MULTIPLE ANATOMICAL VARIATIONS OF RENAL VESSELS: AN ANATOMICAL-TOPOGRAPHIC STUDY

MÚLTIPLAS VARIAÇÕES ANATÔMICAS DOS VASOS RENAIS: ESTUDO ANATÔMICO-TOPOGRÁFICO

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ABSTRACT

Introduction: Understanding anatomical variations of renal vessels is clinically relevant for surgeons performing adequate and safe preoperative assessments. **Case report**: During the dissection of a male cadaver, a duplication of the left renal vein and the presence of the left inferior polar artery were observed. The left inferior renal artery polarized between the anterior and left lateral surfaces of the abdominal portion of the descending aorta, at the level of the inferior mesenteric artery. The superior left renal vein exited the renal hilum with a slight downward obliquity, passing anterior-inferior to the left artery and superior to the inferior left renal vein, before draining into the left lateral wall of the inferior vena cava. The superior left renal vein followed a preaortic course and received the inferior left renal vein as a tributary 4.5 cm from the inferior vena cava. **Comments**: Preoperative anatomical assessment of the renal vasculature allows for the prediction of most vascular distribution patterns, thereby guiding the selection of optimal surgical strategies and minimizing the risk of iatrogenic injury or inappropriate therapeutic approaches.

Keywords: Anatomy, Kidney, Renal Artery, Surgery.

RESUMO

Introdução: Conhecer as variações anatômicas dos vasos renais é clinicamente importante para a realização de uma avaliação pré-operatória mais adequada e segura pelos cirurgiões. **Relato do caso:** Durante dissecação de cadáver do sexo masculino, foram encontradas duplicidade da veia renal esquerda e artéria polar inferior esquerda. A artéria renal polar inferior esquerda originava-se entre as faces anterior e lateral esquerda da porção abdominal da artéria aorta descendente, ao nível da artéria mesentérica inferior. Já a veia renal superior esquerda deixava o hilo renal com uma discreta obliquidade para baixo, em posição anteroinferior à artéria renal esquerda e superior à veia renal inferior esquerda, até sua desembocadura na face lateral esquerda da veia cava inferior. A veia renal superior esquerda apresentava um trajeto pré-aórtico e recebia como tributária a veia renal inferior esquerda a uma distância de 4,5 cm da veia cava inferior. **Comentários:** O estudo pré-operatório da anatomia vascular do rim permite predizer a maioria dos padrões de distribuição dos vasos renais e, por conseguinte, escolher a tática operatória mais adequada para prevenir lesões cirúrgicas ou condutas terapêuticas inadequadas.

Palavras-chave: Anatomia; Rim; Artéria renal; Cirurgia

INTRODUCTION

Anatomical variations in the number of renal vessels are frequently reported and may occur unilaterally or bilaterally, including duplication or triplication of renal arteries and veins1. A recent study reported a 31.3% prevalence of polar renal arteries identified by computed tomography angiography. This finding prompts a critical assessment of the anatomical concepts of normality and variation, given the recurrence of such findings in anatomical studies[2].

Classical anatomical descriptions state that each kidney is typically supplied by a single hilar renal artery, arising from the abdominal aorta at the level of the first and second lumbar vertebrae. This artery usually measures between 4 and 6 cm in length, 5 and 6 mm in diameter, and divides near the hilum into four or five branches. However, this classical configuration is present in fewer than 25% of cases[3].

ANATOMICAL-TOPOGRAPHIC STUDY

Renal artery variations have been described using inconsistent terminology, including accessory, aberrant, anomalous, supernumerary, supplementary arteries, or other[3]. This lack of standardization has contributed to theoretical controversies. To address this issue, it has been recommended that renal arteries be classified according to the vascular territory supplied, as hilar artery, extra-hilar superior polar artery, extra-hilar inferior polar artery, superior polar artery, or inferior polar artery[4].

Beyond variations in the number of renal vessels, early branching of the renal artery and multiple patterns of the left renal vein have also been described[3,5].

Understanding renal vascular anatomy is clinically relevant, as it enables accurate preoperative planning and reduces intraoperative risks6. In this way, this study reported a case of anatomical variation in renal vessels, emphasizing its implications for surgical decision-making.

CASE REPORT

During the dissection of a male cadaver, multiple renal arteries and veins were observed on the left side. The abdominal cavity of a male cadaver preserved in 10% formalin, provided by the *Laboratório Morfofuncional* of the *Faculdade de Medicina de Olinda*, was dissected. The dissection began with the removal of the parietal peritoneum from the posterior abdominal wall, exposing the pararenal fat and renal compartment. This compartment comprises the perirenal space, with perirenal fat and the adrenal gland, and is enclosed by the renal fascia (i.e., Gerota fascia). Next, the prerenal layer of Gerota fascia was incised, and the perirenal fat was carefully removed to expose and isolate the structures of the renal pedicle. During dissection, duplication of the left renal vein and the presence of a left inferior polar artery were identified (Figure 1).

Figure 1. Multiplicity of renal vessels (anterior view). RE: left kidney; PAUE: abdominal portion of the left ureter; VSRE: supra-renal left vein; VRSE: left superior renal vein; ARE: left renal artery; VRIE: left inferior left renal vein; VTE: left testicular vein; PAAAD: abdominal portion of descending aorta artery; ARPIE: left inferior polar renal artery; AMI: inferior mesenteric artery.

The left renal artery originated from the left lateral surface of the abdominal aorta, inferior to the superior mesenteric artery. It measured 5.7 cm in length, followed a horizontal course, and presented stenosis shortly after its origin and again 4.0 cm proximal to the renal hilum. The left inferior polar renal artery arose from the anterior-lateral aspect of the abdominal aorta at the level of the inferior mesenteric artery, 0.5 cm lateral to its origin. This artery measured 4.9 cm in length, followed an oblique ascending course, and inserted into the medial border of the left kidney approximately equidistant between the renal hilum and the inferior pole.

The superior left renal vein (SLRV) measured 9.3 cm in length, exiting the renal hilum with a slight downward obliquity. It coursed anterior-inferior to the left renal artery and superior to the inferior left renal vein (ILRV) before draining into the left lateral wall of the inferior vena cava. The left suprarenal vein and the left testicular vein drained into the SLRV at distances of 2.5 cm (superior position) and 4.0 cm (inferior position) from the inferior vena cava, respectively.

The ILRV measured 4.8 cm in length and drained into the inferior aspect of SLRV, 4.5 cm from the inferior vena cava.

COMMENTS

Classical anatomical descriptions indicate that renal veins originate at the renal hilum and are formed by the anastomosis of five to six tributaries. Following a transverse course, renal veins drain blood from the kidneys into the inferior vena cava. The left renal vein is longer than the right and passes anterior to the abdominal aorta, inferior to the origin of the superior mesenteric artery. The left renal vein typically receives the left suprarenal vein, inferior phrenic vein, and left gonadal vein (testicular or ovarian); in some cases, it also receives the left renoazygolumbar vein, draining into the inferior vena cava at a slightly higher level than the right renal vein7.

During embryogenesis, the left renal vein develops from the intersubcardinal anastomosis, which courses anterior to the aorta. A retroaortic left renal vein results from the regression of this anastomosis and renal drainage via the retroaortic intersupracardinal anastomosis. Persistence of both anastomoses leads to the formation of two renal veins, one anterior and one posterior to the aorta, resulting in a periaortic or circumaortic left renal vein, with the retroaortic vein located caudally relative to the preaortic vein. The circumaortic left renal vein may also consist of a single trunk emerging from the kidney that bifurcates before draining into the inferior vena cava, with one branch crossing anterior and the other posterior to the aorta5,8.

Multiple renal veins are nearly as common as multiple renal arteries on the right side; however, such variations are rare on the left side9. Despite its lower incidence, cases of duplicated or triplicated left renal veins have been previously reported5,10.

In the present case, duplication of the left renal vein was observed, with the SLRV receiving the ILRV as a tributary and following a preaortic course, supporting the hypothesis that duplicated left renal veins typically follow a preaortic trajectory5.

Preoperative assessment of renal vascular anatomy enables prediction of vascular distribution patterns and facilitates the selection of optimal surgical strategies, thereby reducing the risk of intraoperative injury or inappropriate therapeutic decisions.

This anatomical evaluation is particularly relevant for candidates undergoing endovascular treatment of aortic aneurysms using fenestrated or branched aortic stent grafts. In addition to assessing the location and caliber of hilar arteries, the presence of polar arteries must be identified to anticipate potential renal injury. Although stent graft-occluded small-caliber polar arteries may be sacrificed, this is only justified when the resulting ischemic segment of the kidney is minimal11.

Preoperative assessment of the renal artery is primarily indicated in living donor nephrectomies for kidney transplantation3. Due to its longer venous pedicle, the left kidney is generally preferred. Anatomical variations in renal arteries rarely constitute absolute contraindications for transplantation; however, the presence of more than three arteries is considered a limiting factor, and transplants involving multiple renal arteries are associated with a higher incidence of late arterial stenosis3,12.

Early bifurcation of the renal artery may complicate vascular anastomosis in the recipient, but the ligation of a superior polar artery with a diameter less than 2 mm may be performed without significant graft ischemia4.

Last, identification of an inferior polar accessory artery is crucial for surgical planning in cases of ureteropelvic junction obstruction. In endoscopic procedures involving a long longitudinal incision of

the junction, an unrecognized vessel may be compromised; in these cases, laparoscopic pyeloplasty is recommended as a safer alternative13,14.

REFERENCES

1. Aragão JA, Santos RM, Aragão FMSA, Aragão ICSA, Carvalho HDG, Matos IQ, Reis FP. Multiple renal vessels. Int J Anat Res. 2017; 5 (4.1): 4460-62.
2. Cinar C, Türkvatan A. Prevalence of renal vascular variations: Evaluation with MDCT angiography. Diagn Interv Imaging. 2016; 97(9): 891-7.
3. Palmieri BJ, Petroianu A, Silva LC, et al. Study of arterial pattern of 200 renal pedicle through angiotomography. Rev Col Bras Cir. 2011; 38(2):116-21.
4. Shigueoka DC. Anatomic variations of the renal arteries, as characterized by computed tomography angiography: rule or exception? Its usefulness in surgical plannning. Radiol Bras. 2016; 49(4):vii-viii.
5. Duques P, Rodrigues JR, Silva Neto FB, Neto EMVS, Toledo ES. Estudo anatômico da veia renal esquerda de cadavers humanos brasileiros. Medicina Ribeirão Preto. 2002; 35(2):184-91.
6. Melo do Espírito Santo T, Bacalhau F, Paschôa AF, van Bellen Bono, Austin I, Raci D. Tomoghaphic anatomy of the vena cava and renal veins features relevent to vena cava filter placement. J. Vasc Bras. 2015; 14 (1): 10-5. doi:101590/1677-5449.20130106.
7. Toda R, Iguro Y, Moriyama Y, Hisashi Y, Masuda H, Sakata R. Double left renal vein associated with abdominal aortic aneurysm. Ann Thorac Cardiovasc Surg. 2001; 7(2): 113-5.
8. Morad Filho JFM, Rodrigues MBS, Dellai RCA, Sauan CM, Martins ACM, França FC, Morad JFM. Variação anatômica: veia renal esquerda retroaórtica. Rev. Faculd Ciên. Med de Sorocaba. 2008; 10(4): 26-7.
9. Famurewa OC, Asaleye CM, Ibitoye BO, Ayolla OO, Aderibige As, Baomus TA. Variations of renal vascular anatomy in a nigerian population: A computerized tomography studys. Niger J. Clin Pract. 2018; 21 (7): 840-46. doi: 10.4103/njcp.njcr-237-17.
10. Mas AG, Arango O, Guzmán A, Coronado J, Rosales A; Cortadellas R, Ballesteros JJ. Anatomia hilar venosa renal. A propósito de 110 nefrectomias para transplante. Actas Urol Esp. 1987; 11:172-175.
11. Mendes BC, Oderich GS, Reis de Souza L, et al. Implications of renal artery anatomy for endovascular repair using fenestrated, branched, or parallel stent graft techniques. J Vasc Surg. 2016; 63(5):1163-9.e1.
12. Benedetti E, Troppman C, Gillingham K, Sutherland DE, Payne WD, Dunn DL, Matas AJ, Najarian JS, Grussner RW. Short- and long-term outcomes of kidney transplants with multiple renal arteries. Ann Surg 1995; 221(4):406-14.
13. Liu PS, Platt JF. CT angiography of the renal circulation. Radiol Clin North Am. 2010; 48(2):347-65, viii–ix.
14. Mello Júnior C, Araujo Neto SA, Carvalho Junior AM, et al. Multidetector computed tomography angiography of the renal arteries: normal anatomy and its variations. Radiol Bras. 2016; 49(3):190-5.

Figura 1. Multiplicidade dos vasos renais. Vista anterior. Legenda: rim esquerdo (RE), porção abdominal do ureter esquerdo (PAUE), veia suprarrenal esquerda (VSRE), veia renal superior esquerda (VRSE), artéria renal esquerda (ARE), veia renal inferior esquerda (VRIE), veia testicular esquerda (VTE), porção abdominal da artéria aorta descendente (PAAAD), artéria renal polar inferior esquerda (ARPIE) e artéria mesentérica inferior (AMI)