Aims and objectives

Prominent column of Bertin is well known pseudolesion may mimic renal mass and is also known that there is no relationship with other anomalies in urinary tracts and it is not significant finding. Yeh et al. (1) categorized prominent column of Bertin as five types by their shape. In this article, the shape which perfectly divided upper and lower part of kidney was categorized as type III and, in ultrasonography, we sometimes met this shape. However, unlike previous knowledge, we have experienced some cases of perfectly divided shaped kidney (prominent column of bertin type III) which were associated with duplication of ureter which it is most common congenital urinary tract anomaly and it can be associated with other congenital abnormalities and complication such as obstruction and infection (2).

So the purpose of this study is to assess the incidence of divided shaped kidney and the relationship between divided shaped kidney and duplication of ureter by using CT.
Fig. 1

Methods and materials

Our institutional review board approved this study. Patient informed consent was not required for this retrospective analysis, though radiological examination-related informed consent were obtained from all patients.

Patients

We reviewed 857 consecutive patients who had performed enhanced CT with abdomen and pelvic CT protocol of our institution from 2012 May 1st to June 30th. The mean patient age was 39.6 years (range 2 to 98 years). 493 patients were male, and 364 were female. There were 15 patients with single kidney and 60 kidneys had to be excluded from this study because they had problems which obscure the evaluation of renal shape or duplication of ureter as like follows; renal tumor in 3, percutaneous nephrostomy in 9, polycystic kidney in 4, renal trauma in 1, renal infarction in 1, severe hydronephrosis in 18, parapelvic cyst in 17, artifact in 5, and horseshoe kidney in 2 kidneys). So total 1639 kidneys in 845 patients were included.

Image Acquisition

All CT scans (Brilliant 64, Philips Medical Systems, Netherlands) were performed using the following scanning parameters: detector configurations of 64 × 0.625 mm, section thicknesses of 3.0 mm, reconstruction intervals of 2 mm, table speeds of 46.8 mm per rotation, effective amperage settings of 150 mAs, rotation times of 0.75 second, a tube voltage of 120 kVp, and a matrix of 512 × 512.

A total of 1.5 mL of nonionic contrast material per kilogram of body weight was injected into an antecubital vein at a rate of 3.0 mL/sec by using a power injector. The scanning delay for the corticomedullary phase was 7 seconds after achieving enhancement of the descending aorta of up to 130 HU, as measured by using a bolus-tracking technique. 70-second and 3 minute scanning delay after the contrast material injection were used for the hepatic venous phase and delayed phase, respectively.

Image Analysis

Two residents of radiologic departement of our institution who were unaware of the overall goal of the study reviewed the CT images independently and separately. one resident (with 2 years experience) only assessed the shape of kidney, and another one (with 4 years experience) only assessed the duplication of ureter. Initial 100 patients, a board-certified radiologist who had 10 years of experience in genito-urinary image interpretation co-read the images with residents, respectively for avoiding bias. All images
were reviewed on a 2560 x 1920 Picture Archiving and Communication Systems (PACS, Marotech, Seoul, Korea) monitor.

We categorized the shape of kidney as two groups (normal and prominent column of Bertin). Prominent column of Bertin were defined when the renal column protruded to renal sinus (figure 2), and were also categorized the divided shape, AS1, AS2, and hypertrophy. The shape which perfectly divided upper and lower part of renal sinus by column of Bertin at the longest renal section on coronal image was defined as the divided shape like as type III in the article of Yeh et al. we also defined AS1 and AS2 when the shape which divided upper and lower part of renal sinus by column of Bertin was seen at the 1\textsuperscript{st} and 2\textsuperscript{nd} anterior or posterior image section (3mm and 6mm gap from longest renal section on coronal image) from longest section on coronal image, respectively. All other prominent column of Bertin except the divided shape, AS1 and AS2 were defined as hypertrophy. And normal is no evidence of enlarged columns.

The duplication of ureter were evaluated as bifid (figure 3), incomplete (figure 4) and complete type. The number of cases which present divided shaped kidney, Prominent column of Bertin and Duplication of ureter (Bifid, Incomplete, Complete) were recorded.

Statistical Analysis

The statistical analysis was performed using the SPSS statistical software version21 (IBM SPSS stastics for medical research, Korea). the relationship between the shape of kidney and the duplication of ureter were compared using the Fisher’s exact test. Differences at the p<0.05 level were defined as being statistically significant.
Images for this section:

**Fig. 2:** Coronal CT and USG scan show prominent column of Bertin at Lt. kidney, 58 years old men underlying gastric cancer

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**Fig. 3:** Coronal CT scan show bifid ureter at Rt. kidney, 75 years old men underlying rectal cancer

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Fig. 4: Coronal CT scan show bifid ureter at Lt. kidney, 50 years old men was visited ER due to colitis.

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**Fig. 5:** Coronal CT scan show Duplication of ureter on divided kidney, Rt. 40 years old men.

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![Coronal CT scan showing Duplication of ureter on divided kidney, Rt. 40 years old men.](image)

**Fig. 6:** Coronal CT scan show Duplication of ureter on divided kidney, Rt. 80 years old women underlying cervix cancer.

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Results

RESULT

CT showed 30% of prominent column of Bertin in all kidneys (495/1639). There were 4% the divided shaped kidney (66/1639), 4.9% the AS1 (80/1639), 4.5% the AS2 (73/1639), and 16.9% the hypertrophy (276/1639) (table 1).

The incidence of duplication of ureter was 5.4% (88/1639). The detailed results followed as; Bifid in 69, incomplete in 19 and complete in 0 kidneys. There were 9 duplication of ureter in the 1144 normal shaped kidneys (0.8%). However, 28 duplication of ureter were seen in the 66 divided shaped kidneys (42%). 13 duplication of ureter in the 80 AS1 (16.25%), 8 duplication of ureter in the 73 AS2 (11%), and 30 duplication of ureter in the 276 hypertrophy (10.9%) were also seen (table 2).

And the incidence of incomplete duplication of ureter was 1.16% (19/1639). The detailed results followed as; There were 0 incomplete duplication of ureter in the 1144 normal kidneys (0%), However, 11 in the 66 divided shaped kidneys (16.67%). 3 in the 80 AS1 (3.75%), 8 in the 73 AS2 (4.11%), and 2 in the 276 hypertrophy (0.72%) (table 3).

<table>
<thead>
<tr>
<th>N</th>
<th>H</th>
<th>AS1</th>
<th>AS2</th>
<th>D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>1144</td>
<td>276</td>
<td>80</td>
<td>73</td>
<td>66</td>
</tr>
<tr>
<td>%</td>
<td>70%</td>
<td>17%</td>
<td>5%</td>
<td>4%</td>
<td>4%</td>
</tr>
</tbody>
</table>

column of bertin : 30% (495)

Table 1. Incidence of prominent column of Bertin and normal shape. N : normal, H : hypertrophy, D : divided shaped kidney.

<table>
<thead>
<tr>
<th>N</th>
<th>H</th>
<th>AS1</th>
<th>AS2</th>
<th>D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>(1144)</td>
<td>(276)</td>
<td>(80)</td>
<td>(73)</td>
<td>(66)</td>
</tr>
<tr>
<td>%</td>
<td>0.8%</td>
<td>10.9%</td>
<td>16.3%</td>
<td>11%</td>
<td>42%</td>
</tr>
</tbody>
</table>

Table 2. Incidence of duplication of ureter on each shape of kidney. N : normal, H : hypertrophy, D : divided shaped kidney.

<table>
<thead>
<tr>
<th>Shape</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>1144</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hypertrophy</td>
<td>276</td>
<td>0.72%</td>
</tr>
<tr>
<td>Divided</td>
<td>80</td>
<td>3.75%</td>
</tr>
<tr>
<td></td>
<td>73</td>
<td>4.11%</td>
</tr>
<tr>
<td></td>
<td>66</td>
<td>16.67%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.16%</td>
</tr>
</tbody>
</table>

DISCUSSION

Fine and Keen(3) found that most kidneys develop by means of the actual fusion of two kidneys (an upper and lower), which correspond to the upper and lower group of calyces. And Yeh(1) recognized most often the two subkidneys fuse end-to-end with complete resorption of the polar parenchyma at the fusion site. In this situation, hypertrophic column of bertin is not present. However if the two subkidneys fail, the unresorbed portion of the polar parenchyma remains as a hypertrophic column of bertin. Therefore two subkidneys complete fail to resorb then kidney's shape remain as a divided kidney. And aggravating of two subkidneys unresorb lead to more hypertrophic state of column of Bertin.

Lafortune et al(4) reported the incidence of prominent column of Bertin was 16.2% (22/136 kidneys). However, the incidence of prominent column of Bertin in this study were 30% (495/1639). It is high proportional incidence compared with previous reports. We think because our study evaluated by 3mm thin section CT unlike the study by Lafortune et al. which evaluated by sonography.

Duplication of ureter may be either complete or incomplete and is often accompanied by various complications. Incomplete duplication is most often associated with ureteroureteral reflux or ureteropelvic junction obstruction of the lower pole of the kidney. Complete duplication is most often associated with vesicoureteral reflux, ectopic ureterocele, or ectopic ureteral insertion (2).

The relationship between prominent column of Bertin and ureter duplication is unknown to yet. Horgan et al (5). reported in their study using 12 kidneys with nonobstructive duplication that splitting of renal sinus echo was not associated with duplication. In our study, the incidence of ureter duplication was so different between in normal kidney and in prominent column of Bertin group and it was considered significant statistically (p<0.05). Despite of the difference in the result of two studies, we believed that the result of our study was more reliable because our study was a larger than that.

Yeh et al. differentiated prominent column of Bertin as three types using by ultrasonography and defined type 3 as the shape of perfectly divided upper and lower part of renal sinus by column. In our study, we newly defined as the divided shaped kidney which had the same shape of type 3 in Yeh at al article. In 66 the divided shape of kidney group, the incidence of ureter duplication was 42% (28/66). There were significant difference in the incidence of ureter duplication between divided shape and
normal shape (p<0.01) and between divided shape and other prominent column of Bertin (p<0.01). More specifically, there was significant difference in the incidence of incomplete duplication of ureter associated several complication between divided shape and normal shape kidney (16.67% VS 0%, p<0.01).

MDCT is the better modality for exactly evaluating prominent column of Bertin than ultrasonography. However, unlike ultrasonography, we may experience some difficulty for evaluating renal shape along renal longest axis because coronal image of CT scan did adjusted to the axis of body did not adjusted to axis of kidney. So we also had to evaluate AS1 and AS2. However there were no significant difference in the incidence of ureter duplication between AS1 or AS2 and prominent column, but there was statistically difference in the incidence of ureter duplication between the divided shape and AS1 or AS2.

There were two limitations in our study. First, the study use of general coronal image. Our coronal image did adjusted to the axis of body did not adjusted to axis of kidney. Almost kidney axis similar to body axis but some kidney has malrotation. However overall incidence of malrotated kidneys in the population is reported to be between 1:400 and 1:200(6). So effect of wrong axis on general coronal image is negligible size. Second, we cannot detect of complete duplication of ureter. However overall incidence of complete duplicated ureter in reported to be 8:4215 (0.18%) (7). It is too small incidence to affect incidence of duplication of ureter.
Conclusion

The incidence of Divided shaped kidney is 4 % in this study and there is a high relationship between Divided shaped kidney and Duplication of ureter than normal or other shaped ones. So we have to recommend more examination to the patient who has this findings.
References


4. Lafortune M et al. sonography of the hypertrophied column of bertin. AJR 1986;146:53-56

