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A study of branching pattern of renal artery in cadavers

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Abstract
Variations of renal arteries have been the subject of interest in recent decades due to the increased need for renal transplant. However, the presence of different branching pattern of the renal artery results in technical limitations in kidney transplantation. So this study was conducted on 100 human cadavers to find the variations in the branching patterns of renal artery in the human cadavers. We found different types of branching pattern of renal artery and have been classified into different types. Presences of multiple renal arteries were also encountered. The knowledge of the branching pattern of the renal artery helps to approach surgical procedures on the kidney.

Keywords: kidney, real artery, renal transplant

Introduction
Knowledge regarding variations in the branching pattern and termination of the renal artery have assumed increased importance as renal transplantation, renovascular hypertension, vascular reconstruction for both congenital and acquired lesions, and reconstructive surgery for abdominal aortic aneurysms have become more common place in clinical surgical practise [1]. Variations in branching pattern of the renal artery have been observed frequently, either in routine dissection or in clinical practice. Some of these variations do not even cause clinical symptoms and do not require treatment. However some of them are predisposing to some pathological disorders because of the decrease in the blood supply or urinary flow [2]. Thus it is important for surgeons and radiologists to be aware of the possible variations of the renal artery, in order to prevent complications during surgical and diagnostic procedures.

Renal arteries originate at right angle from the abdominal aorta at the level of intervertebral disc between L1 and L2 vertebra [3]. Before entering into the kidney substance, the renal artery gives off one or more inferior suprarenal arteries, a branch to the ureter and small branches which supply the perinephric tissue, the renal capsule and the pelvis of the ureter [4]. At or near the hilum of the kidney, the renal artery divides into segmental arteries each of which supplies one vascular segment of the kidney [5]. The segmental arteries are end arteries, so that the vascular segments are independent units. The division of renal artery into segmental arteries is not in a definite pattern in all the subjects.

For the development and improvement of surgical approaches to the kidneys, along with the development of diagnostic methods such as angiography, ultrasonography, Doppler and cast technique, we need anatomical studies by cadaveric dissection to define the division of the renal artery. Further most of the study is focused on the presence of multiple renal arteries rather than its branching pattern [6, 7]. So, there is a need of study on different branching pattern of renal artery which is important during the surgical procedures at the hilum of the kidney.

Materials and Methods
The institutional ethical clearance was obtained from the ethical committee. After acceptance of ethical committee 50 embalmed human adult cadavers irrespective of sex were dissected in the Anatomy Department. All the cadavers were embalmed and preserved in 10% formaldehyde. A total of 100 kidneys with their renal artery were analysed for the study of branching patterns of renal artery. The method of dissection was done according to the “Cunningham’s manual of practical anatomy’’ [8]. The findings of the branching pattern were collected, tabulated and statistically analysed.

Result
We have classified the branching pattern of renal artery into different types on the basis of similarity. In ladder type the branches from the main renal artery are arise sequentially from one side (fig.1). Such type of branching pattern was found in 9%. In fork type the renal artery divided into two divisions in a U shaped manner (fig 2) which was found in 12%. The triplicate type of branching pattern was found in 15% (fig 3) in which the renal artery divided into three division from the same point. The most common type of branching pattern was bifurcating and branches from anterior division which was present in 50%. Few renal arteries which have unique patterns and their prevalence were less were categorised into miscellaneous type.

Photographs of Branching Pattern of Renal Arteries

Fig 1: Ladder Type of Branching Pattern of Renal Arter

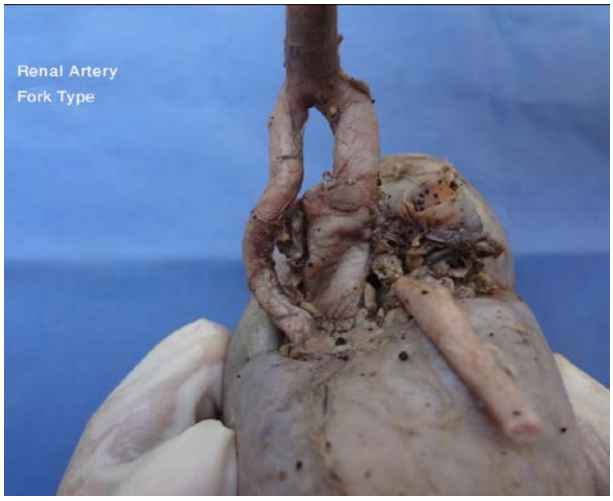

Fig 2: Fork Type of Branching Pattern of Renal Artery

Fig 3: Triplicate Type of Branching Pattern of Renal Artery.

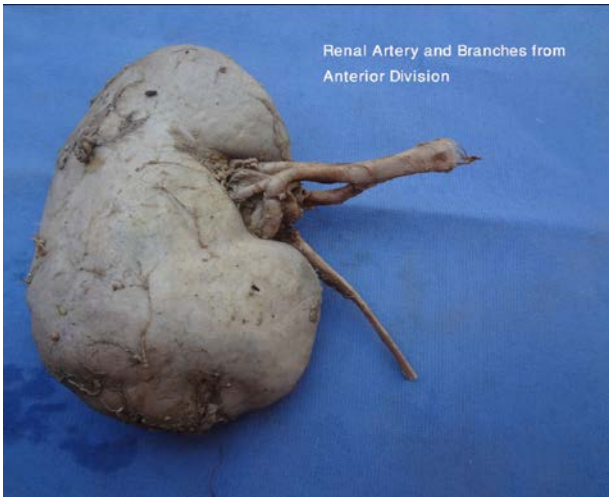

Fig 4: Bifurcating and Branches from Anterior division of Renal Artery.

Fig 5: Bifurcating and Branches from Posterior division of Renal Artery.

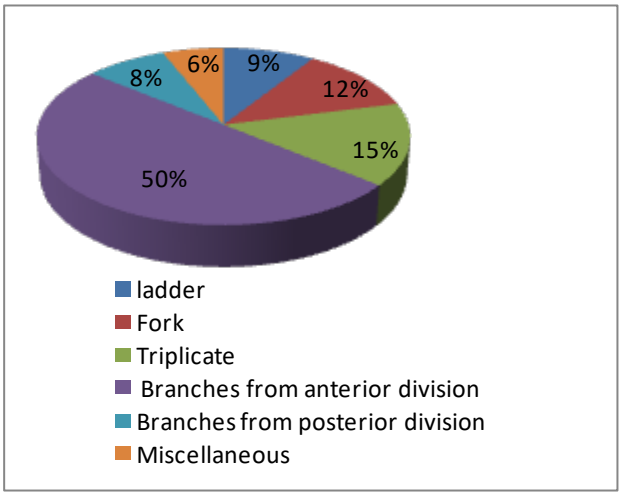

Fig 6: Pie chart showing branching patterns of renal arteries and their prevalence.

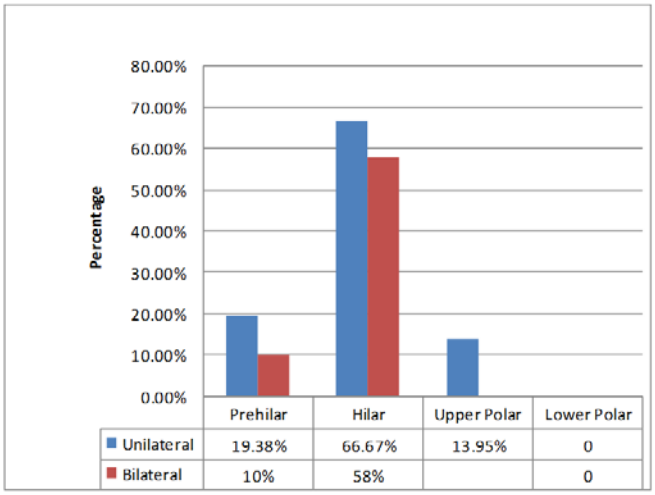

Fig 7: Bar chart showing termination of renal arteries

Discussion

The presence of unusual branching pattern of the renal arteries is not uncommon. In our study we found that in 70% of cases there was a single renal artery supplying each kidney. Multiple branching patterns of the renal arteries may not be an uncommon finding. The clinical implications of such anomalous branching patterns need to be given due attention.

Most of the authors have concentrated on the variations and presence of multiple renal arteries. H. Fine and E.N. Keen in 1966 studied in detail about the branches of renal arteries with respect to the vascular segment of the kidney. According to them a renal artery has primary three branches, posterior, upper and lower. So their study was limited only with the origin of these primary branches from the renal artery [9]. Knowledge of branching patterns of renal artery are important during the surgical procedures at the hilum of the kidney.

We classified the renal arteries into six categories according to their pattern of termination. They were ladder type (6%), fork type (12%); triplicate (15%): bifurcating and branching from anterior division (50%); bifurcating and branches from posterior division (8%) and miscellaneous type (6%). Shoja MM *et al* in 2008 studied 81 kidneys and reported ladder pattern in 7.4% and triplicate in 12.4%. These reports match with our result. They included our fork and two bifurcating types in the fork type which was 92.6% [10]. In our miscellaneous category the polar arteries arose from the renal artery close to the origin from the aorta. These types of artery are equally important as multiple renal arteries. These variations have been reported by other authors. In two cases in the miscellaneous category the renal arteries divided into four branches more or less from the same point. In one case the renal artery divided into two division and the branches were emerged immediately from both the division.

In this study all the arteries (both main and accessory) were analyzed according to their place of termination into the kidney as: upper polar, lower polar, hilar and prehilar renal arteries. In cases when the kidney was provided by two arteries, the accessory arteries were terminated in upper pole or in hilun of the kidney.

Upper polar arteries are a type of accessory artery, originating from the aorta and directly entering the renal parenchyma at its upper pole. The incidence of upper polar artery in this study was 13.95%. This percentage was greater than that reported by Talovic in 2007 (5.1 %.) and Budhiraja in 2010 (6.66%) [11, 12]. There was a rare case report in 1979 by Stephenson and Paul where a single renal artery terminated at the upper pole. No such report was found in this study [13].

Regarding the range of frequency of accessory renal arteries some discrepancy is noted in the relative proportions of upper and lower accessory renal polar arteries. An inferior polar renal artery has a lower frequency as compared to the upper polar artery. Nathan in 1958 studied 400 renal pedicles. He found 3.5% lower polar arteries [14]. Anatomical Societies of Great Britian and Ireland in 1891 reported 4% lower polar artery [15]. In the present study we did not find any lower polar artery. Lower polar arteries are of extreme importance clinically and surgically. Lipshutz in 1926 described kinking or compression of the pelvis or of the ureteropelvic junction by accessory inferior polar renal artery, arising from the aorta, may produce attacks of high obstruction of the urinary tract and lead to the development of hydronephrosis [16].

In this study prehilar segemental branching was found in 19.38% which was similar to 17% reported by Harrison *et al*. in 1977 [1]. The presence of bilateral pre- hilar termination of renal artery in our study was 10% which is similar to that of (11.66%) Budhiraja in 2010 [12]. In our study 66.6% of the renal arteries terminated at the hilum. Walker *et al* 1988. Reported 63% terminated at the hilum [17]. Khamanarong *et al* in 2004 presented a remarkably greater frequency (82%) of renal arteries terminating at the hilum [18].

Numerous studies on renal artery variations are done and evaluated by anatomists. It is also important for the surgeons and radiologists to be aware of the possible renal artery variations in order to prevent complications during diagnostic and therapeutic implications, including surgical procedures for renal transplantation and abdominal aortic diseases.

Conclusion

In many of the cases the kidney is nourished by single artery but duplication of the renal artery is not uncommon. The branching pattern of the renal artery is fork type, ladder type, triplicate and bifurcate. The most common is the bifurcation and the segmental branches from the anterior division. The termination of the main renal artery is hilar. If accessory renal artery is present, the termination is usually upper polar and in some hilar but rarely lower polar. Nevertheless, to plan an adequate surgical procedure and to avoid any vascular complications, the investigations of the branching pattern of the renal artery should be performed prior to nephrectomy.

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