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ORIGINAL STUDIES

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Association of adoption of transradial access for percutaneous coronary intervention in ST elevation myocardial infarction with door-to-balloon time

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Abstract

Objectives: We aimed to study adoption of transradial primary percutaneous coronary intervention (TR-PPCI) for ST elevation myocardial infarction (STEMI) ("radial first" approach) and its association with door-to-balloon time (D2BT).

Background: TR-PPCI for STEMI is underutilized in the United States due to concerns about prolonging D2BT. Whether operators and hospitals adopting a radial first approach in STEMI incur prolonged D2BT is unknown.

Methods: In 1,272 consecutive cases of STEMI with PPCI at our hospital from January 1, 2011, to December 31, 2016, we studied TR-PPCI adoption and its association with D2BT including a propensity matched analysis of similar risk TR-PPCI and trans-femoral primary PCI (TF-PPCI) patients.

Results: With major increases in hospital-level TR-PPCI (hospital TR-PPCI rate: 2.6% in 2011 to 79.4% in 2016, *p*-trend<.001) and operator-level TR-PPCI (mean operator TR-PPCI rate: 2.9% in 2011 to 81.1% in 2016, *p*-trend = .005), median hospital level D2BT decreased from 102 min [81, 142] in 2011 to 84 min [60, 105] in 2016 (*p*-trend<.001). TF crossover (10.3%; *n* = 57) was not associated with unadjusted D2BT (TR-PPCI success 91 min [72, 112] vs. TF crossover 99 min [70, 115], *p* = .432) or D2BT adjusted for study year and presenting location (7.2% longer D2BT with TF crossover, 95% CI: –4.0% to +18.5%, *p* = .208). Among 273 propensity-matched pairs, unadjusted D2BT (TR-PPCI 98 [78, 117] min vs. TF-PPCI 101 [76, 132] min, *p* = .304), and D2BT adjusted for study year and presenting location (5.0% shorter D2BT with TR-PPCI, 95% CI: –12.4% to +2.4%, *p* = .188) were similar.

Conclusions: TR-PPCI can be successfully implemented without compromising D2BT performance.

KEYWORDS
cardiac catheterization, myocardial infarct, percutaneous transluminal coronary angioplasty, radial artery, reperfusion

1 | INTRODUCTION

Transradial primary percutaneous coronary intervention (TR-PPCI), a proven strategy to reduce morbidity and mortality from ST elevation myocardial infarction (STEMI), is used in <25% of STEMI patients in the United States.[1–4] Many practicing interventional cardiologists in the United States do not routinely use TR-PPCI in STEMI, and consequently most U.S. hospitals perform a low rate of TR-PPCI in STEMI patients.[4] Concerns about prolonging door-to-balloon time (D2BT) have contributed to slow adoption of TR-PPCI in the United States, where D2BT has been an important quality metric.[5] Adoption of this technique has been inadequate despite recognition that a delay in D2BT of >21 min is needed to offset the mortality benefit observed in randomized clinical trials.[6] To encourage adoption of TR-PPCI in STEMI patients, TR-PPCI experts have recently advocated for changing national guideline D2BT goals to allow an additional 10 min in TR-PPCI cases.[7] The actual impact of TR-PPCI adoption on D2BT is unknown. We studied the association between TR-PPCI use and D2BT performance during adoption of a radial first approach in STEMI in a quaternary care hospital in the United States.

2 | MATERIALS AND METHODS

2.1 | Study population

This observational registry of all patients with STEMI treated with PPCI at our hospital from January 1, 2011, to December 31, 2016, was approved by the institutional review board at our hospital with a waiver of written informed consent. No informed consent was required or collected for this study. Clinical data including D2BT were recorded prospectively according to the standards of the American College of Cardiology National Cardiovascular Data Registry (ACC NCDR) CathPCI Registry.[8] No patients were excluded (Figure 1).

2.2 | Transradial primary percutaneous coronary intervention

During the study period, we transitioned from an operator-dependent approach to vascular access to a radial first approach in STEMI patients. Published randomized trial data demonstrating the benefit of TR-PPCI in STEMI were discussed among operators at our hospital, and we arrived at a consensus to make radial access the first choice for STEMI patients.[2,3,9] Given the clinical trial evidence of benefit with TR-PPCI in STEMI, operators were actively encouraged to adopt TR-PPCI in STEMI, but adoption was not formally mandated. We invited external experts in TR-PPCI to our catheterization lab to teach nurses, fellows, and staff physicians the procedural tricks, workflow tips, and optimal use of equipment. We carefully monitored TR-PPCI efficiency and outcomes with frequent discussions in catheterization conferences about procedural details. Operators also gained experience through increased use of transradial (TR) access in patients undergoing PCI for indications other than STEMI (Supplementary Figure 1), however there was no required elective TR case volume prior to attempting TR-PPCI in STEMI.

2.3 | Outcomes and analysis

We studied TR-PPCI implementation (a) at the hospital level as the percentage attempted TR-PPCI per year, (b) at the operator level (operator N = 21) as the operator average percentage attempted TR-

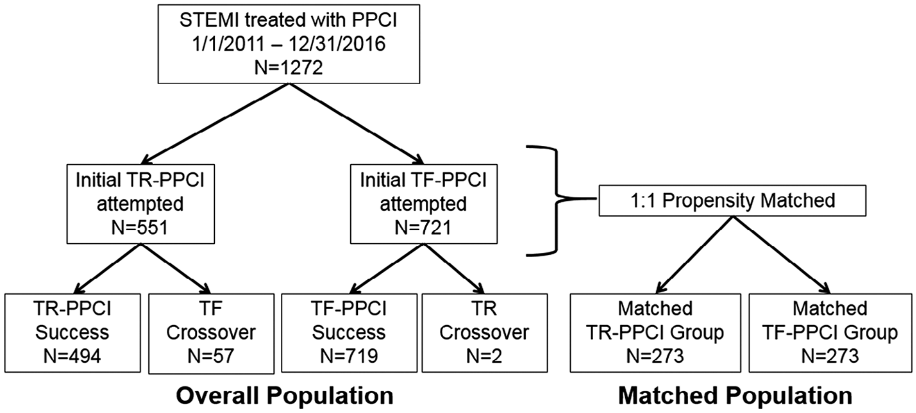

FIGURE 1 Study population. PPCI, primary percutaneous coronary intervention; TF-PPCI, transfemoral primary percutaneous coronary intervention; TR-PPCI, transradial primary percutaneous coronary intervention; STEMI, ST elevation myocardial infarction

PPCI per year, and (c) for operators who performed PCI in STEMI patients longitudinally from 2011 to 2016 (operator $N = 12$) as the average percentage attempted TR-PPCI in 2016 compared with 2011. The primary outcome was D2BT in the overall unmatched study population. D2BT was defined based on the reporting standards of the ACC NCDR CathPCI Registry in concordance with prior literature on this topic.[8,10] In brief, D2BT was measured as facility arrival time to time of first mechanical treatment of the culprit lesion during PCI. In patients transferred from another facility, facility arrival time was defined as arrival time at the transferring facility. In patients with STEMI while hospitalized for a separate medical condition, facility arrival time was defined as time of first ECG demonstrating STEMI. Secondary outcomes were (a) the association of transfemoral (TF) crossover with D2BT in the overall study population and (b) the association of TR-PPCI use with D2BT in a propensity matched population of TR- versus TF-PPCI. Successful TR-PPCI was defined as successful radial artery cannulation and completion of the PCI procedure without TF crossover, meaning switch to TF approach to complete the PCI. All decisions regarding TF crossover were at the discretion of the attending operator and were not dictated by a specific protocol. TF access obtained solely for insertion of a mechanical circulatory support device was not considered TF crossover if PCI was completed from the TR approach.

We present categorical variables as percentage (count), and comparisons were made using chi-square or Fisher's exact tests. We present continuous variables as mean ± *SD* or median (25th percentile, 75th percentile). We compared continuous variables with the Wilcoxon rank-sum test, except when comparing operators TR-PPCI% in 2011 with TR-PPCI% in 2016, in which case we used a paired samples *t*-test. We used Kendall's tau-B correlation test to study trends in categorical outcomes and a nonparametric generalized estimating equation model to study trends in D2BT. Raw unadjusted D2BT data are shown as median value and box plots and analyzed using Wilcoxon rank-sum tests. To minimize confounding due to (a) changes in D2BT performance over time and (b) D2BT differences by STEMI presenting location (primary emergency department, interhospital transfer, inhospital), we assessed adjusted D2BT performance using a nonparametric generalized estimating equation model adjusted for study year and STEMI presenting location. Models were constructed using a gamma distribution and log transformation to account for nonparametric distribution of D2BT, so percentage change in D2BT rather than change in minutes is reported.

2.4 | Propensity score matching

To compare similar risk patients treated with TR-PPCI versus TF-PPCI, we performed propensity score matching. We created a multivariable propensity model with TR-PPCI group membership as the dependent variable. We included all baseline characteristics that differed between TR-PPCI and TF-PPCI at $p < .10$ in the overall population, and we forced age, sex, and study year into the model producing a model with C-statistic of 0.879, $p < .001$ for TR-PPCI group membership (Supplementary Table 1 and Supplementary Figure 2). We then performed 1:1 propensity score matching with a matching caliper of 0.10, and all other patients were considered unmatched. The matching process yielded 273 well-matched pairs of TR-PPCI and TF-PPCI patients (Supplementary Table 2 and Supplementary Figure 3).

3 | RESULTS

3.1 | Study population

From January 1, 2011, to December 31, 2016, 1,272 cases of STEMI were treated with PPCI at our hospital, of which 43.3% ($N = 551$) had an initial attempted TR-PPCI and 56.7% ($N = 721$) had an initial attempted TF-PPCI. The TR-PPCI group had heavier body weight, more Caucasian race, and less hyperlipidemia, prior myocardial infarction, prior coronary artery bypass graft surgery, prior heart failure, end-stage renal disease on dialysis, and cardiogenic shock or cardiac arrest within the prior 24 hr (Table 1). The TF-PPCI group was more likely to require intraaortic balloon pump insertion. The rate of successful TR-PPCI was 89.7% ($N = 494$), and 10.3% ($N = 57$) required TF crossover (Figure 1). The rate of successful TF-PPCI was 99.7% ($N = 719$), and 0.3% ($N = 2$) required TR crossover.

After propensity matching, baseline demographics and comorbidities in the TR versus TF-PPCI groups were similar except for a significantly lower rate of cardiogenic shock within 24 hr prior to PCI in the TR-PPCI group (7.3 vs. 14.3%, $p = .009$) (Supplementary Table 2).

3.2 | Trends in TR-PPCI implementation

The annual rate of TR-PPCI attempts at our hospital increased from 2.6% in 2011 to 79.4% in 2016 (p-trend<.001), reflecting a transition from a low percentage TR-PPCI hospital to a high percentage TR-PPCI hospital (Figure 2). Among all 21 individual attending operators, the average operator TR-PPCI attempt rate increased from 2.9 ± 8.3% in 2011 to 81.1 ± 17.2% in 2016 (p-trend = .005), reflecting a transition from low percentage TR-PPCI operators to high percentage TR-PPCI operators. Additionally, among the 12 attending operators who performed PPCI in STEMI patients at our hospital longitudinally from 2011 through 2016, we observed a significant increase in the average operator TR-PPCI rate from 3.9 ± 9.5% in 2011 to 77.4 ± 16.6% in 2016 ($p < .001$), reflecting that individual operators in practice prior to common use of TR-PPCI in STEMI successfully implemented a radial first approach in STEMI.

3.3 | Primary outcome: D2BT performance (overall population)

We observed a significant reduction in median D2BT (102 min [81, 142] in 2011 to 84 min [60, 105] in 2016, p-trend<.001) (Figure 3). When considering the individual components of D2BT, we observed significant reductions in both door to cath lab arrival time

TABLE 1 Baseline and procedural characteristics

Variable	TR-PPCI (*N* = 551)	TF-PPCI (*N* = 721)	*p*
Baseline characteristics			
Age (years)	61.3 (52.5, 69.3)	61.8 (53.4, 70.7)	.137
Height (cm)	173 (165, 180)	173 (165, 180)	.502
Weight (kg)	86.8 (77.0, 102.0)	84.0 (72.5, 96.0)	<.001
Men	70.2% (387)	66.7% (481)	.181
Caucasian	71.5% (394)	66.0% (476)	.037
Hypertension	74.7% (411)	75.7% (545)	.692
Hyperlipidemia	70.3% (384)	77.2% (555)	.006
Diabetes mellitus	32.1% (177)	32.5% (234)	.900
Smoking history	46.1% (254)	44.8% (323)	.645
Prior myocardial infarction	19.1% (105)	37.3% (269)	<.001
Prior percutaneous coronary intervention	18.5% (102)	22.7% (164)	.066
Prior coronary artery bypass surgery	0.4% (2)	8.2% (59)	<.001
Prior heart failure	10.2% (56)	15.6% (112)	.005
New York Heart Association class IV	6.2% (34)	8.5% (61)	.124
End-stage renal disease on dialysis	0.5% (3)	2.4% (17)	.011
Prior cerebrovascular disease	10.9% (60)	13.3% (96)	.191
Prior peripheral arterial disease	9.1% (50)	9.6% (69)	.758
Chronic lung disease	12.2% (67)	11.9% (86)	.890
Cardiogenic shock within prior 24 hr	5.3% (29)	15.0% (108)	<.001
Cardiac arrest within prior 24 hr	6.9% (38)	15.3% (110)	<.001
Procedural characteristics			
Presenting location			
Primary emergency department	23.2% (128)	25.8% (186)	.218
Interhospital transfer	71.5% (394)	67.3% (485)	
Inhospital	5.3% (29)	6.9% (50)	
Culprit artery			
Left main trunk	0.5% (3)	0.8% (6)	.186
Left anterior descending	38.5% (212)	43.8% (316)	
Left circumflex	17.4% (96)	17.9% (129)	
Ramus intermedius	1.5% (8)	0.7% (5)	
Right coronary	42.1% (232)	36.6% (264)	
Bypass graft	0.0% (0)	0.1% (1)	
Intraaortic balloon pump	8.0% (44)	14.3% (103)	<.001
Salvage percutaneous coronary intervention status	1.6% (9)	3.2% (23)	.079
Contrast medium (ml)	150 (110, 190)	180 (140, 230)	<.001
Fluoroscopy (Gy)	1.27 (0.73, 2.09)	1.53 (1.00, 2.41)	<.001
Procedural medications			
Aspirin	98.2% (541)	98.6% (710)	.545
Clopidogrel	34.3% (189)	71.9% (518)	<.001
Prasugrel	2.7% (15)	5.0% (36)	.040
Ticagrelor	67.2% (368)	31.5% (174)	<.001
Unfractionated heparin	96.4% (531)	82.8% (596)	<.001
Low-molecular weight heparin	1.1% (6)	0.7% (5)	.546
Bivalirudin	25.0% (138)	60.1% (433)	<.001
Direct thrombin inhibitor	0.5% (3)	0.3% (2)	.658
Glycoprotein 2b/3a inhibitor	15.2% (84)	27.1% (195)	<.001

Note: Categorical variables presented as % (*N*) and continuous variables as median (25th, 75th percentile).
Abbreviations: TF-PPCI, transfemoral primary percutaneous coronary intervention; TR-PPCI, transradial primary percutaneous coronary intervention.

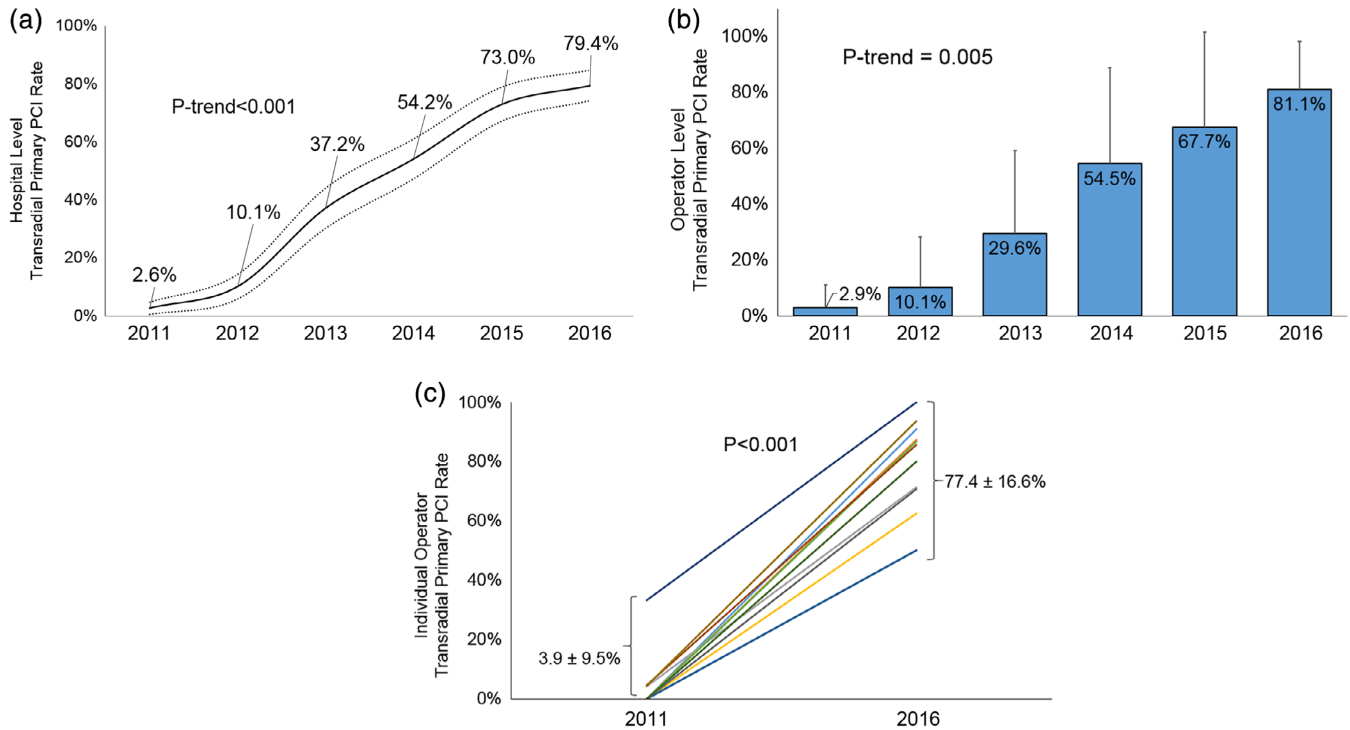

FIGURE 2 Hospital- and operator-level trends in transradial primary percutaneous coronary intervention (TR-PPCI). (a) The rate of attempted TR-PPCI at our hospital increased significantly during the study period. Solid line represents the point estimate for percentage of cases with attempted TR-PPCI with dotted lines showing 95% confidence interval of the point estimate, (b) The mean percentage of cases per year with attempted TR-PPCI for all operators (*N* = 21) at our hospital increased significantly during the study period. Error bar shows 1 *SD*, and (c) The percentage of cases per year with TR-PPCI increased significantly for each individual operator who performed percutaneous coronary intervention (PCI) in ST elevation myocardial infarction (STEMI) during each year of the study period from 2011 to 2016 (*N* = 11). Ten operators who performed a total of 302 cases (23.7% of study population) are not shown. The mean ± *SD* TR-PPCI% in 2011 and 2016 are shown. Abbreviations as per prior figures

(72 min [47, 106] in 2011 to 61 min [28, 81] in 2016, *p*-trend <.001) and cath lab arrival to balloon time (30 min [22, 50] in 2016 to 24 min [19, 31] in 2011, *p*-trend <.001). Among patients with an initial TR-PPCI attempt, median D2BT fell from 102 min [80, 129] in 2011 to 85 min [60, 104] in 2016 (*p*-trend <.001), and among patients with an initial TF-PPCI attempt median D2BT fell from 102 min [80, 143] in 2011 to 82 min [59, 116] in 2016 (*p*-trend <.001). We observed no significant difference in median D2BT performance in patients with an initial TR- versus TF-PPCI attempt during any year of the study (*p* > .40 for TR-PPCI vs. TF-PPCI in each study year).

3.4 | Secondary outcome 1: TF crossover and D2BT performance (overall population)

Median D2BT was 91 min (72, 112) in patients with successful TR-PPCI versus 99 min (70, 115) in patients with attempted TR-PPCI who required TF crossover to complete the PCI procedure (*p* = .432) (Figure 4). Median D2BT was 103 min [78, 133] in patients with initial TF-PPCI who did not require crossover (*p* = .139 compared with initial TR-PPCI who required TF crossover). After adjusting for study year and STEMI presenting location, there was no significant change in D2BT in patients with TF crossover compared with successful TR-PPCI (7.2% longer D2BT with TF crossover vs. successful TR-PPCI, 95% confidence interval –4.0% to +18.5%, *p* = .208) or in patients with TF crossover compared with successful TF-PPCI (0.8% shorter D2BT with TF crossover, 95% confidence interval –12.8% to +11.3%, *p* = .900).

3.5 | Secondary Outcome 2: TR-PPCI versus TF-PPCI and D2BT Performance (Matched Population)

In the propensity matched analysis, median D2BT was 98 min (78, 117) in patients with initial TR-PPCI compared with 101 min (76, 132) in patients with initial TF-PPCI (*p* = .304) (Figure 4). After adjusting for study year and STEMI presenting location, there remained no statistical difference between TR-PPCI and TF-PPCI (5.0% shorter D2BT in TR-PPCI versus TF-PPCI, 95% confidence interval –12.4% to +2.4%, *p* = .188).

4 | DISCUSSION

4.1 | Principal findings

In this observational study of TR-PPCI implementation in STEMI at a U.S. quaternary care hospital, we observed the following principal

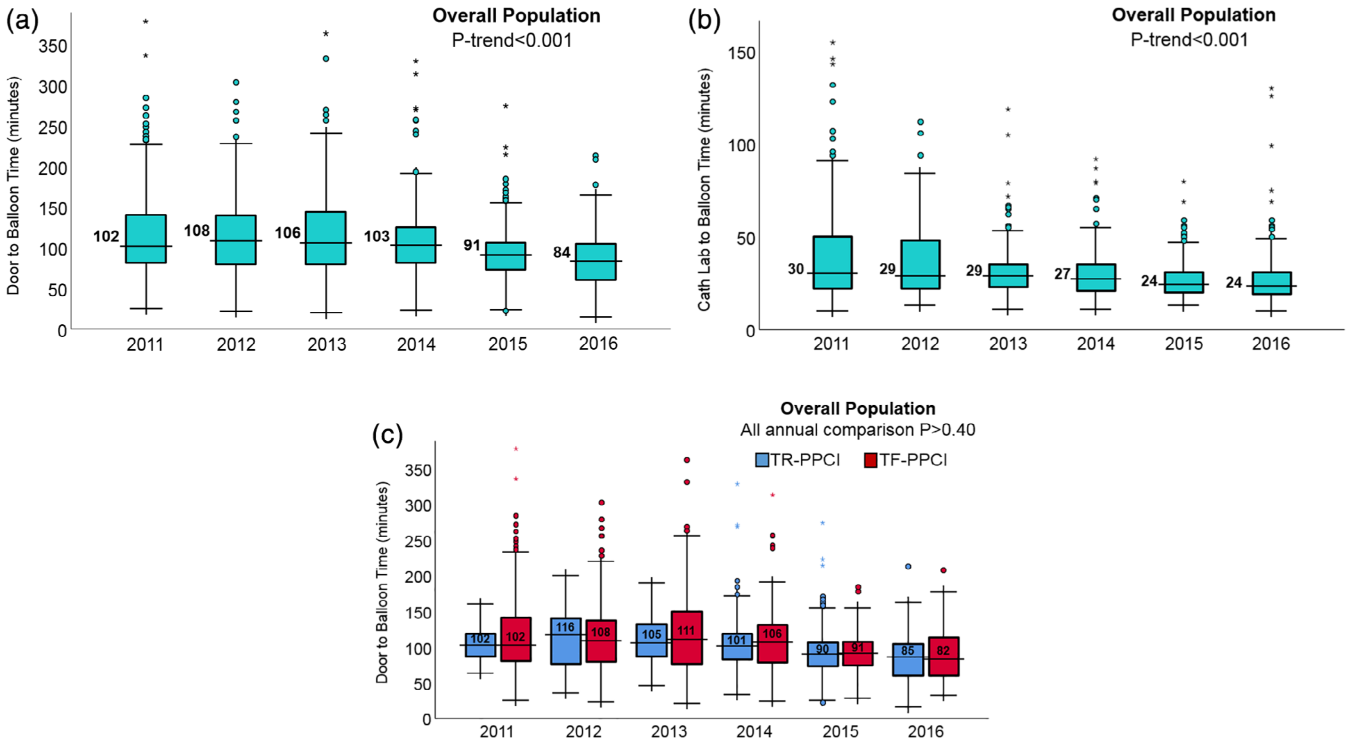

FIGURE 3 Primary outcome–annual trends in door-to-balloon time (D2BT). In the overall population, (a) we observed a significant decrease in annual D2BT and (b) a significant decrease in annual cath lab arrival to balloon time, while (c) D2BT time was similar each year in the transradial primary percutaneous coronary intervention (TR-PPCI) and transfemoral primary percutaneous coronary intervention (TF-PPCI) groups. The proportion of patients with interhospital transfer presentation was ~65% and was statistically similar between the TR-PPCI and TF-PPCI groups within each year ($p > .1$ for each year). Boxes show 25th percentile (bottom), median (middle line with number shown), and 75th percentile (top). Whiskers extend to 1.5 times the height of the box or to minimum/maximum value if no value beyond that range. Outliers beyond the whiskers are shown as points. Stars indicate extreme outliers more than three times the height of the box, but values >350 min (D2BT) and > 150 min (cath lab to balloon time) are omitted from this image to maintain scale. Remaining abbreviations as per prior figures

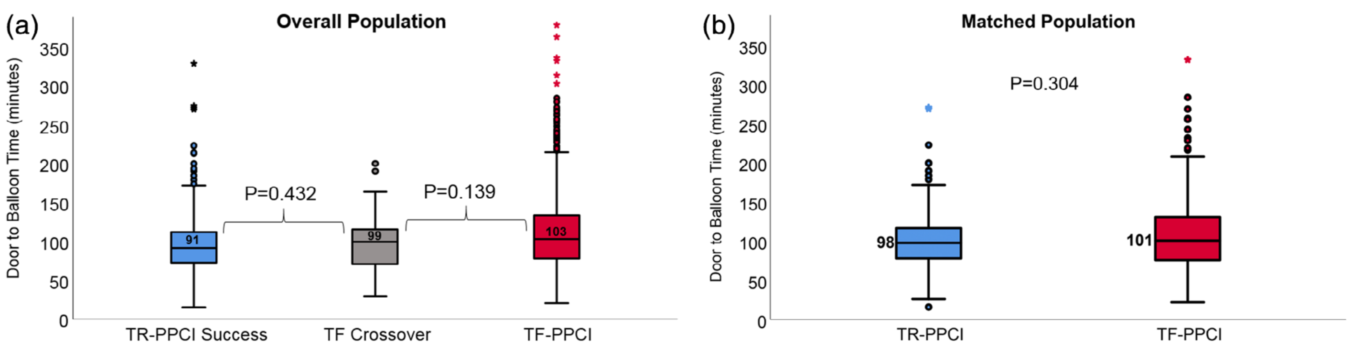

FIGURE 4 Secondary outcomes-door to balloon time by access and crossover status. (a) In the overall population, median door-to-balloon time (D2BT) was 91 min (72, 112 min) in patients with a successful transradial primary percutaneous coronary intervention (TR-PPCI) compared with 99 min (70, 115 min) in patients with attempted TR-PPCI who required transfemoral (TF) crossover ($p = .432$). Median D2BT was 103 min (78, 133 min) in patients with initial transfemoral primary percutaneous coronary intervention (TF-PPCI) which was successful ($p = .139$ compared with TF crossover after attempted TR-PPCI). Two patients who required TR crossover after an initial TF-PPCI attempt are not shown in this figure. Among patients with TR-PPCI success, TF crossover, and TF-PPCI the percentage of patients with primary emergency department (ED) presentation was 22.5, 29.8, and 25.7%, respectively, the percentage with in-hospital STEMI was 5.3, 5.3, 7.0%, respectively and the percentage with interhospital transfer presentation was 72.3, 64.9, and 67.3%, respectively ($p = .340$), and (b) In the propensity-matched population, median D2BT was 98 min in patients with initial TR-PPCI (78, 117 min) compared with 101 min in patients with initial TF-PPCI (76, 132 min) ($p = .304$). Boxes show 25th percentile (bottom), median (middle line with number shown), and 75th percentile (top). Whiskers extend to 1.5 times the height of the box or to minimum/maximum value if no value beyond that range. Outliers beyond the whiskers are shown as points. Stars indicate extreme outliers more than three times the height of the box. Values >350 min are omitted from these figures to maintain scale. Remaining abbreviations as per prior figures

findings. First, a radial first approach to PPCI can be successfully adopted with a > 25-fold increase in hospital and operator level TR-PPCI use. Second, despite the presence of 21 attending operators and universal involvement of trainees during these procedures, we observed a 90% TR-PPCI success rate, and D2BT in patients with TF crossover was similar to patients with initial TF-PPCI. Third, among similar risk patients treated with TR- and TF-PPCI, we observed no significant increase in D2BT with TR-PPCI. Our findings demonstrate that TR-PPCI can be adopted at U.S. hospitals without sacrificing the tremendous gains that have been achieved in D2BT over the past two decades.

4.2 | Underutilization of TR-PPCI in U.S. hospitals

Despite multiple randomized trials supporting its use and a class 1A indication in the 2017 European STEMI guidelines,[1–3,9,11,12] TR-PPCI is still used in a minority of cases (<25%) in the United States with major hospital and operator level variability.[4] A recent report from the ACC NCDR CathPCI registry demonstrated that academic affiliation, rural location, and Northeast region were hospital-level factors independently associated with increased likelihood of TR-PPCI use in STEMI.[4] The reasons for underutilization of TR-PPCI in U.S. hospitals are multifactorial, but a long-standing focus on achieving rapid D2BT is also a key contributor.[7] Even brief delays in D2BT are associated with increased risk of early mortality,[13,14] and consequently D2BT performance has been at the forefront of hospital level STEMI quality metrics in the United States.[5,15–24]

4.3 | D2BT in TR- versus TF-PPCI

Recent studies evaluating D2BT in TR-PPCI versus TF-PPCI have demonstrated conflicting results. Among 453,769 STEMI patients in a report of the ACC NCDR CathPCI registry, median D2BT was 2 min faster in TR-PPCI versus TF-PPCI (55 vs. 57 min, $p < .0001$), although the number of TR-PPCI patients was far lower than TF-PPCI patients in that study, and patients were not matched for risk factors.[4] In the safety and efficacy of Femoral Access versus Radial Access in STEMI trial (SAFARI-STEMI, presented at 2019 American College of Cardiology annual scientific sessions, NCT01398254), a randomized controlled trial of TR-PPCI versus TF-PPCI in STEMI, the authors presented a 3-min increase in D2BT in TR-PPCI patients (47 min [interquartile range 35–63] vs. 44 min [33–60], $p = .007$). However, the manuscript of that study has not been published.[25] In a multicenter Canadian registry, Cantor et al. reported that TR-PPCI was associated with a 3-min delay in the time from cath lab arrival to first balloon inflation (30 vs. 27 min, $p < .001$) compared with TF-PPCI among 2,947 patients with STEMI, but the difference in the time from first ECG showing STEMI to balloon inflation was not statistically different (91 vs. 88 min, $p = .20$).[26] These comparisons of D2BT in TR-PPCI versus TF-PPCI have provided mixed results, and there is a need for evidence that US hospitals and operators can successfully transition from TF- to TR-PPCI as the default strategy in STEMI without compromising D2BT performance.

4.4 | Operator level variability in TR-PPCI

In the United States, 88% of PCI cases in STEMI are performed by operators in practice prior to 2012.[4] These operators are significantly less likely to use TR-PPCI in STEMI with an odds ratio of <0.40 compared with more recent trainees, highlighting operator level variability as a separate issue from hospital level variability. In an early report of TR-PPCI use in STEMI in the United States, Pancholy et al. reported that all TR-PPCI cases in STEMI at their hospital were performed by two expert radial operators while the remaining three operators at that hospital performed only TF-PPCI cases in STEMI patients, highlighting that stark operator-level variability in TR-PPCI exists even within a single hospital STEMI system.[27] Training the next generation of interventional cardiologists to perform TR-PPCI is an important goal. However, strategies to promote existing low-percentage TR-PPCI operators in the United States transitioning into high-percentage TR-PPCI operators are of the utmost importance, because only a small minority of STEMI cases are performed by recent trainees.

4.5 | Strategies to improve TR-PPCI adoption

From the operator's standpoint, the TR strategy is associated with unique technical challenges compared with TF-PPCI.[28] These challenges are magnified under the time pressure of STEMI, and operators may worry about encountering the need for potential TF crossover. Our study highlights that these concerns of increased technical challenge are valid as the TF crossover rate was 10.3%. However, concerns regarding major delays in D2BT with TF crossover were not validated. Operators should be confident in approaching a STEMI patient with radial first strategy knowing that although TF crossover will be required at times, it will not negatively affect D2BT performance in the context of a high quality STEMI system. Additionally, TF-PPCI will always maintain a role in selected STEMI patients in whom TR-PPCI may not be the optimal approach.

Operators should expect that increasing experience with TR-PPCI will translate into greater ease of the procedure. A report of new radial operators from the NCDR CathPCI registry demonstrated that as radial PCI volume increased, operators were more likely to perform TR-PPCI in STEMI.[29] Additionally TR procedural success was high and major complications (bleeding, mortality) were low regardless of operator TR experience in that study, demonstrating that even the early adoption period is safe.

4.6 | Limitations

First, these data represent the experience of a large referral center with high PPCI case volume. Our findings warrant validation at other centers in the United States to support their generalizability.

However, we expect that our experience should be similar to many other large U.S. hospitals. Second, TR-PPCI was implemented at our institution concomitantly with several STEMI systems improvements.[30] Changes in D2BT during the study period are not solely related to vascular access, but also reflect improvements in the STEMI system. However, in a propensity-matched analysis, including matching by study year to account for changes over time, TR-PPCI was not associated with worsening D2BT performance versus TF-PPCI. Third, despite propensity matching, the comparison of TR-PPCI to TF-PPCI patients may be subject to residual confounding.

5 | CONCLUSION

The purposeful transition of low-percentage TR-PPCI hospitals and operators into high-percentage TR-PPCI hospitals and operators can be achieved without sacrificing D2BT gains, offering the potential to improve STEMI outcomes at the population level if widely embraced.

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CONFLICT OF INTEREST

Stephen Ellis has served as a consultant for Abbott Vascular, Boston Scientific, and Medtronic. Umesh Khot has served as a consultant for AstraZeneca. The remaining authors have no conflicts of interest to disclose. Michael Lincoff has served as a consultant for Novo Nordisk, Akcea, and Novatis and has received research funding for his institution from AbbVie, AstraZeneca, CSL Behring, Eli Lilly, and Pfizer.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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