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A case of left testicular artery with high origin passing through a left renal vein fenestration

Authors: Ebru Yılmaz, Cem Tatar, Aleyna Keskin, Büşra Yalçın, Ilke Ali Gurses

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CASE REPORT

Left testicular artery with high origin passing through a left renal vein fenestration and double right renal arteries in a male cadaver: a case report

Ebru Yılmaz et al., Left renal vein fenestration

Ebru Yılmaz[1], Cem Tatar[1], Aleyna Keskin[1], Büşra Yalçın[1], İlke Ali Gürses[2*]

[1]School of Medicine, Koç University, İstanbul, Türkiye

[2]Department of Anatomy, School of Medicine, Koç University, İstanbul, Türkiye

Address for correspondence: İlke Ali Gürses, Rumeli Feneri Caddesi, Koç Üniversitesi, Tıp Fakültesi, 34450, Sarıyer, İstanbul, Türkiye, e-mail: iagurses@gmail.com

ABSTRACT

Background: Fenestrations are extremely rare in the venous system, especially renal veins. This paper aims to present a case of left renal vein fenestration where a high origin testicular artery passes through it.

Materials and methods: The variations were observed incidentally in a 74-year-old Caucasian male cadaver during routine retroperitoneal dissections for second year medical students.

Results: A fenestration in the mid portion of the left renal vein was observed. The length and height of the fenestration was 23 and 3.6 millimeters, respectively. The left testicular artery passed through the fenestration and followed a normal course distal to the fenestration. Posterior to the left renal vein, the testicular artery originated from the lateral aspect of abdominal aorta, just caudal to the left renal artery. On the right side, the testicular artery had a similar high origin, and two hilar renal arteries were present. No venous variations were observed on the right side.

Conclusions: The long course of the left renal vein is a factor of preference for donor kidney selection. Uncommon variations of the left renal veins, such as fenestrations, might result in a change in surgical technique and would put the left donor kidney at risk of prolonged anastomosis time and lower survival rates.

Keywords: anatomic variation, fenestration, renal veins, left renal vein, cadaver

INTRODUCTION

Fenestrations are rare anatomical variations where a vessel (an artery or a vein) splits in two and then fuses again along its course before giving a branch or draining to a new vein.

Arterial fenestrations are more common compared to venous fenestrations [5]. Venous fenestrations rarely can occur in various veins. Gündoğdu et al. [5] reported a case of a left renal vein (LRV) fenestration, with a segmental renal artery passing through the fenestration. Similarly, Padur et al. [12] reported a similar LRV fenestration that accommodated the testicular artery. It's important to note that although there are sporadic case reports on venous fenestrations, no research in the English literature reports the frequency of these fenestrations.

Testicular artery variations are quite common due to the abnormal regression of the lateral mesonephric arteries in embryological development [4]. The most common variations include changes in the level, source of origin, number, and course of arteries. Normally, testicular arteries originate from the anterolateral aspect of the abdominal aorta, typically at the level of the second lumbar vertebra, just below the origin of the renal arteries. As a variation, testicular artery's origin can be higher above the renal artery and vein [14].

This case report aims to present a rare LRV fenestration with a high-origin testicular artery passing through the fenestration.

Case report

An uncommon fenestration of LRV was observed incidentally during routine retroperitoneal dissection of a 74-year-old male Caucasian cadaver embalmed with a formaldehyde-ethanol-glycerin-phenol solution at Koç University School of Medicine. Photoshop (Adobe Inc., v24,3) was used for photogrammetric measurements. This study was exempt of IRB approval.

The origin of the left testicular artery was the lateral aspect of abdominal aorta, caudal to left renal artery and posterior to the LRV (Figs. 1B, 2). As the testicular artery coursed inferiorly, it passed through a fenestration on the LRV which was located at its mid portion (Figs. 1A, 2). The left testicular artery followed a normal course distal to the fenestration. The left suprarenal vein (cut during dissection) drained into the superior portion of LRV fenestration, and the left testicular vein drained into the inferior portion of LRV fenestration. The LRV drained into the inferior vena cava (IVC) at a lower level compared to the right renal vein, lower than the origin of superior mesenteric artery.

On the right side of the cadaver, there were two hilar renal arteries originating from the lateral aspect of abdominal aorta. The right testicular artery originated from the inferior hilar renal artery, arched over it, crossed it anteriorly, and followed a normal path in the retroperitoneal region (Figs. 1A, 2).

The length and height of the fenestration was 23 and 3.6 millimeters, respectively. External diameters of the vessels were as follows: left renal vein (at mid aortic crossing) was 17.5 mm, left testicular artery was 1.8 mm, left renal artery was 11.7 mm, right testicular artery was 2.4 mm, right upper hilar renal artery was 7.8 mm, and right lower hilar renal artery was 5.2 mm.

DISCUSSION

This paper reported a cadaveric case of a very rare vascular variation where a testicular artery with high origin passed through a fenestration of the LRV. Variations of the renal veins are less frequent compared to renal arteries [14]. A recent meta-analysis on renal vein variations reports a prevalence of 3.5% for circumaortic renal vein, 3% for retroaortic renal vein, and 16.7% for multiple renal veins with a dominance on the right side (16.6% for right vs. 2.1% for left side) [6]. Despite these rather common variations, no cohort or meta-analysis studies report a frequency for renal vein fenestrations. To our knowledge, there are only a few case reports on the fenestration of renal veins [5, 14].

Departmental records showed no previous clinical conditions or pathologies related to the cadaver in this study. It is known that most renal vein variations are usually asymptomatic and identified incidentally [3]. Although some papers report that renal vein variations could cause left flank pain, hematuria, proteinuria, or left sided varicocele rarely. Gündoğdu et al. [5] reported a case where the posterior segmental artery passed through a LRV fenestration. Despite the patient was diagnosed with rectal bleeding due to internal hemorrhoidal disease, they hypothesized that the indentation of the posterior segmental artery on the renal venous system may have caused increased pressure that resulted with the microscopic hematuria seen in patient’s blood chemistry [5]. Macroscopically observable compression of left renal veins by variational testicular arteries is reported in cadaveric series as well [7, 11]. Conversely, testicular arty compression by an anomalous renal vein is not reported.

Importance of renal venous anatomy is prominent especially in harvesting and transplanting donor kidneys for end-stage renal disease. The short length of the right renal vein creates technical challenges such as using IVC extensions to mitigate short right renal vein and prolonged anastomosis time for right kidneys which result in increased risk for graft thrombosis and lower survival rates for right kidneys [1].

Presence of multiple renal veins is more common on the right side in living donor renal transplantation studies. This might explain prolonged anastomosis time and increased technical complications in right kidney transplantations [1].

Unfortunately, a recent meta-analysis showed that the effects of venous anatomy on kidney transplantation are poorly reported. For example, data on how much or how frequently right renal vein extensions are used is missing. Similarly, presence of multiple or variant veins is reported in a limited number of studies without reporting their effects of surgical outcome [1].

In the presented case, using the left kidney as a donor organ would need either sacrificing the left testicular artery or possibly using an IVC extension like right kidney transplantation. A change in surgical technique would put the left donor kidney at risk of a prolonged anastomosis time, increased risk for thrombosis, and lower survival rate.

Presence of multiple renal arteries is well documented phenomenon in anatomical literature. The number of renal arteries can be up to six and the most common being two renal arteries, similar to our case [10, 13]. Despite differences in frequency of multiple renal arteries in cadaveric and radiological studies, the reported frequency of multiple renal arteries is around 20% [2, 13]. Two or double renal arteries are reported to make up 89.5% of all multiple renal arteries [13].

Renal transplantation is the recommended treatment option for end-stage renal disease, yet growing shortage in donors creates pressure on finding suitable donor organs. Therefore, although being considered as a potential risk factor for transplantation, the use donor organs with multiple renal arteries are increasing [15]. Despite surgical and technical advancements, renal transplantation with multiple renal arteries has significantly higher vascular and urological complication rates, higher warm ischemia time during surgery, more delayed graft function, and lower one-year graft survival rate [15].

Similar to renal vein variations, multiple renal arteries frequently require vascular reconstruction during surgery. Unfortunately, the arterial reconstruction technique or type is not reported in most studies [15]. Additionally, the remaining literature does not provide data on the outcomes of different reconstruction methods and donor organ types (cadaveric vs. living) that could be pooled for detailed analysis [15].

Embryology might explain possible mechanisms for the presence of such rare variations. At around the eighth week of development, the dorsal aorta gives off nine paired lateral branches named the mesonephric arteries. These arteries could be divided into three groups as the cranial (1^{st} and 2^{nd} arteries on both side), middle (3^{rd} and 4^{th} arteries on the right; 3^{rd} to 5^{th} arteries on the left), and caudal (5^{th} and 6^{th} arteries on the right; 6^{th} to 9^{th} arteries on the left) groups [4].

The middle group of arteries frequently develop into the definitive renal arteries. Level of origin or the number of renal arteries is the result of regression patterns of these mesonephric arteries. Interestingly, any mesonephric artery may become the definitive gonadal artery. Therefore, a gonadal artery developed from the cranial or middle groups may have a high origin from the abdominal aorta above the renal veins (as in our case) or an aberrant origin from the renal or inferior phrenic arteries [4].

The renal veins are formed by a complex process of formation, anastomosis, and regression of three embryological veins which are the posterior cardinal, subcardinal, supracardinal veins.

Paired posterior cardinal veins that are located lateral and dorsal to the mesonephros become the dominant vein during the sixth week of gestation. Later they persist as the most distal portion of the IVC and both common iliac veins [4, 8].

Paired subcardinal veins located ventromedial to posterior cardinal veins appear by the end of the sixth week, and supracardinal veins located dorsomedial to posterior cardinal veins emerge in the embryo at the beginning of the seventh week. Subcardinal and supracardinal veins gradually take over the drainage of the caudal part of the body [8].

Between eighth and tenth weeks, the cranial end of the right subcardinal vein forms the suprarenal segment of the IVC. Caudally, the right supracardinal vein persists as the infrarenal segment of the IVC. The caudal left supracardinal vein and left subcardinal veins regress, establishing the right-sided dominance for the IVC [8].

At the beginning of the eighth week, three precursor veins located around the dorsal aorta relate to numerous anastomotic networks formed between paired subcardinal veins (intersubcardinal anastomosis) ventrally, between supracardinal and subcardinal vessels (suprasubcardinal anastomosis) laterally, and between paired supracardinal veins (intersupracardinal anastomosis) dorsally. Distal segments of renal veins at both sides extend from the suprasubcardinal anastomoses. Complete regression of intersupracardinal anastomosis and partial regression of the dorsal portion of suprasubcardinal anastomosis forms the mature LRV’s course anterior to dorsal aorta [9].

This developmental pattern usually explains some major variations of the renal veins. The persistence of intersupracardinal anastomosis results in a circumaortic LRV, while the persistence of intersupracardinal anastomosis along with the complete and partial regression of the intersubcardinal anastomosis ventrally and left suprasubcardinal anastomosis, respectively, results in a retroaortic LRV [8, 9].

Unfortunately, these developmental processes do not explain a fenestration of the middle and distal portions of the LRV. According to Felix [4], the posterior cardinal veins develop multiple horizontal (segmental) branches within the developing mesonephros that communicate with the subcardinal veins and form a very rudimentary double mesonephric circulation. It is possible that as the proximal posterior cardinal veins regress and the metanephric kidneys ascend to connect with the suprasubcardinal anastomoses, persistence and partial fusion of the rudimentary connections between the posterior cardinal and subcardinal veins might be responsible for the development of the segmental veins of the mature kidney and the distal portion of both renal veins.

In our case, we hypothesize that the presence of a high origin gonadal artery developed from the middle group of mesonephric arteries interrupted the fusion of horizontal connections between the posterior cardinal and subcardinal veins and resulted in the fenestration of the LRV.

CONCLUSIONS

Although fenestration of the LRV is extremely rare, the presence of a fenestration where additional structures, such as gonadal arteries, may alter the surgical technique and risk the survival of the donor kidney.

Article information and declarations

Ethics statement

The study did not require approval by the ethical committee of Koç University. Informed consent for body donation was obtained from the donor prior his death. The study followed the Declaration of Helsinki (64th WMA General Assembly, Fortaleza, Brazil, October 2013).

Author contributions

Data Collection and/or Processing — EY, CT, AK, BY; Analysis and/or Interpretation — EY, CT, AK, BY, IAG; Writing — EY, CT, AK, BY; Critical Review — IAG; Supervision — IAG.

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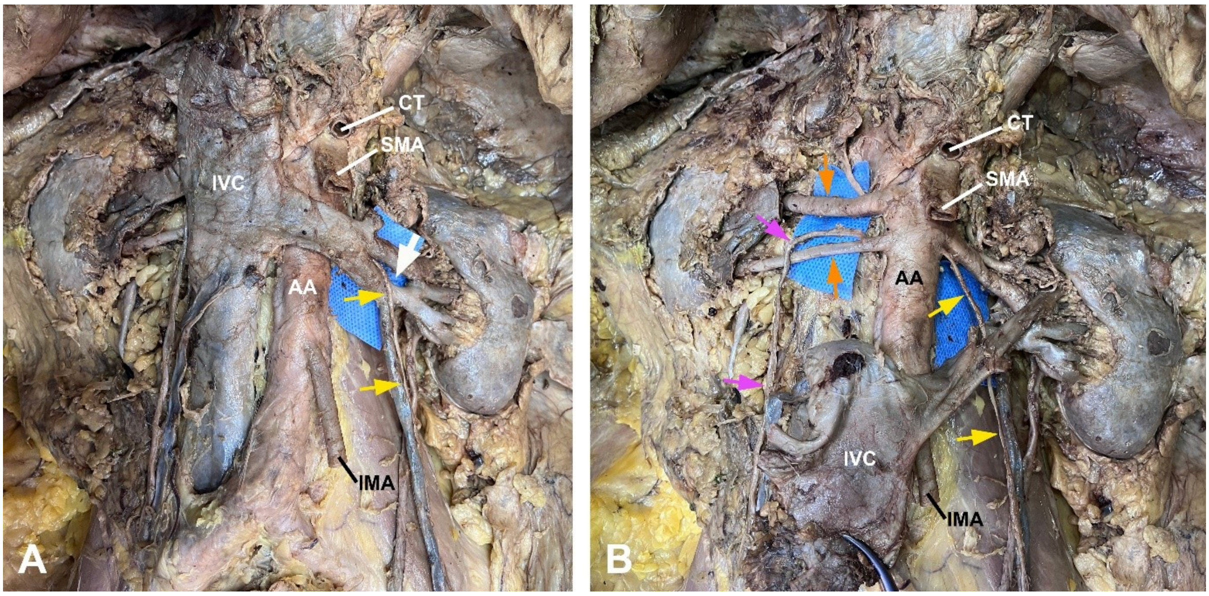

Figure 1. Anterior view of retroperitoneal region. The inferior vena cava (IVC) is intact (**A**) and reflected (**B**) to show the left renal vein fenestration along with renal and gonadal arteries. IVC — inferior vena cava; AA — abdominal aorta, CT — coeliac trunk; SMA — superior mesenteric artery; IMA — inferior mesenteric artery; yellow arrows: left testicular artery; pink arrows — right testicular artery; orange arrows — superior and inferior hilar renal arteries; white arrow — left renal vein fenestration.

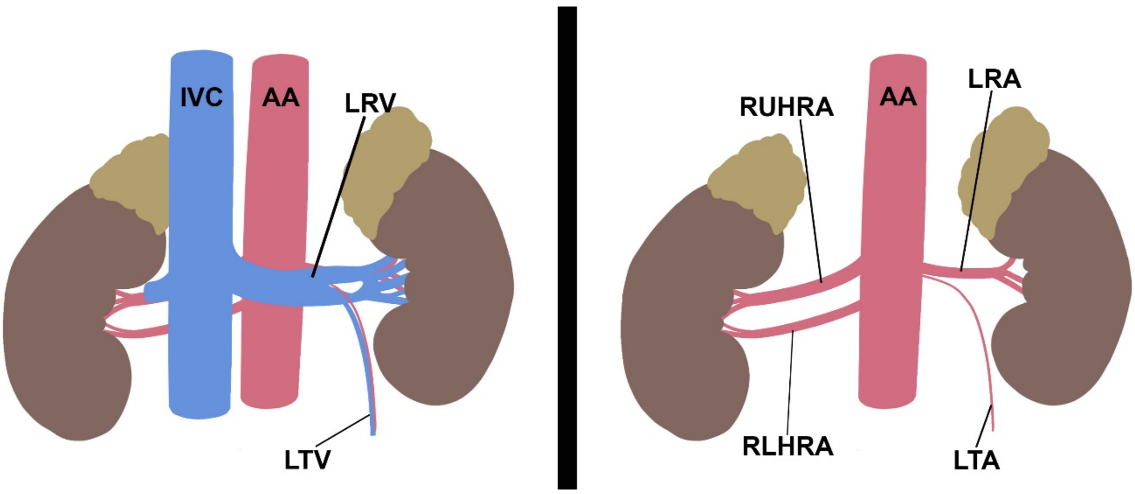

Figure 2. An illustration showing the vascular variations observed in the cadaver. On the right image, the venous structures are excluded for e better view of arterial variations. IVC — inferior vena cava; AA — abdominal aorta; RUHRA — right upper hilar renal artery; RLHRA — right lower hilar renal artery; LRA — left renal artery; LTA — left testicular artery; LTV — left testicular vein.