

Original Articles

Morphological Study of Human Kidney – A Post Mortem Study

SM Nurul Hassan¹, Borhan Uddin Ahamed², Md Abul Kalam Azad³, Mansur Khalil⁴,
Mohsin Khalil⁵

Abstract

Context: Retroperitoneal location of kidney implies much difficulties in management of renal diseases, specially for surgeons. Appropriate knowledge on three dimensional morphological status of kidney may be helpful for successful surgery of this region. So this study was performed to evaluate the age related changes in length, breadth and thickness of kidney collected from Bangladesh.

Materials and methods: A cross sectional analytical type of study was conducted at the department of Anatomy, Mymensingh Medical College, Mymensingh, Bangladesh.

A total of 70 (seventy) fresh human of right & left kidneys of both sexes were collected from the morgue of Mymensingh Medical College. The selected cases were between 5 to 60 years of age. The samples were divided into 3 different age groups (A: 05-15 years, B: 16-35 years, C: 36- 60 years) to observe the variations in length, breadth and thickness of kidney.

Results: Statistically significant differences were found in the values of length, breadth and thickness among these groups except the difference of values regarding breadth and thickness between group C & A which were not significant ($P > 0.05$).

Conclusion: There were changes in the values of length, breadth and thickness of kidneys.

Keywords: Kidney, morphology.

Introduction

Human kidneys are paired retroperitoneal organs situated on the posterior abdominal wall, one on each side of the vertebral column at the level of T₁₂ to L₃ vertebrae.^{1,2} They excrete toxic waste

products^{2,3,4} and secrete some hormones.^{5,6} At birth, the kidneys have a lobulated appearance but the lobulation disappears during infancy.^{7,8} The increase in kidney size after birth results mainly from the elongation of the proximal convoluted tubules as well as an increase of interstitial tissue.⁸ The normal kidney is typically 10 to 12 cm in vertical dimension, 5 to 7 cm in transverse width and approximately 3 cm in anteroposterior thickness.⁹ The normal kidney measures about 12x6x3 cm.¹⁰ Average measurements of each kidney are - length 11 cm, breadth 6 cm, thickness 3 cm.^{2,11,12} According to Moore and Dalley¹ each kidney was 10 cm in length, 5 cm in breadth and 2.5 cm in thickness. Again the size in females tends toward

1. Professor (c.c.) & Head, Department of Anatomy, Uttara Adhunik Medical College, Dhaka.
2. Assistant Professor, Department of Forensic Medicine, Dhaka Community Medical College, Dhaka.
3. Assistant Professor, Department of Surgery, Sylhet MAG Osmani Medical College, Sylhet.
4. Principal, Professor & Head, Department of Anatomy, Shahid Syed Nazrul Islam Medical College, Kishoreganj.
5. Professor & Head, Department of Anatomy, Mymensingh Medical College, Mymensingh

Correspondence: Dr SM Nurul Hassan

the lower ends of these measurement ranges, but these dimensions are related more to overall body size rather than to sex with smaller individuals having generally smaller kidney than larger individuals. The kidneys are larger relative to body size in children.⁹ Measurements made with ultrasound are generally less than those made by radiography. According to ultrasonography in adult the length extends upto 12 cm and not less than 9 cm; the width is normally 4-6 cm but may vary a little with the angle of the scan; the thickness extends upto 3.5 cm but may vary a little with the angle of the scan.¹³

Renal mass increases from birth to third and fourth decades¹⁴ and declines approximately a fifth between fourth and eighth decades of life.¹⁵ Age is a biologic process the effect of which is the gradual loss of functioning cells that do not have the ability to divide even in those persons who are fortunate enough to be spared from disease related tissue changes.¹⁴ This is supported by the report of Sultana¹⁶ and Alam¹⁷ that the values of gross morphological parameters reach to their highest level by the age of 20-25 years than remain unchanged for 30-35 years and finally become progressed accordingly, particularly after 40 years of age which may be a reflection of senile changes of kidney.

Available articles are the evidences that human kidney have been widely studied in different races by various investigators. By studying kidney of different age groups, it is found that there are considerable structural and functional changes. These studies show normal growth process as well as degenerative changes after certain age.^{9,14,15,16,17} But regarding three dimensional morphological study of kidney, very few research works have been performed on kidney collected from Bangladesh. In our country, we depend on the data of Western people published in textbook and literature. So this study was intended to evaluate the length, breadth and thickness of kidney with its changes in different age groups.

Materials and Methods

The present study was performed on 70 (seventy) kidneys of both sexes and both sides in the Department of Anatomy of Mymensingh Medical College. The samples were collected from unclaimed fresh dead bodies that underwent routine postmortem examination in the morgue of the Department of Forensic Medicine, Mymensingh Medical College from January 2004 to June 2005. Kidneys of decomposed case, poisoned cases, kidneys with gross anatomical anomalies and known renal were excluded. The collected samples were divided into three age groups (Table-I). The samples preserved in 10% formol saline were washed to avoid irritation of the eyes and nasal mucosa. Then the samples were taken in metallic tray and the surrounding fat and other unwanted structures were removed carefully. After that length, breadth and thickness of each kidney were measured with the help of a slide caliper, graduated in cm. Fractions of cm were measured with vernier scale, graduated in mm for more accurate measurements. The length was measured from the upper to the lower pole. The breadth and thickness were measured in the smooth middle portion of the kidney at the level of hilum.

Table-I
Distribution of the study samples in different age groups.

Group	Age in years	Number of samples (%)
A	05-15	07 (10%)
B	16-35	42 (60%)
C	36-60	21 (30%)
Total	05-60	70 (100%)

Results

The level of statistical significance varied for the length, breadth and thickness among different age groups. The values of all these external dimensions showed highly significant difference among almost all the age groups, specially in group A & B. However, no significant difference was observed between the age group A & C (table-IIa and IIb).

Table-IIa
Length, breadth and thickness of kidney in different age groups

Group	Length(cm) Mean±SD	Breadth(cm) Mean±SD	Thickness(cm) Mean±SD
A	7.79±0.67 (6.10-8.60)	4.16±0.42 (3.25-4.90)	2.04±0.20 (1.10-1.90)
B	9.51±0.63 (7.30-11.40)	4.83±0.47 (3.70-5.75)	2.82±0.42 (1.25-2.98)
C	8.75±0.96 (6.70-10.25)	4.46±0.36 (3.62-5.63)	2.20±0.26 (1.14-2.85)
Total	8.68±0.75 (6.10-11.40)	4.48±0.41 (3.25-5.75)	2.37±0.29 (1.10-2.98)

SD = Standard deviation, Figures in parentheses indicate range

Table-IIb
Statistical analysis of table IIa.

Group	Length P value	Breadth P value	Thickness P value
A vs B	<0.001***	<0.001***	<0.001***
B vs C	<0.001***	<0.01**	<0.01**
C vs A	<0.05*	>0.05 ^{ns}	>0.05 ^{ns}

Statistical analysis was done by ANOVA, ns = not significant

* = significant, ** = moderately significant, *** = highly significant

Discussion

In this study the average length, breadth and thickness of kidney were 8.68 cm, 4.48 cm and 2.37 cm respectively which are considerably lower than the findings reported by Walsh⁹, Sinnatamby¹⁰, Datta¹¹, Sibani¹² and Standing². It is obviously clear that the kidneys collected from Bangladesh on which the present study was carried out were shorter, narrower and thinner in comparison with the kidneys of the Western people. This may be due to the higher body weight as well as greater body surface area of Western people. However the present study is consistent with the findings of

Mullick¹⁸ who worked on 21 pairs of human kidneys of the East Pakistani (now Bangladesh) adult and found the average length, breadth and thickness being 9.85 cm, 4.70 cm and 3.60 cm respectively. This is also similar with the observations of Sultana¹⁶ and Alam¹⁷.

The average measurements of the East Pakistani human right and left kidneys were 9.8 cm and 9.9 cm respectively in length, 4.8 cm and 4.6 cm respectively in breadth at the hilum and 3.5 cm and 3.7 cm respectively in thickness.¹⁸ The left kidney may be 1.5 cm longer than the right, it is rare for the right kidney to be more than 1 cm longer than the left.² The size of kidney is slightly smaller in the females.⁹ This study doesn't include sex or side specific comparison of size of the kidney. Mullick¹⁸ and Sultana¹⁶ made an anatomical study on kidney of East Pakistani and Bangladeshi people respectively where no statistically significant difference was observed between sexes (i.e. male & female) and laterality (i.e. right and left) which was also correlated with the findings reported by Walsh⁹. So established data showed, there were negligible differences in length, breadth and thickness between two kidneys of one individual as well as two sexes of same age. Because, the kidney size is being more dependent on individual's body built⁹.

In this study, group B presented with maximum mean three dimensional features of kidneys whereas group A found to show the lowest. The mean differences in these external dimensions among the groups were statistically significant. These findings indicate that the peak values of length, breadth and thickness of the kidney is confined to middle age group (up to 35 years) and the smaller values being observed at younger (up to 15 years) as well as elderly (up to 60 years) age groups. This is supported by the reports of Sultana¹⁶ & Alam¹⁷ that the length, breadth and thickness of the kidneys increase with increasing age up to 35 years and gradually decrease after 40 years, which may be a reflection of senile changes of the kidney and was similar with the observation reported by McLachlan¹⁵. Renal mass increases from about 50 gms at birth to more than 400 gms during the third and fourth decades.¹⁴ From this finding, it may be

inferred that-at early period of life kidney size remains small. So in our study, presenting lowest values of these external dimensions at the younger age group could be explained by the relation of kidney size to one's body built; with smaller individuals having generally small kidney than larger individuals⁹.

In this present study, the average length, breadth and thickness of the kidneys in different age groups were established as well as the changes of these external dimensions among the age groups had been identified. The cause of increase or decrease of these external dimensions of kidney at different periods of life might be related to the increase or decrease of body size with age.

References

1. Moore KL, Agur AMR, Dalley AF. Clinically oriented anatomy 6th ed. Baltimore: Lippincott, Williams & Wilkins 2010: 292.
2. Standring S, Ellis H, Healy JC, Johnson D, William A, editors. Gray's Anatomy. 40th ed. London: Churchill Livingstone 2008: 1225.
3. Kelly DE, Wood RL, Enders AC, editors. Bailey's text book of microscopic anatomy. 18th ed. Baltimore: Williams and Wilkins 1989: 645-71.
4. Larsen WJ. Anatomy: development, function, clinical correlations. Philadelphia: Saunders 2002: 262.
5. Mescher AL. Junqueira's basic histology text & atlas. 12th ed. Singapore: The McGraw-Hill companies, Inc 2010: 332.
6. Way LW, Doherty GM, editor. Current surgical diagnosis & treatment. 11th ed. Boston: McGraw-Hill Companies, Inc 1994: 1013-15.
7. Sadler TW. Langman's medical embryology 12th ed. Baltimore: Lippincott Williams and Wilkins 2012: 236.
8. Moore KL, Persaud TVN. The developing human clinically oriented embryology. 8th ed. Philadelphia: Saunders, Inc. 2008: 246.
9. Walsh PC, editor. Campbell's urology (v-1). 8th ed. Philadelphia: Saunders 2002: 19-35.
10. Sinnatamby CS. Last's anatomy regional and applied. 12th ed. UK: Churchill Livingstone Elsevier 2011:283.
11. Datta AK. Essentials of human anatomy (part-1) 9th ed. Calcutta: Current Books International 2012: 290.
12. Mazumdar S. Anatomy at a glance. 1st ed. New Delhi: Jaypee Brother Medical Publisher (P) Ltd. 2009:170.
13. Palmer PES, editor. Manual of diagnostic ultrasound. 1st ed. USA: World Health Organization 1995: 154-55.
14. Anderson S & Brenner BM. Effect of aging on the renal glomerulus. AM J Med 1986:435-37.
15. McLachlan MSF. The aging kidney. Lancet 1978; 11: 143-46.
16. Sultana A. Anatomical study of human postmortem kidney in Bangladeshi people (thesis). Dhaka: Institute of postgraduate medicine and research 1991.
17. Alam MZ. Gross morphological and histological features of the kidneys in Bangladeshi people (thesis). Dhaka: Institute of postgraduate medicine and research 1994.
18. Mullick MH. A comparative study of renal arterial system in man, goat and cow (thesis). Dhaka: University of Dhaka 1969.