Reconstructive surgery for complex aortoiliac occlusive disease in ypoung adults

Reconstructive surgery for complex aortoiliac occlusive disease in young adults

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Background: **Although aortoiliofemoral bypass grafting is the optimal revascularization method for patients with severe aortoiliac occlusive disease (AIOD), previous studies have documented poor patency rates in young adults. This study investigated whether young patients with AIOD have worse outcomes in patency, limb salvage, and long-term survival rates after reconstructive surgery than their older counterparts.**

Methods: **Patients aged ≤50 years undergoing reconstructive surgery at our institution for AIOD between 1995 and 2010 were compared with a cohort of randomly selected patients aged ≥60 years (two for each of the young patients, matched for year of operation), analyzing demographics, risk factors, indications for surgery, operative details, and outcomes.**

Results: **Among 927 consecutive patients undergoing primary surgery for AIOD, 78 (8.4%) aged ≤50 years (mean age, 48.4 years) and 156 older control patients (mean age, 71.2 years) were identified. The younger patients were mainly men (81%) and 59% had surgery for limb salvage and 41% for disabling claudication ($P = .02$). Compared with older patients, they were significantly more likely to be smokers (90% vs 72%; $P = .002$) and had previously needed significantly more inflow procedures (28% vs 16%; $P = .03$). Only one death occurred perioperatively (30-day) among the control patients, and no major amputations or graft infections occurred in either group. The need for subsequent infrainguinal reconstructions was greater in the younger patients (18% vs 7%; $P = .01$). The primary patency rates were inferior in the younger patients at 5 years (82% and 75%) and 10 years (95% and 90%; $P = .01$), whereas assisted secondary patency (89% and 82% vs 96% and 91%; $P = .08$), secondary patency (93% and 86% vs 98% and 92%; $P = .19$), limb salvage (88% and 83% vs 95% and 91%; $P = .13$), and survival rates (87% and 76% vs 91% and 84%; $P = .32$) were comparable in the two groups.**

Conclusions: **This study shows that despite a higher primary graft failure rate than that in older patients, aortoiliofemoral revascularization for complex AIOD is a safe procedure for younger patients with disabling claudication or limb-threatening ischemia, providing they are willing to follow a regular protocol to complete their postoperative surveillance and to undergo graft revision as necessary. (J Vasc Surg 2012;56:1606-14.)**

Atherosclerosis is the most common cause of peripheral vascular disease in young adults,[1-4] and the aortoiliac district the most often involved site.[3,5-7] Although premature peripheral atherosclerotic disease (PAD) has been associated with an aggressive clinical course, a poor prognosis, and a higher arterial revascularization failure rate, few investigators have focused on young adults undergoing vascular reconstructive surgery to treat aortoiliac occlusive disease (AIOD), and they have reported contrasting results. Several studies identified relatively unfavorable outcomes of aortoiliac reconstructions in patients with premature atherosclerosis, with 5-year patency rates as low as 50%.[7,8] However, various authors reported acceptable patency rates in patients with premature PAD primarily involving the aortoiliac location,[3,5,9-15] and others found arterial reconstruction failure and major amputation rates for young patients with AIOD no different from those of young patients with infrainguinal arterial disease or disease affecting both districts.[2,15,16]

Different conclusions were also reported when other clinical conditions associated with poor outcomes in premature PAD were analyzed. Several retrospective studies identified factors such as diabetes mellitus (DM), cigarette smoking, arterial hypertension, the site of the PAD, small aortic diameter, and hypercoagulable states, alone or in various combinations, as predictors of a rapid progression of premature PAD and poor outcomes after surgery.[2,5,7,16-18] Other studies contradicted these findings, however.[10,19,20] In light of such clinical experiences, it has been hard to draw any final conclusions and predict the proportion of younger patients whose disease can be expected to progress or their revascularization to fail.

Although traditional surgical treatment remains the gold standard for managing extensive, complex AIOD, assessed as TransAtlantic Inter-Society Consensus (TASC II) type C and D lesions,[21] the recent development of devices for crossing chronic total occlusions and experience gained by interventionalists have increased the use of endovascular procedures even for complex AIOD.[22-26] Such treatments have revealed a limited durability, however, with long-term primary patency rates that are still unable to compete with those reported for open reconstructive sur-

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Author conflict of interest: none.

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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.2012.05.105

gery (74% vs 93% at 3 years), especially in younger patients.[25,26] The aim of this study was to address the question of whether younger patients with complex AIOD have worse outcomes after reconstructive surgery in patency, limb salvage, and long-term survival rates than their older counterparts.

METHODS

Details of all consecutive patients who had elective primary infrarenal abdominal aortic reconstruction to treat AIOD at our institution between 1995 and 2010 were prospectively stored in a vascular registry. For the purposes of this study, the registry was queried to identify patients aged ≤50 years old (group I). The control group (group II) comprised randomly selected patients aged ≥60 years old (two for each of the younger patients), matched for year of operation. A restricted randomization, by referring to a table of random numbers, was used to select the control patients from among the patients aged ≥60 years undergoing reconstructive surgery for AIOD during the study period.

The study excluded patients with systemic conditions such as Takayasu, Buerger, fibromuscular, or aneurysmal diseases, acute ischemia, or a history of irradiation. Patient details included demographics; atherosclerotic risk factors, including diabetes mellitus (DM) and smoking habits (current smokers or smokers who had stopped ≤5 years previously), arterial hypertension (blood pressure ≥140/90 mm Hg, recorded on the strength of a clinical diagnosis, including the ongoing use of antihypertensive therapy), cardiac disease (prior myocardial infarction, stable or unstable angina, ST segment alteration on electrocardiogram), pulmonary disease, cerebrovascular disease or chronic kidney disease (creatinine value >2.0 mg/dL); indication for revascularization (disabling claudication or critical limb ischemia); operative details; major and minor perioperative (30-day) complications; and patency, limb salvage, and survival rates.

All patients underwent preoperative standard digital subtraction angiography, magnetic resonance angiography, or computed tomography angiography, or a combination of these methods for surgical planning and to confirm the clinical and vascular laboratory diagnosis of AIOD, as assessed by arterial mapping with duplex ultrasound imaging and measurement of the ankle-brachial index (ABI). All preoperative imaging studies were also reviewed retrospectively to categorize iliac artery lesions according to the TASC II morphologic classification.[21]

A standardized surgical technique was used. All procedures were performed by the same surgeon using a transperitoneal approach through a midline incision. Separate groin incisions were made before the prosthetic limbs were tunneled to perform the prosthetic-to-femoral anastomoses. Prosthetic material consisted of collagen-coated Dacron grafts in most cases and knitted polyester in the remainder. The aortic graft size was chosen to optimize the size match with the native vessels and used as a surrogate for definite aortic diameter, which was not measured.

The type of proximal anastomosis (end-to-end or end-to-side) was based on the quality of the aorta, as estimated on preoperative imaging findings and confirmed intraoperatively. The proximal anastomosis was usually performed in an end-to-side fashion, leaving a short graft body in an effort to enhance graft hemodynamics, and reserving end-to-end anastomosis for patients with total occlusion of the aorta, mural aortic thrombus, occlusion of the inferior mesenteric artery, or severe calcifications that may make longitudinal aortic clamping troublesome. An endarterectomy of the anastomotic site can be performed before starting the anastomosis in case of severe calcifications.

The distal anastomosis was constructed to the common/external iliac or common femoral artery when angiographic and intraoperative findings indicated that the distal arterial axis was widely patent. Lack of patency was usually due to atherosclerotic involvement of the distal common femoral artery, or the initial tract of the deep femoral artery, with or without concomitant occlusion/stenosis of the superficial femoral artery. In these cases, the anastomosis was carried onto the deep femoral artery, after the latter had been endarterectomized and closed with vein patching. Proximal and distal anastomoses were always performed with running monofilament polypropylene sutures.

Our antimicrobial policy included administering intravenous cefazolin intraoperatively and until postoperative day 3 or 4. Amoxicillin-clavulanate was administered to patients with renal failure. Intravenous amoxicillin-clavulanate or levofloxacin was associated with cefazolin if patients had a temperature >38°C. All patients were discharged with the recommendation that they continue oral antimicrobial therapy with amoxicillin-clavulanate or ciprofloxacin until the surgical wounds had healed completely.

Postoperative surveillance. After discharge, all patients took antiplatelet agents or anticoagulants only if they were taking anticoagulants for other reasons preoperatively. Postoperative surveillance included clinical examinations, supplemented with duplex scans and ABI measurements at discharge, at 30 to 60 days, at 6 months and 1 year, and yearly thereafter. Graft patency was confirmed by the presence of a palpable femoral pulse and by duplex scanning. Recurring symptoms or a marked change in vascular laboratory test results prompted further imaging investigations (digital subtraction angiography or computed tomography angiography) and reintervention as necessary. Graft failure was defined as an occlusion of the graft as a whole or of a single limb graft. Primary patency, assisted primary patency, secondary patency, and limb salvage rates were defined in accordance with the reporting standards suggested by the Society for Vascular Surgery Ad Hoc Committee and the North American Chapter of the International Society for Cardiovascular Surgery.[27]

Statistical analysis. Continuous data were compared with the Student *t*-test. Frequencies and categoric data were compared with a χ^2 or Fisher exact test, as appropri-

Table I. Characteristics of study population

Variable[a]	*Group I* *n = 78*	*Group I* *n = 156*	P
Age, years	48.4 ± 1.9 (44-50)	71.2 ± 4.9 (62-77)	
Male sex	63 (80.7)	109 (69.9)	.07
Risk factors			
Diabetes mellitus	27 (34.6)	68 (43.6)	.19
Hyperlipemia	38 (48.7)	95 (60.9)	.08
Hypertension	43 (55.1)	93 (59.6)	.51
Smoking history	70 (89.7)	112 (71.8)	.002
Chronic kidney disease	5 (6.4)	18 (11.5)	.25
Cardiac disease	28 (35.9)	72 (46.1)	.13
Cerebrovascular disease	6 (7.7)	29 (18.6)	.03
Pulmonary disease	8 (10.2)	31 (19.8)	.06
Indications for surgery			
Disabling claudication	32 (41.0)[b]	57 (36.5)[c]	.50
Critical limb ischemia	46 (59.0)[b]	99 (63.5)[c]	.50
TASC II classification			
Type B	7 (8.9)	14 (8.9)	.99
Type C	29 (37.2)	54 (34.6)	.70
Type D	42 (53.8)	88 (56.4)	.71
Prior endovascular inflow procedures	22 (28.2)	25 (16.0)	.03
PTA alone	15 (19.2)	19 (12.2)	.15
PTA and stenting	7 (9.0)	6 (3.8)	.10
Pre-op ABI measurement at rest			
In claudication	0.52 ± 3.7	0.54 ± 2.9	.96
In critical limb ischemia	0.47 ± 4.3	0.46 ± 5.8	.98

ABI, Ankle-brachial index; *PTA,* percutaneous transluminal angioplasty; *TASC,* TransAtlantic Inter-Society Consensus.
[a]Continuous data are shown as the mean ± standard deviation (range) and categoric data as number (%).
[b]$P = .02$.
[c]$P < .001$.

ate. The primary patency, assisted primary patency, secondary patency, limb salvage, and long-term survival rates were assessed using Kaplan-Meier analysis, and curves were compared using the Mantel-Cox log-rank test. A Cox proportional hazard model was used to identify the factors with statistical or marginal significance at univariate analysis that could influence outcomes, calculating the odds ratio (OR) with 95% confidence intervals (95% CIs). All tests were two-tailed, and statistical significance was inferred at $P < .05$.

RESULTS

Between 1995 and 2010, 927 consecutive patients underwent elective infrarenal abdominal aortic reconstruction for AIOD at our institution. Among them, 78 (8.4%) who were aged ≤50 years old (mean age, 48.4 years; range, 44-50 years) were matched with 156 control patients (mean age, 71.2 years; range, 62-77). The younger patients were mostly men (81%), significantly more were current or former smokers (89.7% vs 71.8%; $P = .002$), and were less likely to have cerebrovascular disease (7.7% vs 18.6%; $P = .03$) then older patients (Table I). Overall, 62% (145 of 234) of the surgical reconstructions were performed for limb salvage and 38% for disabling claudication, with significantly more patients operated on for limb salvage than for claudication (59% vs 41% in group I [$P = .02$]; 63.5% vs 36.5% in group II [$P < .001$]). Of the 234 patients, 47 (20%) had undergone inflow endovascular treatments, consisting exclusively of percutaneous angioplasty with or without stenting, 2 to 3 years before the aortoiliac reconstruction, with significantly more such procedures in group I than in group II (28.2% vs 16%; $P = .03$). No significant differences emerged between the two groups for any of the other variables considered, including sex, risk factors, comorbidities, TASC II classification, and ABI measurement (Table I).

Table II summarizes some technical and operative details for the two groups. The graft consisted of collagen-coated Dacron grafts (79.5% in group I vs 83.3% in group II) or knitted double velour (20.5% in group I vs 16.7% in group II). The proximal anastomosis was constructed end-to-side in 149 of 234 patients (63.6%), with a statistically higher incidence in group I (73.1% vs 59.0%; $P = .03$). The younger patients required significantly fewer endarterectomies at the proximal anastomotic site than the older patients (6.4% vs 17.3%; $P = .02$) and fewer distal anastomoses constructed to an endarterectomized common femoral artery (8.9% vs 19.8%; $P = .03$) or after a concomitant profundoplasty (19.2% vs 32%; $P = .03$). However, the younger patients needed more subsequent outflow surgical procedures (18% vs 7%; $P = .02$), within a mean interval of 27 months, for infrainguinal occlusive disease that most of them had already at the time of the aortic revascularization. No significant differences emerged between the

Table II. Technical and operative data

Variable[a]	*Group I (n = 78)*	*Group II (n = 156)*	P
Prosthetic graft			
Collagen-coated Dacron	62 (79.5)	130 (83.3)	.47
Knitted double velour	16 (20.5)	26 (16.7)	.47
Proximal anastomosis			
End-to-end	21 (26.9)	64 (41.0)	.03
End-to-side	57 (73.1)	92 (59.0)	.03
Graft size, mm			
18 × 9.5	4 (5.1)	16 (10.3)	.22
16 × 8	66 (84.6)	119 (76.2)	.14
14 × 7	8 (10.2)	21 (13.5)	.48
Bypass grafting			
Aortobiiliac	10 (12.8)	13 (8.3)	.27
Aortobifemoral	59 (75.6)	124 (79.5)	.50
Aortoiliac-femoral	9 (11.5)	19 (12.2)	.88
Endarterectomy at the proximal anastomotic site	5 (6.4)	27 (17.3)	.02
IMA reimplantation	4 (5.1)	5 (3.2)	.47
Concomitant CFA endarterectomy	7 (8.9)	31 (19.8)	.03
Concomitant profundoplasty	15 (19.2)	50 (32.0)	.03
Subsequent outflow procedures	14 (18.0)	11 (7.0)	.01

CFA, Common femoral artery; *IMA,* inferior mesenteric artery.
[a]Categoric data are shown as number (%).

Table III. Perioperative (30-day) outcomes

Variable[a]	*Group I (n = 78)*	*Group II (n = 156)*	P
Death	0	1 (0.6)	.99
Major complications			
Cardiac[b]	2 (2.5)	7 (4.5)	.72
Gastrointestinal[c]	0	3 (1.9)	.55
Pulmonary failure[d]	1 (1.3)	3 (1.9)	.99
Stroke	0	1 (0.6)	.99
Acute renal failure	0	0	
Thrombosis of 1 limb graft	0	1 (0.6)	.66
Entire graft occlusion	0	1 (0.6)	.99
Amputation	0	0	
Minor complications[e]	5 (6.4)	11 (7.0)	.99
ABI measurements			
In claudication	0.85 ± 0.3	0.83 ± 0.5	.74
In critical limb ischemia	0.81 ± 0.2	0.80 ± 0.4	.83

ABI, Ankle-brachial index.
[a]Categoric data are shown as number (%) and continuous data as mean ± standard deviation.
[b]Arrhythmia, myocardial infarction, and congestive heart failure.
[c]Prolonged ileus, colon ischemia, gastrointestinal bleeding, and hepatic failure.
[d]Respiratory assistance for 48-72 hours.
[e]Total or partial wound dehiscence at the groin; lymphocele or hematoma at the groin; femoral hemorrhage.

two groups in graft size, type of bypass grafting, or number of inferior mesenteric artery reimplantations.

Perioperative mortality and morbidity data. A detailed list of the perioperative outcomes is given in Table III. Overall, the only perioperative death was one patient in group II who died of multisystem organ failure. No graft infections or major amputations occurred in either group. The overall systemic and minor complication rates, including wound infection, total or partial wound dehiscence, inguinal lymphocele, or hematoma, were comparable between the two groups. No differences emerged between the groups in improvement in their postoperative ABI measurements.

Long-term outcomes. Five of the 233 patients alive 30 days after surgery (2.1%; one in group I) were lost to follow-up, so 228 patients (77 in group I) completed the follow-up. The mean follow-up was 88.7 ± 2.2 months (median, 76 months) for group I and 86.4 ± 7.2 months (median, 74 months) for group II. Kaplan-Meier life-table analyses for groups I and II are presented for primary patency (Fig 1), assisted primary patency (Fig 2), secondary patency (Fig 3), and limb salvage rates (Fig 4).

At 5 and 10 years, the younger patients had significantly lower primary patency rates (82% and 75%) than the older patients (95% and 90%; OR, 2.52; 95% CI, 1.22-6.38; log-rank test, $P = .01$; Fig 1).

Overall, seven patients (3%; five in group I) required surgical revision for graft failure due to a severe symptomatic stenosis of the distal anastomosis (bilaterally in four patients), treated with endarterectomy of the intimal hyperplasia and vein patching in all patients. The assisted primary patency rates at 5 and 10 years were 89% and 82% for group I and 96% and 91% for group II, with no statistically significant difference between the two groups (OR, 2.18; 95% CI, 0.87-6.11; log-rank test, $P = .08$; Fig 2).

Two total graft occlusions (0.8%; one in group I) were managed surgically, one with thrombectomy and concomitant profundoplasty, and the other with an axillobifemoral bypass, after repeat thrombectomy failed. In five patients with single limb thrombosis (2.2%; three in group I), patency was restored by means of thrombectomy and profundoplasty in one or by prosthetic crossover bypass grafting in four, after thrombectomy failed to restore blood flow. Two other total graft occlusions (0.8%; one in group I) and three single limb thromboses (1.3%; all in group I) were managed conservatively. The secondary patency rates at 5 and 10 years were 93% and 86% for group I and 98% and 92% for group II, with no statistically significant difference between the two groups (OR, 1.94; 95% CI, 0.69-6.21; log-rank test, $P = .19$; Fig 3).

The younger group was more likely than the older group (18% vs 7%; $P = .01$) to require subsequent infrainguinal reconstructions, due more to disease progression than to graft failure.

Overall, repeatedly failing distal arterial revascularizations resulted in 11 late major amputations (4.7%; 5 in group I), eight above knee and three below knee, all involving patients operated for limb salvage with a patent aortobifemoral reconstruction. The limb salvage rates at 5 and 10 years were 88% and 83% for group I, and 93% and

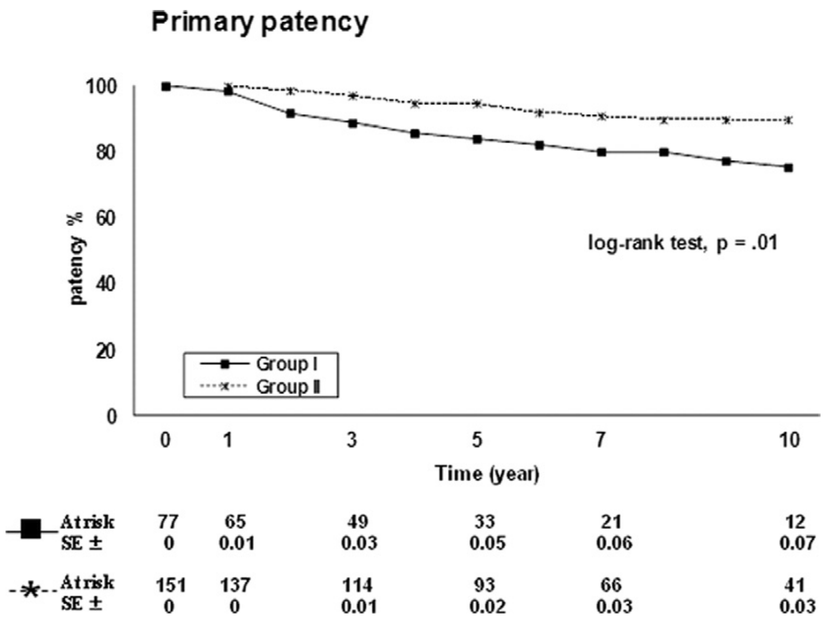

Fig 1. Kaplan-Meier life-table analysis is shown for the primary patency rates for younger (*group I*) and older (*group II*) patients (odds ratio [OR], 2.52; 95% confidence interval [CI], 1.22-6.38; log-rank test, *P* = .01). Raw number of the patients at risk and the standard error (*SE*) analyzed for each interval are shown for each group.

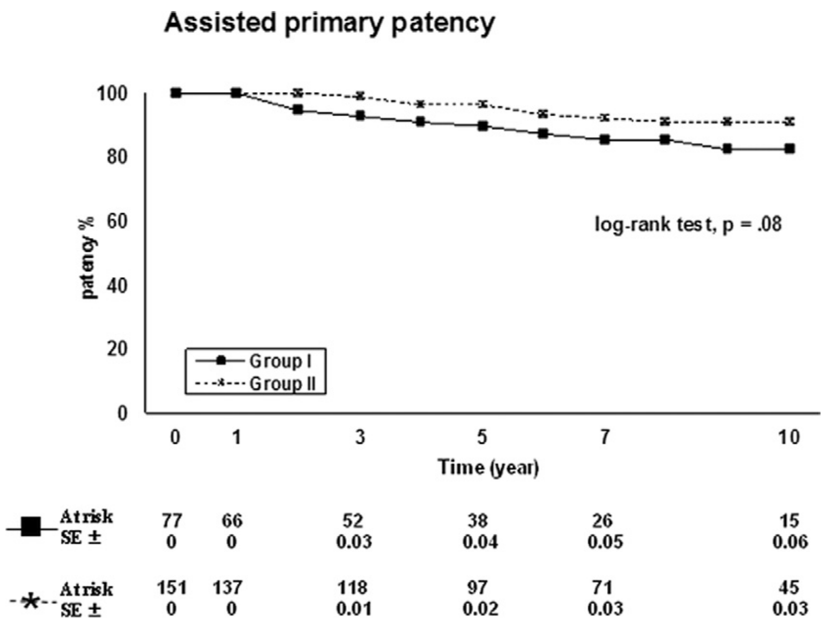

Fig 2. Kaplan-Meier life-table analysis is shown for the assisted primary patency rates for younger (*group I*) and older (*group II*) patients (odds ratio [OR], 2.18; 95% confidence interval [CI], 0.87-6.11; log-rank test, *P* = .08). Raw number of the patients at risk and the standard error (*SE*) analyzed for each interval are shown for each group.

91% for group II, with no statistically significant difference between the two groups (OR, 2.38; 95% CI, 0.72-11.01; log-rank test, *P* = .13; Fig 4).

Overall, there were 27 late deaths (11.8%; 11 in group I). The main known cause of death in either group was cardiac disease. The survival rates at 5 and 10 years were 87% and 76% for group I and 91% and 84% for group II, with no statistically significant difference between the two groups (OR, 1.47; 95% CI, 0.67-3.38; log-rank test, *P* = .32).

Univariate analysis showed smoking was the only predictor of graft failure in the younger group ($P <$

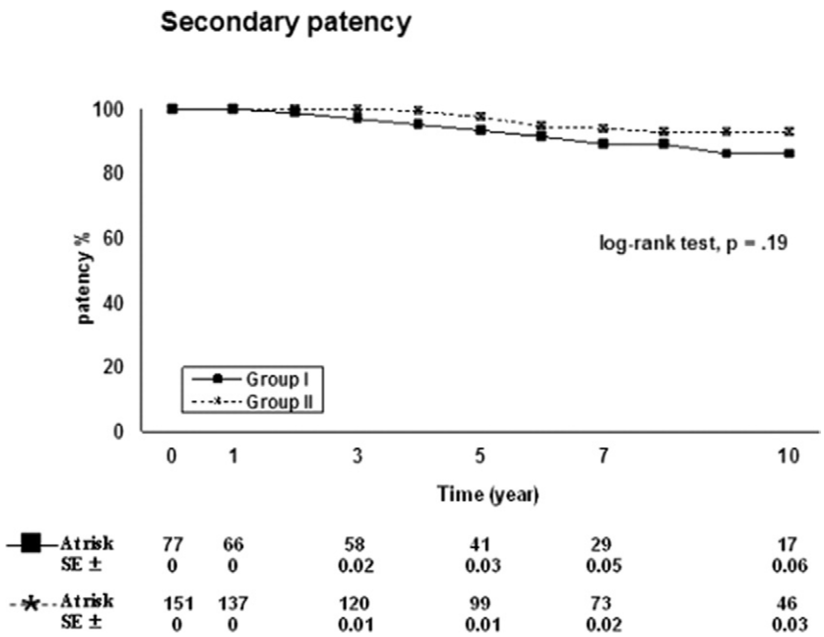

Fig 3. Kaplan-Meier life-table analysis is shown for secondary patency rates for younger (*group I*) and older (*group II*) patients (odds ratio [OR], 1.94; 95% confidence interval [CI], 0.69-6.21; log-rank test, $P = .19$). Raw number of the patients at risk and the standard error (*SE*) analyzed for each interval are shown for each group.

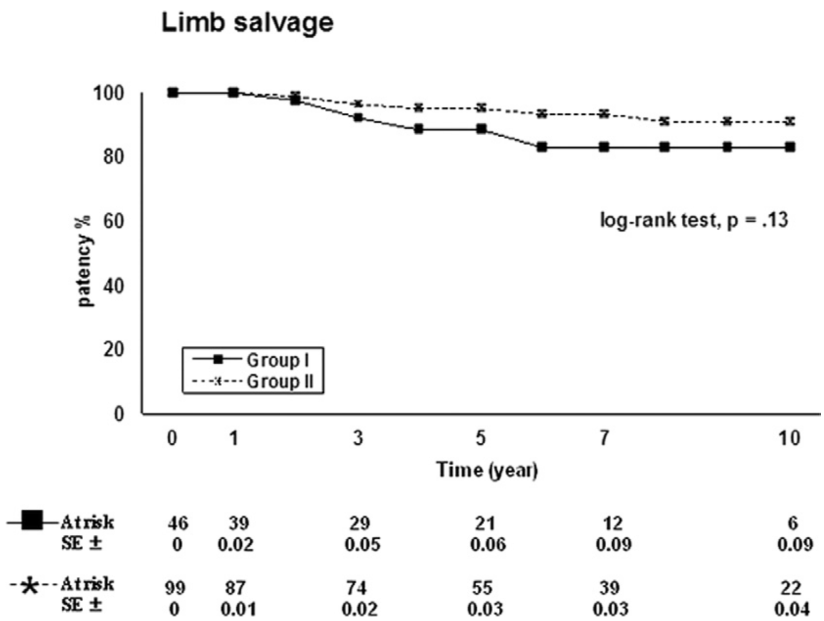

Fig 4. Kaplan-Meier life-table analysis is shown for limb salvage rates for younger (*group I*) and older (*group II*) patients with critical limb ischemia (odds ratio [OR], 2.38; 95% confidence interval [CI], 0.72-11.01; log-rank test, $P = .13$). Raw number of the patients at risk and the standard error (*SE*) analyzed for each interval are shown for each group.

.001), with no significant influence on limb salvage or long-term survival; a need for subsequent distal procedure due to outflow disease was the only predictor of limb loss ($P < .001$). None of other prognostic variables considered (demographics, risk factors, clinical data, or prior inflow endovascular procedure) could predict graft failure or limb loss. Multivariate analysis confirmed smoking and subsequent outflow procedures as independent predictors, respectively, of graft failure ($P < .001$) and limb loss ($P < .001$).

DISCUSSION

The endovascular treatment of iliac occlusive disease has evolved over the last two decades. Endovascular procedures with selective stenting have had an important effect on the management of AIOD, proving effective in treating isolated focal iliac stenosis or occlusions and largely supplanting open revascularization of such lesions. The endovascular treatment of multisegmental and complex AIOD has not been so encouraging, however, especially when diffuse lesions involve the external iliac artery.[22-26,28] An aortobifemoral bypass remains the standard treatment for diffuse and complex AIOD,[21] and is associated with a modest perioperative mortality of 3% to 5%[14,29] and excellent long-term patency rates of 87% to 91% at 5 years and 82% to 87% at 10 years,[29] although the cumulative late survival remains unsatisfactory.[30,31] Reports on the long-term outcome of open reconstructive surgery in younger people are inconsistent.

The results of the present study indicate that surgical reconstruction to treat complex AIOD in patients aged ≤50 years old is a safe and durable procedure, with few major perioperative complications, no life-threatening risks, and good long-term patency and limb salvage rates, despite a significantly higher primary graft failure rate than in older patients ($P = .01$).

Several authors have reported worse long-term patency rates after direct revascularization in younger adults,[7,8,14,18] whereas other surgeons have reported more rewarding experiences in such patients.[9,13,17] Our crude primary patency rates were (1) similar to those seen in many series in which patients were not stratified by age[29]; (2) consistent with a 4-year patency rate of 93% in young women and 89% in young men and women reported by other investigators in the 1980s and 1990s, respectively[9,11]; and (3) comparable with the 5- and 10-year patency rates of 82% and 75% observed in a more recently-published Italian study, in which, however, the long-term outcomes were similar in younger and older patients.[13]

Our data suggest that most primary treatment failures occur ≤24 months after surgery and are associated not so much with any progression of PAD as with intimal hyperplasia at the distal anastomotic site. Why patients with premature PAD are more prone to intimal hyperplasia and consequent graft failure than older patients is not still clear. In our analysis, younger patients were more often former or current smokers (and smoking emerged as the only independent factor for late graft failure) and tended more to have a history of endovascular inflow procedures. All major investigations of premature PAD have emphasized the importance of smoking as a risk factor,[13-15,17-19] although the exact mechanism behind the effect of smoking on these younger patients, and why some individuals seem more exposed to its harmful effects than others, are issues that remain to be fully understood.[32] Similarly, numerous studies on the influence of smoking on graft patency after PAD reconstructive surgery[21] have confirmed its association with a higher graft failure rate.[18,33] The finding of a significantly higher number of patients who had previously had inflow procedures in our younger group is also not new; rather than a predictor of future graft failure, this condition could be considered as a marker of a more aggressive form of atherosclerosis potentially responsible for poor patency rates or it simply could be a feature of multisegmental disease.[3,14]

No differences emerged between our two age groups in secondary patency and limb salvage rates. Adopting an intensive postoperative graft surveillance protocol led to many successful prophylactic lesion revisions in both groups, which explains the marked improvement in the patency rates for failing (with 5- and 10-year assisted primary patency rates of 89% and 82% in group I) and failed revascularizations (with 5- and 10-year secondary patency rates of 93% and 86% in group I).

Patient education is a fundamental aspect of our protocol. Patients are told about the risk of graft thrombosis and the need for regular postoperative assessments to monitor the patency of their graft. They are instructed to contact their physician immediately if symptoms of recurrent ischemia develop, and the vascular registry routinely reminds them, by telephone or mail, to attend their graft surveillance appointments. During follow-up visits, patients are advised about how to reduce their risk factors, especially as concerns smoking.

Despite a similar proportion of AIOD reconstructions being performed for limb salvage in our younger and older patients, we found, like some investigators[14] and in contrast with others,[15] that younger patients had a significantly higher rate of subsequent infrainguinal revascularizations than their older counterparts and that these peripheral arterial reconstructions were prompted more by their premature PAD progressing than by graft failure. In addition, all major amputations occurred after repeated distal revascularizations failed in patients with a patent proximal reconstruction. This finding suggests that the limb's fate is dictated by the infrainguinal disease being associated with complex AIOD, despite the protective effect of a patent aortoiliac revascularization.

The following further points emerged from our study:

- Surgical reconstruction involved an end-to-side proximal anastomosis in approximately two-thirds of the younger patients, requiring concomitant endarterectomy of the proximal site statistically less often than in older patients (6% vs 17%, $P = .02$).
- The need for concomitant common femoral artery endarterectomy (9% vs 20%, $P = .03$) or profundoplasty (19% vs 32%, $P = .03$) was statistically lower in the younger group.

Like some authors,[34] although we were unable to measure the diameter of the infrarenal aortic segment, we found no evidence that graft size (as a surrogate measure of the aorta's size) influenced long-term patency or the risk of limb loss. Other authors have reported, however, that patients with smaller aortas had worse long-term patency rates,[7,14] finding a small aortic diameter often associated with a small outflow vessel in the groin, more prone to hemodynamic impairments, and less able to allow for intimal hyperplasia,[7,9,14] which could account for a faster progression of premature PAD than in larger vessels.

This study has several limitations. First, the analysis is naturally limited by its retrospective nature, although our data were collected prospectively. Second, for a series of patients spanning such a lengthy period, the numbers are rather small. However, the TASC II lesions were comparable in our two groups and so were the patients' presenting symptoms and the status of their atherosclerotic disease (judging indirectly from their ABI values), indicating that the burden of AIOD was much the same in the two groups, warranting a technical homogeneity between them and supporting the reliability of our results. All patients also attended the same center and were treated by the same surgeon, ensuring a uniform surgical approach.

CONCLUSIONS

This study shows that aortoiliofemoral revascularization is a safe procedure for complex AIOD in younger patients with premature PAD presenting with disabling claudication or limb-threatening ischemia, providing the patients comply with a close postoperative monitoring protocol and undergo graft revision if necessary. In this setting, despite the higher primary graft failure rate, aortoiliac reconstruction in young adults carries minimal life-threatening risks and achieves secondary patency and limb salvage rates comparable with those seen in older patients with typical atherosclerotic disease.

AUTHOR CONTRIBUTIONS

Conception and design: EB, AT
Analysis and interpretation: EB, GD, AT
Data collection: RL, GP, FT
Writing the article: EB, AT
Critical revision of the article: EB, GD, AT
Final approval of the article: EB, RL, GP, FT, GD, AT
Statistical analysis: GD
Obtained funding: Not applicable
Overall responsibility: EB

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Submitted Apr 20, 2012; accepted May 30, 2012.