Utility of 320 Slice Mapping CT for Adrenal Vein Sampling in Subjects Suspected of Having Primary Aldosteronism Compared with Digital Subtraction Angiography and Selective Retrograde CT Adrenal Venography

Masae Uehara, Nobusada Funabashi, Takashi Higashide, Hiroyuki Takaoka, Koya Ozawa, Yoshio Kobayashi
Chiba University Graduate School of Medicine
DISCLOSURE INFORMATION:
The following relationships exist related to this presentation:
Masae Uehara, Nobusada Funabashi, Takashi Higashide, Hiroyuki Takakoa, Koya Ozawa, Yoshio Kobayashi.

- None of authors have relationships to disclose.
Background

• Adrenal vein (AV) sampling (AVS) is considered the diagnostic gold standard for primary aldosteronism (PA).

• Recently, there has been an increasing requirement for AVS due to the realization that primary aldosteronism occurs more frequently than previously believed.
However, AVS is an invasive and difficult technique. Right-sided AVS is especially difficult because the right AV is small and difficult to distinguish from other vessels that may arise from the posterior wall of the inferior vena cava (IVC), such as the hepatic vein or right renal vein.
Purpose

To evaluate the utility of preliminary 320 slice mapping CT for AVS in subjects suspected to have PA, we compared 320 slice mapping CT with digital subtraction angiography (DSA) and selective retrograde CT adrenal venography (SRCTAV) in successful AVS cases.
Materials and Methods

- 64 subjects (28 male, mean age $55\pm11$ yrs) who were suspected of having PA and who underwent preliminary 320 slice mapping CT (Aquilion one, Toshiba Medical), DSA, and SRCTAV with successful AVS results were retrospectively analyzed.

- Prior to AVS examination, visualization of the AV was attempted using 320 slice mapping CT.
• During the AVS procedure, visualization of the AV was confirmed on DSA and SRCTAV.

• AVS was carried out before the adrenocorticotropic hormone loading test, and 30 minutes afterwards.

• After the adrenocorticotropic hormone loading test, if the plasma cortisol concentration (PCC) acquired from either the left or right AV was >200µg/dl, AVS was regarded as successful.
320 slice Mapping CT Protocol

• Mapping CT was undertaken using 320 slice CT (Aquilion ONE, Toshiba Medical).
• Contrast material was injected at a rate of 3.0ml/sec.
• Conventional volume scan was performed at non-contrast, 30, 45, 60, and 90 seconds after contrast injection.
• On CT, AV was defined as the enhanced vessel originating from the adrenal body flowing into IVC.
right adrenal adenoma

320 slice mapping CT

AV
SRCTAV Protocol

• Selective angio MDCT (Aquilion, 4 slice, Toshiba Medical) with an invasive angiographic system was performed with a helical scan.
• AV were catheterized percutaneously via the femoral vein.
• A total of 50ml of contrast material was injected at a rate of 1.5ml/sec.
• On SRCTAT, AV was defined as the enhanced vessel originating from IVC flowing into the adrenal body and simultaneously when the adrenal body itself was enhanced.
Using SRCTAV, the right AV can be clearly identified and anatomical information can also be acquired.
DSA

On DSA, visualization of AV was confirmed when the capsular vein of the kidney was visualized. If it was not visualized, we determined whether visualization of AV had succeeded or not from total morphology of the enhanced vessel on DSA.
Right AV on DSA

It is difficult to identify the AV. The right AV is especially prone to misdiagnosis because of its anatomical location.
320 slice Mapping CT, DSA, SRCTAV and AVS procedures were all undergone while the patient was briefly holding his/her breath.
Results

The detectability of left and right AV using mapping CT, DSA, and SRCTAV

N=64

<table>
<thead>
<tr>
<th></th>
<th>Mapping CT n, (%)</th>
<th>DSA n, (%)</th>
<th>SRCTAV n, (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left AV</td>
<td>64 (100)</td>
<td>64 (100)</td>
<td>64 (100)</td>
</tr>
<tr>
<td>Right AV</td>
<td>56 (88)</td>
<td>50 (78)</td>
<td>64 (100)</td>
</tr>
</tbody>
</table>

As the AVS gold standard, left and right AV could be observed in 100% and 88% of subjects on mapping CT, 100% and 78% subjects on DSA, and 100% and 100% subjects on SRCTAV, respectively.
The detection of left and right AV compared with mapping CT, DSA, and SRCTAV

Detection of the right AV was significantly lower on mapping CT and DSA than on SRCTAV (both $p<0.01$).
The cause of non-detection of right AV using 320 slice mapping CT and DSA as the AVS gold standard

1) 320 Slice Mapping CT (n=8)
   • Small vessel diameter or joined to the accessory hepatic vein
   • Inappropriate acquisition time

2) DSA (n=14)
   • Vessel spasm
   • Right AV joined to the right accessory vein
All subjects underwent laparoscopic adrenalectomy by urologists and all specimens were evaluated by pathologists using
1) Macro evaluation,
2) hematoxylin and eosin (HE) stain for diagnosis of adrenocortical adenoma and to differentiate adrenocortical adenoma from idiopathic hyperaldosteronism, which reveals nodular hyperplasia, and
3) 3β-Hydroxysteroid dehydrogenase (3βHD) stain for diagnosis of aldosterone-producing adenoma.
Histopathological Findings of Adenoma in Right Adrenal Gland after Laparoscopic Adrenalectomy

Macro Findings of Adenoma Surrounded by a Large Amount of Adipose Tissue.

Adenoma

Cut Surface of Adenoma
Histopathology (H&E stain) of right adrenal gland
The nodule after laparoscopic adrenalectomy is consistent with adrenocortical adenoma.

- Clear cell mainly filled with cholesterol
- Compact (Solid?) cell without cholesterol
Histopathology findings (3βHSD stain) of right adrenal gland.

This nodule revealed positive findings for 3-βHSD stain in this lesion and was diagnosed as an aldosterone-producing adenoma.
Histopathology (H&E stain) of right adrenal gland at another location. At this location, combined with negative findings in 3βHSD stain, this finding is consistent with paradoxical hyperplasia accompanied by aldosterone-producing adenoma of the zona glomerulosa.
Results Summary-1

1) Successful AVS was confirmed in all 64 subjects.

2) As the AVS gold standard, left and right AV could be observed in 100% and 88% of subjects on mapping CT, 100% and 78% subjects on DSA, and 100% and 100% subjects on SRCTAV, respectively.

3) Detection of the right AV was lower on mapping CT and DSA than on SRCTAV (both $p<0.01$).
Results Summary-2

4) The right AV could not be visualized on 320 slice mapping CT in 8 subjects because it was narrow, or joined to the accessory hepatic vein, or due to inappropriate acquisition time.

5) The right AV could not be visualized on DSA in 14 subjects because of vessel spasm, or the right AV joined to the right accessory vein.
Discussion

• In this study, we have shown that 320 slice mapping CT is useful in planning AVS by demonstrating the anatomy and positions of the AVs. SRCTAV can also help to confirm the exact positioning of catheters in the AV during the AVS procedure.

• Preliminary 320 slice mapping CT and SRCTAV during the AVS procedure have the disadvantage of increasing the amount of radiation exposure due to the procedures themselves.
However, if we can confirm the AV on 320 slice mapping CT, we can get a spatial relationship between AV and IVC and will use this information to determine the suitable angle for setting of the catheter in DSA, SRCTAV and AVS procedures and the accurate distance of AV from the vertebral body. Both of these may help to shorten the total examination time of the AVS procedure, decrease the total amount of radiation exposure, and lead to accurate results and treatment.
Limitations

• The estimated mean radiation exposure with 320 slice mapping CT was 3.84mSv.

• Our angio CT equipped with the invasive angiographic system was only a 4 detector MDCT which has poorer spatial and temporal resolution and more radiation exposure in comparison with the current generation of 64-slice or greater CT scanners.

• The success of sampling is due to the result of serum concentration of hormones determined by an external company, and use of these results on later days.
Conclusions

• Preliminary 320 slice mapping CT could detect the AV, especially the left AV, as accurately as DSA and SRCTAV and may provide useful information to improve success rates of AVS and reduce examination time.
• To improve visualization of the right AV, improvement of acquisition methods of CT may be needed.