Percutaneous Transluminal Angioplasty of the Infrarenal Aorta: Initial Outcome and Long Term Clinical and Angiographic Results

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Objective: Report of 1–8 year follow-up of patients treated by percutaneous transluminal angioplasty (PTA) for obstructive atherosclerosis of the infrarenal aorta.

Design: Cohort study.

Materials: Thirty-eight patients aged 26–81 years (mean 50 years) were submitted to undergo percutaneous transluminal angioplasty of the infrarenal aorta. All patients had symptomatic isolated stenotic lesions of the aorta located below the renal arteries and above the bifurcation. Stenoses at bifurcation-level and the iliac arteries were excluded.

Methods: PTA of the aorta was performed under local anaesthesia in the radiological department. Clinical symptoms and ankle/brachial indices were registered before, directly after the procedure and at follow-up. Angiography was performed in all patients pre- and post-procedure, and at follow-up. All patients received angiography in March 1995. Clinical data were analysed based on intention-to-treat.

Results: Initial clinical and angiographic success was achieved in 36 patients (94%). Mean follow-up was 34 months (range 1–92). Recurrent stenosis was seen in seven patients (19%) at follow-up. Only five (13%) of these had recurrent symptoms and were treated successfully with a second PTA. No major complications were seen.

Conclusion: These results show PTA to be a safe, minimally-invasive and effective alternative to surgery in case of symptomatic stenosis of the infrarenal abdominal aorta.

Key Words: Aortic stenosis; Percutaneous transluminal angioplasty; Single balloon angioplasty; Double balloon angioplasty.

Introduction

Isolated atherosclerotic stenosis of the infrarenal abdominal aorta is seen in a relatively small number of patients with atherosclerotic disease. This condition is typically seen in young female patients with a history of heavy smoking. Percutaneous transluminal angioplasty (PTA) has become a routine form of treatment in stenotic peripheral artery disease. And in the 1980s first reports of PTA of stenotic lesions of the aorta were published.3–5 In addition to the well-known advantages of PTA over surgery (minimally invasive, lower cost, shorter hospital stay and lower morbidity and mortality rates) PTA of the aorta also has the advantage of preserving and improving sexual function. Reports of isolated aortic PTA have been scarce with small patient numbers and short follow-up. Most studies did not discriminate between solitary aortic stenosis and aortoiliac disease, making the study groups heterogeneous. However, initial and short-term results invariably have been good with very few complications. In this report we present our experiences of PTA of the infrarenal aorta in 38 patients with stenotic lesions below the renal arteries and above the aortic bifurcation.

Materials and methods

From 1986 to 1995, 38 patients were selected to undergo balloon angioplasty of a symptomatic stenosis of the infrarenal aorta. Selection was performed by a team of vascular surgeons and interventional radiologists.

Included in this study were only patients with an isolated symptomatic stenosis of the aorta located below the renal arteries and at least 1cm above the aortic bifurcation. Exclusion criteria were aortic occlusions and combined aortoiliac lesions, needing additional iliac or femoral intervention. Demographic data and risk factors for atherosclerosis were collected.
Preprocedural assessment included measurements of Doppler ankle-brachial blood pressure index (ABI). Initial diagnostic imaging consisted of arterial or intravenous digital subtraction angiography in two planes. Run-off was scored according to Rutherford.9

**Procedure**

All patients were treated via the femoral route using conventional techniques. Sizes of balloons available ranged from 6 to 20 mm. In patients with stenotic lesions well clear of the aortic bifurcation a single balloon dilatation was performed. If the stenosis was near the aortic bifurcation the kissing-balloon technique was preferred. Following dilatation a control angiography in two planes was obtained.

The procedure was defined as being successful when there was resolution of complaints and a residual radiological stenosis less than 50%. One day prior to PTA patients were started on an antiplatelet regimen, which was continued for a period of at least 6 months (aspirin 100 mg daily).

**Follow-up**

Directly after PTA and at follow-up ankle/brachial indices were measured and angiograms were performed in all cases at 3, 6 and 12 months. After that they were seen on a yearly basis. In March 1995 all treated patients were examined and an angiogram in two planes was obtained. All patients were available for follow-up, which ranged from 1–92 months with a mean of 34 months.

**Results**

The patient group consisted of 29 females and nine males, mean age was 50 years (26–81 years). Risk factors for atherosclerosis included: history of smoking 38 patients (100%); diabetes 2 patients (5%); hypercholesterolaemia 10 patients (26%); hypertension 9 patients (23%). Associated symptomatic coronary heart disease was present in 9 (23%) patients. Indications for PTA procedure were (SVS/ISCVS-NA criteria) rest-pain and bluish discoloration of the toes (“blue-toe syndrome”) in four cases. All other patients (34) had claudication, mostly of thigh and buttocks. Three men complained of sexual impotence.

Initially, 38 PTA procedures were attempted. In 36 patients PTA was successful. Using the Seldinger technique of introduction, the stenosis was dilated with the single balloon technique (Fig. 1) in 17 cases and using the kissing balloon technique in 19 cases (Fig. 2). In two patients the PTA could not be performed due to technical problems. In one case it was difficult to transverse the stenosis with the guidewire. In the other case, recoil of the aorta after PTA was such that no dilatation was noted after several attempts. No large calibre stents were available at that time. In both cases aorta bifurcation bypass grafts were successfully placed.

In two patients PTA of the aorta was complicated by iliac dissection, which was treated by local iliac PTA in one case and local PTA with concomitant stent placement in the other case. No cases of PTA induced emboli were noted in this group and no clinical important bleeding at the femoral puncture site occurred.

Directly after PTA 90% of patients had an increase of ankle/brachial index more than 0.15. This percentage remained unchanged at follow-up. In seven patients there was angiographic restenosis greater than 50% at follow-up. However only five patients were symptomatic. All five patients were treated successfully by a second PTA of the distal aorta at respectively 12, 15, 20, 63 and 79 months. Three of the four patients with previously blue-toe syndrome remained asymptomatic. The fourth presented with recurrent symptoms of mild claudication but no discoloration of the foot or pain at rest. He underwent a second PTA of the infrarenal aorta.

The three men who complained of impotence before PTA all reported significant improvement in erectile function after angioplasty. This phenomena however was not an objective in this study. One patient who previously had no sexual dysfunction complained of progressive impotence after PTA. Angiography at follow-up showed normally patent internal and external iliac arteries. Endocrinological causes for his sexual impotence were excluded.

The average hospital stay was 2.5 days, including the admission time of the two patients who underwent surgery. Nowadays patients are treated the day of admission, stay supine for 12 h and are discharged after 24 h.

**Discussion**

Stenoses of the lower abdominal aorta were traditionally treated surgically. Endarterectomy was performed.
for focal stenosis and more extensive disease was treated by surgical bypass.\textsuperscript{1,2} Both of these treatments are associated with good long-term results in a high proportion of patients. However, these surgical modalities are highly invasive and carry a significant risk of morbidity and mortality. Since the introduction of percutaneous transluminal angioplasty (PTA) by Dotter and Judkins\textsuperscript{10} in 1964, balloon angioplasty of

![Fig. 1. (a) Focal stenosis of the infrarenal aorta located well above the aortic bifurcation. (b) Balloon dilatation via the femoral route using a single large caliber balloon. (c) Control angiography shows clear reduction of the stenosis, however there is some residual stenosis.](image-url)
Stenoses and occlusions in peripheral arteriosclerotic disease has become a well-accepted form of treatment in small and medium sized arteries. Initially, application of this technique for aortic stenoses was restricted by the lack of larger size balloons. With the introduction of the kissing balloon technique, stenoses in a large calibre vessel could also be treated. Recently, larger size balloons have become available which require only single access and exert evenly divided pressure when inflated.

Cases of aortic dilatation were first reported in 1980 by Grollmann et al., 3 Tegtmeyer et al. 4 and Velasques et al. 5 They reported good initial and short-term results with few complications. Later studies confirmed this. 21-24 However, PTA of solitary lesions of the infrarenal aorta has been reported only sporadically and only for small groups of patients. Most studies compromise of mixed groups of patients with both solitary infrarenal aortic stenoses as well as aortoiliac stenoses.

Aortic angioplasty achieves comparable or even better results than iliac angioplasty, with reported initial success rates varying from 95 to 100% and 5 year symptom-free success rates varying from 70 to 89%. 6-8,11 This may be as a result of the larger calibre of the aorta and to analyse the results of PTA of purely aortic stenoses we decided to study our results of PTA procedures of infrarenal aortic stenoses in which there was a good iliac outflow it was proposed that strict selection of patients with only lesions in the distal aorta would yield even better patency rates than patients with concomitant iliac disease, while giving more specific information on the value of balloon dilatation of the aorta. In our 38 patients there was a 94% initial success rate if patients were evaluated on an intention to treat basis. We did not encounter major procedural complications; two iliac artery dissections occurred, which could be overcome by local endovascular treatment as mentioned above. However, iatrogenic rupture of the aorta during PTA has been described. 12 The law of Laplace states that for a given pressure, wall tension is proportional to vessel diameter. Consequently larger vessels may be dilated by lower pressures. This also means that the wall of a

![Fig. 2. Kissing balloon technique necessitating bilateral femoral access: (a) Dilatation near the aortic bifurcation with positioning of the distal parts of the balloons in the common iliac arteries to prevent contralateral plaque dislodgement. (b) Infrarenal dilatation above the aortic bifurcation using the kissing balloon technique.](image)
large calibre vessel is prone to rupture at a lower pressure. Pain, usually located in the back, is a sign of overstretching of the arterial wall and excessive pressure. If experienced further dilatation should be omitted. We did not see this phenomena in our treatment group.

As in most other studies the majority of our patients were female (75%) and heavy smokers. All our patients had smoked while 80% still smoked at the time of first PTA. Delaurentis et al. described an associated small calibre of aorta in combination with a high localisation of the aortic bifurcation as well as an entity of hypoplastic aortas with high bifurcations in young females. Sproul and Pinto feel that there is a definite association between aortic stenosis and women smokers and suggested that abdominal aortic stenosis appearing in the fourth decade or later indicates acquired atherosclerosis secondary to smoking superimposed upon a congenitally hypoplastic aortic segment. Associated smoking supposedly makes this anatomical variant prone to infrarenal arteriosclerosis. Only one of our female patients seemed to have a hypoplastic aortoiliac segment.

Initial or late failure of PTA of the infrarenal aorta does not preclude further treatment either by repeat PTA or by surgery. In our series all five patients who presented with recurrent symptoms could successfully be treated by a second PTA. No surgery was needed to treat recurrent disease. In general the recurrence rate after PTA is reported to be around 30%. The significantly lower re-stenosis rate in our study is probably related to strict inclusion criteria which created a homogenous group of patients with only large calibre vessel pathology with good run-off. This reflects the expectation of prolonged success when PTA is applied to larger arteries.

No randomised studies have been reported in which the kissing balloon technique has been compared with the single balloon technique. The former technique creates a more ovoid profile after dilatation in comparison to the circular shape created by inflation of one single balloon. We performed comparable numbers of both procedures and did not see differences in initial and longer term success. Advantage of the single balloon technique is the single access needed. We however still choose the kissing balloon technique in aortic stenoses due to lesions near the bifurcation to iliac plaque dislodgement or intimal dissection.

We saw an increase in ABI greater than 0.15 in 90% of patients after PTA in our series. Whilst this percentage remained unchanged at follow-up some patients who did not show an increase in ABI directly after PTA later rose to normal values, while all five symptomatic patients with recurrent stenosis decreased in ABI while becoming symptomatic again. The two patients with radiological recurrence without clinical signs did not change in ABI. It was not possible in every case to relate the ABI to the anatomical substrate at the time of measurement. This could well be a result of progressive distal arteriosclerosis.

Our long term results compare well, clinically and angiographically, with previously reported series. Five patients developed symptomatic restenoses with an interval varying from 12 to 79 months. Although the application of aortic stenting has been described by several authors in primary procedures, it is questionable whether this will lower the incidence of restenosis. Aortic stenting has only been introduced recently and no long term data are yet available. The long term patency rate of PTA of the aorta without stents seems to be that good, that we feel that the use of stents should be reserved for selected cases only, such as stenotic lesions with severe initial recoil or PTA induced dissection.

In conclusion, PTA is an effective, safe and minimally invasive treatment in case of stenoses of the infrarenal aorta. Initial and long term results are good with minimal procedure related morbidity when compared to surgery. Classic surgery, either endarterectomy or bypass surgery has an almost 100% success-rate. PTA was initially successful in 94% and improved symptoms in 100% of our series. At a mean follow-up of 34 months, seven patients developed recurrent radiological disease, five of whom were symptomatic. Recurrent disease was effectively treated in all cases by a second PTA. Initial technical failure was seen in two cases only, while minor complications were encountered in another two patients. In case of failure surgery remains an option and is not complicated by earlier attempted PTA.

There were no deaths in our study group. Being minimally invasive, hospital admission is significantly shorter than in aortic surgery. We consider PTA to be the procedure of first choice in case of focal aortic stenosis.

References

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