A Case of Horseshoe Kidney

KATSUMARO AIDA, TSUYOSHI SAGA, KOH-ICHI YAMAKI, YOSHIAKI DOI*, TETSUSHI HIRATA**, KENGO TANAKA, HIROSHI HARADA AND MITSUAKI YOSHIZUKA

Department of Anatomy, Kurume University School of Medicine, Kurume 830, *Department of Anatomy, University of Occupational and Environmental Health, School of Medicine, Kitakyusyu 807 and **Department of Health and Physical Education, Fukuoka University of Education, Munakata 811-41, Japan

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During the gross anatomy course at Kurume University School of Medicine in 1995, an anomaly of the kidney was found in the cadaver of an 88-year-old Japanese male. The lower ends of both kidneys were fused and thus formed a horseshoe kidney. The fused region is called an isthmus, and the isthmus was located ventral to the abdominal aorta and inferior vena cava. In this subject, the isthmus consisted of renal tissue, and the thickness was approximately 1.6 cm. The boundaries between the isthmus and the kidneys were indistinct. The long axes of both kidneys ran from the outer upside to the inner lower side. On the surface of the kidney, there were some small scattered cysts (Fig. 1).

Position: The upper pole of the left kidney was positioned at the level of the upper region of the first lumbar vertebral body. The upper pole of the right kidney was located at the level of the lower border of the first lumbar vertebral body. The lower border of the

Correspondence to: M. Yoshizuka, M.D., Department of Anatomy, Kurume University School of Medicine, Kurume 830, Japan. Tel: 0942-31-7540, 0942-35-3311 (EXT: 3135) Fax: 0942-33-3233
isthmus was placed at the level of the lower border of the fourth lumbar vertebral body. The results of the measurements of the size of the kidney and the lengths of each section are shown in Fig. 2 and Table 1.

**Hilums:** Both hilums of the kidney were widely opened in the ventral direction, and the left hilum was larger than the right (Fig. 1).

**Renal pelvis, calyx and ureter:** The renal pelvis and calyx on both sides were disclosed on the hilums, and the left renal pelvis was larger than the right. Both ureters descended from the ventral side of each kidney and penetrated normally into the bladder.

**Arterial system:** The abdominal aorta originated at the level of the twelfth thoracic vertebral body. It descended, turned slightly to the right and passed through the dorsal side of the isthmus. Subsequently, it diverged into the left and right common iliac arteries at the level of the fifth lumbar vertebral body. The arterial system of this horseshoe kidney is shown in Fig. 3. The left and right renal arteries branched from the abdominal aorta at the levels of the upper and lower borders of the first lumbar vertebral body, respectively. Moreover, three surplus arteries from the abdominal aorta penetrated into the horseshoe kidney. The first surplus artery branched from the ventral side of the aorta below the origin of the inferior mesenteric artery between the levels of the second and the third lumbar vertebral bodies, and distributed to the lower inner part of the left kidney. The second surplus artery arose from the ventral side of the aorta behind the isthmus at the level of the third lumbar vertebral body.

**Fig. 2.** Various measurements of the horseshoe kidney. The results of the measurements are shown in Table 1.

A: Distance between the tops of the left and right kidneys.
B: Distance between the top of the left kidney and the center of the isthmus.
C: Distance between the top of the right kidney and the center of the isthmus.
D: Distance between the aortic hiatus and the top edge of the isthmus.
E: Distance between the lower edge of the isthmus and the divergent points of the common iliac arteries.
F: Width of the left kidney.
G: Width of the right kidney.
H: Width of the isthmus.
I: Major axis of the hilum of the left kidney.
J: Minor axis of the hilum of the left kidney.
K: Major axis of the hilum of the right kidney.
L: Minor axis of the hilum of the right kidney.
TABLE 1. Results of the measurements of the horseshoe kidney. Each region is shown in Fig. 2.

<table>
<thead>
<tr>
<th>Regions</th>
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<tbody>
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<td>G</td>
<td>5.2</td>
</tr>
<tr>
<td>B</td>
<td>11.5</td>
<td>H</td>
<td>4.7</td>
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<tr>
<td>C</td>
<td>11.4</td>
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<tr>
<td>D</td>
<td>6.8</td>
<td>J</td>
<td>3.6</td>
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<tr>
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<tr>
<td>F</td>
<td>5.1</td>
<td>L</td>
<td>3.2</td>
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Fig. 3. Schematic diagram of the distribution of the arteries to the kidney. One surplus artery (S2) arises from the abdominal aorta behind the isthmus.

Venous system: The inferior vena cava formed from the junction of the two common iliac veins at the level of the fifth lumbar vertebral body. It ascended to the right of the abdominal aorta behind the isthmus. In this case, ten renal veins were observed. In the left kidney, five veins arose from the left hilum and joined into one vein that opened into the inferior vena cava. In the right kidney, five veins also arose from the right hilum. Four of the veins joined and then opened into the inferior vena cava, while the remaining branch opened directly into the inferior vena cava.

It is known that the horseshoe kidney has its shape due to fusion of the lower or upper poles of the right and left kidneys. Matsumoto et al. (1963) classified horseshoe kidneys into: type A(a), fused at the superior poles; type A(b), fused at the inferior poles; type B(a), fused by fibrous tissue; type B(b), fused directly; and type B(c), fused by mediators. Moreover, the most common type was a combination of type A(b) and B(c). Honjin and Osugi (1955) also reported that a combination of type A(b) and B(c) was the most common type. Based on the above classification, the present case is a combination of type A(b) and B(c) because the junctions between the original kidneys and the isthmus were unclear.

The incidence of horseshoe kidneys in Japanese is 0.15% (Matsumoto et al. 1963) to 0.48% (Sone and Tamura, 1962). This is the fifth case in our laboratory, which is a frequency of 0.30% (five out of 1689 bodies) from 1952 to 1995.

Embryologically, the kidney develops from the metanephros in the 4 week vertebral body, and supplied the left upper region of the isthmus. The third artery arose from the end of the abdominal aorta and supplied most of the isthmus.
embryo. Thereafter, nephrons develop from nephric blastema, and the collecting tubular system differentiates from the metanephric bud. In the early embryonic stage, the left and right kidneys are located separately in the pelvic cavity, and then begin to ascend along the umbilical artery with a progressive internal rotation. This rotation is completed by the 8th week. Budde (1913) reported that horseshoe kidneys already existed in the 6-week-old embryos. Therefore, the horseshoe kidney is probably formed during the 5th week. In the present case, the internal rotation of the kidney was not completed and the hilum opened forward on the horseshoe kidney. In the early developmental stages, the kidney receives arterial branches from the common iliac, median sacral and inferior mesenteric arteries. With the ascent of the kidneys, the initial arterial connections degenerate and disappear, and the renal arteries branch afresh from the abdominal aorta. In the

References