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Original Research Article

Ultrasound assessment of renal volume in healthy, pregnant women of central India-its correlation with body mass index, parity and gestational age

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Article History:*Received:** 04/02/2017**Revised:** 19/03/2017**Accepted:** 19/03/2017**DOI:** <https://dx.doi.org/10.7439/ijbr.v8i3.3919>**Abstract**

Objective: Renal volume changes occur due to varied physiological changes, especially in the kidneys of pregnant women. For the identification and monitoring of renal disease, renal size is an important factor. No established data is available in the literature for the sonographical nomogram of renal volume in the normal pregnant women in Indian population. Sonographically establish the nomogram of renal volume in the normal healthy pregnant women in central India population.

Methods: Renal dimensions including length, width and thickness were measured using ultrasound in 501 normal, healthy pregnant women (mean age: 24.7 years). Renal volume was calculated by using the formula $\text{volume} = \text{length} \times \text{width} \times \text{breadth} / 2$. Every pregnant women's age, weight, height and body mass index were recorded. Gestational age and parity were acquired. The correlations between the variables were estimated.

Results: A total of 501 normal pregnant women of age ranging from 18 to 38 years with a mean age of 24.7 years took part in the study. Parity ranged from 0 to 4. Body mass index ranged from 13.39 to 36.89. Gestational age ranged from 4 weeks to 40 weeks. The mean renal volume was $104.23 \text{ cm}^3 \pm 28.18$ for left kidney and $105.77 \text{ cm}^3 \pm 27.29$ for the right kidney with significant positive linear relationship between right renal volume and left renal volume (P value = 0.00). No significant positive linear relationship was observed between the gestational age and either of the kidney volume. Also no significant difference between mean right kidney volume across different parity (P value=0.05) and mean left kidney volume across different parity (P value=0.18) was noted.

Conclusion: This study provides data for normal sonographic renal volumes in healthy pregnant women of central India.

Keywords: Pregnant women, renal volume, sonography, Body mass index, parity.

1. Introduction

Various physiological changes occur in kidney during pregnancy. During pregnancy, there is significant volume expansion and vasodilatation. Glomerular filtration rate increases by 50 % and renal plasma flow (RPF) increases upto 80 % as compared with non pregnant levels [1]. Volume of kidneys increases upto 30% during pregnancy [2].

This increase in the volume of kidneys is due to increased kidney vascular and interstitial volume and not due to any changes in the number of nephrons [3,4].

Various studies have shown that progesterone administration in non pregnant women does not cause hydronephrosis and there is no demonstrated correlation between progesterone or estrogen levels and severity of calyceal dilatation [5,6]. The kidney returns to normal function by two to three months after delivery. Renal pelvis, calyceal and ureteral dilatation ends by 6-8 weeks for most women while in some it may continue for as long as 16 weeks[7].

During pregnancy, to assess the renal health, sonographic measurement of renal volume and renal length

are important and is also useful for the follow up of patients with renal pathologies.

Ultrasound assessment of renal volume is simple, reliable, non invasive. Ultrasound uses sound energy and it has no adverse effects on the developing fetus and thus it is safe. Ultrasound can be used at any stage of pregnancy. It has advantage that it does not have ionizing radiation as in conventional radiography and computed tomography.

Many studies have been done regarding sonographic assessment in chronic renal disease, diabetes and in non pregnant population. Most of the data available in the literature regarding the renal volumes is for caucasian population. Very minimal data is available for Indian population. That too the data regarding the sonographic evaluation of renal volumes in normal pregnant women in Indian population is not present. We expect that the data regarding the renal volumes will be different in healthy, normal pregnant women and women in general population. For this reason, the study is undertaken to establish the normal renal volume in healthy pregnant women.

2. Subjects and methods

This was a prospective, descriptive, cross sectional study in which sonographic assessment of the renal volume was done. The normal pregnant women were randomly selected. This study was carried out in the department of Radiodiagnosis over a one year period from September 2015 to September 2016. Our hospital is a 250 bedded tertiary hospital and serves the surrounding towns and villages in Central India. The research protocol of this study was approved by the Institutional ethical committee.

The subjects included in the study were the normal pregnant women with no known renal or cardiovascular diseases, who attends the antenatal clinic of the hospital and were referred to radiology department for a routine obstetric scan during the period. Informed consent was taken of every pregnant woman.

Age, height, weight and blood pressure of patients were obtained. Height (in meters) and weight (in kilograms) were obtained. The body mass index (BMI) was calculated by using the formula $\text{weight}/\text{Height}^2$ [8-10].

Urine analysis of every pregnant woman was done prior to ultrasound examination to exclude proteinuria and glycosuria. Pregnant women detected with proteinuria and glycosuria was not included in the study.

A real time grey scale ultrasound examination was done by using My lab 50 esaote machine which was fitted with a 3.5-5 MHz curvilinear transducer with electronic callipers to measure length, width and thickness of each kidney. The maximal renal length of right kidney was recorded in left posterior oblique or left lateral decubitus position by scanning through the anterior axillary line subcostally or intercostally while the left kidney was scanned through the right posterior oblique or right lateral decubitus position by scanning through the anterior axillary line intercostally or subcostally.

On the right side, liver serves as an acoustic window and on left side spleen acts as an acoustic window. The maximal renal length was recorded after repositioning

the probe in several angulations. Renal width was measured at renal hilum and thickness was recorded from transverse scan showing maximum dimension. All the measurements were made by one investigator.

The anteroposterior diameter (AP) thickness (in cms) was measured in longitudinal scans. It was taken as the maximum distance between the anterior and posterior walls of the kidney at the middle. The renal width (W) (in cms) was measured in transverse scans, by identifying the hilum and measuring the width at this level (fig 1 and 2). The renal volume was calculated by the formula, $\text{volume} = \text{length} \times \text{width} \times \text{breadth}/2$.



Figure 1: A Longitudinal ultrasound image showing renal length (AB) measurement in Right Kidney

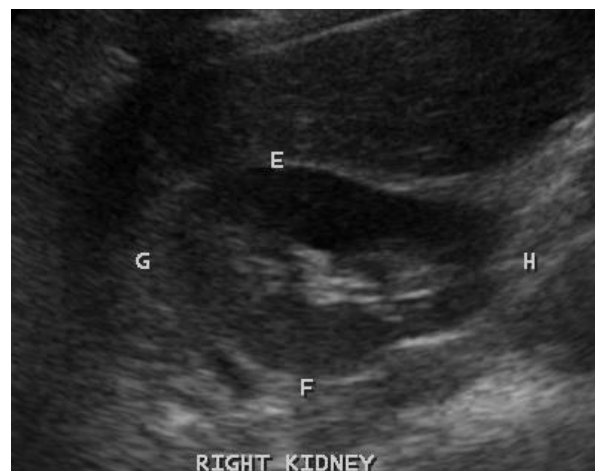


Figure 2: A transverse ultrasound image of Right kidney showing Renal width (Breadth GH) and Thickness (Anteroposterior dimension EF).

3. Results

A total of five hundred and one healthy, pregnant women participated in the study with their age ranging from 18 years to 38 years with a mean age of 24.7 years. The age group of less than 24 years had the highest number of subjects i.e. 267 women (53.29%) followed by age group of 25 – 29 years in which 180 (35.93%) women participated. The women in age group of more than 30 years of age were 54 women (10.78%).

The parity ranged from 0 to 2 with the women of parity 0 were 440 (87.82%) and those of parity 2 were low i.e. 61(12.18%).

The body mass index ranged from 13.39 to 36.89 with a mean of 22.06. 265 women (53.64%) have BMI in the range of 18.5-22.9. (Figures 3-5)

The gestational age ranged from 4 weeks to 40 weeks with an average mean of 24 weeks. Most of the women were seen in the third trimester while only 69 (13.77%) were seen in the first trimester.

The mean renal volume throughout the pregnancy was found to be 104.23 cm³ ±28.18 for left kidney and 105.77 cm³ +/-27.29 for the right kidney. There is significant positive linear relationship between right renal volume and left renal volume (P value = 0.00)

The lowest mean renal volume of both the kidneys was seen in the underweight group (BMI<18.5).The highest values of the renal volumes were seen in the obese groups in both the kidneys (BMI >27).

On an average, it was observed that mean renal volume steadily increased with increase in the gestational age. The highest value of renal volume was observed in third trimester. However no significant positive linear relationship was observed between the gestational age and either of the kidney volume [r=0.2094, p value =0.0 for right kidney volume, r=0.14, p value =0.001 for left kidney volume].

Women of parity 2 had the highest values of mean renal volume. On an average, there was steady increase in the renal volume with an increase in parity, in both the kidneys till 0 to 2 parity. But then it was observed that as the parity increased i.e. from 3 to 4, left renal volume did not increase and right renal volume increased but not significantly. So there is no significant difference between mean right kidney volume across different parity (P value=0.05) and mean left kidney volume across different parity (P value=0.18).

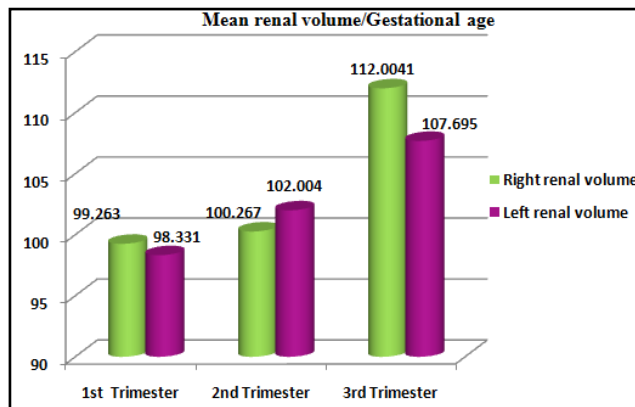


Figure 4: Column diagram showing distribution of mean renal volume and gestational age

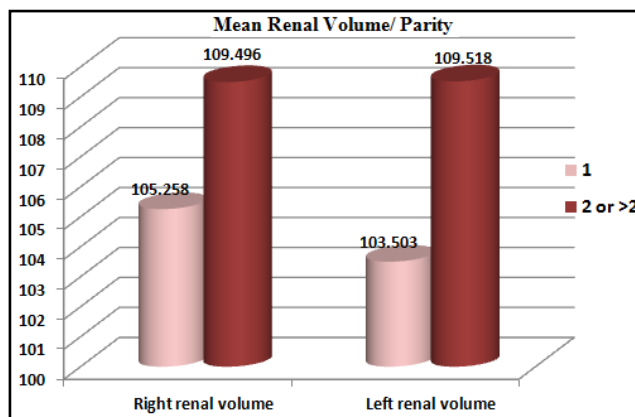


Figure 5: Column diagram showing distribution of mean renal volume and parity of healthy pregnant women.

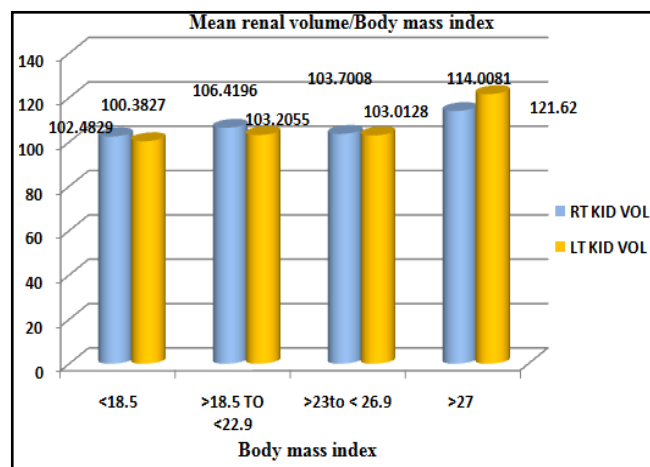


Figure 3: Column diagram showing distribution of mean renal volume and body mass index.

4. Discussion

During pregnancy, volume expansion and vasodilatation occurs with the help of coordination of hormones. Maternal hormones have an effect on the hemodynamic changes in pregnancy. Vasodilating hormone relaxin is manufactured by corpus lutea, decidua and placenta. In a study by Ogeuh *et al* [11], gradual increase in the relaxin levels during pregnancy with decrease in its levels post partum is noted; Due to these physiological variations, renal volume during pregnancy changes.

Present study revealed that the mean right volume is 105.77±27.29 and mean left renal volume is 104.23±28.18 with a range of 100-122 cm³ for both kidneys.

In present study, mean renal volume increased throughout the pregnancy with mean renal volume being largest in third trimester. This was in agreement with Ugboma *et al* [12] and Reynard *et al*[13] findings.

Reynard *et al* [13] stated that as the renal plasma flow rate increased by 75% in third trimester, the renal volume increased. As during third trimester, there was increase in glomerular filtration rate due to increase in renal plasma flow, this leading to hyperfiltration and causing increase in renal volume.

Present study revealed that there is increase in the mean renal volume with increase in the BMI. However no significant positive linear relationship between BMI and right or left kidney volume could be found. It could be stated that there could be non-linear relationship.

Significant positive linear correlation between the renal volume and the body mass index was found in a study by Ugboma *et al*[12]. Cohen *et al*[14] and other studies stated that total renal volume correlated positively with the body mass index in the non pregnant state.

Present study showed there is a no significant difference between mean kidney volumes across different parities ($p=0.18$). Present study also showed that there is no significant correlation of the renal volume with an increase or decrease in the parity.

This was in agreement with the findings of the study by Ugboma *et al*[12] and Obembe *et al*[15]. These studies showed that there is little or no effect on the renal function. Explanation to this could be that after pregnancy, the kidney volume returns back to its pre-pregnant state and in subsequent future pregnancies, no additional enlargement of the renals is there.

However further studies will be needed in which renal volume will be recorded with prepregnant state, during pregnancy and post partum state with women of different parities and if any significant change takes place, needs to be studied. These women need to be followed in their subsequent pregnancies to study if any change occurs in the renal volume or the renal volume remains the same.

The main strength of this study is that it is a prospective study done especially to know sonographic renal dimensions in normal pregnant women of central India population and to produce the population data. Also it is carried out by a single ultrasonographer with a predefined technique to produce maximum uniformity. This has also prevented the interobserver unevenness. Intraobserver irregularities are reduced by taking multiple readings and averaging them. Also pregnant women with hypertension and diabetes were not included in study as these comorbid conditions affect the renal sizes.

But then this again remains the limitation of this study that pregnant women with non renal pathologies were included and other pathologies are not excluded. So another study in 'Healthy' pregnant women with exclusion of all the pathologies is justified.

Another limitation of this study was that the pre and post pregnancy renal volumes and Body mass Index were not compared. It is recommended that a future study involving the general population is needed to establish the renal volume data and compare the data with healthy pregnant women population.

In conclusion, this study established a value for the right and left renal volume in pregnancy in central India region, which can be used as a reference value for pregnant women of this region.

This study also revealed that gestational age had a significant positive linear correlation with the renal volume but not with body mass Index and parity.

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Conflicts of Interest: None

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