A cadaveric study on morphometry and congenital anomalies of human adult kidneys

Agamdeep Singh Bedi, Ananya Jindal, Shilpa M. Bhimalli
Department of Anatomy, J.N. Medical College, Belagavi, Karnataka,India

Abstract

Introduction: A pair of kidneys is present in the human adults, 11cm long, 6cm broad and 3 cm thick with an average weight of 150g in males and 135g in females. The kidney is lobulated and is made of 12 lobules in the fetal stage. Human kidney development begins in the third week of embryonic development and develops fully between the 5th and 12th week.

Aim: To study the dimensions (height, breadth, thickness) and weight, along with the congenital anomalies of human kidney.

Materials and Methods: 36 pairs (72) of human adult kidneys were obtained from embalmed cadavers of both sex from Department of Anatomy, KAHER's J.N. Medical College, Belagavi. The dimensions were measured using a Vernier caliper and the weight was noted. A few congenital anomalies were also observed.

Results: Variations in Length, breadth, thickness and weight were observed. Congenital anomalies such as polycystic kidney, monocystic kidney, hypoplasic, hyperplasic and lobulated kidneys were also present.

Dimensions range: Length: 7.1-12.5cm, Breadth: 2.4-5.9cm, Thickness: 1.7-5.6cm, Weight: 54.21-238.24g.

Congenital Anomalies: Monocystic kidney- 2.77% (2/72), Bicystic Kidney- 2.77% (2/72), Polycystic kidney- 13.88% (10/72), Hypoplasic-1.38% (1/72), Hyperplasic-1.38% (1/72), Lobulated kidneys- 8.33% (6/72).

Conclusion: The knowledge of congenital anomalies is useful for better insights on systemic and urinary tract diseases. The cause of change of dimensions maybe related to change in body size and age.

Keywords: Congenital Anomalies, Morphometry, Cadavers, Kidneys.

Introduction:

Kidneys are retroperitoneal organs and are situated in the posterior abdominal wall beside the vertebral column and extend from T1 to L3 vertebra. 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.

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[1].

Usually the kidney is 11cm long, 6cm broad and 3 cm thick with an average weight of 150g in males and 135g in females.

Embryonic disorders known as Congenital Anomalies of the Kidney and the Urinary Tract (CAKUT) occur during development and they result in the defects in kidneys, ureters, urinary bladder and the urethra.

Congenital kidney malformations are defined macroscopically by changes in kidney size, shape, position, or number, or microscopically by a reduced number of nephrons and/or abnormal histology. The spatial and temporal events that give rise to CAKUT are critical for the phenotypes that arise. An absent or malformed kidney is a severe defect occurring early in gestation, whereas defects that occur later are generally less severe. Later defects include obstruction, vesicoureteric reflux (VUR), or posterior urethral valves, in which kidneys form but the outflow tract is abnormal[2]. The size of the kidney is considered to be an important indication for may clinical signs.

The kidney is lobulated and is made of 12 lobules in the fetal stage. Foetal lobulation could persist in the adult life such that the renal outline appears larger than the normal[3].

This study would help in determining the renal

Address for Correspondence:
Agamdeep Singh Bedi
Department of Anatomy,
J.N. Medical College, Belagavi, Karnataka, India.
Email: agamdeepsbedi@gmail.com

anatomical variants which would improve the surgical and radiological interventions. Moreover, it would further help in furnishing better insights on urinary tract diseases and congenital anomalies.

Materials And Methods:

36 pairs (72) of human kidneys of both sex were obtained from the Department of Anatomy, KAHER's J.N. Medical College, Belagavi. Upon dissection of embalmed cadavers, 36 pairs of kidneys (72 in total) were obtained. All the kidneys were observed and studied in relation to dimensions, weight and presence of any congenital anomalies.

Figure 1: Sample of 36 pairs (72) of adult human kidneys

The dimensions were measured using a Vernier caliper and the weight was noted.

Figure 2: Measuring the length of the kidney

Figure 3: Measuring the breadth of the kidney

Figure 4: Measuring the thickness of the kidney

Results:

All the kidneys (36 pairs) were bean shaped. The range of dimensions and weight of the right and left kidneys are given in table 1:

Table 1: Dimensions and weight of the kidneys

SIDE OF KIDNEY	LENGTH		BREADTH						THICKNESS		WEIGHT	
	RANGE	AVERAGE	RANGE AT SUPERIOR POLE	RANGE AT HILUM	RANGE AT INFERIOR POLE	AVERAGE			RANGE	AVERAGE	RANGE	AVERAGE
						AT SUPERIOR POLE	AT HILUM	AT INFERIOR POLE				
LEFT	7.1-12.5 cm	9.70 cm	3-5.6 cm	2.4-5.6 cm	2.8-6.5 cm	4.5 cm	4.2 cm	4.3 cm	1.8-5.6 cm	3.31 cm	54.21-190.42 gm	120.39 gm
RIGHT	7.2-10.9 cm	8.97 cm	2.5-5.8 cm	2.9-5.9 cm	2.9-6 cm	4.1 cm	4.2 cm	4.1 cm	1.7-4.9 cm	2.98 cm	57.48-238.24 gm	104.93 gm

The length of left kidneys ranged from 7.1cm to 12.5cm with an average of 9.70cm and for the right kidneys it ranged from 7.2cm to 10.9cm with an average of 8.97cm.

The breadth of left kidneys at superior pole ranged from 3cm to 5.6cm with an average of 4.5cm and for the right kidneys at superior pole it ranged from 2.5cm to 5.8cm with an average of 4.1cm. The breadth of left kidneys at the hilum ranged from 2.4cm to 5.6cm with an average of 4.2cm and for the right kidneys at the hilum ranged from 2.9cm to 5.9cm with an average of 4.2cm. The breadth of left kidneys at inferior pole ranged from 2.8cm to 6.5cm with an average of 4.3cm and for the right kidneys at inferior pole it ranged from 2.9cm to 6cm with an average of 4.1cm.

The thickness of left kidneys ranged from 1.8cm to 5.6cm with an average of 3.31cm and for the right kidneys it ranged from 1.7cm to 4.9cm with an average of 2.98cm.

The weight of left kidneys ranged from 54.21gm to 190.42gm with an average of 120.39gm and for the right kidneys it ranged from 57.48gm to 238.24cm with an average of 104.93gm.

The congenital anomalies observed during the study were monocystic kidney, bicystic kidney, polycystic kidney, hypoplasic kidney, hyperplasic kidney and lobulated kidneys. The following data was collected:

Table 2: Occurrence of congenital anomalies

Congenital Anomalies	Occurrence
Monocystic Kidney	2.77% (2/72)
Bicystic Kidney	2.77% (2/72)
Polycystic Kidney	13.88% (10/72)
Hypoplasic	1.38% (1/72)
Hyperplasic	1.38% (1/72)
Lobulated Kidneys	8.33% (6/72)

The occurrence of various congenital anomalies were monocystic kidney 2.77% (2/72), bicystic kidney 2.77% (2/72), polycystic kidney 13.88% (10/72), hypoplasic kidney 1.38% (1/72), hyperplasic kidney 1.38% (1/72) and lobulated kidneys 8.33%(6/72).

Figure 5: Monocystic kidney

Figure 6: Bicystic kidney

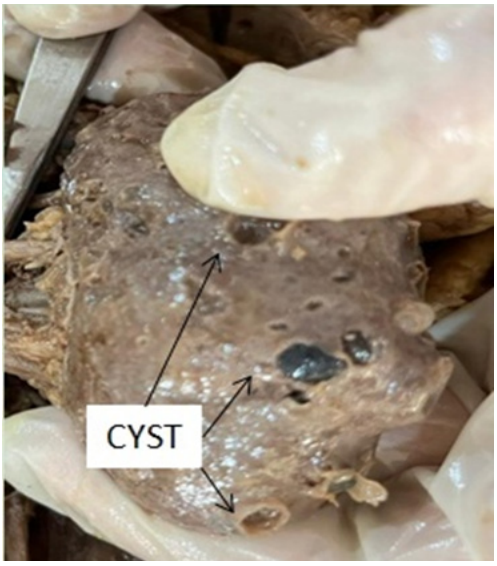

Figure 7: Polycystic kidney

Figure 8: Hyperplasic and hypoplasic kidney

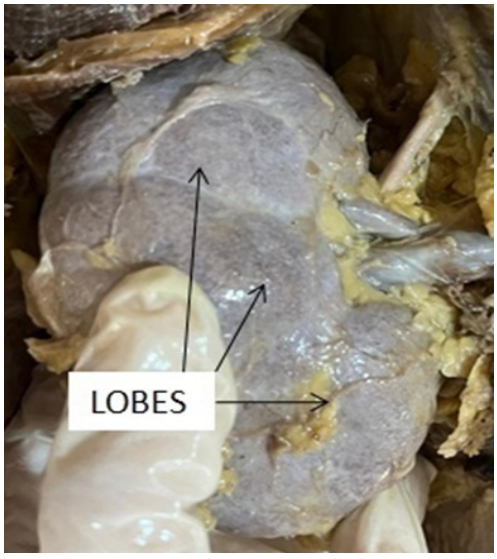

Figure 9: Lobulated kidney

Discussion:

Kidney size is considered as an important indication for many clinical signs It has been shown through 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 renal dimensions might also vary among population of different geographical origin[4].

Recently, a significant correlation between kidney size and kidney function was observed in patients with chronic kidney disease (CKD)[5].

Table 3: Comparison of measurements of right and left kidneys with previous studies

NAME OF STUDY	CRITERIA OF COMPARISON	RIGHT KIDNEY		LEFT KIDNEY	
		RANGE	AVERAGE	RANGE	AVERAGE
1. Present Study	Length	7.2-10.9 cm	8.97 cm	7.1-12.5 cm	9.70 cm
	Breadth At Superior Pole	2.5-5.8 cm	4.1 cm	3-5.6 cm	4.5 cm
	Breadth At Inferior Pole	2.9-6 cm	4.1 cm	2.8-6.5 cm	4.3 cm
	Thickness	1.7-4.9 cm	2.98 cm	1.8-5.6 cm	3.31 cm
	Weight	57.48- 238.24 gm	104.93 gm	54.21-190.42 gm	120.39 gm
2. Manisha S More et al[4]. (2015)	Length	7.7-14	11.5	8-14.5	12.71
	Breadth	3-8	5.325	3.5-8	6.07
	Thickness	2-4.8	3.32	2-5	3.64
	Weight	59.2-197.1	102.48	60-200	122.15
3. Ashwini N.S et al [6]. (2017)	Length	7.5- 11 cm	9.22 cm	7.5-11.5 cm	9.29 cm
	Breadth At Superior Pole	4-6.1 cm	4.89 cm	3.8-6.3 cm	4.91 cm
	Breadth At Inferior Pole	3.7-6.6 cm	4.91 cm	3.2-6 cm	4.57 cm
	Thickness	2.6-4.6 cm	3.85 cm	2.5-5 cm	3.57 cm
	Weight	36.7-160 gm	107.37 gm	64.9-194.6 gm	105.18 gm
4. Rao, Sivanageswara et al [7]. (2013)	Length	-	10.92 cm	-	11.32 cm
	Breadth	-	6.2 cm	-	6.62 cm
	Thickness	-	3.34 cm	-	3.54 cm
	Weight	-	103.04 gm	-	114.48 gm

In our study, the length and breadth were almost within the same range as in the previous studies.

The lower limit of the thickness (1.8 cm in left and 1.7 cm in right kidneys) was less than the previous studies conducted. The range of weight of right kidneys was almost similar to that of Manisha S More et al[4]. However, the upper limit of weight left kidney in our study was the maximum (238.24 gm).

Table 4: Comparison of presence of congenital anomalies in human adult kidneys with previous studies

Name of Study	Criteria of Comparison	Right Kidney	Left Kidney
1. Present Study	Lobulation	5.55% (4/72)	2.77% (2/72)
	Hypoplasia	0	1.38% (1/72)
2. Ashwini N.S et al [6]. (2017)	Lobulation	6.66% (3/45)	20% (9/45)
	Presence of cyst (Ranging 1 to 4)	3.33% (3/90)	
3. Rao, Sivanageswara et al [7]. (2013)	Lobulation	8%	16%
4. P.R. Reddy[8] (2017)	Lobulation	4% (2/50)	
	Hypoplasia	2% (1/50)	

In our study the occurrence of lobulated kidneys was within the range of the previous studies done. Presence of cystic kidney in our study was more than that observed by Ashwini N.S. et al[6].

Conclusion:

Morphometric studies of renal dimensions have gained much research attention as they are believed to possess significant clinical importance. 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 furnish better insights on systemic diseases, urinary tract diseases, congenital anomolies, neoplasia, micro and macrovascular diseases which were reported to significantly influence kidney sizes[6].

The patients are surviving due to improvements in the management of CKD, corrective urologic surgery, dialysis, and transplantation. For children with severe CAKUT that require dialysis and transplantation as infants, there are significant comorbidities that have an effect on the ability of these children to lead independent lives as adults. Individuals with mild forms of CAKUT, such as reduced nephron endowment at birth, are likely much more common than appreciated and may only be identified in adulthood. However, thus far, there has been no way to identify them in a systematic way due to the absence of noninvasive methods to assess nephron number[2].

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