ORIGINAL ARTICLE

Estimation of Size of the Kidney in Normal Nepalese Population by Ultrasonography

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ABSTRACT

The aim of the study: To estimate the size of kidneys in normal population according to the age and sex. **Methods:** this was a perspective crossectional study conducted at department of radiology and Imaging, TU Teaching hospital. A total of 209 normal cases were studied (103 males and 106 females). Statistical calculation was done using parametric and non-parametric measurement quantity of length and breadth of kidneys were done. **Results:** The mean length of kidney was found to be 9.56±0.05 cm and breadth was 4.12±0.04 cm. significant difference was noted between right and left side kidneys. **Conclusion:** It can be concluded that kidney size is related to age, sex, and side. The mean kidney size is 9.56 ± 0.05 cm × 4.12 ± 0.04 cm and 95% people have the kidney size ranging 7.59–11.52 cm × 2.59–5.65 cm (using parametric method) and 7.69–11.77 cm × 2.65–5.84 cm (using N.M). The P.M can be considered more reliable than N.M. This study is extremely useful for routine evaluation and monitoring of urological and nephrological diseases

Key words: Ultrasonography, Kidney size, parametric test, nonparametric test.

INTRODUCTION

In the present study "estimation of size of kidney in normal Nepalese population by ultrasonography" (USG), we determined the USG kidney dimensions in individuals excluding pregnant patient, diabetes patient, patient with known kidney diseases, and the patients with single kidney. For the study, we had taken 209 patients (103 males and 106 females) who came to Tribhuvan University Teaching Hospital, Maharajgunj, Kathmandu, in April–June 2010 for their abdominal ultrasound checkup.

This dissertation is a fieldwork research and it examined kidney size in different age, sex, and side. In general, average kidney size is 9.56 ± 0.05 cm × 4.12 ± 0.04 cm, and we found that 95% of populations have their kidney size ranging 7.69–11.77 cm × 2.65–5.85 cm (using non-parametric method [N.M]). As the parametric method (P.M) is considerably more than N.M, the kidney size ranging 7.59–11.52 cm × 2.59–5.65 cm testifies 95% of acceptable level of accuracy and, therefore, can be treated as of normal size.

There has not been any research about the size of the kidney in normal Nepalese population. Western data are still in practice in the practice in the hospitals of Nepal. However, such type of measurement may not be practically suitable for normal Nepalese people. Hence, we expect that this research will be helpful for the diagnosis of the renal disease and determination of normal kidney size in the Nepalese context.

The kidney size of a patient is a valuable diagnostics parameter in urological and nephrological practice. Renal size may be an inductor for the loss of kidney mass and kidney function. While the renal size varies with the age, gender, body mass index (BMI), pregnancy, and co-morbid conditions, it is necessary to first establish the normal values. It is valuable in monitoring unilateral kidney disease through comparison with the other. The information available in the

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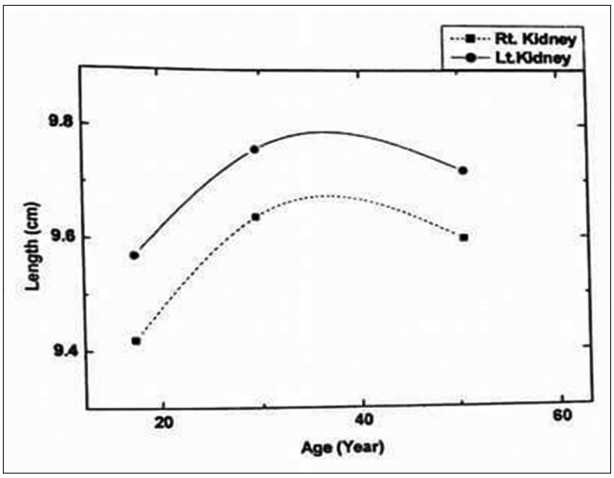

Figure 1: Comparative study of male kidney length according to age group

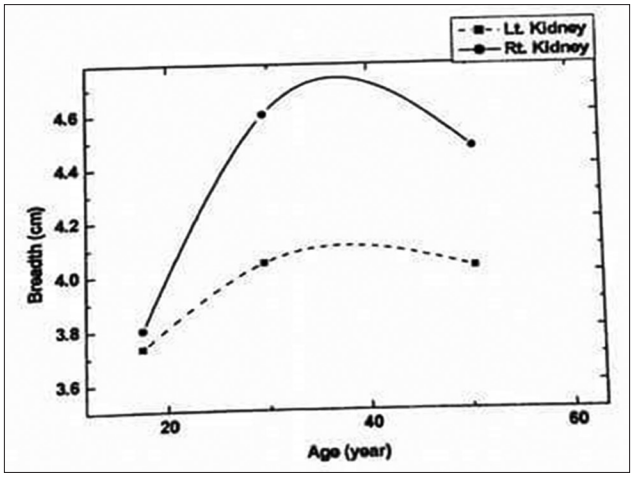

Figure 2: Comparative study of male kidney breadth according to age group

west may not be extrapolated to our population since the renal size may differ between entire groups and according to body size.

METHODOLOGY

Preparation

To measure the size of kidneys of normal Nepalese people, the following steps should be carried out carefully:

1. Preparation of the patient: The patient should come with an empty stomach and full urinary bladder. Hence, he/she should drink plenty of water 2 or 3 h before the checkup. Without full bladder, internal organs cannot be examined perfectly.
2. Position of the patient: We start to check up with the patient lying on his/her back (spine). The abdominal clothes should be removed out. Acoustic coupling agent (gel) is used to make the fluid medium between transducer and the patient's muscle. As the reflection coefficient is high for some interface, so coupling agent is compulsory.
3. Choice of transducer: We use different transducer for different age group patients. Different types of transducer are needed for different parts of body. Especially, to check up the kidney, we need 3.5 MHz transducer for adults and 5.0 MHz transducer for children and thin adult.
4. Setting the correct gain: In this stage, transducer should be rubbed on the patient's body. We start by placing the transducer over the right upper abdomen. We take the angle of beams as necessary and adjust our gain to obtain the best image of the renal parenchyma.
5. Scanning technique: When the patient supines on the bed comfortably with the loose body, we ask the patient to take a deep breath and hold the breath in. It is necessary to tell the patient to relax and breath normally again. On making the patient breathing correctly, we take up the transducer and start with a longitudinal scan over the right upper abdomen and then follow with transverse scan. Again we rotate the patient to the left lateral position, to visualize the right kidney in this coronal view. To visualize the left kidney, coupling agent should

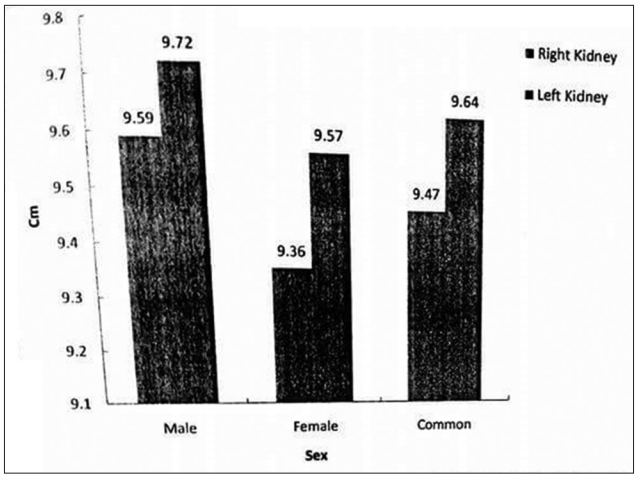

Figure 3: Comparative study of kidney length based on side

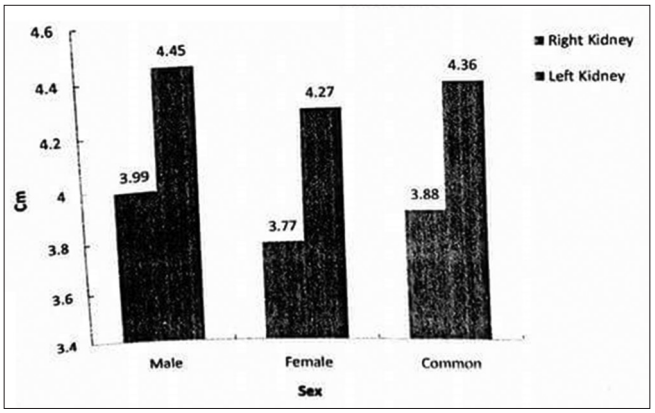

Figure 4: Gender variation of kidney sizes bar graph .

Table 1: Size of the kidney for male

Age	Right kidney		Left kidney	
	Length (cm)	Breadth (cm)	Length (cm)	Breadth (cm)
16–19				
Mean	9.42	3.73	9.57	3.80
Range				
P.M	7.28–11.56	2.59–4.87	7.24–11.90	2.78–4.82
N.M	7.32–11.67	2.32–4.92	7.32–11.84	3.04–4.92
20–39				
Mean	9.64	4.04	9.76	4.60
Range				
P.M	7.76–11.52	2.78–5.29	7.86–11.66	3.01–6.18
N.M	8.09–11.92	2.63–5.37	8.11–11.95	3.10–6.37
40–60				
Mean	9.60	4.02	9.72	4.47
Range				
P.M	7.79–11.40	2.80–5.23	8.05–11.38	2.94–5.99
N.M	8.00–11.75	3.00–5.00	8.17–11.67	3.08–5.90

P.M: Parametric method, N.M: Non-parametric method

Table 2: Size of the kidney for female

Age	Right kidney		Left kidney	
	Length (cm)	Breadth (cm)	Length (cm)	Breadth (cm)
16–19				
Mean	9.17	3.63	9.43	3.77
Range				
P.M	7.38–10.95	2.18–4.86	7.29–11.56	2.14–5.39
N.M	7.38–10.87	2.18–4.91	7.34–11.62	2.18–5.81
20–39				
Mean	9.42	3.80	9.62	4.37
Range				
P.M	7.48–11.36	2.48–5.11	7.50–11.74	2.92–5.82
N.M	7.47–11.30	2.35–5.30	7.70–11.87	3.80–5.87
40–60				
Mean	9.34	3.78	9.56	4.32
Range				
P.M	7.73–10.95	2.35–5.21	7.43–11.66	2.52–6.12
N.M	7.44–11.56	2.29–5.56	7.44–12.12	2.87–5.91

P.M: Parametric method, Non-parametric method

be applied to the left upper abdomen. Then, we follow the scanning technique similar to the right kidney.

Sometimes, the left kidney cannot be seen due to excess bowel gas. In this situation, we should lay the patient on the right side. If still, the kidney cannot appear clearly, then the patient must send to drink 3 or 4 glasses of water. When patients drink plenty of water, then the bowel gas can be displaced. The left kidney can then be visualized through the fluid-filled stomach with the patient in the supine position.

In many cases, it is quite difficult to visualize the kidney; it may be due to the wrong lying position. Hence, to image clearly, we should scan through the lower intercostal spaces.

Table 3: Common value of male and female

Age	Right kidney		Left kidney	
	Length (cm)	Breadth (cm)	Length (cm)	Breadth (cm)
16–19				
Mean	9.28	3.68	9.50	3.78
Range				
P.M	7.20–11.34	2.52–4.84	7.34–11.65	2.35–5.21
N.M	7.23–11.30	2.23–4.91	7.35–11.77	2.35–5.65
20–39				
Mean	9.53	3.91	9.68	4.48
Range				
P.M	7.73–11.33	2.57–5.24	7.54–11.82	2.97–5.99
N.M	7.88–11.69	2.44–5.34	8.02–11.92	3.80–5.97
40–60				
Mean	9.47	3.91	9.65	4.41
Range				
P.M	7.57–11.37	2.59–5.22	7.86–11.43	2.84–5.98
N.M	7.62–11.68	2.47–5.37	7.94–11.82	3.03–5.91

P.M: Parametric method, N.M: Non-parametric method

Table 4: Size of the kidney for all ages

Age	Right kidney		Left kidney	
	Length (cm)	Breadth (cm)	Length (cm)	Breadth (cm)
Male				
Mean	9.59	3.99	9.72	4.45
Range				
P.M	7.57–11.61	2.72–5.26	7.82–11.62	2.88–6.02
N.M	8.02–11.80	2.64–5.14	8.08–11.84	3.08–5.97
Female				
Mean	9.36	3.77	9.57	4.27
Range				
P.M	7.57–11.14	2.44–5.10	7.69–11.44	2.87–5.67
N.M	7.38–11.34	2.29–5.34	7.53–11.89	2.88–5.88

P.M: Parametric method, N.M: Non-parametric method

Instruction should be given to the patient to turn prone on the bed and apply coupling agents to the left and right renal area; we can scan the kidney properly. If either kidney cannot be seen, searching should be continued from all possible angles, and we should adjust the gain to show the liver parenchyma and spleen and scan in different projections. If there is one large kidney and the other cannot be visualized after a careful search, it is probable that the patient has only one kidney.[1-9]

Measurement of kidney size

It should be kept in mind that the measurement made with ultrasound is generally less than those made by radiography,

Table 5: Average range of sizes in both kidneys

Age	Mean	Range	
		P.M	N.M
Right kidney			
Length (cm)	9.47±0.07	7.49–11.45	7.58–11.65
Breadth (cm)	3.88±0.05	2.57–5.19	2.40–5.25
Left kidney			
Length (cm)	9.64±5–5.970.07	7.81–11.46	7.87–11.86
Breadth (cm)	4.36±0.06	2.75–5.97	3.03–5.93

P.M: Parametric method, N.M: Non-parametric method

Table 6: Average range of sizes in both kidneys

Size	Mean	Range	
		P.M	N.M
Length (cm)	9.56±0.05	7.59–11.52	7.69–11.77
Breadth (cm)	4.12±0.04	2.59–5.65	2.65–5.84

The average kidney size of normal Nepalese people is 9.56±0.05 cm×4.12±0.04 cm, P.M: Parametric method, N.M: Non-parametric method

and they are more accurate. No magnification is seen with USG, while 30% magnification occurs with radiography. It is notable that, in general, the left kidney is larger than the right kidney.

To measure the kidneys size, we proceed all the above techniques and visualize the kidney on the computer screen. Now, we take the length and breadth from to another pole.

Statistical observation

Now, we interpret the measurement statistically. The following steps should be carried out sincerely for the detailed result.

Collection of data

The collection should be done on the basis of age, sex, and side. Hence, the following points should be kept in mind while collecting the data.

a. The measurement of length and breadth must be correct in cm for both the right and left kidneys.
b. The individual age of the patient should be written clearly.
c. The sex is very important factor for different age of the population.
d. The kidney must not be diseased and damaged.
e. Observations must be primary data for its reliable result.

Classification

Classification is the arrangement of the data into different classes which are to be determined depending on the nature, objective, and scope of the inquiry. Here, the data will be classified and analyzed according to sex, age, and sides. The classifications basis will be as follows:

a) Age basis: Divide the whole data into three classes, for example, age groups: 16–19, 20–39, and 40–60. It is, the lowest age group is 16 years and the uppermost age is 60 years which is taken for normal Nepalese population.
b) Sex basis (gender basis): To find the kidney dimension, total data can be divided into different classes according to age group and then proceeded to classify each age group into male and female. Now, the average range of length and breadth can be calculated for whole data divided as sex.
c) Side basis: There are two sides of kidney location, i.e., left and right. We observe the kidney dimension according to these sides. There may be the difference in length or breath but not significantly. The dimension of the kidney for both the sides can be calculated according to age and sex for whole population.

Tabulation

Tabulation is one of the most important and ingenious devices of presenting the data in a condensed and readily comprehensible form and attempts to furnish the maximum information contained in the data in the minimum possible space, without sacrificing the quality and usefulness of the data. For the good statistical table, the following parts must be included: Table number, title, headnotes, captions, body of the table, footnote, and source note.

We classify the data into two groups - length and breadth group in a continuous series with class size 1 cm for each group. Then, we find the frequencies for each class with the help of tally marks from raw data.

Analysis and calculation

The tabulated data are analyzed carefully, and the average value of kidney's length and breadth for middle 95% of the Nepalese population according to age, sex, and sides is calculated. The following calculations are required to get suitable analysis.[10-13]

a. For percentile
   - Calculations of 2.5^{th} percentile, i.e., p = 2.5.
   - Calculations of 97.5^{th} percentile, i.e., p = 97.5.

Below *P* = 2.5 value represents the least 2.5% of the extreme value and above p = 97.5 gives the middle 95% value of the observation. Hence, middle 95% range can be estimated. This gives the information for the range of normal kidney size.[14-17]

b. Normal distribution
   Middle 95% area of the Gaussian curve can be calculated by the following formula:
   - $X=\sigma Z+\mu$.
   - Where, μ=Mean

Calculation of arithmetic mean gives the average value of kidney length and breadth.

Comparison

Comparison of the result gives the desired information. We compare the observation according to age, sex, and sides. Comparison leads to observe the followings:

- Change in length and breadth with age
- Change in size according to sex
- Change in size with sides.

Diagrammatic and graphical representation

- We present the data in simple, readily compressible form using graphs and histograms.

RESULTS

Here, we have determined the ultrasonographical kidney dimensions in individuals without known renal disease. We assessed that whether age, sex, and side affect the renal size. Measurement included only length and breadth.

The range of kidney size of normal population in Nepalese population has been evaluated using two methods:
1. P.M and
2. N.M.

P.M includes Gaussian distribution method and N.M includes percentile method. For the detail study, both the results are presented in the following tables. The following tables show average kidney length and breadth for 95% of the taken population according to the age, sex, and side [Tables 1-6].

DISCUSSION

The study of size of the kidney has a great importance in medical science. Here, we have estimated the renal size by USG, and we examined that whether the kidney sizes vary with age, sex, and side or not. From our experiment, it was found that a kidney size is affected by all above three factors.

In the present study, we had taken 209 patients between 16 and 60 years of age, who underwent an abdominal diagnostic ultrasound at the Department of Radiology, T.U. Teaching Hospital, Maharajgunj, Kathmandu, in April–June 2010. Pregnant patient, diabetes patient, patients with known kidney diseases, and patients with single kidney were excluded from the study. The kidney size measurement includes pole to pole distance.

A large volume of information have been studied and analyzed to bring out the result. Among 209 patients, 103 were male and 106 were females. Statistical tools such as mean, percentile, and normal distribution were used to calculate the average kidney size. Two different methods were used to find the range of the size of kidney.
- Percentile method (N.M)
- Normal distribution method (P.M)

N.M removes the upper and lower extremes values of the data by 2.5% using percentile method and gives the middle 95%. However, in P.M, the boundary points of middle 95% area of Gaussian curve give lower and upper limit of 95% level of accuracy.

Statistics assumes the result reliable if there is 95% level of accuracy. Hence, the present result was described in 95% level of acceptable value. The following information can be computed from above calculations and related diagrams and graphs presented in previous chapter.

The average kidney size of normal Nepalese people is about 9.56 ± 0.05 cm × 4.12±0.04 cm and 95% population have the range of kidney size by P.M is 7.59–11.52 cm × 2.59–5.65 cm and by N.M is 7.69–11.77 cm × 2.65–5.84 cm [Table 5 and 6].

- The left kidney is longer than the right kidney by 1.8%.
- The left kidneys' breadth is 12.3% greater than the right kidney.

The kidney size was found different in different age groups. The size of kidney is maximum at age (20–39). After the age of 40, the size starts decreasing due to the senile atrophy (as bone). The size starts decreasing faster in female than male.

Comparing with western people, Nepalese people have smaller kidney size. The size of kidney depends on BMI and height. As compared to western people, Nepalese people have relatively low BMI and height, so this may be the reason of smaller kidney size in Nepalese people [Figures 1-4].

CONCLUSION

Our study "estimation of size of kidneys in normal Nepalese population by USG" presents a practical fieldwork about the average kidney size of Nepalese people of different age, sex, and side. We conclude that kidney size is related to age, sex, and side. The mean kidney size is 9.56 ± 0.05 cm × 4.12 ± 0.04 cm and 95% people have the kidney size ranging 7.59–11.52 cm × 2.59–5.65 cm (using parametric method) and 7.69–11.77 cm × 2.65–5.84 cm (using N.M). The P.M can be considered more reliable than N.M. This study is extremely useful for routine evaluation and monitoring of urological and nephrological diseases.

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