Complex distribution of renal vessels

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Abstract

The retroperitoneal lumbar vessels should be immediately recognized during urological, vascular and radiological medical procedures. Few studies have tried to define an exact pattern for the lumbar vasculature and most of the anatomical descriptions suggest the presence of a regular pattern. Nevertheless, for the renal blood vessels, despite the described regular pattern, several anatomical variations have interested anatomists for more than a century. Taking into account that there is a constant need for reviewing this anatomy due to the advances in surgical and/or uroradiological procedures techniques, we describe a complex variation of the renal blood vessels found during the dissection routine in our laboratory. A male cadaver, aged 65 years, embalmed with 10% formalin solution presented, on the left side, two renal arteries arising from the abdominal aorta, both of them entering the kidney on the hilar region. From the hilar region of the left kidney, there were also two tributary renal veins, which join together 3.0 cm from the hilus, before draining into the inferior vena cava. These two tributary veins were large in diameter, and made a loop around the two renal arteries and also the ureter. No anatomical variations were found on the right side. This is a complex anatomical variation of the renal vessels which might have functional implications once the venous loop described might be a compression factor for the renal arteries and for the ureter.

Keywords: renal artery, renal vein, anatomical variation, uroradiological procedures, vascular surgery.

1 Introduction

The anatomy of the renal vascular pedicle is of great value during many surgical procedures, such as those on the abdominal aorta, inferior vena cava, portal vessels and nephrectomy, and on the renal pelvis, kidney transplantation and also on operations of the vertebral column (CAGGIATI, PICUCCI and BARBERINI, 1977). A correct preoperative diagnosis of the arrangement of the renal vessels is mandatory in such cases and the surgeons might be aware of the presence of vessels variations. Inadvertent injury of a variant vessel leads to unwelcome bleeding, which can be avoided to a great extent with prior knowledge of possible variations that may exist when an earlier developmental arrangement persists in the adult (DHAR, 2002).

Knowledge of possible anatomical variation of renal blood vessels was also described of major importance for the radiologist who performs diagnostic renal arteriography and also for procedures such as balloon angioplasty and stent implantation for the treatment of renal artery pathologies (BEREGI, MAUROY, WILLOTEAUX et al., 1999).

We share the opinion that it is important to document variations of the renal blood vessels since it may influence surgery in this region, including kidney transplantation, and radiological diagnosis and procedures.

2 Case report

An adult, white, male cadaver, aged 65 years, fixed in 10% formalin solution, was used in this study. During the routine dissection of the retroperitoneal space, no variations were found on the right side. Nevertheless, the left side showed the presence of unexpected blood vessels to and from the kidney. Particular care was taken in dissecting these vessels and surrounding structures, so we could correctly evidence all vessels described as follows. With the aid of an electronic digital caliper (range of 0-300 mm, resolution 0.001 mm, Gehaka, SP, Brazil), the variant vessels were measured in length and diameter, as previously reported (FAZAN, BORGES, SILVA et al., 2004). Two renal arteries arose from the abdominal aorta (Figure 1a). The main renal artery (AR1), with 0.7 cm in diameter, branched into three other arteries, at 2.8 cm from its origin. The first branch, an upper polar artery (AP), was 3.1 cm long, with 0.4 cm in diameter. The second and the third branches inserted normally on the renal hilus (both with 0.6 cm in diameter and 2.9 and 3.3 in length, respectively). The additional renal artery (AR2) originated at 5.2 cm inferiorly from the main renal artery, being 3.1 cm long and 0.6 cm in diameter. From the renal hilus, two tributary renal veins were found (Figure 1b): the upper one (VR1) with 1.4 cm in diameter and 3.1 cm long; and the lower one (VR2) with 1.1 cm in diameter and 3.0 cm long. Both veins join to form a main renal vein, 4.6 cm long, than drains into the inferior vena cava. The two tributary renal veins form a venous loop around the main renal artery and its branches, except the upper polar artery, and also around the ureter (PU). After carefully describing and measuring the variant vessels, in order to document the variation for publication and also for our Anatomical Museum, they were colored with white latex mixed with different ink colors, being red for arteries, blue for veins and dark green for the ureter (Figure 1).

3 Discussion

3.1 Additional renal artery

The normal or main renal artery is described as a single vessel, at a more or less constant position opposite the renal hilus, from the abdominal aorta and which continues undivided, except for several small branches – the inferior suprarenal, the perirenal and the ureteral arteries – in its straight course to the renal hilus (SATYAPAL, HAFFEJEE, SINGH et al., 2001). The literature is replete of different nomenclature for cases when more than one renal artery is found and Satyapal et al. (2001) have proposed a simple definition as that an additional renal artery, other than the main renal artery, is one which arises from the aorta and terminates in the kidney. In this way, the second renal artery we are describing in the left kidney of this cadaver is being so called an additional renal artery, as suggested previously (SATYAPAL, 2004).

Additional renal arteries have been described in the literature, not only on dissection material (BANIEL, FOSTER and DONOHUE, 1995; KHAMANARONG, PRACHANEY, UTRARAVICHIEN et al., 2004; OZAN, GÜMÜSALAN, ÖNDEROGLU et al., 1995; SATYAPAL, HAFFEJEE, SINGH et al., 2001; ZHAO, SIDIROPOULOS, PEUKER et al., 1997), but also on radiological exams (BEREGI, MAUROY, WILLOTEAUX et al., 1999; BUSH, BRANNEN and LEWIS, 1989). They are described as originating usually caudal to the main artery (BANIEL, FOSTER and DONOHUE, 1995). The average incidence of additional renal arteries is reported as being wide-between 8.7 and 75.7% (SATYAPAL, HAFFEJEE, SINGH et al., 2001). Some authors report their incidence higher on the right side (BANIEL, FOSTER and DONOHUE, 1995) wile others attest that they are more common on the left side (SATYAPAL, HAFFEJEE, SINGH et al., 2001). Two hilar arteries are found in a frequency of 7.5% being a renal hilar artery defined as those renal arteries that originate from the abdominal aorta and terminate at the renal hilus (KHAMANARONG, PRACHANEY, UTRARAVICHIEN et al., 2004).

In the present study, the described additional renal artery is a hilar artery (KHAMANARONG, PRACHANEY, UTRARAVICHIEN et al., 2004), while an upper polar artery is a branch of the main renal artery. It is a left side variation, which would account for the Satyapal et al. (2001) statistics on the left side being more affected than the right, and it is also accompanied by a venous variation, which is rare in the literature.

3.2 Additional renal vein

Typical arrangement of the left renal vein is described in percentages ranging from 79 to 91% (DAVIS and LUNDBERG Jr., 1968; REIS and ESENTHER, 1959). Two renal veins are described in about 3.1% of cases

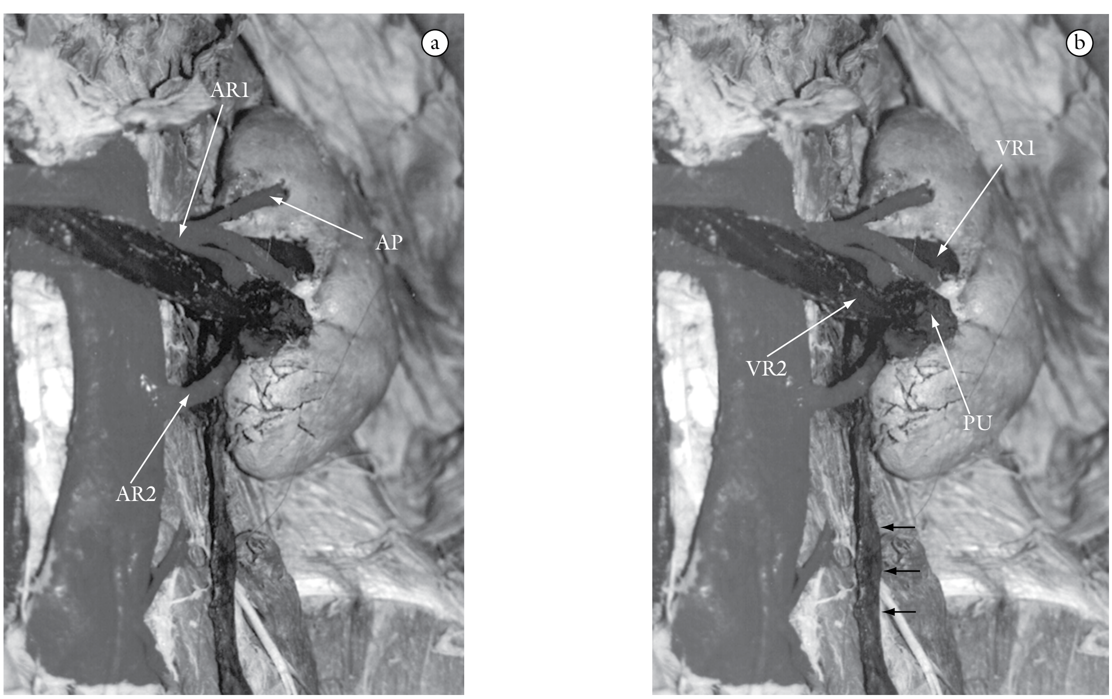

Figure 1. a) The main renal artery (AR1) branched into three other arteries: the first branch, an upper polar artery (AP) and the other two branches for the hilus. The additional renal artery (AR2) originated at 5.2 cm inferiorly from the main renal artery and also entered the renal hilus; and b) Two tributaries of the main renal vein were found: the upper one (VR1) and the lower one (VR2) join to form a main left renal vein than drains into the inferior vena cava. The two tributary veins form a venous loop around the main renal artery and its branches, except the upper polar artery, and also around the ureter (PU and arrowheads).

(GOSWAMI, 1976). Additional veins are seen much more frequently on the right side than on the left side (DHAR, 2002; SATYAPAL, RAMBIRITCH and PILLAI, 1995). The different development of the right and left sub-supracardinal anastomosis is thought to count for the inverse relationship between supernumerary renal veins (MACCHI, PARENTI and DE CARO, 2003). Although multiple renal veins are more common on the right side, the variations in the course are almost exclusively located on the left (MACCHI, PARENTI and DE CARO, 2003), with a reported incidence of a single vein on the right side of 26% and only 2.6% on the left (SATYAPAL, RAMBIRITCH and PILLAI, 1995). While on the right side the sub-supracardinal anastomosis is incorporated into the inferior vena cava, which might be a factor favoring the persistence of both right primitive renal veins, on the left side, the sub-supracardinal anastomosis fully regresses (MACCHI, PARENTI and DE CARO, 2003). Consequently, the persistence of more than one primitive renal vein appears improbable. In the case we reported here, it seems that the regression of the sub-supracardinal anastomosis was partial, leading to the persistence of a loop between two tributaries outside the hilus, which joined together further from the hilus to form the main renal vein.

Despite the fact that Satyapal (1995) have demonstrated that 39% of the renal veins consists of two primary tributaries only, as is the case of our description, it is important to mention that, in our case, these two tributaries were large veins (measuring 1.4 and 1.1 cm in diameter – which is close to the average diameter of the main renal vein, described by Satyapal et al. (1995)), forming a loop around the main renal artery branches (except the upper polar artery., which is a branch of the main renal artery), and also around the ureter. Such variation has not been described previously and might have clinical implications because of the possibility of a compression of these structures by this venous loop.

3.3 Concludding remarks

Describing anatomical variations such as the one in the present study is not only of academic interest, but also important to help radiologists on the correct interpretation of image examinations and for surgeons who will do any intervention in the related area. We believe that complex anatomical variations with direct clinical implications such as the described in the present study are worth of publication and discussion.

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References

BANIEL, J., FOSTER, RS. and DONOHUE, JP. Surgical anatomy of the lumbar vessels: Implications for retroperitoneal surgery. *J. Urol.* 1995, vol. 153, no. 5, p. 1422-1425.

BEREGI, JP., MAUROY, B., WILLOTEAUX, S. et al. Anatomic variation in the origin of the main renal arteries: spiral CTA evaluation. *Eur. Radiol.* 1999, vol. 9, no. 7, p. 1330-1334.

BUSH, WH., BRANNEN, GE. and LEWIS, GP. Ureteropelvic junction obstruction: treatment with percutaneous endopyelotomy. *Radiology* 1989, vol. 171, no. 2, p. 535-538.

CAGGIATI, A., PICUCCI, K. and BARBERINI, F. On a complex arrangement of the vascular pedicle of the left kidney. *Ann. Anat.* 1977, vol. 179, no. 3, p. 269-271.

DAVIS, CJ. and LUNDBERG Jr., GD. Retroaortic left renal vein, a relatively frequent anomaly. *Am. J. Clin. Pathol.* 1968, vol. 50, no. 6, p. 700-703.

DHAR, P. An additional renal vein. *Clin. Anat.* 2002, vol. 15, no. 1, p. 64-66.

FAZAN, VPS., BORGES, CT., SILVA, JH. et al. Superficial palmar arch: an arterial diameter study. *J. Anat.* 2004, vol. 204, no. 4, p. 307-311.

GOSWAMI, AP. Anatomical variation of the renal veins with varicosity presenting as pseudotumor of the kidney. *J. Urol.* 1976, vol. 116, no. 5, p. 648-649.

KHAMANARONG, K., PRACHANEY, P., UTRARAVICHIEN, A. et al. Anatomy of renal arterial supply. *Clin. Anat.* 2004, vol. 17, no. 4, p. 334-336.

MACCHI, V., PARENTI, A. and DE CARO, R. Pivotal role of the sub-upracardinal anastomosis in the development and course of the left renal vein. *Clin. Anat.* 2003, vol. 16, no. 4, p. 358-361.

OZAN, H., GÜMÜSALAN, Y., ÖNDEROGLU, S. et al. High origin of gonadal arteries associated with other variations. *Ann. Anat.* 1995, vol. 177, no. 2, p. 157-160.

REIS, RH. and ESENTHER, G. Variations in the pattern of renal vessels and their relation to the type of posterior vena cava in man. *Am. J. Anat.* 1959, vol. 104, p. 295-318.

SATYAPAL, KS., HAFFEJEE, AA., SINGH, B. et al. Additional renal arteries incidence and morphometry. *Surg. Radiol. Anat.* 2001, vol. 23, no. 1, p. 33-38.

SATYAPAL, KS., RAMBIRITCH, V. and PILLAI, G. Additional renal veins: incidence and morphometry. *Clin. Anat.* 1995, vol. 8, no. 1, p. 51-55.

SATYAPAL, KS. Classification of the drainage patterns of the renal veins. *J. Anat.* 1995, vol. 186, no. 2, p. 329-333.

SATYAPAL, KS. Letter to editor. Reply to "Anatomy of enal arterial supply". *Clin. Anat.* 2004, vol. 17, no. 8, p. 688.

ZHAO, B., SIDIROPOULOS, A., PEUKER, ET. et al. A new distinctive variation of renal arterial vascularization. *Ann. Anat.* 1997, vol. 179, no. 5, p. 487-488.

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