

## Original article

## Use of the Radial Approach in Primary Angioplasty: Results in 1029 Consecutive Patients and Analyses in Unfavorable Subgroups

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## ABSTRACT

**Introduction and objectives:** The transradial approach is associated with a reduction in vascular access-related complications after primary percutaneous coronary interventions. The purpose of this study was to examine the feasibility of the routine use of transradial access in primary angioplasty and to evaluate how it affects subgroups with less favorable characteristics.**Methods:** We analyzed 1029 consecutive patients with an ST-segment elevation acute coronary syndrome treated with primary angioplasty.**Results:** Transradial access was the primary approach in 93.1% of the patients. The success rate of primary angioplasty was 95.9%, and 87.6% of the patients were event-free 30 days after the procedure. Crossover was required in 3.0% of the patients with primary transradial access, and this rate remained stable over the years. Predictors of the need for crossover were age older than 75 years (odds ratio=2.50, 95% confidence interval, 1.09–5.71;  $P=0.03$ ) and a history of ischemic heart disease (odds ratio=2.65; 95% confidence interval, 1.12–6.24;  $P=0.02$ ). Primary transfemoral access use was higher in women older than 75 years. Use of the transradial approach in this subgroup did not affect reperfusion time or the success of angioplasty, although there was a greater need for crossover (10.9% vs 2.6%;  $P=0.006$ ). Among patients in cardiogenic shock, the transradial approach was used in 51.5%; reperfusion times and angioplasty success rates were similar to those obtained with transfemoral access, but there was a greater need for crossover.**Conclusions:** Transradial access can be used safely and effectively in most primary angioplasty procedures. In older women and in patients in cardiogenic shock, there is a higher crossover requirement, with no detriment to reperfusion time.

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## El uso del acceso radial en la angioplastia primaria: resultados en 1.029 pacientes consecutivos y análisis en subgrupos desfavorables

## RESUMEN

**Introducción y objetivos:** El acceso radial reduce las complicaciones vasculares tras la angioplastia primaria. El objetivo es examinar la factibilidad del acceso radial sistemático en la angioplastia primaria y evaluar cómo afecta a los subgrupos menos favorables.**Métodos:** Se ha analizado a 1.029 pacientes consecutivos con síndrome coronario agudo con elevación del segmento ST tratados con angioplastia primaria.**Resultados:** En el 93,1% de los pacientes, el acceso radial ha sido el acceso primario. La tasa de éxito de angioplastia primaria fue del 95,9%, y el 87,6% de los pacientes estaban libres de eventos clínicos a los 30 días del procedimiento. La tasa de cruce vascular fue del 3,0%, estable durante el periodo estudiado. La edad mayor de 75 años (odds ratio = 2,50; intervalo de confianza del 95%, 1,09-5,71;  $p = 0,03$ ) y la historia de cardiopatía isquémica previa (odds ratio = 2,65, intervalo de confianza del 95%, 1,12-6,24;  $p = 0,02$ ) fueron predictores de necesidad de cruce. En las mujeres y los mayores de 75 años, el uso del acceso femoral primario fue mayor. Sin embargo, en este subgrupo de pacientes el acceso radial no afectó a los tiempos de reperusión ni al éxito de la angioplastia, aunque sí se observó una mayor tasa de cruce (el 10,9 frente al 2,6%;  $p = 0,006$ ). En los pacientes en shock cardiogénico, el acceso radial se utilizó en el 51,5% de los casos, con tiempos de reperusión y tasas de éxito de la angioplastia similares a los del acceso femoral, aunque con mayor necesidad de cruce.**Conclusiones:** El acceso radial se puede utilizar de manera segura y eficaz en la mayoría de las angioplastias primarias. En mujeres de edad avanzada y en pacientes en shock, aumenta la necesidad de cruce sin penalizar los tiempos de reperusión.

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## Palabras clave:

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Acceso radial

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## Abbreviations

PPCI: primary percutaneous coronary intervention  
 TFA: transfemoral access  
 TRUA: transradial/ulnar access

## INTRODUCTION

Primary percutaneous coronary intervention (PPCI) is the preferred treatment for patients with ST-segment acute coronary syndrome (STEACS). Systematic use of this procedure improves the outcome of reperfusion in these patients, while bringing to light complications related to vascular access.<sup>1,2</sup> There is sufficient evidence that patients with periprocedural bleeding have an unfavorable prognosis.<sup>3,4</sup>

Although these complications are generally uncommon, several studies published since 2003 have shown that transradial/ulnar access (TRUA) is associated with a lower risk of developing such complications than transfemoral access (TFA), with no detriment to reperfusion time.<sup>5–11</sup> These studies, which are limited by the small number of patients included and by selection bias, have generated an ongoing debate in the scientific community since the first angioplasty procedure using radial access was reported in 1993 by Kiemeneij and Laarman.<sup>12</sup>

The results of the largest study comparing the surgical approaches used in PPCI were published in 2011.<sup>13</sup> Despite the growing evidence on this issue, there remains considerable controversy on the routine use of TRUA, based on the idea that this approach could affect the success of angioplasty and reperfusion time in specific patient groups. The interventional cardiology unit in our center has wide experience in TRUA (more than 90% of all angioplasties performed). The aim of this study was to evaluate the feasibility of the routine use of TRUA for PPCI in a high-volume center and to analyze its effect in patient subgroups with less favorable characteristics.

## METHODS

### Patients and Procedure

The analysis included all consecutive patients with an STEACS treated by PPCI in *Hospital Universitario Puerta de Hierro de Majadahonda* (Madrid, Spain) between January 2005 and December 2011. In our center, 85% of the patients with STEACS receive PPCI treatment.<sup>14</sup> PPCI was indicated in patients with symptoms of angina of less than 12 h' duration and ST-segment elevation greater than 0.1 mV in at least 2 contiguous leads on electrocardiography. Patients received dual antiplatelet therapy with a loading dose of 300 mg of acetylsalicylic acid and 600 mg of clopidogrel. Since 2011, patients younger than 75 years weighing more than 60 kg and with no history of previous stroke have received a loading dose of 60 mg of prasugrel, with a subsequent regimen of 10 mg daily.<sup>15</sup> In addition, during the procedure, an initial dose of 5000 IU of sodium heparin was administered, followed by 1000 IU for each additional 30 min' duration, as well as glycoprotein IIb/IIIa inhibitors, which in most patients was 2 intravenous bolus doses of eptifibatid 180 µg/kg, 10 min apart, followed by infusion of 2 µg/kg/min for 12 h.

The procedures were carried out by 5 interventional cardiologists highly experienced in performing TRUA. The primary access route was at the discretion of the operator. In most patients, the right radial artery was used, with a 6 Fr introducer. A spasmolytic

cocktail containing verapamil was routinely used to avoid radial spasm. The introducer was withdrawn in the catheterization laboratory and various devices were used for TRUA hemostasis (TR-Band<sup>®</sup>, D-Stat<sup>®</sup>, and conventional access).

## Definitions

- *Primary access*: the first vascular approach attempted, regardless of whether or not it was successful.
- *TRUA*: vascular access obtained in the wrist area, usually the right radial artery, and less often, the left radial artery or ulnar artery.
- *Crossover*: change of vascular access when the procedure could not be carried out through the primary access.
- *Successful PPCI*: angiographically-proven residual stenosis of less than 50% and TIMI flow greater than or equal to 2, and no death, reinfarction, acute or subacute thrombosis, or need for a new percutaneous or surgical revascularization procedure in the artery causing the infarction.
- *Needle-guidewire time*: time from the first radial puncture to passage of the angioplasty guidewire through the obstruction, in minutes.

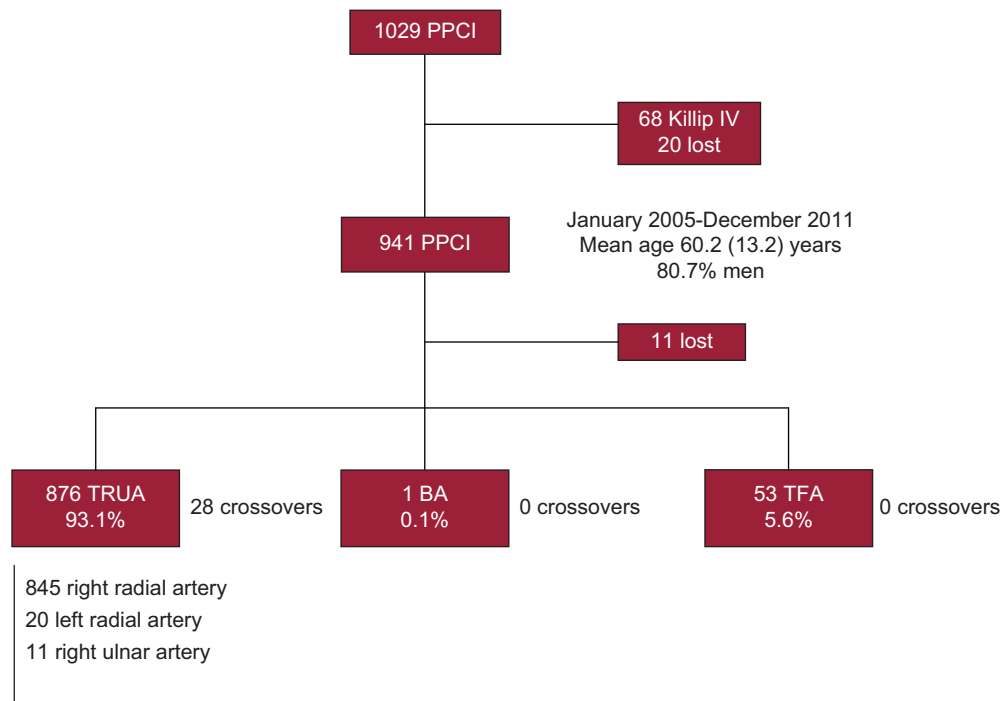
## Data Collection and Analysis

During catheterization, clinical cardiologists prospectively collected demographic data, the patients' baseline characteristics, and the procedure-related characteristics, and entered the information in the PPCI database of our center. A total of 1029 PPCIs were performed during the study period. A separate analysis was performed in 68 patients (6.6%) in cardiogenic shock (see "Special Subgroups: Patients in Cardiogenic Shock"), and 20 patients (1.9%) were excluded because their clinical status at presentation was unknown. Hence, 941 PPCI procedures formed the nucleus of our study (Fig. 1). Data were analyzed retrospectively at completion of the recruitment period.

### Objectives of the Analyses

- *Primary aim*: To evaluate the feasibility of routine use of TRUA in PPCI, analyzing the crossover rate and the procedure-related variables (fluoroscopy time, needle-guidewire time, contrast volume, and angioplasty success rate).
- *Secondary Aims*:
  - To identify the clinical and procedure-related variables associated with a greater need for crossover or primary use of TFA. To characterize a less favorable patient subgroup using the above-defined variables.
  - To evaluate the effect of the use of TRUA in this less favorable subgroup, by analyzing the angioplasty success rate and the above-proposed procedure-related variables.

Qualitative variables were analyzed with the chi-square test for parametric data and the Fisher exact test for nonparametric data, and are expressed as rates or percentages. Quantitative variables were analyzed with the Student *t* test or analysis of variance for more than 2 measures, and are expressed as the mean (standard deviation). Survival is represented by Kaplan-Meier curves. Univariate and multivariate logistic regression analyses were used to identify the variables associated with a greater need for crossover or greater use of the femoral access. All tests were 2-tailed, and results were considered statistically significant at a *P* value of <.05. The statistical analysis was performed with SPSS (SPSS V.20.0 for Macintosh).



**Figure 1.** Flow chart of the study population. BA, brachial artery; PPCI, primary percutaneous transluminal coronary angioplasty; TFA, transfemoral access; TRUA, transradial/ulnar access.

## RESULTS

### Study Population

Between January 2005 and December 2011, 941 PPCIs were performed. The mean age of the patients was 60.2 (13.2) years, and 80.7% were men. Between 2005 and 2011, the percentage of smokers increased from 64.7% to 74.7% ( $P=.009$ ). The demographic and clinical characteristics of the study population are summarized in [Table 1](#).

### Feasibility of Routine Use of Transradial/Ulnar Access

TRUA was the primary access route in 876 of 941 patients (93.1%; 845 in the right radial artery, 20 in the left radial artery,

11 in the right ulnar artery). The left brachial artery was used in only 1 patient (1/941; 0.1%) and the femoral artery in 53 of 941 cases (5.6%; 51 right and 2 left femoral artery). Information was not available in 11 patients ([Fig. 1](#)). Primary TRUA use significantly increased from the 2005-2006 period to 2011 (89.7% vs 93.3%;  $P=.007$ ) and primary TFA use decreased (9.8% vs 6.7%;  $P=.007$ ) ([Table 2](#)).

Crossover was required in 28 of 941 PPCIs, which yielded a crossover rate of 3.0%. All crossover cases occurred at the start of the procedure with TRUA (28 in the right radial artery). There were no significant differences in the crossover rate between the periods studied (3.1% in 2005-2006 vs 4.4% in 2011;  $P=.585$ ). Among the 28 patients requiring a change of vascular access, the femoral artery was chosen in 19 (68%) (17 right femoral, 2 left femoral), the right ulnar artery (homolateral to the radial route at the start of the procedure) in 3 (11%), and the contralateral radial artery in the

**Table 1**  
Demographic and Clinical Characteristics of the Population Studied

	2005-2006	2007-2008	2009-2010	2011	P	Total
Procedures, no.	227	257	275	182		941
Age, years	61 (13)	61 (13)	59 (13)	59 (14)	.05	60 (13)
Age $\geq$ 75 years, %	21.1	16.0	13.1	15.4	.109	16.3
Women, %	19.8	22.2	18.5	15.4	.359	19.3
Weight, kg	78 (13)	79 (13)	79 (14)	80 (17)	.625	79 (14)
Height, cm	167 (8)	168 (9)	169 (9)	168 (12)	.613	168 (9)
BMI	27 (4)	28 (4)	28 (4)	30 (22)	.089	28 (11)
BSA, m <sup>2</sup>	1.8 (0.2)	1.9 (0.2)	1.9 (0.2)	1.9 (0.2)	.53	1.9 (0.2)
HT, %	48.5	47.1	46.2	41.2	.493	46.1
Diabetes mellitus, %	23.3	18.7	17.1	17.0	.278	19.1
Dyslipidemia, %	40.1	38.9	40.4	36.3	.817	39.2
Smoking, %	64.7	70.4	77.8	74.7	.009	72.1
Previous ischemic heart disease, %	12.8	12.8	14.5	13.2	.927	13.4

BMI, body mass index; BSA, body surface area; HT, hypertension.

**Table 2**  
Procedure-related Characteristics in the Population Studied

	2005-2006	2007-2008	2009-2010	2011	P	Total
Procedures, no.	227	257	275	182		941
Crossover, %	3.1	2.7	2.2	4.4	.586	3.0
Access route, %					.007	
Primary TRUA rate	89.7	95.6	97.1	93.3		93.1
Primary TFA rate	9.8	4.3	2.9	6.7		5.6
Killip class, %					.001	
I	81.5	86.0	81.5	94.5		85.2
II	14.5	12.5	16.4	3.3		12.3
III	4.0	1.6	2.2	2.2		2.4
GPIIb/IIIa inhibitors, %	66.4	78.8	81.5	91.3	<.001	78.8
Abciximab	63.4	26.8	0.4	1.2		23.3
Tirofiban	0.4	0.4	0.7	0.6		0.5
Eptifibatide	2.6	51.6	80.4	89.5		55.0
Stent thrombosis, %	2.2	3.5	4.3	2.7	.218	3.6
Needle-guidewire time, min	22.4 (14.3)	21.3 (12.1)	19.5 (12.2)	18.6 (10.2)	.007	20.6 (12.4)
Contrast volume, mL	176 (68)	159 (59)	156 (49)	151 (47)	<.001	159 (56)
Fluoroscopy time, min	14.2 (6.6)	14.1 (8.2)	14.6 (9.7)	14.1 (9.7)	.952	14.3 (8.9)
Successful primary angioplasty, %	92.9	97.1	96.9	97.5	.07	95.9

GPIIb/IIIa, glycoprotein IIb/IIIa; TFA, transfemoral access; TRUA, transradial/ulnar access.

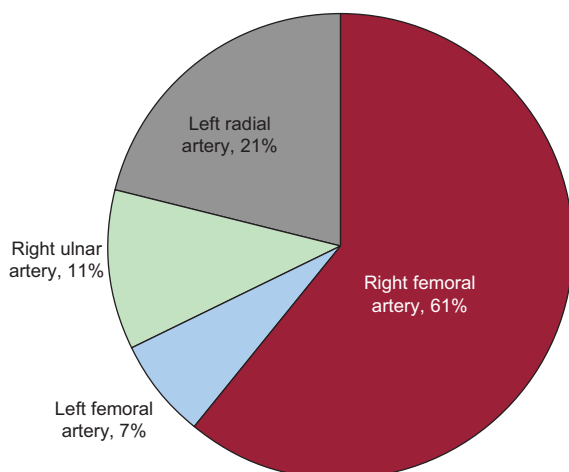
remaining 6 (21%) patients (Fig. 2). The most common reasons for crossover were difficulty canalizing the artery owing to a weak pulse (15/28 patients) and inability to advance the guidewire due to peripheral artery occlusion or tortuosity of the brachiocephalic trunk (6/28 patients). Only 2 PPCI procedures were performed on coronary bridges, 1 by left TRUA and the other by ATF; crossover was not required in either patient. On multivariate analysis, 2 factors were identified as predictive of the need for crossover: older than 75 (odds ratio [OR]=2.50; 95% confidence interval [95%CI], 1.09-5.71;  $P=.03$ ) and a history of previous ischemic heart disease (OR=2.65; 95%CI, 1.12-6.24;  $P=.02$ ).

During the procedure, the mean fluoroscopy time was 14.3 (8.9) min, needle-guidewire time was 20.6 (12.4) min, and contrast volume was 159 (56) mL. Between 2005-2006 and 2011, needle-guidewire time significantly decreased from 22.4 (14.3) min to 18.6 (10.2) min ( $P=.007$ ) and contrast volume from 176 (68) mL to 151 (47) mL ( $P<.001$ ), whereas fluoroscopy time remained stable (14.2 [6.6] min vs 14.1 [9.7] min;  $P=.952$ ). In

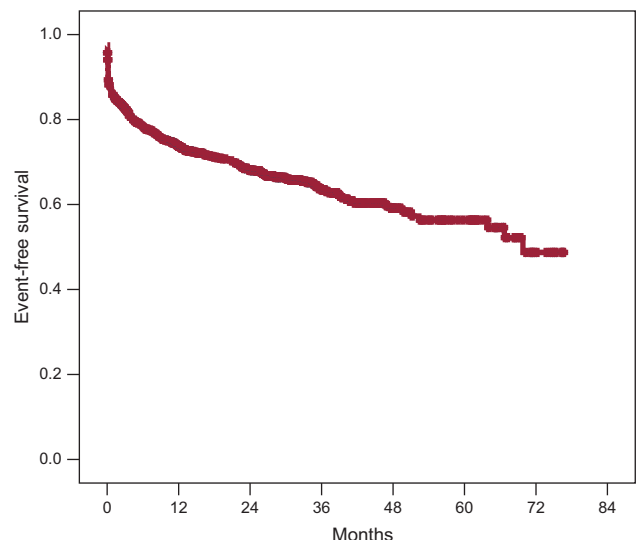
patients requiring crossover, fluoroscopy time (22.3 vs 14.1 min;  $P=.009$ ), needle-guidewire time (38.1 vs 20.0 min;  $P<.001$ ), and contrast volume (204 vs 158 mL;  $P<.001$ ) were significantly higher than in the remaining patients.

The success rate of PPCI in our series was 95.9%, and it remained stable during the periods studied (2005-2006 vs 2011, 92.9% vs 97.5%;  $P=.07$ ). In patients requiring crossover, the success rate was significantly lower (78.0% vs 96.4%;  $P=.02$ ). Nonetheless, in the multivariate analysis, crossover requirement was not predictive of a lack of success of PPCI (OR=1.24; 95%CI, 0.58-2.77;  $P=.56$ ).

Survival was 97.7% at 30 days following PPCI, and 95.6% at 1 year. In the survival analysis, with a composite endpoint of events that included death, angina, reinfarction, new angioplasty, need for cardiac surgery, and heart failure, the event-free cumulative survival was 87.6% at 30 days after the procedure and 75.9% at 1 year (Fig. 3).



**Figure 2.** Alternative access routes in crossover cases (n=28).



**Figure 3.** Event-free survival curve (n=941).

### Primary Transfemoral Access

Primary TFA was used in 53 (5.6%) of the 941 patients who underwent PPCI. Patients with primary TFA were older, there were more women, and body weight, height, and body surface area were lower than in patients who underwent primary TRUA. Furthermore, there were fewer patients with a history of smoking, and more cases of stent thrombosis and Killip III infarction (Table 3). On multivariate analysis, the predictors of a primary TFA use were age older than 75 years (OR=2.88; 95%CI: 1.36-6.07;  $P=.005$ ) and female sex (OR=2.91; 95%CI: 1.39-6.09;  $P=.005$ ).

The needle-guidewire time was greater in patients with TFA than in those with TRUA (27.4 [16.1] vs 20.1 [12.1] min;  $P<.001$ ), whereas fluoroscopy time (16.6 [7.2] vs 14.2 [8.9] min;  $P=.141$ ), and contrast volume (170 [65] vs 158 [55] mL;  $P=.210$ ) showed no significant differences. There were no cases of crossover with TFA (0% vs 3.2%;  $P=.02$ ) and the PPCI success rate was similar to that observed with TRUA (93.0% vs 96.2%;  $P=.110$ ) (Table 3).

### Identification of a Less Favorable Subgroup and Subgroup Results

Based on the variables that led to the choice of a primary vascular access other than TRUA, and reinforced by the additional greater need for crossover in patients older than 75 years, we identified a patient profile that was less favorable for TRUA: women older than 75 years. The use of TRUA was lower in this subgroup than in the remaining patients but was still quite frequent (80% vs 95.5%;  $P=.001$ ). In the subgroup analysis of

**Table 3**

Clinical and Procedure-related Differences According to the Primary Vascular Access

	TRUA (n=876)	TFA (n=53)	P
<b>Clinical</b>			
Age, years	60 (13)	67 (15)	<.001
Age>75 years, %	15.1	37.7	<.001
Women, %	19.1	41.5	<.001
Weight, kg	79 (14)	69 (16)	<.001
Height, cm	168 (9)	163 (10)	<.001
BMI	28 (11)	26 (4)	.194
BSA, m <sup>2</sup>	1.89 (0.18)	1.75 (0.23)	<.001
HT, %	46.2	45.3	1
Diabetes mellitus, %	19.1	18.9	1
Dyslipidemia, %	39.8	28.3	.111
Smoking, %	73.1	50.9	.001
Previous ischemic heart disease, %	13.1	18.8	.218
<b>Interventional procedure</b>			
Crossover rate, %	3.2	0.0	.020
Killip class, %			.047
I	85.6	79.2	
II	12.2	13.2	
III	2.1	7.5	
GPIIb/IIIa inhibitors, %	79.6	71.1	.134
Stent thrombosis, %	3.3	9.4	.009
Needle-guidewire time, min	20.1 (12.1)	27.4 (16.1)	<.001
Contrast volume, mL	158 (55)	170 (65)	.210
Fluoroscopy time, min	14.2 (8.9)	16.6 (7.2)	.141
Successful primary angioplasty, %	96.2	93.0	.110

BMI, body mass index; BSA, body surface area; GPIIb/IIIa, glycoprotein IIb/IIIa; HT, hypertension; TFA, transfemoral access; TRUA, transradial/ulnar access.

women older than 75 years in whom TRUA was the primary approach used (n=55), there were no differences in the PPCI success rate relative to the remaining patients (90.0% vs 96.4%;  $P=.105$ ) or in the time to reperfusion (needle-guidewire time, 22.0 [12.7] vs 20.0 [12.0] min;  $P=.243$ ; fluoroscopy time, 14.8 [8.1] vs 14.1 [8.9] min;  $P=.669$ ; or contrast volume, 158 [61] vs 158 [54] mL,  $P=.987$ ), but there was a significant increase in the crossover rate (10.9% vs 2.6%;  $P=.006$ ).

### Special Subgroups: Patients in Cardiogenic Shock

Between 2005 and 2011, 68 patients (6.6%) underwent PPCI while in cardiogenic shock. The mean age of this subgroup was 69.2 (12.1) years and the percentage of patients older than 75 years was higher than in the remaining groups (38.2% vs 16.3%,  $P<.001$ ). Furthermore, there was a higher rate of diabetes mellitus (35.8% vs 19.1%;  $P=.002$ ) and fewer patients with a history of smoking (49.3% vs 72.1%;  $P<.001$ ).

The primary approach was TRUA in 35 of 68 patients (51.5%), the brachial artery in 1 patient (1.5%), and the femoral approach in 30 of 68 patients (44.0%). In 2 of 68 patients (3.0%), this information was not available. The crossover rate in patients in shock was significantly higher than in the remaining patients (8.8 vs 3.0%;  $P=.02$ ) and the PPCI success rate was lower (80.3% vs 95.9%;  $P=.002$ ). In addition, glycoprotein IIb/IIIa inhibitors were used less frequently, and there was a lower rate of stent thrombosis (Table 4).

In the analysis of crossover rates according to the primary vascular access route, more crossovers were associated with TRUA

**Table 4**

Clinical and Procedure-related Differences Between Patients in Cardiogenic Shock and the Remaining Series at the Time of Presentation

	Shock (n=68)	No shock (n=941)	P
<b>Clinical</b>			
Age, years	69 (12)	60 (13)	<.001
Age>75 years, %	38.2	16.3	<.001
Women, %	19.3	25.0	.268
Weight, kg	77 (19)	79 (14)	.407
Height, cm	165 (13)	168 (9)	.074
BMI	30 (22)	28 (11)	.247
BSA, m <sup>2</sup>	1.8 (0.2)	1.9 (0.2)	.445
HT, %	55.2	46.1	.164
Diabetes mellitus, %	35.8	19.1	.002
Dyslipidemia, %	37.3	39.2	.797
Smoking, %	49.3	72.1	<.001
Previous ischemic heart disease, %	21.2	13.4	.095
<b>Interventional procedure</b>			
Crossover rate, %	8.8	3.0	.02
Primary vascular access			<.001
TRUA, %	51.5	93.1	
TFA, %	44.0	5.6	
GPIIb/IIIa inhibitors	56.1	78.8	.02
Stent thrombosis, %	7.3	3.6	.04
Needle-guidewire time, min	23.1 (16.8)	20.6 (12.4)	.142
Contrast volume, mL	167 (67)	159 (56)	.319
Fluoroscopy time, min	19.2 (12.4)	14.3 (8.9)	.001
Successful primary angioplasty, %	80.3	95.9	.002

BMI, body mass index; BSA, body surface area; GPIIb/IIIa, glycoprotein IIb/IIIa; HT, hypertension; TFA, transfemoral vascular access; TRUA, transradial/ulnar access.



in this subgroup than with TFA (17.1% vs 0%;  $P=.028$ ). Nonetheless, the PPCI success rate (77.4% vs 83.3%;  $P=.871$ ), needle-guidewire time (22.4 [13.6] vs 24.9 [21.4] min;  $P=.596$ ), fluoroscopy time (17.4 [9.7] vs 20.9 [14.7] min;  $P=.364$ ), and contrast volume (171 [68] vs 162 [67] mL;  $P=.596$ ) showed no differences in relation to the access used.

## DISCUSSION

This study presents the results (without exclusions) of a PPCI program in 1029 patients, in whom more than 93% of PPCI procedures were carried out using TRUA. The angioplasty success rate was nearly 96%, and crossover was required in only 3.0%. These values remained stable during the period studied, and the procedure-related parameters showed a continuing improvement (shorter needle-guidewire time and smaller contrast volume). In addition, a subgroup of patients was identified (older women) in whom primary use of TFA was greater. Nonetheless, in this less favorable subgroup, the use of TRUA did not affect the success rate of angioplasty or reperfusion time, although we did observe a higher crossover rate (10.9% vs 2.6%;  $P=.006$ ). The same occurred in patients in cardiogenic shock, in whom the use of TRUA was associated with a higher crossover rate, but the variables related to angiographic success were unaffected. These results indicate that experienced operators can identify and use TRUA even in less favorable subgroups without a negative impact on reperfusion time. Therefore, in general, TRUA could be the recommended primary approach in the scenario of sufficient expertise.

### Transradial/Ulnar Access in Primary Angioplasty: Fewer Adverse Events

In 2011, the RIVAL trial results were published, the largest clinical trial to date (more than 7000 patients) comparing TRUA with TFA in patients with an acute coronary syndrome. Adverse event rates were similar in the 2 groups, but there were fewer local vascular complications in patients with TRUA.<sup>13</sup> Recently, the RIVAL results were reported for the subgroup of patients with ST-segment elevation acute coronary syndrome. Not only was there a reduction in the primary outcome, complications due to the vascular approach, with a benefit for radial access, but there was also a significant reduction in the composite outcome of death, infarction, stroke, and non-coronary artery bypass graft-related major bleeding (3.1% vs 5.2%;  $P=.026$ ), and in all-cause death (1.3% vs 3.2%;  $P=.006$ ).<sup>16</sup> These results, which concur with those obtained in the RIFLE-STEACS,<sup>17</sup> add a net clinical benefit to the results of most related observational studies and clinical trials published to date.<sup>5–11,18–25</sup> Although the benefits with regard to bleeding seem to clearly favor radial access, the results of the recent STEMI-RADIAL clinical trial found no differences in major events or in 30-day mortality between the 2 access routes.<sup>26</sup>

### Routine Use of the Transradial/Ulnar Approach: Crossover and Success of Primary Angioplasty

Although the literature contains a great deal of data favoring TRUA, results from large clinical trials<sup>13,17</sup> are needed to confirm the benefits of this technique. Because of this lack of definitive evidence, systematic use of TRUA in actual practice is not widespread, and there is little available real-life data on its applicability and reproducibility. In 2011, use of the radial approach in percutaneous coronary procedures in Spain

exceeded the femoral approach for the first time (55.5% of all angioplasties).<sup>27</sup>

The crossover rates with this technique published to date have varied considerably, from 0% to more than 10%.<sup>5–7,9</sup> In the RIVAL study, a 5.3% crossover rate was documented in PPCI,<sup>13</sup> which fell to 4.4% in the tertile of centers with highest volume. In one of the few studies focussed on routine use of TRUA in PPCI, a group from The Netherlands reported a crossover rate of 3.8% that decreased with the learning curve to 1.5%.<sup>28</sup> In contrast, the published success rates of PPCI with TRUA have been more stable and are not lower than those of TFA.<sup>5–7</sup> In our series, the crossover rate was 3.0%, and the angioplasty success rate exceeded 95%. These parameters were unaffected by the greater complexity of patients who are currently treated by PPCI or the greater use of devices.

Although the need for crossover in our series was associated with longer fluoroscopy time, longer needle-guidewire time, a larger volume of contrast material, and lower PPCI success rates, we believe that these results were not solely due to the delay in obtaining a vascular access, but also to the possibility that the patients and procedures in the group requiring crossover may have been more complex. We consider that these results can be accepted in groups with low crossover rates.

### Transradial/Ulnar Access in Less Favorable Subgroups

Primary use of TFA in our series was associated with women older than 75 years. These 2 variables have been predictive of crossover in other series.<sup>28</sup> The probable causes are a smaller diameter of the wrist arteries, which leads to atherosclerotic involvement and stenosis, increased vascular stiffness, and/or arterial loops. In our opinion, primary use of TFA in our center represents a “surrogate” indicator of the need for crossover. However, the use of TRUA in older women did not affect reperfusion time, although the crossover rate was greater.

Similar results were obtained in patients in cardiogenic shock; TRUA was used in more than half of these patients. Until the results of randomized studies become available and assuming a higher crossover rate in this subgroup, cardiogenic shock does not seem to be a contraindication for the use of TRUA, and furthermore, it frees both femoral arteries for potential implantation of devices for circulatory assistance.<sup>29</sup>

### Study Limitations

Since this is a retrospective study in a patient series, the results may have been affected by unidentified confounding variables. Furthermore, the absence of an adequate control group may limit interpretation of the results. Lastly, extrapolation of our results to other centers should be done with caution. To obtain results similar to ours with TRUA, training and a sufficient volume of patients is required.

## CONCLUSIONS

TRUA can be safely and effectively used in most PPCI procedures with high success rates and little need for crossover. In certain subgroups with less favorable characteristics, such as older women and patients in cardiogenic shock, success rates and time to reperfusion are unaffected, but there is an increased need for crossover. Therefore, use of a femoral access should be considered early on in these patients.

TRUA should be the primary vascular access of choice in most patients undergoing PPCI.

## CONFLICTS OF INTEREST

None declared.

## REFERENCES

- Verheugt FW, Steinhubl SR, Hamon M, Darius H, Steg PG, Valgimigli M, et al. Incidence, prognostic impact, and influence of antithrombotic therapy on access and nonaccess site bleeding in percutaneous coronary intervention. *JACC Cardiovasc Interv.* 2011;4:191–7.
- Hermanides RS, Ottervanger JP, Dambrink JH, De Boer MJ, Hoorntje JC, Gosselink AT, et al. Incidence, predictors and prognostic importance of bleeding after primary PCI for ST-elevation myocardial infarction. *EuroIntervention.* 2010;6:106–11.
- Rao SV, Eikelboom JA, Granger CB, Harrington RA, Califf RM, Bassand JP. Bleeding and blood transfusion issues in patients with non-ST-segment elevation acute coronary syndromes. *Eur Heart J.* 2007;28:1193–204.
- Doyle BJ, Rihal CS, Gastineau DA, Holmes Jr DR. Bleeding, blood transfusion, and increased mortality after percutaneous coronary intervention: implications for contemporary practice. *J Am Coll Cardiol.* 2009;53:2019–27.
- Saito S, Tanaka S, Hiroe Y, Miyashita Y, Takahashi S, Tanaka K, et al. Comparative study on transradial approach vs. transfemoral approach in primary stent implantation for patients with acute myocardial infarction: results of the test for myocardial infarction by prospective unicenter randomization for access sites (TEMPURA) trial. *Catheter Cardiovasc Interv.* 2003;59:26–33.
- Cantor WJ, Puley G, Natarajan MK, Dzavik V, Madan M, Fry A, et al. Radial versus femoral access for emergent percutaneous coronary intervention with adjunct glycoprotein IIb/IIIa inhibition in acute myocardial infarction—the RADIAL-AMI pilot randomized trial. *Am Heart J.* 2005;150:543–9.
- Brasselet C, Tassan S, Nazeyrollas P, Hamon M, Metz D. Randomised comparison of femoral versus radial approach for percutaneous coronary intervention using abciximab in acute myocardial infarction: results of the FARMi trial. *Heart.* 2007;93:1556–61.
- Yan ZX, Zhou YJ, Zhao YX, Liu YY, Shi DM, Guo YH, et al. Safety and feasibility of transradial approach for primary percutaneous coronary intervention in elderly patients with acute myocardial infarction. *Chin Med J (Engl).* 2008;121:782–6.
- Chodór P, Krupa H, Kurek T, Sokal A, Swierad M, Was T, et al. RADIAL versus femoral approach for percutaneous coronary interventions in patients with Acute Myocardial Infarction (RADIAMI): a prospective, randomized, single-center clinical trial. *Cardiol J.* 2009;16:332–40.
- Hou L, Wei YD, Li WM, Xu YW. Comparative study on transradial versus transfemoral approach for primary percutaneous coronary intervention in chinese patients with acute myocardial infarction. *Saudi Med J.* 2010;31:158–62.
- Chodor P, Kurek T, Kowalczyk A, Swierad M, Was T, Honisz G, et al. Radial vs femoral approach with StarClose clip placement for primary percutaneous coronary intervention in patients with ST-elevation myocardial infarction. *RADIAMI II A prospective randomised single centre trial Kardiol Pol.* 2011;69:763–71.
- Kiemeneij F, Laarman GJ. Percutaneous transradial artery approach for coronary stent implantation. *Cathet Cardiovasc Diagn.* 1993;30:173–8.
- Jolly SS, Yusuf S, Cairns J, Niemelä K, Xavier D, Widimsky P, et al.; RIVAL trial group. Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL): a randomised, parallel group, multicentre trial. *Lancet.* 2011;377:1409–20.
- Mingo S, Goicolea J, Nombela L, Sufate E, Blasco A, Millán I, et al. Angioplastia primaria en nuestro medio. Análisis de los retrasos hasta la reperfusión, sus condicionantes y su implicación pronóstica. *Rev Esp Cardiol.* 2009;62:15–22.
- Wiviott SD, Braunwald E, McCabe CH, Montalescot G, Ruzyllo W, Gottlieb S, et al. Prasugrel versus clopidogrel in patients with acute coronary syndromes. *N Engl J Med.* 2007;357:2001–15.
- Mehta SR, Jolly SS, Cairns J, Niemelä K, Rao SV, Cheema AN, et al.; RIVAL Investigators. Effects of radial versus femoral artery access in patients with acute coronary syndromes with or without ST-segment elevation. *J Am Coll Cardiol.* 2012;60:2490–9.
- Romagnoli E, Biondi-Zoccai G, Sciahbasi A, Politi L, Rigattieri S, Pendenza G, et al. Radial versus femoral randomized investigation in ST-segment elevation acute coronary syndrome: the RIFLE-STEACS (Radial Versus Femoral Randomized Investigation in ST-Elevation Acute Coronary Syndrome) study. *J Am Coll Cardiol.* 2012;60:2481–9.
- Valsecchi O, Musumeci G, Vassileva A, Tespili M, Guagliumi G, Gavazzi A, et al. Safety, feasibility and efficacy of transradial primary angioplasty in patients with acute myocardial infarction. *Ital Heart J.* 2003;4:329–34.
- Ziakas A, Klinke P, Mildemberger R, Fretz E, Williams M, Della Siega A, et al. Comparison of the radial and the femoral approaches in percutaneous coronary intervention for acute myocardial infarction. *Am J Cardiol.* 2003;91:598–600.
- Philippe F, Larrazet F, Meziane T, Dibie A. Comparison of transradial vs. transfemoral approach in the treatment of acute myocardial infarction with primary angioplasty and abciximab. *Catheter Cardiovasc Interv.* 2004;61:67–73.
- Ziakas A, Gomma A, McDonald J, Klinke P, Hilton D. A comparison of the radial and the femoral approaches in primary or rescue percutaneous coronary intervention for acute myocardial infarction in the elderly. *Acute Card Care.* 2007;9:93–6.
- Hetherington SL, Adam Z, Morley R, De Belder MA, Hall JA, Muir DF, et al. Primary percutaneous coronary intervention for acute ST-segment elevation myocardial infarction: changing patterns of vascular access, radial versus femoral artery. *Heart.* 2009;95:1612–8.
- Siudak Z, Zawislak B, Dziewierz A, Rakowski T, Jakala J, Bartus S, et al. Transradial approach in patients with ST-elevation myocardial infarction treated with abciximab results in fewer bleeding complications: data from EUROTRANSFER registry. *Coron Artery Dis.* 2010;21:292–7.
- Genereux P, Mehran R, Palmerini T, Caixeta A, Kirtane AJ, Lansky AJ, et al.; HORIZONS-AMI Trial Investigators. Radial access in patients with ST-segment elevation myocardial infarction undergoing primary angioplasty in acute myocardial infarction: the HORIZONS-AMI trial. *EuroIntervention.* 2011;7:905–16.
- Díaz de la Llera LS, Fournier Andray JA, Gómez Moreno S, Arana Rueda E, Fernández Quero M, Pérez Fernández-Cortacero JA, et al. Vía transradial en el tratamiento percutáneo del infarto agudo de miocardio con stents coronarios. *Rev Esp Cardiol.* 2004;57:732–6.
- Bernat I. STEMI-RADIAL: a prospective, randomized trial of radial vs. femoral access in patients with ST-Segment elevation myocardial infarction. *TCT 2012 (Transcatheter Cardiovascular Therapeutics).* Miami, Florida, October 26; 2012.
- Díaz JF, De La Torre JM, Sabaté M, Goicolea J. Registro Español de Hemodinámica y Cardiología Intervencionista. XXI Informe Oficial de la Sección de Hemodinámica y Cardiología Intervencionista de la Sociedad Española de Cardiología (1990-2011). *Rev Esp Cardiol.* 2012;65:1106–16.
- Vink MA, Amoroso G, Dirksen MT, Van der Schaaf RJ, Patterson MS, Tijssen JG, et al. Routine use of the transradial approach in primary percutaneous coronary intervention: procedural aspects and outcomes in 2209 patients treated in a single high-volume centre. *Heart.* 2011;97:1938–42.
- Hamon M, Pristipino C, Di Mario C, Nolan J, Ludwig J, Tubaro M, et al. Consensus document on the radial approach in percutaneous cardiovascular interventions: position paper by the European Association of Percutaneous Cardiovascular Interventions and Working Groups on Acute Cardiac Care and Thrombosis of the European Society of Cardiology. *EuroIntervention.* 2013;8:1242–51.