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Short communication

Adrenal venous sampling using Dyna-CT—A practical guide

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ABSTRACT

Primary hyperaldosteronism due to aldosterone secreting adrenal adenomas is an important and potentially curable cause for hypertension. The differentiation between unilateral or bilateral adrenal adenomas is crucial, as unilateral adenomas can easily be cured by surgery whereas bilateral adenomas have to be treated conservatively. Exact diagnosis can be made when unilateral or bilateral hormone production is proven with adrenal vein sampling. We present an effective step-by-step technique how to perform an adrenal vein sampling with a special emphasis on how to reliably catheterize the right adrenal vein using Dyna CT.

1. Introduction

5–10% of all hypertensive patients suffer from hypertension due to primary hyperaldosteronism [1,2]. The most common type of primary aldosteronism is bilateral cortical hyperplasia; the second most common type is unilateral secretion of aldosterone due to a solitary adenoma. In rare cases adrenal carcinoma accounts for excessive aldosterone secretion [3]. As many as 4.8% of hypertensive patients present with unilateral adenomas which can be cured surgically by resection [4].

Adrenal vein sampling is an essential diagnostic tool to differentiate bilateral from unilateral aldosterone secreting adrenal adenomas as the latter are treated with unilateral adrenalectomy whereas bilateral adenomas are managed conservatively.

Adrenal vein sampling has a history of being a difficult and tricky procedure as the catheterization of the right adrenal vein can be challenging even for experienced interventionalists. C arm CT has been described to be a useful aid for the differentiation of the right adrenal vein [5,6]. In this technical note we want to emphasize on the procedure details and technical realization of successful right adrenal vein sampling using C arm CT.

2. Materials and methods

2.1. Patient preparation and positioning

Correct patient positioning and removal of any obstacles for the C arm before the actual start of the intervention are essential for a quick, effective and sterile procedure. Special emphasis should be drawn to lines and cables, which should be placed outside the rotation trajectory. Especially objects that can cause metallic artifacts have to be placed outside the field of view.

The arms of the patient have to be above the head to prevent streak artifacts during C arm CT. In our institution we use commercially available butterfly shaped armrest devices (Siemens, Erlangen, Germany). Using these devices primary positioning of the patient's arms above the head is possible as well as maintaining this position for the entire procedure.

2.2. Angiography suite

Our angiography labs are equipped with a ceiling mounted Axiom Artis System (Siemens, Erlangen, Germany) with a flat panel detector (30 cm × 40 cm, diagonal 48 cm, pixel size 154 μm) which allows a spatial resolution of 3.52 line pairs/mm.

2.3. Sampling procedure

Following the sampling protocol (Fig. 1) venous blood is sampled from the following locations: 1 Inferior vena cava – above renal veins, 2 Inferior vena cava – below renal veins, 3 Left renal vein proximal to the left adrenal vein orifice, 4 Left renal vein distal to the left adrenal vein orifice, 5 Left adrenal vein, 6 Right renal vein, 7 Right adrenal vein.

Blood vials are numbered according to this protocol. The blood vial identification code is placed into the rectangular numbered fields to prevent accidental mixing up of the probes.

First a 6 French Sidewinder Simmons 2 (Cordis, Johnson & Johnson Medical N.V./S.A, Waterloo, Belgium) catheter is used to drain

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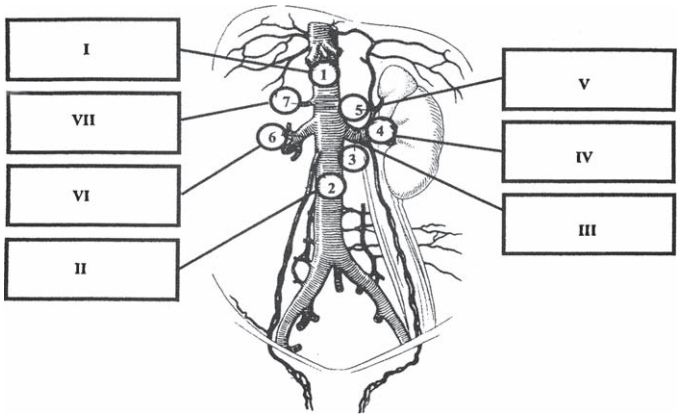

Fig. 1. Adrenal sampling protocol. Venous blood is sampled from the following locations: 1 Inferior vena cava – above renal veins, 2 Inferior vena cava – below renal veins, 3 Left renal vein proximal to the left adrenal vein orifice, 4 Left renal vein distal to the left adrenal vein orifice, 5 Left adrenal vein, 6 Right renal vein, 7 Right adrenal vein.

blood from the following locations: Inferior vena cava (IVC) above the renal veins, right renal vein, left renal vein and IVC below the renal veins.

10 ml of blood are sampled from each location. Blood vials are numbered according to our sampling protocol. Before sampling 2–5 ml of 300 ml iodine/ml contrast agent (Ultravist, Bayer, Leverkusen, Germany) is injected slowly by hand to check for the right position. Then the catheter is flushed again gently with saline to avoid high iodine concentrations in the probe which have been described to alter the laboratory results [7].

As the venous wall tends to collapse around the catheter tip sometimes, we generally use sidehole catheters for this procedure. Additionally, when gentle suction fails, the catheter end is placed somewhat below the patient and following gravity blood is let to drop freely into the vial.

Catheterization of the left adrenal vein is performed using a Sidewinder Simmons 2 (Cordis, Johnson & Johnson Medical N.V./S.A, Waterloo, Belgium) which is advanced into the left renal vein first, then the catheter tip is directed cranially by pulling it back and rotating it gently. In almost all cases the left adrenal vein can be hit this way. In rare cases when the catheter tip cannot be advanced into the left adrenal vein a guidewire can be advanced and the catheter will slip into the left adrenal vein over the guidewire. Contrast agent is injected slowly with a 2 ml syringe to check for right position.

Catheterization of the right adrenal vein is performed using a 4F Cobra (Cordis, Johnson & Johnson Medical N.V./S.A, Waterloo, Belgium) catheter or a 4F Sidewinder Simmons 1 (Cordis, Johnson & Johnson Medical N.V./S.A, Waterloo, Belgium) catheter. The right adrenal vein is located posterior superior to the right renal vein below the level of the hepatic veins. Often multiple passes are necessary to locate the orifice of the vein.

When the catheter is thought to be in the right place C arm CT (Dyna CT) is performed.

2.4. Dyna CT procedure

After setting the isocenter in anterioposterior and left anterior oblique position a test run is performed to ensure that the C arm can rotate freely around the patient.

After the test run the actual series is acquired. During the acquisition contrast agent (Ultravist, Bayer, Leverkusen, Germany) is injected very gently in a concentration of 300 mgI/ml for opacification of the right adrenal vein and the adrenal gland.

The rotation time for Dyna CT is 8 s and the C arm is rotating at a speed of 60°/s, acquiring 60 frames per second. Performing one series is possible within one breath hold as we use a 8 s rotational scan of 210°. The detector moves at 60°/s and images are acquired every 0.5° for a total of 419 images. Source power is 90 kVp, receiver dose is approximately 0.36 μGy/frame. Voxel matrix is 512 × 512, FOV is 48 cm.

After the run data are automatically and immediately sent to a workstation (Leonardo Siemens, Erlangen, Germany), which is located in the control room outside the angio suite.

3D multiplanar reconstructions are reconstructed using the 3D task card for the Dyna CT software. In this task card the standard reconstruction planes axial, coronal and sagittal are displayed in 3 windows. Routinely thick MPRs in the standard planes with a slice thickness of 3 mm and 5 mm are generated. As the monitor of the workstation console is mirrored in the angio suite the interventionalist is able to look at these images from inside the angio suite and check for right catheter position.

Catheterization of an accessory hepatic vein happens frequently. Sometimes it is difficult to distinguish liver parenchymal staining from the typical gland like staining of an adrenal vein in conventional digital subtraction angiography. Fig. 2 clearly depicts wrong catheter position in an accessory hepatic vein on MPR images.

After correct catheter positioning in the right adrenal vein (Figs. 3 and 4) blood is sampled as described above.

When blood has been sampled sufficiently from all locations the catheter and the sheath are removed and the puncture site in the groin is compressed manually.

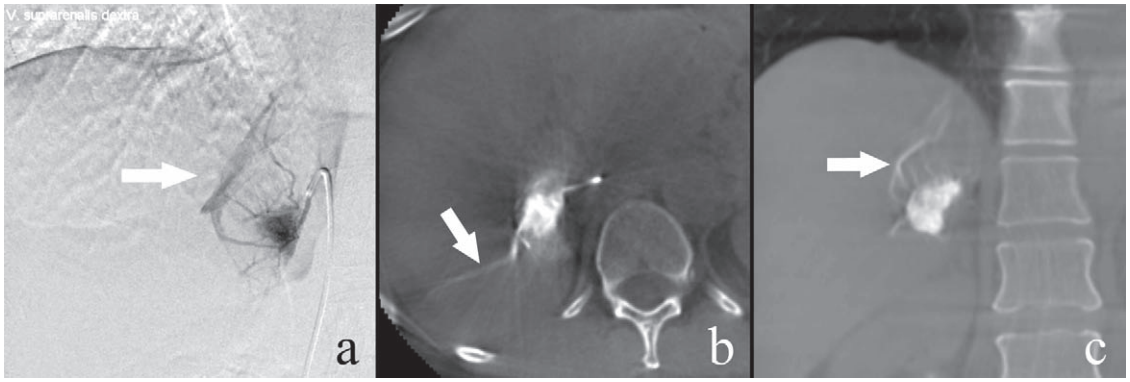

Fig. 2. Accessory hepatic vein. Catheterization of an accessory hepatic vein happens frequently. Sometimes it is difficult to distinguish liver parenchymal staining from the typical gland like staining of an adrenal vein. (a) The angiogram depicts parenchymal staining and a draining hepatic vein (arrow). b + c axial (b) and coronal (c) Dyna CT MPRs clearly depict intrahepatic contrast proving catheter position in an accessory hepatic vein (arrows).