

## Case Report

# Replaced Right Hepatic Artery Associated with Uncommon Triplet Right Renal Vein: Embryological Perspective and Clinical Importance

Satheesha NB, Srinivasa RS (✉), Surekha DS, Naveen K, Anita G

Department of Anatomy, Melaka Manipal Medical College, Manipal Campus, Manipal University, Madhav Nagar. Manipal. Karnataka State. India. 576104.

### Abstract

Vascular variations in the abdomen are common and mostly asymptomatic. Knowledge of these variations are of tremendous clinical importance in patients undergoing invasive endovascular interventions such as liver transplantation, renal transplantation, and vascular reconstruction for congenital and acquired lesions and trans-arterial chemoembolization for the hepatic tumors. During regular dissection classes for the medical undergraduates, we encountered concurrent vascular variations in an elderly male cadaver. In the present case, we report multiple vascular anomalies involving the right hepatic artery and the right renal vein. The right hepatic artery branched off from superior mesenteric artery, and it was identified as a replaced right hepatic artery. The right kidney was drained by three renal veins, the uppermost among the three twisted around the superior branch of the right renal artery before terminating into the inferior vena cava. In addition, the left kidney was supplied by two renal arteries, and drained by a single renal vein.

**Keywords:** Renal, vein, artery, right hepatic, left hepatic, coeliac trunk, superior mesenteric

### Correspondence:

Srinivas Rao Sirasanagandla., Department of Anatomy, Melaka Manipal Medical College, Manipal Campus, International Centre for Health Sciences Manipal University, Madhav Nagar, Manipal Udupi District, 576 104 Karnataka State, India. Tel: +91-820-2922644 Fax: +91-820-2571905 Email: seenaih.anat@gmail.com

Date of submission: 17 Aug, 2012

Date of acceptance: 24 Oct, 2012

### Introduction

The coeliac trunk (CT) supplies the abdominal oesophagus, stomach, duodenum up to major duodenal papilla, liver, pancreas, gall bladder and spleen. The classic branches of CT are the common hepatic, splenic and left gastric arteries. The common hepatic artery after originating from the CT runs downwards to the first part of the duodenum, where it divides into hepatic artery proper and gastroduodenal arteries. The common hepatic artery gives right gastric branch before its termination. The hepatic artery proper runs in the right free margin of lesser omentum and divides into right and left hepatic arteries at or near the porta hepatis.

The renal veins are the tributaries of the inferior vena cava, and they lie anterior to the renal artery. They open into the inferior vena cava at the level of L2

vertebra. Right renal vein typically receives blood solely from the right kidney. The left renal vein is three times larger than right renal vein and it receives blood from the left kidney, left gonad and left suprarenal gland. Multiple variations in the abdominal vessels are commonly observed and have been reported in the past. Mostly reported variations are that of hepatic artery, coeliac trunk and its branches and renal vessels. However, multiple vascular variations of these vessels in a person are rarely reported in the past. In the present case, we report the vascular variations involving RHA and right renal vein with their embryological aspects and clinical significance.

### Case Report

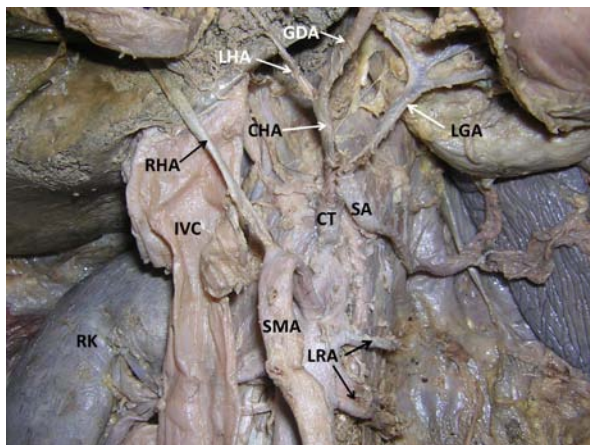
During regular dissections for the medical undergraduates, we found multiple vascular variations,

in the retroperitoneal region of an elderly male cadaver. The CT trifurcated into splenic artery left gastric artery and common hepatic artery. The common hepatic artery divided into left hepatic artery and gastroduodenal artery. The right hepatic artery (RHA) arose from the superior mesenteric artery (SMA), close to its origin from the abdominal aorta (AA). This artery was found to be solely supplying the right lobe of the liver, and it was identified as a replaced RHA (Fig. 1).

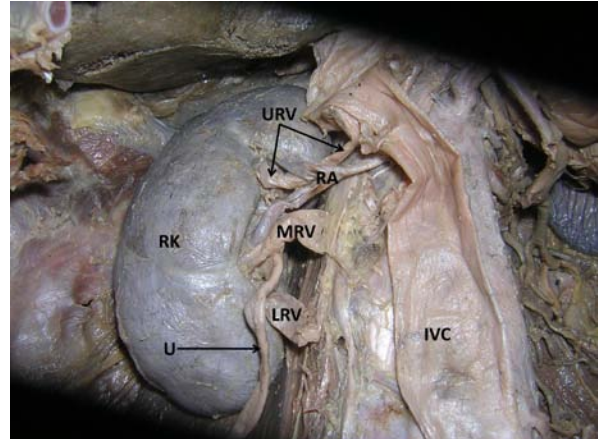
The right kidney was drained by three renal veins (Fig. 2). The upper most among the three twisted around the superior branch of right renal artery. It terminated into inferior vena cava by entering through its posterior surface (Fig. 2 and 3). The middle renal vein passed behind, and the inferior renal vein passed in front of the proximal part of the ureter before ending in the inferior vena cava. In addition, the left kidney was supplied by two renal arteries, and drained by a single renal vein.

## Discussion

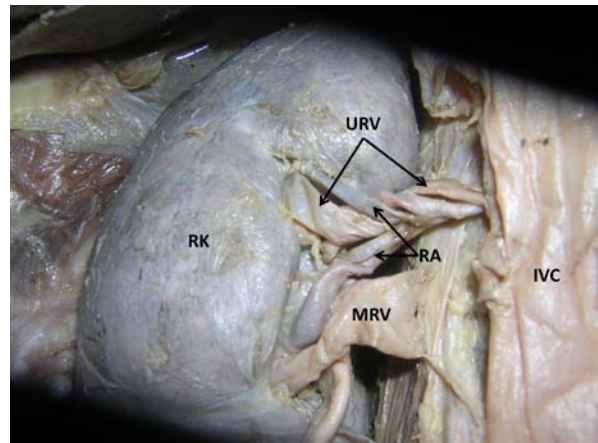
RHA usually arises from the proper hepatic artery, a branch of common hepatic artery and supplies the right lobe of the liver. If it originates from any artery other than hepatic artery proper and replaces the RHA arising from the hepatic artery proper, it is defined as replaced RHA, but if the artery serves as an additional branch it is defined as accessory RHA (1). The replaced right hepatic artery may arise from the SMA. Earlier, many studies have documented the incidence of replaced or accessory RHA from the SMA, and the incidence varied from 10.6% to 18% in various groups (2,3,4,5). The



**Figure 1:** Dissection of the upper part of the abdominal cavity showing the branches of the coeliac trunk and origin of right hepatic artery from the superior mesenteric artery. Left kidney has been removed. (SMA; superior mesenteric artery, RHA; right hepatic artery, CT; coeliac trunk, SA; splenic artery, CHA; common hepatic artery, RHA; right hepatic artery, GDA; gastroduodenal artery, LGA; left gastric artery, LRA; left renal arteries, IVC; inferior vena cava, RK; right kidney)



**Figure 2:** Dissection of right part of the abdominal cavity showing the right renal vessels. (IVC; inferior vena cava, RK; right kidney, RA; right renal artery, URV; upper renal vein, MRV; middle renal vein, LRV; lower renal vein, U; ureter)



**Figure 3:** Dissection of right part of the abdominal cavity showing the closer view of the twisted upper renal vein. (RK; right kidney, URV; twisted upper renal vein, MRV; middle renal vein, RA; renal artery, IVC; inferior vena cava)

persistence of replaced RHA can be explained on the basis of embryonic development of ventral branches of the abdominal aorta. In the fetal life, aorta gives off ventral branches, four of which forms the celiac, splenic, common hepatic and SMA. Later, a longitudinal arterial anastomoses is formed between these segments. Persistent longitudinal arterial segment connecting the SMA may attribute to the development of replaced RHA, in the postnatal life (6).

In the present case, we report a replaced RHA from the SMA, and the common hepatic artery continued as a left hepatic artery. This anatomical variant is clinically very important, as the occlusion of the SMA by various means invites the necrosis of right lobe of the liver, along with the affected gut. Occlusion of SMA is

a common clinical problem because approximately 4% of all arterial emboli, characteristically cardiac in origin, are lodged in it (7). In the current era, knowing the detailed vascular anatomy and the possible vascular variations of the liver is very much essential for the surgeons as liver transplantation has become a routine method of treatment. Presence of the replaced or accessory hepatic arteries may be revealed by the angiography of the celiac and mesenteric arteries. Prior knowledge of replaced RHA, and its relation with surrounding structures is also important to prevent the vascular or biliary damage while performing laparoscopic cholecystectomy and the radiological procedure such as trans-arterial chemoembolization for the hepatic tumors (6).

Generally, the renal veins show less variation than to the renal arteries. However, the variations of right renal veins are more common than left renal veins. Presence of multiple renal veins was reported in a study conducted by Janschek et al (8). In their study, these variations were observed more on the right side (23%) than on the left (6.7%). Malcic-Gurbuz et al. have reported a doubling of right renal vein (9). Two rare anatomical variations of the left renal veins, the circumaortic venous ring and a retro-aortic bifid left renal vein have been reported (10). The same authors also reported the unusual branching of left renal vein and its drainage into azygos vein and inferior vena cava. Any additional renal vein arising from the hilum of the kidney and draining into the IVC is defined as supernumerary renal vein (11). Earlier incidence of supernumerary renal veins has been studied by many authors. Baptista-Silva *et al.* observed multiple right renal veins in 8 to 9.2% of cases (12). In a study conducted by Bregman these veins were found more on right side (18%) than left side (9%) (13). Similarly, Dhar and Ajmani observed 12% of cases on the right side, 3% of cases on the left side (14). In a recent study by Anupama et al, 33% of cases were found on right side and 3.3% of cases on the left side (11). Based on the existing literature, it is evident that even though incidence of supernumerary renal veins occurs on both sides, they are more frequently observed on the right side. Occurrence of varying pattern of supernumerary renal veins, and their frequent incidence on the right side can be explained on the basis of their embryonic development (15). The development of renal vein begins with, and is a part of complex developmental process of IVC. In this complex process, three pairs of temporary veins, the postcardinals, subcardinals and supracardinals are formed on each side. Successively, there are numerous anastomoses formed between these three pairs of parallel veins. The developing mesonephros receives the branches from the right postcardinal vein, dorso-medial branches of the

supracardinal vein and ventral branches of the subcardinal veins. Later fusion of these branches forms single renal vein on each side. The developmental error in the fusion of these branches results in the varying pattern of supernumerary renal veins (15). At the time of development, most of the portions of the temporary veins on each side disappear, to form the right sided IVC. Probably, this shifting of venous arrangement to the right side and complex embryogenesis of left renal vein may explain the higher incidence of supernumerary renal veins on the right side compared to the left side (11).

Right renal vein may be doubled, even though left renal vein is usually single. The incidence of a right triple renal vein is very rare (16). In the present case, we reported a rare case of triple renal veins. Amongst the three, the superior renal vein was twisted around the superior branch of the renal artery before terminating into the IVC. To the best of our opinion, the present case was unique because of the twisted course of the superior renal vein. Twisting of renal vein may not be due to the abnormal rotation of the kidney, if that was the case the other renal veins, renal arteries and ureter would have been twisted as well. Based on the existing literature, there is no embryological explanation for the twisting of renal vessels. Twisting of renal vessels may cause functional disturbance in the kidney. In our case the twisting of superior renal vein is of no clinical meaning as the middle and inferior renal veins were normal.

Prior knowledge and familiarity of the occurrence of multiple renal veins, reported in the present case, may be useful to avoid vascular injuries in retroperitoneal procedures. A sound knowledge of the congenital anomalies of renal veins is also essentially important for the vascular surgeons and urologist as it is vital in the renal transplantation, treatment of renovascular hypertension, renal artery embolization, angioplasty or vascular reconstruction for congenital and acquired lesions, surgery for abdominal aortic aneurysm and conservative or radical renal surgery (16).

## Conclusion

Prior knowledge and familiarity of the occurrence of vascular anomalies of right hepatic artery and multiple renal veins, reported in the present case, may be useful to avoid vascular injuries in the retroperitoneal procedures.

## References

1. Weiglein AH. Variations and topography of the arteries in the lesser omentum in humans. *Clin Anat* 1996; 9(3):143–150.

2. Gruttadauria S, Foglieni CS, Doria C, Luca A, Lauro A, Marino IR. The hepatic artery in liver transplantation and surgery: vascular anomalies in 701 cases. *Clin Transplant* 2001; 15:359–363.
3. Covey AM, Brody LA, Maluccio MA, Getrajdman GI, Brown KT. Variant hepatic arterial anatomy revisited: digital subtraction angiography performed in 600 patients. *Radiology* 2002; 224:542–547.
4. Coskun M, Kayahan EM, Ozbek O, Cakir B, Dalgic A, Haberal M. Imaging of hepatic arterial anatomy for depicting vascular variations in living related liver transplant donor candidates with multidetector computed tomography: comparison with conventional angiography. *Transplant Proc* 2005; 37(2):1070–1073.
5. Koops A, Wojciechowski B, Broering DC, Adam G, Krupski-Berdién G. Anatomic variations of the hepatic arteries in 604 selective celiac and superior mesenteric angiographies. *Surg Radiol Anat* 2004; 26(3):239–244.
6. Judy J, Coen A, James M. Right hepatic artery branching off the superior mesenteric artery and its potential implications. *International Journal of Anatomical Variations (IJAV)* 2009; 2:143–145.
7. Barakate MS, Cappe I, Curtin A, Engel KD, Li-Kim-Moy J, Poon MS, Sandeman MD. Management of acute superior mesenteric artery occlusion. *ANZ J Surg* 2002; 72(1):25-29.
8. Janschek EC, Rothe AU, Holzenbein TJ, Langer F, Brugger PC, Pokorny H, Domenig CM, RasoulRockenschau S, Mühlbacher F. Anatomic basis of right renal vein extension for cadaveric kidney transplantation. *Urology* 2004; 63(4):660-664.
9. Malcic-Gürbüz J, Akalin A, Gümüşcü B, Cavdar S. Clinical implications of concomitant variations of the testicular, suprarenal and renal veins: a case report. *Ann Anat* 2002; 184(1):35-39.
10. Senecail B, Bobeuf J, Forlodou P, Nonent M. Two rare anomalies of the left renal vein. *Surg Radiol Anat* 2003; 25(5-6):465-467.
11. Anupama G, Raman G, Rikki S. Congenital variations of renal veins: embryological background and clinical Implications. *Journal of Clinical and Diagnostic Research*. 2011; 5(6): 1140-1143.
12. Baptista-Silva JC, Verissimo MJ, Castro MJ, Camara, AL, Pestana JO. Anatomical study of the renal veins observed during 342 living-donor nephrectomies. *Rev Paul Med* 1997; 115(3):1456-1459.
13. Bregman RA, Afifi AK, Miyauchi R. *Virtual Hospital: Illustrated encyclopedia of human renal arteries*: 2000; 15-18.
14. Dhar P, Ajmani ML. Major anomalies of left renal vein and inferior vena cava. *Int Med J*. 2004; (2).
15. Gillot C. La veinerenale gauche: etude anatomique, aspects angiographiques, abord chirurgical. *Anat Clin* 1978; 1:135–155.
16. Fernandes RMP, Conte FHP, Favorito LA, Abidufigueiredo M, Babinski MA. Triple right renal vein: An uncommon variation. *Int J Morphol* 2005; 23(3):231-233.