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Transradial Versus Transfemoral Access for Percutaneous Coronary Intervention of Unprotected Left Main Coronary Artery Stenosis: A Systematic Review and Meta-Analysis☆

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ABSTRACT

Introduction: PCI of ULMS is frequently performed through TFA because of technical complexity and safety concern. Studies have shown comparable efficacy and safety of TRA versus TFA, however, these studies are few in number. We intended to compare the clinical outcomes between transradial access (TRA) and transfemoral access (TFA) in patients undergoing percutaneous coronary intervention (PCI) for unprotected left main coronary artery stenosis (ULMS) by performing a meta-analysis.
Method: A systematic search of database, including, PubMed, Web of Science, Google scholar and Cochrane Database were performed by two independent reviewers. Studies were included comparing "TRA" versus "TFA" in patients undergoing PCI in ULMS. The primary outcome was a procedural success rate. Secondary outcomes were major bleeding, access site complications, in-hospital and long term: major adverse cardiac events (MACE), myocardial infarction (MI) and cardiovascular mortality.
Results: Eight studies were included in the analysis. The procedural success rate was 97.3% and there was no statistically significant difference between TRA and TFA groups (OR, 1.41 [CI 0.64, 3.12], $I^2 = 26\%$). The rates of access site complications (OR, 0.17 [CI 0.07, 0.41], $I^2 = 16\%$), major bleeding (OR, 0.39 [CI 0.17, 0.86], $I^2 = 0\%$) and all-cause mortality (OR, 0.28 [CI 0.12, 0.64], $I^2 = 0\%$) were lower in the TRA group. There were no significant differences in in-hospital and long term cardiovascular mortality, MI and MACE between the two groups.
Conclusion: In contrast to TFA, TRA is associated with reduced bleeding and access site complications, with similar procedural success rate in patients undergoing PCI of ULMS.

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1. Introduction

Transradial access (TRA) has increased steadily and universally in recent years for percutaneous coronary intervention (PCI) because it has fewer vascular complications and access site bleeding compared to transfemoral access (TFA) [1,2]. Coronary artery bypass surgery (CABG) remains the treatment of choice for unprotected left main coronary artery stenosis (ULMS), with a class Ib indication per the American College of Cardiology (ACC) 2011 guidelines [3]. Studies have reported the relative efficacy and safety of PCI in ULMS and have shown good short- and long-term clinical outcomes, especially in non-bifurcation lesions. ACC gives a level IIa recommendation for PCI in patients with ULMS with a SYNTAX score of <22, and ostial or trunk left main lesion in which the Society of Thoracic Surgeons (STS) predicted a risk of operative mortality >5% [3]. Despite studies that have supported the relative safety of PCI of ULMS, it remains a challenging procedure for interventionalists because of technical complexities and the frequent presence of bifurcation lesions [4]. Frequently, PCI of ULMS requires a large guide catheter and intravascular imaging, and interventionalists perform PCI through TFA often because of the need for better support and anticipation of complexities [5]. Although studies have reported the feasibility and safety of TRA compared to TFA for PCI of ULMS, these studies are few in number and have included only small samples [6–13]. The objective of this study was to summarize the evidence available by performing a meta-analysis and comparing the clinical outcomes between TRA vs. TFA in PCI of ULMS.

Abbreviations: ULMS, Unprotected left main coronary artery stenosis; TRA, Transradial access; TFA, Transfemoral access; PCI, Percutaneous coronary intervention; DES, Drug eluding stent; BMS, Bare metal stent; MI, Myocardial infarction; TVR, Target vessel revascularization; MACE, Major adverse cardiac events.

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2. Methods

PRISMA statement (Preferred Reporting Items for Systematic reviews and Meta-Analyses) was used for the conduct of the current systematic review and meta-analysis [14].

2.1. Data source and searches

A systematic search of, PubMed, Web of Science, Google scholar and Cochrane Database were performed. Following key words were used in various combinations, "Transradial", "Radial", "Left main coronary artery" and "Percutaneous coronary intervention". Our search details are as follows: transradial[All Fields] OR (radial[All Fields] AND left[All Fields] AND main[All Fields] AND ("coronary vessels"[MeSH Terms] OR ("coronary"[All Fields] AND "vessels"[All Fields]) OR "coronary vessels"[All Fields] OR ("coronary"[All Fields] AND "artery"[All Fields]) OR "coronary artery"[All Fields]) AND ("percutaneous coronary intervention"[MeSH Terms] OR ("percutaneous"[All Fields] AND "coronary"[All Fields] AND "intervention"[All Fields]) OR "percutaneous coronary intervention"[All Fields]). Additionally, references from previous trials, meta-analysis and web base were also searched to identify any relevant studies. No language restriction was enforced. The abstracts or manuscripts of all retrieved studies cited before May 2017 were reviewed.

2.2. Study selection

The inclusion criteria were based on the following attributes: 1) design: randomized or non-randomized trials or registries; 2) population: adult patients who underwent PCI for significant ULMS; 3) intervention: TRA vs. TFA for PCI; and 4) at least one of the outcomes reported: procedural success, in-hospital and long-term major adverse cardiac events (MACE), in-hospital and long-term cardiovascular mortality, access site complications, myocardial infarction (MI), major bleeding, contrast agent volume, fluoroscopy time, and total procedure time. Patients were included in these studies if their lesion was considered suitable for PCI and ineligible for CABG because of one of the following criteria: very high risk for CABG, limited life expectancy, patient refused CABG, or was regarded as unstable for CABG by surgeons.

2.3. Data extraction and validity assessment

Two independent reviewers [AB and SP] performed the literature search and identified relevant studies. The following information was abstracted: author name, publication year, country in which the study was performed, study design, inclusion and exclusion criteria, total participants in the study, mean age, number of male and female participants, baseline demographics, and cardiovascular risk factors, including diabetes mellitus, hypertension, left ventricular ejection fraction (LVEF), angiography findings, percent bifurcation lesions, patients with cardiogenic shock, and use of stents (bare metal stents [BMS] or drug-eluding stents [DES]). A third investigator was available for arbitration in the event of disagreement on the data extracted, but there was no significant disagreement.

2.4. Definitions

Significant left main coronary artery stenosis was defined as clinical symptoms or objective evidence of myocardial ischemia and stenosis of >50% in the left main coronary artery. ULMS was defined as significant left main stenosis without the presence of patent bypass graft to the left anterior descending or left circumflex artery. Procedural success was defined as residual diameter stenosis <30% after balloon dilation, with TIMI-3 flow without procedural related death, stroke, Q wave MI, repeat PCI, and emergent CABG. MACE was defined as the composite end point of cardiac death, MI and target lesion revascularization (TLR), or target vessel revascularization (TVR) – either PCI or CABG – for a restenotic left main lesion >50%. TLR was determined as any

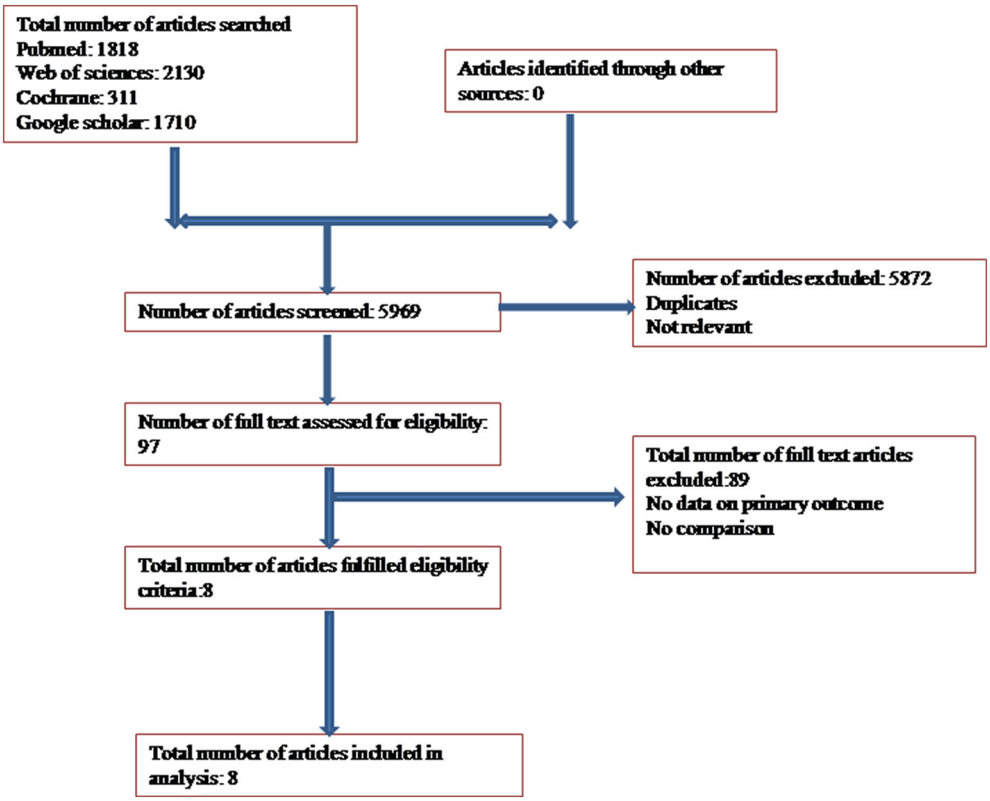

Fig. 1. Study selection flow diagram.

Table 1
Characteristics of included studies.

Author	Year	Country	Study type	N	TR/TF	Stents DES (%)	Follow-up	EF (%)		Mean age (years)		Male (%)		DM (%)		HTN (%)		Previous PCI (%)		Distal lesion (%)	
								TR	TF	TR	TF	TR	TF	TR	TF	TR	TF	TR	TF	TR	TF
Ziakas et al [6]	2004	Canada	Retrospective	80	27/53	0	27 months	56.5 + 11.1	49.2 + 14.7	74.8 + 9.6	71.3 + 8.7	85.2	69.8	29.6	41.5	32.7	41.5	29.7	52.8	70.4	69.8
Hsueh et al [7]	2008	Taiwan	Retrospective	131	116/15	80/3	6 months	NA	NA	67.4 + 10.4	65.6 + 10.6	76.7	53.3	37.9	46.7	68.1	93.3	42.2	40	74.1	80
Yang et al [8]	2010	China	Retrospective	821	353/468	100/100	6 months	58 + 10	59 + 11	59 + 11	61 + 11	78	77	24	24	53	54	23	25	56	67
Bertrand et al [9]	2010	Canada	Retrospective	103	90/13	44/69	Not defined	49 + 14	42 + 19	85 + 3	82 + 3	57	38	24	38	77	62	14	15	73	84
Tomassini et al [10]	2013	Italy	Retrospective	49	27/22	100/95.4	32 months	54 + 10	46 + 13	68 + 9	72 + 9	66.7	81.8	40.7	31.8	81.5	40.9	NR	NR	92.6	90.1
Chung et al [11]	2015	Korea	Retrospective	483	161/322	100/100	1038 d	59 + 10	61 + 11	63 + 10	63 + 10	77.6	76.4	30.4	32	59.6	58.4	24.8	23	100	100
DeMaria et al [12]	2015	UK and Italy	Retrospective	467	246/221	100/100	12 months	55	50	70.6 + 10.9	69.3 + 10.8	79.3	73.7	29.5	33.5	75.1	63.2	18.3	22.6	100	100
Gili et al [13]	2017	Italy and Spain	Retrospective	354	177/177	100/100	726 + 654 d	NR	NR	69.7 + 10.9	71 + 9.2	NR	NR	38.4	29.9	83.1	83.1	35.5	35.9	79.1	85.3

TR: transradial; TF: transfemoral; EF: ejection fraction; DES: drug eluding stents; DM: diabetes mellitus; HTN: hypertension; PCI: percutaneous coronary intervention; NR: not reported; d: days, UK: United Kingdom.

repeated PCI or bypass grafting surgery to treat a luminal renarrowing in-stent or within 5-mm borders adjacent to the stent, including the ostia of the left coronary arteries. Major bleeding was defined using the Bleeding Academic Research Consortium Classification (BARC) or Thrombolysis in Myocardial Infarction (TIMI) bleeding criteria, or bleeding requiring blood transfusion. Post-procedure MI was diagnosed by electrocardiographic changes and/or a rise and fall of the creatine kinase-myocardial band fraction in the presence of ischemic symptoms. New development of pathological Q waves in 2 contiguous leads was defined as Q-wave MI, and in the absence of pathological Q waves, an elevation in the creatine kinase-myocardial band level >2 times the upper limit of normal was defined as non-Q-wave.

2.5. Outcomes

Study endpoints: The primary outcome of interest was the procedural success rate, and secondary outcomes were: 1) In-hospital outcomes: access site complications, major bleeding events, MI, procedural time, fluoroscopy time, MACE, all-cause mortality and cardiovascular mortality, and 2) Long-term outcomes: MACE, cardiovascular mortality, TLR, and MI.

2.6. Data synthesis and statistical analysis

A study level analysis was done using Review manager 5.3 [The Nordic Cochrane Centre, The Cochrane Collaboration, 2008] and CME version 3. Odds ratio (RR) and 95% confidence intervals [95% CI] were used as summary statistics for all outcomes except the continuous variables. Studies were evaluated for heterogeneity by visual inspection of the confidence intervals and by means of I^2 [$I^2 = (Q - df) / Q$], where Q is the χ^2 statistic and df is degree of freedom. As a guide, an I^2 >30% was considered as an indicator of statistical heterogeneity among the studies. A Mantel-Haenszel fixed effect model was used to calculate the pooled OR for homogeneous end points. Random effect [DerSimonian] analysis was reported in the presence of significant heterogeneity. Even if there was little or no evidence of heterogeneity, a random effects model was used for each outcome because of the arguments put forth by many authors for using random effects models in medical decision-making contexts, especially in the case of rare events. A weighted mean difference [WMD] was calculated to summarize the continuous outcome in studies that reported means and standard deviations. A p value of <0.05 was considered significant. Sensitivity analysis was performed by removing one study at a time. Publication bias was assessed using the Egger linear regression test, visual inspection of funnel plots, and the Begg-Mazumdar test for procedure success, major bleeding and MACE at follow up [15]. The trim-and-fill method was used to adjust for publication bias. The trim-and-fill method determines where missing studies are likely to fall, adds them to the analysis, and then recomputes the combined effect. As suggested previously, the studies were not scored based on their quality [16].

3. Results

3.1. Search strategy and study characteristics

Study selection details are listed in Fig. 1. Of a total of 5969 citations, 8 studies fulfilled our eligibility criteria and outcomes required. All of the studies included were non randomized studies. Studies by Gili et al. and Chung et al. reported both unadjusted and propensity-adjusted data and only propensity-adjusted data were included in the final analysis [11,13]. Two of the studies included were conducted in Canada, two in Italy, and others in UK, China, Korea, and Taiwan. All studies reported data on in-hospital outcomes except that of Bertrand et al., which reported thirty-day outcomes [9]. Long-term outcomes were reported in which the longest follow-up was 6 months in 3 studies and a mean of 32 months in Tomassini et al., 12 months in Chung et al. and DeMaria et al., and 24 months in Gili et al. [6–13]. All of the studies included had

a similar MACE definition, except those of Tomassini et al. and Bertrand et al., which also used cerebrovascular accidents as an additional component [9,10]. There was some variability in the definition of bleeding used in the studies. We used TIMI major bleeding data from Chung et al. and Hsueh et al., BARC major from Tomassini et al., TIMI major and minor from Yang et al., and any bleeding requiring transfusion from Bertrand et al. and DeMaria et al. [6–13].

3.2. Patient demographics and characteristics (Tables 1 and 2)

The eight studies included a total of 2858 patients. The mean age of the patients in each study ranged from 59 to 85 years. Bernard et al.'s study included only octogenarian patients. Both groups were comparable and no significant differences between demographic and cardiovascular characteristics were observed in any study except in the left ventricle ejection fraction in Ziakas et al. and Tomassini et al., and previous PCI in Ziakas et al., as shown in Table 1 [6,10]. Ziakas et al.'s study used only BMS, and Bernard et al. used DES in 44% of the TRA group and 69% of the TFA group, while the other studies used largely DES only. Dual antiplatelet therapy (DAPT) was used for 1 year in all of the studies. Ziakas et al.'s study used 4 weeks of DAPT because of the use of BMS. All studies had a high number of bifurcation lesions, ranging from 56 to 90%, except those of Chung et al. and DeMaria et al., in which the studies focused exclusively on left main bifurcation lesions.

3.3. Primary outcome

Six studies reported the procedural success rate (Fig. 2), which was 97.3% (97.7% in TRA vs. 97% in TFA) overall, and there was no statistically significant difference between the TRA and TFA group (OR, 1.41 [CI 0.64, 3.12], $I^2 = 26\%$). Sensitivity analyses were performed by removing one study at a time, and the OR calculated remained statistically nonsignificant with this procedure. When we excluded Chung et al.'s study, the heterogeneity became zero, but the results remained statistically nonsignificant (OR, 1.63 [CI 0.90, 2.96], $I^2 = 0$).

3.4. In-hospital secondary outcomes

The rate of access site complications (OR, 0.17 [CI 0.07, 0.41], $I^2 = 16\%$), major bleeding (OR, 0.39 [CI 0.17, 0.86], $I^2 = 0\%$), all-cause mortality (OR, 0.28 [CI 0.12, 0.64], $I^2 = 0\%$), and contrast agent volume (OR, −11.36 [CI −15.20, −7.52], $I^2 = 0\%$) were lower in the TRA group than the TFA group. The rate of MACE (OR, 0.42 [CI 0.14, 1.24], $I^2 = 67\%$), cardiovascular mortality (OR, 0.30 [CI 0.05, 1.71], $I^2 = 37\%$), and MI (OR, 1.34 [CI 0.76, 2.36], $I^2 = 0\%$) did not differ significantly between the two groups. If we removed Yang et al.'s study, there was less heterogeneity, and the MACE rate in the two groups became statistically significant and was lower in the TRA group (OR, 0.26 [CI 0.11, 0.66], $I^2 = 21\%$: Figs. 3 and 4). Fluoroscopy (WMD, 0.59 [CI −2.27, 3.44], $I^2 = 39\%$) and total procedure time (WMD, −1.07 [CI −2.52, 0.32], $I^2 = 0\%$) did not differ significantly between the two groups (Fig. 5).

3.5. Long-term secondary outcomes

Long-term outcomes were measured at the time of the longest follow up. There were no statistically significant differences in the rate of MACE (OR, 0.95 [CI 0.72, 1.25], $I^2 = 14\%$), MI (OR, 1.20 [CI 0.72, 1.98], $I^2 = 0\%$), TVR (OR, 0.86 [CI 0.50, 1.47], $I^2 = 8\%$), and cardiovascular mortality (OR, 1.19 [CI 0.63, 2.26], $I^2 = 0\%$) between the two groups (Figs. 6 and 7).

3.6. Publication bias

A funnel plot was created to ascertain publication bias in our study by comparing the procedural success rate between the TRA and TFA groups. This is a scatter plot of the treatment effects estimated from the individual studies plotted on the horizontal axis (OR) against the standard error (SE) of the estimate shown on the vertical axis. Visual inspection of the funnel plot showed evidence of publication bias with possible weaker strengths of association ranging between log odds ratio 0 and 1 (Supplement Fig. 1A). However, the Egger linear regression test ($p = 0.46$) and Begg and Mazumdar rank correlation test ($p = 0.5$) showed no bias. The results of trim and fill analysis using a random effect model showed no missing studies and the adjusted odds ratio remained unchanged (Supplement Fig. 1B). The funnel plot for major bleeding showed some asymmetry again, but Egger linear regression ($p = 0.79$) and Begg and Mazumdar rank correlation ($p = 0.5$) showed no evidence of publication bias (Supplement Fig. 2). The plot for MACE at long-term follow up also exhibited some asymmetry. However, again, Egger linear regression ($p = 0.11$) and Begg and Mazumdar correlation ($p = 0.08$) showed no evidence of bias (Supplement Fig. 3A). Trim and fill analysis showed two studies missing on the right of the mean, but their addition did not change the odds ratio (OR 0.98, CI [0.70, 1.35]) to any great extent (Supplement Fig. 3B).

Table 2
Procedural characteristics.

Author	Sheath size (Fr)		Guide catheter (Fr)		% Stenosis		Lesion length (mm)		GpIIb/IIIa (%)	
	TR	TF	TR	TF	TR	TF	TR	TF	TR	TF
Ziakas et al. [6]	6:55.6% 7:44.4% 8:0	22.7% 50.9% 26.4%	NR	NR	84.6 + 16.01	84.5 + 13.5	11.3 + 4.58	10.4 + 5.5	48.1	28.3
Hsueh et al. [7]	NR	NR	6: 85.3% 7:13.8% 8:0.9% 9:0 10:0	20% 20% 33.3% 13.3% 13.3%	62.7 + 16	70.3 + 21.6	16.03 + 9.5	11.7 + 7.7	NR	NR
Yang et al. [8]	NR	NR	Mean: 6.1 + 0.4	6.9 + 0.8	80.6 + 15.6	82.1 + 13	NR	NR	7	9
Bertrand et al. [9]	5:1% 6:92% 7:7%	8% 77% 15%	NR	NR	NR	NR	NR	NR	33	23
Tomassini et al. [10]	NR	NR	Guide catheter >6: 12.5%	59.1%	NR	NR	NR	NR	33.3	27.3
Chung et al. [11]	NR	NR	6.5 + 0.6	7.1 + 0.5	NR	NR	NR	NR	NR	NR
DeMaria at al [12]	NR		6:76.9% 6.5:3.6% 7.5:19.5% 8:0	72.4% 0 8.6% 19%	NR	NR	NR	NR	8.9	0.9
Gili et al. [13]	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

NR: not reported, TR: transradial, TF: transfemoral.

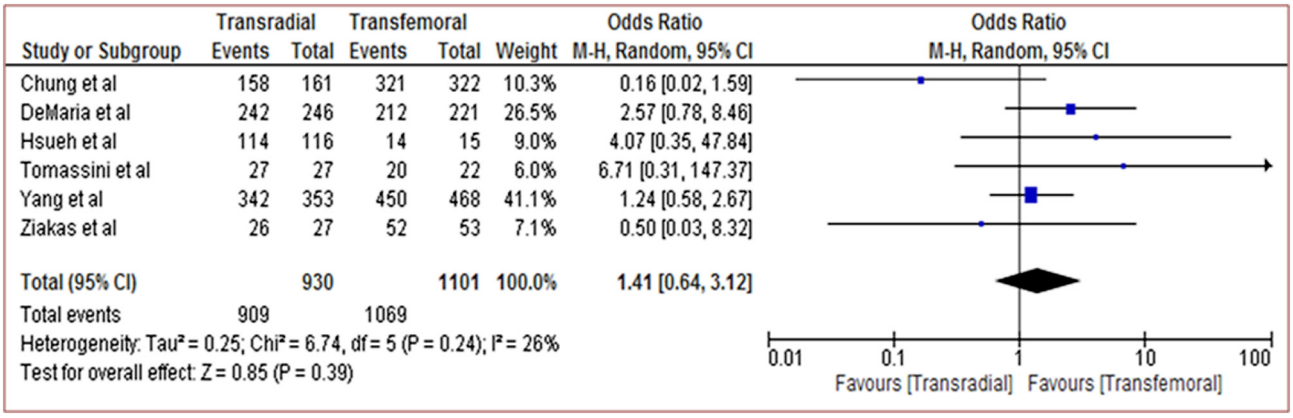

Fig. 2. Forest-plot comparing transradial access and transfemoral access for procedure success rate in patients undergoing percutaneous coronary intervention of unprotected left main coronary artery stenosis. The squares and horizontal lines indicate odd ratios for random effect model and their 95% CI for each study included. The size of each square is proportional to the statistical weight of a study. The diamond indicates the effect estimate derived from meta-analysis with center indicating the point estimate and right and left end indicating the 95% CI. PCI: percutaneous coronary intervention; OR: odds ratio.

4. Discussion

In this study, we reported the association between the access site and clinical outcomes in patients undergoing PCI of ULMS. To the best of our knowledge, our meta-analysis is the first performed to compare the clinical outcomes between TRA and TFA in patients undergoing PCI of ULMS. The salient findings of our study were: 1) PCI of ULMS through TRA is safe, feasible and has a procedural success rate comparable to that of TFA; 2) PCI of ULMS through TRA is associated with a lower bleeding rate and fewer access site complications; 3) in-hospital all-cause mortality and possible in-hospital MACE were significantly less in the TRA group compared to the TFA group, probably because of a reduction in bleeding events; 4) TRA and TFA had similar long-term clinical outcomes, and 5) There was no difference in fluoroscopy time and total procedural time between the two groups. All of the studies included in our analysis reported the similar finding that TRA is feasible, with similar procedural success rates and no increase in the rate of cardiovascular events.

Based on the results of our analysis, TRA may be the access site of choice for PCI of ULMS. TFA has the advantage of using a larger sheath

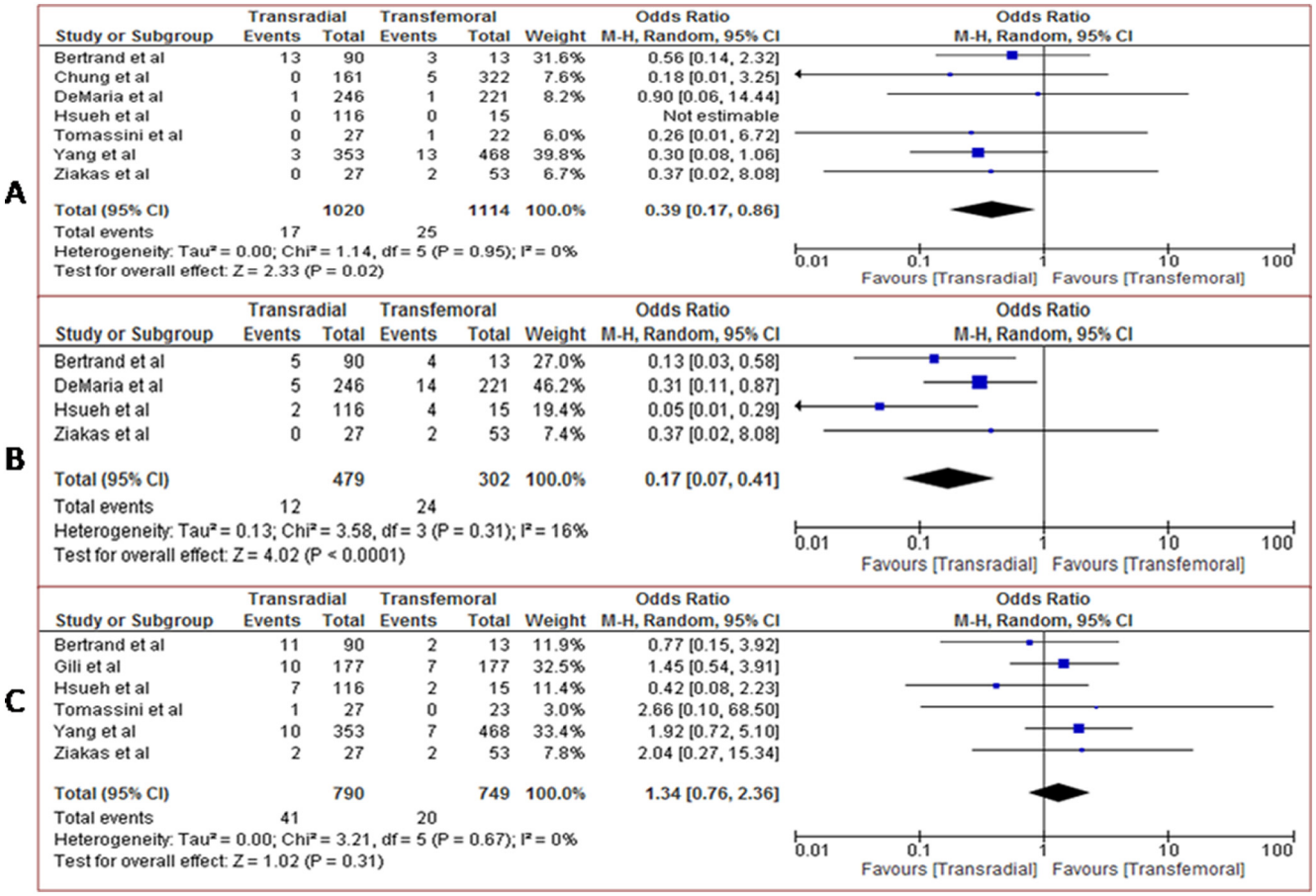

Fig. 3. Forest-plot comparing transradial access and transfemoral access for the following: (A) major bleeding, (B) access site complications and (C) in-hospital myocardial infarction in patients undergoing percutaneous coronary intervention of unprotected left main coronary artery stenosis. MI: myocardial infarction.

size to manipulate large guide catheters and provide better support. Studies have shown that most PCI of ULMS, even those with bifurcation lesions, can be performed with a 6 French (Fr) guide catheter and one larger than 6 Fr is associated with a greater number of PCI-related complications [7,8,10,17]. However, many operators still prefer TFA for PCI of ULMS, especially those with bifurcation lesions, because of fear of suboptimal angiographic results and intraprocedural complications. Nonetheless, TRA's limitations are reduced because of the developments in catheter technology and the availability of a newer glide slender sheath. The newer slender sheath is designed with a unique thin-wall structure in which the outside diameter is reduced by one Fr size, while the inner-diameter equivalent is maintained. These slender sheaths are available up to 7 Fr (7 Fr internal lumen and 6 Fr outer caliber). TRA now can adapt guide catheters with larger calibers either to the sheath developed recently (Glide slender sheath) or through the sheathless 8 Fr catheter. Increasing worldwide operators' experience in TRA has increased their confidence further in performing complex PCI through TRA.

Our meta-analysis also showed that the contrast agent volume used was significantly less in the TRA than the TFA group. Numerous studies have reported that the contrast agent's volume is associated directly with the risk of acute kidney injury and the lower contrast agent volume in the TRA group potentially could decrease this risk and hence constitute an additional advantage of TRA [18]. One could argue that the TRA group had simpler left main lesions and hence needed less contrast volume, but we found no difference in the lesions' complexity between the two groups. As Table 1 shows, both groups had similar numbers of distal left main bifurcation lesions, except that of Yang et al. [8]. We did not compare the incidence of acute kidney injury between the groups in our meta-analysis because of the lack of data available in the studies analyzed.

Further, one could argue that patients in the TFA group were sicker and had more complicated diseases, and thus, TFA was chosen because it is difficult to feel a radial pulse in patients with shock and hence, mortality increases. However, there was no significant difference in the two groups between patients with acute coronary syndrome and cardiogenic shock.

Numerous studies have shown repeatedly that TRA is associated with decreased access site complications and bleeding rate than is TFA [1,2]. Patients undergoing PCI of the left main often require such hemodynamic support such as intra-aortic balloon pumps and Impella, both of which TFA provides. Having two TFA in place increases the risk of major bleeding substantially and hence, the length of stay and mortality overall.

5. Study limitations

The main limitations of our meta-analysis were as follows: 1) all were non-randomized studies, which have several inherent biases and confounding variables; 2) small number of studies; 3) small patient sample size in some of the studies; 4) variability in the definition of MACE and major bleeding the studies used, in which some used the BARC classification and others the TIMI classification, and 5) the mean duration of follow up also varied between the studies and ranged from six to thirty-two months.

6. Conclusions

Our meta-analysis demonstrated that, compared to the traditional TFA, TRA for PCI of ULMS is safe, feasible and is associated with similar procedural success. Further, TRA has the benefits of reducing access

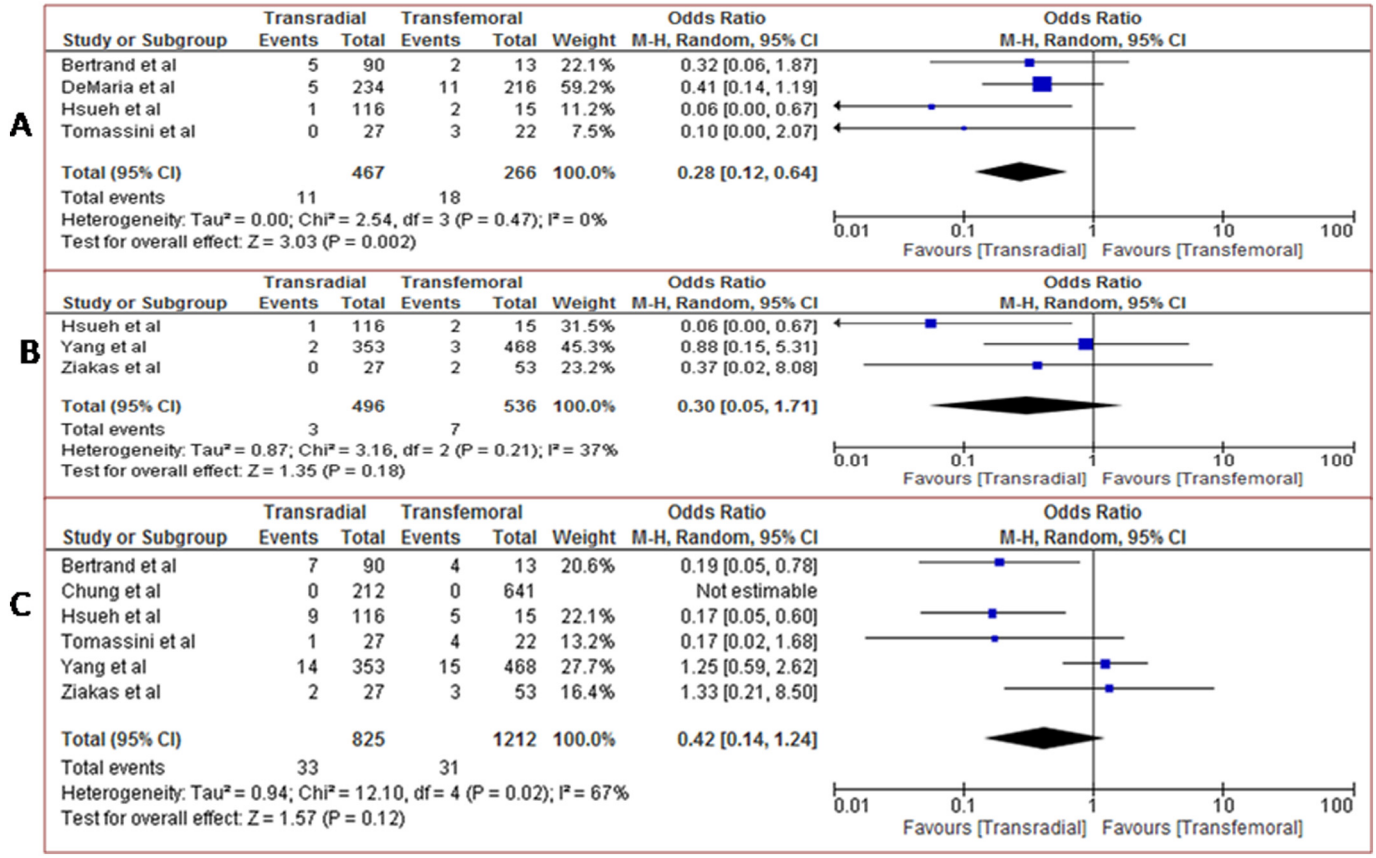

Fig. 4. Forest-plot comparing transradial access and transfemoral access for the following: (A) all-cause mortality, (B) cardiovascular mortality and (C) in-hospital major adverse cardiac events in patients undergoing percutaneous coronary intervention of unprotected left main coronary artery stenosis. MACE: major adverse cardiac events. CV mortality: cardiovascular mortality.

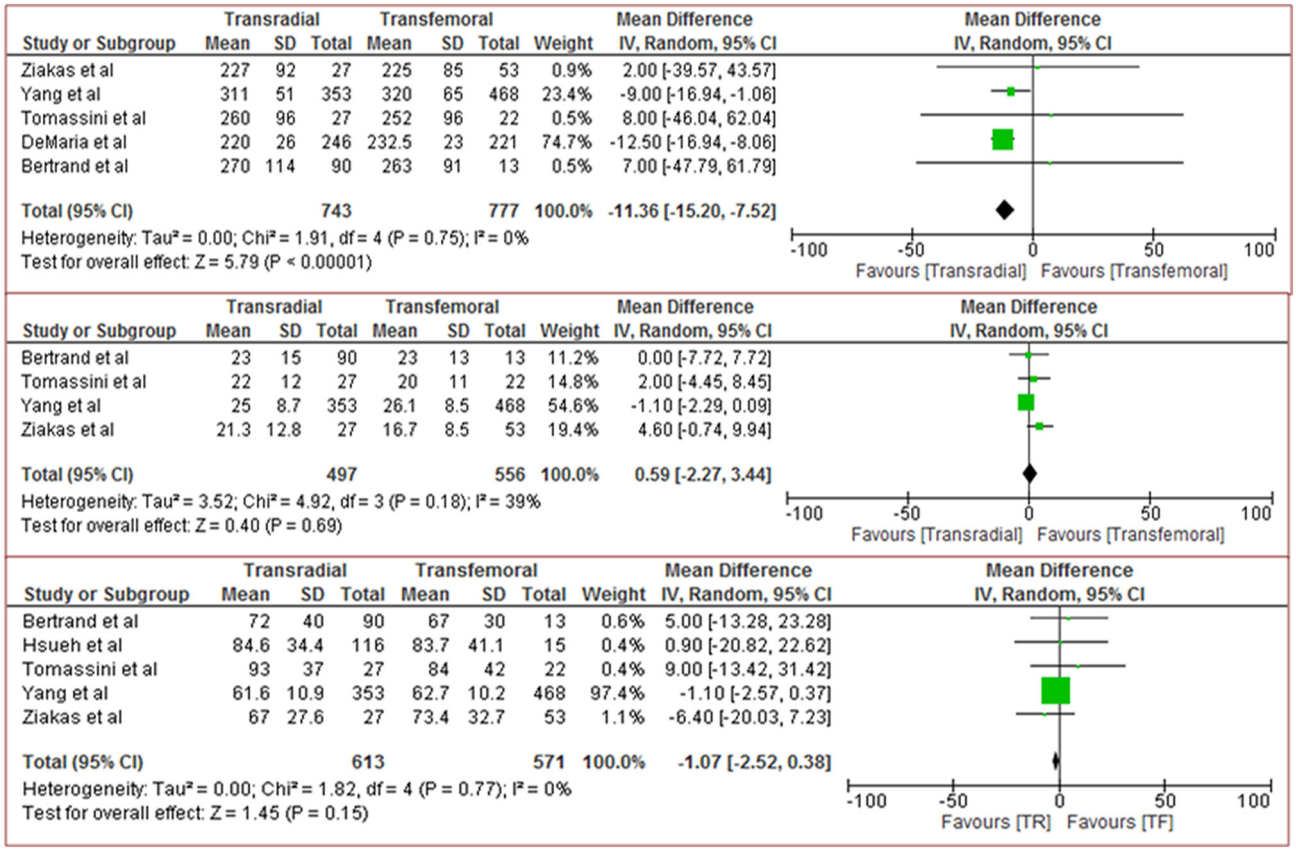

Fig. 5. Forest-plot comparing transradial access and transfemoral access for the following: (A) contrast agent volume, (B) fluoroscopy time and (C) procedural time in patients undergoing percutaneous coronary intervention of unprotected left main coronary artery stenosis.

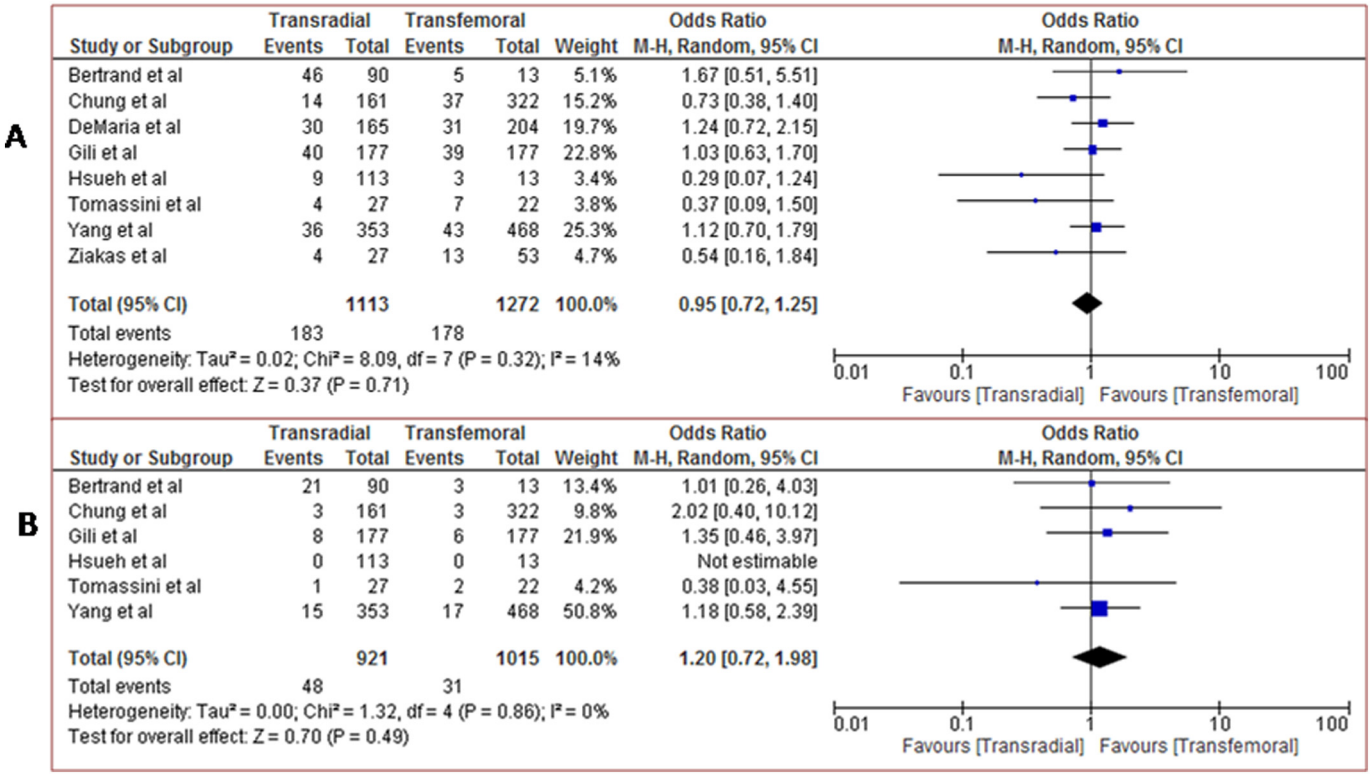

Fig. 6. Forest-plot comparing transradial access and transfemoral access for the following: (A) long term major adverse cardiac events and (B) myocardial infraction in patients undergoing percutaneous coronary intervention of unprotected left main coronary artery stenosis. MI: myocardial infraction.

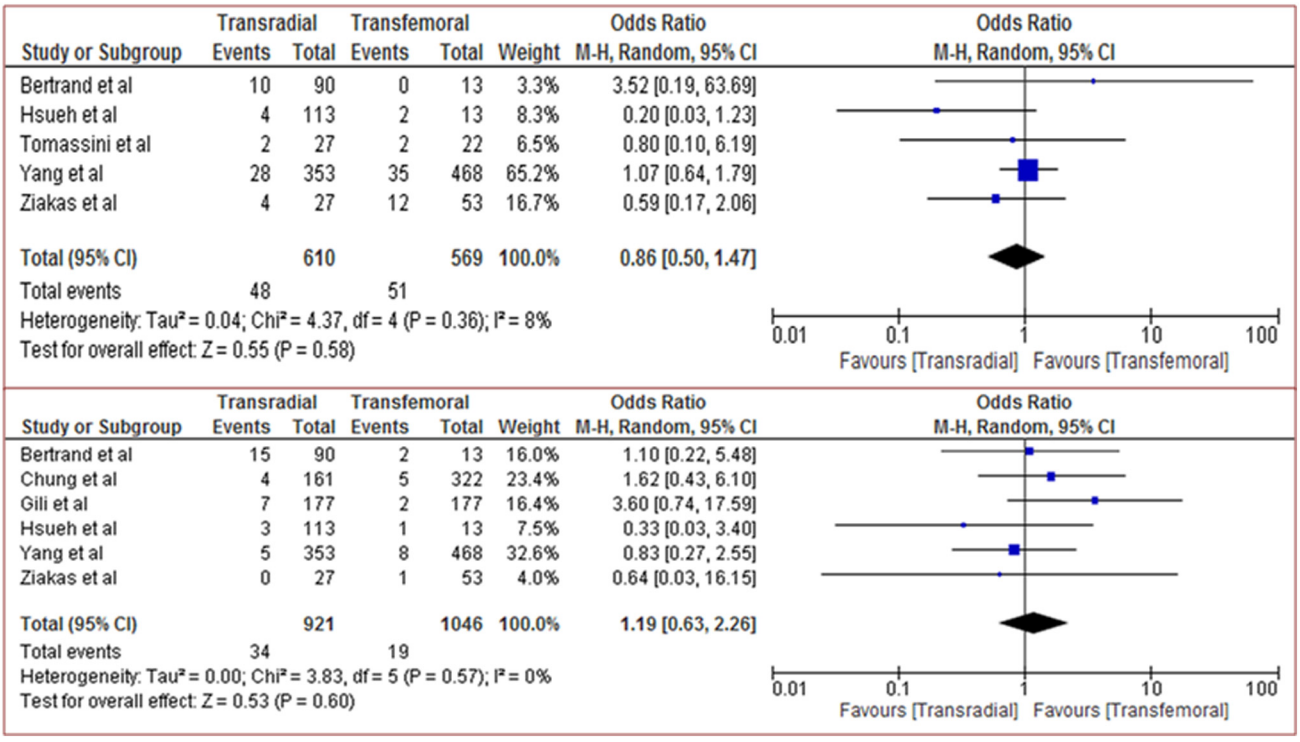

Fig. 7. Forest-plot comparing transradial access and transfemoral access for the following: (A) target vessel revascularization and (B) long term cardiovascular mortality in patients undergoing percutaneous coronary intervention of unprotected left main coronary artery stenosis. TVR: target vessel revascularization; CV mortality: cardiovascular mortality.

site complications and bleeding. Multicenter randomized controlled trials are needed for further evidence.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.carrev.2018.10.025.

Authorship declaration

I would like to state that all authors listed above meet the authorship criteria according to the latest guidelines of the International Committee of Medical Journal Editors, and ii) that all authors are in agreement with the manuscript.

Submission declaration

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Disclosure of interest

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