Heart, Lung and Circulation (2019) **28,** 727–734
1443-9506/04/$36.00
https://doi.org/10.1016/j.hlc.2018.03.020

ORIGINAL ARTICLE

Gender is Not a Predictor of Mortality or Major Adverse Cardiovascular Events in Patients Undergoing Percutaneous Coronary Intervention for Acute Coronary Syndromes

Angeline Josiah, MChD [a*], Ahmad Farshid, BMBS [a,b]

[a]Department of Cardiology, The Canberra Hospital, Canberra, ACT, Australia
[b]College of Medicine, Biology and Ecology, Australian National University, Canberra, ACT, Australia

Received 8 January 2018; received in revised form 2 March 2018; accepted 20 March 2018; online published-ahead-of-print 4 April 2018

Background Historically, studies of percutaneous coronary intervention (PCI) for acute coronary syndrome (ACS) have reported worse outcomes for women. We sought to determine if contemporary PCI techniques eliminate gender differences in PCI outcomes.

Methods This was a retrospective study of 4,776 consecutive patients who underwent PCI for acute coronary syndromes between January 2008 and July 2015. Primary outcomes studied were major adverse cardiovascular events (MACE) and death at 1 year.

Results Percutaneous coronary intervention success was similar in men and women (97.8% v 97.7%, p = 0.76). There was no significant gender difference in the number of vessels attempted (1.14 vs 1.12, p = 0.25), mean number of lesions treated (1.34 vs 1.32, p = 0.21) or the mean number of stents used (1.32 vs 1.30, p = 0.31). There was equivalent use of drug eluting stents (38.2% vs 38.3%, p = 0.94). Women with ST-elevation myocardial infarction STEMI had longer median symptom-to-door time (111 vs 90 mins, p = 0.0411) but there was no gender difference in door-to-balloon time or symptom-to-balloon time. There was no significant difference in percentages of women and men <75 years treated with prasugrel or ticagrelor (11.1% vs 13.4%, p = 0.092). Unadjusted 1-year mortality was 6.4% for women and 4% for men (p = 0.0012), but on multivariate analysis, female sex was not a predictor of death. There was no significant gender difference in the overall incidence of unadjusted 1-year MACE (11.6% vs 10.8%, p = 0.434).

Conclusions When contemporary PCI techniques are applied equally to men and women with ACS there is no gender difference in mortality or MACE at 1 year.

Keywords Percutaneous coronary intervention • Gender differences • Major adverse cardiovascular event • Acute coronary syndromes

*Corresponding author at: Department of Cardiology, The Canberra Hospital, Canberra, ACT, Australia., Email: u5133564@anu.edu.au

Introduction

Ischaemic heart disease (IHD) remains the leading cause of death for both men and women in Australia [1]. Percutaneous coronary intervention (PCI) is associated with improved survival in patients with acute coronary syndrome (ACS) [2]. Women consistently represent a quarter to one-third of all patients undergoing reperfusion therapy for ACS in published studies and have been reported to have worse PCI outcomes [3,4]. Greater incidences of in-hospital death, MACE, associated bleeding, vascular complications and post-procedure contrast-induced nephropathy have been reported in women [4,5] In patients under 55 undergoing PCI, females have been found to have a significantly higher risk of 1-year MACE than men [6] and, more recently, this younger cohort of women has been reported to have a greater risk of mortality than men [7].

Differences in risk factors are often thought to contribute to worse PCI outcomes in women [3,4]. Women undergoing PCI for ACS have been found to be older with significantly higher prevalence of diabetes and hypertension [6,8,9]. Men are more likely to be smokers, have multivessel disease, higher rates of prior myocardial infarction and coronary artery bypass graft (CABG) [8,10].

In conducting this study, we hypothesised that when equivalent treatment was offered to men and women with ACS undergoing contemporary PCI, there would be no gender difference in PCI outcomes. We sought to answer the questions: 1. Does the cohort of patients treated with contemporary PCI show a gender difference in baseline characteristics? 2. Was similar treatment offered to men and women undergoing PCI? 3. Were there any gender differences in 1-year outcomes following PCI?

Methods

We conducted a retrospective analysis of 4,776 consecutive patients who had undergone PCI between January 2008 to June 2015 for either ST-elevation myocardial infarction (STEMI), non ST-elevation myocardial infarction (NSTEMI) or unstable angina pectoris (UAP). Patient details were obtained from our prospective PCI registry and approved by the regional Health Research Ethics Committee. Patient consent was obtained for data collection and follow-up.

Setting

The Canberra Hospital is the major PCI referral centre in the ACT and surrounding NSW regions; an area with a population of about 700,000, serving two nearby non-PCI hospitals as well as several smaller regional hospitals up to 200 km away. The primary PCI service is operated 24 hours a day with onsite cardiothoracic surgery back-up. Activation of the catheter laboratory is performed by Emergency Department clinicians at the Canberra Hospital and at referring non-PCI hospitals or by ambulance paramedics attending to patients at the scene. Patients with NSTEMI or unstable angina undergo angiography and PCI as soon as possible after presentation and generally within 48 hours.

Prior to PCI, patients were loaded with aspirin 300 mg, a P2Y12 receptor inhibitor (prasugrel 60 mg, clopidogrel 600 mg or ticagrelor 180 mg) and 5,000 units of intravenous unfractionated heparin. Prasugrel was not used for patients older than 75 years, in those weighing less than 60 kg or with a history of transient ischaemic attack (TIA) or stroke. The choice of radial or femoral access site and use of glycoprotein 2b-3a inhibitors or intra-aortic balloon pump was at the interventional cardiologist's discretion. Percutaneous coronary intervention was conducted according to standard techniques [11]. All patients were prescribed dual antiplatelet therapy for one year after PCI.

Definitions and Endpoints

STEMI was diagnosed if a patient presented with chest pain or other symptoms suggestive of ACS with associated ECG criteria of ST-segment elevation of $\geq$0.1 mV in at least two contiguous precordial or adjacent limb leads ($\geq$0.2 mV in leads V2-V3), new onset left bundle branch block, or ST-segment depression in the anterior leads consistent with posterior infarction. NSTEMI was diagnosed based on ischaemic pain, elevation in serum troponin, with or without ischaemic ECG changes. Unstable angina was defined as a clinical history of angina with or without ischaemic changes on ECG, with no significant rise in serum troponin [12].

The primary endpoints assessed in this study were MACE and death from all causes. MACE was a composite of all-cause-death, TIA or stroke, stent thrombosis, myocardial infarction, target lesion repeat PCI and CABG at 1 year with specific definitions as follows: (i) TIA: a focal neurological dysfunction lasting less than 24 hours, with no imaging evidence of infarction (ii) Stroke: sudden onset of focal neurological dysfunction due to infarction or haemorrhage in the relevant part of the brain, retina, or spinal cord lasting longer than 24 hours or of any duration if there is clinically relevant evidence on imaging [13] (iii) Stent thrombosis: definite stent thrombosis with angiographic confirmation as per the Academic Research Consortium criteria [14] (iv) Myocardial infarction (MI): defined according to the third universal definition of MI as myocardial cell death due to prolonged ischaemia and detected by increased blood troponin levels [15]. Percutaneous coronary intervention angiographic success was defined as a residual stenosis of <30% with Thrombolysis In Myocardial Infarction (TIMI) grade 3 flow.

Data Collection and Validation

The PCI registry was populated prospectively by catheter laboratory technologists who obtained patient details from discussion with patients and clinical notes. Follow-up was done by letter, telephone or review of clinical notes at 1 year. Approval was sought to access the Australian Institute of Health and Welfare (AIHW) National Death Index. Death was confirmed by comparison and matching of patient names and dates of birth with reciprocal data on the AIHW National Death Index as previously described [16].

Statistical Analysis

Categorical data is presented as frequencies and percentages and analysed by chi square test or Fisher's Exact test. Continuous variables are presented as means with standard deviation or median values with interquartile ranges. Continuous variables were analysed using the t test and Wilcoxon tests. Kaplan Meier survival analysis was conducted to assess the endpoints of death and adverse events with log rank tests used to obtain p values. To assess the relationship of independent variables to death and adverse events, Cox proportional hazard multivariate analyses were conducted. Variables entered into the model included age >70, gender, cardiovascular risk factors, prior PCI or CABG, ACS category, presence of cardiogenic shock or cardiac arrest, procedural and lesion characteristics and use of glycoprotein 2b-3a inhibitors. Risk ratios (RR) and 95% confidence intervals (CI) were calculated. All analyses were two-tailed and p values <0.05 considered significant. The statistical package used was JMP version 12 (JMP Division, SAS Institute Inc, Cary, NC, USA).

Results

Patient Characteristics

We analysed data from 4,776 patients who underwent PCI for ACS between January 2008 and June 2015. Women represented 24.2% of all patients. Baseline characteristics differed significantly between men and women (Table 1). At presentation, women were on average 5.6 years older than men with a higher prevalence of diabetes (25.5% vs 20.8%, p = 0.001), hypertension (58.1% vs 50.3%, p < 0.0001) and comparatively higher average BMI (29.1 ± 6.6 vs 28.5 ± 4.9, p = 0.0047). Men were more likely to be current or past smokers and to have had prior PCI or CABG. There was no gender difference in the prevalence of hypercholesterolaemia (p = 0.55) or family history of IHD (p = 0.36). Among patients with STEMI (Table 2) women took significantly longer following onset of symptoms to first medical contact (median time 111 vs 90 mins, p = 0.0411). However, there was no significant gender difference in door-to-balloon time (p = 0.76) and overall symptom-to-balloon time (p = 0.063).

Table 1 Baseline characteristics of patients.

	Male (n = 3621)	Female (n = 1155)	P value
Age (years), mean ± SD	62.6 ± 11.7	68.2 ± 12.8	<0.0001
Diabetes	753 (20.8%)	294 (25.5%)	0.001
Diabetes on insulin	83 (2.3%)	32 (2.8%)	0.36
Hypertension	1820 (50.3%)	671 (58.1%)	<0.0001
Smoker	988 (27.3%)	247 (21.4%)	<0.0001
Ex-smoker	1083 (29.9%)	245 (21.2%)	<0.0001
High cholesterol	1566 (43.3%)	488 (42.3%)	0.55
BMI ± SD	28.5 ± 4.9	29.1 ± 6.6	0.0047
Family history of IHD	1200 (33.1%)	366 (31.7%)	0.36
Prior PTCA	827 (23.4%)	223 (19.9%)	0.0135
Prior CABG	322 (9.1%)	67 (6.0%)	0.0007

Abbreviations: BMI, body mass index; SD, standard deviation; PTCA, percutaneous transluminal coronary angioplasty; CABG, coronary artery bypass graft.

Table 2 Median treatment times (and interquartile range) in patients with STEMI.

	Male (n = 1,377)	Female (n = 408)	P value
Symptom-to-door	90 (60, 165)	111 (60, 240)	0.0411
Door-to-balloon time	85 (55, 136)	86 (44, 145)	0.7647
Symptom-to-balloon time	194 (134, 334)	215 (140, 387)	0.0626

Procedural Characteristics

Table 3 compares the procedural characteristics for men and women. Procedural success was 97.7% in men and 97.8% in women (p = 0.76). There was no significant difference in the number of vessels attempted in men and women (p = 0.25), mean number of lesions treated (p = 0.21) or the mean number of stents used (p = 0.31). Stents were used in approximately 93% of cases in both groups and there was no gender difference in the use of drug eluting stents (35.7% v 35.6%, p = 0.65). In patients aged ≤75 years, there was no significant difference in the proportion of women and men treated with the new antiplatelet drugs, prasugrel or ticagrelor (11.1% v 13.4%, p = 0.092). Presentation with unstable angina was more common in women (23.1% vs 20.1%, p = 0.0105) while NSTEMI and STEMI rates were similar between the genders.

Men had more complex coronary artery disease than women, as reflected by more frequent three-vessel disease (20.4% vs 14.9%, p < 0.0001), more complex (B2 and C) lesions (71.5% vs 68%, p = 0.029), and higher frequency of initial slow flow (TIMI 0-II, 43.8% vs 37.6%, p = 0.0003). The radial access site was more frequently used in males than in females (12.8% vs 10%, p = 0.0089). Glycoprotein 2b-3a inhibitors were used less frequently in women compared with men (19.4% vs 25.7%, p < 0.0001).

Adverse Events and Mortality

Unadjusted 1-year mortality rate was 6.4% for women and 4.0% for men, p = 0.0012 (Table 4 and Kaplan Meier survival plot, Figure 1). When analysed by age group, there were no significant differences in mortality between males and females in any age group (Figure 2). Men experienced a slightly increased risk of recurrent myocardial infarction (2% vs 1.1%, p = 0.032), but overall, there was no significant difference in unadjusted 1-year MACE between men and women (11.6% v 10.8%, p = 0.434). After multivariate analysis, gender was not a predictor of MACE or death at 1 year

Table 3 PCI characteristics.

	Male (n = 3621)	Female (n = 1155)	P value
Indication for PCI			
STEMI	1377 (39.2%)	408 (36.5)	0.099
NSTEMI	1427 (40.7%)	445 (39.8)	0.61
Unstable angina	705 (20.1%)	265 (23.7%)	0.0105
Access site			0.0089
Femoral access site	3158 (87.2%)	1040 (90.0%)	
Radial access site	463 (12.8%)	115 (10%)	
Three vessel disease	728 (20.4%)	169 (14.9%)	<0.0001
Mean contrast volume (ml)	149.8 (±54.5)	137.9 (±51.7)	<0.0001
Number of vessels attempted (mean)	1.14 (±0.37)	1.12 (±0.35)	0.25
Number of lesions treated (mean)	1.34 (±0.61)	1.32 (±0.62)	0.21
Denovo lesion	3376 (93.2)	1083 (93.8)	0.52
Complex lesions (B2, C)	2506 (71.5%)	762 (68%)	0.029
Initial TIMI flow 0-2	1548 (43.8%)	424 (37.6%)	0.0003
Number of stents used (mean)	1.32 (±0.78)	1.30 (±0.77)	0.31
Device used			0.65
Bare metal stent	2087 (58.0%)	659 (57.4%)	
Drug eluting stent	1288 (35.7%)	409 (35.6%)	
Balloon only	226 (6.3%)	81 (7.0%)	
Mean stent diameter	3.15 (±0.46)	3.02 (±0.4)	<0.0001
Mean stent length	22.76 (±11.51)	21.87 (±11.98)	0.029
Mean stent deployment pressure	14.54 (±3.18)	14.1 (±3.16)	0.0002
P2Y12 inhibitor antiplatelet therapy			0.0054
Clopidogrel	3114 (88.1%)	1022 (91.3%)	0.0022
Ticagrelor	52 (1.5%)	16 (1.4%)	0.92
Prasugrel/Ticagrelor use <75 years	404 (13.4%)	86 (11.1%)	0.0924
glycoprotein 2b/3a inhibitors	931 (25.7%)	224 (19.4%)	<0.0001
Procedural success	3537 (97.7)	1130 (97.8)	0.76

Abbreviations: PCI, percutaneous coronary intervention; STEMI, ST-elevation myocardial infarction; NSTEMI, non ST-elevation myocardial infarction; TIMI: thrombolysis in myocardial infarction (TIMI).

Table 4 Outcomes at 1 year following PCI.

	Male (n = 3621)	Female (n = 1155)	P value
Major adverse cardiovascular event	390 (10.8%)	134 (11.6%)	0.434
TIA/CVA	4 (0.1%)	4 (0.4%)	0.11
Stent thrombosis	32 (0.88%)	7 (0.6%)	0.35
Myocardial infarction	74 (2.0%)	13 (1.1%)	0.032
Cardiogenic shock	104 (2.9%)	31 (2.7%)	0.736
Cardiac arrest	36 (1.0%)	16 (1.4%)	0.278
Access site bleeding	20 (0.6%)	14 (1.3%)	0.285
Target lesion repeat PCI	135 (3.7%)	31 (2.7%)	0.0828
CABG by 1 year	61 (1.7%)	16 (1.4%)	0.475
Death	146 (4.0%)	74 (6.4%)	0.0012

Abbreviations: TIA/CVA, transient ischaemic attack/cerebrovascular accident; PCI, percutaneous coronary intervention; CABG: coronary artery bypass grafting.

(Tables 5 and 6). Age over 70 years, diabetes, three-vessel disease, prior PCI, bare metal stent use, cardiogenic shock and cardiac arrest were identified as predictors of both MACE and death following PCI. STEMI and the use of glycoprotein 2b-3a inhibitors were additional predictors of death.

Discussion

The key findings in this contemporary study of PCI for ACS are: (1) Males and females presenting with ACS had different baseline characteristics with women being 5.6 years older on average and having a greater prevalence of diabetes and hypertension. (2) Women with ACS received similar interventional treatment to men and (3) PCI success rates and 1-year adverse outcomes were similar between men and women, after adjustment for baseline variables.

Several studies have found poorer outcomes in women compared with men following PCI. A 1985–1986 cohort of patients in a US Registry recorded higher rates of

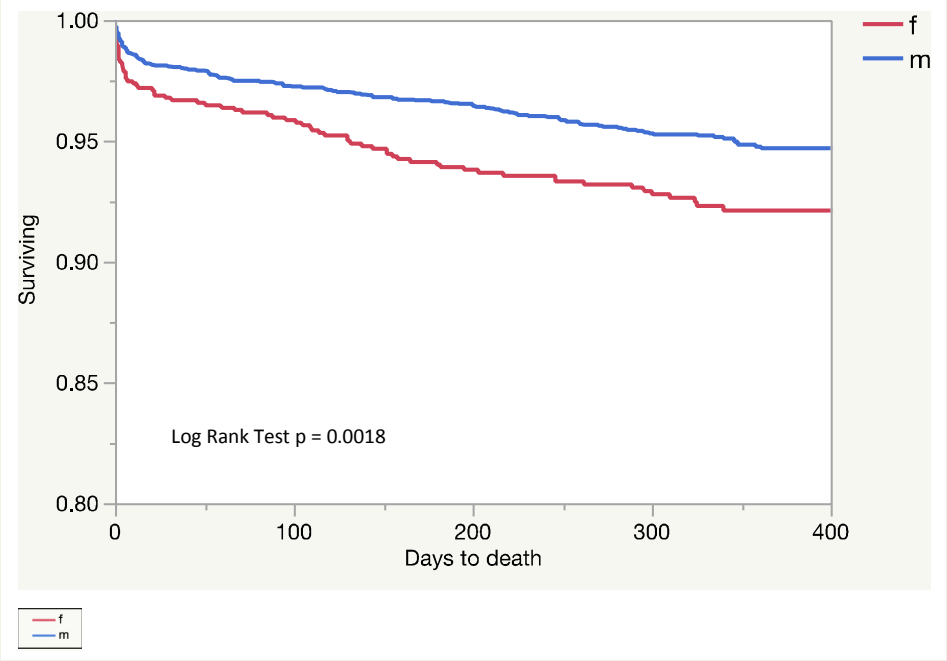

Figure 1 Kaplan Meier survival curve for mortality at 1 year.

complications in women [4]. Duvernoy, et al.'s data from 2002 to 2003 showed an increased risk of in-hospital death and MACE in women following PCI [5]. Two meta-analyses of STEMI patients reported a higher risk of death in women within 30 days of PCI [17,18] The publication of a large study showing higher mortality in women <50 years of age after PCI in the 90s was a cause for concern [19]. The authors speculated that the result may have occurred due to higher prevalence of baseline comorbidities such as diabetes and heart failure, and the presence of smaller vessel size in women, making PCI more challenging. It is also possible that, at that time, women were referred for PCI later than men, after onset of symptoms. In contrast, other studies have shown no gender differences in PCI outcomes after adjustment for various baseline and procedural factors [20].

There are a number of explanations for equivalent PCI outcomes in women and men in our study. We observed

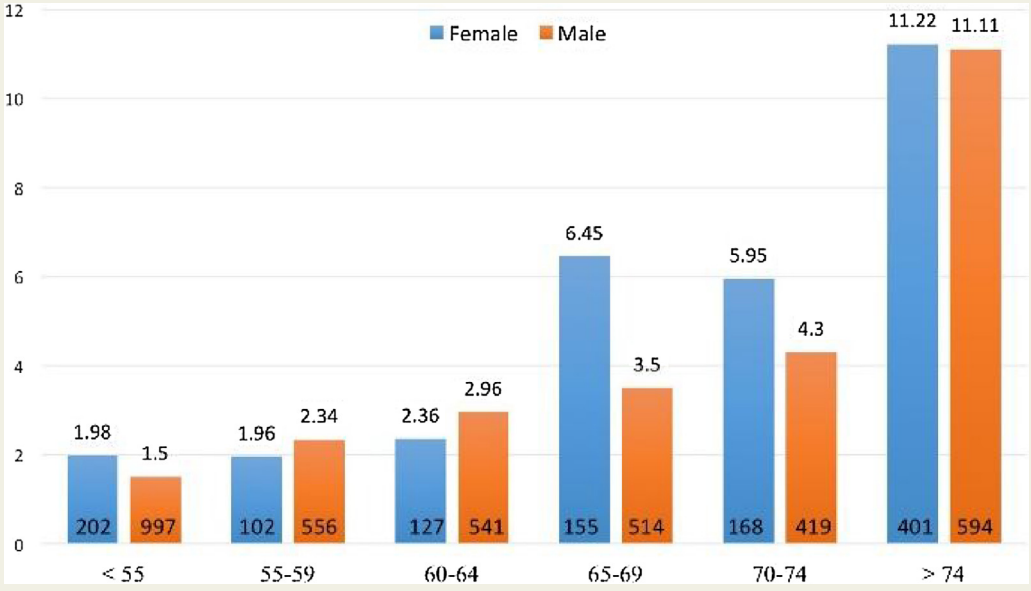

Figure 2 1-year mortality for females and males by age group represented as % mortality. The numbers of patients in each age group are shown at the base of each bar. P value was not significant for all age groups.

Table 5 Multivariate analysis of predictors of MACE at 1 year.

	Risk Ratio	P value
Age >70	1.56 (1.27–1.90)	<.0001
Female sex	0.99 (0.78–1.24)	0.9083
Diabetes	1.47 (1.17–1.82)	0.0008
Three vessel disease	1.77 (1.43–2.19)	<0.0001
Prior PTCA	1.49 (1.18–1.85)	0.0006
Bare metal stent	1.69 (1.36–2.10)	<0.0001
Cardiogenic shock	4.63 (3.07–6.72)	<0.001
Cardiac arrest	2.21 (1.11–4.06)	0.0259

Abbreviation: PTCA, percutaneous transluminal coronary angioplasty

Table 6 Multivariate analysis of predictors of death at 1 year.

	Risk Ratio	P value
Age >70	3.63 (2.62–5.07)	<0.0001
Female sex	0.81 (0.58–1.14)	0.2305
Diabetes	1.77 (1.25–2.48)	0.0015
STEMI	1.68 (1.18–2.37)	0.0035
Three vessel disease	1.56 (1.11–2.17)	0.0111
Complex lesion	1.30 (0.90–1.93)	0.1696
Prior PTCA	1.60 (1.11–2.27)	0.0133
Cardiogenic shock	7.62 (4.60–12.18)	<0.0001
Cardiac arrest	3.93 (1.83–7.88)	0.0008
Bare metal stent	1.79 (1.25–2.59)	0.0011
Glycoprotein 2b 3a inhibitor	1.44 (1.01–2.03)	0.0413

Abbreviations: PTCA, percutaneous transluminal coronary angioplasty; STEMI, ST-elevation myocardial infarction.

differences in baseline characteristics and adjusted for these differences, whereas some previous studies did not. Another factor contributing to similar outcomes is that men and women in our study received almost identical treatment with regards to drugs and interventions. A comparable number of vessels and lesions were treated in both men and women, and total stent and drug eluting stent (DES) usage was identical. Use of stents in women during PCI was lower in some published reports [21] and this may have contributed to higher adverse events in those studies. In addition, all men and women in our study received P2Y12 inhibitor antiplatelet therapy and the proportion of women ≤75 treated with new antiplatelet agents was similar to men. In STEMI patients, although symptom-to-door time was longer in women, door-to-balloon time was almost identical to men, further reinforcing that equal treatments were offered to both men and women once they made contact with the health service.

Interestingly, a recent Australian PCI registry reported a higher risk of mortality in women under 55 compared to men after PCI for ACS [7]. Of note is that the study was conducted on data from 2003 to 2010 with almost universal use of femoral access for PCI (97–99%), low usage of DES (23–24%) and significantly smaller mean stent diameter in women. We studied a larger cohort of patients who underwent PCI between 2008 and 2015 with greater use of radial access (10–12.8%), higher use of DES and identical mean stent diameter for both men and women. Improvements in PCI technique over the last 10 years have contributed significantly to the success and safety of these procedures. These improvements include smaller diameter catheters, better designed wires and balloons, more effective antiplatelet agents and smaller and more reliable DES which can be used in virtually all patients. We believe that using these contemporary techniques, our PCI results have improved for all patients and the uniform application of these techniques to both men and women resulted in equivalent outcomes. We did not find any significant trend towards higher mortality in young women, even without adjustment for baseline variables.

Women in our study were 5.6 years older than men, had higher rates of hypertension and diabetes and a higher BMI. However, they were less likely to have a history of smoking, prior PCI or CABG. These results are similar to published data on baseline characteristics of women with ACS [8–10,22]. The pathophysiology of ischaemic heart disease has been reported to differ among males and females. Men have a greater plaque burden and higher incidence of plaque rupture, while women have greater plaque erosion and non-obstructive coronary artery disease [23,24]. We did not directly study plaque characteristics but established that men had more complex disease with more frequent three-vessel disease and a greater incidence of complex lesions. Higher use of glycoprotein 2b-3a inhibitors in men is explained by a higher prevalence of slow flow which is often associated with presence of intracoronary thrombus. Our findings are in line with published data that on average women have less extensive coronary artery disease [25]. Considering the different risk profiles of men and women, it is possible that the presence of more complex coronary disease in men balanced the negative effect of worse baseline characteristics in women, contributing to similar outcomes between the sexes in our study.

Spontaneous coronary artery dissection may be the cause of up to 4% of ACS cases and women are over-represented [26–28]. Percutaneous coronary intervention success has been reported to be lower in SCAD in earlier studies (30–48%) with the risk of extension of the dissection and higher need for CABG [26,29,30]. It is possible that the higher rate of adverse PCI outcomes in women in earlier studies may be partly due to misdiagnosis of SCAD which was treated as coronary plaque rupture. We did not specifically record cases of SCAD in our database, but based on our high overall PCI success rate, we feel that SCAD is unlikely to have made a significant contribution to adverse events or the overall results.

As we have found equivalent PCI outcomes in men and women in our study, we feel that gender should not be a

deciding factor when considering PCI for patients with ACS. It was reassuring to establish that there was uniform application of interventional treatment to both women and men. We postulate that the higher crude 1-year mortality rate for women as compared to men, was related to the older age of the women and presence of greater comorbidities. Age group comparison of men and women, however, showed no significant difference in mortality rate. When treating individual patients of any gender, specific risk factors should be considered to select specific strategies to optimise the success rate of PCI and avoid ischaemic and bleeding complications. Education and cardiac rehabilitation following PCI are also important factors, regardless of gender, to achieve favourable long-term outcomes.

Study Limitations

This was a single-centre observational study and the results may not be applicable to other centres with different practices. However, this was a large cohort of consecutive patients from a defined geographic area who were all referred to a single PCI centre for treatment and we feel the results are representative of real world cardiology practice in Australia and other developed countries. The focus of our study was on outcomes following PCI and all patients included in our study underwent PCI. Our outcome results are not applicable to women with ACS who did not receive PCI. Cardiac technicians relied on information obtained from patients regarding baseline characteristics which may not always be accurate.

Conclusion

In spite of differences in baseline characteristics between men and women, we have shown equal PCI success rates and 1-year outcomes for males and females presenting with ACS and offered similar interventional treatment. Additionally, assessing outcomes based on age groups did not reveal worse outcomes in younger women. Female gender was not found to be a predictor of death or MACE at 1 year after PCI.

Funding

This research did not receive any specific funding grant.

References

[1] Australian Bureau of Statistics. 3303.0 - Causes of Death, Australia, 2015; 2015, Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/3303.0~2015~Main%20Features~Key%20changes%20in%20this%20issue~2. Viewed 15 October 2016.

[2] Wada H, Ogita M, Miyauchi K, Tsuboi S, Konishi H, Shitara J, et al. Contemporary sex differences among patients with acute coronary syndrome treated by emergency percutaneous coronary intervention. Cardiovasc Interv Ther 2016;1–8.

[3] Alfonso F, Hernández R, Bañuelos C, Fernández-Ortíz A, Escaned J, Sabaté M, et al. Initial results and long-term clinical and angiographic outcome of coronary stenting in women. Am J Cardiol 2018;86(12):1380–3.

[4] Kelsey SF, James M, Holubkov AL, Holubkov R, Cowley MJ, Detre KM. Results of percutaneous transluminal coronary angioplasty in women. 1985-1986 National Heart, Lung, and Blood Institute's Coronary Angioplasty Registry. Circulation 1993;87(3):720–7.

[5] Duvernoy CS, Smith DE, Manohar P, Schaefer A, Kline-Rogers E, Share D, et al. Gender differences in adverse outcomes after contemporary percutaneous coronary intervention: An analysis from the Blue Cross Blue Shield of Michigan Cardiovascular Consortium (BMC2) percutaneous coronary intervention registry. Am Heart J 2010;159(4):677–683.e1.

[6] Chandrasekhar J, Baber U, Sartori S, Faggioni M, Aquino M, Kini A, et al. Sex-related differences in outcomes among men and women under 55 years of age with acute coronary syndrome undergoing percutaneous coronary intervention: Results from the PROMETHEUS study. Catheter Cardiovasc Interv 2017;89:629–37.

[7] Idris H, French JK, Shugman IM, Hopkins AP, Juergens CP, Thomas L. Influence of Age and Gender on Clinical Outcomes Following Percutaneous Coronary Intervention for Acute Coronary Syndromes. Heart Lung Circ 2016;26(6):554–65.

[8] Naito R, Miyauchi K, Konishi H, Tsuboi S, Ogita M, Dohi T, et al. Gender difference in long-term clinical outcomes following percutaneous coronary intervention during 1984–2008. Atherosclerosis 2016;247:105–10.

[9] Fath-Ordoubadi F, Barac Y, Abergel E, Danzi GB, Kerner A, Nikolsky E, et al. Gender Impact on Prognosis of Acute Coronary Syndrome Patients Treated With Drug-Eluting Stents. Am J Cardiol 2012;110(5):636–42.

[10] Berger JS, Elliott L, Gallup D, Roe M, Granger C, Armstrong P, et al. Sex differences in mortality following acute coronary syndromes. JAMA 2009;302(8):874–82.

[11] Chew DP, Scott IA, Cullen L, French JK, Briffa TG, Tideman PA, et al. National Heart Foundation of Australia; Cardiac Society of Australia and New Zealand: Australian Clinical Guidelines for the Management of Acute Coronary Syndromes 2016. Heart Lung Circ 2016;25(9):895–951.

[12] Deckers JW. Classification of myocardial infarction and unstable angina: A re-assessment. Int J Cardiol 2013;167(6):2387–90.

[13] Hankey GJ. Stroke. Lancet 2016;389(10069):641–54.

[14] Cutlip DE, Windecker S, Mehran R, Boam A, Cohen DJ, van Es G-A, et al. Clinical End Points in Coronary Stent Trials. A Case for Standardized Definitions. Circulation 2007;115(17):2344–51.

[15] Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD, et al. Third universal definition of myocardial infarction. Eur Heart J 2012;33(20):2551–67.

[16] Doost Hosseiny A, Moloi S, Chandrasekhar J, Farshid A. Mortality pattern and cause of death in a long-term follow-up of patients with STEMI treated with primary PCI. Open Heart 2016;3(1).

[17] Pancholy S, Shantha G, Patel T, Cheskin LJ. Sex differences in short-term and long-term all-cause mortality among patients with st-segment elevation myocardial infarction treated by primary percutaneous intervention: A meta-analysis. JAMA Intern Med 2014;174(11):1822–30.

[18] Bavishi C, Bangalore S, Patel D, Chatterjee S, Trivedi V, Tamis-Holland JE. Short and long-term mortality in women and men undergoing primary angioplasty: A comprehensive meta-analysis. Int J Cardiol 2018;198:123–30.

[19] Abramson JL, Veledar E, Weintraub WS, Vaccarino V. Association between gender and In-Hospital mortality after percutaneous coronary intervention according to age. Am J Cardiol 2016;91(8):968–71.

[20] Hess CN, McCoy LA, Duggirala HJ, Tavris DR, O'Callaghan K, Douglas PS, et al. Sex-Based Differences in Outcomes After Percutaneous Coronary Intervention for Acute Myocardial Infarction: A Report From TRANSLATE-ACS. J Am Heart Assoc 2014;3(1).

[21] Jacobs AK, Johnston JM, Haviland A, Mori Brooks M, Kelsey SF, Holmes Jr DR, et al. Improved outcomes for women undergoing contemporary percutaneous coronary intervention: A report from the national heart, lung, and blood institute dynamic registry. J Am Coll Cardiol 2002;39(10):1608–14.

[22] Anand SS, Xie CC, Mehta S, Franzosi MG, Joyner C, Chrolavicius S, et al. Differences in the Management and Prognosis of Women and Men Who Suffer From Acute Coronary Syndromes. J Am Coll Cardiol 2005;46(10):1845–51.

[23] Chandrasekhar J, Mehran R. Sex-Based Differences in Acute Coronary Syndromes: Insights From Invasive and Noninvasive Coronary Technologies. JACC Cardiovasc Imaging 2016;9(4):451–64.

[24] Kawamoto KR, Davis MB, Duvernoy CS. Acute Coronary Syndromes: Differences in Men and Women. Curr Atheroscler Rep 2016;18(12):73.

[25] Lansky AJ, Ng VG, Maehara A, Weisz G, Lerman A, Mintz GS, et al. Gender and the Extent of Coronary Atherosclerosis, Plaque Composition, and Clinical Outcomes in Acute Coronary Syndromes. JACC Cardiovasc Imaging 2012;5(3, Supplement):S62–72.

[26] Saw J, Aymong E, Sedlak T, Buller CE, Starovoytov A, Ricci D, et al. Spontaneous Coronary Artery Dissection. Association With Predisposing Arteriopathies and Precipitating Stressors and Cardiovascular Outcomes. Circ Cardiovasc Interv 2014;7(5):645–55.
[27] Rashid HNZ, Wong DTL, Wijesekera H, Gutman SJ, Shanmugam VB, Gulati R, et al. Incidence and characterisation of spontaneous coronary artery dissection as a cause of acute coronary syndrome; A single-centre Australian experience. Int J Cardiol 2018;202:336–8.
[28] Nishiguchi T, Tanaka A, Ozaki Y, Taruya A, Fukuda S, Taguchi H, et al. Prevalence of spontaneous coronary artery dissection in patients with acute coronary syndrome. Eur Heart J Acute Cardiovasc Care 2016;5(3):263–70.
[29] Tweet MS, Eleid MF, Best PJM, Lennon RJ, Lerman A, Rihal CS, et al. Spontaneous Coronary Artery Dissection. Revascularization Versus Conservative Therapy. Circ Cardiovasc Interv 2014;7(6):777–86.
[30] Vanzetto G, Berger-Coz E, Barone-Rochette G, Chavanon O, Bouvaist H, Hacini R, et al. Prevalence, therapeutic management and medium-term prognosis of spontaneous coronary artery dissection: results from a database of 11,605 patients. Eur J Cardiothorac Surg 2009;35(2):250–4.