



Original Contribution

QUANTITATIVE MORPHO-FUNCTIONAL ANALYSIS OF SIMMETRY-ASIMMETRY CONDITION OF HUMAN NORMAL KIDNEY

M. Dgebuadze^{1*}, G. Svanidze², D. Gachechiladze²

¹Department of Human Normal Anatomy, Tbilisi State Medical University, Tbilisi, Georgia

²Department of Ultrasound Diagnostics, Todua Research Institute of Clinical Medicine, Tbilisi, Georgia

ABSTRACT

PURPOSE: The aim of the present research was to perform quantitative morpho-functional analysis of the symmetry-asymmetry condition of human normal autopsy and “live” kidneys using the complex of morphological and ultra-sonographic methods. **METHODS:** Morphometric study of 10 autopsy kidneys of healthy men 36 - 60 years of age was conducted; retrospective analysis of data obtained by vital ultra-sonographic study of 65 kidneys of men without renal diseases at the same age period was performed as well. All kidneys were with a single renal artery. **RESULTS:** The kidney length and width are statistically significantly greater on right, than on left, but there were no statistically significant differences between right and left kidneys in thickness of the kidney and size of its parenchyma. Results of morphometric study of autopsy renal glomeruli, as well as multislice computed tomographic angiography and doppler investigation of renal artery in color duplex scan mode did not show any statistically significant differences on right and on left. **CONCLUSIONS:** For determining of the standard quantitative indicators of kidney it is necessary to take into account the age and gender of the studied people, as well as the effect of side.

Key words: Human normal kidney, symmetry-asymmetry, autopsy, vital ultrasonography, vessels

INTRODUCTION

One of the urgent problems of modern theoretical and clinical medicine is the question of the symmetry-asymmetry of organs. The principle of symmetry has great importance in the organization of biological objects. In the individual human development are distinguished 2 types of symmetry and, accordingly, of asymmetry: bilateral and axial. It's well known that the kidneys belong to the organs with pronounced asymmetry, but the symmetry - asymmetry of right and left normal kidneys is less frequently studied using the complex of morphological and ultra-sonographic methods. In the literature there are evidences of an asymmetry in the size of the right and left kidneys, about asymmetry of renal vessels (especially - the asymmetry of

extra organic renal vessels and their large branches) as well - variations including their number, source, size, branching and course on left and on right are very common. Noteworthy, that the presented data are contradictory (1, 2). According to some literature data renal artery size is positively associated with kidney volume and may be used as a more easily measured surrogate marker for kidney size with its attended implications in living donor transplantation (3). Relationship between live donor renal anatomic asymmetry and post-transplant recipient function has not been studied extensively (4). Many authors highlight the importance of studying the function of both kidneys separately (5). Quantitative parameters of normal renal sizes and hemodynamic parameters of renal vessels, especially separately for the right and left kidneys, are not well documented yet. The aim of the present research was to perform quantitative morpho-functional analysis of symmetry-

*Correspondence to: Maia Dgebuadze, Didi Digomi, Petritsi Str. 2, app. 36, 0159 Tbilisi, Georgi, (+995) 571 20 54 98, illusion_ia2001@yahoo.com

asymmetry condition of human normal autopsy and “live” kidneys using the complex of morphological and ultrasonographic methods.

MATERIAL AND METHODS

Using histological and morphometric methods the investigation of 10 autopsy kidneys of healthy men 36 - 60 years of age was conducted. Retrospective analysis of data obtained by vital study of 65 kidneys of men without renal diseases at the same age period was performed as well: multislice computed tomographic angiography (MSCTA) was performed by 16-slice CT scanner (Somatom Sensation Cardiac 16, "Siemens") (6 kidneys) – the length, the character of the branching, the diameter and origination angles of the renal artery were determined; doppler investigation of renal artery in color duplex scan mode was carried out according to the generally accepted technique on the Acuson CV 70 with a 3.5 MHz sensor - in the longitudinal sections the peak systolic velocity of the blood flow (Vps), the end diastolic velocity of the blood flow (Ved), the resistive

index (RI) and the acceleration time (AT) were determined (32 kidneys); the length (pole to pole), width and thickness of the kidney, as well as the size of its parenchyma (in millimeters), were measured on Toshiba Aplio i800, Aplio 500 and Aplio 300 Ultrasound Machine (27 kidneys). All kidneys were with a single renal artery. Data was processed in the special statistical program IBM_SPSS_2015. The T-test comparison of the average was used; differences were considered significant at *p* values less than 0.05. The ethical standards of the WMA Declaration of Helsinki were taken into account; ethical approval was obtained from the local ethical committee of Research Institute of Clinical Medicine of Georgia.

RESULTS

According to morphometric study of autopsy kidneys by comparison of normal, sclerotic, partly and completely hyalinized glomeruli on right and left statistically significant differences were not detected (**Figure 1**).

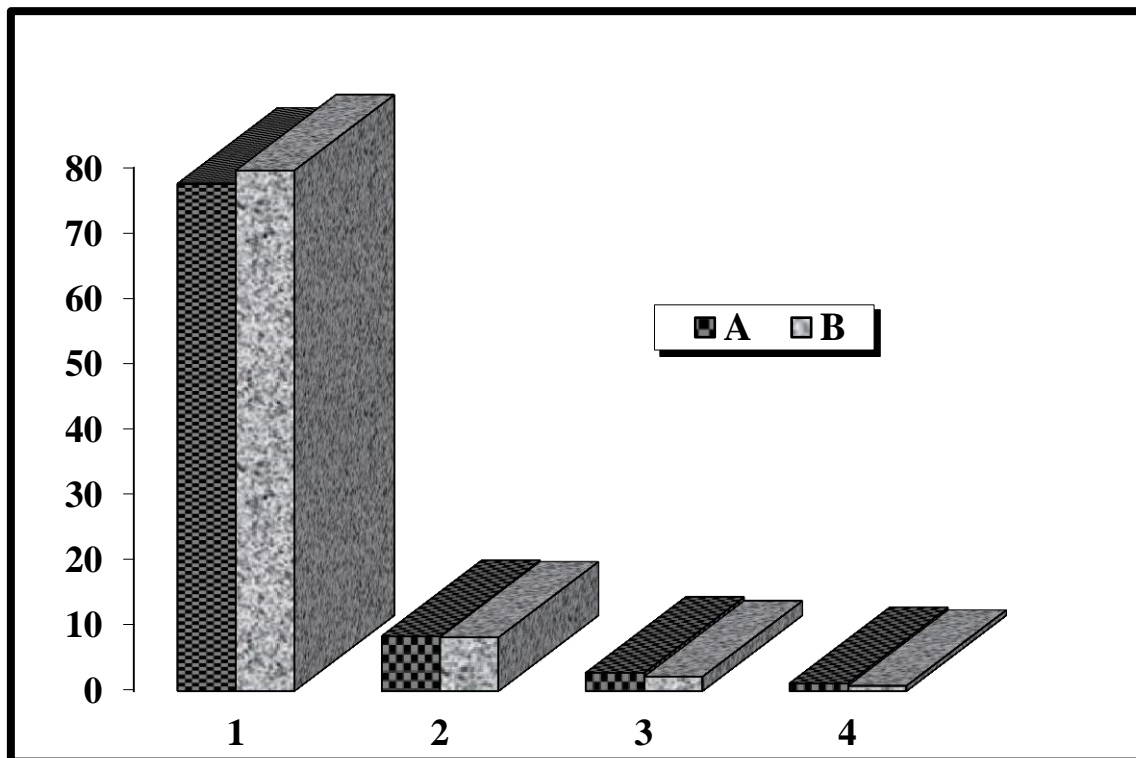


Figure 1. Normal (1), sclerotic (2), partly hyalinized (3) and completely hyalinized (4) glomeruli (%) in right (A) and left (B) kidneys

Comparison of MSCTA data did not show any statistically significant differences in

origination angle, length and internal diameter between right and left renal arteries (**Table 1**).

Table 1. *Origination angle, length (cm) and internal diameter (mm) of renal artery*

Measurements	Men	
	Right side	Left side
Origination angle of renal artery	67.33±8.81	73.00±5.10
	P=0.459	
Length of renal artery (cm)	4.47±0.95	3.70±1.19
	P=0.371	
Internal diameter of renal artery (mm).	6.74±0.17	6.74±0.17
	P=0.954	

No statistically significant differences were found in quantitative hemodynamic parameters of right and left renal arteries, obtained by

doppler investigation in color duplex scan mode (**Table 2**).

Table 2. *Results of doppler investigation of right and left renal arteries in color duplex scan mode*

Vps (cm/s)		Ved (cm/s)		RI		AT (s)	
on right	on left	on right	on left	on right	on left	on right	on left
88.63±3.18	88.13±2.98	37.25±5.08	37.50±4.56	0.67±0.01	0.67±0.02	0.08±0.01	0.08±0.01
P=0.556		P=0.851		P=0.580		P=0.652	

At sonography by comparison of quantitative parameters of kidney were established that kidney length, as well as kidney width, are statistically significantly greater on right, than

on left; but thickness of the kidney and size of its parenchyma did not show any statistically significant differences between right and left kidneys (**Table 3**).

Table 3. *The length, width, thickness of kidney and the size of renal parenchyma (mm).*

Measurements	Men	
	Right side	Left side
Length of kidney	98.63±6.86	93.67±1.56
	P=0.007	
Width of kidney	44.68±6.13	41.11±1.91
	P=0.02	
Thickness of kidney	37.84±2.28	36.78± 2.57
	P=0.06	
Size of renal parenchyma	16.68±1.92	16.22±1.31
	P=0.32	

DISCUSSION

In our previous published works by comparison of quantitative parameters of kidney in men and women [36 - 60 years of age] we established that kidney length and width in men was statistically significantly greater than in women on right, as well as on left (6); we observed increasing with aging structural changes of blood vessels in autopsy kidneys of healthy people at I (22–35) and II (36-60) periods of maturity (7). Taking into the account the results of our previous investigations and literature data (8) to exclude the influence on the results of our research sex- and age-related morphofunctional peculiarities of kidney we in this work investigated the kidneys of only men of the same age.

In this work morphometric study of autopsy kidneys by comparison of normal, sclerotic, partly and completely hyalinized glomeruli on right and left statistically significant differences did not detect (**Figure 1**). Appearance of sclerotic, partly and completely hyalinized glomeruli in autopsy kidneys of healthy men 36 - 60 years of age is result of senescence: by age 80, about 40 % of glomeruli are not functioning, with aging they become damaged or decrease in number (9); according to some literature data (10) a decrease in glomerular filtration rate starts between ages 20 to 33.

According to the classic anatomic descriptions, due to the position of the aorta, the inferior vena cava, and the kidneys in the body, the right renal artery is normally longer than the left renal artery, what point out many authors as well (11); comparison of MSCTA data in our study did not show any statistically significant differences in length between right and left renal arteries. It's well known that origination angles and internal diameters of vessels play a significant role in blood flow and blood supply of organs; comparison of MSCTA data in our study did not show any statistically significant differences in origination angle and an internal diameter between right and left renal arteries (**Table 1**).

The diameters of the right and left renal arteries did not differ in the works of other authors as well (11, 12). According to some literature data in 98% of the patients, right renal artery and in 97% of the patients, left renal artery originated between the upper

margin of L1 and the lower margin of L2 vertebrae (13).

Doppler ultrasound enables beside visualization also determination of flow, its direction and its velocity within a vessel; no statistically significant differences were found in quantitative hemodynamic parameters of right and left renal arteries, obtained by doppler investigation in color duplex scan mode (**Table 2**). Our data are consistent with those of other authors (5), who also found no functional asymmetry of renal blood flow in norm, but functional asymmetry of the kidneys was noted both in norm and in pathology by some authors (14). It is generally assumed that renal blood flow is symmetric in the absence of renal artery stenosis and twin organs such as the kidneys have similar functions. This concept is based screening tests for renal artery stenosis. According to the other literature data this concept is wrong; it is underlined that asymmetric result of a functional test does not necessarily point towards the presence of renal artery stenosis; conversely, you cannot exclude the possibility that there are patients with renal artery stenosis who have completely symmetric renal perfusion (14).

The knowledge of actual normal renal sizes is essential when evaluating patients with possible renal pathology. The standard indicators of the sizes of "live" kidney for people of different sex and age are not yet established. In our opinion, this is a significant gap in the correct interpretation of the results of kidney's sonography. At sonography by comparison of quantitative parameters of kidney were established that kidney length, as well as kidney width, are statistically significantly greater on right, than on left; but thickness of the kidney and size of its parenchyma did not show any statistically significant differences between right and left kidneys (**Table 3**). These data contradict even our previous work (15), in which we studied the same question, but in another age period (healthy men 22-35 years of age) - there were no statistically significant differences in kidney length between right and left side, but statistically significantly greater was kidney width on left and size of its parenchyma - on right. The mean renal parenchymal thickness of the left kidney was found to be statistically higher than that of the right kidney by other authors (16). According to the classic anatomic descriptions, the size of the left kidneys is

greater than the right, but many authors did not observe any differences between the size of the right and left kidneys (12, 17). The mean renal size correlated with age, sex, side, etc. Many authors emphasize that it has to be borne in mind the ethnic background as well; the information available in the West may not be extrapolated to Pakistani population since the renal size may differ between ethnic groups (17). Some authors indicate the role of the method that was used by kidney size measurements; abdominal coronal CT section predicted kidney length more accurately than other radiological methods, but all radiological methods were associated with prediction errors (18). Measurement of renal length can be done with the subject prone or supine (8).

CONCLUSIONS

1. In our study the effect of side on results of morphometric study of autopsy renal glomeruli, on normal kidney dimensions (thickness of the kidney and size of its parenchyma) and on its hemodynamics was not revealed; kidney length and width were statistically significantly greater on right than on left.

2. In our opinion, the reason for contradictory data presented in the literature is that the influence of local (effect of side, different segments, presence of aberrant renal arteries), sex- and age-related peculiarities of the human normal kidney is not often taken into account. For determining the standard quantitative indicators of kidney it is necessary to be borne in mind the age and gender of the studied people, as well as the effect of side.

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