadelha JG; analysis and interpretation of the data: Gonçalves ALC, Cavalcante DVS, Martins BAR, Bacca COF, Gadelha JG; statistical analysis: Gonçalves ALC, Cavalcante DVS, Queiroz S; writing of the manuscript: Gonçalves ALC, Martins BAR; critical revision of the manuscript for intellectual content: Gonçalves ALC, Cavalcante DVS, Guina OD.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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There were no external funding sources for this study.

Study Association

This study is not associated with any thesis or dissertation work.

Ethics Approval and Consent to Participate

This article does not contain any studies with human participants or animals performed by any of the authors.

Use of Artificial Intelligence

The authors did not use any artificial intelligence tools in the development of this work.

Research Data

The underlying content of the research text is contained within the manuscript.

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*Supplemental Materials

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