

Cardiovascular profile of patients with unilateral four renal arteries. A systematic study

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INTRODUCTION

The prevalence of multiple renal arteries (RA) ranges between 6 and 33% [1]. Surprisingly, reports of unilateral four or more RA are mainly post-mortem findings or descriptions of living kidney donors. Very little is known about the cardiovascular profile of patients (or deceased) with four or more RA. We aimed to retrospectively assess the clinical profile and imaging data of patients with unilateral four-RA.

METHODS

Individual patients' reports of computed tomography (CT) examinations (January 2008–November 2020) of the abdominal aorta of 7136 patients filed in the electronic databases from a single high-volume tertiary cardiac center were retrospectively screened for the presence of unilateral four-RA.

The study was approved by the institutional ethics committee (no. 4.60/VI.21). The informed patients' consent was waived because of the retrospective study design.

Statistical analysis

Please see the Supplementary material.

RESULTS AND DISCUSSION

Eleven patients with at least four unilateral RA were identified (prevalence 0.15%; 11/7136) — see the Supplementary material, *Figure S1*. Demographics, clinical and laboratory data, as well as medications, are presented in the Supplementary material, *Table S1*.

Cardiovascular profile

Ten patients had arterial hypertension (HTN), out of whom four had resistant HTN. Eight patients had hyperlipidemia or were on the lipid-lowering treatment, four patients had diabetes mellitus, three patients experienced acute coronary syndrome, two patients had heart failure, two patients had atrial fibrillation, and one patient had hypertrophic obstructive cardiomyopathy. In one patient, a common origin of the carotid arteries was visualized. None of them had a history of stroke.

Renal arteries

Among the 11 patients with (at least) unilateral four RA, different numbers of RA were present on the opposite kidney, namely: three patients had kidneys with one RA, six patients had kidneys with two RA, and two patients had kidneys with four RA. The total number of RA and the mean number of RA per patient were the same on the left side compared to the right side (mean 3.2 ± 1.2 vs. 2.9 ± 1.3 ; $P = 0.695$).

Measurements of the kidneys and RA are presented in the Supplementary material, *Tables S2* and *S3*.

Charts in the Supplementary material, *Figure S2A* and *S2B*, present paired profiles of the mean ostial lumen diameter and mean ostial lumen area, respectively, of RA for consecutive nine patients. The mean lumen diameter and area of the four RA were significantly smaller than the mean lumen diameter and area

Table 1. Brief literature review of four or more unilateral renal arteries

Author, year of publication	Total number of renal arteries (right/left)	Diagnosis	Number of patients
Unilateral six renal arteries			
Orlando G et al., 2008	7 (6 + 1)	DKD	1
Unilateral five renal arteries			
Naito M et al., 2011	8 (5/3)	D with history of HF	1
Krishnaveni C et al., 2013	7 (5/2)		
Hwang JK et al., 2010	5 ^a	DKD/LKD	2
Tuteja S et al., 2019	5 ^a	DKD	1
Bachul PJ et al., 2017	5 ^a		
Soliman SA et al., 2011	5 ^a	LKD	
Adaci B, 1928	5		
Unilateral four renal arteries			
Hwang JK et al., 2010	4 ^a	DKD/LKD	5
Özkan U et al., 2006	4 ^b	Angiography in LP	2
Hirai S et al., 2013	9 (4/4 + common trunk)	D with history of HF	1
Lee H et al., 2019	7 (3/4)	D	
Miclăuș G et al., 2012	7 (3/4)	CTA in LP	
Gupta A et al., 2011	7 (3/4)	D	
Hager E et al., 2008	7 (3/4)	CTA in LP	
Rossi U et al., 2006	7 (3/4)		
Kondo T et al., 2018	6 (2/4)	Surgical finding in cancer-LP	
Sezer TO et al., 2012	4 ^a	UKD	
Hollosy T et al., 2020	5 (1/4)	D	
Pusztai A et al., 2019	5 (1/4)	CTA in LP	
Wróbel G et al., 2019	5 (1/4)	D	
Kamali K et al., 2012	4 ^a	LKD	
Soliman SA et al., 2011	4 ^a		
Ali-El-Dein B et al., 2003	4 ^a		

^aMultiple renal arteries in donor kidneys. No data on the contralateral donor kidney. ^bMultiple renal arteries in living patients. No data on the contralateral arteries

Abbreviations: CTA, computed tomography angiography; D, deceased; DKD, deceased kidney donor; HF, heart failure; LKD, living kidney donor; LP, living patients; UKD, unspecified kidney donor

of the contralateral one or two RA. This was valid for all nine patients.

Charts in the Supplementary material, *Figures S3A* and *S3B*, present the ostial lumen diameter and ostial lumen area of the eleven kidneys with four RA. The first (from the top) of the four unilateral RA was significantly larger than the remaining three RA, in terms of lumen diameter.

Finally, we matched 33 patients (1:3) by sex and age (group 2) from the cohort of 300 patients with unilateral two RA to compare the studied cohort (group 1) with matched group 2 in terms of the cardiovascular profile. No significant differences were found between both groups (Supplementary material, *Table S1*; taking into account the power of the test of only 45%–49%).

This is the first study, to our knowledge, looking specifically at living patients with 4 or more RA. We have described the cardiovascular profile of patients in this small cohort, which was nonetheless the largest group of such patients so far — see *Table 1*).

We also performed precise measurements of the four RA in each case, as well as the measurements of kidney dimensions.

In the whole cohort of 7136 patients, who underwent CT of the abdominal aorta and abdominal contrast-en-

hanced CT for various reasons, we found at least 4 unilateral RA in 11 patients. This gives the prevalence of 0.15%.

The clinical characteristics of the whole group are interesting, but unfortunately, we cannot compare our cohort to the general population, which limits our considerations mostly to descriptive aspects. There are several rather obvious reasons for this. These were patients hospitalized for cardiovascular causes, not healthy individuals. Vascular studies are done for certain indications, resistant HTN or atherosclerosis being some of them, so this is certainly a selected cohort.

Given the above, it is unsurprising that the great majority of patients with 4 unilateral RA had HTN, also resistant HTN. The prevalence of HTN in this group is very high. Not unexpectedly — one reason may be the selection bias mentioned above, the other is the fact that multiple RA have also previously been found to correlate with a high incidence of HTN [2].

However, more recently a study based on magnetic resonance imaging assessment of RA found no such correlation [3]. So perhaps the very high incidence of HNT in our cohort of patients was not related to the presence of 4 or more unilateral RA but had more to do with the fact that these were selected patients with cardiovascular disease who are often hypertensive. The mean lumen diameter

and area of the four RA were significantly smaller than one or two contralateral RA and smaller than those in the historical study on the deceased [4]. However, it probably has no influence on kidney perfusion as both longitudinal dimensions, kidney volume, and parenchyma thickness were comparable on both sides.

The question, therefore, remains whether multiple unilateral RA, especially 4 or more unilateral ones, are a phenomenon of any clinical significance. There certainly are obvious clinical situations when that may be the case. As frequently seen, harvesting and transplanting kidneys with multiple RA tends to be more complicated and may result in worse graft function. The ischemic time is increased; there may be vascular complications, higher infection rates, and delayed graft function [5]. While recent data seem to indicate that multiple RA kidney transplant recipients have long-term outcomes that are non-inferior to those patients who received a single RA allograft [6], those data come from patients whose allografts usually had only 2 RA as other variations are much rarer.

Another clinically relevant aspect, especially pertinent as the era of treating HTN by renal denervation therapy is dawning, is the feasibility of performing renal denervation safely and effectively in patients with multiple RA. As our data indicate, in patients with 4 unilateral RA, the mean RA diameter at the narrowest point was 2.9 mm, which precludes renal denervation in most cases. Hence, these patients, who may have a higher prevalence of resistant HTN (although it has not been conclusively proven), would not have the chance of receiving effective treatment. All available devices for denervation are recommended in arteries with at least 3 mm in diameter [7].

Limitations

Retrospective nature carries inherent limitations. First, a relatively high number of abdominal CTs were done for the diagnostic purposes of HTN. Secondly, we did not specifically analyze every CT image, but instead, we searched for specific keywords in the electronically stored CT reports. Importantly, not all cases with multiple RA (including unilateral four RA) might have been described in our CT reports. Finally, the number of patients is relatively small, and thus the statistical analysis is limited.

CONCLUSION

Unilateral four RA is a very rare finding on CT imaging. Dimensions (the lumen diameter and lumen area) of the four unilateral RA are not uniform, with the largest RA being the first RA (counting from the top).

Supplementary material

Supplementary material is available at https://journals.viamedica.pl/kardiologia_polska.

Article information

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