The influence of gender on patency rates after iliac artery stenting

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Objective: **The purpose of this study was to investigate the influence of gender on the long-term outcome after iliac artery stenting and to assess gender-specific differences of the influence of risk factors on treatment success and patency rates.**
Methods: **Between January 2000 and December 2006, 404 percutaneous transluminal angioplasties with primary stent deployment for symptomatic iliac artery occlusive disease were performed at our center. These included 128 interventions in women and 276 interventions in men.**
Results: **Whereas average age was significantly higher (65.9 ± 12.9 years; $P = .007$) and arterial hypertension more frequent (60.9% vs 49.3%; $P = .032$) in women, hyperuricemia (7.0% vs 14.1%; $P = .047$) and a positive smoking status (61.7% vs 74.3%; $P = .014$) were more frequently observed in men. Fontaine stage was more advanced (stages III and IV) in women than in men ($P = .028$; $P < .001$). Technical success was 97.7% in women and 99.3% in men. Overall complication rate was higher in women compared with men ($P = .002$), mostly caused by access site hematomas (4.7% vs 0.4%) and pseudoaneurysms (8.6% vs 2.5%). Patients were followed up for 45.0 ± 33.3 months. Restenosis developed in 16.8% of cases in women and in 14.6% of cases in men and was treated in 73.7% by an endovascular approach. Primary patency rates at 1, 3, 5, and 7 years were 90.3%, 77.2%, 60.2%, and 46.4% in women and 89.9%, 71.5%, 63.6%, and 59.7% in men, respectively ($P = .524$; log-rank, .406). Secondary patency rates were 97.2%, 91%, 81.5%, and 70.3% in women and 97.1%, 89.1%, 82.6%, and 78% in men, respectively ($P = .959$; log-rank, .003). Multivariate analysis identified lower age as the only independent risk factor for recurrent disease in both groups. Age-defined subgroup analysis showed a restenosis/reocclusion rate of 23.9% in men and 22.1% in women older than 63.5 years ($P = .861$) but 32.1% in men and 49.1% in women younger than that ($P = .034$).**
Conclusions: **Our data suggest that although women are older and present with a more advanced stage of peripheral arterial occlusive disease, endovascular therapy is equally effective irrespective of gender. Surprisingly, the subgroup of young female patients had a specifically poor outcome. (J Vasc Surg 2014;59:1588-96.)**

The annual prevalence of peripheral arterial occlusive disease (PAOD) in the Western community varies between 10% and 30%, depending on the presence of risk factors. Population-based studies showed that the disease does almost equally affect women and men, and some studies have even reported a predominance of women with critical limb ischemia (CLI).[1] About one third of PAOD lesions affect the aortoiliac segment.[2] According to the TransAtlantic Inter-Society Consensus (TASC) II, an endovascular intervention is the standard of care for the treatment of patients with TASC type A and preferably also for patients with TASC type B atherosclerotic lesions of the iliac artery. Although surgical treatment is generally recommended for TASC II type C and type D lesions, recent advancements in techniques and devices (primary stenting, longer stents) have extended the indications for endovascular treatment, especially in patients who are poor candidates for a major operation. The broader application of endovascular therapy is supported by the fact that stenting of the vessel has consistently been shown to provide excellent immediate and satisfactory long-term results.[3-5] Several risk factors, such as poor runoff, presence of CLI, long iliac lesions, iliac artery occlusion, involvement of the external iliac artery (EIA), and diabetes or renal failure, are associated with reduced patency rates.[6-9] Data on the impact of other risk factors, including gender, on long-term outcome are inconsistent.[6-9] However, most previous investigations with the exception of one report did not specifically stratify for gender.[6]

This study was designed to investigate the influence of gender on the long-term outcome after iliac artery stenting and to assess gender-specific differences of the influence of risk factors on treatment success and patency rates.

METHODS

The study was approved by the Ethics Committee of the Medical University Innsbruck.

Patients. Between January 2000 and December 2006, a total of 463 iliac artery revascularizations were performed in 396 patients at our center. These included 52 open iliac reconstructions (eight women), seven percutaneous transluminal angioplasties (PTAs; two women), and a total of

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The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.
0741-5214/$36.00

http://dx.doi.org/10.1016/j.jvs.2014.01.010

404 PTAs with primary stent deployment. Thus, 5.8% of iliac artery reconstructions in women were done by open surgery and 92.8% by stenting; this ratio was 13.5% for open and 84.9% for stenting in men (P = .0015). For the current analysis, the 404 cases of iliac artery stenting were stratified for gender and include 128 interventions in women and 276 interventions in men. Indications for treatment were the presence of symptomatic PAOD of Fontaine stage II or higher (Table I) and the concomitant presence of a hemodynamically significant lesion (defined as a greater than 60% reduction of arterial diameter). Patients who had undergone previous surgical or endovascular arterial revascularization (PTA or stenting) were not included for this analysis.

Preinterventional diagnostic assessment consisted of a clinical examination, assessment of the ankle-brachial index, and standardized treadmill test at 3 km/h and 12% incline. Duplex ultrasound of the iliac and lower limb arteries was performed to define the iliac artery stenosis and to screen for multilevel disease. In case of a pathologic finding, magnetic resonance angiography was performed. For all patients, the TASC II classification was used.[1]

Follow-up investigations included a clinical evaluation, ankle-brachial index assessment, and duplex ultrasound investigation of the target vessels at 3, 6, and 12 months after the intervention and once every year thereafter. Ultrasound scans during follow-up were performed to exclude a restenosis or vessel occlusion. Thereby even asymptomatic restenoses or occlusions were detected. A lumen reduction of more than 60% of diameter detected by duplex ultrasound was considered a significant restenosis, defined as peak velocity ratio >2.4.

Stent technique and treatment. For endovascular interventions, all patients were referred to the interventional radiologist. By retrograde ipsilateral or contralateral femoral artery puncture, 6F to 8F sheaths and 0.035-inch hydrophilic guidewires were placed. A bilateral approach was used for patients requiring bilateral iliac artery stenting. Predilation with an undersized balloon before stent deployment was performed only if the lesion could not be passed with the stent delivery catheter to minimize the risk of distal embolization of atherosclerotic debris. The choice of which balloon diameters were used was determined according to the diameter of the reference vessel in the vicinity of the lesion. The diameter of a balloon-expandable stent was sized to the actual normal artery diameter to avoid risk of rupture of the artery. A self-expanding stent was oversized intentionally by 10% to 15% in relation to the original arterial diameter. Postdilation results aimed at less than 10% residual stenosis. In selected cases with multilevel disease affecting the femoral bifurcation or the superficial femoral artery, a surgical endarterectomy in combination with patch angioplasty or femoropopliteal bypass was performed. With regard to the endovascular technique, balloon-expandable stents (Palmaz stent; Cordis/Johnson & Johnson, Bridgewater, NJ; Express stent, Boston Scientific, Natick, Mass) were used for severely calcified and ostial lesions. In less calcified or tortuous arteries, self-expandable stents (Wallstent; Boston Scientific, Natick, Mass; and S.M.A.R.T. stent; Cordis/Johnson & Johnson, Bridgewater, NJ) were preferred. A kissing stent technique was applied in cases that showed involvement of the aortic bifurcation. During intervention, all patients received a bolus of 5000 IU of unfractionated heparin followed by intravenous infusion of 500 IU/h for 24 hours. Patients receiving oral anticoagulation before intervention received a peri-interventional bridging therapy with low-molecular-weight heparin, and anticoagulation was resumed afterward. In these cases, 100 mg of acetylsalicylic acid was administered for 3 months after the intervention. In patients who were already taking clopidogrel before the intervention, this medication was continued afterward. All other patients received acetylsalicylic acid (100 mg/d) as permanent therapy.

Table I. Fontaine Classification[25]

Stage	
I	Asymptomatic
II	Intermittent claudication
IIa	Claudication at a distance of more than 200 meters
IIb	Claudication at a distance of less than 200 meters
III	Rest pain
IV	Necrosis or gangrene of the limb

Statistical analysis. Statistical analysis was performed with SPSS 15.0 for Windows (SPSS Inc, Chicago, Ill). The patient population was stratified by gender. Distribution of continuous variables was assessed by the Kolmogorov-Smirnov test. Descriptive statistics (mean, standard deviation, range) were applied to acquired data, and t test or Wilcoxon signed rank tests were used for comparison of continuous variables, as applicable. Categorical variables were expressed as frequencies and percentages, and differences between groups were investigated by the Pearson χ^2 and Fisher exact tests. P values < .05 were considered significant. Univariate and multivariate Cox regression analysis was performed to identify risk factors associated with target lesion patency. Follow-up data were plotted as Kaplan-Meier life-table analysis, and differences between groups were assessed by application of the log-rank test.

RESULTS

Demographics, clinical data, and anatomic status. During the assessed time period, a total of 404 primary iliac artery stent-PTAs in 337 patients were performed. Case-related data are summarized in Table II. Cardiovascular risk factors were defined as previously described.[10]

With regard to comorbidities, peri-interventional medication, and most of the cardiovascular risk factors, no significant differences between genders were found. However, women were significantly older (P = .007), and arterial hypertension was more prevalent (P = .032). In men, hyperuricemia and a positive smoking status were observed more frequently (P = .047 and P = .014,

Table II. Demographics, cardiovascular risk factors, comorbidities, clinical and anatomic status, and prestent and poststent medication

Variable[a]	*All (404 interventions)*	*Women (128 interventions)*	*Men (276 interventions)*	P
Age, years	63.5 ± 11.5 (35.7-95.1)	65.9 ± 12.9 (35.9-89.2)	62.4 ± 10.7 (35.7-95.1)	.007
Cardiovascular risk factors				
Arterial hypertension	214 (53.0)	78 (60.9)	136 (49.3)	.032
Diabetes mellitus	99 (24.5)	28 (21.9)	71 (25.7)	.456
Hyperlipidemia	222 (55.0)	69 (53.9)	153 (55.4)	.830
Hyperuricemia	48 (11.9)	9 (7.0)	39 (14.1)	.047
Obesity	72 (17.8)	26 (20.3)	46 (16.7)	.403
Smoking history				
Current	241 (59.7)	69 (53.9)	172 (62.3)	.127
Current or previous	284 (70.3)	79 (61.7)	205 (74.3)	.014
Comorbidities				
CHD	114 (28.2)	39 (30.5)	75 (27.2)	.553
Previous MI	61 (15.1)	18 (14.1)	43 (15.6)	.766
Previous TIA or stroke	33 (8.2)	11 (8.6)	22 (8.0)	.846
COPD	65 (16.1)	19 (14.8)	46 (16.7)	.771
Chronic renal insufficiency	47 (11.6)	13 (10.2)	34 (12.3)	.618
Ankle-brachial index at baseline	0.66 ± 0.28 (0.00-1.30)	0.62 ± 0.30 (0.00-1.30)	0.67 ± 0.26 (0.00-1.30)	.132
Fontaine stage				
II	307 (76)	76 (59.4)	231 (83.7)	<.001
III	32 (7.9)	16 (12.5)	16 (5.8)	.028
IV	65 (16.1)	36 (28.1)	29 (10.5)	<.001
TASC				
A	221 (54.7)	62 (48.4)	159 (57.6)	.087
B	133 (32.9)	40 (31.3)	93 (33.7)	.651
C	13 (3.2)	6 (4.7)	7 (2.5)	.362
D	34 (8.4)	17 (13.3)	17 (6.2)	.021
Prestent medication				
Antiaggregation	203 (50.2)	61 (47.7)	142 (51.4)	.522
ASA	182 (45.0)	58 (45.3)	124 (44.9)	1.000
Clopidogrel	9 (2.2)	2 (1.6)	7 (2.5)	.725
ASA + clopidogrel	12 (3.0)	1 (0.8)	11 (4.0)	.114
Acenocoumarol	30 (7.4)	9 (7.0)	21 (7.6)	1.000
Statin	40 (9.9)	8 (6.3)	32 (11.6)	.108
Poststent medication				
Antiaggregation	379 (93.8)	122 (95.3)	257 (93.1)	.508
ASA	332 (82.2)	98 (76.7)	234 (84.8)	.051
Clopidogrel	27 (6.7)	13 (10.2)	14 (5.1)	.084
ASA + clopidogrel	22 (5.4)	9 (7.0)	13 (4.7)	.352
Acenocoumarol	30 (7.4)	9 (7.0)	21 (7.6)	1.000
Statin	167 (41.3)	50 (39.1)	117 (42.4)	.587

ASA, Acetylsalicylic acid; *CHD,* coronary heart disease; *COPD,* chronic obstructive pulmonary disease; *MI,* myocardial infarction; *TASC,* TransAtlantic Inter-Society Consensus; *TIA,* transient ischemic attack.

[a]Data are expressed as mean ± standard deviation (range) or number (%).

respectively). Before the endovascular intervention, 50.2% of cases received an antiplatelet therapy, which must be attributed to the fact that a substantial number of patients were referred to our center from different medical facilities or private practices within days before treatment. After the intervention, 93.8% of cases were treated with antiaggregatory medication. In a minority of our cases (7.4%), a preexisting medical condition required the continuation of antithrombotic therapy with acenocoumarol. Fontaine stage was more advanced in women; stages III and IV were present in 12.5% and 28.1% compared with 5.8% and 10.5% in men ($P = .028$ and $P < .001$, respectively). In contrast, Fontaine stage II was significantly more prevalent in men compared with women (83.7% vs 59.4%; $P < .001$). However, univariate analysis did not show a significant effect of Fontaine stage on the outcome of the intervention. A similar pattern of gender difference with regard to disease severity was also seen for the TASC II classification (Table II).

Treatment details. In 64 cases, femoral access was gained during open arterial reconstructions. In two of these (both men), a concomitant PTA of the superficial femoral artery was performed. In an additional 19 cases, stent-PTA of the iliac artery was combined with an ipsilateral femoral intervention (Table III).

There were no significant differences concerning location and extent of the treated lesions as well as type, number, and deployment modality of the devices. The only exception was that more kissing stents were placed in women ($P = .007$). The average number of stents placed was 1.24 in both groups ($P = .952$; Table IV). Corresponding to the smaller vessel calibers in women, diameters

Table III. Additional ipsilateral interventions

Variable[a]	*All (404 interventions)*	*Women (128 interventions)*	*Men (276 interventions)*	P
Total additional interventions	85 (21.0)[b]	23 (18.0)	62 (22.5)[b]	.231
SFA PTA/stent	21 (5.2)	4 (3.1)	17 (6.2)	.237
Femoral endarterectomy	40 (9.9)	11 (8.6)	29 (10.5)	.596
Femoropopliteal bypass	20 (5.0)	6 (4.7)	14 (5.1)	1.000
Femorofemoral (crossover) bypass	4 (1.0)	2 (1.6)	2 (0.7)	.594

PTA, Percutaneous transluminal angioplasty; *SFA,* superficial femoral artery.
[a]Variables are given as total number (percentages).
[b]In two men, femoral endarterectomy was performed with a concomitant PTA of the SFA (n = 2).

Table IV. Distribution of the iliac lesions and stent characteristics

Variable[a]	*All (404 interventions)*	*Women (128 interventions)*	*Men (276 interventions)*	P
Bilateral intervention	134 (33.2)	50 (39.1)	84 (30.4)	.090
Target vessel				
CIA	211 (52.2)	72 (56.3)	139 (50.4)	.286
Kissing stent	34 (8.4)	18 (14.1)	16 (5.8)	.007
EIA	115 (28.5)	31 (24.2)	84 (30.4)	.236
CIA/EIA	78 (19.3)	25 (19.5)	53 (19.2)	1.000
Occlusion type (n = 399)				
>60% stenosis	345 (86.5)	107 (83.6)	238 (86.2)	.753
Occlusion	54 (13.5)	18 (14.1)	36 (13.0)	.753
Number of stents	1.24 ± 0.47 (1.0-3.0)	1.24 ± 0.48 (1.0-3.0)	1.24 ± 0.46 (1.0-3.0)	.952
1	314 (77.7)	100 (78.1)	214 (77.5)	1.000
2	83 (20.5)	25 (19.5)	58 (21.0)	.792
3	7 (1.7)	3 (2.3)	4 (1.5)	.684
Stent type (n = 390)				
Steel	293 (72.5)	98 (76.6)	195 (70.7)	.168
Nitinol	97 (24.0)	25 (19.5)	72 (26.1)	.168
Deployment type (n = 392)				
Balloon expanded	80 (19.8)	20 (15.6)	60 (21.7)	.178
Self-expanding	312 (77.2)	105 (82.0)	207 (75.0)	.178
Dimension (n = 399)				
Length, mm	59.7 ± 30.4 (15.0-180.0)	59.0 ± 28.5 (15.0-145.0)	60.1 ± 31.4 (15.0-180.0)	.726
Maximum diameter, mm	8.6 ± 1.3 (4.0-15.0)	8.1 ± 1.4 (5.0-12.0)	8.8 ± 1.2 (4.0-15.0)	<.001
Minimum diameter, mm	8.3 ± 1.3 (4.0-12.0)	7.8 ± 1.4 (5.0-12.0)	8.5 ± 1.2 (4.0-12.0)	<.001

CIA, Common iliac artery; *EIA,* external iliac artery.
[a]Data are expressed as mean ± standard deviation (range) or number (%).

of the implanted stents were significantly smaller in women ($P <$ .001).

Postoperative medical treatment consisted of lifelong antiplatelet monotherapy in 93.8% of cases, and 5.4% received double antiplatelet treatment. Clopidogrel was prescribed twice as often after the treatment of women compared with men (10.2% vs 5.1%, respectively); however, this difference was not statistically significant ($P =$ .084).

Perioperative and early postoperative results (<30 days). The technical success rate was high with a revascularization rate of 97.7% in women and 99.3% in men (Table V). One case of acute stent thrombosis was treated by thrombolysis. In one patient, the lesion could not be passed. In three other cases, significant arterial wall dissection was not manageable by an endovascular approach; in these patients, open surgery was performed. Clinically relevant puncture site bleeding (major hematomas and pseudoaneurysms) at the arterial access site occurred more often in women than in men (4.7% vs 0.4% and 8.6% vs 2.5%; $P =$ .005 and $P =$ .009, respectively). To investigate additional risk factors for hematomas and pseudoaneurysms, multivariate analysis was performed including the variables age, gender, obesity, and minimal stent diameter as a benchmark for iliofemoral vessel diameter. Whereas age proved to be a second independent risk factor for puncture site bleeding ($P =$ .019; hazard ratio = 1.53; 95% confidence interval, 1.07-2.19), gender remained the single most important risk factor ($P =$ .005; hazard ratio = 3.68; 95% confidence interval, 1.48-9.13). A target vessel rupture occurred in one case in each group and was treated by stent graft insertion.

During early follow-up, one man died of myocardial infarction. Three in-stent restenoses occurred and were not treated in one asymptomatic patient; the remaining two patients were treated by PTA or stent-PTA. In 10 cases (four women, six men), early stent thrombosis was observed and treated by thrombolysis in one case, stent-PTA in seven cases, and open iliofemoral reconstruction

Table V. Outcome

Variable[a]	*All (404 interventions)*	*Women (128 interventions)*	*Men (276 interventions)*	P
Complications	51 (12.6)[b]	26 (20.3)[b]	25 (9.1)	.002
Hematoma	7 (1.7)	6 (4.7)	1 (0.4)	.005
Pseudoaneurysm	18 (4.5)	11 (8.6)	7 (2.5)	.009
Dissection	12 (3.0)	5 (3.9)	7 (2.5)	.531
Rupture	3 (0.7)	2 (1.6)	1 (0.4)	.237
Embolization	4 (1.0)	2 (1.6)	2 (0.7)	.594
Residual stenosis (50%-60%)	9 (2.2)	2 (1.6)	7 (2.5)	.725
Primary success	399 (98.8)	125 (97.7)	274 (99.3)	.332
Follow-up interval, months	45.0 ± 33.3 (0.0-128.6)	45.6 ± 30.6 (0.0-128.6)	45.2 ± 34.5 (0.1-128.4)	.902
Primary patency, months	39.3 ± 32.4 (0.0-123.9)	42.1 ± 31.1 (6.7-112.3)	38.0 ± 33.0 (0.0-123.9)	.229
Recurrence	89 (22.3)	33 (26.4)	56 (20.4)	.306
Restenosis >60%	61 (15.3)	21 (16.8)	40 (14.6)	.771
Occlusion	28 (7.0)	12 (9.6)	16 (5.8)	.205
Early recurrence (<30 days)[c]	13 (3.3)	4 (3.2)	9 (3.3)	1.000
Secondary patency, months	44.1 ± 32.8 (6.7-128.4)	46.8 ± 30.6 (6.7-112.3)	42.8 ± 33.8 (6.7-128.4)	.250
Recurrence	29 (7.3)	8 (6.4)	21 (7.7)	.836
Restenosis >60%	14 (3.5)	3 (2.4)	11 (4.0)	.563
Occlusion	15 (3.8)	5 (4.0)	10 (3.6)	1.000

[a]Binary variables are given as total numbers and percentages; continuous variables are given as mean ± standard deviation (range).
[b]In two women, two complications occurred simultaneously: pseudoaneurysm and dissection (n = 1); pseudoaneurysm and residual stenosis (n = 1).
[c]Includes early restenosis and occlusion <30 days.

in two cases. Primary patency at 30 days was 96.8% in women and 96.7% in men; primary assisted patency was 100% in both groups. Within early follow-up, minor amputations were performed in three cases (two women; *P* = .237) and major amputations in one case (man; *P* = 1.00).

Univariate and multivariate analysis of risk factors potentially affecting early results did not reveal any significant associations with regard to gender (data not shown).

Follow-up. On follow-up, all treated vessels were investigated with duplex ultrasound. Twenty-four patients (nine women) died during follow-up. Average follow-up time was 45.6 ± 30.6 months for interventions in women and 45.2 ± 34.5 months in men.

Significant (>60%) late restenosis (>30 days) was detected in 21 (16.8%) cases in women and in 40 (14.6%) cases in men (Table V). Restenosis was treated by PTA in 19 (31.1%) and by stent-PTA in 26 (42.6%) cases. In one patient, femoral endarterectomy with retrograde iliac thrombectomy was performed, and one patient underwent open aortobifemoral reconstruction because of multiple bilateral high-grade restenoses (two limbs). In the remaining 13 cases (21.3%), restenosis was asymptomatic and therefore managed conservatively.

Late (>30 days) stent thrombosis occurred in 8 (6.4%) cases in women and in 10 (3.6%) cases in men. Iliac arteries were treated by PTA (n = 3; 16.7%), stent-PTA (n = 7; 38.9%), or open reconstruction (four iliofemoral, one aortobifemoral [n = 6; 33.3%]). One patient with bilateral claudication opted for conservative treatment.

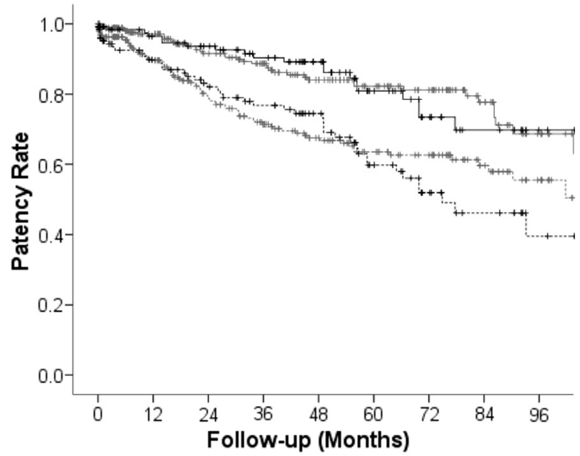
Primary patency rates at 1, 3, 5, and 7 years were 90.3% (standard error [SE], 2.8), 77.2% (SE, 4.1), 60.2% (SE, 5.5), and 46.4% (SE, 6.6) and 89.9% (SE, 2.0), 71.5% (SE, 3.2), 63.6% (SE, 3.6), and 59.7% (SE, 4.1) for women and men, respectively (*P* = .524; log-rank, .406). The respective secondary patency rates were 97.2% (SE, 1.6), 91% (SE, 2.9), 81.5% (SE, 4.5), and 70.3% (SE, 6.6) and 97.1% (SE, 1.1), 89.1% (SE, 2.2), 82.6% (SE, 3.0), and 78% (SE, 3.8) for women and men, respectively (*P* = .959; log-rank, .003; Fig 1).

Univariate analysis of risk factors revealed lower age as a predictor for decreased patency for both groups (*P* = .002 and *P* = .013, respectively). Continued smoking (*P* = .041) and minimum stent diameter (*P* = .013) had a significant negative effect on long-term outcome in men. Multivariate analysis identified lower age as the only independent risk factor for stent occlusion or restenosis for both groups (Table VI). In addition, the risk of stent failure was significantly lower with larger stent diameters in men (*P* = .013).

As a result, age-defined subgroups were analyzed with a cutoff at the median age of 63.5 years. The reocclusion/restenosis rate was 23.9% in men and 22.1% in women for the age of 63.5 years or older (*P* = .861). For younger patients, however, the rate of reocclusion/restenosis was 32.1% in men (n = 14) but 49.1% in women (n = 57; *P* = .034). However, available follow-up intervals varied significantly between younger (54.7 ± 33.0 months) and older (36.2 ± 31.0 months) patients (*P* < .001). Consequently, Kaplan-Meier life-table analysis was performed and showed a considerable but nonsignificant negative effect of young age on stent patency in women (*P* = .166; log-rank, 1.916; Figs 2 and 3).

DISCUSSION

The perception of cardiovascular disease has long been that of being a typically "male" disease. This may be associated with the fact that women are frequently underrepresented in reports on the outcome of vascular surgery procedures. However, the outcome of those procedures is often significantly different in women



Months	0	12	24	36	48	60	72	84	96
Primary patency									
Females (n. at risk)	125	95	80	69	56	35	22	14	6
Males (n. at risk)	274	193	148	119	94	72	62	35	19
Secondary patency									
Females (n. at risk)	125	101	93	79	63	40	26	16	7
Males (n. at risk)	274	207	169	143	109	86	73	41	22

Fig 1. Gender-specific cumulative primary and secondary patency rates. *n. at risk*, numbers at risk. *Black curves* represent the female study population; *gray curves*, the male study population. *Interrupted lines* represent primary patency rates; *solid lines*, secondary patency rates. Log-rank testing did not reveal significant gender-specific differences concerning either primary or secondary patency rates.

compared with men. For example, it is well established that the short-term outcome after carotid revascularization in women is less favorable[11] and that women with abdominal aortic aneurysms tend to be diagnosed at a later stage of disease and have a worse short-term outcome.[12] Lower patency rates and worse survival have been reported for women with PAOD.[13] Women are often affected by an increased number of complications after surgical and endovascular procedures.[14,15] In this study, the higher total complication rate of 20.3% in women vs 9.1% in men ($P = .003$) was almost entirely due to an increased rate of access site complications, including hematomas (4.7% vs 0.4% in women and men, respectively) and pseudoaneurysms (8.6% vs 2.5%). Reasons may be the higher age associated with possible agitation during intervention.

In this study, women were significantly older, suffered more often from hypertension, and presented with a more severe stage of PAOD than men. It is a common finding in the literature that women are older on first presentation and suffer from a more severe stage of disease as defined by a more complex pathologic process of their lesions.[8,16,17] Surprisingly, despite the more adverse factors being present in women, the overall long-term patency was comparable between the genders. Even for the subgroup of patients with the worst clinical parameters of CLI and TASC type D lesions, these factors did not negatively affect patency rates in men or women. However, previously published studies have delivered inconsistent results concerning the influence of disease severity as assessed by the TASC classification and the patency of stents. Kudo et al[7] reported an increased risk for recurrent disease in patients after angioplasty with selective stenting of TASC II type C and type D lesions compared with TASC type A lesions. In contrast, Sixt et al[18] reported comparable primary patency rates of 85% to 89% and secondary patency rates of 98% to 100% irrespective of TASC II lesion type after endovascular treatment at 1 year.

Similarly, kissing stent deployment has previously been associated with a higher risk of restenosis and reocclusion.[19,20] In our study, the higher frequency of kissing stent deployment in women was not associated with a decreased patency.

Whereas our overall primary patency rates are comparable with existing data of mixed populations,[9,11] our results in women are clearly better than numbers published previously. In a study investigating patients with CLI, Timaran et al[8] found primary patency rates of 92%, 88%, and 88% for men but only 79%, 57%, and 38% for women at 1, 3, and 5 years. The authors identified female gender as an independent predictor of decreased stent patency. The lowest patency rates were identified in women with angioplasty and stenting, including EIA lesions, but one has to take into account the small number of cases in that subgroup analysis (36 stents including the EIA: 18 women, 18 men). In this study (including 115 EIA stents and 78 combined common iliac artery/EIA stents), neither treatment of the EIA nor smaller vessel diameters in women were significant risk factors for reduced primary patency rates. However, we included patients with claudication and with CLI. Furthermore, the rate of TASC type C and type D lesions was clearly higher in the collective investigated by Timaran et al: 46% in women compared with 22% in men, as opposed to 18% and 8.7%, respectively, in this study.

On the basis of the multivariate analysis, lower age for both genders and minimum stent diameter in men were associated with a significant negative effect on the outcome after iliac artery stenting. A more virulent form of PAOD might be a reason for the poorer outcome in our younger patient group. Patients with premature PAOD do have the traditional cardiovascular risk factors, but the course of atherosclerosis is more aggressive than in older patients, thus leading to an earlier and more severe development of disease.[21] Our finding of lower patency rates in younger patients is in line with previously published data. Davis et al[22] found that patients requiring reinterventions were more frequently of younger age, were of female gender, and had a history of smoking. Yasuhara et al[23] identified younger age as an independent risk factor for poor outcome after iliac artery balloon angioplasty. The

Table VI. Independent predictors of primary patency stratified by gender

	Women			*Men*		
	P	*Hazard ratio*	*95% Confidence interval*	P	*Hazard ratio*	*95% Confidence interval*
Univariate analysis						
Age (10 years)	.002	0.648	0.495-0.848	.013	0.708	0.540-0.929
Ankle-brachial index (factor 0.1)	.298	0.935	0.824-1.061	.674	0.978	0.879-1.087
TASC A/B vs C/D	.149	1.813	0.808-4.069	.822	1.111	0.444-2.785
Fontaine stage II vs III/IV	.813	0.912	0.425-1.958	.789	1123	0.480-2.625
Cardiovascular risk factors						
Arterial hypertension	.591	0.824	0.407-1.668	.134	0.672	0.400-1.131
Diabetes mellitus	.230	0.557	0.214-1.447	.813	0.930	0.509-1.699
Hyperuricemia	.452	0.046	0.000-139.561	.043	0.301	0.094-0.963
Obesity	.965	0.981	0.425-2.266	.158	0.566	0.257-1.248
Current smoker	.052	2.317	0.994-5.402	.041	1.905	1028-3.532
Current or previous smoker	.116	2.047	0.838-5.003	.485	1.264	0.655-2.438
Postinterventional medication						
Antiaggregation	.486	21.735	0.004-124,414.028	.442	0.697	0.277-1.750
ASA	.410	1.496	0.573-3.905	.821	0.921	0.452-1.878
Clopidogrel	.435	0.564	0.134-2.372	.901	1.067	0.385-2.954
ASA + clopidogrel	.586	1.395	0.421-4.618	.855	0.876	0.214-3.594
Statin	.035	2.106	1.054-4.206	.248	1.353	0.810-2.261
Treatment characteristics						
Occlusion vs stenosis	.566	1.302	0.529-3.205	.518	1.280	0.605-2.710
CIA only	.481	0.781	0.394-1.551	.246	0.738	0.442-1.233
Stent material	.952	0.973	0.397-2.382	.095	1.585	0.924-2.720
Deployment mode	.878	1078	0.413-2.814	.127	1546	0.884-2.704
1 stent only	.686	1.189	0.513-2.752	.975	0.990	0.524-1.871
Minimum stent diameter[a]	.404	0.667	0.257-1.729	.013	0.492	0.281-0.861
Length of treated segment[a]	.781	0.907	0.454-1.809	.801	0.936	0.561-1.562
Additional outflow procedure	.272	1.601	0.691-3.707	.459	1.256	0.688-2.294
Multivariate analysis						
Age (10 years)	.002	0.648	0.495-0.848	.010	0.682	0.516-0.916
Minimum stent diameter				.007	0.462	0.263-0.811

ASA, Acetylsalicylic acid; *CIA,* common iliac artery; *TASC,* TransAtlantic Inter-Society Consensus.
The following cardiovascular risk factors were entered into a multivariate Cox regression model and selected by forward stepwise selection: age, ankle-brachial index, TASC II, critical ischemia, arterial hypertension, diabetes mellitus, hyperuricemia, smoking status (current smoker), postinterventional antiaggregation, postinterventional statin use, preinterventional target vessel occlusion, treated vessel segment (CIA only), stent material, deployment mode, number of stents used, minimum stent diameter (<median), length of treated segment (>median).
[a](>Median).

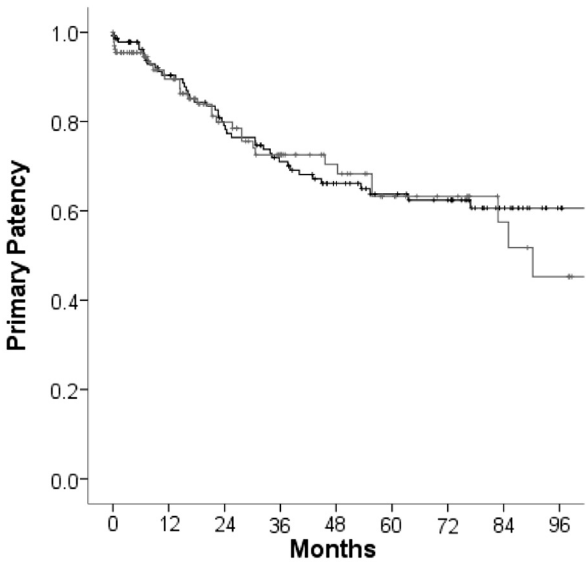
restenosis-free patency rates at 1, 2, and 5 years were 93%, 87%, and 80% for patients older than 60 years but 85%, 77%, and 57% for younger patients, respectively. Elderly patients showed significantly better results than the group of younger patients ($P = .024$). Siskin et al[24] reviewed the long-term outcome of 42 patients 50 years and younger after iliac artery stent placement. They showed a 1-, 2-, and 3-year primary patency rate of 86%, 72%, and 65%, respectively, and a 3-year secondary patency rate of 88%. Despite successful stent placement with an initial technical success of 95% and symptom relief in 76.2% of patients, the need for repeated interventions was 28.6%, even though restenosis could mostly be treated with an endovascular approach.

However, none of these authors has identified young women as a group that has an exceptionally high risk of significant restenosis/reocclusion, whereas in our collective, recurrence rates reached nearly 50% in women younger than 63.5 years compared with 22% in the older population. The fact that this was not statistically significant is most likely due to the shorter follow-up intervals in younger patients.

Limitations of the study. This is a retrospective analysis of a single-center institution. Women were more likely to undergo iliac artery stenting as opposed to open surgery, which may have caused a bias in patient selection. In addition, a higher number of male claudicants were included. However, the proportion of women being included was high, and patient and stent characteristics were well balanced between genders. Patency was assessed not only by clinical examination but also by imaging in all cases. This accurately identified all restenoses and reocclusions and not only symptomatic recurrences.

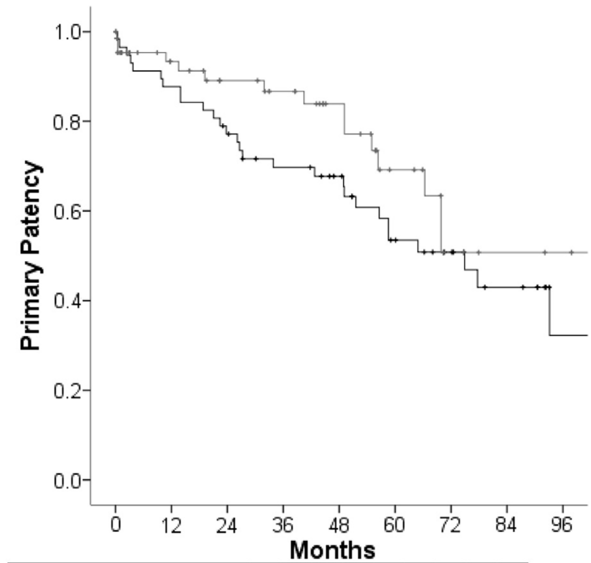
CONCLUSIONS

To unequivocally prove that young women have a worse outcome compared with young men, a prospectively conducted trial with comparable characteristics of patients would be necessary. The fact that young and especially female patients have a higher life expectancy compared with



Months	0	12	24	36	48	60	72	84	96
younger than 63.5 years (n. at risk)	140	107	90	76	61	50	45	25	12
older than 63.5 years (n. at risk)	134	86	58	43	33	22	17	10	7

Fig 2. Age-dependent primary patency rates in men. *n. at risk*, numbers at risk. *Black curves* represent patency in men younger than 63.5 years; *gray curves* represent patency in men older than 63.5 years. Log-rank testing did not reveal significant age-dependent differences concerning primary patency rates.



Months	0	12	24	36	48	60	72	84	96
younger than 63.5 years (n. at risk)	57	50	43	36	31	21	16	10	3
older than 63.5 years (n. at risk)	68	45	37	33	25	14	6	4	3

Fig 3. Age-dependent primary patency rates in women. *n. at risk*, numbers at risk. *Black curves* represent patency in women younger than 63.5 years; *gray curves* represent patency in women older than 63.5 years. Log-rank testing did not reveal significant age-dependent differences concerning primary patency rates.

men requires the optimization of treatment strategies in a patient cohort that has previously been identified as problematic. The use of drug-eluting balloons or stents would certainly be a treatment approach that is worthwhile to be tested in patients with an unfavorable biology of their PAOD. In addition, surgical therapy must be considered an alternative to stenting of aortoiliac disease in young women who are good candidates for surgery. Which approach proves to be best needs to be prospectively addressed.

Our data show that although women are older and present with a more advanced stage of PAOD, treatment with an endovascular technique is equally effective irrespective of gender. However, young female patients are at risk for a less favorable outcome after iliac artery stenting, and therefore this group of patients requires attention. Further investigations are mandatory to develop risk-adapted treatment strategies.

AUTHOR CONTRIBUTIONS

Conception and design: BH, AG
Analysis and interpretation: BH, JF, AC, GF
Data collection: BH, OG
Writing the article: BH, JF
Critical revision of the article: BH, JF, OG, AG, AC, GF
Final approval of the article: BH, JF, OG, AG, AC, GF
Statistical analysis: BH, JF
Obtained funding: Not applicable
Overall responsibility: GF

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Submitted Sep 25, 2013; accepted Jan 9, 2014.