# Gender differences in the outcome of interventional cardiac procedures

Patrizia Presbitero, Addolorata Carcagnì

*Division of Interventional Cardiology, Istituto Clinico Humanitas, Rozzano (MI), Italy*

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**Coronary angioplasty; Sex.**

**Prior studies have reported significant gender differences in the procedural outcomes after elective percutaneous transluminal coronary angioplasty (PTCA). Many of these differences have been explained by the presence of more comorbidities and worse clinical characteristics such as older age, unstable angina, congestive heart failure, diabetes mellitus, and hypertension in women than in men. Moreover, women have a smaller vessel diameter, more coronary tortuosity and different plaque composition compared to men that can lead to a higher dissection rate and a greater number of procedural complications. Although early data on PTCA suggested worse immediate results in women than in men, more recent data suggest that this difference is less marked. The introduction of stents with a low profile and a higher tractability and pushability has allowed the extensive application of these devices even in small and tortuous vessels improving the outcome of PTCA. This improvement has been higher in women than in men leading to the equalization of the immediate outcome in the two sexes, even if the baseline characteristics remain worse in women. In particular, mortality and the need for urgent surgical revascularization have become extremely low without any differences between sexes. However, some authors have still found a higher incidence of complications in the first period after the procedure due to stent thrombosis in the stenting era. For this reason, meticulous antiplatelet treatment should be prescribed and drugs such as glycoprotein IIb/IIIa inhibitors may also be considered advisable to reduce the excess risk in the female population particularly in women with prothrombotic risk factors such as diabetes. At 6 and 12 months similar rates of death, late myocardial infarction, and repeated revascularization have been shown in the two sexes.**

**Coronary stenting and the use of glycoprotein IIb/IIIa inhibitors have also improved the immediate results in patients with acute myocardial infarction (AMI) undergoing primary PTCA. Studies comparing the outcome differences between women and men with AMI and treated with primary PTCA are limited but all suggest that women benefit more than men from this procedure. The in-hospital mortality in patients with AMI is significantly higher in the female than in the male population with a higher incidence of intracranial hemorrhage in women among tissue-type plasminogen activator-treated patients. Vice versa, women and men have a similar or a slightly higher in-hospital mortality after primary PTCA without intracranial bleeding complications. For this reason, an earlier diagnosis of AMI, an earlier hospital admission and an earlier primary PTCA should be the aims of management in order to improve the outcome in women with AMI and to equalize the procedural results in the two sexes.**

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*Address:*
Dr.ssa Patrizia Presbitero
*Cardiologia Interventistica*
*Istituto Clinico Humanitas*
*Via Manzoni, 56*
*20089 Rozzano (MI)*
*E-mail:*
*patrizia.presbitero@humanitas.it*

Percutaneous transluminal coronary angioplasty (PTCA) has become a widespread and useful alternative technique to coronary artery bypass grafting (CABG), and nowadays women represent 25-30% of the population undergoing this procedure. In accordance with this datum, of the 2029 patients treated with PTCA between 1999 and 2001 in our department, 397 were women (24.3%).

Women undergoing PTCA are older than men and have a higher incidence of diabetes (Table I), the worst factor for the long-term prognosis of patients with coronary artery disease and hypertension[1]. Furthermore, a previous acute myocardial infarction (AMI) and previous coronary revascularization are less frequent in the female population, although women more commonly complain of angina (Table I). Multivessel disease is also less frequent in women. In our experience, multivessel coronary artery disease was present in 45% of women and in 59% of men ($p < 0.01$). The female patients have shown a better left ventricular ejection fraction, but even so, previous episodes of heart failure are more frequent in women because of hypertension, coronary artery disease and probably other not well known causes.

## Elective coronary angioplasty in women

**Acute outcome.** Prior studies have reported significant gender differences in proce-

**Table I.** Gender differences in clinical characteristics in our institute database (1999-2001).

| | Women (n=397) | Men (n=1632) |
|---|---|---|
| Age (years) | 68.8 ± 0.4* | 61.9 ± 0.3 |
| Diabetes (%) | 26.4* | 20.6 |
| Hypertension (%) | 68.1* | 54.9 |
| Cholesterolemia (%) | 61.3 | 56.7 |
| Smoking (%) | 29.7 | 72.7* |
| Angina (%) | 80.4* | 69.0 |
| Previous myocardial infarction (%) | 42.5 | 50.4* |
| Previous coronary revascularization (%) | 24.9 | 32.1* |

* $p < 0.05$.

dural outcomes[2-7]. As with CABG, the early data showed that women who underwent conventional balloon angioplasty had a lower clinical and angiographic success rate, a higher in-hospital mortality, and many more adverse events than men[2-7].

The first National Heart, Lung and Blood Institute's (NHLBI) Coronary Angioplasty Registry showed a lower procedural success rate in women who underwent conventional balloon angioplasty than in men (Table II)[2]. However, in the second and third NHLBI registries the procedural success rate increased to a similar extent in both sexes, probably because of the increased experience of the operators and because of technological developments (Table II)[3,8]. No differences were found in the occurrence of periprocedural AMI and emergency CABG in the registries. However, the in-hospital mortality was higher in women than in men in the first two registries, but not in the third one (Table II). Apart from similar success rates, even the increased in-hospital mortality has been confirmed by other studies[3-5,7,9-13] (Table III). Many of these differences were attributed to the presence of more comorbidities and worse clinical characteristics in women such as older age, unstable angina, congestive heart failure, diabetes mellitus, and hypertension. After accounting for these differences, gender has little or no independent effect on procedural outcomes[5-7]. Moreover, women have a smaller body surface area, a smaller vessel diameter and more coronary tortuosity than men: this can lead to a greater number of procedural complications. The worst outcomes after CABG reported in women were attributed to the smaller vessel size[7]. Arnold et al.[5] have shown, in more than 5000 patients treated with PTCA, that women had a higher in-hospital mortality than men (1.1 vs 0.3%, $p < 0.001$), but after correcting for body surface area this difference disappeare[14]. A small vessel size has also been reported as one of the major factors associated with abrupt vessel closure, due to plaque dissection and/or plaque thrombosis with an increased mortality and a higher incidence of AMI and emergency

**Table II.** Immediate procedural outcomes in the National Heart, Lung and Blood Institute trials[2,3,8].

| | 1977-1982 | | 1985-1986 | | 1993-1994 | |
|---|---|---|---|---|---|---|
| | Women | Men | Women | Men | Women | Men |
| No. patients | 705 | 2374 | 546 | 1590 | 975 | 1880 |
| Mean age (years) | 56 | 53 | 61 | 56 | 65 | 61 |
| Procedural success (%) | 60.3* | 66.2 | 89.0 | 88.0 | 90.0 | 91.3 |
| Dissections (%) | 5.8* | 4.0 | 6.8* | 4.5 | – | – |
| Death (%) | 1.8* | 0.7 | 2.6* | 0.3 | 1.4 | 1.1 |
| AMI (%) | 4.7 | 5.1 | 4.6 | 4.3 | 0.9 | 1.1 |
| CABG (%) | 6.5 | 6.6 | 4.8 | 3.3 | 1.5 | 1.0 |

AMI = acute myocardial infarction; CABG = coronary artery bypass grafting. * $p < 0.05$.

**Table III.** Gender differences in mortality in different series.

| Study | Method | Death women vs men (%) | OR (95% CI) |
|---|---|---|---|
| McEniery et al.[10], 1987 | POBA | 0.3 vs 0.09 | p = NS |
| Kelsey et al.[3], 1993 | POBA | 2.6 vs 0.3 | 4.53 (1.39-14.7) |
| Bell et al.[7], 1993 | POBA | 1.39 vs 0.66 | 1.51 (1.0-2.29) |
| Malenka et al.[4], 1996 | NDA | 1.64 vs 0.7 | 1.64 (1.09-2.47) |
| Arnold et al.[5], 1994 | POBA | 1.1 vs 0.3 | 1.08 (0.81-1.45) |
| Bell et al.[11], 1995 | POBA | 1.4 vs 1.1 | 0.94 (0.76-1.15) |
| Robertson et al.[12], 1997 | NDA | 1.4 vs 1.1 | 1.02 (0.87-1.2) |
| Jacobs et al.[13], 1997 | NDA | 1.7 vs 0.3 | 1.08 (0.81-1.45) |

CI = confidence interval; NDA = non-directional atherectomy; OR = odds ratio; POBA = plain old balloon angioplasty. The first three studies show increased mortality in women, whereas the other authors did not confirm the data.

CABG[4,5,15]. In the first NHLBI registry women had a higher incidence of both non-occlusive dissections (16.6 vs 10.7%, $p < 0.05$) and occlusive dissections (5.8 vs 4.0%, $p < 0.05$) than men[2]. These findings are also confirmed by our study, which showed more angiographic dissection even with a lower procedural success rate[16]. In the literature, several other factors have been associated with abrupt coronary closure and procedural complications[15,17-22]. Diabetes mellitus is one of the most important ones, and in all reported series its occurrence was higher in women. Diabetes causes unstable atherosclerotic plaques and a hypercoagulable state that could be associated with an increased mortality[23] due to dissection or thrombosis. Another hypothesis is that the plaque composition could be different in the two sexes. Some authors have found in women more hypercellular plaques, with less dense connective tissue[24]. In women atherosclerosis starts with menopause and develops faster than in men; this different composition probably makes the plaques more liable to rupture and dissection during PTCA.

The initial data on PTCA suggested worse immediate results in women than in men, but this difference is less apparent in more recent data[25,26]. The introduction of stents has improved the immediate outcome of PTCA; however, the first generation of these devices was not used so extensively in women[25], because of their smaller and more tortuous vessels. This obstacle was overcome with the introduction of stents with a low profile and a higher tractability and pushability, which allowed their extensive application even in this kind of vessels. In our first study, which compared the procedural PTCA results in women and in men matched for the same vessel size, coronary stents were used more frequently in women than in men (70.4 vs 52.2%, $p < 0.05$)[16]. The reason was a coronary dissection (49.5 vs 41.7, $p < 0.05$); however, no differences were found in elective coronary stenting or stenting for suboptimal result. Recently, the use of these devices in our laboratory increased largely, and coronary stents are now used in 79.2% of women and in 77.7% of men ($p < 0.5$). Stents have improved the outcome of PTCA, which nowadays reaches a success rate of 94-98%. This improvement was more marked in women and has led to the equalization of the immediate outcome in the two sexes. The incidence of major adverse cardiac events decreased. In particular, mortality and the need for urgent surgical revascularization have become extremely low in both sexes. In our first experience, Q and non-Q wave AMI were more frequent in women (5.0 vs 0.8% in men, $p < 0.05$), because of coronary dissection and intrastent thrombosis[16]. However, in our more recent analysis no statistical differences were found between the two sexes in the occurrence of periprocedural AMI, as a coronary stent was deployed in almost 80% of our procedures in both sexes. Even if stents have improved the in-hospital outcome in women, some authors still report a higher incidence of complications during the first period after the procedure. Mehilli et al.[26] have reported a significantly higher risk of death or AMI during the first 30 days after coronary stenting in women. This high risk persists even after adjustment for the baseline clinical differences (older age, higher incidence of hypertension and diabetes) and it is mainly due to stent thrombosis[27,28]. As a result, women appear to be at higher risk for thrombotic complications and should be prescribed meticulous antiplatelet treatment. New antithrombotic drugs such as glycoprotein IIb/IIIa inhibitors may also be considered advisable to reduce the early excess risk and improve the overall results of coronary interventions in women. However, no advantage was shown in the literature. In a meta-analysis of the EPIC, EPILOG and EPISTENT trials, Cho et al.[29] have shown that the benefit from abciximab at 1, 6 and 12 months was similar in men and women undergoing PTCA. In this analysis women presented more bleeding complications than men, regardless of the use of abciximab. However, another study suggests a more pronounced beneficial effect of glycoprotein IIb/IIIa inhibition among diabetic patients treated with coronary stenting[30]. In a recent subanalysis of the BARI trial, better outcomes in women who underwent PTCA than in those treated with CABG, especially in the diabetic population, were shown[31]. When initially treated with CABG, women had a higher incidence of periprocedural complications and of repeated CABG or PTCA, compared with those initially submitted to PTCA. For this reason, PTCA could probably be considered the revascularization procedure of choice, especially in diabetic women in whom the use of glycoprotein IIb/IIIa receptor inhibitors is mandatory, even at the price of a higher risk of bleeding and peripheral complications. In our series peripheral problems, in particular pseudoaneurysm and artero-venous fistula, occurred more frequently in women than in men.

In summary, it is very likely that apart from the higher risk profile a sex-specific influence of genetic gender-related, not well known, risk factors such as estrogen receptor abnormalities, ovarian dysfunction, premature menopause, and genetic variants of platelet glycoprotein IIIa may lead to a higher risk of complications in women undergoing PTCA procedures. However, with the new stent generation the worst complications such as dissections have been overcome, making PTCA a very safe procedure even in women.

**Middle and late outcomes.** Similar rates of death, late AMI and repeated revascularization were shown in both sexes at 6 and 12 months, even if some series report a slightly higher rate of repeated PTCA in women[26,31]. Our experience confirms that there is no difference in mortality (0.8% in both sexes) and in the recurrence of AMI at 6-month follow-up (1.29% in women and 0.52% in men, p = NS).

A small number of studies include the angiographic control of restenosis at 6 months. Gender was not found to be an independent risk factor for this complication; in our analysis the rate of restenosis was 29.3% in women and 27.6% in men. Even though women do not have a higher risk of restenosis, they complain more often of angina during the follow-up. This could be caused by myocardial hypertrophy due to hypertension (discrepancy angina), to a higher sensitivity to pain or to diabetic microangiopathy. In our series even angina was more frequent in women than in men (19.6 vs 13.9%), without differences in the incidence of repeated PTCA (8 vs 8.8%) or CABG (0.8 vs 1.25%). In our database the female gender was not an independent risk factor for major adverse cardiac events and coronary restenosis even at 1-year follow-up (Table IV). Age and diabetes remain the most important determinants of a worse prognosis in patients undergoing a PTCA procedure.

**Coronary angioplasty in women with acute myocardial infarction.** The mortality in women with non-Q wave AMI is comparable to or slightly higher than that of men, whereas the overall mortality for acute Q wave AMI has been reported to differ between sexes. Previous studies have already demonstrated a higher rate of adverse events and mortality among women with Q wave AMI treated with thrombolytic therapy during hospitalization and at 30-day follow-up[32-35]. Some of these differences have been explained by the older age of women at the time of AMI, by the presence of more comorbidities and by the longer delays in hospital admission. However, the determinants of the worst prognosis in this population are not completely understood. Even after adjusting for the differences in the baseline characteristics of women with AMI treated with thrombolytic therapy, gender still remains independently associated with a higher mortality; this probably because of unidentified gender-related factors.

Primary PTCA proved to be a more effective reperfusion strategy than intravenous thrombolysis in patients with AMI[34,35]. Weaver et al.[36] have demonstrated, in a review of all trials comparing primary PTCA with thrombolytic therapy, that the mortality at 30 days was 4.4% in patients treated with PTCA and 6.5% in those treated with thrombolytic therapy ($p < 0.02$). Studies comparing the outcome differences between women and men with AMI treated with primary PTCA are limited, but all suggest that women benefit from PTCA more than men[37,38]. Stone et al.[38] showed that the in-hospital mortality in patients with AMI was significantly higher in women than in men (14.0 vs 3.5%, $p < 0.006$) with a higher incidence of intracranial hemorrhage in women (5.3 vs 0.7%, $p < 0.03$) among tissue-type plasminogen activator-treated patients. Vice versa, women and men had a similar in-hospital mortality after primary PTCA (4.0 vs 2.1%, p = NS) without intracranial bleeding complications. At the logistic regression analysis of this study, primary PTCA, rather than tissue-type plasminogen activator treatment, was an independent predictor of in-hospital survival only in women. However, these studies did not take into account the good positive effect of the new adjuncts to conventional balloon angioplasty such as stents and glycoprotein IIb/IIIa receptor antagonists. The advantage of stents in these subjects is not clear. The Stent PAMI and EPISTENT trials have suggested that women with AMI did not have any adjunctive advantage from coronary stenting alone[39,40]. More recent data showed that the use of glycoprotein IIb/IIIa inhibitor receptors such as abciximab is particularly beneficial in women undergoing coronary stenting, in spite of the possibility of a higher incidence of bleeding[29,41].

In a recent study, Azar et al.[41] compared the short- and medium-term outcomes of women and men with AMI treated with primary PTCA. In this series, stent placement was used in 48% of women and 47% of men and glycoprotein IIb/IIIa receptor antagonists in 50% of women and in 60% of men. The mortality was higher in women than in men at 30 days (10 vs 0.9%) and 7 months (15 and 4.4%) of follow-up. Similarly, even the composite endpoint of unstable angina, AMI, target lesion revascularization, and death was higher in women than in men, both at 30 days (15 vs 4.4%) and at the end of follow-up (40 vs 15%). At multivariate analysis, these poorer outcomes for women after primary PTCA were found to be related to their worse conditions, while the female gender was not an independent predictor of mortality. It is well known that women with AMI treated with primary PTCA are older than men and more frequently have hypertension, diabetes mellitus, and congestive heart failure. Moreover, women have a higher incidence of anterior AMI and cardiogenic shock, and a longer pre-hospital delay[42-44].

Cardiogenic shock is a very important predictor of in-hospital death in patients with AMI after primary PTCA. Hannan et al.[44] showed that the overall in-hospital mortality rate for patients treated with primary PTCA was 5.8%. When patients with periprocedural shock – who had a mortality rate of 45% – were excluded, the in-hospital mortality rate dropped to 2.6%. In the SHOCK registry, women with cardiogenic shock

**Table IV.** Odds ratios (OR) of women towards men for major adverse cardiac events and restenosis at 1-year follow-up in 2029 patients.

| Variable | OR (95% CI) | p |
|---|---|---|
| AMI | 0.88 (0.2-3.4) | 0.85 |
| CABG | 0.25 (0.04-1.3) | 0.1 |
| Mortality | 0.88 (0.2-3.4) | 0.85 |
| Restenosis | 0.85 (0.6-1.1) | 0.3 |

AMI = acute myocardial infarction; CABG = coronary artery bypass grafting; CI = confidence interval.

had a significantly higher incidence of mechanical complications, including ventricular rupture and acute severe mitral regurgitation[45]. Primary PTCA improves the prognosis in these patients by reducing the risk of left ventricular free wall rupture to a greater extent than thrombolysis[46]. In the SHOCK trial, women and men equally benefited from primary PTCA, and had a similar mortality rate (44 vs 38%, $p < 0.2$)[45]. Another important factor in the prognosis after AMI is the delay of the interventional procedure from the time of symptom onset. In a recent analysis of the National Registry of Myocardial Infarction, the proportion of patients with a delay of primary angioplasty from the time of hospital admission (door-to-balloon delay) > 2 hours was greater in women and in patients > 65 years[47]. This may explain the higher rates of cardiac complications in the female population. For this reason, an earlier diagnosis of AMI and an earlier hospital admission and PTCA should be the goals to set, in order to improve the outcome in women with AMI and to equalize the procedural results in the two sexes.

The difference in mortality after AMI treated with primary PTCA, higher in women than in men during hospitalization and during the first months of follow-up, disappears at 1-year follow-up, despite the older age and a higher risk profile in women[43]. In this series, the mortality rate was 13.8% in women and 12.9% in men ($p < 0.7$), but after age adjustment women had a lower risk of death. These findings suggest that primary PTCA could be the reperfusion strategy of choice in this population. Paradoxically, older age itself and the presence of more severe comorbidities, which refrain the cardiologists from a more aggressive procedure treatment in female patients with AMI, select a higher-risk population that could benefit more from an aggressive treatment even if the risk of complications is higher.

## Conclusions

Although recent technological advances have improved the success rate of PTCA in women, reaching the same immediate and long-term results as in men, greater cardiac and peripheral procedural complications are still more frequent in women. This is mainly due to a more advanced age and more comorbidities – in particular diabetes –, smaller vessels and, probably, some sex-related factors. Single or double vessel disease is more common in women than in men and the results of CABG are worse in women; hence, PTCA may become the preferable revascularization procedure for women. To minimize the risks and maximize the procedural success, coronary disease should be investigated and detected as soon as possible in women, and the procedure should be performed by skillful operators who are aware of the particular problems of PTCA in women.

## References


1. Wenger NK, Speroff L, Packard B. Cardiovascular health and disease in women. In: Proceedings of the National Heart, Lung and Blood Institute Conference. Greenwich, CT: Le Jacq Communication, 1993: 103-4.
2. Cowley MJ, Mullin SM, Kelsey SK, et al. Sex differences in early and long-term results of coronary angioplasty in the NHLBI PTCA Registry. Circulation 1985; 71: 90-7.
3. 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: 720-7.
4. Malenka DJ, O'Connor GT, Quinton H, Wennberg D, Robb JF. Differences in outcomes between women and men associated with percutaneous transluminal coronary angioplasty. A regional prospective study of 13 061 procedures. Northern New England Cardiovascular Disease Study Group. Circulation 1996; 94 (Suppl): II99-II104.
5. Arnold AM, Mick MJ, Piedmonte MR, Simpfendorfer C. Gender differences for coronary angioplasty. Am J Cardiol 1994; 74: 18-21.
6. Kahn JK, Rutherford BD, McConahay DR, et al. Comparison of procedural results and risks of coronary angioplasty in men and women for conditions other than acute myocardial infarction. Am J Cardiol 1992; 69: 1241-2.
7. Bell MR, Holmes DR Jr, Berger PB, Garratt KN, Bailey KR, Gersh BJ. The changing in-hospital mortality of women undergoing percutaneous transluminal coronary angioplasty. JAMA 1993; 269: 2091-5.
8. Williams DO, Holubkov R, Yeh W, et al. Percutaneous coronary intervention in the current era compared with 1985-1986: the National Heart, Lung, and Blood Institute Registries. Circulation 2000; 102: 2945-51.
9. Weinstraub WS, Wenger NK, Kosinski AS, et al. Percutaneous transluminal coronary angioplasty in women compared with men. J Am Coll Cardiol 1994; 24: 81-90.
10. McEniery PT, Hollman J, Knezinek V, et al. Comparative safety and efficacy of percutaneous transluminal coronary angioplasty in men and in women. Cathet Cardiovasc Diagn 1987; 13: 364-71.
11. Bell MR, Grill DE, Garratt KN, Berger PB, Gersh BJ, Holmes DR Jr. Long-term outcome of women compared with men after successful coronary angioplasty. Circulation 1995; 91: 2876-81.
12. Robertson T, Kennard ED, Mehta S, et al. Influence of gender on in-hospital clinical and angiographic outcomes and on one-year follow-up in the New Approaches to Coronary Intervention (NACI) registry. Am J Cardiol 1997; 80: 26K-39K.
13. Jacobs AK, Kelsey SF, Yeh W, et al. Documentation of decline in morbidity in women undergoing coronary angioplasty (a report from the 1993-94 NHLBI Percutaneous Transluminal Coronary Angioplasty Registry). National Heart, Lung, and Blood Institute. Am J Cardiol 1997; 80: 979-84.
14. Cantor WJ, Miller JM, Hellkamp AS, et al. Role of target vessel size and body surface area on outcomes after percutaneous coronary interventions in women. Am Heart J 2002; 144: 297-302.
15. Tenaglia AN, Fortin DF, Califf RM, et al. Predicting the risk of abrupt vessel closure after angioplasty in an individual patient. J Am Coll Cardiol 1994; 24: 1004-11.
16. Carcagnì A, Camellini M, Maiello L, et al. Percutaneous transluminal coronary revascularization in women: higher risk dissection and need for stenting. Ital Heart J 2000; 1: 536-41.

17. Tan K, Sulke N, Taub N, Sowton E. Clinical and lesion morphologic determinants of coronary success and complications: current experience. J Am Coll Cardiol 1995; 25: 855-65.
18. Hermans WR, Foley DP, Rensing BJ, et al. Usefulness of quantitative and qualitative angiographic lesion morphology, and clinical characteristics in predicting major adverse cardiac events during and after native coronary balloon angioplasty. CARPORT and MERCATOR Study Groups. Am J Cardiol 1993; 72: 14-20.
19. Raymenants E, Bhandari S, Stammen F, et al. Effects of angioplasty balloon material and lesion characteristics on the incidence of coronary dissection in 2150 dilated lesions. (abstr) J Am Coll Cardiol 1993; 21: 291A.
20. Roubin GS, Lin S, Niederman A, et al. Clinical and anatomic descriptors for a major complication following PTCA. J Am Coll Cardiol 1987; 9: 20-5.
21. Ellis SG, Roubin GS, King SB III, et al. Angiographic and clinical predictors of acute closure after native vessel coronary angioplasty. Circulation 1988; 77: 372-9.
22. Lincoff AM, Topol EJ. Abrupt vessel closure. In: Topol EJ, ed. Textbook of interventional cardiology. Philadelphia, PA: WB Saunders, 1994: 207-30.
23. Van Belle E, Abolmaali K, Bauters C, McFadden EP, Lablanche JM, Bertrand ME. Restenosis, late vessel occlusion and left ventricular function six months after balloon angioplasty in diabetic patients. J Am Coll Cardiol 1999; 34: 476-85.
24. Mautner SL, Lin F, Mautner GC, Roberts WC. Comparison in women versus men of composition of atherosclerotic plaques in native coronary arteries and in saphenous veins used as aortocoronary conduits. J Am Coll Cardiol 1993; 21: 1312-8.
25. Gowda MS, Vacek JL, Hallas D. Gender related risk factors and outcomes for non-Q wave myocardial infarction patients receiving in-hospital PTCA. J Invasive Cardiol 1999; 11: 121-6.
26. Mehilli J, Kastrati A, Dirschinger J, Bollwein H, Neumann FJ, Schomig A. Differences in prognostic factors and outcomes between women and men undergoing coronary artery stenting. JAMA 2000; 284: 1799-805.
27. Vaccarino V, Parsons L, Every NR, Barron HV, Krumholz HM. Sex-based differences in early mortality after myocardial infarction. National Registry of Myocardial Infarction 2 Participants. N Engl J Med 1999; 341: 217-25.
28. Vaccarino V, Abramson JL, Veledar E, Weintraub WS. Sex differences in hospital mortality after coronary artery bypass surgery: evidence for a higher mortality in younger women. Circulation 2002; 105: 1176-81.
29. Cho L, Topol EJ, Balog C, et al. Clinical benefit of glycoprotein IIb/IIIa blockade with abciximab is independent of gender: pooled analysis from EPIC, EPILOG and EPISTENT trials. Evaluation of 7E3 for the Prevention of Ischemic Complications. Evaluation in Percutaneous Transluminal Coronary Angioplasty to Improve Long-Term Outcome with Abciximab GP IIb/IIIa Blockade. Evaluation of Platelet IIb/IIIa Inhibitor for Stent. J Am Coll Cardiol 2000; 36: 381-6.
30. Marso SP, Lincoff AM, Ellis SG, et al. Optimizing the percutaneous interventional outcomes for patients with diabetes mellitus: results of the EPISTENT (Evaluation of platelet IIb/IIIa inhibitor for stenting trial) diabetic substudy. Circulation 1999; 100: 2477-84.
31. Jacobs AK, Kelsey SF, Brooks MM, et al. Better outcome for women compared with men undergoing coronary revascularization: a report from the Bypass Angioplasty Revascularization Investigation (BARI). Circulation 1998; 98: 1279-85.
32. Becker RC, Terrin M, Ross R, et al. Comparison of clinical outcomes for women and men after acute myocardial infarction. The Thrombolysis in Myocardial Infarction Investigators. Ann Intern Med 1994; 120: 638-45.
33. Maynard C, Litwin PE, Martin JS, Weaver WD. Gender differences in the treatment and outcome of acute myocardial infarction. Results from the Myocardial Infarction Triage and Intervention Registry. Arch Intern Med 1992; 152: 972-6.
34. Lincoff AM, Califf RM, Ellis SG, et al. Thrombolytic therapy for women with myocardial infarction: is there a gender gap? Thrombolysis and Angioplasty in Myocardial Infarction Study Group. J Am Coll Cardiol 1993; 22: 1780-7.
35. Woodfield SL, Lundergan CF, Reiner JS, et al. Gender and acute myocardial infarction: is there a different response to thrombolysis? J Am Coll Cardiol 1997; 29: 35-42.
36. Weaver WD, Simes RJ, Betriu A, et al. Comparison of primary coronary angioplasty and intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review. JAMA 1997; 278: 2093-8.
37. Vacek JL, Rosamond TL, Kramer PH, et al. Sex-related differences in patients undergoing direct angioplasty for acute myocardial infarction. Am Heart J 1993; 126 (Part 1): 521-5.
38. Stone GW, Grines CL, Browne KF, et al. Comparison of in-hospital outcome in men versus women treated by either thrombolytic therapy or primary coronary angioplasty for acute myocardial infarction. Am J Cardiol 1995; 75: 987-92.
39. Brodie BR, Stone GW, Morice MC, et al. Importance of time to reperfusion on outcomes with primary coronary angioplasty for acute myocardial infarction (results from the Stent Primary Angioplasty in Myocardial Infarction Trial). Am J Cardiol 2001; 88: 1085-90.
40. Randomised placebo-controlled and balloon-angioplasty-controlled trial to assess safety of coronary stenting with use of platelet glycoprotein-IIb/IIIa blockade. The EPISTENT Investigators. Evaluation of Platelet IIb/IIIa Inhibitor for Stenting. Lancet 1998; 352: 87-92.
41. Azar RR, Waters DD, McKay RG, et al. Short- and medium-term outcome differences in women and men after primary percutaneous transluminal mechanical revascularization for acute myocardial infarction. Am J Cardiol 2000; 85: 675-9.
42. Heer T, Schiele R, Schneider S, et al. Gender differences in acute myocardial infarction in the era of reperfusion (the MITRA registry). Am J Cardiol 2002; 89: 511-7.
43. Mehilli J, Kastrati A, Dirschinger J, et al. Sex-based analysis of outcome in patients with acute myocardial infarction treated predominantly with percutaneous coronary intervention. JAMA 2002; 287: 210-5.
44. Hannan EL, Racz MJ, Arani DT, Ryan TJ, Walfort G, McCallister BD. Short- and long-term mortality for patients undergoing primary angioplasty for acute myocardial infarction. J Am Coll Cardiol 2000; 36: 1194-201.
45. Wong SC, Sleeper LA, Monrad ES, et al. Absence of gender differences in clinical outcomes in patients with cardiogenic shock complicating acute myocardial infarction. A report from the SHOCK Trial Registry. J Am Coll Cardiol 2001; 38: 1395-401.
46. Moreno R, Lopez-Sendon J, Garcia E, et al. Primary angioplasty reduces the risk of left ventricular free rupture compared with thrombolysis in patients with acute myocardial infarction. J Am Coll Cardiol 2002; 39: 598-603.
47. Angeja BG, Gibson CM, Chin R, et al, for the Participants in the National Registry of Myocardial Infarction 2-3. Predictors of door-to-balloon delay in primary angioplasty. Am J Cardiol 2002; 89: 1156-61.