ORIGINAL ARTICLES

Angiographic evaluation of renal artery variation amongst Greeks

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ABSTRACT: Most Anatomical textbooks describe the kidney's blood supply by a single artery.
However, the existence of additional renal arteries is quite common; about one in four people possess more than one renal artery. Since the incidence of additional renal arteries, can vary according to the ethnic origin of the individual. The objective of the present study was to define the incidence and the distribution of additional renal arteries in a Greek population and comment on the possible complications they might cause to the individual during surgical interventions, especially in cases of renal transplantation. Angiographies (n=215) were performed prior to renal donation for transplantation. Cases with single kidney or kidney failure were excluded. Digital subtraction angiography and 3D reconstruction from computer tomography were used for the images. Additional renal arteries were found in 27.4% of Greeks, more in males (28.9%) than in females (22.4%). Compared to other population groups there are a number of differences in sides and percentages within the Greek population. Surgeons performing renal transplantations should be well aware of the layout of the arteries supplying the kidneys as well as their variation in different ethnic groups.

Key Words: Angiography, Additional renal arteries, Transplantation.

INTRODUCTION

Kidneys usually get their blood supply by the renal artery, arising from the aorta and terminating in the kidney. There are cases though when more than one renal artery can be found. The first systematic attempt to study the frequency of occurrence of renal vascular variations was that undertaken by the Anatomical Society of Great Britain and Ireland as far back as 1890[1]. The term «additional renal artery» was first established by Satyapal[2,3], and by replacing terms like «accessory», «aberrant», «anomalous», «supernumerary», «supplementary» and «multiple», it was used as a more comprehensive expression in describing renal arteries, other than the main one[4,5,6,7,8,9,10].

Additional renal arteries are not uncommon; they appear in about 25 to 30% of the general population[6,7,8,11] and represent persistence of the embryonic pattern[6,8,11,12].

It is important to remember that renal arteries are end arteries, that do not intrarenally anastomose and each one feeds only a segment of the kidney's parenchyma. Because of that the occlusion or obstruction of the blood flow in one of them may cause segmental ischaemia with subsequent hypertension[6,7,8,13,14,15]. On the contrary, veins do anastomose and that is why variations of the veins are not so important and may be tied [9,16].

Additional arteries may be equally[7,9,15] or differently[2] distributed between the two kidneys. Additional veins are more common on the right kidney[14] and they do not necessarily correspond to the number of the arteries[9].

The incidence of additional renal arteries, vary according to the ethnic origin of the individual[2]. Indians show an incidence of 17.4 %, coloured 18.5%, Caucasians 35.3% and the Africans as high as 37.1%[2,3].

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Table 1. Additional renal arteries for males and females.

Sex	All	Single artery	One additional artery	Two additional arteries	Three additional arteries	Any additional arteries
Males	166 (100%)	118 (71.1%)	36 (21.7%)	11 (6.6%)	1(0.6%)	48 (28.9%)
Females	49 (100%)	38 (77.6%)	10 (20.4%)	1 (2%)	_	11(22.4%)
Total percentages	215 (100%)	156 (72.6%)	46 (21.4%)	12 (5.6%)	1(0.5%)	59 (27.4%)

Following the evolution in the fields of urology and vascular surgery including the interventional radiological procedures and renal transplantations, the value of a report of renal artery variation is increasing.

The objective of the present study was to define the incidence and distribution of renal artery variations within the Greek population and comment on the possible complications that arise during or after surgical interventions, especially in cases of renal transplantation.

MATERIALS AND METHODS

Three centres covering the greater part of Greece, the Department of Anatomy of Democritus University of Thrace and the Radiology Departments of Athens and Thessaloniki Medical Schools, were involved in this study. A total of 215 adults, 166 males and 49 females with their age ranging between 19 to 68 years (mean 51.43, SD±20.05) were submitted to angiographies prior to donation for renal transplantation. Individuals selected for this study were of general good health, with both kidneys functioning properly. The selection was done prior to the angiography. For the creation of the images digital subtraction angiography and 3D reconstruction from computer tomography were used. The angiograms were then analysed again for this study, with the number of renal arteries per kidney recorded.

RESULTS

Percentages were calculated and are presented in Table 1. As it is shown, the overall percentage of additional renal arteries in the group studied was over 27%.

The incidence of additional renal arteries was higher in males (28.9%) than in females (22.4%).

One additional renal artery was detected in 21.4% of the subjects, two additional arteries in 5.6% and three in only one of the cases (0.4%).

Figures are showing additional renal arteries from our group (by digital subtraction angiography, Figure 1, and three dimensional reconstruction from a computer tomography, Figure 2).

DISCUSSION

The selection of the subjects did not include other clinical data or specific diseases other than that mentioned before since no such data were available to us. This and the relatively limited number of subjects is why there is no regional distribution.

Satyapal et al.[2], reported that additional renal arteries were found more often in males (33.1%) than in females (20.2%). In our cases additional renal arteries were also detected more often in males (28.9%) than in females (22.4%) although the difference between sexes was smaller.

There is no definite limit to the number of additional renal arteries; although more than three seems to be very rare. Rossi et al.[17] reported a case with seven renal arteries while Kinnunen et al.[7] reported another with ten additional renal arteries. In addition, their distribution between the two kidneys can vary significantly, with no particular pattern to follow[2,7,9,15] .

In our series, one additional renal artery was found with double incidence on the right side (40.8%) than on the left (20.4%). Two additional arteries were found on the left side in three individuals, on the right side in one, while in four persons there was an equal distribution in both kidneys.

Additional renal veins are rare on the left kidney occurring in only 1-2,6% while they are common on

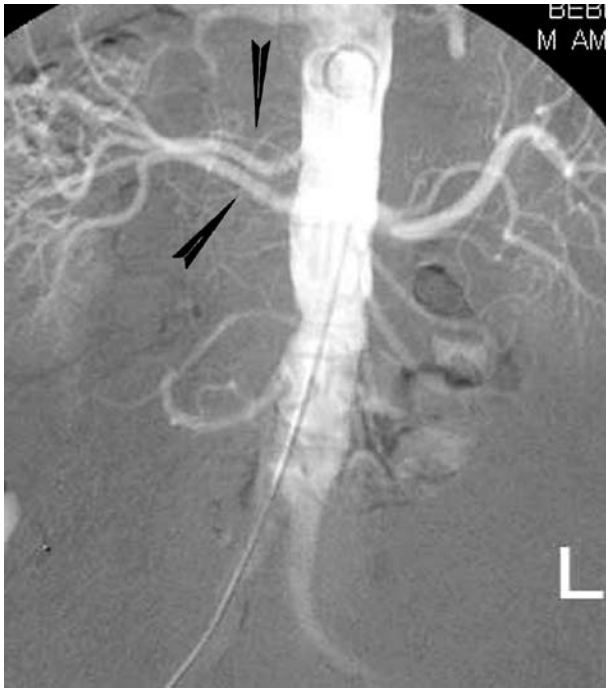

Figure 1. Digital subtraction angiography depicts two renal arteries supplying the right kidney (arrows).

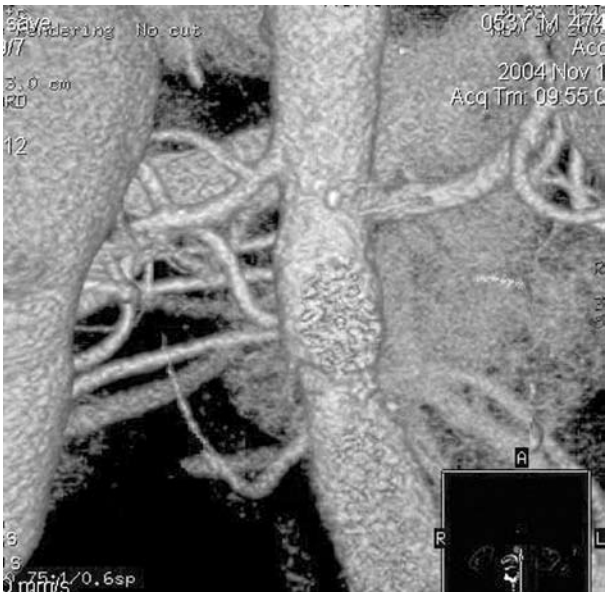

Figure 2. Three dimensional reconstruction from a computer tomography angiography shows the medial side of the right kidney and depicts a lower pole right renal artery.

the right one at 25-26%[14,18]. The variations of the veins are not as important as in arteries and generally, most veins can easily be tied up without causing any harm, because they anastomose[9,16]. The right renal vein is considerably shorter than the left one and the length of a renal vein can be a limiting technical factor during the recipient operation, that's why several large centres have reported that they perform only left sided nephrectomies laparoscopically[10].

The occurrence of additional renal arteries can be a problem for the surgeon because in contrast to the veins, they do not anastomose intrarenally and each one nourishes only a segment of the kidney's parenchyma[8,11,12,16,19,20]. The occlusion or obstruction of the blood flow in any of the arteries would cause an infarction at the corresponding segment[6,7,14,15,21]. Therefore an arterial complication should be suspected in cases when hypertension develops postoperatively[22].

Furthermore, renal transplantations require the detailed knowledge of renal vessels and an angiography is performed routinely preoperatively. The increase in the number of renal transplantations meant more angiographies were performed and a higher number of additional renal arteries were discovered[2,6,14,15,23].

Another complication may arise when one of the additional renal arteries penetrates into the lower part of the kidney where it can constrict the upper part of the ureter and lead to hydronephrosis[7,15,24].

In 215 Greeks, the overall incidence of additional renal arteries was 27.4%. Although, as far as we know, this is the first study assessing the incidence of additional renal arteries in Greeks, further studies with more individuals should be done in order to verify the exact percentages in the Greek population.

Αγγειογραφική εκτίμηση παραλλαγών της νεφρικής αρτηρίας στον ελληνικό πληθυσμό

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ΠΕΡΙΛΗΨΗ: Τα περισσότερα Ανατομικά συγγράμματα περιγράφουν την αιμάτωση του νεφρού σαν συντελούμενη από μία αρτηρία. Η ύπαρξη όμως επιπρόσθετων νεφρικών αρτηριών είναι αρκετά συχνή αφού περίπου ένας στους τέσσερις ανθρώπους διαθέτει πάνω από μία. Καθώς η συχνότητα επιπρόσθετων νεφρικών αρτηριών εξαρτάται και από την φυλετική προέλευση ο σκοπός της παρούσας μελέτης ήταν αφενός να καθοριστεί η συχνότητα και η κατανομή υπεράριθμων νεφρικών αρτηριών στον ελληνικό πληθυσμό και αφετέρου να εντοπιστούν πιθανές επιπλοκές που η ύπαρξή τους μπορεί να έχει, ιδιαίτερα σε περιπτώσεις χειρουργικών επεμβάσεων και πιο ειδικά στις μεταμοσχεύσεις νεφρών.
΄Εγιναν 215 αγγειογραφίες υποψήφιων δοτών για μεταμόσχευση. Αποκλείστηκαν περιπτώσεις με μονήρη νεφρό ή με νεφρική ανεπάρκεια. Οι μέθοδοι της ψηφιακής αφαιρετικής αγγειογραφίας και της τρισδιάστατης ανακατασκευής χρησιμοποιήθηκαν για την παραγωγή των εικόνων.
Επιπρόσθετες νεφρικές αρτηρίες βρέθηκαν στο 27,4% των Ελλήνων, 28,9% στους άντρες και 22,4% στις γυναίκες.
Σε σχέση με μελέτες άλλων σειρών παρατηρούνται μικρές διαφορές στην πλευρά και στα ποσοστά στον ελληνικό πληθυσμό. Οι χειρουργοί των μεταμοσχεύσεων νεφρών θα πρέπει να γνωρίζουν το δίκτυο αιμάτωσης των νεφρών και των διαφορών του από το φυσιολογικό καθώς και ποιο θεωρείται το φυσιολογικό σε διαφορετικές φυλετικές ομάδες.

Λέξεις Κλειδιά: Αγγειογραφία, Επιπρόσθετες νεφρικές αρτηρίες, Μεταμόσχευση.

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