

Percutaneous Transluminal Angioplasty: Newer Applications

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Recent experience suggests that there is a wider spectrum of applications for percutaneous transluminal angioplasty than just dilating lesions of the iliofemoral, popliteal, renal and coronary arteries. Atherosclerotic and nonatherosclerotic lesions of other blood vessels as well as postoperative stenoses may be treated. Five patients from Massachusetts General Hospital are described in whom transluminal angioplasty was successful in relieving atherosclerotic stenoses of the axillary, subclavian, and superior mesenteric arteries; a stenotic, splenorenal shunt anastomosis; and an anastomotic stenosis in a renal dialysis angioaccess shunt. The experience of other investigators in dealing with these less common applications of transluminal angioplasty is summarized.

Percutaneous transluminal angioplasty (PTA) with the Grüntzig balloon dilatation catheter has become an increasingly popular technique for treating atherosclerotic stenoses and occlusions of the iliofemoral arteries [1, 2]. This technique has also been successful in selected series of patients with stenotic lesions of the renal [3] and coronary [4] arteries.

Our own experience and recent reports from other hospitals suggest a wide spectrum of applications for percutaneous transluminal angioplasty. To date, stenoses of the abdominal aorta and brachial, axillary, carotid, subclavian, celiac, superior mesenteric, and hypogastric arteries have been successfully treated [5-8] (Katzen B, Schwarten D, Ring E, personal communications). In addition to atherosclerotic lesions, PTA has been successfully applied to stenoses caused by fibromuscular disease and Takayasu arteritis [9]. Angioplasty has been used to dilate vein graft stenoses [10], stenotic angioaccess dialysis fistulae and shunts [9], postoperative arterial anastomoses in renal transplant patients [11], stenotic or occluded portosystemic venous shunts [12], and stenotic Blalock-Taussig (subclavian-pulmonary artery) anastomoses in patients with tetralogy of Fallot (Casarella WJ, personal communication).

We are just now beginning to realize the enormous potential for transluminal angioplasty in treating stenotic and occlusive lesions throughout the vascular system. Some of our experience in dealing with less common applications of PTA is illustrated by the following cases.

Case Reports

Case 1: Atherosclerotic Brachial Artery Stenosis

A 62-year-old woman had progressive right arm claudication that began 3 years earlier. She also noted numbness and a heavy feeling in the same arm. On physical examination,

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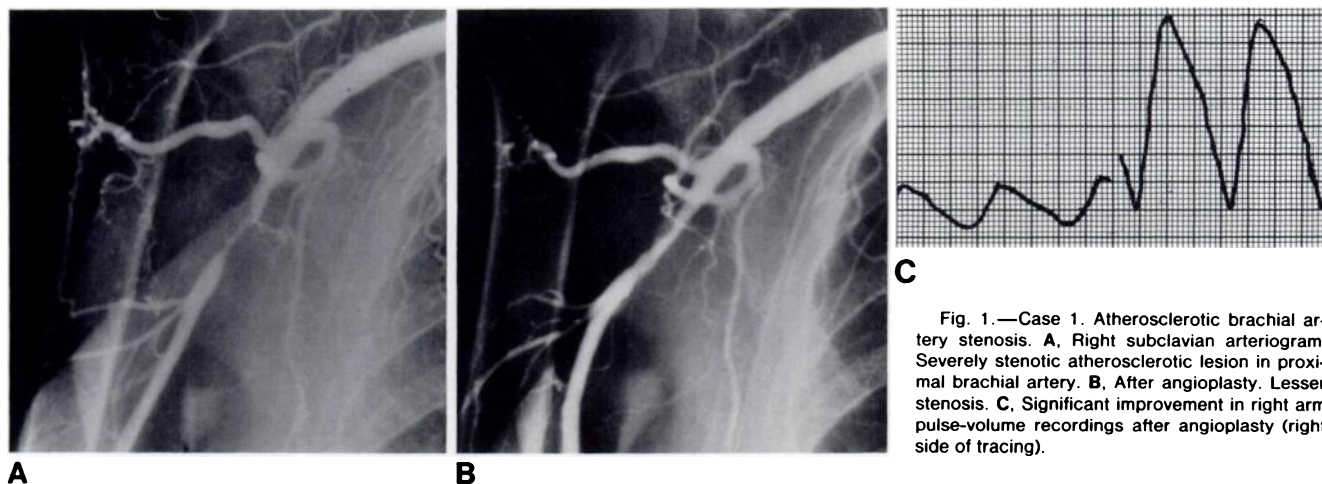


Fig. 1.—Case 1. Atherosclerotic brachial artery stenosis. A, Right subclavian arteriogram. Severely stenotic atherosclerotic lesion in proximal brachial artery. B, After angioplasty. Lesser stenosis. C, Significant improvement in right arm pulse-volume recordings after angioplasty (right side of tracing).

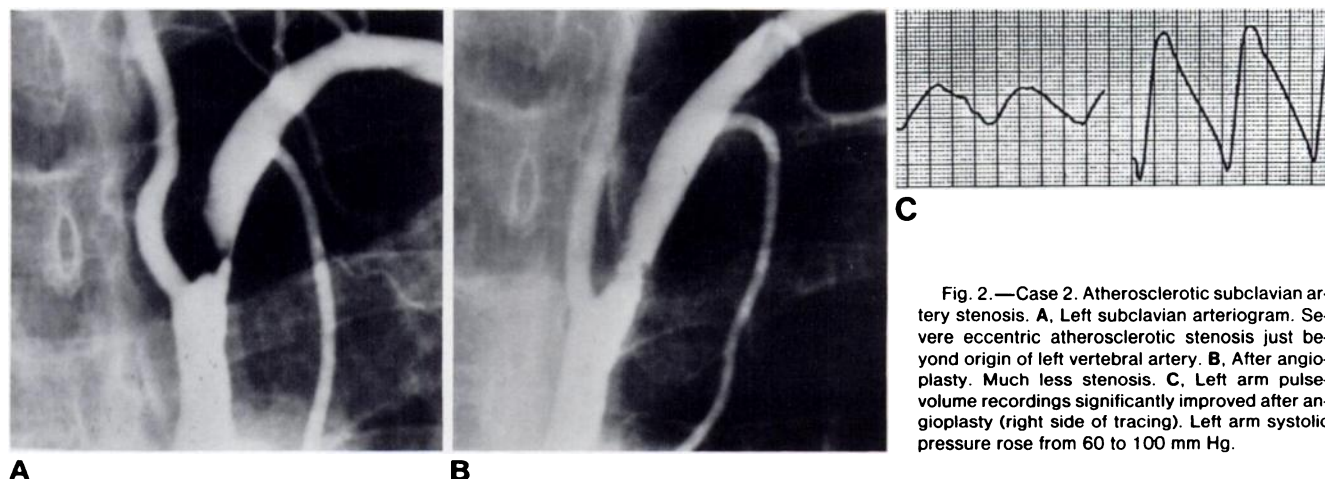


Fig. 2.—Case 2. Atherosclerotic subclavian artery stenosis. A, Left subclavian arteriogram. Severe eccentric atherosclerotic stenosis just beyond origin of left vertebral artery. B, After angioplasty. Much less stenosis. C, Left arm pulse-volume recordings significantly improved after angioplasty (right side of tracing). Left arm systolic pressure rose from 60 to 100 mm Hg.

the right hand was cooler than the left, and the right brachial and wrist pulses were barely palpable. The right arm blood pressure was lower than the left and the right arm pulse volume recordings were also diminished. She had been a heavy cigarette smoker and had a long history of hypertension.

A right subclavian arteriogram (fig. 1A) showed a tight stenosis in the proximal brachial artery just distal to the origin of the circumflex humeral branches. The appearance was consistent with an atherosclerotic lesion. A straight guide wire was advanced across the stenosis, and the selective angiography catheter was exchanged for a 7 French dilatation catheter with a 4-mm-diam balloon. The dilatation catheter was easily advanced over the guide wire and through the stenotic segment. After several balloon inflations, the stenosis was successfully dilated (fig. 1B). After angioplasty, there was a significant improvement in the right arm pulse volume recordings (fig. 1C), and the right arm blood pressure became equal to the left. The patient was clinically improved and continued free of claudication during 4 months of follow-up.

Case 2: Atherosclerotic Subclavian Artery Stenosis

A 65-year-old woman had ischemic skin lesions on the tip of the left index finger. She had been suffering from left arm claudication

for several months. On physical examination, the left arm pulses were absent and the left arm blood pressure was diminished. The initial angiographic examination was a thoracic arch aortogram that showed a tight atherosclerotic stenosis of the left subclavian artery just distal to the origin of the vertebral artery. It was best delineated on a left subclavian arteriogram (fig. 2A). The stenosis was negotiated with a straight guide wire, and a 7 French balloon dilatation catheter was advanced over the guide wire and through the stenosis. The stenotic segment was dilated with several inflations of the 4 mm balloon (fig. 2B).

After angioplasty, the left arm systolic pressure rose from 60 to 100 mm Hg, and the pulse volume recordings were significantly improved (fig. 2C). There were no complications related to the vertebral artery. The patient was clinically improved after angioplasty and her skin lesions healed.

Case 3: Atherosclerotic Superior Mesenteric Artery Stenosis

A 44-year-old woman had an extensive workup for poorly defined abdominal pain related to meals. Barium examinations, endoscopy, and sonography failed to find any cause for her symptoms. She was referred to angiography for evaluation of possible abdominal angina.



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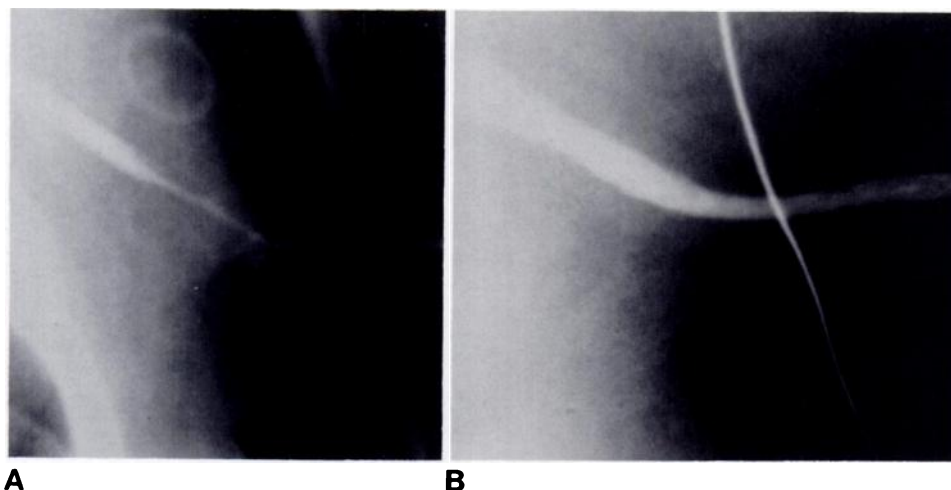


Fig. 5.—Case 5. Stenotic angioaccess dialysis shunt. **A**, Angiogram. Long stenosis at anastomosis between prosthetic subcutaneous shunt and left axillary vein. **B**, After angioplasty. Improvement in anastomotic stenosis.

returned to its original configuration. It was apparent that angioplasty could not reduce the external fibrous ligament compression on the superior aspect of the celiac artery.

After superior mesenteric artery angioplasty, the stenosis was eliminated and there was a marked improvement in the superior mesenteric artery pressure tracings recorded distal to the stenosis (fig. 3C). Although tracings and pressures were dampened by the recording catheter across the stenosis, the superior mesenteric artery systolic pressure rose from 50 to 115 mm Hg. Clinically the patient was improved by angioplasty and had no further abdominal pain during 6 months of follow-up.

Case 4: Stenotic Splenorenal Shunt Anastomosis

A 39-year-old woman had a 13-year history of ulcerative colitis. In recent years she had developed macronodular cirrhosis with portal hypertension from chronic active hepatitis. After suffering a series of upper gastrointestinal hemorrhages from gastroesophageal varices, she underwent a proximal splenorenal shunt with splenectomy and proximal splenic vein end-to-side anastomosis with the left renal vein.

Initially she did well but was readmitted 3 years later with massive upper gastrointestinal bleeding. Endoscopy showed bleeding from recurrent gastroesophageal varices. Clinical diagnosis was occlusion of the splenorenal shunt, and she was referred to angiography for evaluation.

A superior mesenteric arteriogram showed that the shunt was open but the anastomosis was stenotic (fig. 4A). Patency was confirmed by placement of a second catheter from a femoral vein approach, across the stenosis, with its tip in the splenic vein. With injection of contrast medium into the splenic vein (figs. 4B and 4C), the stenotic anastomosis was shown in better detail. The stenosis was successfully dilated from the femoral vein approach with a balloon dilatation catheter carrying an 8-mm-diam balloon. Postangioplasty angiography (figs. 4D and 4E) showed a marked improvement. The anastomosis was widened and portosystemic flow was favorably altered. Before angioplasty contrast medium could be identified flowing hepatofugally down the inferior mesenteric vein. After angioplasty, nearly all the contrast material flowed across the splenorenal anastomosis, into the renal vein, and up the inferior vena cava.

Portal pressure, as recorded in the splenic vein across the anastomosis, dropped from 24 cm H₂O preangioplasty to 5 cm H₂O

after angioplasty. Almost immediately, the variceal bleeding stopped and did not recur. Unfortunately, the patient later suffered a severe exacerbation of ulcerative colitis with massive lower gastrointestinal hemorrhage. An emergency subtotal colectomy was performed, and she developed fatal disseminated intravascular coagulation. At postmortem examination, the splenorenal shunt anastomosis was intact and patent. The cause of the stenosis was thought to be external compression from fibrous tissue that was identified around the anastomosis.

Case 5: Stenotic Angioaccess Dialysis Shunt

A 32-year-old woman had a long history of lupus nephritis, chronic renal failure, and multiple failed angioaccess dialysis fistulae and shunts. Her most recent angioaccess procedure was placement of a subcutaneous prosthetic shunt between the left brachial artery and the left axillary vein. The shunt initially worked well but after several months dialysis became difficult. Very high dialysis pressures were required, suggesting that a venous outflow problem existed. This was confirmed by angiography (fig. 5A), which showed a long stenosis at the anastomosis between the prosthetic shunt and left axillary vein.

The axillary vein was selectively catheterized from a femoral vein approach. The venous catheter was advanced up the inferior vena cava and the superior vena cava, and out the left innominate and subclavian veins to the left axillary vein. The anastomosis was initially dilated with a straight Teflon catheter and later with a balloon dilatation catheter (5-mm-diam balloon). After angioplasty, the anastomotic stenosis was reduced (fig. 5B) and the patient was able to undergo uncomplicated dialysis. The stenosis did not recur during 6 months of follow-up.

Discussion

Other authors have also been successful in the use of angioplasty in other vessels. Grollman et al. [5] reported a case of a 56-year-old woman with a severe angina pectoris and bilateral hip and lower extremity claudication. Aortography showed a 75% localized stenosis in the midabdominal aorta that was dilated with a 9-mm-diam balloon catheter. After angioplasty, the aortic stenosis was increased from 4

to 7 mm in diameter and the patient was free of claudication after 18 months of follow-up.

Valasquez et al. [6] reported a 55-year-old patient with Leriche syndrome whose abdominal aortic stenosis was dilated with a pair of balloon dilatation catheters. The 9-mm-diam balloons were inflated simultaneously and kept inflated for 2–3 min. After angioplasty, the aortic stenosis was reduced, a 60 mm aortic systolic gradient was eliminated, and the patient discharged free of claudication.

Hasso et al. [7] reported two patients with fibromuscular stenoses of the internal carotid artery that were successfully dilated with balloon dilatation catheters. Mullen et al. [8] reported a case of a 35-year-old woman with a weblike stenosis in the proximal right internal carotid artery that produced a pulsating noise in the right ear and thrill in the right side of her neck after therapeutic occlusion of the left internal carotid artery for a giant aneurysm of the left cavernous sinus. The stenosis was successfully dilated with balloon catheter angioplasty and the patient's symptoms entirely disappeared. No complications were reported by either Hasso et al. [7] or Mullen et al. [8].

Alpert et al. [10] reported a series of 12 high-grade stenoses occurring in autogenous vein bypass grafts. Angioplasty was successful in treating 11 of these, and reoperation was avoided in all but one patient.

Martin et al. [9] reported a series of 14 patients treated with transluminal angioplasty whose stenoses or occlusions resulted from causes other than atherosclerosis. Included were successful angioplasties of fibromuscular stenoses and Takayasu arteritis, and patients with vein graft stenoses and stenotic angioaccess dialysis fistulae. In 11 of 14 patients, angioplasty was successful and there were no complications. Sniderman et al. [11] reported seven hypertensive patients who were treated with transluminal angioplasty for relief of arterial stenoses complicating renal allotransplantation. Six of seven patients underwent successful angioplasty with sufficient reduction in mean blood pressure to either decrease or eliminate the need for antihypertensive drugs.

Cope [12] reported the use of PTA for dilating occluded mesocaval shunts in patients with portal hypertension. In four of five patients, he was able to open a thrombosed or stenotic shunt and gradually dilate the tract up to 9 mm in diameter. In three of four patients whose portal pressures fell to near-normal values, there was no recurrent variceal bleeding after 1 year of follow-up.

In addition to our cases reported above, successful angioplasty of other vessels has been performed in other patients from our hospital, including two superior mesenteric artery stenoses, three stenotic angioaccess dialysis fistulae or shunts, one other axillary artery stenosis, and one other subclavian artery stenosis. Abdominal aortic angioplasty was performed in an elderly man with a stenotic proximal anastomosis of an aortobifemoral bypass graft. The pressure gradient was reduced and the patient was improved clinically.

Because of the grave consequences that might result from distal embolization into the cerebral circulation, patients with lesions of the brachiocephalic arteries should be

carefully selected for transluminal angioplasty. In our two patients with left subclavian artery stenoses, one stenosis was distal to the origin of the left vertebral artery and the other had a separate origin at the left vertebral artery from the aorta, and consequently there was no route for distal embolization. The three reported cases of internal carotid artery stenosis treated with percutaneous angioplasty were performed in patients with nonatherosclerotic disease, and thus the likelihood of distal embolization was low.

Patients with true abdominal angina usually have stenoses of either the celiac artery or inferior mesenteric artery in addition to a superior mesenteric artery stenosis. In case 3, abdominal angina resulted from a combination of an atherosclerotic superior mesenteric artery stenosis and an arcuate ligament compression of the celiac artery origin. Although the arcuate ligament compression could not be relieved, the superior mesenteric artery lesion was successfully dilated and the angina eliminated.

Atherosclerotic stenoses of the subclavian, axillary, and visceral arteries require major surgical procedures for correction that are associated with high cost, increased length of hospitalization, and the expensive facilities. The surgical risk is higher for elderly and sick patients. When these lesions can be corrected with percutaneous angioplasty, there are obvious benefits for patients and medical facilities. Postoperative anastomotic stenoses, whether arterial, venous or associated with prosthetic graft materials, are easier to treat with percutaneous angioplasty than with reoperation at a site of previous surgical intervention.

Percutaneous angioplasty with balloon dilatation catheters is new and investigators are just beginning to realize the widespread applications for this technique. We will know its limitations for specific arterial and venous lesions and postoperative conditions when large clinical series are reported. Experience so far suggests a high degree of success and low complication rate when careful selection of patients is made and the angioplasty is performed by experienced individuals.

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