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# The Association of Aberrant Renal Vessels with Hypertension among Patients with Hydronephrosis in Albania

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## Abstract

**Purpose**: The data related to the clinical implications of aberrant (or accessory or multiple) renal arteries are not very abundant, and in some cases are even contradictory. In this context our aim was to determine whether the presence of aberrant renal vessels is associated with blood pressure in a group of patients diagnosed with hydronephrosis in Albania

**Material and methods**: This study included 81 patients diagnosed with hydronephrosis who showed up at the Urology Service of the University Hospital Center "Mother Teres" in Tirana, Albania, during 2010-2014, for further treatment, follow-up and management. The presence of aberrant renal vessels was determined by a range of imaging examinations. Blood pressure was measured upon hospitalization and mean blood pressure among patients with and without aberrant renal vessels was compared using non-parametric tests and binary logistic regression.

**Results**: The mean age of participating patients was 27.7 years ± 13.78 years (51.9% males). The overall prevalence of aberrant vessels in patients with hydronephrosis in the study was 42%. Meanwhile, the prevalence of aberrant renal arteries was 29.6%, and the prevalence of aberrant renal veins was 18.5%. 32.1% of all patients with hydronephrosis had one type of aberrant renal vessel (artery or vein), while 9.9% had both types of aberrant renal vessel (both artery and vein). In 9.9% of cases aberrant renal

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vessels were located in the right kidney, in 30.9% of the participants they were located in the left kidney and in 1.2% of all participants the aberrant vessels were present in it both kidneys simultaneously (bilateral). There were no statistically significant differences in mean systolic and diastolic arterial pressure between all groups under study; however, mean systolic and diastolic arterial pressure tended to be higher in patients with aberrant renal veins and those with bilateral aberrant renal vessels compared to patients without these conditions, respectively, but these differences were not statistically significant (P>0.05). After controlling for the confounding effect of age and gender still there was no statistical association between systolic and diastolic blood pressure and aberrant renal vessels.

**Conclusions**: Our findings suggest that there is no statistical association between the presence of aberrant renal vessels and blood pressure among patients with hydronephrosis.

**Keywords**: Albania, aberrant renal vessels, diastolic blood pressure, prevalence, systolic blood pressure.

## INTRODUCTION

The data related to the clinical implications of aberrant (or accessory or multiple) renal arteries are not very abundant, and in some cases are even contradictory. The lack of reports regarding the fact that multiple renal arteries can be risk factors for various health conditions may also be related to the fact that, as suggested by Graves and other authors, multiple renal arteries are not considered abnormal or excessive structures, but they should be considered as normal segmental arteries whose origin is more proximal than necessary (1), with very pronounced morphological variations which are mainly based on the phenomena that occur during the embryonic stage of kidney development.

There are several reports suggesting that accessory renal arteries are a risk factor for hypertension. For example, a study among 162 middle-aged patients with primary hypertension, who were divided into the group without accessory renal artery (108 patients or 66.7%) and the group with accessory renal artery (54 patients or 33.3% of all patients in the study), reported that direct renin concentration and ambulatory day, night, and 24-hour blood pressure were significantly higher in patients with accessory renal arteries compared with patients without accessory renal arteries; therefore, the authors concluded that the presence of accessory renal arteries is associated with higher blood pressure and a higher renin concentration in middle-aged patients with primary hypertension, implicating accessory renal arteries as a cause of hypertension and damage to target organs; therefore, patients with accessory renal artery and primary hypertension need a stricter blood pressure control (2). Several other studies have reached similar conclusions. For example, a study among two cases with hypertension and secondary hyperaldosteronism reported that hypertension was associated with accessory renal arteries with the latter being a potential cause of renovascular hypertension (3). Another paper reported the case of a 31-year-old female with longstanding hypertension in whom echocardiography revealed a left superior accessory artery and suspected bilateral renal venous congestion; compression of the left renal vein between the aorta and the superior mesenteric artery was also evident; in this case, the hypertension was suspected to be secondary to accessory renal artery stenosis, a condition that is rare but adds to the argument that accessory renal artery stenosis may be an etiological factor for hypertension (4).

Other studies have also concluded that accessory/aberrant/multiple renal arteries are associated with arterial hypertension (5-9).

Some researchers put forward a hypothesis regarding the pathophysiological basis through which multiple renal arteries can lead to arterial hypertension: usually the vessels that enter the poles of the kidney are much narrower than the main renal artery and this makes the renal segment supplied by this vessel to be subjected to a lower pressure than the rest of the parenchyma that is supplied by the main artery; the inability of the kidney's self-regulatory system to compensate for this pressure difference may stimulate renin production exceeding the levels of the rest of the parenchyma and leading to a systemic increase in blood pressure; most likely the baroreceptor mechanism may be responsible for hypertension in patients with multiple renal arteries similarly to the Goldblatt mechanism that induces hypertension in the presence of renal artery stenosis; this may also explain the higher incidence of stenosis of the main renal artery and pole vessels in the presence of multiple renal arteries, just as hypertension appears to represent a risk factor for atherosclerosis (10). In patients with secondary hypertension, the incidence of atherosclerosis tends to be higher than in the control group (10). This hypothesis was also confirmed by another study where apparently primary hypertension was encountered more often in the group of individuals with multiple renal arteries compared to those with single renal arteries, as it was concluded that patients with multiple renal arteries have a higher activity of plasma renin being more prone to develop arterial hypertension (11).

However, one study concluded that accessory renal arteries are not associated with hypertension risk (12).

Clearly, further scientific research is needed to clarify the relationship between accessory renal arteries and hypertension, as the data to date are conflicting or insufficient to reach a clear conclusion.

In this context the aim of this study was to determine whether the presence of aberrant renal vessels was associated with blood pressure in a group of patients diagnosed with hydronephrosis in Albania.

## METHODS

### *Study design*

This is a case-series study that included 81 patients diagnosed with hydronephrosis in Albania during 2010-2014. All patients showed at the Urology Service of the University Hospital Center "Mother Teresa" in Tirana, Albania.

### *Data collection*

Besides basic socio-demographic information about the study participants, various imaging examinations were carried out to determine the presence of hydronephrosis and aberrant (or accessory or multiple) renal vessels. These examinations included ultrasound, pyelography, scintigraphy, computed tomography scan, and magnetic resonance. In addition, the arterial systolic and diastolic blood pressure was measured at the moment of admission.

### *Statistical analysis*

Based on the status of aberrant renal vessels presence, the participants were divided into two groups: with and without aberrant renal vessels. Then the mean value of the arterial systolic and diastolic blood pressure was compared between these two groups in order to detect potential significant associations. To compare the mean values of systolic and diastolic blood pressure between study groups the Mann-Whitney U-test (for two independent samples) and Kruskal-Wallis test for k independent samples were used. In addition, Binary Logistic Regression was used to detect the association between blood pressure with independent variables, controlling for the potential confounding effect of age and gender of the participants. An association was considered significant if P value <0.05. All statistical analyzes were performed through the statistical package Statistical Package for Social Sciences, version 25 (IBM SPSS Statistics for Windows, version 26).

## RESULTS

The mean age of participating patients was 27.7 years ± 13.78 years (51.9% males, 53.1% residing in urban areas, 42% unemployed).

The overall prevalence of aberrant vessels in patients with hydronephrosis in the study was 42%. Meanwhile, the prevalence of aberrant renal arteries was 29.6%, and the prevalence of aberrant renal veins was 18.5% (Table 1). 32.1% of all patients with hydronephrosis had one type of aberrant renal vessel (artery or vein), while 9.9% had both types of aberrant renal vessel (both artery and vein). In 9.9% of cases aberrant renal vessels were located in the right kidney, in 30.9% of the participants they were located in the left kidney and in 1.2% of all participants the aberrant vessels were present in it both kidneys simultaneously (bilateral) [Table 1].

**Table 1.** Prevalence, type and localization of accessory renal vessels among study participants

| Variable | Absolute number | Frequency (%) |
|---|---|---|
| *Total* | *81* | *100.0* |
| **Aberrant renal vessels** | | |
| No | 47 | 58.0 |
| Yes | 34 | 42.0 |
| **Aberrant renal arteries** | | |
| No | 57 | 70.4 |
| Yes | 24 | 29.6 |
| **Aberrant renal veins** | | |
| No | 66 | 81.5 |
| Yes | 15 | 18.5 |
| **Type of aberrant vessels** | | |
| No aberrant vessels | 47 | 58.0 |
| Aberrant artery or vein | 26 | 32.1 |
| Aberrant artery and vein | 8 | 9.9 |
| **Localization of aberrant vessels** | | |
| No aberrant vessels | 47 | 58.0 |
| Right kidney | 8 | 9.9 |
| Left kidney | 25 | 30.9 |
| Bilateral | 1 | 1.2 |

Table 2 presents the mean systolic arterial pressure of patients with hydronephrosis with and without aberrant renal vessels. It can be noted that there were no statistically significant differences in mean systolic arterial pressure between all groups under study. However, mean systolic arterial pressure tended to be higher in patients with aberrant renal veins and those with bilateral aberrant renal vessels compared to patients without these conditions, respectively, but these differences were not statistically significant (P>0.05). The clinical implication of these findings is that aberrant renal vessels are not related to systolic blood pressure.

Table 3 presents the mean diastolic arterial pressure of patients with hydronephrosis with and without aberrant renal vessels. It can be noted that there are no statistically significant differences in mean diastolic arterial pressure between all groups under study. However, mean systolic arterial pressure tended to be higher in patients with aberrant renal vessels, those with aberrant renal arteries and veins, and in those with bilateral aberrant renal vessels compared with patients

**Table 2.** Mean values of systolic arterial pressure among patients with hydronephrosis with and without aberrant renal vessels included in the study

| **Variable** | **Mean value *** | **95% confidence interval for the mean value (95% CI)** | | **P-value **** |
|---|---|---|---|---|
| | | **Lower limit** | **Upper limit** | |
| **Aberrant renal vessels** | | | | 0.708 |
| No | 126.234 | 123.343 | 129.125 | |
| Yes | 125.941 | 122.542 | 129.340 | |
| **Aberrant renal arteries** | | | | 0.274 |
| No | 126.877 | 124.271 | 129.484 | |
| Yes | 124.292 | 120.275 | 128.308 | |
| **Aberrant renal veins** | | | | 0.747 |
| No | | | | |
| Yes | 125.848 | 123.412 | 128.284 | |
| | 127.267 | 122.157 | 132.376 | |
| **Localization of aberrant vessels** | | | | 0.793 |
| No aberrant vessels | 126.234 | 123.316 | 129.152 | |
| Right kidney | 124.250 | 117.178 | 131.322 | |
| Left kidney | 126.240 | 122.239 | 130.241 | |
| Bilateral | 132.000 | 111.997 | 152.003 | |

* Mean value of systolic arterial pressure in patients with hydronephrosis included in the study.
** P-value according to the non-parametric Mann-Whitney U-test for two independent samples or Kruskal-Wallis non-parametric test for k independent samples.

**Table 3.** Mean values of diastolic arterial pressure among patients with hydronephrosis with and without aberrant renal vessels included in the study

| Variable | Mean value * | 95% confidence interval for the mean value (95% CI) | | P-value ** |
|---|---|---|---|---|
| | | Lower limit | Upper limit | |
| **Aberrant renal vessels** | | | | 0.362 |
| No | 78.851 | 76.935 | 80.767 | |
| Yes | 79.882 | 77.630 | 82.135 | |
| **Aberrant renal arteries** | | | | 0.779 |
| No | 79.263 | 77.518 | 81.008 | |
| Yes | 79.333 | 76.644 | 82.022 | |
| **Aberrant renal veins** | | | | 0.621 |
| No | 79.152 | 77.531 | 80.772 | |
| Yes | 79.867 | 76.468 | 83.265 | |
| **Localization of aberrant vessels** | | | | 0.656 |
| No aberrant vessels | 78.851 | 76.919 | 80.783 | |
| Right kidney | 79.000 | 74.317 | 83.683 | |
| Left kidney | 79.960 | 77.311 | 82.609 | |
| Bilateral | 85.000 | 71.755 | 98.245 | |

* Mean value of systolic arterial pressure in patients with hydronephrosis included in the study.
** P-value according to the non-parametric Mann-Whitney U-test for two independent samples or Kruskal-Wallis non-parametric test for k independent samples.

without these conditions, respectively, but these changes did not reach statistical significance (P>0.05). The clinical implication of these findings is that aberrant renal vessels are not related to diastolic blood pressure.

Table 4 presents the relationship between the systolic and diastolic arterial pressure of the hydronephrosis patients in the study and the presence of aberrant renal vessels. It can be noted that there is no relationship between systolic arterial pressure and the presence of aberrant renal vessels in both analysis models: for a 1 mmHg increase in systolic blood pressure, the likelihood of the presence of aberrant renal vessels does not change (remains 1). Similarly, the relationship between diastolic arterial pressure and the presence of aberrant renal vessels is very weak and is not statistically significant (P>0.05) in both analysis models. In Model 1 (crude) and Model 2 (controlled for the confounding effects of age and gender) for every 1 mmHg increase in diastolic blood pressure the odds of having aberrant renal vessels increases by 1.03 times with associations not reaching statistical significance.

**Table 4.** Association of systolic and diastolic arterial pressure with the presence of aberrant renal vessels: odds ratio (OR) from Binary Logistic Regression

| Variable | Model 1 | | | Model 2 | | |
|---|---|---|---|---|---|---|
| | Odds Ratio (OR) * | 95% CI ** | P-value *** | Odds Ratio (OR) * | 95% CI ** | P-value *** |
| Systolic arterial pressure | 1.00 | 0.95-1.04 | 0.895 | 1.00 | 0.95-1.05 | 0.950 |
| Diastolic arterial pressure | 1.03 | 0.96-1.10 | 0.484 | 1.03 | 0.96-1.11 | 0.448 |

* Odds ratio of the presence of aberrant renal vessels versus their absence. ** 95% confidence interval (95% CI) for the odds ratio. *** P-value according to Binary Logistic Regression.
Model 1: Crude (not controlled, not adjusted) odds ratio.
Model 2: Odds ratio controlled for the potential confounding effect of age and gender of participants.

## DISCUSSION

This is the first study in Albania reporting about the association of aberrant renal vessels with systolic and diastolic blood pressure among patients with hydronephrosis. Our findings suggest that there is no statistically significant association between the presence of aberrant (accessory, multiple) renal vessels and blood pressure.

According to the international literature, aberrant renal arteries can lead to a number of urological diseases and their presence should be suspected first in patients with systemic hypertension and proximal ureteral obstruction. Cerny and Karsch (13) present the case of a 55-year-old patient with hypertension that did not respond to drug treatment; after examinations an aberrant renal artery was discovered; treatment continued with removal of the right kidney whose examination revealed a renal arterial aneurysm secondary to atherosclerosis with parts of the kidney supplied by this segmental branch with signs of severe ischemia and chronic pyelonephritis; the authors concluded that the aberrant renal artery in this case was the cause of hypertension, based also on a series of autopsies by other authors who had evidenced a significantly higher incidence of aberrant renal arteries in hypertensive patients than in normotensive ones (13). Other lesions of interest in the background of aberrant renal artery are obstruction caused by vessels in the lower pole of the kidney and pyelonephritis caused by aberrant vascular ischemia or ureteral obstruction (13).

Another study among 400 individuals (264 males and 136 females) examined by autopsy reported that the presence of aberrant renal arteries was significantly higher in hypertensive males (80.6%) and females (80.5%) compared with corresponding normotensive individuals (51.7%

in normotensive men and 43.2% in normotensive women); in total, the frequency of aberrant renal arteries was 80.6% in hypertensive individuals and 49% in normotensive ones (14).

Another report of two cases with hypertension and accessory renal arteries concluded that accessory renal arteries may be a potential cause of renovascular hypertension (3). Likewise, a study among 126 renal patients with a single renal artery and 118 patients with accessory renal arteries compared various parameters related to hypertension between them and concluded that patients with accessory renal arteries may have higher blood pressure compared to patients with a single renal artery (15).

Other studies have found associations between renal accessory artery stenosis and hypertension (16). Arterial stenosis is mainly caused by atherosclerosis and less often by fibromuscular dysplasia; meanwhile, risk factors for this condition include aging, high blood pressure, high cholesterol levels, diabetes, obesity, smoking, sedentary lifestyle, family history of heart disease, etc. (17). If renal artery stenosis occurs, its complications are significant and include chronic kidney disease, coronary artery disease, atrophy of the affected kidney, renal failure, peripheral arterial disease, and renal hypertension, among others (18).

Accessory renal arteries are usually smaller in diameter compared to the main renal artery; it is possible that for this reason they are affected earlier by the effects of atherosclerosis leading to their faster narrowing, faster stenosis, and this may explain the association of stenosis of these vessels with arterial hypertension in affected patients. Likewise, since accessory renal vessels are smaller, they may have increased resistance predisposing them to under-perfusion (19). Meanwhile, a study in two patients with aberrantly elongated renal arteries without focal stenosis found a decrease in blood flow compared with tissue requirements, and the authors concluded that increased vessel length may contribute to decreased blood flow leading to stimulation of renin secretion, as above, and hypertension (20).

There are reports that accessory renal arteries may play a role in atherosclerosis of blood vessels due to disturbances of blood flow in these often tortuous (i.e., not straight) and smaller diameter vessels (21); atherosclerosis of the vessels can lead to narrowing of their lumen, stenosis of the arteries and this increases the risk of hypertension (22).

Regarding the association of aberrant renal vessels with hypertension, in our study we did not find evidence of any such association: the mean values of systolic and diastolic arterial pressure were almost the same, without statistically significant differences, between hydronephrosis patients with aberrant renal vessels and those without aberrant renal vessels; also, the odds of the presence of aberrant renal vessels did not vary significantly with a unit increase in systolic or diastolic arterial pressure, implying a lack of association in our study.

However, reports in the international literature regarding whether aberrant renal arteries are risk factors for hypertension are conflicting, although most of them lean toward the conclusion that accessory renal arteries increase the risk for hypertension.

For example, one study concluded that accessory renal arteries are not associated with the risk of hypertension: among 185 hypertensive patients, 140 patients or 24% of all participants had accessory renal arteries, of which 20% had stenosis of these arteries while they were normal in the rest of 80% of patients with accessory renal artery; on the other hand, 140 patients or 76% of all participants had a single renal artery, so they were normal; among these 30% had renal artery stenosis (12). The authors reported that the odds of the presence of arterial stenosis in the group with accessory renal artery versus the group with a single renal artery (no accessory renal artery) was 0.58, without statistical significance (P>0.05), concluding that the presence of accessory renal arteries is not associated with hypertension risk, and that accessory renal arteries are an anatomic variant rather than a true cause of hypertension (12).

The finding of this study regarding the lack of association between aberrant renal arteries and hypertension is in full agreement with the finding in our study where no significant association was found between them. We support the idea that the accessory renal arteries are an anatomic variant of the vascularization of the kidney and, as such, should be subject to the same factors leading to hypertension as in the case of renal artery stenosis from atherosclerosis or other factors and that, by itself, the presence of accessory renal arteries does not necessarily cause hypertension independently and in the absence of other risk factors (atherosclerosis, stenosis, fibrosis, etc.). However, at the moment the literature is dominated by reports suggesting an increased risk of hypertension from the renal accessory arteries and even a causal relationship between them. In this context we have to await other future reports to definitively clarify the role of accessory renal arteries in the development of hypertension.

**Study limitation**

The main limitation of this study relates to its relatively small sample size, which might limit the generalization of our findings because the patients included might not represent all patients affected by these health conditions.

## CONCLUSION

Our findings suggest that there is no statistical association between the presence of aberrant renal vessels and blood pressure among patients with hydronephrosis.

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**Conflict of Interest Statement**: The authors declare that they have no conflict of interest.

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