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CLINICAL PRACTICE

Crossed renal ectopia

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Abstract: *The case of 73 years - old male patient with inferior crossed renal ectopia diagnosed upon imaging workup using a GE LightSpeed 16 Slice CT, with urothelial carcinoma, at the level of the left kidney, nephrolithiasis and thrombosed aneurysm at the level of the origin of right common iliac artery. The upper lobe of the right kidney fused with the lower lobe of the left kidney, on the left side of the midline. There were 6 renal arteries (4 on the left and 2 on the right) originating from the left side of the abdominal aorta, at the level of the termination of the abdominal aorta, the left common iliac artery and the right internal iliac artery. The patient presented with 6 renal veins (3 on the left and 3 on the right) that drained anteriorly on the left side of the inferior vena cava into the left common iliac vein and into the right internal iliac vein.*

Keywords: *crossed renal ectopia; arteries – veins*

INTRODUCTION

Crossed ectopic kidney (CFE) is an anomaly within the fused kidneys (FKs) group of malformations, consisting of the fusing of the upper pole of one kidney with the opposite lower pole of the other kidney traversing the midline, with a reversed L-shaped view. [1] describes 6 types of fused kidneys (FKs). [2], quoting Sousa Escandon and Aguilar Tubet, mentions that the first case of crossed renal ectopia was described by Pamarolus in 1654 and the classification of fused kidneys was done in 1957 by McDonalds and McClellan. According to [3], most frequently, the left kidney is the one fusing on the right part, aspect met in the case described by [1]. In our case, as well as in the first two cases described by [4] and in the case described by [5], it was the right kidney that traversed the midline in order to fuse with the left kidney. Numerical variation are frequently met in crossed fused ectopia of the renal veins, comporting 1 to 6 arteries originating from the aorta or the iliac veins (common and internal), and one or more veins that terminate into the inferior vena cava or in the iliac veins (common or internal). The ureters usually do not present variants or anomalies, being just one for each kidney. The renal hilum is anterior or anteromedial. Frequently, crossed fused ectopia is asymptomatic [2, 3, 5, 6] and incidentally discovered during a consult for different other medical reasons, although cases of crossed fused ectopia may present a pathology associated with congenital malformations. As associated pathologies, we have : hematuria, dysuria, urinary tract infections, renal failure, nephrolithiasis, obstruction of the ureteropyelic junction, hydronephrosis, urinary stasis, ectopic ureterocele, urothelial carcinoma [2, 3, 5, 6, 7]. As for congenital malformations, we may encounter the following: cardiac malformation, skeletal-muscle malformation, genital malformations, gastrointestinal malformation [3, 6, 7, 8, 9]. The case presented in our review was diagnosed with urothelial carcinoma of the left kidney, nephrolithiasis and thrombosed aneurysm at the level of the origin of right common iliac artery.

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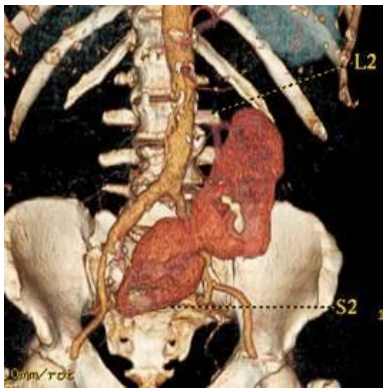
CASE STUDY

73-year old male patient, admitted at the Emergency Clinical County Hospital "Sf. Andrei" in Constanta, diagnosed with urothelial carcinoma of the left kidney, renal lithiasis and thrombosed aneurysm at the level of the origin of right common iliac artery. After the CT scan that was performed using GE LightSpeed 16 Slice CT, the patient was diagnosed with crossed renal ectopia. The right kidney crossed the midline – its upper pole fused with the lower pole of the left kidney, forming a 129,4^{o} angle, showing a reversed L-shape aspect. The diagnosis of inferior crossed renal ectopia – type D was made, according to the classification of [1].

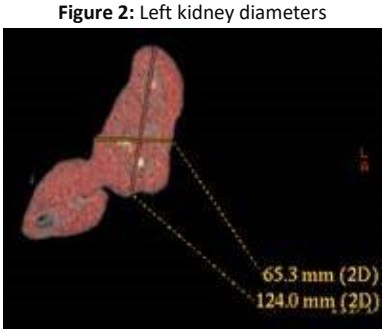
The left kidney was located vertically in the upper part and presented with the upper pole laterally to the costal processes of the L2 vertebra, covering the inferior top of the 12th rib. Its inferior pole reached the pelvis, at the level of inferior half of the S1 vertebra, at the level of sacral ala and the upper medial of the left iliac fossa. The renal isthmus, slightly oblique-inferior to the right, was located above the superior margin of the L5 vertebra and at the level of the L5 – S1 intervertebral disk and at the level of the left lateral part of the S1 vertebral body, at the level of the sacral ala. The inferior pole of the left kidney was positioned anteriorly to the sacral ala and also anteriorly to the upper medial part of the left iliac fossa. The left renal hilum was positioned anteriorly. The right kidney was horizontal (slightly oblique-lateroinferior to the right) with its superior pole corresponding to the inferolateral part of the L5 vertebral body, to the right lateral part of the L5 – S1 intervertebral disk and to the left sacral media ala, and also corresponding to the anterolateral sides of the sacral S1 – S2 vertebras. Its inferior pole overpassed the midline of the sacrum corresponding to the right lateral side of the S3 vertebra, above the anterior third sacral hole (Figure 1). The right hilum was positioned anteroinferiorly.

Figure 1: Our case of CFE in relation with vertebral column



The complex of the 2 kidneys had a longitudinal diameter of 190.6mm, a transverse diameter of 113.8mm and with a volume of 295,788 cm^3. The left kidney (Figure 2) had a bipolar diameter of 122.9mm, a transverse diameter of 65.3mm and an anteroposterior diameter of 36.5mm, with a parenchymal thickness of 20mm and a volume of 160 cm^3.

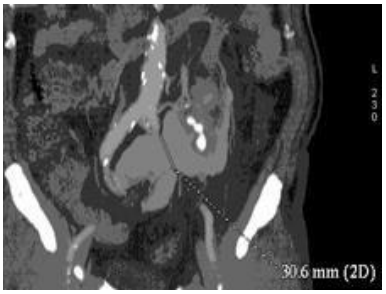
Figure 2: Left kidney diameters



The renal isthmus (Figures 3, 4) had an anteroposterior diameter of 18.1mm, a length of 31 mm, located next to the L4 – L5 intervertebral disk, 30 mm laterally to the midline.

Figure 3: Isthmus antero-posterior diameter (18.1 mm)

Figure 4: Isthmus lenght (30.6 mm)



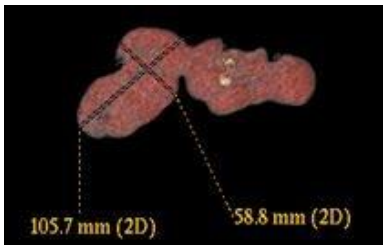
The right kidney (Figure 5) had a bipolar diameter of 105.7 mm, a transverse diameter of 58.8 mm, an anteroposterior diameter of 35.8 mm, with a parenchymal thickness of 20.3 mm and a volume of 136,295 cm^3.

The right ureter had a diameter of 6.0 mm and the left ureter presented with a diameter of 5.0 mm.

The 6 renal arteries of the cross fused ectopia (CFE) were

positioned one under the other, originating at the level of the abdominal aorta and at the level of the internal and common iliac arteries, each artery with its own vascularization territory.

Figure 5: Right kidney diameters



The first renal artery originated on the left side of the aorta, approximately 19mm inferiorly to the origin of the superior mesenteric artery, at the inferior 1/3 of the L1 vertebral body, with a diameter of 1.7 mm that penetrated the upper pole of the left kidney giving birth to a branch the descended anteriorly to the bassinet.

The second renal artery also originated from the left side of the aorta, approximately 55mm inferiorly to the first renal artery, next to the right upper part of the L3 vertebra, with a diameter of 4.3 mm penetrating the renal sinus from behind the bassinet of the left kidney.

The third renal artery originated at the level of the aortic termination, next to the L4 vertebral body, approximately 40 mm inferiorly to the second renal artery, with a diameter of 4.6 mm. It bifurcated into an anterior branch penetrating the renal sinus behind the bassinet and into a posterior branch penetrating the renal parenchyma of the inferior pole issuing a branch that penetrated the renal isthmus and branches for both renal poles.

The fourth artery originated in the left common iliac artery, approximately 60 mm from the bifurcation of the aorta, with a diameter of 2.6 mm. The artery bypasses the lower left pole of the kidney, penetrating the renal sinus anterior to the bassinet flowing into the inferior mesorenal.

The fifth renal artery originated in the right internal iliac artery, at the level of its origin, approximately 62mm from the bifurcation of the aorta, with a diameter of 6.8mm; it penetrated in the right renal sinus where it bifurcated into a prepyelic and retropyelic branches.

The sixth renal artery originated in the posterior trunk of the right internal iliac artery, approximately 62 mm inferiorly to the fifth renal artery, with a diameter of 2.2 mm, perforating the renal parenchyma next to the left inferior kidney.

The left testicular artery originated from the left side of the abdominal aorta, 28 mm under the first renal artery, next to the middle of the L2 vertebral body, with a diameter of 1.7mm and in its ascending route passing behind the left bassinet, issuing a branch for the tumor formation.

There were 6 renal veins (Figures 6, 7, 8), 3 veins for each kidney – for the left kidney we had V1, V2 and V4 and for the right kidney, we had V3, V5 and V6.

Figure 6: CFE 6 renal arteries (R1, R2, R3, R4, R5, R6) and vascular territories

Figure 7: CFE 6 renal veins (V1, V2, V3, V4, V5, V6)

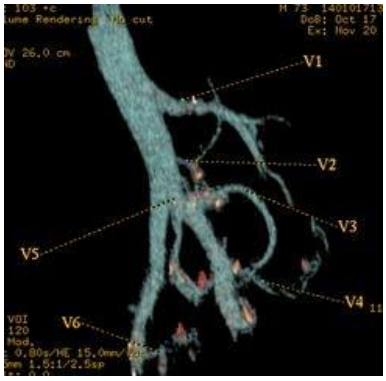


Figure 8: CFE veins and renal drainage territories

The first renal vein ended into the left side of the inferior vena cava, next to the L2 vertebra, it drained the left kidney,

with a retropyelic and retroaortic trajectory and with a diameter of 9.3 mm.

The second renal vein formed by the fusing of an anastomotic branch with the first renal vein with a left lumbar branch, also ending into the left side of the inferior vena cava, next to the L3 vertebra, with a retroaortic trajectory, draining the left kidney and having a diameter of 4.8 mm.

The third renal vein originated from the right renal sinus anterior to the bassinet (also draining the upper pole), ending into the left common iliac vein, 19 mm from the formation of the inferior vena cava, with a diameter of 8.7 mm, draining the right kidney.

The fourth renal vein originated from the left renal sinus next to the inferior pole, accompaning the fourth renal artery, ending into the left common iliac vein, approximately 68 mm from the formation of the inferior vena cava, with a diameter of 5.4 mm.

The fifth renal vein originated from the renal sinus on the posterior side of the right bassinet along with the fifth renal artery was bypassing anteriorly the right common iliac artery, ending on the anterior side of the inferior vena cava, approximately 10 mm above the IVC origin and approximately 22 mm inferiorly to the second renal vein, with a diameter of 8.3 mm.

The sixth renal vein originated from the right inferior pole along with the sixth renal artery, ending in the right internal iliac vein at 33 mm inferiorly to the formation of the right common iliac vein, with a diameter of 5.2 mm.

DISCUSSION

Within the fused kidneys (FKs) group of malformations, the most frequently met is the horseshoe kidney (HK), the crossed fused ectopia (CFE) being the second anomaly in terms of frequency. The horseshoe kidney has a bigger rate of incidence: 1/400 cases according to Lawsley, Eisendrath, Bauer (quoted by 10), 1/600 according to Moore, or 1/1,200 according to Rubin (both quoted by [4]). According to [7], CFE is a rare anomaly of the kidneys, with a prevalence rate of 1/1000 – 1/7500 of cases (Wilmer, Abeshouse, quoted by 10), although a renal anomaly, according to [3] and Bauer (quoted by [7]) incidence rates of 1/300 – 1/7500 of cases. [10] considers the ratio between the frequency of CFE/HK is of 1/7.7. CFE is most frequent in male cases, i.e. double the cases in relation to female cases [9], Bauer (quoted by [7]), 3/1 Boyan (quoted by [5]) or 2.3/1 according to Muttarak (quoted by [5]). [2] describes 3 cases of CFE, 2 of which are female cases and 1 male case.

[4] describes 2 cases of CFE: in one case he finds 6 right renal arteries (2 arteries originating from the lateral side of the aorta and were destined to the left kidney; 1 artery originating from the posterior side of the aorta, vascularizing the isthmus and the left inferior kidney; 1 artery originating at the level of the bifurcation of the aorta that penetrated the left kidney on the posterior side and issued a voluminous branch for the right kidney; the right kidney was vascularized by 2 arteries – one originating on the anterolateral side of the aorta and the other originating from the right common iliac artery). In this case, he finds only 3 renal veins (2 right renal veins and 1 left renal vein). In the second case, he also finds 6 renal arteries: 2 left renal arteries originating on the lateral side of the aorta and 4 right renal arteries - 3 originating on the lateral side of the aorta and one artery originating at the level of the terminal bifurcation of the aorta. In this case, he finds only 2 renal veins – right and left.

[5] describes the case of a CFE that presented 4 renal arteries – 1 artery for the superior renal parenchyma (left kidney) and 3 renal arteries for the inferior renal parenchyma (right kidney). De venous drain was composed of 2 renal veins.

According to Papin, quoted by [7], fused renal anomalies may present with 2 renal arteries (in 20% of the cases), 3-5 renal arteries (in 66% of the cases) and more than 5 renal arteries (in 14% of the cases).

[3] quoting Bauer and bailey, considers that the total number of the arteries for a crossed fused ectopic kidney varies from 1 to most frequently met cases ranging from 2 to 4 arteries; he discovered 3 renal arteries for the left kidney and 1 renal artery for the right kidney.

[6] describes a case of CFE that presented 2 renal arteries originating in the common iliac arteries.

[9] describes one single case presented with only 2 renal arteries (originating on the sides of the aorta), the right renal artery having a precaval trajectory and 2 renal veins – the left renal vein with a retroaortic trajectory.

The origin of the CFE arteries varies, usually the main arteries or in the case where there are only 2 renal arteries originating in the abdominal aorta. [6] finds the origin of the 2 renal arteries in the common iliac arteries.

We found that out of the 6 renal arteries, 2 renal arteries (R1 and R2) originated on the left side of the abdominal aorta, one renal artery originating at the level of the terminal ramification of the aorta (R3) and into the left internal iliac artery (R4), the last 2 arteries originating in the right internal iliac artery – 1 at the level of the unique trunk of the artery (R5) and the other at the level of the posterior trunk of the right internal iliac artery (R5).

[34] finds that most frequently the origin of the CFE arteries is at the level of the abdominal aorta (lateral right side or left side, posterior side and aortic bifurcation), considering the origin of the artery at the level of the right common iliac artery.

In the case of [5], he finds the origin of the 4 renal arteries only at the level of the lateral sides of the aorta – on the right side, 1 artery and on the left side, 3 arteries.

According to [3] the origin of the fused ectopic kidney is at the level of the superior abdominal aorta (in 25% of the cases), whereas for the rest of the cases, he considers the origin at the level of the inferior aorta and the iliac arteries.

The 6 arteries penetrated the kidney at its superior pole (R1), at the level of the renal hilum (R2, R4 and R5), or at the level of the inferior pole of the kidney (R6). R3 terminated into a bifurcation that issued a hilar branch and another branch that inserted in the kidney through its inferior pole. R2 penetrated the hilum posteriorly to the bassinet whereas R4 anteriorly to the bassinet and R5 issued one prepyelic branch and another retropyelic branch.

In two of his cases, [4] finds the CFE arteries penetrating the kidneys about the same levels as ours and he also describes a renal artery for the left kidney that bifurcated into one hilar branch and into an isthmic branch, whereas for the right kidney he finds 2 renal arteries that penetrated the kidney through its anterior side, respectively at the level of its posterior side.

The most voluminous of the arteries was the fifth renal artery that vascularized the right kidney and the less voluminous artery was the sixth renal artery also destined to the right kidney.

There was no renal artery for the renal isthmus. It receives a branch through an artery destined to the inferior pole of the left kidney or through an artery destined to the right kidney.

Out of the 6 renal veins of the CFE, 3 of them terminated in the inferior vena cava, 2 in the left common iliac vein and 1 in the right internal iliac vein. The veins of the left kidney left the kidney through the upper pole (V1) and through the renal hilum (V2 and V4) whereas the veins of the right kidney left the kidney through the renal hilum (V3 and V5) and through the lower pole of the kidney (V6). Out of the veins of the right kidney, the first 2 renal veins had a posterior trajectory to the bassinet, presenting also with a retroaortic trajectory, and out of the veins of the right kidney, the fifth renal vein had a posterior trajectory to the bassinet. The veins of the left kidney terminated on the left side of the inferior vena cava (V1 and V2) and into the left common iliac vein, and the veins of the right kidney terminated into the anterior side of the inferior vena cava (V5) into the left common iliac vein (V4) and in the right internal iliac vein (V6). The first renal vein (V1) was the most voluminous one and belonged to the left kidney, and the less voluminous one was the second vein and originated also from the left kidney. There was no vein to serve exclusively the renal isthmus. Out of the 3 veins of the left kidney only the renal vein had a retroaortic trajectory.

In one of the cases [4] described, he met 3 renal veins: 2 right renal veins – one collecting the blood at the level of the left pole of the left kidney and from the level of the isthmus and flew into the left internal iliac vein, and the other collecting the blood of the upper part of the isthmus ending in the inferior vena cava, above its termination into the cava of the left renal vein. The left renal vein was normally positioned but it received an anastomosis from the left common iliac vein. The other case of CFE of [4] presented a normal left renal vein and 2 right renal veins: one originated at the level of the left pole of the kidney and terminated into the inferior vena cava, 2 cm under the termination of the left renal vein and the left pole of the right kidney with the isthmus presented a vena that terminated in the left iliac vein.

In the case described by [5] there were only 2 renal veins: the upper renal parenchyma was vascularized by a vein that terminated in the left side of the inferior vena cava and the lower renal parenchyma was drained by the second renal vein that terminated also in the left side of the inferior vena cava.

CONCLUSIONS

The case we presented is special due to its uniqueness, as we have not found a similar case of crossed renal ectopia presented with 6 renal arteries (4 left and 2 right) and 6 renal veins (3 left and 3 right) in the specialist literature.

There was no artery – vein correspondence in all 6 cases, such a correspondence was met only at the level of the pole vessels and there was only one case at the level of the hilum vessels. Regarding arteries, the most voluminous was a hilum artery, whereas the veins; the most voluminous, was a superior polar one.

We consider MDCT examination to be the best method of describing vascular and uretheral abnormalities in case of crossed fused ectopia, being able to indentify also, other associated malformation, aspect noted also by [3, 5, 7].

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