

Renal Branch Artery Occlusion in a 13-Year-Old Hypertensive Girl: Initial Treatment and Treatment of Recurrent Stenosis by Balloon Angioplasty

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Abstract

A 13-year-old girl who recently developed hypertension was diagnosed to have an occluded right renal branch artery and was treated successfully with percutaneous transluminal angioplasty (PTA). To our knowledge, PTA has not been reported as a treatment for totally occluded renal branch arteries, and there is no data available regarding the success rate and possible complications.

Key words: Percutaneous transluminal angioplasty—Renal branch artery—Occlusion—Segmental artery—Embolization—Stent

Hypertension affects 1–3% of all children; 3–10% of those children have hypertension due to renal artery stenosis [1–3]. While renal artery stenosis usually affects the main renal artery or its ostium, isolated stenosis or occlusion of a segmental or renal branch artery, usually presumed to be due to fibromuscular dysplasia (FMD), can be a source of hypertension. Percutaneous transluminal angioplasty (PTA) is a well-established, safe procedure for correcting hypertension resulting from stenoses of the main renal artery or one of its main branches (segmental renal artery or renal branch artery) [4], but is not feasible in patients with obstruction of very small peripheral branches. Embolization of the stenotic vessel and/or collateral circulation is often effective in obliterating the source of renin and correcting the hypertension, and the volume of renal parenchyma destroyed by this technique is usually small. However, in the presence of occlusion of a major branch supplying a large volume of kidney, it would be preferable to re-establish arterial patency. This is especially true in children, in whom fibromuscular dysplasia is often multifocal and bilateral. There is no data in the literature regarding the efficacy of PTA to recanalize totally occluded renal branch arteries. We present a case of a single renal branch artery occlusion, in which PTA was used as a primary treatment modality. The patient required a second PTA procedure due to restenosis, but had an excellent long-term response after the second procedure.

Case Report

A previously healthy 13-year-old girl was referred to our hospital for management of recently diagnosed, poorly controlled hypertension. Her weight was 36.5 kg (5th percentile), her height 154 cm (25th percentile). She had a 1-month history of occasional headaches and vomiting, and a possible episode of hypertensive encephalopathy with severe headache and vomiting. She was subsequently found unconscious in the bathroom. Her complaints persisted despite antihypertensive medication (labetolol 50 mg tid and nifedipine 15 mg

qid). Renal angiography performed at another institution showed occlusion of an upper-pole branch of the right renal artery, with a large collateral from the lower branch supplying the ischemic kidney. Therapeutic options considered by the referring physicians initially included embolization of the collateral branch, and partial nephrectomy. She was, however, referred to our hospital to explore the possibility of balloon dilatation of the occluded renal branch artery. Although the patient's blood pressure during her pre-procedure assessment was mildly elevated (120–130/80–90 mmHg), her previous random pressure readings were noted to be as high as 150/110 mmHg.

Renal angiography and renal vein sampling were carried out under general anesthesia. The left femoral artery and femoral vein were both cannulated percutaneously with 5 Fr arterial and 4 Fr venous introducer sheaths. Blood samples were obtained from the inferior vena cava, above and below the renal veins, from the left renal vein, and from several sites within the right renal venous system for renin assay. Plasma renin activity was found to be elevated in all of the collected blood samples (according to the pediatric reference range), although the activity in the right renal vein was almost twice that in the left renal vein (24 ng/ml/hr versus 13.5 ng/ml/hr). Abdominal aortography showed two renal arteries on the right. Selective renal arteriograms demonstrated an occlusion, approximately 1.5 cm in length, of the origin of the right upper renal arterial branch, which was shown on oblique projections to supply the upper and anterior one third of the right kidney (Fig. 1A, B). The distal portion of this vascular territory was opacified through tortuous collaterals from the posterior branch, as well as from the right lower renal artery branch and adjacent intercostal arteries. The right lower renal artery and its distal branches appeared normal, except for opacification of some small collaterals to the obstructed renal territory. Fibromuscular dysplasia (FMD) was considered foremost in the differential diagnosis based on the fact that FMD is the most common cause of branch artery stenosis or occlusion in children [4, 7]. The left renal arteriogram was essentially normal, aside from a slight kinking of the extrarenal portion of the main renal artery without any evidence of stenosis. After discussing the therapeutic options, it was felt that PTA should be attempted. The patient was systemically heparinized (100 units/kg i.v. bolus). Using a 0.035-inch hydrophilic guidewire (Boston Scientific, Natick, MA, USA), a 4 Fr catheter was advanced across the occluded right renal branch artery without difficulty. The main renal artery measured approximately 5 mm in diameter and the caliber of the occluded branch artery was expected to be 3 mm. The catheter was then exchanged over a 0.016-inch guidewire (Taper Stubbie Mandril wire, Boston Scientific) for a 3.8 Fr balloon angioplasty catheter (Boston Scientific) with a 3-mm × 2-cm balloon. The balloon was fully inflated to 10 atm across the area of the occlusion. Then, due to mild residual stenosis noted on the subsequent selective arteriogram, a balloon catheter with a 3.5-mm × 2-cm balloon was positioned across the stenosis and fully inflated to 10 atm. No significant residual stenosis was noted on repeat selective arteriography, and pressure recording made during catheter pull-back demonstrated no gradient following PTA. The patient was kept anticoagulated with heparin for 24 hr (20 U/kg/hr). Post-procedural blood pressure readings were 150/90 mmHg in the Post-Anesthesia Recovery Unit (PACU). The following day the patient's blood pressure decreased to 110–120/70–80 mmHg and she was discharged on continued anticoagulation (coumadin 2.5 mg/day, aspirin 81 mg/day) and antihypertensive medication (labetolol 100 mg/day).

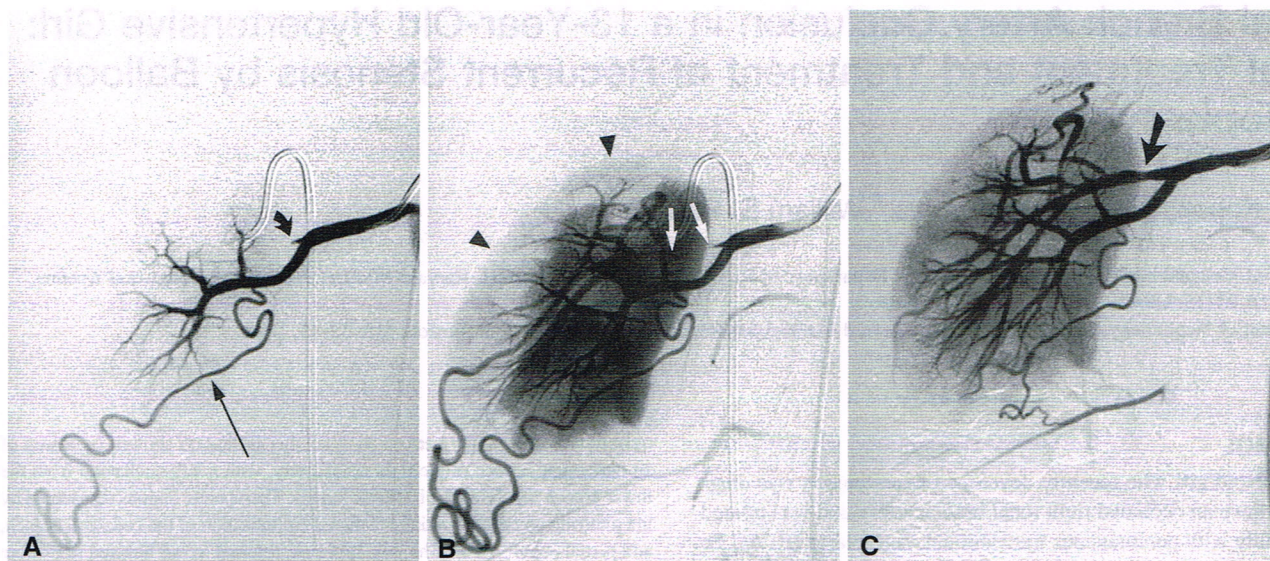


Fig. 1. Initial renal arteriogram and angioplasty. **A** Early arterial phase of selective right renal arteriogram shows occlusion of the posterior superior branch renal artery (curved arrow). Note the large collateral artery (long arrow). **B** Late arterial phase shows decreased perfusion of the supply territory of the occluded branch via the collateral artery (arrowheads). The proximal and distal ends of the occluded branch are seen (arrows). The lower pole of the right kidney is supplied by a second renal artery. **C** Post-PTA selective arteriogram demonstrates reopening of the occluded branch (less than 20% residual stenosis) (arrow).

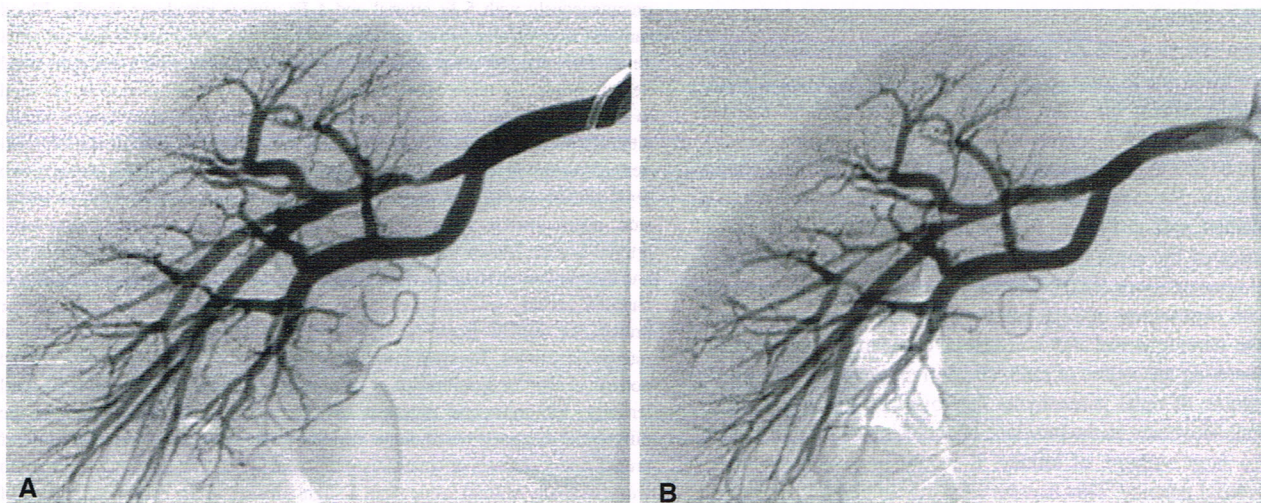


Fig. 2. Recurrent stenosis and PTA approximately 2.5 months after the first intervention. **A** There is significant stenosis seen at the location of the previously dilated occlusion (60–70%). **B** Essentially normal caliber postero-superior branch following high-pressure balloon angioplasty.

During the following months the patient's blood pressure gradually rose again despite increased antihypertensive medication (labetelol and nifedipine), and she was referred to our department for a second time, approximately 2.5 months after the initial intervention. The patient's blood pressure at that time was 130/85 mmHg. Following induction of general anesthesia, 5 Fr arterial and 4 Fr venous introducer sheaths were placed in the right common femoral artery and vein. Blood samples for renin assay were again obtained from the inferior vena cava, above and below the renal veins, as well as from both renal veins, and revealed normal plasma renin activity in all of the collected samples (right renal vein 4.4 ng/ml/hr and left renal vein 2.5 ng/ml/hr). Angiography showed significant restenosis at the site which was previously balloon-dilated. The branches to the upper pole, which previously received the collaterals and appeared somewhat tortuous on the prior angiogram, appeared normal at this time. Using a technique similar to the one described above, including i.v. heparin (100 U/kg bolus) a 5 Fr dilatation catheter with a 3.0-mm \times 1.5-cm high-pressure balloon (Diamond; Boston Scientific) was advanced across the

stenosis. The balloon was inflated twice to 20 atm for approximately 3 min each time. No residual stenosis on the post-procedure angiogram or significant pressure gradient across the lesion was noted following PTA. The patient was again anticoagulated with i.v. heparin (20 units/kg/hr overnight) and aspirin after the procedure. Her blood pressure readings following PTA were within normal range. She was discharged the following day with prescribed anticoagulation and antihypertensive medication, and was scheduled for a routine follow-up. The patient's blood pressure responded well to PTA. Antihypertensive medication was gradually eliminated. Presently, 3 years later, the patient is normotensive without medication.

Discussion

Renovascular etiology is found in approximately 3–10% of hypertensive children, whereas this is the case in only 1–5% of the entire hypertensive population [1–3, 5]. Most cases of pediatric renovas-

cular hypertension are diagnosed during routine check-ups or during the diagnostic workup following hypertensive encephalopathy [1, 6]. Fibromuscular dysplasia (FMD) is considered to be the most common cause of renal arterial stenoses in children, whereas atherosclerosis is the leading cause in the adult population. Although most obstructions involve the main renal arteries, segmental renal artery or renal branch artery stenosis or occlusion may be encountered, either as an isolated abnormality or associated with the main renal arterial stenosis. FMD appears to be the most common cause of these intrarenal arterial obstructions, particularly in children. Segmental renal arteries are affected in 30–56% of patients with FMD [4, 7]. Other causes of renal artery stenosis in children include neurofibromatosis, Takayasu arteritis, Williams syndrome, Ehler-Danlos syndrome, congenital aneurysms, extrinsic compression due to a tumor or a hematoma, Kawasaki syndrome, polyarteritis nodosa, radiotherapy, and nonspecific aortoarteritis [6, 8].

Arteriography remains the gold standard for the diagnosis of renovascular hypertension. Since its introduction in 1978, PTA has evolved into a successful method for correcting main renal artery stenoses [9, 10]. PTA has also become the treatment of choice for correcting isolated segmental renal artery or renal branch artery stenoses [4, 11]. Nephrectomy or partial nephrectomy for intrarenal arterial stenoses or occlusions is no longer a primary treatment option. Previously, surgical ligation of stenotic segmental renal arteries or renal branch arteries was sometimes attempted to treat renovascular hypertension [12]. Cluzel et al. [4] reported an 84% success rate of PTA for correcting renal branch artery stenoses in 20 patients with a mean age of 30.5 years. Their patients included two cases of complete or near-complete branch artery occlusion, but attempts to cross the lesions were not successful and the branches were embolized. Currently there are no data regarding the success rates or complications of PTA for correcting renal branch or segmental arteries in children. Preservation of renal tissue in these patients, particularly in children, is crucial because of the high prevalence of bilateral disease and the frequent progression of fibromuscular disease. Therefore, treatment of segmental renal artery or renal branch artery stenoses with PTA is preferable for preserving maximal renal tissue. When a stenosis or occlusion is noted involving the main renal artery or one of the branching arteries, PTA should be performed to correct potential future complications, particularly in children, even though the patient's blood pressure may be well controlled on antihypertensive medication.

When segmental renal artery stenosis that cannot be dilated or an occlusion of the renal branch artery with collateral formation is encountered, embolization of either the collateral vessels feeding the ischemic renal parenchyma or the stenotic artery is preferred over surgical intervention [13–16]. Attempted recanalization of the obstructed branch was considered appropriate in our patient because retrograde opacification of the distal portion of the occluded artery showed that the occlusion was relatively short. The small opacified stump at the origin of the occluded artery was useful in identifying the point of occlusion and is probably a prerequisite for attempting to cross an occlusion.

There are no data available for the use of metal stents in renal branch artery stenoses, although they are commonly used following PTA of main renal artery stenoses. Renal vascular stents are generally used to prevent elastic recoil of the lesion and to cover and tack down intimal flaps. A stent was not used in our patient because of the small caliber of the stenotic vessel and the young age of the patient, but it would have been considered if the stenosis had recurred.

Patients with renovascular hypertension are expected to show increased renin activity from the ischemic kidney and decreased activity from the normal kidney. Although some centers still rely on renal vein assays to establish the diagnosis of renovascular hypertension, most centers do samplings of the renal veins and IVC as complimentary studies to the renal arteriography and perform PTA based on the severity of angiographic stenosis. There are several factors (e.g., drug interference and high sodium level) affecting the results of renal vein renin assays that, if not properly managed, lead to erroneous results [20]. Antihypertensive medications must be withheld for at least 5 days prior to performing the renal vein sampling to eliminate false-negative results. While renin activity was elevated and lateralized appropriately during the first procedure, it was normal during the second procedure, even though the patient had significant angiographic renal artery stenosis and an excellent response to PTA. This confirms the appropriateness of using angiographic findings to determine the suitability of PTA in children.

Based on the excellent outcome in our patient, we feel that attempts to restore patency of an occluded renal branch artery are justified, especially if the occluded branch supplies a relatively large volume of renal parenchyma. Visualization of the occluded artery, proximally and distally, and short-segment involvement are probably prerequisites for attempting recanalization. Anticoagulation and antiplatelet therapy may be important, and close follow-up is advised, with re-intervention if necessary.

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