

Aortoiliac Reconstructive Surgery Based Upon the Results of Duplex Scanning

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Objective: to evaluate whether duplex scanning can replace angiography in patients operated for aortoiliac obstructive disease.

Design: retrospective.

Materials and methods: between January 1995 and October 1996, 44 patients underwent vascular surgery of the aortoiliac tract. The study population was divided into two groups; patients operated upon the results of duplex scanning only and patients who also underwent angiography prior to surgery. The additional value of angiography and the differences between both groups concerning unexpected peroperative findings, early postoperative failures and the need for additional radiological or surgical interventions in the first three postoperative months were studied.

Results: Duplex scan group: 22 patients were operated upon the results of duplex scanning only. In two patients surgical strategy had to be changed. Early postoperative graft occlusion occurred in one case. A haemodynamically significant graft stenosis within 3 months of surgery occurred in one patient. Duplex/angiography group: 22 patients underwent both duplex scanning and angiography. Six patients underwent diagnostic angiography after failed duplex scanning. In 10 patients angiography was part of percutaneous transluminal angioplasty prior to surgery. In six patients angiograms were performed after successful duplex scanning. Angiography failed in two patients and added information in four of 16 patients. Unexpected findings at operation occurred in four patients. Graft stenosis within 3 months was detected in three patients.

Conclusion: after successful duplex scanning information obtained by angiography has only a limited impact on therapeutic decision-making. In the majority of patients vascular reconstructive surgery of aortoiliac arteries can be planned based on duplex scanning only.

Key Words: Aortoiliac obstructive diseases; Duplex scanning; Angiography; Clinical impact.

Introduction

When patients are selected for aortoiliac reconstructive surgery based upon the results of duplex scanning, additional angiography is usually still performed to plan the definitive surgical approach. However, duplex scanning may replace diagnostic angiography because both the aortoiliac and femoropopliteal arteries can be accurately assessed. In a recent meta-analysis, based on results of both conventional and colour-coded duplex scanning, we reported a pooled sensitivity of 80% and specificity of 95% for the detection of stenosis greater than 50% in the aortoiliac arteries. If duplex scanning has to differentiate between open or occluded aortoiliac arteries, the sensitivity becomes even greater than

Table 1. Surgery for aortoiliac obstructive disease.

Treatment	Duplex group	Angiography group	Total
Aortobi-iliac bypass	3	0	3
Aortobifemoral bypass	5	4	9
Iliobifemoral bypass	1	0	1
Iliofemoral bypass	5	8	13
Femorofemoral crossover bypass	7	10	17
Endarterectomy of the iliac tract	1	0	1
Total	22	22	44

90% and these figures may be higher if colour-coded duplex scanning is used.^{1,2} In view of the high accuracy of duplex scanning compared to angiography, the need for preoperative angiography must be questioned.

Several reports describe the potential of duplex scanning in clinical decision-making.³⁻¹⁰ If a lesion can be treated by percutaneous transluminal angioplasty

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Table 2. Preoperative work-up in patients operated for aortoiliac obstructive disease.

	n	Lesion		Angiography			
		St *	Occ †	Diagnostic	Interventional	Add information	Decisive for surgical strategy
Duplex scan group	22	5	17	1‡	1§	0	
Angiography group	22	3	19	12	10	10	6

* Stenosis

† Occlusion

‡ Intraoperative angiogram for successive femorocrural bypass

§ Intraoperative transluminal dilatation of superficial femoral artery

Table 3. Treatment strategy in patients treated for bilateral aortoiliac obstructive disease.

Case	Duplex scanning Aortoiliac	Strategy	Discrepancy between duplex and angiography	Treatment change	Unexpected findings at operation
1	L* Stenosis	PTA EIA†	No	No	No
	R Occlusion	Iliofemoral bypass	Progression of occlusion	No	No
2	L Stenosis	PTA CIA	No	No	No
	R Occlusion	Iliofemoral bypass	No	No	No
3	L Occlusion	Iliofemoral bypass	No	No	Yes§
	R Stenosis	PTA EIA	Stenosis <50%‡	Procedure abandoned	No
4	L Occlusion	Femorofemoral crossover bypass	No	No	No
	R Stenosis	PTA EIA	No	No	No

* L=Left/R=Right

† Percutaneous transluminal angioplasty of the external iliac artery (EIA)/common iliac artery (CIA)

‡ After multiplane views and intra-arterial pressure measurements

§ Due to calcification of the arterial wall end-to-side anastomosis is converted into end-to-end anastomosis

Table 4. Treatment strategy in patients operated within 6 months after percutaneous transluminal angioplasty.

Case	Duplex scan Aortoiliac tract	Strategy	Discrepancy between duplex and angiography	Treatment change	Duplex surveillance	Strategy	Unexpected findings at operation
1.	Stenosis	PTA EIA*	No	No	Reocclusion	Iliofemoral bypass	No
2	Stenosis	PTA EIA	Acute occlusion	Thrombolysis	Reocclusion	Iliofemoral bypass	No
3	Stenosis	PTA CIA	Lesion extension into aorta	PTA Aorta bif.	Reocclusion	Aortobifemoral bypass	Yes†
4	Occlusion	PTA EIA	No	No	Reocclusion	Iliofemoral bypass	No
5	Occlusion	PTA EIA	No	No	Reocclusion	Iliofemoral bypass	No
6	Stenosis	PTA EIA	No	No	Restenosis	Iliofemoral bypass	Yes‡

* Percutaneous transluminal angioplasty of the external iliac artery (EIA)/common iliac artery (CIA)

† Due to calcification of the aorta the proximal anastomosis is reimplemented more proximally

‡ Due to perivascular cicatrization of the common iliac artery as a result of prior operation, the iliofemoral bypass is converted into a femorofemoral crossover bypass.

(PTA), duplex scanning can correctly select these patients in over 80% of cases.³⁻⁷ Only three studies, however, describe the role of duplex scanning in planning surgical approach.⁸⁻¹⁰ A theoretical decision analysis showed a good agreement between a surgeon's decision based on duplex scanning versus that based on angiography.⁸ Two studies described the use of duplex scanning as the sole imaging modality in a selected, small number of patients. In one of these, all

patients also underwent on-table angiography prior to surgery anyway.^{9,10}

In our hospital the decision to schedule a patient for a PTA is routinely based upon the results of duplex scanning only, and in an increasing number of patients surgical reconstructions are performed without angiography. This applies mainly to reconstructions of the aortoiliac tract, as assessment of the crural outflow is necessary for femorodistal bypasses and duplex

Table 5. Intraoperative findings and clinical outcome in patients operated for aortoiliac obstructive disease.

	<i>n</i>	Operation Unexpected findings*	Restenosis <3 months	Reintervention <3 months
Duplex scan group	22	2	1	1
Angiography group	22	4	3	0

* Intraoperative findings which changed surgical strategy.

scanning of these arteries is, as yet, insufficiently validated.¹ In a retrospective study we analysed the contribution of duplex scanning to the work-up and clinical decision-making in patients operated for aortoiliac obstructive disease, to determine whether angiography was needed after successful duplex scanning.

Patients and Methods

All patients referred to our vascular laboratory for aortoiliac duplex investigation between January 1995 and October 1996 were identified. Aortoiliac reconstructive surgery was performed in 47 of these patients. Only those patients who were operated within 6 months after duplex examination were analysed. In three patients this time span exceeded 6

months. The remaining 44 patients consisted of 28 men and 16 women ranging in age from 29 to 82 years. The indications for operation were disabling claudication in 29 patients, rest pain in 14 patients and ischaemic ulceration in one patient. The results of duplex scanning and angiograms were collected and analysed.

Duplex scanning was performed with a Hewlett-Packard sonos 1000 or 2000. The aortoiliac segments, common femoral and the orifice of both the deep and superficial femoral arteries were routinely examined on both sides (with a 3.5–4.5 MHz probe). Femoropopliteal outflow of the affected limb was also assessed, whereas crural arteries were not investigated. Peak systolic velocity (PSV) ratios were used to grade stenoses; a lesion with a PSV-ratio greater than or equal to 2.5 or occlusion was considered as haemodynamically significant.^{11,12} The results of duplex scanning, including the length of the lesions, were drawn on an anatomical line diagram, providing the vascular surgeon with a road map to plan the surgical technique.

Intra-arterial digital subtraction angiography via retrograde femoral puncture was performed using the Seldinger technique. Stenoses were graded based upon cross-sectional diameter reduction and considered haemodynamically significant if greater than 50%. Monoplane views were taken routinely. When the results of the duplex scan were not in accordance with

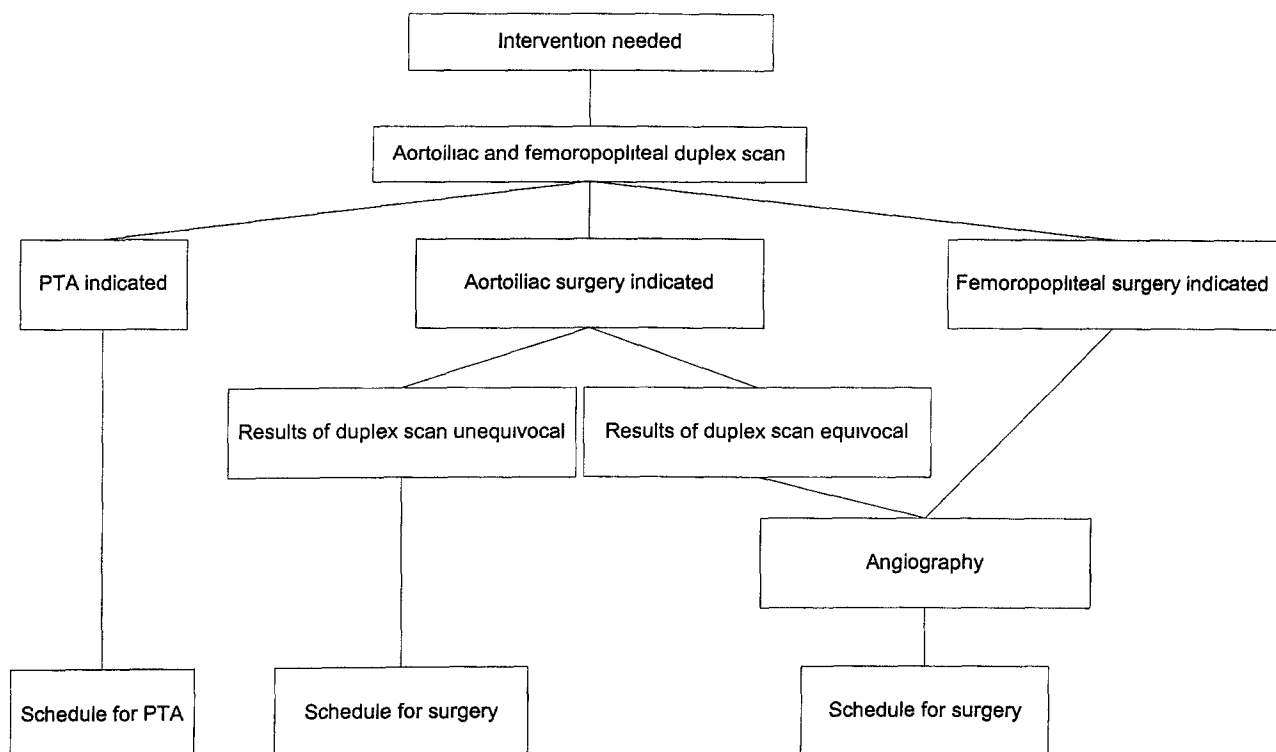


Fig. 1. Algorithm of preoperative work-up in patients with peripheral arterial obstructive disease.

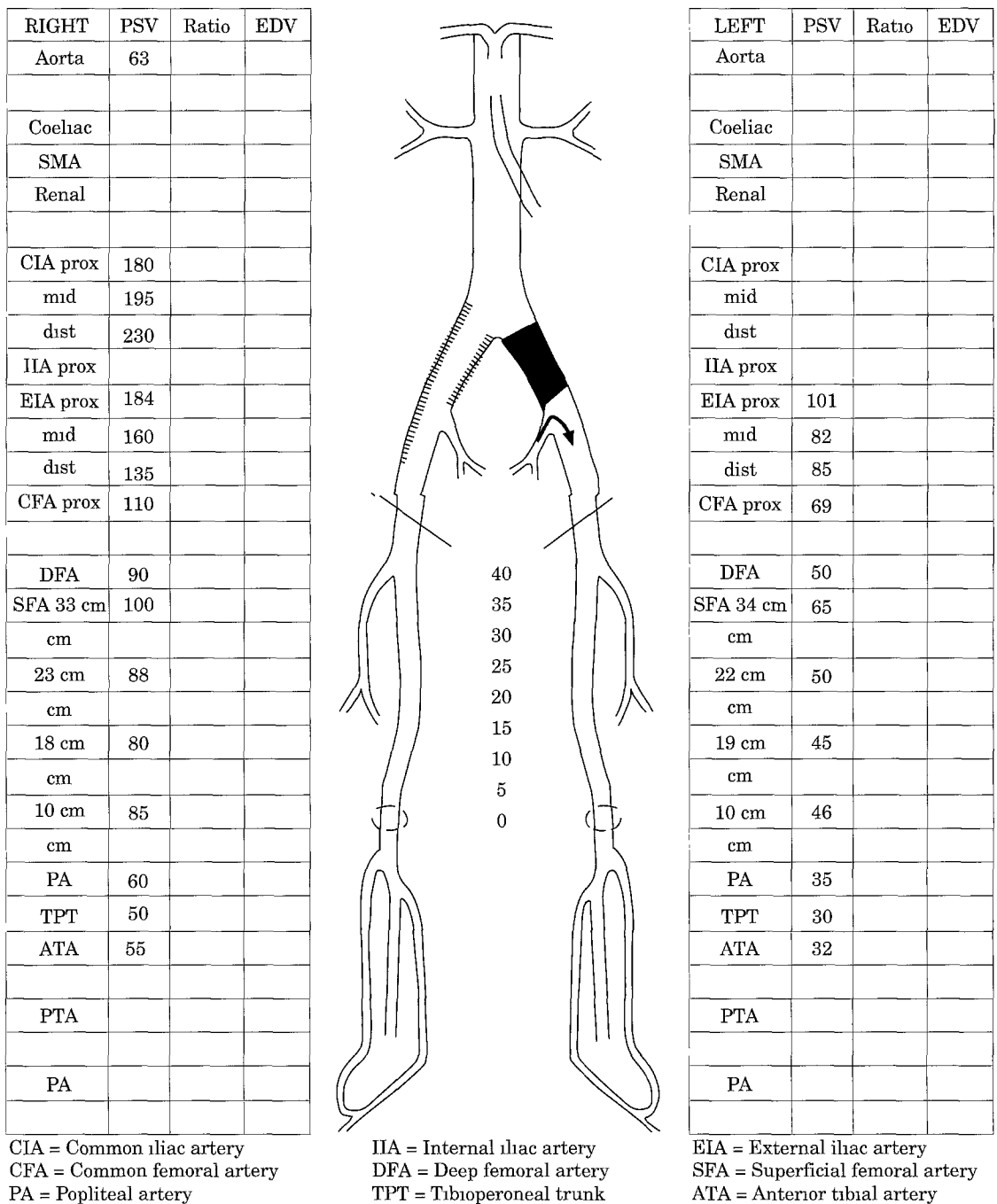


Fig. 2. Results of duplex scanning reported on a standard data sheet

the monoplane angiography, multiplane views were made or intra-arterial femoral pressure measurements were performed: an absolute peak systolic brachial-femoral pressure gradient greater than 20 mmHg at rest, or a drop in femoral to brachial index greater than 15% after administration of papaverine, was considered haemodynamically significant.¹²

Based on preoperative work-up, the study population was divided retrospectively into a duplex scan

group (those who were operated on without additional angiography) and an angiography group (those who had both duplex scanning and additional angiography). The results of angiography were compared with duplex scanning to assess the additional value of angiography. Surgical reports were reviewed to detect differences between both groups concerning the occurrence of unexpected intraoperative findings and changes of the surgical approach. Blood systolic ankle

pressure, results of duplex surveillance and the occurrence of reinterventions (PTA or surgery) were reviewed to detect differences in clinical outcome between both groups in the course of the first 3 postoperative months. The Wilcoxon paired-test was used to compare pre- and postoperative blood systolic ankle pressure measurements.

Results

Preoperative work-up

Duplex scan group. Based on the results of the duplex scan, 22 patients underwent vascular reconstructive surgery of the aortoiliac tract without additional angiography (Table 1). The median time between duplex examination and operation was 60 days (range: 2–135 days).

Angiography group The other 22 patients underwent duplex scanning as well as angiography before operation (Table 1). For this group of patients the median time between duplex examination and operation was 52 days (range: 1–126 days). There were no complications after angiography. In 12 patients additional angiography was performed solely for diagnostic reasons and in 10 patients angiography was part of percutaneous treatment prior to surgery (Table 2). Of the 12 diagnostic angiographies, six were necessary because duplex scanning failed due to obesity. The other six patients underwent an angiogram after successful duplex scanning. In four patients this diagnostic angiogram added no new information regarding the surgical strategy. In two patients the guidewire could not pass the atherosclerotic lesion in both groins and angiography failed. In these patients the final decision (for an aortobifemoral bypass) was therefore based on duplex scanning alone. Of the 10 patients who had percutaneous treatment prior to surgery, four were scheduled for a combination of both percutaneous and surgical treatment for bilateral aortoiliac obstructive disease based on duplex scanning only (Table 3). The other six patients had to be operated after early graft stenosis of PTA of the aortoiliac tract. Both the patient selection for percutaneous treatment and detection of early failures were based on the information of duplex scanning (Table 4). Four of these 10 angiograms performed during percutaneous treatment did add new information which changed the percutaneous approach, but did not affect the surgical strategy.

Intraoperative findings

Duplex scan group. In two patients the surgical strategy had to be changed, as unexpected findings occurred during operation (Table 5). In the first case, endarterectomy of the occluded external iliac artery was extended into the common iliac artery, as a pinpoint stenosis was detected intraoperatively in the common iliac artery. In the second case a patient received a femorofemoral crossover bypass instead of a combination of an endarterectomy of the common femoral artery and a transluminal dilatation of a stenosis of the ipsilateral common iliac artery, because the entire iliac tract appeared to be calcified and virtually occluded, making it unsuitable for percutaneous treatment.

Two of the 22 patients underwent on-table angiography for complementary outflow reconstructions, which was already scheduled preoperatively, one, to assess the suitability of the crural arteries for successive distal bypass surgery and one because of a transluminal dilatation of a stenosis in the superficial femoral artery.

Angiography group. In this group of patients four unexpected findings occurred during operation (Table 5). In two patients the proximal end of the graft had to be anastomosed more proximally because of excessive calcification. In one, the option of an end-to-side anastomosis was converted into an end-to-end anastomosis because of unexpected dilatation of the abdominal aorta. In the final patient the common iliac tract could not be explored because of excessive scarring after previous vascular reconstructive surgery and the planned iliofemoral bypass was converted into a femorofemoral crossover bypass.

Clinical outcome

Duplex scan group. Early failure of one graft occurred (Table 5). One hour after initial surgery, duplex scanning confirmed acute thrombosis of the graft and a surgical thrombectomy was successfully performed. All patients recovered well after surgery and median ankle-brachial indices rose from 54% (range: 0–109%) preoperatively to 75% (range: 45–111%) postoperatively ($n = 15$, $p < 0.05$). In one patient, duplex surveillance detected a haemodynamically significant graft stenosis during the 3 months following surgery.

Angiography group. There were no early failures of surgical treatment in this patient group (Table 5).

Median ankle to brachial indices rose from 35% (range: 0–56%) up to 77% (range: 27–100%) postoperatively ($n=14$, $p<0.05$). In three patients haemodynamically significant graft stenoses were detected within 3 months. Because of persistent rest pain due to infrainguinal obstructive arterial disease, one patient underwent distal bypass surgery 1 week after initial aortobifemoral bypass surgery.

Discussion

This study shows that in a considerable number of patients with aortoiliac obstructive disease reconstructive surgery can be performed on the basis of duplex scanning only. Preoperative angiography was mainly performed as part of a percutaneous intervention (10/44) or because of inability to visualise the entire aortoiliac tract (6/44). Six out of 44 patients underwent a diagnostic angiography after successful duplex scanning. These examinations were probably performed out of habit, although there might have been a well-founded reason which can be difficult to discern in a retrospective study like this.

In both groups, unexpected findings occurred which required a change in surgical strategy. No significant differences were found, however, between the groups and there was no difference in the need for additional intervention during the 3 months following surgery.

Over the past years the use of duplex scanning has radically changed the pre-interventional work-up in our patients. An algorithm of our current work-up is shown in Fig. 1. Duplex examinations are not requested in our vascular laboratory if no intervention is considered. Diagnostic angiography is always asked for when duplex scanning shows that the patient needs a femorodistal bypass or if it is not clear whether a PTA might be possible. However, some papers indicate that in selected cases femorodistal bypass surgery might be possible without additional angiography.^{9,13,14}

If the duplex examination is performed according to a standard protocol by well trained vascular technologists and results are reported on a data sheet which combines information on changes in cross-sectional area based on PSV-ratios, and with an anatomical line drawing in which length and localisation of lesions are precisely indicated (Fig. 2), the vascular surgeon can plan the surgical approach without the need for angiography. Duplex scanning of the renal, the inferior mesenteric and internal iliac arteries is time-consuming and for the inferior mesenteric and internal iliac arteries insufficiently validated. Therefore these arteries are not routinely scanned. However, for most patients

treated for obstructive aortoiliac disease, information concerning the patency of inferior mesenteric and internal iliac arteries is not essential when planning the surgical technique.

The technologist and vascular surgeon should discuss the (abnormal) results of duplex scanning or unexpected intraoperative findings, to improve the diagnostic performance. A preoperative work-up based on duplex scanning alone is beneficial for the patient as it is performed in the outpatient clinic and excludes the discomfort and risks of unnecessary angiography.

In conclusion, this study shows that after successful duplex scanning information obtained by angiography has only a limited impact on therapeutic decision-making when aortoiliac reconstructive surgery is needed. Angiography should be reserved for those patients in whom the results of duplex scanning are equivocal.

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