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Research Article

ANATOMICAL VARIATIONS OF THE RENAL AND GONADAL VESSELS: CIRCUMAORTIC LEFT RENAL COLLAR TRIPLE LEFT RENAL ARTERY AND DOUBLE ORIGIN OF THE LEFT GONADAL ARTERY

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ABSTRACT

Variations of the origin of renal and testicular arteries and their drainage pattern are many. Lack of knowledge of these variations during surgery can result into accidental injuries of vessels, leading to severe hemorrhage. With this knowledge in mind, preoperative detection of these anatomical variations is mandatory to avoid iatrogenic injuries. In routine procedures involving the retroperitoneal surgeries, the anatomy of these vessels is important for safety surgical procedure. Variations of renal and gonadal vessels have been documented in different studies. The incidences of these variations many, so still no single study has covered the scope of these variations.

With the advancement in technology, routine renal conservative open surgeries are now done laparoscopically. This procedure needs precise knowledge of vascular anatomy. With an increase in renal transplantation procedures in our settings, the succinct knowledge of the renal anatomy particularly arterial supply and venous drainage is highly needed. In addition the gonadal vessels have been discussed for the reason that are either drained by renal veins or originated from the abdominal aorta, such that surgeries involving renal vessels can accidentally injure the gonadal vessel leading to avascular necrosis of gonads.

The variations are also important to explain the phenomena of ontogenesis among human and their clinical implication. The present work was designed to study the renal veins, arteries and gonadal vessels and their variations using cadaveric specimens. This in turn could provide knowledge so as to avoid iatrogenic injuries encountered during different retroperitoneal procedures. The variations were observed in routine dissection of retroperitoneal structures at Muhimbili University and St Joseph University College of health sciences. The present study has put forward the different variations of renal vessels and gonadal vessels. In this current study we found the rare variations of renal arteries; the triple renal arteries, the left renal collar and double origin of left gonadal artery.

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BACKGROUND

The abdominal aorta becomes retroperitoneal as it traverses the diaphragmatic hiatus. It gives several branches on its course. At the earliest part of its course it gives the celiac axis and both superior and inferior mesenteric artery. Both renal and testicular arteries are also given as it descends down the pelvis. Alongside the Aorta, the inferior venacava collect blood from corresponding vessels; with classical drainage pattern depend of side of the organs.

Variations of renal veins and renal arteries are the result of abnormal embryogenesis. Various anomalies of renal vein mainly result from errors of the embryological development.

These variations are seen frequently in imaging techniques (Park, *et.al* 2012). The renal arteries originate from the lateral aspect of aorta below the origin of superior mesenteric artery at the level of L2 vertebra (Anju *et.al* 2015). The renal veins lie anterior to renal artery and open into the inferior vena cava at the level of L2 vertebra. The right renal vein is a shorter than the left renal vein. Both left and right renal vein drain into the inferior venacava. The left renal vein also receive tributaries from the left adrenal vein and left gonadal vein. (Anupma *et.al* 2011)

The inferior venacava is formed by a complex process during the sixth and eighth weeks of gestation. Pairs of primitive veins

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namely the postcardinal, subcardinal and supracardinal veins will eventually forms hepatic, suprarenal, renal and infrarenal (Jime and Gimeno 2017). The most frequent anomalies are detected in the renal vessels. Understanding such variations is the crucial to avoiding vascular injury during in retroperitoneal procedures.

The development of aortic renal collar results from persistence of embryonic renal venous collar thus the dorsal limb of embryonic left renal vein and dorsal arch of renal collar which is formed due to inter supra cardinal anastomosis of inferior vena cava(Sreekanth, 2015). Persistence of the dorsal limb of the embryonic left renal vein and of the dorsal arch of the renal collar (intersupracardinal anastomosis) results in circumaortic left renal vein (Marjeta et al. 2015).

The better understanding of circumaortic renal collar is very important in the medical field especially for angiographers when doing preoperative angiograph of patients or donors. For kidney transplant procedures, this kind of knowledge is needed since iatrogenic damage to these vessels may results into fatal hemorrhage that can predispose a patient into death. Since most of anomalies occurs on the left side then attention should be drawn as the left kidney which is usually preferred for transplant surgery because of its longer left renal vein (Halord,1975).

In addition; knowledge concerning the variation in renal vascular supply can be used as the criteria when selecting patients as donors for kidney transplant(Anju et.al 2015). Similarly knowing these variation is essential for correct interpretation of images by radiographers, to avoid incorrect diagnosis of masses or adenopathy and awareness of surgeon to avoid potential complications intraoperatively (Töre,et.al 2008).

MATERIAL AND METHODS

This study comprises of 30 well embalmed human cadavers (60 renal veins) of known sex, obtained from department of Anatomy. The data were collected during routine dissections of the structures of the posterior abdominal wall. All cadavers were male. The abdominal cavity was opened, flaps were reflected and abdominal viscera were systemically removed according to Zukerman dissection manual. This involved the removal of the intraperitoneal visceral organs systematically and finally the exposure of the retroperitoneal structures, including the kidneys and major blood vessels with their branches. Renal veins were identified and traced from the hilum of kidney up to their termination in inferior vena cava. All of their tributaries were also traced up to their respective origins.

RESULTS

Out of 30 cadavers of present study a classical patterns of renal veins was observed only in 13(42%) cadavers. In the rest of 17(58%) cases, a wide range of variations were encountered. From developmental point of view, four major congenital variations of the renal vein namely the supernumerary renal veins retro-aortic; circumaortic and plexiform renal vein were observed. We encountered the following three rare variations; below

Case 1: The left kidney was found supplied by three different renal arteries that are arising from the abdominal aorta at different level (Figure.1), the accessory renal artery was arising from the abdominal aorta at the level of superior mesenteric artery and enters the left kidney near to the superior pole, the second accessory renal artery was also arising from the abdominal aorta with little distance below the first(superior) one ,where it divides into two segmental renal arteries before entering the left kidney just above the left renal vein

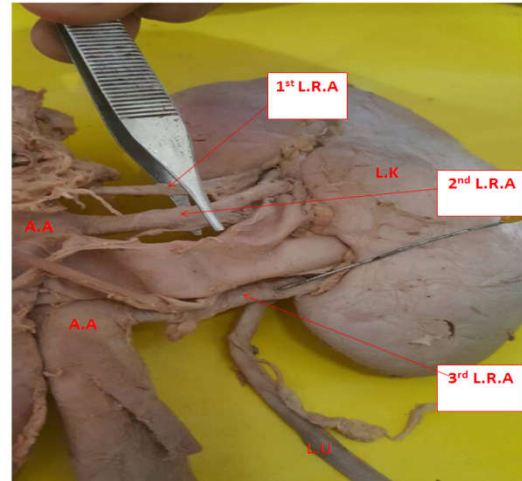


Figure 1 Picture showing the multiple renal arteries supplying the left kidney whereby A.A=Abdominal Aorta, L.U=Left Ureter, L.K=Left Kidney, 1st L.R.A=First/Superior Accessory Left Renal Artery, 2nd L.R.A=Second/Middle Accessory Left Renal Artery, 3rd L.R.A=Third/Inferior Accessory Left Renal Artery

Case 2: The case of left renal collar, Supernumerary renal vein: Supernumerary renal vein is defined as any additional vein arising from hilum of kidney and draining into Inferior vena

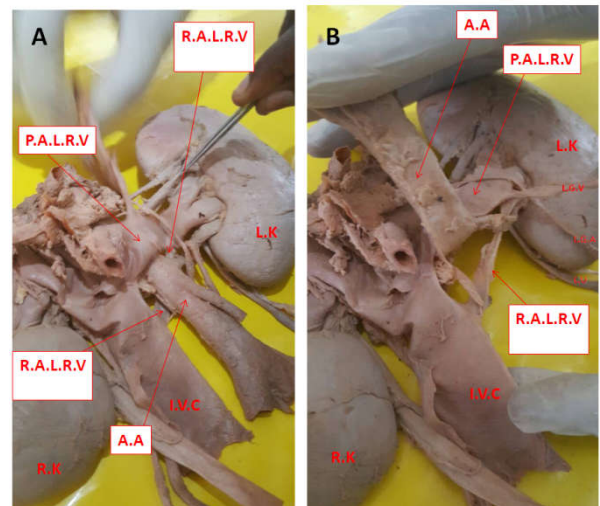


Figure 2 Pictures A and B showing the Circumaortic left renal collar; In picture A the abdominal aorta is left undisturbed lying over the retroaortic renal vein while in picture B the abdominal aorta is pulled away to allow full view of retroaortic renal vein arising from the I.V.C at the level of Inferior mesenteric artery. Where by A.A=Abdominal Aorta, R.A.L.R.V=Retroaortic Left Renal Vein, I.V.C=Inferior Vena Cava, L.U=Left Ureter, L.G.V=Left Gonadal Vein, L.K=Left Kidney, R.K=Right Kidney, P.A.L.R.V=Preaortic Left Renal Vein, L.G.A=Left Gonadal Artery,

Case 3: The case of Double origin of left gonadal artery

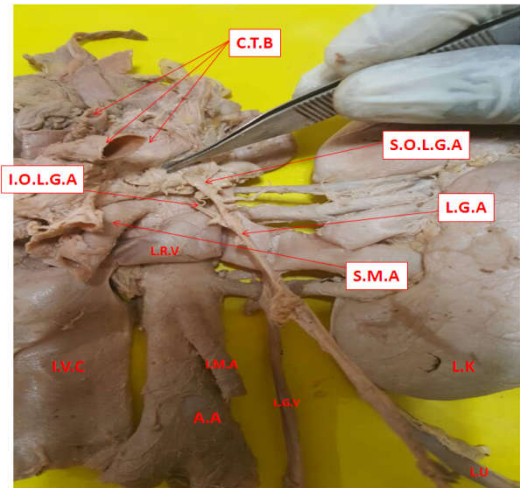


Figure 3 Picture showing the Double origin of Left Gonadal artery, whereby A.A=Abdominal Aorta,I.V.C=Inferior Vena Cava L.U=Left Ureter, L.K=Left Kidney, S.M.A=Superior Mesenteric Artery, I.M.A=Inferior Mesenteric Artery, L.G.V=Left Gonadal Vein, L.R.V=Left Renal Vein, I.O.L.G.A=Inferior Origin of Left Gonadal Artery, S.O.L.G.A=Superior Origin of Left Gonadal Artery, L.G.A=Left Gonadal Artery, CTB=Celiac Trunk Branches

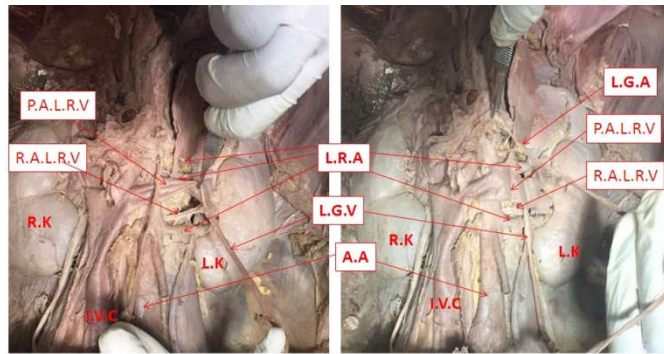


Figure 4 A Picture showing all three Major Vascular anomalies and variations of this case report, whereby A.A=Abdominal Aorta, R.A.L.R.V=Retroaortic Left Renal Vein, I.V.C=Inferior Vena Cava, L.G.V=Left Gonadal Vein, L.K=Left Kidney, P.A.L.R.V=Preaortic Left Renal Vein, L.G.A=Left Gonadal Artery, L.R.A= Left Renal Arteries.

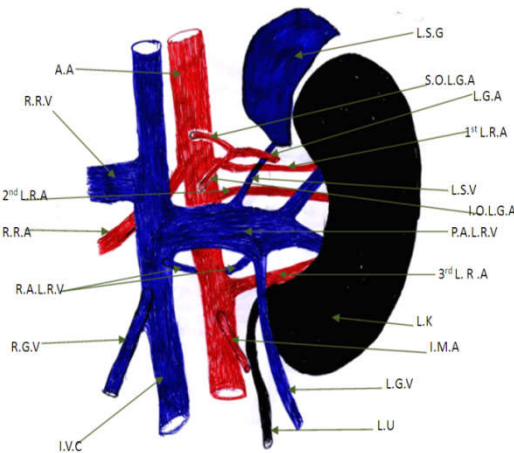


Figure 5 A Diagram describing Three Major Vascular anomalies and variations of this case report as shown in Figure 4 above, whereby A.A=Abdominal Aorta, R.R.V=Right Renal Vein, R.R.A=Right Renal Artery, R.G.V=Right Gonadal Vein, R.A.L.R.V=Retroaortic Left Renal Vein, I.V.C=Inferior Vena Cava, L.U=Left Ureter, L.G.V=Left Gonadal Vein, I.M.A=Inferior Mesenteric Artery, L.K=Left Kidney, P.A.L.R.V=Preaortic Left Renal Vein, L.S.V=Left Suprarenal Vein, I.O.L.G.A=Inferior Origin of Left Gonadal Artery, S.O.L.G.A=Superior Origin of Left Gonadal Artery, L.G.A=Left Gonadal Artery, L.S.G=Left Suprarenal Gland, 1st L.R.A=First/Superior Accessory Left Renal Artery, 2nd L.R.A=Second/Middle Accessory Left Renal Artery, 3rd L.R.A=Third/Inferior Accessory Left Renal Artery

DISCUSSION

A circumaaortic left renal vein surrounding the abdominal aorta, where the superior left renal vein passes anterior to the abdominal aorta just inferior to the celiac artery and the inferior left renal vein passes posterior to the aorta, were observed in preoperative work out for renal using multidetector CT angiography (Rathod *et.al* 2004). This would be otherwise missed and could cause problems intraoperatively. In case of circumaaortic renal vein ,the risk of venous injury as the large component of anterior renal collar can confuse the surgeon and therefore injury of retroaortic component(Anupma *et.al* 2011). In a study among Indians the incidence of renal veins anomalies circumaaortic renal vein were 3.3%(2/60) and retroaortic left renal vein both types were 7.6%(5/60)(Bhanu *et al.* 2015).In another study the incidence of circumaaortic renal collar among 50 cadavers were found to be 2%(Sreekanth *et.al* 2015).The awareness of circumaaortic renal collar is compulsory as it can be confused with various pathological conditions such as lymphadenopathy (Marjeta *et al.* 2015).In a different study the persistent of retroaortic renal vein was also reported (Bhattarai *et.al* 2009).

In another study the double retroaortic renal vein was also found in 66 years old male cadaver draining into the inferior venacava. (Kyung *et al.* 2012). The circumaaortic left renal veins was after division of left renal vein at the point after the left spermatic vein joined the left renal vein(Odgers,2000.). Double retroaortic renal vein was also encountered in 51 years old woman during cross-section imaging(Park *et al.* 2012). Double renal artery on the left side was also found in a cadaveric study . In this same study the double renal vein was also observed forming the left renal collar with the left gonadal vein drain into the accessory left renal vein(Mitesh *et.al* 2012).

In another study the three right renal arteries, inferior suprarenal artery were originating from the middle right renal artery. In the same study the two right renal veins and the origin of the right testicular artery from the inferior right renal artery were observed. In addition there was a termination of the termination of the right testicular vein into the right renal vein(Nayak, 2008).

Multiple variation of retroperitoneal blood vessels was also observed in different studies(Rodrigues and Rodrigues 2013) (Sreekanth. 2015) (Taylor,*et.al* 2016) (Thejodhar *et al.* 2007) (Töre *et al.* 2008) (Andrade *et al.* 2005) (Anju *et.al* 2015) with the left renal vein being the most aberrant vessels with more potentially dangerous variations. In our study however; we have encountered the left renal collar and Supernumerary renal vein. Supernumerary renal vein is defined as any additional vein arising from hilum of kidney and draining into Inferior vena) this is a rare variation. Also triple renal arteries were supplying the left kidney.

CONCLUSION

Variation of blood vessel supplying and drain the retroperitoneal structures should not be overlooked. Many different variations can be encountered during various invasive procedures. Knowledge of variants retroperitoneal blood vessels is essential to surgeons and radiographer and for correct interpretation of pathological conditions and avoiding iatrogenic injuries. Preoperatively screening of patients who are

schedules for any surgical procedures involving the retroperitoneal structures should be considered. This will reduce the possibility of iatrogenic injuries intraoperatively which may be life threatening.

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