ORIGINAL ARTICLE
KLİNİK ARAŞTIRMA

Renal artery variations with clinical significance: Multiple renal arteries and their coexistent anatomical abnormalities: A cadaveric study

Klinik önemi olan renal arter varyasyonları: Çoklu renal arterler ve eşlik eden anatomik varyasyonlar: Bir kadavra çalışması

Hürriyet Çetinok[1,2]

[1]Department of Anatomy, Faculty of Medicine, Istanbul Atlas University, Istanbul, TURKEY
[2]Albert Einstein College of Medicine, Department of Anatomy and Structural Biology, Yeshiva University New York, USA

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Correspondence: Hürriyet Çetinok
Department of Anatomy, Faculty of Medicine, Istanbul Atlas University, Istanbul, TURKEY
e-mail: hurriyet.cetinok@atlas.edu.tr

ORCID ID: HC 0000-0001-7083-966X

SUMMARY

Aim: This cadaveric study aimed to identify the multiple renal arteries and evaluate their association with other anatomical abnormalities. The possible clinical consequences of more than one renal artery were analyzed.

Material and Methods: This study was carried out by accessing the Abdominal aorta (AA) from 20 American formalin-embalmed cadavers [12 males, 8 females, ages 50-96] donated to the C&DA Department of Albert Einstein College of Medicine. From the cadavers in the supine position, the branch points of the renal artery from the abdominal aorta on the right and left sides were checked to see if there was more than one. Renal artery (left side), celiac trunk, superior mesenteric artery, inferior mesenteric artery, and aortic bifurcation were measured in 3 ways: linear, longitudinal, and transverse. The obtained results were assessed using a comparative analysis with earlier research findings documented in the literature.

Results: Among the 20 cadavers included in the study, two of males, were found to have two renal arteries on the right side, and both of them are hiler arteries. These Multiple renal arteries were coexistent with splenomegaly, tortuosity of the abdominal aorta, and deviation of the vertebral column at the level of the 3rd lumbar vertebra. 94.7% of the cadavers exhibited normal renal arterial anatomy. The most common branching location of the main renal arteries and multiple renal arteries (MRA) were the find from the abdominal aorta.

Conclusion: Before surgical or radiological procedures in the anatomical region related to and adjacent to renal arteries, knowing the possible renal artery variations in the anatomy of the region is very important to reduce mortality and morbidity during surgical or interventional procedures. Knowing the anatomy of renal arteries and evaluating it radiologically will guide renal transplantation, hepatorenal surgery, interventional radiology, and nephrology the prevention and treatment of many conditions such as hypertension, and target organ damage them.

Keywords: Accessory renal artery, Multiple renal arteries, renal artery variations

ÖZET

Amaç: Bu kadavra çalışmasının amacı multipl renal arterleri tanımlamak ve aynı zamanda diğer anatomik anormallikler ile birlikteliğini değerlendirmekti. Birden fazla arteria renalis'in bulunmasının olası klinik sonuçları analiz edildi.

Materyal ve Metodlar: Bu çalışma, Albert Einstein College of Medicine C&DA Anabilim Dalı'na bağışlanan 20 Amerikan formalin fikse kadavradan [12 erkek, 8 kadın, yaşları 50-96] Aorta Abdominalis (AA)'e ulaşılarak gerçekleştirildi. Supin pozisyondaki kadavralardan Arteria renalis'in sağ ve sol tarafta Aorta abdominalis'ten dallanma noktaları, birden fazla sayıda olup olmadıkları kontrol edildi. Arteria renalis(sol taraf), Truıncus coeliacus, arteria(a.) mesenterica superior, a. mesenterica inferior, bifurcatio aorta arasındaki mesafeler, lineer, longitudinal ve transvers olmak üzere 3 şekilde ölçüldü. Elde edilen sonuçlar oranlanarak, lieratürdeki önceki çalışmalarla kıyaslanarak değerlendirildi.

Bulgular: Çalışmaya alınan 20 kadavradan iki erkek cinsiyette, ikiside hiler arter olmak üzere sağ tarafta iki adet renal arter olduğu tespit edildi. Multiple renal arterlere, splenomagali, abdominal aorta da ondülan seyir, 3. Lumbal vertebra seviyesinde columna vertebralis'te deviasyon olduğu gözlendi. Hastaların %94,7'si normal renal arter anatomisine sahipti. Ana renal arterlerin ve ARA'nın en sık Aorta abdominalis'ten dallanıyordu.

Sonuç: Arteria renalis ile ilişkili ve komşuluğundaki Anatomik bölgedeki cerrahi veya radyolojik işlemler öncesinde bölge Anatomisindeki olası arteria renalis varyasyonlarının bilinmesi cerrahi veya girişimsel işlemler sırasındaki mortalite ve morbiditeyi azaltmakta çok önemlidir. Renal transplantasyon ve Hepatorenal cerrahi, girişimsel radyoloji, nefroloji başta olmak üzere A.(arteria) renalis anatomisinin bilinerek, radyolojik olarak değerlendirilmesi, hipertansiyon, hedef organ hasarı gibi pek çok kliniğin önlenmesi ve tedavisine kılavuz olacaktır.

Anahtar kelimeler: Aksesuar renal arter, multipl renal arter, a. renalis varyasyonları

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INTRODUCTION

In the postconceptional ninth week, the kidneys achieve their adulthood position embryologically. When the kidneys reach their adult position, the blood procurement is made by the branches that arise from the cranial terminal of the abdominal aorta (AA), and the early branches atrophy (1, 2). Renal arteries are frequently at the plane of L1 and L2 vertebrae, the superior mesenteric artery is immediately below the inception. The left renal artery is generally located slightly upper than the right. The right renal artery is longer and goes under the inferior vena cava (3). Every renal artery inserts the hilum and is branched into anterior and posterior branches that supply the kidney parenchyma, then they are typically branched into four or more segmental branches (4). Several words, including "aberrant," "abnormal," "accessory," "additional," "extra," "supernumerary," and "supplementary," are used to describe to multiple renal arteries. Twenty to thirty percent of people have multiple renal arteries (MRA) (two in twenty-two, three in one to two percent, and four in 0.1%) (5). Variations in the number of renal arteries, particularly dual renal arteries, are the most frequently identified variant in addition to physical variations (6)

An embryological explanation for the existence of MRA was presented by Felix et al. in their work. Sampaio and Passos (13) divided the renal arteries into groups based on the portal of admission a branch of the aorta that penetrates the kidney in the hilum is called the Hilar artery. The kidney is penetrated by the Superior Polar artery (SPA), a branch of the aorta, and the inferior polar artery (IPA), a branch of the aorta that enters the inferior pole of the kidney. The extra-hilar artery is a renal artery from the abdominal aorta that has an extra-hilar branch to the poles. Compared to other arteries of the same size, renal arteries are more prone to show multiplicity (7,8). Comprehending the function of MRA can help avert inadvertent perioperative damage and the subsequent infarction of the impacted area. This has led to easier surgical planning and better outcomes (9).

Knowledge of MRA's existence will aid in preventing unintentional harm during surgery and the ensuing segmental infarction. Better surgical outcomes have resulted from this (6). Accessory renal arteries (ARAs) are present in approximately 22–24% of hypertension patients. Prior research has demonstrated that ARA is connected to renin-dependent hypertension as well as resistant hypertension (9).

For a long time, one of the relative contraindications to kidney transplantation was the presence of multiple renal arteries. Additionally, studies have suggested that anatomical differences in the accessory renal arteries may be linked to post-transplantation hemorrhage, arterial thrombosis, renal artery stenosis, atherosclerosis, and parenchymal necrosis (6).

There is significant variation in the incidence of MRA, ranging from 8.7 to 75.7% (median 28.2%) (10). MRA are more frequently found unilaterally (30%) than (10%) on both sides (1,11), and there is racial variation in their occurrence (10, 12). While having many arteries is normal in itself, the existence of MRA may make transplant surgery, RA embolization or angioplasty, reconstructive therapy of AA aneurysms, and urological operations more difficult (13, 14, 15). Furthermore, there is a correlation between a greater MRA frequency and the risk of renovascular hypertension (16), hydronephrosis (17), occlusion of the ureteropelvic junction, and chronic pyelonephritis (18).

MATERIAL AND METHODS

From 20 American formalin-embalmed cadavers donated for anatomical practice to the Department of Anatomy, Albert Einstein College of Medicine (AECOM), this study was performed using the AA from 12 cases [12 males, 8 females, age 50-96]. All donors that were approved for the donation and usage for clinical studies were accepted according to New York's Anatomical Gift Law. In this study, ethical approval is not required since the study is based on course cadavers from the Albert Einstein College of Medicine C&DA Department according to the exemption categories in Enstein-IRB-citation104(d). Because of the involvement of metastatic gastric cancer in the para-aortic area, a 52-year-old female case was excluded from the study. The others have no history of previous abdominal injury, pathologic condition, or surgeryThe abdominal aorta of the cadavers that were brought to the supine position was approached anteriorly and focused on the branches of the AA. During our studies, we utilized Mitutoyo Digital Caliper (calibration certificated by Mitutoyo America Corp. Calibration Lab.- control number 887014, range 0.000 inch- 0006 inch), goniometer, essential dissection instruments, and a digital camera (Olympus). In our study first, we analyzed abdominal aorta trajectory, branching levels of vertebral column for each branch (Coeliac trunk (CT), superior mesenteric artery (SMA), inferior mesenteric artery (IMA), left renal artery (LtRA), BA) morphological changes, tortuosity, aneurysm, thickness of the AA wall, variations, osteodegenerative changes, and compression fracture vertebral column. We classified vertebral bodies according to their height: upper 1/3, middle 1/3, and lower 1/3. However, some of the AA branches arose from the intervertebral disc level. We used LtRA as a critical landmark regarding literature search in our previous cadaveric study which is called 'Clinical Significance, Variations and Anatomical Relationships of Coeliac Trunk, Superior Mesenteric Artery, Inferior Mesenteric Artery and Left Renal Artery in Colon and Hepatorenal Surgery, Abdominal Aorta Mapping: Cadaveric Study'. CT, SMA, IMA, LtRA, and BA were studied, and transverse, longitudinal, and linear distances of them, and in addition to this calculation, arteries' origins and their branching angles them were also statistically analyzed. We removed AA from the cadaver and then vertically dissected along the major axis of the AA, starting at the branching point of the right and left common iliac artery, and split into the ventral and dorsal sides. The removed ventral sides of the AA were taken photographs from the intravascular lumen utilizing a digital camera. The horizontal and vertical diameters of the sites of confluence with the IMA, SMA, and CT were evaluated. In addition, the left/right deviation of the sites of confluence from the center line along the vertical axis of the vessels that went through the midpoint among both sides of the branching point of the left renal artery was evaluated. We also evaluated the branching points of the IMA, SMA CT, and left renal artery (LtRA) utilizing the BA as the point of origin, ARAs, and MRAs and measured the distances between the branching points.

RESULTS

In all of 38 kidneys, renal arteries arose from the abdominal aorta. Single renal artery (SRA) was seen in 36 kidneys while MRA(Multiple renal artery) was seen in Double renal arteries (DRA) were noted in 12 (%), and triple renal arteries (TRA) in 0/absent/none (0%). Among the MRA, DRA was seen in two out of 38 (%5.25) right-sided kidneys. There is not left-sided MRA in this study. Only 94.7% of the patients exhibited normal renal arterial anatomy. Both of them found in the male gender. Hilar ARA (100%) was significantly more common than polar ARA.

All 38 renal arteries included in the study branched from the aorta abdominalis. Only 2 double renal arteries were detected. As shown in Figures 1 and 2, in a 62-year-old male cadaver, the right main renal artery was observed to branch just distal to the superior mesenteric artery and enter the right kidney from the renal hilum.

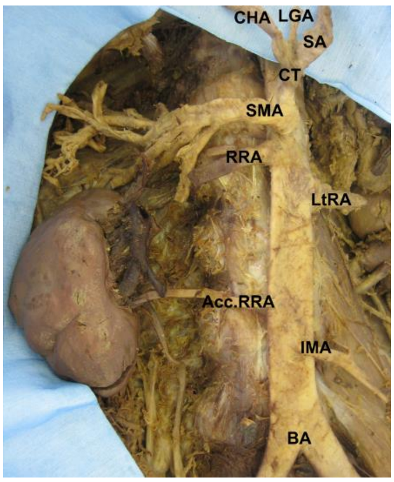

Figure 1. The aspect of the superior side of the supine-positioned cadaver. The accessory renal artery should be paid attention and three branches of coeliac trunk are clearly observed.

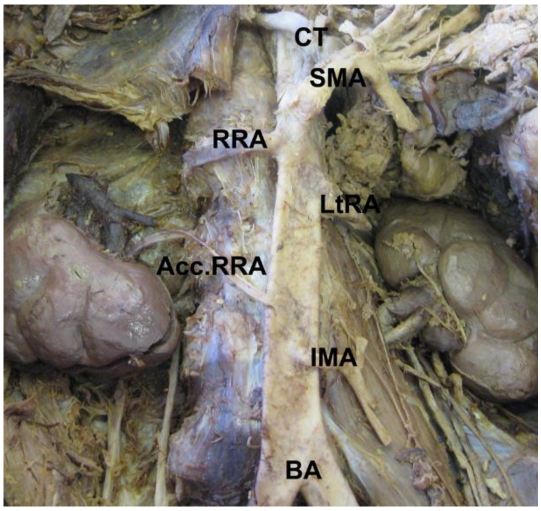

Figure 2. The aspect of the superior side of the supine-positioned cadaver. The diamater of accesory renal artery is thinner than the right renal artery as it is seen in this figure.

As seen in Figure 3, 7 cm distal to the right main renal artery, the right accessory renal artery, which is thinner in diameter than the right main renal artery, was seen to branch from the aorta abdominalis and reach the right renal hilum. The right accessory renal artery was branching from the right edge of the aorta abdominalis, 2 cm proximal to the inferior mesenteric artery.

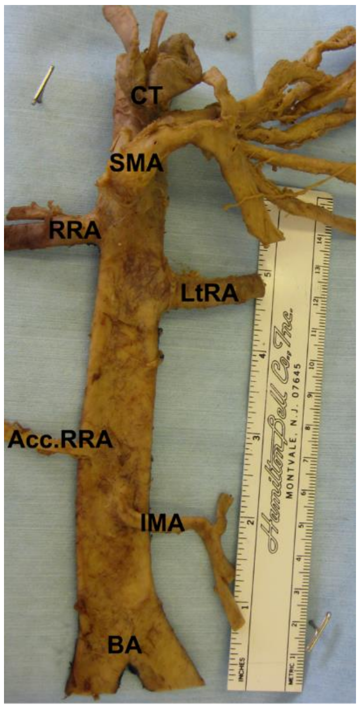

Figure 3. Abdominal aorta which has accessory renal artery occured, removed from the cadaver.

In Figure 2, a clearly visible lobulated kidney structure was observed on both sides. Another remarkable formation in this

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cadaver was splenomegaly, whose superior-inferior length is shown as 13.5 cm in figure 4.

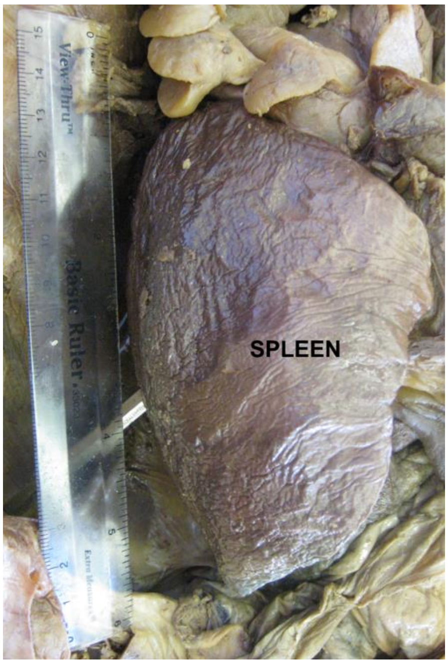

Figure 4. In addition to this anatomic anomaly, splenomegaly (13.5cm/5.5inch liver) was also observed.

In an 80-year-old male cadaver, two right renal arteries were branching from the aorta abdominalis, as seen in Figure 5 from the outer wall of the aorta abdominalis and as seen from the inner wall of the aorta abdominalis in Figure 6. The diameter of the artery we called right renal artery I (RRA-I) was larger than the diameter of the artery we called right renal artery II (RRA-II). Both renal arteries were branching from the abdominal aorta between the superior mesenteric artery and the left renal artery.

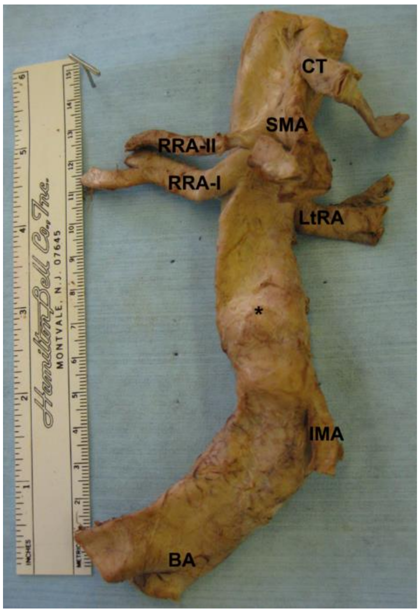

Figure 5. Double renal arteries on the right side arose from abdominal aorta.*Aneurysm of the Abdominal aorta

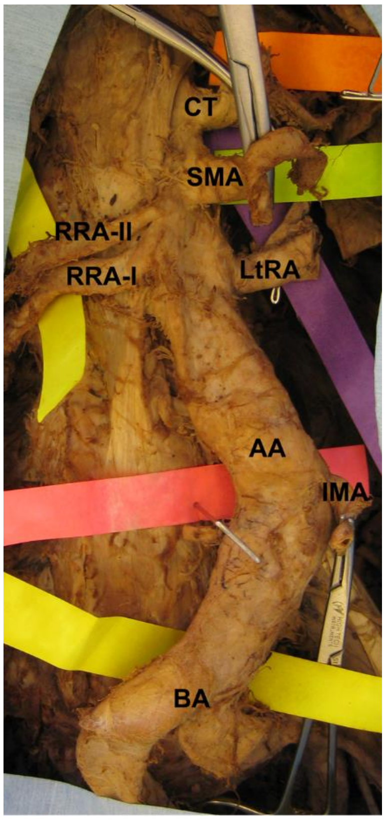

Figure 6. The lumen of the Abdominal aorta which has accessory renal artery occured, was dissected ventrally from the line that crosses Aortic bifurcation.

Figure 7. In addition to this anatomic anomaly, abdominal tortuous aorta and L3 vertebrae deviations are observed.

If figure 6 is examined carefully, RRA-II branches from 0.4 mm distal to SMA, RRA-I branches from 0.3 mm distal to RRA II, and separately from the abdominal aorta. Two aneurysms were detected, the first one with a diameter of 1.5 cm between the left renal artery and the inferior mesenteric artery (Figure 5), the second one with a diameter of approximately 3 cm between the inferior mesenteric artery and the aortic bifurcation (Figure 6). The tortuosity of the abdominal aorta is quite evident in figure 7, and the deviation of the abdominal aorta to the left was observed at the level of the 3rd Lumbal vertebra.

Since the left renal artery was taken as the reference point in previous studies on the abdominal aorta and its branches (19,20,21), in this study, taking into account the variations encountered in the right renal artery, we determined at what level the left renal arteries are located in the abdominal aorta relative to the columna vertebralis. It is shown in Table 1, including the ages and genders of the cadavers. In summary, as seen in graph (Figure 8), 42% of the left renal arteries originate from the upper 1/3 of the 2nd Lumbal vertebra, 32% from the intervertebral disc level of the 1st and 2nd Lumbal vertebra, and 21% from the lower 1/3 of the 1st Lumbal vertebra. It was observed that it branches from the abdominal aorta, 5% from the 2nd lumbar vertebra and the lower 1/3 of the lumbar vertebra. In the case where accessory renal artery was seen, the main renal artery branched from the upper 1/3 part of L2, where the majority of 42% was located, while in the cadaver where RRA I and II were seen, the branching from the abdominal aorta was at the level of the intervertebral disc between L1-L2.

Table 1. Age, gender and branching point of left renal artery from abdominal aorta

Cad. No	Age	Gender	Level of left RA*
1	73	M	L1/2M
2	70	F	L2L
3	79	M	L1L
4	92	M	L1/2-IVD
5	91	M	L2U
6	80	M	L1/2-IVD
7	88	M	L2U
8	84	F	L2U
9	79	F	L2U
10	50	F	L1L
11	82	F	L2U
12	86	F	L1/2-IVD
13	96	M	L1L
14	75	M	L1/2-IVD
15	87	M	L2U
16	65	M	L1L
17	62	M	L2U
18	72	F	L2U
19	83	M	L1/2-IVD

Measured distances between various points are shared in Table 2. Particularly considering the cases in which renal artery variations were observed, the left renal artery was used as the reference point. The measurements of the case with accessory right renal artery and splenomegaly are shown in the 1st column (Case 1), and the measurements of the cadaver with RRA I and RRA II are shown in the second column (Case 2).

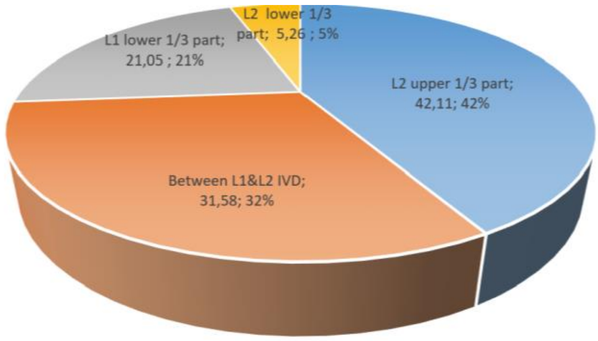

Figure 8. Distribution of Branching points of Left Renal Artery from Vertebral Point

Table 2. Measured distances between various points

Abbreviations*	Distance	Case I	Case 2
a	Transverse diameter of the AA at level LtRA	19.1 mm	24.08 mm
b1	LtRA-CT linear distance	45.85 mm	40.47 mm
b2	LtRA-CT longitudinal distance	49.92 mm	39.1 mm
b3	LtRA – CT transverse distance	11.48 mm	5.27 mm
c1	LtRA – SMA linear distance	25.16 mm	22.02 mm
c2	LtRA – SMA longitudinal distance	23.52 mm	18.65 mm
c3	LtRA- SMA transverse distance	11.01 mm	9.32 mm
e2	LtRA – BA longitudinal distance	95.77 mm	102.91 mm
e3	LtRA – BA transverse distance	7.01 mm	9.3 mm
LtRA	Arising level of vertebral column	L2U	L1/2-IVD

** a : transverse diameter of the AA at level LtRA, b1 : LtRA-CT linear distance, b2 : LtRA-CT longitudinal distance, b3 : LtRA – CT transverse distance, c1 : LtRA – SMA linear distance, c2 : LtRA – SMA longitudinal distance, c3: LtRA- SMA transverse distance, e2: LtRA – BA longitudinal distance, LtRA: Left Renal Artery, BA: Aortic Bifurcation, IVD: Intervertebral disc, U: Upper 1/3 part of the vertebral body, M: Middle 1/3 part of the vertebral body, L: Lower 1/3 part of the vertebral body*

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DISCUSSION

In the etiologies of hypertension defined as primary, renovascular or idiopathic, which is one of the most important health problems of recent years, the presence of multiple renal arteries may be in question, as we found in our study. MRA renin-angiotensin-angiotensinogen can play an active role in hypertension and target organ damage by affecting the angiotensinogen system more than normal. Some studies verified that ARA activated the renin-angiotensin system and produced abundant renin, which raised blood pressure in patients with primary hypertension. Stricter blood pressure management was warranted for ARA due to their substantial target organ damage to prevent serious cardiovascular events. Related studies offered compelling proof that hypertensive patients with ARA should get intensive treatment in routine clinical settings (22, 23, 24).

In two cases with numerous and accessory renal arteries, earlier research that was available in the literature was consulted in this investigation (25). Based on this, the landmark, or left renal artery (LtRA), was identified, and measurements were taken of the linear, longitudinal, and transverse distances between them and the aortic bifurcation (BA), superior mesenteric artery (SMA), and coeliac trunk (CT). The left renal artery was used to assess the abdominal aorta's diameter at the same moment. The left renal artery's longitudinal and transverse diameters were measured concurrently, and the outcomes were compared to those of earlier research.

The measurements of AA transverse diameter at the LtRA level in cases 1 and 2 in our investigation were 19.1 mm and 24.08 mm, respectively, matching the findings of Takahashi et al. (25). It was discovered within the 17.5-25.2 mm range that his investigation had established. In Case 1, the linear, longitudinal, and transverse LtRA-CT distances were 45.85 mm, 49.92 mm, and 11.48 mm, respectively. In Case 2, the corresponding values were 40.47 mm, 39.1 mm, and 5.27 mm. These values fall into the ranges that Takahashi et al. found for this distance: 28.9 mm - 51.9 mm, 23.7 mm - 51.0 mm, and 2.1 mm - 18.7 mm, respectively. While LtRA – SMA linear, longitudinal and transverse distances are 25.16 mm, 23.52 mm, 11.01 mm, for Case 1, they are 22.02 mm, 18.65 mm, 9.32 mm for Case 2, and these values are 12.5 mm – 37.7 mm, respectively, found in the study of Takahashi et al. Compatible with 6.6 mm - 35.6 mm, 4.8 mm - 18.6 mm values.

The MRA's nomenclature is still ambiguous and divisive ("multiple"). The labels "main renal," "aortic superior and inferior polar," and "renal inferior polar" arteries were used by Merklin and Michels (1958) (26) for the single RA. The terms "accessory" and "supplementary" refer to RAs that have an aortic ostium that is distinct from the main RA and that enter the hilum directly, respectively, according to Holden et al. (2005) (26). The renal arteries were divided into hilar and polar (superior and inferior) arteries by Daescu et al. (2010) (26).

Patients were the sample in some angiographic investigations, although dissected cadavers or autopsy specimens were used in many other research. It is suggested that cadaver dissection, as opposed to aortography, likely provides a more accurate estimate of the number of RA (26). Because of their thickness (diameter <2 mm), MRA was less frequently discovered in angiographic studies. They are not visible, and the arteries entering the kidney outside the hilum are sometimes mistaken for the adrenal or capsular arteries, especially when the MRA originated from AA (26). Interestingly, compared to angiography, where the relative incidence was 3%, magnetic resonance angiography was unable to forecast the morphology of the renal arteries in 10% of patients with MRA (26).

Thirty percent was found to be the incidence of MRA in the first investigation (18). Satayapal et al. (2001) (2) examined data from 1883 to 1999 and calculated the MRA incidence to be 28.1%.

The current investigation attempted to compile all pertinent papers published between 2000 and the present and earlier works that were not assessed (26). The incidence of MRA was found in several populations (26), with a mean of 23.3% and a range of 4% to 61.5%. The frequency was calculated based on the specimen: transplant (20.4%), radiographic (21.8%), and cadaveric (28.2%). There is a large variety of MRA incidence within a single community, with Brazilians having an MRA incidence of 18.5-26.5% and Turks having an MRA incidence of 14.5-27%. These differences could be explained by the sample's size, origin, and MRA documentation technique. The estimated incidence of MRA in a Greek population studied in our study was 11.2%. The MRA were found in 11.2% (23/206) of the kidneys. MRA were located on the right side in 52.2% (12/23) and the left side in 47.8% (11/23) of cases. MRA was found in 11.3% (12/106) of the male population, 50% (6/12) on the left side, and 50% (6/12) on the right. Table 1 shows that in females, MRA were found in 11% (11/100), 54.5% (6/11) on the right side, and 45.5% (5/11) on the left. After dissecting 266 kidneys, Sampaio and Passos discovered that 53.3% of the kidneys had a single hilar artery, 7.9% had a double hilar artery, and 5.3% had a hilar with a single inferior polar artery (13).

Thirty percent of kidneys have supernumerary renal vessels. They extend from the 11th thoracic to the 4th lumbar vertebra along the aorta, both in number and with similar periodicity to the sides.

For surgical treatments linked to kidney transplants, abdominal aortic aneurysms, posterior abdominal walls, angiographic interventions, and ureter surgeries, it is important to understand this anatomical variance and coexisting disorders. Fibromuscular dysplasia in an ARA has the rare potential to cause renovascular hypertension. According to Sampaio et al. (1992) (13), each MRA is a member of the segmental arteries and is susceptible to postoperative hypertension rises, hemorrhage during urological procedures or renal transplants, and segmental ischemia. Since there is currently a huge demand for kidney donations, it is imperative to be aware that donors with numerous renal arteries and accessory renal arteries do exist (26-28). Arteriography is advised before any nephrectomy to design the surgical process and avoid any vascular problems (Sampaio et al., 1992) (13).

According to Feller and Woodburne, The abdominal aorta's lateral displacement, is an important clinical symptom since it could be mistaken for an aneurysm when palpated through the abdominal wall as a pulsatile mass (29). When it comes to invasive vascular treatments and abdominal surgeries, the knowledge of such instances is extremely clinically significant. One of the factors contributing to inferior vena cava inhibition is an Abdominal aorta tortuosity. This defect may result in liver cirrhosis and fibrosis, as well as necrosis and centrilobular congestion, which are ultimately the cause of the condition (30).

The literature is replete with research on supernumerary renal vessels. Urinary and vascular problems are more common after transplantation due to MRA in the graft kidney, according to some of these publications. The MRA rate was reported to be 21% in a study involving 288 live donor nephrectomies. Demir et al. claimed that the presence of MRA had no effect on the clinical outcomes that followed open donor nephrectomies, but that there was more blood loss and a longer recovery time following laparoscopic donor nephrectomies than those without MRA (31). Hypertension, discomfort, and aortic insufficiency can result from aortic lumen blockage, depending on the level and degree of tortuosity of the abdominal aorta.

Further studies on patients who had endovascular aneurysm restoration with ARA covering revealed that 67% to 84% of individuals experienced renal infarction (32,33). Ultimately, the decision of whether to reimplant or immolate ARAs rests on the surgeon's judgment, which is hampered by a number of patient -specific circumstances. As we previously discussed, MRA and ARA are uncommon variants that accompany Abdominal aorta tortuosity. We reported two cases of MRA and ARA independently in our cadaveric study, together with coexisting anatomical anomalies. Considering our background literature review, this is the only cadaveric study that reports splenomegaly in conjunction with ARA.

Patients with a single kidney artery are also said to have lower transplant rejection chances. For a long time, one of the relative contraindications to kidney transplantation was the presence of auxiliary renal arteries (10). Changes in the size of other vessels, such as the testicular arteries, supra renal arteries, or auxiliary phrenic arteries, as a result of accessory renal arteries, are another clinically significant aspect of these arteries (11). Additionally, studies have suggested that atherosclerosis, elevated blood pressure, arterial thrombosis, renal artery stenosis, parenchymal necrosis, and bleeding after transplantation may be linked to structural differences in accessory renal arteries (17) Finding out more about the auxiliary renal arteries and their structural changes is crucial for the diagnosis and treatment of renal disorders. They reported a prevalence rate of 20.2 percent in women and 32.1 percent in males. In order to prevent problems, this issue is especially crucial for artery procedures, kidney damage therapies, and transplant surgeries (17).

The occurrence of the MRA demonstrates racial variability (18, 26), and they are more frequently diagnosed unilaterally (30%) than bilaterally (10%) (1, 29). Multiple artery persons are normal, but the existence of MRAs may complicate procedures such as urological treatments, RA embolization or angioplasty, transplant surgery, and reconstructive therapy of AA aneurysms (20, 30, 31). Furthermore, there is a correlation between a greater MRA frequency and the likelihood of ureteropelvic junction blockage, hydronephrosis, renovascular hypertension, and chronic pyelonephritis (32, 33). According to Gupta and Tello (17), in 24% of the hypertensive individuals, accessory RAs are a vascular anomaly rather than the direct cause of hypertension (18, 22).

Thus, knowledge and a comprehensive preoperative radiological evaluation are crucial for surgical and endovascular procedures to be successful and safe. To establish a safe preoperative and intraoperative management of the renal vascular supply, it is crucial to understand the morphology and topography of the various renal arteries (18).

CONCLUSION

The knowledge of the Topographic and Clinical Anatomy of the Renal Arteries has become significantly important in recent years due to increasing number of kidney transplantions, renovascular surgeries, diagnostic and interventional radiology. Some of the pathologies that coexist with MRA are related to Anatomical structures, such as vertebral column deformities, splenomegaly, abdominal aorta tortuosity, aneurysm. Some studies verified that ARA activated the renin-angiotensin system and produced abundant renin, which raised blood pressure in patients with primary hypertension. More research is required to determine the likely consequences of

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additional anomalies and anatomical changes coexisting with ARAs and MRAs. Thus, knowledge and a comprehensive preoperative radiological evaluation are crucial for clinical, surgical and endovascular procedures to be successful and safe.

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