Geographic Distribution of Multiple Arteries and Veins of 878 Kidney Donors From a Transplant Center in Turkey

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ABSTRACT

Aim. The diagnosis and management of multiple renal arteries and veins have gained importance with the increasing number of kidney transplantations and improved techniques in interventional radiology and vascular reconstructions. The aim of this study is to define and to detect the rate of multiple renal arteries and veins in our living kidney transplant donors coming from all parts of our country.

Methods. Abdominal computed tomography angiogram findings of 878 kidney transplant donors were analyzed. The presence and the distribution of multiple renal arteries and veins in donors coming from 7 geographic regions in Turkey were noted.

Results. The presence of multiple renal arteries was observed in 34% (48/141) of patients in the Marmara Region, 36.7% (79/215) of patients in the Black Sea Region, 37.2% (64/172) of patients in the Central Anatolia Region and 36.1% (30/83) of patients in the Southeastern Anatolia Region. The highest incidences of multiple renal arteries were observed in the Mediterranean and Aegean regions, affecting 40% (32/80) and 41.9% (26/62) of patients, respectively, while East Anatolia was found to have the lowest incidence, affecting 28% (35/125) of patients. The incidence of multiple renal veins also varied across regions. The highest incidence was observed in the Central Anatolia Region, where 23.3% (40/172) of patients were affected; the lowest was seen in the Aegean Region, where 11.3% (7/62) of patients were affected. In Turkey as a whole, 35.8% (314/878) of patients presented with multiple renal arteries, while the rate of multiple renal veins was found to be 19% (167/878) among our donors.

Conclusions. As 80% of the kidney transplantations performed in Turkey involve living donors, we think it will be useful to have knowledge of not only the presence of multiple renal arteries and veins, but also the distribution of this feature throughout the different regions of the country.

KIDNEY transplantation is known to be the best treatment for end-stage renal disease patients. As most end-stage renal disease patients must remain on dialysis due to organ shortage, the number of living kidney donations has increased significantly in recent years.

Detailed preoperative evaluations of the renal vascular anatomy of kidney transplant donors thus play a crucial role in minimizing intra- and post-operative complications during surgery. Diagnosis and management of multiple renal arteries and veins have gained great importance with the increasing number of kidney transplantations and improved techniques in interventional radiology and vascular reconstructions.

Renal vascular patterns vary greatly among populations with regard to ethnicity and race [1,2]. The prevalence of multiple renal arteries is highly variable in different parts of the world, fluctuating from 4% in Malaysia up to 61.5% in

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Table 1. Demographic Data of 878 Donors

Regions	Number of Donors	Age of Donors (Mean ± SD, y)	Sex of Donors (Male/Female)
Southeast Anatolia Region	83 (9.5%)	47 ± 13	44/39
East Anatolia Region	125 (14.2%)	48 ± 12	52/73
Central Anatolia Region	172 (19.6%)	48 ± 12	75/97
Black Sea Region	215 (24.5%)	49 ± 12	98/117
Marmara Region	141 (16.1%)	53 ± 13	67/74
Mediterranean Region	80 (9.1%)	50 ± 12	39/41
Aegean Region	62 (7.1%)	49 ± 12	28/34
Total	878 (100%)	49.3 ± 12.5	403/475

Abbreviation: SD, standard deviation.

Brazil [3,4]. The lowest incidence of multiple renal arteries is observed in Eastern and Southern Asia [3], while India and Brazil have the highest incidence [4–6]. In the Turkish and Iranian populations, similar incidences of multiple renal arteries have been reported, but these incidences are still higher compared to the majority of European countries [7–12].

The presence of supernumerary renal veins is regarded as the most common renal venous system variation [8,9], although it also differs among different ethnic groups. Unlike multiple renal arteries, it is hard to define the incidences of multiple renal veins predominating in particular region of the world [10–14].

The aim of this study is to define and to detect the incidence of the multiple renal arteries and veins in the living kidney transplant donors coming from all parts of Turkey.

METHODS

From October 2010 to March 2018, 878 patients were successfully transplanted from living donors in our center. During the preoperative evaluation of the renal vascular anatomy, an abdominal computed tomography (CT) angiography performed using a Siemens SOMATOM definition AS CT scanner (Siemens AS, Berlin, Germany) was performed on each kidney transplant donor. A volume of 70–90 mL of nonionic contrast medium was injected at 3.5–4 mL/s through the antecubital veins with an automatic power injector. Images were obtained from the level of diaphragm to end of the pelvis. The axial, coronal, sagittal, and 3D reconstruction images were assessed by a radiologist.

The reports of the CT angiograms were analyzed in order to confirm the number and morphology of the renal vessels. In this study, the renal arterial system was defined by the number of arteries arising from the abdominal aorta and entering the renal hilum or directly into the renal parenchyma. The presence of either an accessory or a polar renal artery was reported as multiple renal arteries. In renal venous system analysis, the presence of multiple numbers of renal veins arising from the renal hilum and draining into the inferior vena cava was reported as multiple renal veins. The terms "multiple renal arteries" and "multiple renal veins" were used whether they existed uni- or bilaterally.

After obtaining informed consent from all donors with multiple renal vessels, these individuals' birth places and ethnic origin documents were extracted from their patient files. The results were analyzed based on the 7 geographic regions of Turkey (Southeast Anatolia, East Anatolia, Central Anatolia, the Black Sea, Marmara, the Mediterranean, and the Aegean).

Statistical analysis was done using SPSS software, version 24 (IBM, Armonk, NY, United States). Demographic data were expressed as mean ± standard deviation of ages and frequencies of sex. The χ^2 test was used to evaluate the statistical significance of distribution of multiple arteries and veins in the 7 geographic regions of Turkey and the association of multiple renal vessels with sex; $P < .05$ was considered statistically significant.

RESULTS

The demographic features of 878 donors (403 men, 475 women; mean age 49.3 ± 12.5 years) are presented in Table 1. No statistical differences were observed in terms of sex and age among the 7 geographic regions of Turkey.

The incidences and percentages of multiple renal arteries and veins are presented in Table 2. The presence of multiple renal arteries was observed in 34% (48/141) of patients in the Marmara Region, 36.7% (79/215) of patients in the Black Sea Region 37.2% (64/172) of patients in the Central Anatolia Region and 36.1% (30/83) of patients in the Southeastern Anatolia Region. The highest incidences of multiple renal arteries were observed in the Mediterranean and Aegean Regions, with 40% (32/80) and 41.9% (26/62) of patients affected, respectively, while East Anatolia was found to have the lowest incidence, with 28% (35/125) patients affected. The incidences of multiple renal arteries in the Southeast

Table 2. Presence of Multiple Renal Arteries and Veins in 878 Donors

Regions	Number of Donors	Number of Donors With Multiple Renal Arteries	Number of Donors With Multiple Renal Veins
Southeast Anatolia Region	83 (9.5%)	30 (36.1%)	15 (18.1%)
East Anatolia Region	125 (14.2%)	35 (28%)	26 (20.8%)
Central Anatolia Region	172 (19.6%)	64 (37.2%)	40 (23.3%)
Black Sea Region	215 (24.5%)	79 (36.7%)	42 (19.5%)
Marmara Region	141 (16.1%)	48 (34%)	22 (15.6%)
Mediterranean Region	80 (9.1%)	32 (40%)	15 (18.8%)
Aegean Region	62 (7.1%)	26 (41.9%)	7 (11.3%)
Total	878 (100%)	314 (35.8%)	167 (19%)

Anatolia, Central Anatolia, Black Sea, and Marmara Regions were similar and resembled the overall incidence of multiple renal arteries among our donors (35.8%).

The incidences of multiple renal veins were found to be lower than those of multiple renal arteries and also reflected regional differences. The highest incidence was observed in the Central Anatolia Region, at 23.3% (40/172 patients), while the lowest was seen in the Aegean Region, at 11.3% (7/62 patients).

In Turkey as a whole, 35.8% (314/878) of patients presented with multiple renal arteries, while the rate of multiple renal veins was found to be 19% (167/878) among our donors.

Neither of the distributions of multiple renal arteries or multiple veins among our donors from the 7 geographic regions of Turkey showed any statistical significance; nor was any association between sex and the presence of multiple renal vessels observed.

DISCUSSION

Having sufficient information about possible renal vascular variations are of paramount importance in most invasive renal procedures, especially kidney transplantation [4]. It is well documented that the presence of renal vascular variations varies widely according to ethnicity and race [4,15,16]. The complexity of renal embryogenesis, type of population, and sensitivity of visualizing technique can also cause different incidences of multiple renal arteries [3].

Incidences of multiple renal arteries differ widely across the world. The lowest incidences are observed in East Asia, while the highest incidences are seen in India and Brazil [3–5,14]. Some Western countries, such as Poland and Greece, have lower multiple renal arteries incidences (11.2%) compared to Asian countries [6,15]. Therefore, although the statement "the lowest incidence of multiple renal arteries is seen in the East" is accurate, the gradual increase in incidences from East to West does not always hold true.

In Turkey a number of studies have mentioned unequal percentages of multiple renal arteries. Gumuş et al reported in 2012 that more than 1 renal artery was found in 27% of 820 patients [16]. Ozkan et al also reported a percentage of 24% in a study of 855 patients [1]. According to Zagyapan et al, 42% of 150 individuals had multiple renal arteries in the Central Anatolia Region [7]. A relatively similar percentage (37.2%) for the same geographic region is found in our present study as well. However, it is worth noting that Zagyapan et al did not mention places of birth and all of the patients in one center were assumed to have come from Central Anatolia.

As indicated by Gulas et al, the lowest incidence of multiple renal arteries was observed in East Asia. Similarly, in our present study, the lowest percentage of multiple renal arteries predominated in the eastern part of Turkey (the East Anatolia Region).

CONCLUSIONS

Our study defined an interesting perspective on multiple renal arteries and veins based on the 878 donors from 7 different geographic regions of Turkey we assessed. However, regarding differences in parameters of sex and regions, no statistical significance was observed, which may be due to the limited study group. On the other hand, 80% of kidney transplantations are performed using living donors in our country; we therefore think it will be useful to have knowledge of not only the presence of multiple renal arteries and veins, but also the distribution of this feature throughout the different regions of Turkey.

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