Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://Elsevier.com/locate/radcr

Case Report

Transarterial embolization of a hyperfunctioning aldosteronoma in a patient with bilateral adrenal nodules

Jason T. Salsamendi MD[a], *Francisco J. Gortes BS*[a,*], *Alejandro R. Ayala MD*[b], *Juan D. Palacios MD*[b], *Sanjit Tewari MD*[a], *Govindarajan Narayanan MD*[a]

[a] *Department of Vascular and Interventional Radiology, University of Miami Miller School of Medicine, 1611 NW 12th Ave, Miami, FL 33136-1005, USA*

[b] *Department of Endocrinology, University of Miami Miller School of Medicine, 1400 NW 10th Ave, Miami, FL 33136, USA*

ARTICLE INFO

Article history:
Received 11 September 2016
Received in revised form
18 October 2016
Accepted 23 October 2016
Available online 29 November 2016

Keywords:
Aldosteronoma
Transarterial
Embolization
Alcohol
Adrenal nodule

ABSTRACT

Primary hyperaldosteronism often results in resistant hypertension and hypokalemia, which may lead to cardiovascular and cerebrovascular complications. Although surgery is first line treatment for unilateral functioning aldosteronomas, minimally invasive therapies may be first line for certain patients such as those who cannot tolerate surgery. We present a case of transarterial embolization (TAE) of an aldosteronoma. The patient presented with a cerebrovascular accident, and subsequently developed uncontrolled hypertension, hypokalemia, and a myocardial infarction. Following TAE, potassium returned to normal levels and blood pressure control was improved. There were no postoperative complications. TAE thus may be a safe and effective alternative to surgery.

Introduction

Primary hyperaldosteronism, also known as Conn syndrome, is the excessive secretion of aldosterone from hyperfunctioning adrenal gland tissue, resulting in intractable hypertension and hypokalemia, which themselves may lead to cerebrovascular disease, myocardial infarction, congestive heart failure, and cardiac arrhythmias [1,2]. Most cases of primary hyperaldosteronism are secondary to either an adrenal adenoma or bilateral adrenal hyperplasia [1]. Surgical resection is currently the standard treatment for adrenal adenomas. However, percutaneous intervention may play a role in treatment, particularly in those patients that may not tolerate surgery. Here, we present a case of transarterial embolization (TAE) with ethanol and embospheres of an aldosteronoma in a patient with bilateral adrenal nodules and discuss the presentation, assessment, and treatment of functioning aldosterone tumors.

Competing Interests: Dr. Narayanan serves as a consultant at AngioDynamics Inc. All other authors have declared that no competing interests exist.

* *Corresponding author.*
E-mail address: fgortes@med.miami.edu (F.J. Gortes).

http://dx.doi.org/10.1016/j.radcr.2016.10.013

Case report

The patient was a 70-year-old Hispanic male with a past medical history of an adrenal incidentaloma diagnosed 8 years ago, medically controlled hypertension, congestive heart failure, and atrial fibrillation who presented to an outside hospital for a cerebrovascular accident (CVA). Given the patient's history of adrenal nodule, the CVA was thought to be secondary to hypertension from a hyperfunctioning adrenal nodule. A contrast computer tomography (CT) scan was performed, which demonstrated a right nodule measured at 2.2 × 2.5 × 2.4 cm and a left nodule measured at 3.3 × 2.2 × 3.0 cm (Fig. 1). The right adrenal mass demonstrated approximately 88 Hounsfield units (HU) on the arterial phase, 52 HU in the portal venous phase, and 41 HU on the delayed phase, with a 21% relative washout. The left adrenal mass measured 80 HU, 59 HU, and 37 HU in the arterial, portal venous, and delayed phases, respectively, with a 37% relative washout. Both nodules were thus considered to be of indeterminate etiology based on CT criteria. The patient had refractory hypertension and while undergoing physical therapy for the CVA, his blood pressure suddenly rose to 280/110 mmHg. He was subsequently admitted to our hospital, where his blood pressure remained erratic and he developed hypokalemia with a nadir of 2.8 mEq/L.

Endocrine evaluation revealed a plasma aldosterone of 25 ng/dL and a plasma renin activity level of 0.29 ng/mL·h. The patient was scheduled for adrenal vein sampling, but he developed a non-ST elevation myocardial infarction before the procedure requiring emergent cardiac catheterization with placement of a drug-eluting stent. Subsequently, adrenal venous sampling was performed to elucidate the etiology of his primary hyperaldosteronism. Results are summarized in Table 1, which demonstrates right lateralization (aldosterone ratio > 4:1) [3]. Surgical consultation was performed and the patient was deemed a poor surgical candidate. Interventional radiology was then consulted for a minimally invasive alternative.

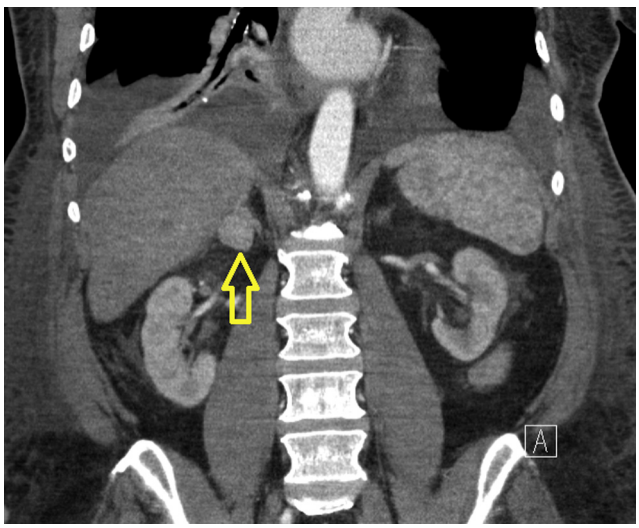

Fig. 1 – Coronal CT slice demonstrating bilateral adrenal nodules with the right nodule (arrow) measuring 2.2 × 2.5 × 2.4 cm.

Table 1 – Results of adrenal venous sampling. Adrenal-to-adrenal aldosterone-to-cortisol ratio greater than 4 indicates lateralization of disease, in this case of the right adrenal gland. Adrenal-to-IVC cortisol greater than 5 indicates correct placement of catheter in adrenal vein. Contralateral adrenal aldosterone suppression is noted.

Vein	Aldosterone (A), ng/dL	Cortisol (C), μg/dL	A:C ratio	Aldosterone ratio
Right adrenal vein	1279	483.4	2.64	22
Left adrenal vein	51	408.5	0.12	
IVC	73	61.7	1.18	

IVC, inferior vena cava.

The patient was placed under general anesthesia and intubated because of his labile blood pressures. After accessing the right common femoral artery, we cannulated the right lateral adrenal artery using the standard technique. Arteriogram showed significant adenoma blush (Fig. 2). Superselective coil embolization of an anomalous phrenic branch was then performed (Fig. 3). The catheter was next pulled back into the right lateral adrenal artery, and 3 mL of hydrated alcohol was injected. At this time, the patient experienced high blood pressures managed by the anesthesia team. Roughly 1 mL of 300-500 μm embospheres was then injected until stasis was achieved after which the proximal right lateral adrenal artery was coiled. Postembolization contrast injection demonstrated no tumor blush (Fig. 4). Right renal artery angiogram showed no evidence of adrenal capsular supply (Fig. 5). Right inferior phrenic artery angiography showed perfusion to the superior lateral limb of the adrenal gland without adenoma blush (Fig. 6).

The patient tolerated the procedure well and was discharged 5 days later. Aldosterone levels normalized and renin levels began to increase. His potassium stabilized at borderline normal levels. As of 2-month follow-up, his blood pressure has been well maintained on antihypertensive medications.

Discussion

Primary aldosteronism is the most common cause of secondary hypertension, accounting for up to 15% of all hypertension cases [4,5]. Conn syndrome, named after Dr Jerome W. Conn who first described the disease, refers specifically to primary hyperaldosteronism resulting from an adrenal aldosteronoma. Although previously considered a rare disease, it has been increasingly recognized as a secondary cause of hypertension that may improve, or resolve, with adrenalectomy [5,6].

Clinical signs of the disease result from excessive aldosterone in the renal tubules and vascular injury [1]. Aldosterone hypersecretion induces excessive renal reabsorption of sodium at the

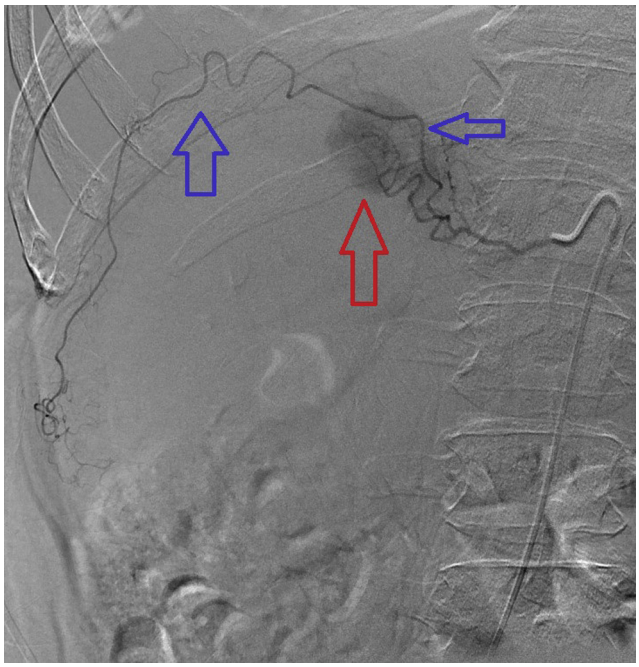

Fig. 2 – Arteriogram of the right lateral adrenal artery showing significant adenoma blush (red arrow). Note the presence of anomalous phrenic branch (blue arrows).

distal convoluted tubules [5]. Sodium retention promotes absorption of water, increasing extracellular fluid volume [1]. Aldosterone also promotes secretion of potassium and hydrogen [5]. The combination of these factors results in hypertension, hypernatremia, hypokalemia, and metabolic alkalosis.

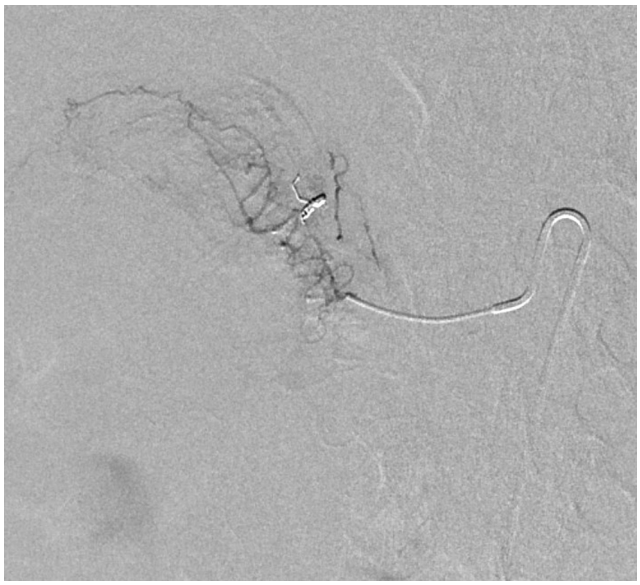

Fig. 4 – Arteriogram taken after transcatheter arterial embolization with ethanol of the right lateral adrenal artery demonstrating the absence of adenoma blush.

An increase in effective circulating volume suppresses the release of renin, an enzyme which ultimately promotes the formation of aldosterone. Decreased renin levels and an elevated aldosterone-to-renin ratio are characteristic of the disease. An aldosterone-to-renin ratio greater than 20-25 is 95% sensitive and 75% specific for the diagnosis of primary aldosteronism [5].

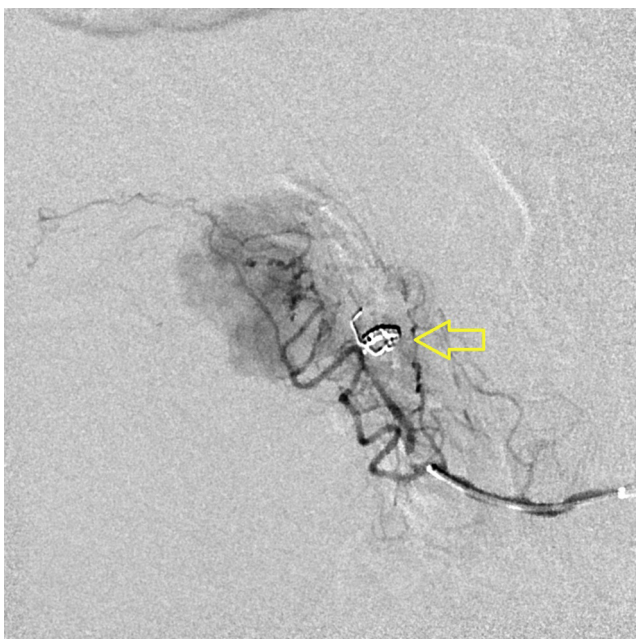

Fig. 3 – Arteriogram following superselective microcoil embolization of an anomalous phrenic branch originating from the right adrenal gland. Note the coil placement (yellow arrow).

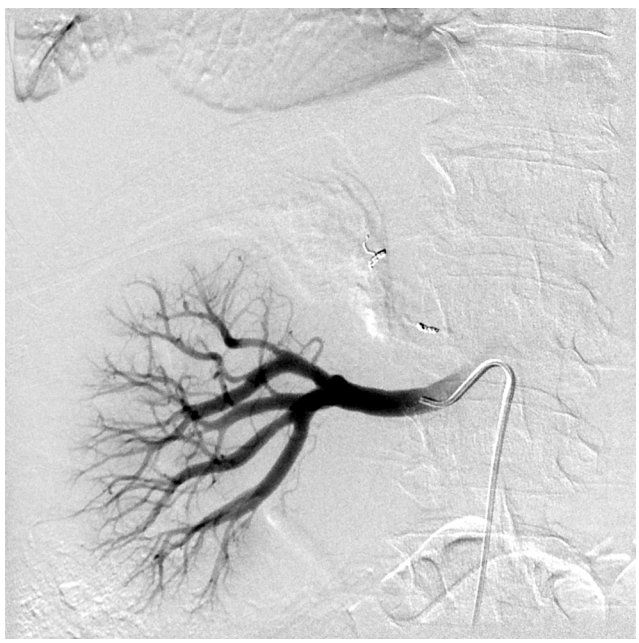

Fig. 5 – Right renal artery angiogram illustrating absence of adrenal capsular supply. Note the coils in the anomalous phrenic branch (top) and right lateral adrenal artery (bottom).

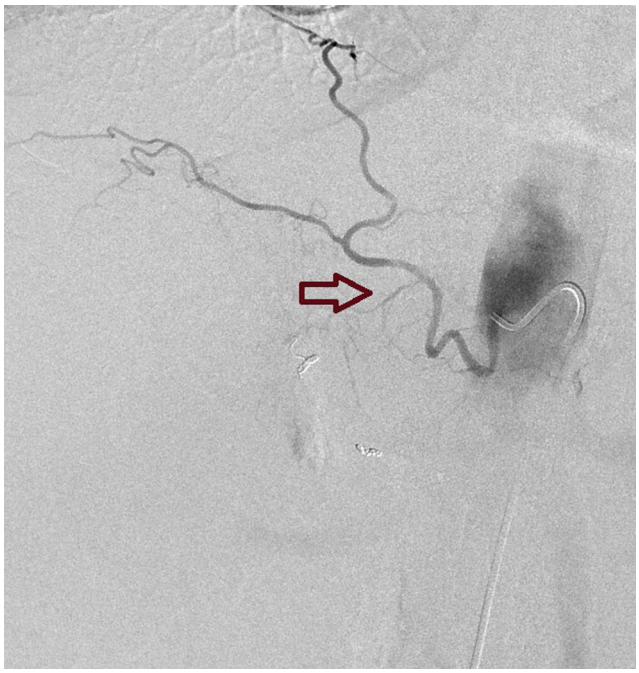

Fig. 6 – Right inferior phrenic artery angiogram showing perfusion of the superior lateral limb of the adrenal gland (arrow) with the absence of adenoma blush.

Adrenal venous sampling is a useful diagnostic test, which can demonstrate lateralization of primary aldosteronism, particularly in cases of bilateral adrenal nodules. Bilateral adrenal tumors occur in 6% of patients, and 49% of these patients have lateralization of the disease [1,5]. Aldosterone and cortisol are measured bilaterally; adrenal-to-adrenal aldosterone-to-cortisol ratios greater than 4 are indicative of lateralization. Ratios less than 3 indicate idiopathic bilateral hyperplasia, and ratios between 3 and 4 are indeterminate [5].

TAE with ethanol (TAEE) has been well documented in the treatment of hepatic metastases, adrenal pheochromocytomas, and renal cell carcinoma; however, its use in the treatment of aldosteronomas is not well established in the literature [1,2]. A study by Hokotate et al [2] found that 27 out of 33 patients with Conn syndrome treated with TAEE experienced a decrease in blood pressure independent of sex, age, duration of hypertension, location of the adenoma, the number of embolized arteries, or the type of alcohol used.

Other minimally invasive alternatives to TAEE include CT-guided percutaneous injection of ethanol or acetic acid (CTEA) and CT-guided percutaneous radiofrequency ablation (RFA). Adrenal hemorrhage has been reported with CT-guided percutaneous injection of ethanol or acetic acid, mainly because of the small size of adrenal tumors. There are no studies describing adrenal hemorrhage after TAEE or RFA [7,8]. Much like TAEE, the use of RFA to treat primary hepatic tumors and metastases has been well documented and accepted, but few cases have been published on the treatment of adrenal lesions [9]. However, recent studies have yielded promising results for RFA. Szejnfeld et al performed RFA on 9 patients with Conn syndrome, and 8 of the patients experienced a significant decrease in aldosterone and blood pressure. A study by Yang et al [10] compared RFA to laparoscopic adrenalectomy for benign aldosterone-producing adenomas. Patients treated with RFA experienced comparable normalization in aldosterone and blood pressure with less postoperative pain and shorter operative times. A potential complication of RFA is thermal damage to the spleen and surrounding vascular tissue. To date, there are no studies comparing TAEE to RFA in the treatment of adrenal adenomas.

Surgery remains the primary treatment for unilateral aldosteronomas, and recent improvements in laparoscopic adrenalectomy have improved postsurgical outcomes. However, TAEE offers several advantages, which include a shorter procedure time, reduced blood loss, and the option of using minimal sedation with local anesthesia instead of general anesthesia [1,2]. Patients with labile blood pressures; however, should be placed under general anesthesia. Lastly, success rates between TAEE and surgery are comparable, at 82% for TAEE vis-à-vis >90% for surgery [11,12].

Overall, our case of TAEE for the embolization of an aldosteronoma was successful. There were no postprocedure complications and the patient experienced complete resolution of symptoms. Although total embolization was not achieved with ethanol alone, embospheres were successfully used to complete embolization. TAEE remains a viable and effective alternative for patients who cannot undergo adrenalectomy. Moreover, our case suggests that TAEE in combination with microparticle embolization is more efficacious. Future studies should explore the use of TAEE with supplemental embolization techniques and compare the efficacy and safety of RFA to TAEE.

REFERENCES

[1] D'Angelo MW. Transcatheter alcohol embolization of an aldosteronoma. Seminars in interventional radiology. Semin Interv Radiol 2007;24(1):96–9.

[2] Hokotate H, Inoue H, Baba Y, Tsuchimochi S, Nakajo M. Aldosteronomas: experience with superselective adrenal arterial embolization in 33 cases. Radiology 2003;227(2):401–6.

[3] Webb R, Mathur A, Chang R, Baid S, Nilubol N, Libutti SK, et al. What is the best criterion for the interpretation of adrenal venin sample results in patients with primary hyperaldosteronism? Ann Surg Oncol 2012;19(6):1881–6.

[4] Khan AN. Hyperaldosteronism. www.emedicine.com/radio/topic354.htm; [accessed 03.08.16].

[5] Uwaifo GI. Primary aldosteronism. http://emedicine.medscape.com/article/127080-overview#a4; [accessed 03.08.16].

[6] Funder J, Carey R, Mantero F, Murad MH, Reincke M, Shibata H, et al. The management of primary aldosteronism: case detection, diagnosis, and treatment: an endocrine society clinical practice guideline. J Clin Endocrinol Metab 2016;101(5):1889–916.

[7] Rossi R, Savastano S, Tommaselli AP, Valentino R, Iaccarino V, Tauchmanova L, et al. Percutaneous computed tomography-guided ethanol injection in aldosterone-producing adrenocortical adenoma. Eur J Endocrinol 1995;132:302–5.

[8] Liang HL, Pan HB, Lee YH, Huang JS, Wu TD, Chang CT, et al. Small functional adrenal adenoma: treatment with

CT-guided percutaneous acetic acid injection—report of three cases. Radiology 1999;213:612–5.
[9] Szejnfeld D, Nunes TF, Giordano EE, Freire F, Ajzen SA, Kater CE, et al. Radiofrequency ablation of functioning adrenal adenomas: preliminary clinical and laboratory findings. J Vasc Interv Radiol 2015;26:1459–64.
[10] Yang M, Tyan Y, Huang Y, Wang S, Chen S. Comparison of radiofrequency ablation versus laparoscopic adrenalectomy for benign aldosterone-producing adenoma. Radiol Med 2016;121:811–9.
[11] Weigel RJ, Wells SA, Gunnells JC, Leight GS. Surgical treatment of primary hyperaldosteronism. Ann Surg 1994;219:347–52.
[12] Granberg PO, Adamsson U, Hamberger B, Lins PE. Surgical treatment of primary aldosteronism. Ann Chir Gynaecol 1983;72:171–6.