A comparison between aortobifemoral bypass and aortoiliac kissing stents in patients with complex aortoiliac obstructive disease

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ABSTRACT

Objective: The aim of this study was to retrospectively compare early and late results of aortobifemoral bypass and endovascular recanalization with the kissing stent technique in the management of TransAtlantic Inter-Society Consensus II (TASC II) C and D lesions in the aortoiliac district in a multicenter study.

Methods: From January 2006 to December 2013, 210 open and endovascular interventions for TASC II class C and D aortoiliac obstructive lesions were performed at three Italian teaching hospitals. In all the cases, the intervention was performed for aortic and bilateral iliac involvement. An aortobifemoral bypass was performed in 82 patients (group 1); in the remaining 128, an endovascular recanalization with the kissing stent technique was carried out (group 2). Early results in the two groups were compared with the χ^2 test. Follow-up results were analyzed with Kaplan-Meier curves and compared with log-rank test. Univariate and multivariate (forward Cox regression) analysis to identify potentially significant predictors of primary patency in the whole study group was performed.

Results: Patients in group 2 were more frequently female and more frequently had diabetes and arterial hypertension than patients in group 1. The indication for surgical intervention was the presence of critical limb ischemia in 29 cases in group 1 (35%) and in 31 cases in group 2 (24%; $P = .07$). Technical success in group 2 was 98.5%; two patients required immediate conversion to open surgery for iliac rupture. There was one perioperative death in group 1 (mortality rate, 1%; $P = .2$ in comparison with group 2). Four perioperative thromboses occurred, two in group 1 and two in group 2 (in one case requiring conversion to open surgical intervention), and no amputations at 30 days were recorded. Cumulative postoperative local and systemic complications occurred in 17 patients in group 1 (20.5%) and in 9 patients in group 2 (7%; $P < .001$). Mean duration of follow-up was 38 months (range, 1-96 months). Survival rates at 6 years were 65.5% (standard error [SE], 0.08) in group 1 and 83.5% (SE, 0.08) in group 2 ($P = .08$; log-rank, 2.2). At the same time interval, primary, assisted primary, and secondary patency rates were similar; reintervention rates were 6% in group 1 (SE, 0.05) and 11% in group 2 (SE, 0.04; $P = .3$; log-rank, 0.8). Univariate and multivariate analysis showed that only the presence of critical limb ischemia was independently associated with poorer primary patency during follow-up (hazard ratio, 2.4; 95% confidence interval, 0.9-6.4; $P = .05$).

Conclusions: In this multicenter experience, endovascular repair of aortoiliac complex lesions with the kissing stent technique provided similar satisfactory early and late results to those obtained with open surgery. (J Vasc Surg 2017;65:99-107.)

Aortobifemoral (AbF) bypass grafting and open endarterectomy remain effective and durable treatment options for aortoiliac occlusive disease (AIOD), but in the most recent years, endovascular revascularization has been used increasingly as an alternative to conventional surgery with good clinical results.[1-3] In particular, the "kissing stent" technique has been proposed for the treatment of complex aortoiliac lesions; it is particularly attractive for patients with high surgical risk because complications and mortality of AbF bypass still remain significant issues.[4-7] Moreover, in more complex disease patterns, such as those with the obstruction extending beyond or those with an associated severe femoral artery disease, hybrid technique using femoral artery endarterectomy in combination with aortoiliac kissing stents has emerged to extend the applicability of an endovascular approach.[8-11]

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Thus, optimal management of AIOD is still under debate. AbF bypass proved to have durable results, but kissing stent series showed fewer postoperative complications and good durability with results resembling those of open surgery, and operative options are not lost even if kissing stents have failed. However, few studies have directly compared AbF bypass grafting and the kissing stent technique, often including patients with heterogeneous clinical conditions.[11-14] The purpose of this study was to retrospectively compare the early and late outcomes of AbF bypass grafting vs kissing stents in the treatment of complex AIOD.

METHODS

Study group. From January 2006 to December 2013, 461 open and endovascular interventions for AIOD were performed in three teaching hospitals. Data concerning these interventions were prospectively recorded in the certified institutional registry at each participating center. Informed consent for the treatment of personal data was acquired for each patient for insertion in the prospective registry, but the retrospective analysis of the data did not require approval of the Institutional Review Board.

Starting from January 2014, the data of each center were retrospectively merged in only one created in the coordinator center and containing main anatomic, clinical, diagnostic, and technical variables. This database also contained perioperative (<30 days) results and all relevant clinical and diagnostic data collected during follow-up. There were 293 interventions performed for TransAtlantic Inter-Society Consensus (TASC II) classification C and D lesions[15]; patients who underwent open or endovascular unilateral treatment were excluded from the analysis. Therefore, the remaining 210 interventions performed for aortic or bilateral iliac involvement formed our study group. Interventions consisted of surgical AbF bypass grafting in 82 cases (39%, group 1) and the kissing stent technique in 128 cases (61%, group 2).

Diagnostic workup and surgical technique. Preoperative diagnostic assessment consisted of ankle-brachial index (ABI) measurement and duplex ultrasound scanning and computed tomography angiography of the aorta and iliac-femoral axis in all the cases. Patients were operated on in the presence of severe lifestyle-limiting intermittent claudication after the failure of other conservative measures or in the presence of critical limb ischemia (CLI). The anatomic indication for open intervention has substantially changed during the years. Whereas in the first years of the examined period AbF bypass was performed in patients with occlusion or subocclusion of the terminal aorta and of the iliac axes, open surgical revascularization was reserved in the most recent period for patients with total occlusion of the infrarenal aorta starting from just below the origin of the renal arteries, for patients with severe and diffuse calcification of the aorta and iliac arteries, and for less complex lesions after the failure of a previous endovascular attempt. On the other hand, a progressive widening of the indications for endovascular treatment occurred, from iliac lesions with minimal aortic involvement in the first years to more complex lesions in recent years; nowadays, all the patients undergo a preoperative feasibility assessment for an endovascular primary approach. Moreover, the general condition of the patients has also been taken into account in choosing one operative strategy; in patients with severe comorbidities, an endovascular approach even in the presence of extensive aortoiliac disease has often been considered. The annual trend of the interventions in the examined period is shown in Fig 1.

Open surgical interventions were performed in the operating room under general anesthesia with standard technique with a transperitoneal approach to the aortoiliac axis and a longitudinal approach to the femoral bifurcations. A bifurcated graft with an end-to-side aortic anastomosis was used in all the cases. The distal anastomoses were performed in an end-to-side fashion at the level of the distal common femoral artery. In selected patients with concomitant occlusive disease of the femoral bifurcation and of the superficial femoral artery, endarterectomy of the bifurcation was carried out and the distal anastomosis was extended into the proximal deep femoral artery.

Kissing stents were performed by the same vascular surgeons in the operating room or in the angiographic suite on the basis of local facilities; local anesthesia was supplemented with intravenous sedation or analgesia when required. A standard technique of arterial access with a unilateral or bilateral femoral approach was preferentially used; concomitant left brachial access was used in selected cases. In case of complex lesions involving the femoral bifurcation, a hybrid approach was performed; in all cases, femoral endarterectomy was closed with a silver-bonded Dacron or pericardial or polyurethane patch. At that time, we punctured the center of the patch, and a retrograde working sheath was placed once inflow had been restored. An intraluminal technique of arterial recanalization was initially attempted whenever possible. In case of long occlusions, a subintimal recanalization with a brachial approach was often unavoidable. After arterial recanalization, a standard kissing stent technique was performed, with the placement of the proximal stent ends at a higher level than the aortic bifurcation or the proximal extension of the lesion.[7] In general, we do not cross the inguinal ligament with the distal edge of the stents to avoid fractures. Our policy was to use self-expanding stents for lesions between 2 and 10 cm in length. Balloon-expandable stents were used preferentially for focal, ostial, and severely calcified lesions. Self-expanding covered stents

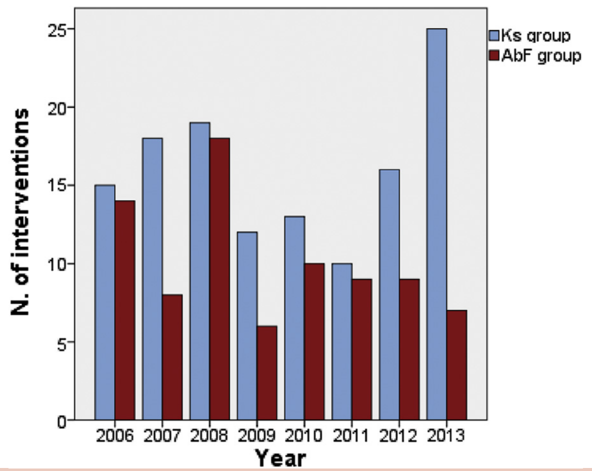


Fig 1. Distribution of interventions during the study period. *AbF,* Aortobifemoral; *Ks,* kissing stents.

were preferentially used for long obstructive segments, when the ipsilateral hypogastric artery was occluded, or for severely calcified lesions. All patients received short-term antibiotic prophylaxis at induction and heparinization (40 IU/kg) at the beginning of the endovascular procedure or just before femoral clamping. Postoperatively, group 1 was prescribed single antiplatelet therapy ad infinitum; patients in group 2 usually had double antiplatelet treatment for at least 24 months and single antiplatelet treatment thereafter; warfarin was continued when it was already used preoperatively. Follow-up included clinical visit with ABI and duplex ultrasound examination at 6-month intervals during the first year and once per year thereafter. During ultrasound examinations, the patency of the treated vessels and the status of the inflow and outflow arteries were assessed. Significant (>70%) restenosis of the treated segment was defined as a significant increase of the peak systolic velocity at the stenotic site >250 cm/s; occlusion was defined as absence of flow into the treated vessels. Computed tomography angiography was performed in such cases and if symptoms were suspected for a recurrent aortoiliac disease as well.

Definitions. Comorbidities and risk factors were defined as previously described.[2,7] The aortoiliac-femoral lesion was defined according to the TASC II classification, and the clinical status was defined according to the Rutherford classification.[15] Early (intraoperative and <30 days) results were analyzed in terms of death, thrombosis, reinterventions, and occurrence of major local and systemic complications defined according to recommended standards for reports dealing with lower extremity ischemia.[16] In group 2, we assessed technical success, defined as a <20% residual stenosis at completion angiography, and conversion to open surgery, defined as technical failure followed by immediate surgical repair.

Primary patency was defined as uninterrupted patency without procedures performed on or at the margin of the treated segment. Loss of patency was diagnosed when ABI deterioration was associated with duplex ultrasound evidence of significant restenosis, requiring or not a secondary intervention to maintain arterial patency, or thrombosis of the treated segment. Follow-up results were analyzed in terms of survival, primary and secondary patency (defined as restored patency through the original treated segment), assisted primary patency (defined as the success of procedures carried out on a still patent segment to prevent its thrombosis), and freedom from reinterventions. The analysis of follow-up results was stopped at December 2014.

Statistical analysis. Statistical analysis was performed by means of SPSS 20.0 for Windows (IBM Corp, Armonk, NY). Results are presented as mean ± standard deviation or median with range for continuous variables and number (percentage) for categorical variables. Continuous variables were analyzed with χ^2 test and Fisher exact test, when necessary. Statistical significance was defined as $P < .05$. The follow-up index for late survival in the overall study group and in both groups was assessed.[17] It was defined as the ratio between the investigated follow-up period and the theoretically possible follow-up period up to December 2014. Follow-up data were analyzed by life-table analysis (Kaplan-Meier test), and results in the two groups were compared by means of log-rank test. A univariate analysis to identify potentially significant predictors of primary patency in the whole study group was performed with Kaplan-Meier survival estimates and log-rank test for each covariate. Associations that yielded a P value $< .2$ on univariate screen were then included in a forward Cox regression analysis with measurement of hazard ratio and confidence intervals (significance criteria 0.25 for entry, 0.05 for removal). Examined covariates and their definitions are reported in Table I.

RESULTS

Clinical and morphologic data. Demographic data, comorbidities, and risk factors are shown in Table II. Briefly, mean age was similar, but in group 2, there were more men than in group 1 as well as a more frequent history of arterial hypertension and diabetes mellitus.

All the patients had a TASC II C and D lesion at the time of the intervention. Patients in group 1 had a TASC II D lesion in most cases; among patients in group 2, a TASC II C lesion was present in about 40% of the cases (Table III). The frequency of TASC II C and D lesions in group 2 during the years is shown in Fig 2.

Among patients in group 1, aortic involvement was present in 77 patients, whereas five patients had isolated bilateral iliac disease. Among the former, concomitant unilateral or bilateral iliac occlusion was present in 74 cases; three patients had bilateral iliac stenoses. Among the five

Table I. Examined covariates and their definitions for univariate analysis

Covariate	Definition
Gender	Male or female patients
Older age	Patient aged 70 years or older
Reintervention	Intervention performed in a previously revascularized aortoiliac axis (open or endovascular)
Diabetes mellitus	Need for specific antidiabetic drugs
Coronary artery disease	Prior myocardial infarction or surgical or percutaneous revascularization
Hyperlipemia	Need for specific drugs
Arterial hypertension	Need for specific drugs
CLI	Presence of rest pain or ulcers
TASC II class	TASC II C or D class
Iliac status	Iliac unilateral or bilateral occlusion
Intervention	Open or endovascular intervention

CLI, Critical limb ischemia; *TASC II,* TransAtlantic Inter-Society Consensus II.

Table II. Demographic data, comorbidities, and main risk factors for atherosclerosis in the two groups

	Group 1 (82 cases)	Group 2 (128 cases)	*P*
Male gender	71 (86)	97 (75)	.03
Mean age, years	63.3	65.7	.1
Smoker or past smoker	50 (61)	66 (51)	.1
Arterial hypertension	59 (72)	109 (85)	.03
Hyperlipemia	48 (58)	68 (53)	.3
Coronary artery disease	23 (28)	31 (24)	.5
Diabetes	13 (16)	35 (27)	.05
Chronic renal failure	2 (2.5)	8 (6.5)	.2

Values are presented as number (%) except as noted.

patients without aortic involvement, three had bilateral iliac occlusion and two had diffuse bilateral stenoses at the level of the common and external iliac arteries. In group 2, four patients had a complete occlusion of the infrarenal aorta and of both common iliac arteries. In 61 cases, stenotic involvement of the terminal aorta was present with concomitant iliac disease; in the remaining cases, only bilateral iliac stenoses or occlusions were present.

Overall, unilateral or bilateral iliac occlusion was present in 94% of patients in group 1 (77 cases) and in 67% of patients (86 cases) in group 2 ($P < .001$). In group 1, five patients were operated on after the late failure of a previous endovascular intervention (unilateral iliac stenting in three cases and bilateral iliac stenting in the remaining two); in one case, the intervention was performed after a previous failed bilateral femoral endarterectomy and patching. These patients were not part of group 2 as they had been operated on in other hospitals (two cases) or in the participating hospitals before the beginning of the study period (three cases). All the patients in group 2 had a primary intervention.

Table III. Clinical and anatomic features in the two groups

	Group 1 (82 cases)	Group 2 (128 cases)	*P*
CLI	29 (35)	31 (24)	.08
Rutherford class			
Class 3	53 (65)	97 (76)	.08
Class 4	23 (28)	23 (18)	
Class 5	4 (5)	7 (5)	
Class 6	2 (2)	1 (1)	
TASC II lesions			<.001
C class	5 (6)	51 (39)	
D class	77 (94)	77 (61)	
Iliac unilateral or bilateral occlusion	77 (94)	86 (67)	<.001

CLI, Critical limb ischemia; *TASC II,* TransAtlantic Inter-Society Consensus II.
Values are presented as number (%).

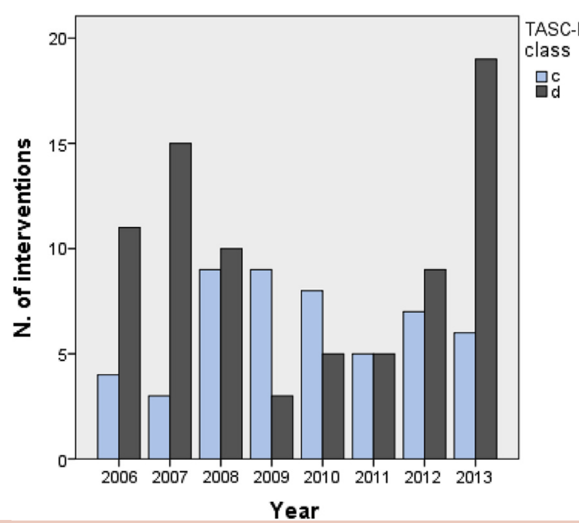


Fig 2. Distribution of TransAtlantic Inter-Society Consensus II (*TASC-II*) lesions in patients of group 2 during the study period.

Preoperative mean ABI was 0.27 ± 0.17 in group 1 and 0.44 ± 0.21 in group 2 ($P = .06$).

Technical details. In group 1, all the interventions consisted of an AbF bypass, Dacron in 57 (69.5%; silver impregnated, n = 2) and expanded polytetrafluoroethylene in the remaining 25 (30.5%). Unilateral or bilateral endarterectomy with patching of the femoral arteries was performed in 12 cases. In two patients, concomitant unilateral below-the-knee femoropopliteal bypass graft was performed. In group 2, all patients had kissing stents at the aortic bifurcation; ipsilateral and contralateral percutaneous femoral access was used in 83 cases, whereas a concomitant percutaneous left brachial access was used in 32. The remaining 13 patients had a unilateral or bilateral open surgical femoral approach. The lesions were successfully crossed in all the cases. Twelve different types of commercially available stents were used: in 106 cases, a nitinol stent; in 17 cases, a covered stent; and in the remaining 5 cases, a steel stent. The mean length of the stented iliac arteries was 15.5 ± 9.5 cm. In 84 cases, two stents were just placed at the iliac aortic bifurcation; in the remaining 44 cases, a mean number of 2.7 stents were used down the common into the external iliac artery. Concomitant associated open surgical intervention was performed in six patients and consisted of femoral endarterectomy and patching in all the cases. In one case, concomitant renal angioplasty and stenting for a severe right renal artery stenosis was performed.

Early (<30 days) results. In group 2, technical success was 98.5% (n = 126); two patients, one operated on for intermittent claudication and one for rest pain, required intraoperative conversion to open surgery for iliac rupture. One perioperative death in group 1 was due to acute myocardial infarction (mortality rate, 1%). Four cases of perioperative thrombosis occurred, two in each group (2% vs 1.5%; $P = .6$). In group 1, thrombosis occurred at postoperative days 12 and 20; in both cases, the patients had been operated on for rest pain, and the complication was treated with a new bypass graft. In group 2, one unilateral stent thrombosis occurred at postoperative day 2, and it was successfully treated with surgical thrombectomy; one patient had a bilateral stent thrombosis at postoperative day 7 that required conversion to AbF bypass. Both patients had been operated on for intermittent claudication. No amputations were performed. Local complications occurred in seven cases in group 1 (8.5%) and in six cases in group 2 (5%; $P = .03$); the kind and distribution of intraoperative and perioperative local complications are listed in Table IV. Major morbidity occurred in 10 cases in group 1 (12%) and in three cases in group 2 (2%; $P = .006$; Table IV). The overall rate of perioperative complications, excluding thromboses, was 20.5% (17 patients) in group 1 and 7% (9 patients) in group 2 ($P < .001$).

At 30 days, mean ABI was 0.82 ± 0.16 in group 1 and 0.91 ± 0.13 in group 2 ($P = .08$).

Follow-up results. All patients who survived the operation entered the follow-up; mean duration of follow-up was 38.1 months (range, 1-96), and 199 (94.5%) patients had regular postoperative follow-up visits. The mean cumulative follow-up index for survival was 0.68 (range, 0.05-1), and it was similar between the two groups (0.65 ± 0.29 in group 1 and 0.7 ± 0.28 in group 2; $P = .9$). During follow-up, 26 deaths occurred, 13 in each group. Estimated 72-month survival rates were 65.5% (standard error [SE], 0.08) in group 1 and 83.5% (SE, 0.05) in group 2 ($P = .1$; log-rank, 2.4).

Table IV. Perioperative outcomes in the two groups

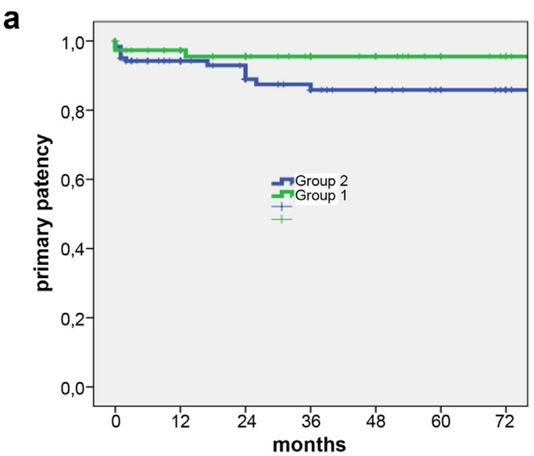
	Group 1 (82 cases)	Group 2 (128 cases)	*P*
Technical failure	—	2 (1.5%)	.3
Intraoperative complications			
Rupture	—	2 (1.5%)	.3
Local complications			
Retroperitoneal hematoma	1[a]	—	
Femoral hematoma	4[b]	2[b]	
Brachial thrombosis	—	1[c]	
Femoral pseudoaneurysm	—	1[e]	
Wound infection/dehiscence	2[d]	—	
Femoral thrombosis	—	1[e]	
Brachial AVF	—	1[d]	
Major morbidity	10	3	.006
Cardiac	4	3	
Respiratory	3		
Urinary	2		
Gastrointestinal	1		

AVF, Arteriovenous fistula.
[a]Treated with surgical drainage.
[b]Treated with surgical drainage in two cases.
[c]Treated with surgical thrombectomy.
[d]Medically treated.
[e]Treated with surgical repair.

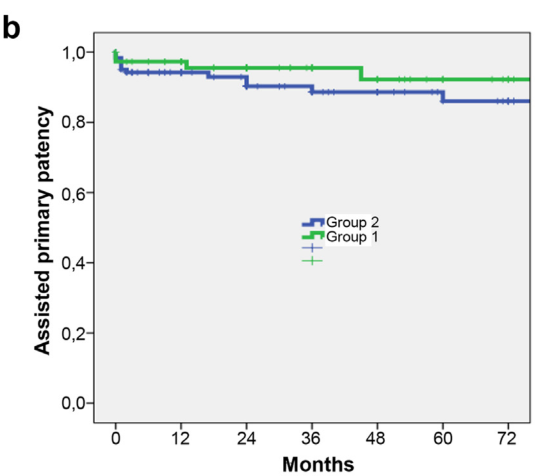
Significant restenosis of the treated vessel occurred in two cases in group 2, successfully treated in both patients with a new endovascular procedure. Eleven thromboses were recorded during follow-up, 1 in group 1 and 10 in group 2. The patient in group 1, operated on for CLI, at 13 months developed a right iliac limb thrombosis, successfully treated with surgical thrombectomy and femoral patching. In group 2, five thromboses occurred in patients operated on for intermittent claudication (one case) and for CLI (four cases) and were successfully treated with a new endovascular procedure; in five cases, the occlusion led to mild claudication and the patients were medically managed. There were no conversions to open surgery among patients of group 2.

Primary patency rates at 6 years were 95.5% (SE, 0.03) in group 1 and 83% (SE, 0.04) in group 2 ($P = .07$; log-rank, 3.3). The corresponding rates of assisted primary patency were 95.5% (SE, 0.03) and 86% (SE, 0.05), respectively ($P = .1$; log-rank, 2.2). Estimated secondary patency rates at 72 months were 97% (SE, 0.2) in group 1 and 93% (SE, 0.03) in group 2 ($P = .6$; log-rank, 0.2). At the same time interval, freedom from reinterventions was 94% (SE, 0.03) in group 1 and 89% (SE, 0.04) in group 2 ($P = .3$; log-rank, 0.8). No amputations were recorded in both groups. Kaplan-Meier curves for long-term outcomes are reported in Fig 3.

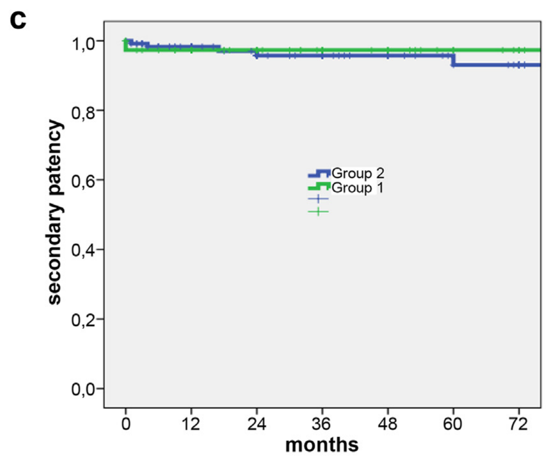
Univariate analysis for factors affecting primary patency in the whole study group is reported in Table V. At



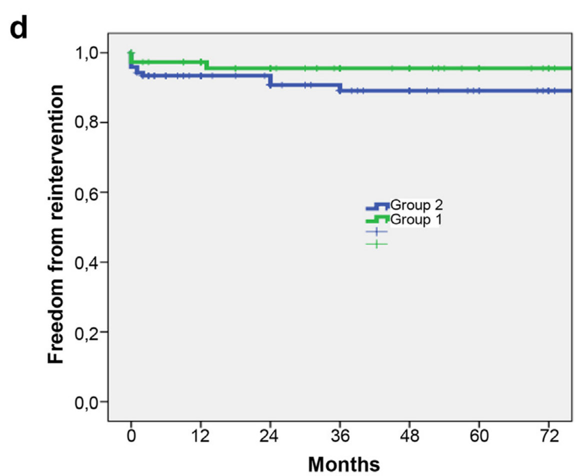
Months	0	24	48	72
Group 1				
• n. at risk	73	50	27	14
• S.E.	.02	.03	.03	.04
Group 2				
• n. at risk	121	69	43	33
• S.E.	.01	.03	.04	.05



Months	0	24	48	72
Group 1				
• n. at risk	73	50	27	14
• S.E.	.02	.03	.03	.04
Group 2				
• n. at risk	121	69	43	29
• S.E.	.01	.03	.04	.05



Months	0	24	48	72
Group 1				
• n. at risk	73	50	27	14
• S.E.	.02	.03	.03	.04
Group 2				
• n. at risk	121	73	45	31
• S.E.	.01	.02	.02	.03



Months	0	24	48	72
Group 1				
• n. at risk	73	49	27	14
• S.E.	.02	.03	.03	.04
Group 2				
• n. at risk	121	68	43	29
• S.E.	.02	.03	.03	.04

Fig 3. Kaplan-Meier curves with number of patients at risk and standard error (*S.E.*) at different follow-up times for primary patency **(a)**, assisted primary patency **(b)**, secondary patency **(c)**, and freedom from reintervention **(d)**.

Table V. Univariate analysis for primary patency

	Primary patency at 6 years, %	Log-rank	*P*
Age, years		0.5	.4
≥70	92		
<70	86		
Gender		0.7	.4
Female	87		
Male	88		
Hyperlipemia		2.4	.1
Yes	83		
No	92.5		
Hypertension		0.04	.8
Yes	89		
No	88		
Coronary artery disease		1.7	.2
Yes	92		
No	86		
Diabetes		0.05	.8
Yes	88		
No	88		
CLI		3.8	.05
No	91		
Yes	80		
TASC II class		0.4	.5
C	85.5		
D	89		
Iliac unilateral or bilateral occlusion		0.03	.8
Yes	87		
No	89		
Intervention		3.3	.07
Open	95		
Endovascular	83		

CLI, Critical limb ischemia; *TASC II*, TransAtlantic Inter-Society Consensus II.

Cox regression analysis, only the presence of CLI was independently associated with poorer primary patency during follow-up (hazard ratio, 2.4; 95% confidence interval, 0.9-6.4; $P = .05$).

DISCUSSION

Both AbF bypass grafting and the kissing stent technique are commonly performed, but only a few studies have addressed a direct comparison because of the difficulty in matching these patients.[18,19] This study is the analysis of two recent cohorts of patients treated in referral centers in a short period of inclusion compared with the similar published papers.[11-14]

Volume at the physician and hospital levels appears to be a robust predictor of patient outcomes after AIOD treatment, either for open surgery or for endovascular intervention.[19,20] Despite a progressive decrease in the number of AbF bypass grafts per year, Patel et al showed that with only minor exception, endovascular surgery has not appreciably increased the complexity of open aortic operations performed for AIOD.[21] Our experience is in line with these findings. We have high-volume programs for both of these interventions, and although our patients were not randomized, we observed no drastic differences in outcome between these two therapies.

The ongoing debate on the optimal operative management of complex AIOD is related to which of these two techniques is superior in terms of clinical and operative outcomes. The durability of the AbF bypass is offset by the low rate of morbidity and mortality of the kissing stent technique, which on the contrary has been questioned in terms of long-term patency and need of reinterventions.[19,21-23] A recent review showed that AbF bypass grafting had a higher mortality than the kissing stent technique; that study highlighted the impact of the higher incidences of coronary and respiratory diseases in patients undergoing open repair.[19] This was surprising, probably because of the fact that anatomically suitable lesions were preferentially treated with the kissing stent technique regardless of the patients' comorbidities.[11,12] Our data combine these two observations; although cardiorespiratory risk factors were homogeneously distributed in the two groups, we can confirm that mortality and major morbidity were mainly hampered by cardiac events. This finding deserves a comment. Danczyk et al reported a better survival in patients undergoing redo AbF bypass grafting compared with those undergoing primary operation despite a higher percentage of cardiac risk factors.[24] The reason that a much more invasive operation has better clinical outcomes lies in the fact that redo patients, at that time, were on a better medical regimen; this may underline the importance on outcomes during primary operation, and it could be a coexplanation of the literature and personal results. Last but not least, it confirms that in contrast to infrainguinal distal revascularization, endovascular-first treatment does not preclude an effective open rescue; this is also supported by the findings of Patel et al, who demonstrated that endovascular surgery has not appreciably increased the complexity of open aortic operations performed for AIOD.[21]

When we consider cardiovascular risk factors and their impact on clinical outcomes, we should take into account that most of these patients presented with a more important severity of ischemia.[11,14,19] Among factors influencing postoperative outcomes, CLI is a known marker of poorer results.[15] This holds true also in our study; CLI was an independent risk factor for worse outcomes. Although AbF bypass grafting and kissing stent technique patencies did not differ in the long run, overall patency results were negatively affected by CLI. Our data find support in another study of Kashyap et al, who showed that the status of the runoff vessels is another important factor negatively affecting the patency of such interventions.[11] In their experience, patients who required concomitant distal revascularization along with either AbF bypass or kissing stents had dismal patency rates, reflecting the more severe atherosclerotic burden in a patient with CLI.

Considering the durability of these two types of treatment, long-term survival is another primary end point to be evaluated. Disappointingly, it is not surprising to find conflicting data. Kashyap et al reported a survival rate of 80% at 3 years in both groups; Sachwani et al had results at 6 years with 76% survival for AbF bypass and 68% for kissing stents.[11,14] At the same time point, our results are exactly the opposite, with better survival for the endovascular group, independent of the initial age of patients in the two groups. Considering long-term survival, we should underline that our study is consistent with many series of interventions for complex AIOD in which most patients were treated for claudication rather than for CLI.[11-14,19] One possible explanation for the better survival in group 2 is represented by the different long-term postoperative regimen, with a wide use of double antiplatelet treatment in the endovascular group, probably favoring a better control of cardiovascular events during the years. Primary, assisted primary, and secondary patency rates were similar between the two groups; there was, however, a trend toward better results for patients in group 1, particularly when primary and assisted primary patency were examined. This is a common finding in the prior vascular literature, and in this study it could be due to type II statistical errors.[19] One can suppose that with a larger number of patients and a longer follow-up time, the difference could become significant; however, all the patients needing a reintervention in group 2 were treated with a novel endovascular approach, allowing the gap between the two groups to be further reduced in terms of secondary patency.

Limitations. Limitations of our study are worthy of mention and inherent to the study design. This is a retrospective nonrandomized study, with heterogeneous criteria for the choice of the treatment and progressive changes in indications during the years. Moreover, we had a higher percentage of more complex lesions in group 1, even if the cumulative number of TASC II C and D lesions was similar in the groups. Furthermore, we did not perform an analysis on costs and postoperative sexual dysfunction. On the other hand, the two groups matched well under a clinical point of view, and the mild anatomic differences between them did not affect late outcomes; moreover, it involves referral centers with a large number of treated cases, and follow-up was consistent, allowing assessment of durability and survival.

CONCLUSIONS

Endovascular repair of aortoiliac complex lesions with the kissing stent technique in suitable patients in this multicenter experience provided satisfactory early and late results similar to those obtained with open aortofemoral bypass surgery. The rate of perioperative complications was lower in patients undergoing endovascular treatment, and there was a trend toward better long-term survival. The numerically higher rate of reintervention over the time observed in endovascularly treated patients is mitigated by the fact that most of the long-term complications were successfully treated with another endovascular procedure.

AUTHOR CONTRIBUTIONS

Conception and design: WD, GP, FP
Analysis and interpretation: WD, GP, PC, FC
Data collection: FP, AT, AF
Writing the article: WD, GP
Critical revision of the article: PC, FC, CP
Final approval of the article: WD, GP, FP, AT, PC, FC, AF, CP
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REFERENCES

1. de Vries SO, Hunink MG. Results of aortic bifurcation grafts for aortoiliac occlusive disease: a meta-analysis. J Vasc Surg 1997;26:558-69.
2. Pulli R, Dorigo W, Fargion A, Innocenti AA, Pratesi G, Marek J, et al. Early and long-term comparison of endovascular treatment of iliac artery occlusions and stenosis. J Vasc Surg 2011;53:92-8.
3. Abello N, Kretz B, Picquet J, Magnan PE, Hassen-Khodja R, Chevalier J, et al. Long-term results of stenting of the aortic bifurcation. Ann Vasc Surg 2012;26:521-6.
4. Piffaretti G, Tozzi M, Lomazzi C, Rivolta N, Laganà D, Carrafiello G, et al. Mid-term results of endovascular reconstruction for aorto-iliac obstructive disease. Int Angiol 2007;26:18-25.
5. Sixt S, Krankenberg H, Möhrle C, Kaspar M, Tübler T, Rastan A, et al. Endovascular treatment for extensive aortoiliac artery reconstruction: a single-center experience based on 1712 interventions. J Endovasc Ther 2013;20:64-73.
6. Indes JE, Tuggle CT, Mandawat A, Sosa JA. Age-stratified outcomes in elderly patients undergoing open and endovascular procedures for aortoiliac occlusive disease. Surgery 2010;148:420-8.
7. Pulli R, Dorigo W, Fargion A, Angiletta D, Azas L, Pratesi G, et al. Early and midterm results of kissing stent technique in the management of aortoiliac obstructive disease. Ann Vasc Surg 2015;29:543-50.
8. Chang RW, Goodney PP, Baek JH, Nolan BW, Rzucidlo EM, Powell RJ. Long-term results of combined common femoral endarterectomy and iliac stenting/stent grafting for occlusive disease. J Vasc Surg 2008;48:362-7.
9. Piazza M, Ricotta JJ 2nd, Bower TC, Kalra M, Duncan AA, Cha S, et al. Iliac artery stenting combined with open femoral endarterectomy is as effective as open surgical reconstruction for severe iliac and common femoral occlusive disease. J Vasc Surg 2011;54:402-11.

10. Piffaretti G, Rivolta N, Bossi M, Fontana F, Piacentino F, Castelli P. Hybrid revascularization for iliac-femoral obstructive disease. Ital J Vasc Endovasc Surg 2015;22:15-9.
11. Kashyap VS, Pavkov ML, Bena JF, Sarac TP, O'Hara PJ, Lyden SP, et al. The management of severe aortoiliac occlusive disease: endovascular therapy rivals open reconstruction. J Vasc Surg 2008;48:1451-7.
12. Hans SS, DeSantis D, Siddiqui R, Khoury M. Results of endovascular therapy and aortobifemoral grafting for Transatlantic Inter-Society type C and D aortoiliac occlusive disease. Surgery 2008;144:583-9.
13. Burke CR, Henke PK, Hernandez R, Rectenwald JE, Krishnamurthy V, Englesbe MJ, et al. A contemporary comparison of aortofemoral bypass and aortoiliac stenting in the treatment of aortoiliac occlusive disease. Ann Vasc Surg 2010;24:4-13.
14. Sachwani GR, Hans SS, Khoury MD, King TF, Mitsuya M, Rizk YS, et al. Results of iliac stenting and aortofemoral grafting for iliac artery occlusions. J Vasc Surg 2013;57:1030-7.
15. Norgren L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FG, et al. Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). Eur J Vasc Endovasc Surg 2007;33(Suppl 1):S1-75.
16. Rutherford RB, Baker JD, Ernst C, Johnston KW, Porter JM, Ahn S, et al. Recommended standards for reports dealing with lower extremity ischemia: revised version. J Vasc Surg 1997;26:517-38.
17. von Allmen RS, Weiss S, Tevaearai HT, Kuemmerli C, Tinner C, Carrel TP, et al. Completeness of follow-up determines validity of study findings: results of a prospective repeated measures cohort study. PLoS One 2015;10:e0140817.
18. Indes JE, Mandawat A, Tuggle CT, Muhs B, Sosa JA. Endovascular procedures for aorto-iliac occlusive disease are associated with superior short-term clinical and economic outcomes compared with open surgery in the inpatient population. J Vasc Surg 2010;52:1173-9.
19. Indes JE, Pfaff MJ, Farrokhyar F, Brown H, Hashim P, Cheung K, et al. Clinical outcomes of 5358 patients undergoing direct open bypass or endovascular treatment for aortoiliac occlusive disease: a systematic review and meta-analysis. J Endovasc Ther 2013;20:443-55.
20. Dimick JB, Cowan JA Jr, Henke PK, Wainess RM, Posner S, Stanley JC, et al. Hospital volume-related differences in aorto-bifemoral bypass operative mortality in the United States. J Vasc Surg 2003;37:970-5.
21. Patel AP, Langan EM 3rd, Taylor SM, Snyder BA, Cull DL, Carsten CG 3rd, et al. Has the emergence of endovascular treatment for aneurysmal and occlusive aortic disease increased the complexity and difficulty of open aortic operations? Ann Vasc Surg 2004;18:212-7.
22. Upchurch GR, Dimick JB, Wainess RM, Eliason JL, Henke PK, Cowan JA, et al. Diffusion of new technology in health care: the case of aorto-iliac occlusive disease. Surgery 2004;136:812-8.
23. Bredahl K, Jensen LP, Schroeder TV, Sillesen H, Nielsen H, Eiberg JP. Mortality and complications after aortic bifurcated bypass procedures for chronic aortoiliac occlusive disease. J Vasc Surg 2015;62:75-82.
24. Danczyk RC, Mitchell EL, Petersen BD, Edwards J, Liem TK, Landry GJ, et al. Outcomes of open operation for aortoiliac occlusive disease after failed endovascular therapy. Arch Surg 2012;147:841-5.

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