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Original Article

Endovascular Treatment for Isolated Atherosclerotic Stenosis of the Infrarenal Abdominal Aorta - Vascular Department Experience

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Abstract

Although symptoms of intermittent claudication can be caused by lesions arising at different levels of the vascular tree, isolated aortic stenosis is not a common cause of claudication. Endarterectomy and bypass surgery are traditional and well-documented methods of management of atherosclerotic stenosis.

We present a retrospective analysis of 10 patients treated during 3 years period in the Department of Vascular Surgery, American Heart of Poland, Chrzanow. The follow-up was 6-34 months; mean 16.5 months.

All patients had a history of intermittent claudication (approximately 100m) but no critical ischemia. The patients' comorbidities did not differ significantly from those typical of atherosclerotic populations. The patients were relatively young (40-69 years, mean age 57). Prior to endovascular treatment, all patients were treated pharmacologically but no improvement was observed.

Subtraction angiography or CTA was performed prior endovascular treatment. An analysis of stenosis length and diameter, plaque characteristics, patency of the inferior mesenteric artery and location of the stenosis in relation to renal vessels and aorta bifurcation allowed us to select appropriate stent placement technique and equipment.

Various types of stents and stent grafts were used. Technical success was 100%. No aorta dissection, peripheral embolization, stent thrombosis or local complications were observed. No symptoms of intermittent claudication were reported by patients during follow-up. CDD and CT measurements did not reveal restenosis.

The outcomes of endovascular treatment are encouraging and the treatment itself might be considered an alternative to surgical management of abdominal aortic stenosis, which, although effective is characterized by a significantly higher complication rate.

Keywords: Abdominal aortic stenosis; Aorta stenting; Endovascular treatment; Vascular surgery

Introduction

Atherosclerotic lesions in patients with intermittent claudication are typically located in the aortoiliac segment; co-existing lesions are frequently found in the other segments of the arterial tree. Isolated atherosclerotic stenosis of the abdominal aorta or bifurcation site is a rare cause of claudication. It is also more difficult to diagnose since if no lesions are present within the peripheral arteries, peripheral pulses can be sensed on palpation. Hence atherosclerotic stenosis is frequently misdiagnosed and treated as lumbosacral spine disease.

Relatively young age of patients is another issue which might mislead a General Practitioner (GP). The youngest patient in our study was 40 years old and the mean age of the study participants was 57 years. GP might not suspect advanced atherosclerotic lesions in such young patients. However, according to scientific data /TASC 2/, 3 - 6% of patients between 40-60 years old may develop symptoms of claudication [1].

Endarterectomy and bypass surgery are traditional and well-documented methods of management of atherosclerotic stenosis. However, they are associated with high mortality and complication rate in comparison to endovascular interventions. Literature review revealed several reports on endovascular treatment for atherosclerotic stenosis, eg., balloon angioplasty or stent placement; however, the number of reports and size of described patients' populations are small [2-8] (Table 1).

Author	N	F-U /śr./
Sheeran /1997/	9	19
Nyman /2000/	30	19
Schedel /2004/	15	36
Yilmaz /2004/	13	43
Poncyljusz /2006/	26	18
Tapping /2012/	22	88
Onder /2012/	40	24

Table 1: List of articles concerning abdominal aorta stenting.

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It should be mentioned that, due to technological progress, endovascular treatment strategies have undergone several changes. The novel endovascular procedures gradually replace gold standard open surgical reconstructions.

Endovascular treatment of abdominal aorta is a particular example of the above-described shift in treatment options. Therefore, the aim of this paper is to present own results concerning 10 patients with abdominal aortic stenosis who received endovascular treatment in the 3 years treatment and follow-up.

Materials and Methods

Patients with abdominal aortic stenosis were treated in the Department of Vascular Surgery, American Heart of Poland in Chrzanow. The patients' data were analyzed retrospectively and the patients were requested to arrive for another follow-up appointment.

At the time of the patients' inclusion to the treatment group, they did not exhibit any significant lesions in lower limb vessels. The patient group consisted of 5 men and 5 women, aged 40-69 years, mean age 57.4 years. The Mann-Whitney U test did not show any statistically significant differences within the group with regard to age, gender and comorbidities. Demographic data and comorbidities are presented in Table 1. The observation period was 6-34 months, mean 16.5 months.

All patients with a history of intermittent claudication but no critical ischemia (Rutherford class 3, claudication distance below 100m) were qualified for the treatment on the basis of Computed Tomography Angiography (CTA) or subtraction angiography. Color-Coded Duplex Doppler (CDD) was an adjunctive component of the examination. Standard pharmacotherapy (ASA, statin, pentoxifylline or cilostazol) administered for approximately 6 weeks prior to the ultimate qualification for endovascular treatment did not cause significant improvement of the patients' condition.

All endovascular interventions were performed in an angiography suite with 1% lidocaine used as a local anesthetic and under sedation with midazolam/fentanyl under anesthetist' s supervision. During the procedure, arterial pressure was monitored with a hemodynamic method and patient's oxygen saturation using pulse oximetry; ECG was also performed. Prior to endovascular interventions, the patients were on antiplatelet therapy, ie. ASA 75mg/once a day and statin 20-40mg. After 6F sheath placement, 5000 units of heparin were administered to the femoral artery. Access was obtained via the right or left femoral artery; the radial artery was accessed and a 5F sheath was placed to obtain reference images during the procedure.

After sheath placement, subtraction angiography was performed through a pigtail catheter to confirm stenosis and serve as a reference image. All patients had a significant >70% stenosis and a pressure gradient greater than 20mmHg below and above the narrowing of the aortic lumen. Terumo Stiff Wire 0.35 guide wire was then inserted to the femoral artery to reach the constriction area. Angiographic images obtained through a calibrated pigtail catheter allowed the assessment of aorta diameter above and below the construction site, length of stenosis, arterial plaque characteristics and anatomical relation of the stenosis to renal vessels, inferior mesenteric artery /IMA/ and aortic bifurcation. Measurement of the above-mentioned parameters was essential for the determination of the optimal treatment strategy and selection of the correct size and type of stent. On the basis of available literature it was assumed that stent will be implanted in all patients.

Patients who underwent angioplasty were divided into those with patent or obstructed IMA. When the IMA was patent, we attempted to maintain blood flow in this artery during the procedure (at least during the time of angiographic observation).

After having obtained the above-mentioned data, angioplasty was started. Considering higher diameter of aortic stents, a 12F sheath was placed for stent deployment. An appropriate stent was individually selected for each patient and advanced over a guidewire into the aorta. The following types and number of stents or stent grafts were used for 10 procedures performed: Sinus XL/Optimed/ - 2x, Advanta / Maquet/ 3x, Fluency / Bard/ 2x, E-Luminex / Bard/ 1x, Lifestream / Bard/ 1x, BeGraft /Bentley/1x. Stent and stent grafts lengths were 29-80mm (average 47 mm) while diameters ranged from 12 to 22mm (Table 2). The correlation between stent length and gender did not reach the level of statistical significance (MW U-test).

Age	**51-69 (57,4 on average)**
Gender	
Men	5 (45%)
Women	6 (55%)
Vascular-Heart Risk Factors	
MIC	4 (40%)
MIC after Percutaneous Coronary Intervention	1 (10%)
MIC after Coronary Artery Bypass Grafting	1 (10%)
HA	6 (60%)
DM	4 (40%)
Coronary artery spasm	2 (20%)
Peripheral by-pass	2 (20%)
Smoker	9 (90%)
Dyslipidemia	8 (80%)
Rutherford class. 3	10 (100%)

Table 2: Patients' characteristics N (%).

One patient underwent angioplasty of the distal segment of the aorta and common iliac arteries using Express iliac stents (Boston). Another patient received an aortic stent and two Flexive iliac stents (Boston) (Table 3). When application of iliac stents was necessary, 6-7F sheaths were inserted through the other femoral artery using the "kissing-stent" technique. Diameters of the self-expanding aortic stents, ie., Sinus, E-Luminex, and Fluency stent grafts were oversized by 10% compared to the angiographic reference segment over the constriction site. Advanta, Lifestreme and BeGraft balloon-expandable stent grafts were adjusted 1:1 and pressure-modeled to the specific diameter. No aorta pre-dilatation was performed. After implantation of self-expanding stents, post-dilatation was performed using a balloon size of 100% of the reference aortic diameter to avoid rupture or dissection of the aorta. Routine angiographic follow-up was performed after angioplasty to confirm technical success and assess flow velocity and volume in the inferior mesenteric artery (Figures 1-6). The sheaths were removed after procedure. Femoral artery hemostasis was achieved with Proliglide Closure System while manual compression was used to achieve hemostasis at the radial access. No increase in creatinine level was found in patients after endovascular treatment.

Stent type	N
Sinus XL	2
Advanta	3
Fluency	2
E-Luminex	1
Lifestream	1
Express iliac	2
Flexive iliac	2
Bentley	1

Table 3: List of stents used during operations.

Figure 1: Aortic stenosis before angioplasty.

Figure 2: Aortic stenosis after stenting /SinusXL/.

Figure 3: Aortic stenosis before angioplasty. Patent IMA.

Results

Technical success defined as aortic diameter ≥ 80% of the reference aortic diameter, absence of aortic rupture, peripheral aorta embolization or alimentary tract ischemia was achieved in 100% of the patients. Follow-up examinations were carried out every 3 months during outpatient appointments including CDD and intermittent claudication assessment. CT angiograms were ordered in selected patients.

Figure 4: Aortic stenosis after stenting. Patent IMA /SinusXL/.

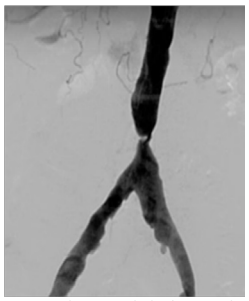

Figure 5: Aortic stenosis before angioplasty.

Figure 6: Aortic stenosis after stenting /BeGraft/.

The study group comprised patients with intermittent claudication; no participants exhibited symptoms or signs of critical ischemia. No patients developed complications during hospital stay or follow-up period. Technical success rate was 100%. Since all procedures were percutaneous, the patients were mobilized on the 1st day after the intervention. There were no deaths, peripheral embolization, extensive hematomas or pseudoaneurysms associated with endovascular treatment. All patients were discharged from hospital after 2-3 days of the intervention. As already mentioned, prior to endovascular interventions, the patients were on antiplatelet therapy, ie., ASA 75mg/once a day. Dual antiplatelet therapy was instituted with 75 mg ASA and 150 mg of clopidogrel on the 1st day after endovascular treatment. Following discharge, pharmacotherapy consisted of 75mg ASA, 75mg

clopidogrel and 40 mg statin daily. Dual antiplatelet therapy was continued for 2-3 months after the endovascular intervention whereas ASA was **r**ecommended as life-long therapy. The first follow-up appointment was scheduled on day 14 after discharge. Claudication distance was measured and CDD was performed. The patients also underwent the ABI test and the ankle-brachial pressure index was calculated (>0.09). Unfortunately, this parameter was not measured in all patients before treatment and so it could not be included in statistical analysis.

The follow-up appointment revealed claudication on a 200 m distance in one patient. He therefore underwent additional angioplasty with stent placement in the left common iliac artery (16 months after aorta stenting) and balloon angioplasty of the left superficial femoral artery (3 and 8 months after aorta stenting). Other patients did not require any further angioplasty procedures. At present, no patients from the treatment group suffer from claudication. Follow-up CDD and CTA were performed in four patients and did not reveal any signs of aortic restenosis. The ankle-brachial pressure index is >0.9. The presented follow-up period is 6-34 months (mean 16.5 months) with 0% mortality.

Discussion

The paper presents the results of endovascular treatment performed in patients with symptomatic abdominal aortic stenosis and short distance claudication (Group B according to TASC II). It has been recommended that these patients should undergoendovascular or surgical treatment (low surgical risk patients).

The technical success was 100%, and long-term follow-up did not reveal restenosis at treatment site. The patients' comorbidities did not differ significantly from those typical of atherosclerotic populations [7,8]. However, it seems reasonable to emphasize young age of our patients. The youngest and oldest patient was 40 and 69 years old, respectively (mean age 57 years). Available literature also stresses the relatively young age of patients with abdominal aortic stenosis. Our findings also confirm the negative effect of multiple risk factor exposure: smokers, dyslipidemic patients and diabetic patients constituted 90%, 80% and 40% of our patient group, respectively.

Aortic stent or stent graft placement should be compared to standard treatment, ie., aortic endarterectomy and Aortobifemoral Bypass (ABF). There are numerous reports concerning surgical treatment which allow an analysis of its efficacy and complications. The cumulative patency rates at 11 years after aortoiliac and aortoiliofemoral interventions were approximately 86% and 91%, respectively [9]. The patency rates of the bifurcated graft were 90% at 5 years and 75-86% at 10 years [10,11]. These are undoubtely very satisfying results, but on the other hand, complication and mortality rates after such extensive surgery are high [12-14]. It should also be remembered that young men after aortoiliac operations may develop sexual dysfunction - a distressing complication and a major factor to decrease the quality of life [15].

Endovascular treatment comprises two techniques, ie., balloon angioplasty versus primary stenting. We chose not to perform aorta pre-dilatation and to use primary stenting technique. Angioplasty equipment was selected based on predetermined anatomy, type of lesion and IMA patency. Among other authors, several decided to perform predilation while others did not [7,8, 16].

In our opinion dilatation might increase the risk of failure by exposure of the aortic wall to additional barotrauma and resulting rupture. It might also cause peripheral embolization. Therefore we performed no predilatation in our patients. Other authors opt for self-expanding stents during this type of angioplasty. After placement, the stents are additionally balloon-expanded. Stents used in our patients are presented in Table 3. Three self-expanding stents and two self-expanding stent grafts were used in 5 angioplasty procedures (50%). In the remaining 5 procedures (50%), balloon-expandable stents and stent grafts were applied. There were a few rationales behind the decision. Firstly, we did not want to perform predilatation. Secondly, in the case of subocclusion (usually severely calcified), a self-expanding device might not open completely. Removal of the deployment system might prove difficult or impossible. Based on our clinical experience, we believe that the application of a balloon-expandable stent or stent graft might be safer. According to our and other authors' opinion, stent/stent graft implantation helps prevent recoil and early restenosis within the treated segment of the aorta. It also seems to reduce the risk of peripheral embolization.

Considering potential occlusion of inferior mesenteric artery ostium resulting from stent placement, assessment of IMA and other visceral vessels patency is an important aspect of endovascular treatment strategy. If the IMA was patent, we used stents to avoid acute inferior mesenteric artery occlusion. Stent grafts were implanted if the IMA was non-patent. No acute occlusion of IMA ostium was observed during angioplasty and no intestinal ischemia was found during the follow-up period. According to literature, ostial IMA occlusion carries the lowest risk, but all efforts should be made to prevent it [8,17-19].

It should be emphasized that some abdominal aortic lesions might affect the segment distal to the IMA; in such case stent or stent graft does not overlap with IMA ostium. In the case of proximal lesions extending to the level of the renal arteries, it is essential that the stent wall does not occlude the ostia of the renal arteries.

The patients also underwent the ABI test and the ankle-brachial pressure index was calculated (>0.09). Unfortunately, this parameter was not measured in all patients before treatment and so it could not be included in statistical analysis.

As mentioned before not all patients underwent the ABI test. The data cannot therefore be included in the analysis which certainly is a limitation in the study design and should be made up for in the future. Another limitation is the small size of the study population although the majority of reports present results obtained in groups of 9 to 40 patients [2-8]. We obtained excellent technical success rate (100%). Follow-up examinations did nt reveal restenosis. There was no need of reintervention and no postoperative complications occurred. All this confirms the efficacy of endovascular treatment.

Last but not least, it seems important to emphasize cost-effectiveness of endovascular treatment. Although a detailed cost analysis was not performed, short hospital stay, quick return to function, lower number of drugs used and good follow-up results are arguments for intraluminal angioplasty.

Summary

The paper summarizes the authors' experience concerning endovascular management of abdominal aortic stenosis - a method

characterized by good safety and efficacy profiles. Randomized trials performed in large patient populations to compare the outcomes of surgical/endovascular treatment, stents/stent grafts, use/nonuse of predilatation would certainly shed more light on this particular treatment option.

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