

## Horseshoe kidney – A case report

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### ABSTRACT

The congenital anomalies of kidney are important as they may cause renal failure in middle age group. Horseshoe kidney is the most common fusion anomaly. It has been said to occur in every 400 births and is seen in approximately 1 out of 300 pyelographies. A horseshoe kidney was observed in a thirty-two year old male in the archives of the Department of Anatomy, PGIMER, Chandigarh. The kidney was placed at lower level as compared to its normal position. The lower poles were fused to form the isthmus opposite to the L4 vertebra. There was no extra renal anomaly. Relation of structures in hilum was normal on right side while on left side pelvis was anterior to vein and artery. The right and left renal arteries arose as usual as lateral branches of the aorta just below the level of superior mesenteric artery. Two accessory renal arteries originated from the ventral aspect of aorta just above the isthmus. Right kidney was drained by three renal veins directly into the inferior vena cava while the left kidney was drained by a renal vein which had three tributaries outside the hilum. The right kidney appeared normal under the light microscope while in the left kidney, glomeruli were decreased and glomerular space appeared more. Some of the glomeruli appeared atrophied and filled with eosinophilic material. The horseshoe kidney has been estimated to be occurring in 0.2% of the general population and is more common in men.

**Keywords:** Accessory renal artery, anomalous kidney, congenital fused kidney, renal ectopia, renal hilum.

The occurrence of the congenital anomalies of kidney is not a rare phenomenon. Some of them are important as they may cause renal failure in middle age group. Horseshoe kidney is the most common fusion anomaly, it has been said to occur in every 400 births and are seen in approximately 1 out of 300 pyelographies.<sup>1,2</sup> Horseshoe kidney occurs because of the fusion of either of the poles of the kidneys. Usually it is the inferior poles that fuse. A horseshoe kidney usually produces no symptoms because there is normal development of its collecting system as well the ureters enter the bladder. If urinary flow is impeded, signs and symptoms of obstruction or infection may appear. About 7.0% of persons with Turner syndrome have horseshoe kidneys. The large U-shaped kidney usually lies in the hypogastrium, anterior to the lower lumbar vertebrae as ascent of the fused kidneys is prevented because of the origin of inferior mesenteric artery from the abdominal aorta. A horseshoe kidney was observed in archives of the Department of Anatomy, PGIMER, Chandigarh. Some interesting vascular arrangement has prompted the authors to report the case. Vascular anatomy of horseshoe kidney is important to the radiologists who are supposed to show all the vessels and to the surgeons who have to operate for one or other complications which occur in horseshoe kidney. There is great variation in the origin, number and size of the arterial supply which may come from inferior mesenteric, common iliac, external iliac and internal iliac arteries or directly from aorta supplying the fused part of kidneys. The present study deals with arterial supply of a horseshoe kidney.

### CASE

The anomaly was observed in a thirty two years old male from the archives of the Department of Anatomy, PGIMER, Chandigarh. The cadaver had no incisional mark on his body. The anomalous kidney along with the blood vessels was dissected out from the abdominal cavity after identifying the various neighboring structures. There was no extra renal anomaly. Observations were recorded, photographed and line diagrams of the blood vessels were drawn. For histological evaluation, small piece from each part of the specimen was processed for paraffin sections. 5 micron thick paraffin sections were stained with H and E, examined under light microscope and photomicrographed using digital camera.

## RESULTS

**External features of the kidney:** Both the kidneys were fused at lower poles by a parenchymal isthmus ventral to the abdominal aorta forming a horseshoe kidney (Fig1, 2). The parenchyma of right kidney and upper part of the isthmus and upper part of left kidney appeared normal. Two depressed areas probably due to sclerotic parenchyma were seen in the lower portion of isthmus and lower part of convex outer border of the left kidney. Ventral side of the kidney was convex while the dorsal side was flattened. Upper and lower borders of the isthmus were concave facing upwards and downwards respectively giving an impression of compression at the site of fusion of the two lower poles.

**Position and size of the kidney:** The kidney was somewhat placed at lower level as compared to its normal position. The upper poles were at the level of L2 vertebra, left pole being slightly higher. The lower poles were fused to form the isthmus opposite to the L4 vertebra. The isthmus was well developed and measured 54mm in width, while the maximum width of right and left part of the kidney was 56mm and 59mm respectively at the center of hilum.

**Structures at the renal hilum:** The renal pelvises of both sides were directed anteriorly and crossed the lateral ends of the isthmus on its anterior aspect. There were two major calyces on the right kidney. The hilum of the left kidney was divided into upper and lower parts. The upper part had two minor calyces forming a major calyx while lower had one major calyx emerging from lower part of the hilum. These two major calyces joined to form renal pelvis on both the sides. Relation of structures in hilum was normal on right side i.e. vein, artery and renal pelvis anteroposteriorly while on left side pelvis of ureter was anterior to vein and artery (Fig. 1, 2).

**Blood supply of the kidney:** The right and left renal arteries arose as usual as lateral branches of the aorta just below the level of superior mesenteric artery.

**Right side:** The right renal artery 4mm in diameter bifurcated into upper and lower branches, the upper branch pierced the cortex of kidney to enter above the hilum while the lower branch redivided into two branches before entering into the upper and lower parts of the hilum. Right kidney was drained by three renal veins directly into the inferior vena cava

**Left side:** The left renal artery 5mm in diameter divided into two branches, upper branch entered into the upper part of hilum, while the lower branch redivided into two branches- right and left. The lower right branch crossed behind the upper branch and entered outside the hilum while the lower left branch entered into the upper part of hilum. The left kidney was drained by a renal vein which had three tributaries outside the hilum. There was no separate vein for isthmus.

**Accessory renal arteries:** Two other accessory renal arteries- right and left originated from left half of the ventral aspect of aorta just above the isthmus and divided into two- lateral and medial to supply the isthmus. The lateral branch gave a small branch to the isthmus before entering the hilum of the left kidney while the medial branch divided into two; one supplied the isthmus while the other entered the hilum.

AV anastomosis was seen just above the isthmus between aorta and inferior vena cava (Fig1, 2).

**Histology:** The demarcation between the fusion of two kidneys could not be identified as it showed normal histology. The right kidney appeared normal under the light microscope while in the left kidney, glomeruli were decreased and glomerular space appeared more. Some of the glomeruli appeared atrophied and filled with eosinophilic material. At places, the tubules were atrophied or greatly dilated (Fig. 3).

## DISCUSSION

The horseshoe kidney has been estimated to be occurring in 0.2% of the general population<sup>3</sup> while Flower<sup>4</sup> found horseshoe kidney in 1 in 1000 necropsies and stated that horseshoe kidney is more common in men. Perimutter *et al*<sup>5</sup> and Basar *et al*<sup>6</sup> stated that horseshoe kidney in men is at least two times more frequent than women. The reported incidences of this anomaly in Japan are 0.5%,<sup>7</sup> 0.1%<sup>8</sup> and 0.2%<sup>9</sup> on anatomical dissection. The first author has an experience of dissecting 284 cadavers over a span of 30 years (1976- Till date) and did not encounter the anomalous horseshoe kidney. In the present case the horseshoe kidney was placed at lower level as compared to its normal position. The origin of inferior mesenteric artery located at junction of 3<sup>rd</sup> and 4<sup>th</sup> lumbar vertebrae prevents full ascent by obstructing the movement of the isthmus as described earlier.<sup>10,11</sup>

Initially during the intrauterine life, the kidneys are located in the pelvis caudal to aortic bifurcation. During 7 to 8 months of intrauterine life, they migrate and ascend out of pelvis and also rotate medially, so that the anteriorly facing pelvis turns medially.<sup>11</sup> Boyden<sup>12</sup> described a 6-week old embryo with a horseshoe kidney, the youngest fetus ever discovered with this anomaly. He postulated that at the 14mm CR stage (4<sup>1/2</sup> weeks), the developing metanephric masses lie close to one another; any disturbance in this relationship may result in joining at their inferior poles. A slight alteration in the position of the umbilical or common

iliac artery could change the orientation of the migrating kidneys, thus leading to contact and fusion. It has been postulated that an abnormality in the formation of the tail of the embryo or some pelvic organ could account for the fusion process.<sup>13</sup> Domenech-Mateu and Gonzales-Compta,<sup>14</sup> after studying a 16mm human embryo suggested that posterior nephrogenic cells may migrate abnormally to form an isthmus or connection between the two developing kidneys to create the horseshoe shape. Rinat *et al*<sup>15</sup> proposed that a defect in the timing of the induction of the ureteric bud and the renal blastema.

The horseshoe kidney formation by joining the lower poles occurs before the kidneys have rotated on their long axis. In its mature form, the pelvis and ureters of the horseshoe kidney are usually anteriorly placed, crossing ventrally to the isthmus. Very rarely, the pelves are anteromedial, suggesting that fusion occurred somewhat later after some rotation had already taken place. In the present case also the renal pelvis of both sides was directed anteriorly and the calyces medially.

Horseshoe kidney may function normally except in 25% of cases, when it requires surgery.<sup>16-18</sup> In the present case, the isthmus was quite well developed and had accessory vessels arising from the distal aorta. Williams *et al*<sup>10</sup> stated that the ascending kidney receives its blood supply sequentially from arteries in its immediate neighbourhood e.g. middle sacral and common iliac arteries; so the additional renal arteries are not uncommon and represent persistent mesonephric arteries. Since the horseshoe kidney is situated in the pelvis, it may acquire additional branches from the distal aorta, iliac or hypogastric arteries.<sup>11</sup> In general horseshoe kidney can be regarded as far as arteries are concerned as two separate kidneys, which either approximate or are continuous across the midline.<sup>19</sup>

In the present case, the left kidney had two hila probably because it retained the fetal lobulation. No vein was seen draining the isthmus separately while Yoshinaga *et al*<sup>9</sup> reported a vein arising directly from the isthmus. AV anastomosis between aorta and inferior vena cava just above the isthmus was also observed.

The area of kidney which showed depression on external feature had histological appearance similar as reported.<sup>9</sup>

It is important for the radiologist and the surgeon to know the anatomical variations in the blood supply of horseshoe kidney as the surgery could be complicated in the presence of anomalous blood supply as there is no collateral circulation.

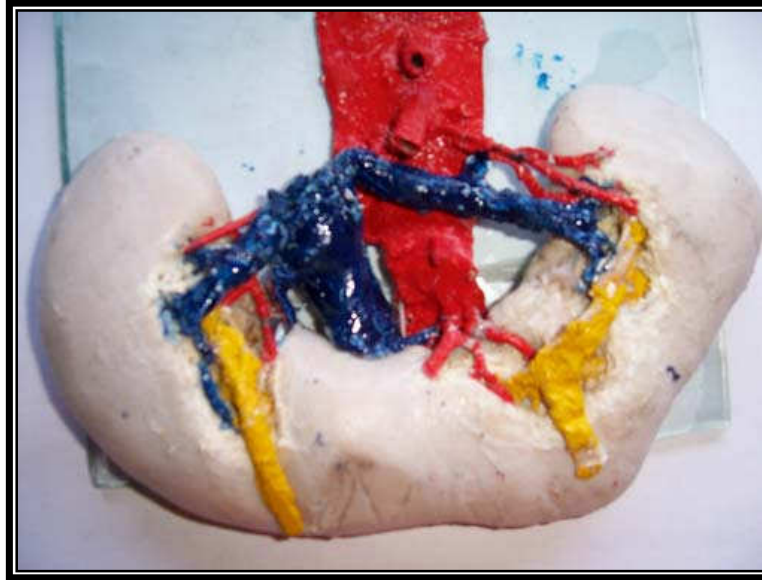
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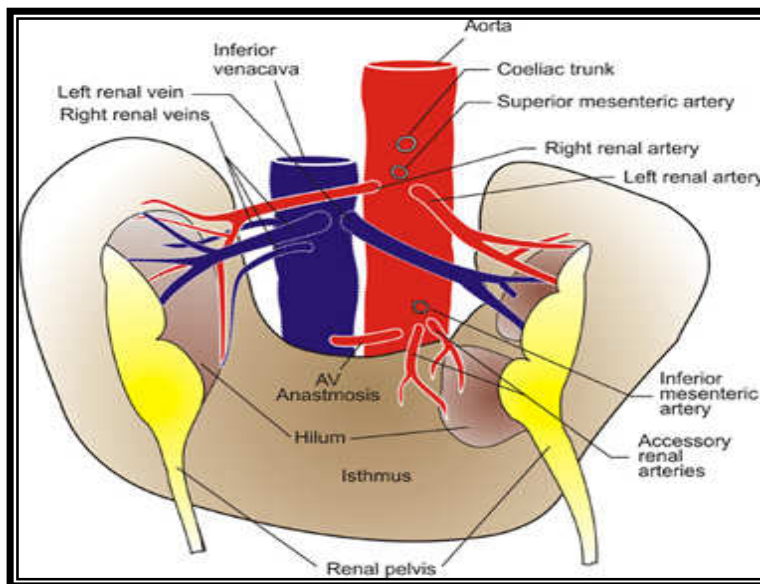
## REFERENCES

1. Dees JE. Clinical Importance of congenital anomalies of upper urinary tract. *J Urol* 1941; 46: 659-66.
2. Lowsley OS. Surgery of horseshoe Kidney. *J Urol* 1952; 56: 565-78.
3. Allen AC. The Kidney: Medical and Surgical Diseases. Grune and Stratton Inc, New York 1951: 94.
4. Flower C. The kidneys and ureters. In Russel RCG, Williams NS, Bulstrode CJK, editors. Bailey and Love's Short Practice of Surgery (23<sup>rd</sup> ed.). London: Arnold 2000: 1173-5.
5. Perimutter AD, Retik AB, Bauer SB *et al*. Anomalies of the upper urinary tract. In Walsh PC, Gittes RF, Perlmutter AD, Stamey TA, editors. Campbell's Urology (5<sup>th</sup> ed.). Philadelphia: WB Saunders 1986: 1665-759.
6. Basar H, Basar R, Basar MM, Erbil M. The comparison of the incidence of horseshoe kidney in autopsy cases versus urologic patient population. *Okajimas Folia Anat Jpn* 1999; 76: 137-9.
7. Sone T, Tamura K. A case of the horseshoe kidney. *Kaibougaku Kyoshitsu Gyosekisyu* 1962; 10: 85-8.
8. Matsumoto T, Arihara K, Oda K, Inoue K. Case of malformation and variation observed at the dissection practice. IV. A case of the horseshoe kidney. *J Kansai Med Coll* 1963; 15: 182-8.
9. Yoshinaga K, Kodama K, Tanii I, Toshimori K. Morphological study of a horseshoe kidney with special reference to the vascular system. *Anat Sci Int* 2002; 77: 134-9.
10. Williams PL, Bannister LH, Berry MM *et al*. Collins P, Dyson M, Dussek JE, Ferguson MWJ. Nervous system. In: Gray's Anatomy (38<sup>th</sup> ed.). Philadelphia: Churchill Livingstone 1995: 199-204.
11. Moore KL, Persaud TVN. The urogenital system. In: The developing human clinically oriented embryology (7<sup>th</sup> ed.). Philadelphia: Saunders 2003: 293-5.
12. Boyden EA. Description of a horseshoe kidney associated with left inferior vena cava and disc-shaped suprarenal glands, together with a note on the occurrence of horseshoe kidneys in human embryos. *Anat Rec* 1931; 51: 187.
13. Cook WA, Stephens FD. Fused kidneys: study and theory of embryogenesis. In Bergsma D, Duckett JW, editors. Urinary systems malformations in children. New York: Allen R Liss 1977.
14. Domenech-Mateu JM, Gonzales-Compta X. Horseshoe kidney: a new theory on its embryogenesis based on the study of a 16-mm human embryo. *Anat Rec* 1988; 222: 408-17.
15. Rinat C, Farkas A, Frishberg Y. Familial inheritance of crossed fused renal ectopia. *Ped Nephrol* 2001; 16: 269-70.
16. Dahlen CP, Schlumberger FC. Surgery of diseased horseshoe kidney. *Amer J Surg* 1957; 93: 405-12.

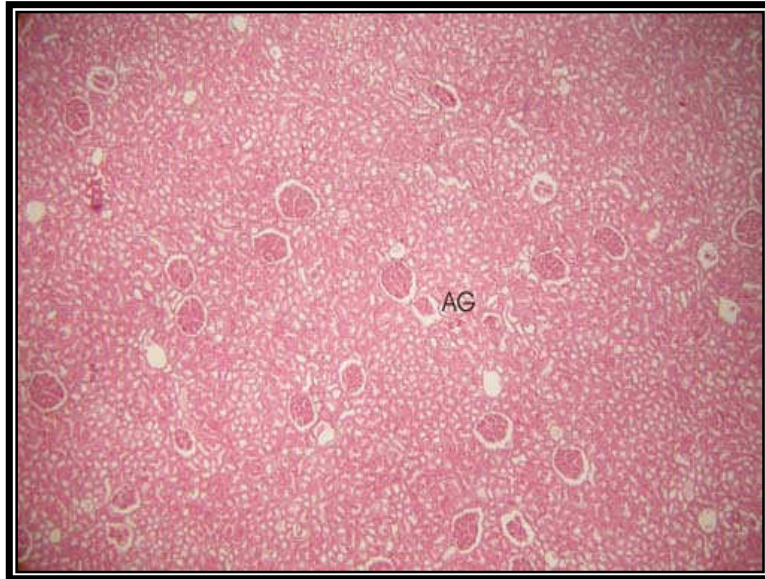
17. Dajani AM. Horseshoe kidney: a review of twenty-nine cases. *Brit J Urol* 1966; 38: 388-402.  
18. Glenn JF. Analysis of 51 patients with horseshoe kidney. *N Engl J Med* 1959; 261: 684-7.  
19. Vahiya VH. Horseshoe kidney with multiple renal arteries and external calyces. *J Anat Soc Ind* 2004; 53, 52-4.



**Fig 1:** Photograph of horseshoe kidney in 32 yr male



**Fig 2:** Schematic diagram of horseshoe kidney



**Fig 3:** Photomicrograph of left kidney showing renal cortex. Atrophied glomerulus (AG). (H&E, X165)