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Original Research Paper

Anatomy

MORPHOMETRIC STUDY OF HUMAN ADULT CADAVERIC KIDNEYS

Reena Agarwal* Associate Professor of Anatomy, Meenakshi Medical college and Research Institute, Enathur, Kancheepuram, India.*Corresponding Author

e.prabhakar Reddy Professor of Biochemistry and Central Laboratory Head, Sri Lakshmi Narayana Institute of Medical Sciences, (Affiliated to Bharath University, Chennai), Pondicherry, India.

ABSTRACT The kidney is a vital organ of the mammalian body and becomes a foremost subject of medical research because many renal diseases in humans are incurable when the kidney is severely damaged. The main aim of the study was to perform morphometric analysis of right and left kidney specimens and compare findings with the previous reports. A total of 50 human adult cadaveric kidneys (25 right and 25 left) were studied. Morphometric features like length, breadth, width and weight were measured. Hilum and lobulation of kidneys were observed. Weight, dimensions, hilar structural variations and lobulations of left kidney were larger than the right kidney. Determination of renal anatomical variants should be greatly encouraged to strengthen the current literature and improve the knowledge needed for surgical and radiological intervention. Variations related to renal dimensions are anticipated to urinary tract diseases,congenital anomolies, neoplasia, micro and macrovascular diseases which were reported to significantly influence kidney sizes.

KEYWORDS : Kidney, Hilum, Length, Breadth, width, Kidney Disease, Renal Parameters.

INTRODUCTION:

The kidney is a vital organ of the mammalian body and becomes a foremost subject of medical research because many renal diseases in humans are incurable when the kidney is severely damaged [1]. It is also a primary target organ in preclinical studies, in which drug-induced nephrotoxicity is a recurrent finding in preclinical studies. In acute renal failure, the damaged tubular epithelium is repaired through repopulation,and tubular function recovers in most cases. The tubular epithelium is especially sensitive to toxic compounds because of water and solute absorption and active transport systems, whichresult in the concentration of toxicants in the tubular cells [2].

Kidneys are a pair of chief excretory organs that not only maintain the electrolyte and water balance but also serve as endocrine organs [3]. Each kidney is bean shaped and has a length of 11 cms, breadth of 6 cms and width of 3 cms. The left kidney is 1.5 cm longer than the right. The average weight of a kidney is 150 grams [4-5]. Kidneys are characterized by a circular and thick superior pole and a pointed and thin inferior pole. The anterior surface is convex and posterior surface is flat [4]. The lateral border is convex, medial border is concave with a hilum that consists of renal vein, renal artery and pelvis of the ureter, anterio-posteriorly 4]. Foetal lobulation could persist in the adult life such that the renal outline appears larger than the normal [5]. In the recent period, morphometric studies have gained much research attention as they are believed to possess significant clinical importance. Most probably, variations related to renal dimensions observed in such studies are anticipated to furnish better insights on anomalies. For instance, conditions like systemic diseases, urinary tract diseases, congenital anamolies, neoplasia, micro and macrovascular diseases were reported to significantly influence kidney sizes [6].

The primary purpose of the renal system is to regulate blood volume, maintain plasma osmolarity and removal of wastage via urine, which is mostly a convenient way to performs many body functions. The investigational parameters like tubular degeneration, interstitial inflammation, fibrosis, and glomerulosclerosis were considered as significant changes occur during advance stages of chronic kidney disease compared with early stages of the disease. These findings will help out to identify therapeutic targets and the stages of disease at which they should be initiated.Studies related to morphometirc determination of renal dimensions and hilum structures still appear limited and need to be strengthened with the additional findings. Therefore, the main objective of the study is to carry out morphometric study of human adult cadaveric kidneys and compare with the data reported elsewhere. current literature and improve the knowledge needed for surgical and radiological intervention[7].Our aim is to determine the renal length, renal breadth, thickness, presence of exaggerated hilum, lobulations or cysts in human adult cadaveric kidneys.

MATERIAL AND METHODS:

A total of 25 right and 25 left human adult cadaveric kidneys were included. Initially, the shapes of kidneys were noted. Then using an electronic weighing machine, kidneys were weighed. Length, breadth and width of kidneys were measured with the help of digital sliding calipers and noted. We studied the structures present at the hilum of the kidneys. We considered the maximum distance between the two poles of the kidneys as its length, maximum distance between two points at the same level between the medial and lateral borders as its breadth and maximum width as the width of kidneys and also studied the lobulation of the kidneys. The data obtained was tabulated, analysed statistically and compared with the previous studies.

RESULTS:

The data obtained was tabulated and analysed statistically. All the 50 kidney specimens were bean shaped. Among the 25 right kidneys, weight ranged from 58 to 180 gms and the average weight was found to be 119.0 gms. The length of right kidney varied between 7.9 and 13 cms with an average length of 10.45 cms.. The breadth of right kidneys was in the range of 5 to 6.4 cms, with an average breadth of 5.7 cms . The width of the right kidney varied between3 and 4.2 cms with an average width of 3.60 cms (Table 1).

Among 25 right kidney specimens, 2 (8%) showed lobulation (Table 4). We observed hilum of the right kidney with an arrangement of renal vein, renal artery and renal pelvis anterio-posteriorly in 23 (92%) specimens. In contrast, 2 (8%) specimens showed renal artery, renal vein and renal pelvis anterio-posteriorly (Table 4).

Among the 25 left kidneys, the weight ranged from 64 to 210 grams and the average weight was found to be 137.0 gms . The length of left kidneys varied between 9.0 and 14.0 cms with an average length of 11.50 cms . The breadth of left kidneys was in the range of 4.5 to 8.5 cms with an average breadth of 6.50 cms . The width of left kidneys varied between 2.5 and 5.5 cms with an average width of 4.0 cms (Table 2). Among 25 left kidney specimens, 4(16%) showed lobulation . We observed the hilum of left kidney with an arrangement of renal vein, renal artery and renal pelvis anterio-posteriorly in 19 (76%) of specimens. The remaining 6(24%) left kidney specimens showed renal artery, renal vein and renal pelvis anterio posteriorly at the hilum (Table 4).

DISCUSSION:

Kidneys are the important organs to maintain the homeostatic function of the body and act as endocrine organs [8]. The present study was done to explore morphological variations of right and left kidneys and describe their significance. We noted several variations in the kidney morphology. In the present study, all the 50 (100%) kidneys were bean shaped as mentioned in the standard text books of Anatomy [8-9]. Previous studies that aging leads to a progressive decrease in kidney size, especially after middle age. The other influencing factors are age, ethnicity, gender, weight and height. A significant correlation between kidney size and kidney function has been observed in patients with chronic kidney disease (CKD). The average weight of right kidneys was 102.54 gms and the average weight of the left kidneys was 113.38 gms. This is not coinciding with the earlier studies that described the average weight to be 108.7 +/- 22.6 g and 111.8 +/- 23.3 g for right and left kidneys, respectively [9]. This is also not in agreement with some studies where the average weight was taken into consideration commonly for both kidneys [10-11]. This could indicate that our present study showed a variation in the weight of kidneys when compared with the earlier findings.

In the present study, right kidney size measurements revealed an average length of 10.45 cms, average breadth of 5.7 cms and the average width of 3.60 cms .These are closer to earlier findings [12-13] but varied with some other [12]. Similarly, left kidney size measurements revealed an average length of 11.50 cms, breadth of 6.50 cms and the width of 4.0 cms which are closer to the previous findings [11] but differed from some other studies [11]. So, this indicated variations in the renal dimensions and could generate considerable medical interest. The volume of the kidney with glomerular filtration rate (GFR) and body mass index (BMI), which might be of great relevance in selection of patients undergoing donor nephrectomy[9]. Renal volume assessment is an important parameter in evaluation and follow up of kidney transplant recipients,CRF and hypertension secondary to renal artery stenosis. It is also useful in younger patients with vesico ureteric reflux (VUR) which alters the morphometrical profile of the kidney[14]. We observed lobulation in 8% of right kidney specimens and 16% of left kidney specimens. Normally, the foetal kidneys are subdivided into lobules which disappear during infancy as the nephrons increase and grow [15]. Patil and his associates reported a rare congenital condition of kidney where bilateral lobulation and malrotation were observed in association with the open hilar structure of kidney [16]. The lobulation observed in the present study although had no associations with any other structural variations or defects, it might highlight certain clinical significance. Renal length estimation by ultrasound is considered as an important parameter in clinical evaluation of kidney disease and healthy donors. Changes in renal volume may be a sign of kidney disease[17].

We observed variations in the renal hilar structures both in the right and left kidneys, but more at the left kidney (24%). Generally, renal hilum variant patterns were reported to be frequent on the left kidney [18]. This could be attributed to the developmental defects of the renal veins. Any abnormality during these channel developments could alter the arrangement of renal hilar structures with regard to the renal vein [18]. So, our findings related to renal hilar structural variation is supported by the previous studies [18-20].

CONCLUSION:

Weight, dimensions, hilar structural variations and lobulations of left kidney were larger than the right kidney. This could indicate that left kidney is more susceptible to anatomical variations than the right kidney. Renal dimensions and hilar structural arrangements could possess significant clinical value. It is necessary to distinguish a pathological kidney from a normal sized healthy kidney. Determination of renal anatomical variants should be greatly encouraged to strengthen the current literature and improve the knowledge needed for surgical and radiological intervention. Variations related to renal dimensions are anticipated to urinary tract diseases,congenital anomolies, neoplasia, micro and macrovascular diseases which were reported to significantly influence kidney sizes.

Table-1: Measurements of Right Kidney

Sr. No	Weight (gms)	Length (Cms)	Breadth (cms)	Weigth(cms)
1	62	7.9	6.6	2.4
2	82	9.5	5.8	2.9
3	87	10	6.8	2.9
4	55	9.4	4.8	2.9
5	84	11	6	3
6	103	11	6	4
7	80	09	6	3
8	138	12	5.5	2.5
9	86	8	6	3
10	126	11	5.5	3.5
11	89	10.5	5.5	3.5
12	89	12	6	4
13	144	12	5.5	3.5
14	129	12	6.5	3.5
15	109	11	7	4
16	98	11	5.5	5
17	108	8	6	3.5
18	72	13	7	4
19	189	10	6	4
20	181	12	6	3
21	134	10	7	5
22	128	10	6	4
23	93	9	5.5	4
24	90	10	7	4
25	125	11	7.5	2.5

Table-2: Measurements of Left Kidney

Sr. No	Weight (gms)	Length (Cms)	Breadth (cms)	Weigth(cms)
1	114	10	6	4
2	114	11	6	4
3	109	9	5	4
4	117	10	5	3
5	148	10	5.5	3
6	120	11	6.5	3
7	140	12	5.5	4
8	125	11	5	3
9	110	12	6	3.5
10	128	13	7	3.5
11	99	11	5.5	3.5
12	92	10	8	3.5

13	103	10	7	4
14	138	12	7	4
15	116	13	6	3.5
16	78	10	8	3.5
17	102	11	5.5	4
18	118	9	5.5	3.5
19	73	9	5	3.5
20	120	11	6	3
21	118	14	6	3
22	114	11	6	3
23	101	10	5.5	5
24	60	10	5.5	3
25	133	12	6	3

Table-3: Comparison between right and left kidney (average weight and dimensions)

Average	Right Kidney	Left kidney
Weight (gms)	119	137
Length (Cms)	10.45	11.50
Breadth (cms)	5.7	6.5
Width (Cms)	3.6	4

Table-4: Comparison between right and left kidney (Lobulation and Hilar variations)

	Right Kidney (%)	Left Kidney (%)
Lobulation	8	16
Hilar Variation	8	24

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