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Investigation of the Effect of Kidney Stones on Renal Morphometry and Volume

Investigación del Efecto de los Cálculos Renales Sobre la Morfometría y el Volumen Renal

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SUMMARY: Kidney stones are one of the oldest and most common urinary system diseases known throughout history. Today, it is an increasing health problem worldwide. Measurements of the anatomical features of the kidneys such as volume, length, width and thickness are of great importance in the diagnosis and treatment of stone disease. The aim of this study is to analyze morphometric measurements using computed tomography (CT) images of individuals with and without kidney stones and thus provide information for the diagnosis and treatment of this disease. Our study was conducted at the Department of Radiology, Malatya Turgut Özal University Training and Research Hospital and Ethics Committee permission number 2023/33 was obtained. Measurements were performed using CT2, CT, Abdominal, and Non-contrast. In our study, 80 individuals with kidney stones and 40 individuals without kidney stones were examined and 60 of them were female and 60 of them were male. Statistical analysis of the data was performed using the SPSS program. A statistically significant increase was observed in the width VCBEUM values of the right kidney morphometric measurements of the patient and control group female subjects ($p<0.05$). When the right kidney volume measurements of the patient and control group male subjects were compared, a statistically significant increase was observed in Volume Itk- Snap and Volume ellipsoid measurements ($p<0.05$). In conclusion, our study provides information about the morphometric and volume measurements of the kidneys of individuals with and without kidney stones. These findings contribute to the existing literature on kidney stone disease and contribute to future research and clinical practice in the diagnosis and treatment of the disease.

KEY WORDS: Kidney; Kidney Stone; Kidney Morphometry; Kidney Volume.

INTRODUCTION

Kidney stone disease (nephrolithiasis) is known as a chronic urinary system disease that is common worldwide, has significant effects on human health and reduces the quality of life (Stoller, 2004). This disease has caused various health problems throughout history and has spread with varying prevalence rates in different geographical regions (Akinci *et al*., 1991; Bird & Khan, 2017). Studies on kidney stone disease have found that many factors such as genetic predisposition, dietary habits, climate and geographical conditions affect stone formation (Jiang, *et al*., 2017). Today, the fact that it is observed with a higher frequency especially in hot climates and developed countries reveals the importance of the effect of environmental factors (Akinci *et al*., 1991).

The anatomical and physiological effects of kidney stone disease have a direct impact on the volumetric and morphometric properties of the kidney. In individuals with kidney stones, various changes are observed in the morphometric structure of the kidney caused by stone formation. Parameters suchas the volume, length, width and thickness of the kidney play a critical role in the diagnosis and treatment of stone disease. Therefore, evaluating the effects of kidney stone disease on kidney morphometry and volume values provides important information to improve the diagnostic process and treatment (Glodny *et al*., 2009; Dias *et al*., 2015; Brisbane *et al*., 2016; Duygˇun & Çıkmaz, 2020).

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It has been reported in the literature that patients with kidney stones exhibit significant differences in renal morphometric measurements compared to healthy individuals. In this context, the high resolution provided by Computed Tomography (CT) imaging techniques allows detailed examination of the effects of kidney stones on anatomical structures. CT is a frequently preferred method in kidney stone studies because it provides accurate results especially in kidney volume measurements. Thanks to the morphometric analysis provided by CT, the measurable effects of kidney stones can be revealed and data on the treatment processes of the disease can be obtained (Brisbane *et al*., 2016).

This study goal to scientifically evaluate the possible effects of kidney stones on renal anatomy by comparing the renal volume and morphometric characteristics of individuals with and without kidney stones on CT images. It is hoped that the results of this study will help guide the diagnosis and treatment of kidney stones.

MATERIAL AND METHOD

This study was a descriptive and comparative study examining the effects of kidney stone disease on renal morphometry and volumetric characteristics and was conducted at Malatya Turgut Özal University Training and Research Hospital. Within the scope of the study, the permission of Malatya Turgut Özal University Non-Interventional Clinical Research Ethics Committee numbered 2023/33 was obtained. During the study period, individuals over the age of 18 who applied to the hospital between 2017 and 2023 and were diagnosed with kidney stones by a radiology physician were evaluated. Individuals with kidney stones were included as the study group and healthy individuals without kidney stones were included as the control group and consisted of 120 people in total. Individuals with pathologic features that would disrupt anatomical integrity (such as atrophic or aplasic kidney, congenital single kidney) were excluded from the study.

Patient group with kidney stones: 80 individuals (40 females, 40 males) were included in the study as patients with kidney stones. The patient group was divided into four subgroups according to gender and side of the kidney with stones: 20 women with stones in the right kidney, 20 women with stones in the left kidney, 20 men with stones in the right kidney, and 20 men with stones in the left kidney.

Control group: 40 healthy individuals (20 females, 20 males) without kidney stones. Morphometric and volume measurements of the right and left kidneys of healthy individuals were analyzed comparatively with those of individuals with kidney stones.

In this study, computed tomography (CT2, CT, Abdomen, Non-Contrast) imaging was used to analyze kidney morphometry and volume. The study aims to investigate the differences in kidney morphometry and volume between individuals with kidney stones and healthy individuals. For this purpose, two programs were used in this study, RadiAnt DICOM Viewer and ITK-SNAP.

Morphometric Measurements

In this section, morphometric measurements of the kidney were performed. These measurements were performed with the RadiAnt DICOM Viewer program. RadiAnt DICOM Viewer is a widely used software in the field of medical imaging. It is designed to view, process and analyze digital medical imaging files in DICOM format. This software offers advanced imaging features to ensure accurate visualization of medical images. RadiAnt DICOM Viewer fully complies with the DICOM standard and supports the safe and effective operation of medical images. The software is widely used in scientific and clinical applications.

Measurement of the thickness of the kidney. Kidney images were taken on the axial section, counted and the two farthest points between the facies anterior and facies posterior on the median image were measured with RadiAnt DICOM Viewer (Fig. 1a).

Measurement of the length of the kidney. The kidney images taken in the sagittal section were counted and the distance between the upper and lower poles of the kidney was measured on the median image with RadiAnt DICOM Viewer (Fig. 1b).

Measurement of the width of the kidney. Kidney images taken in coronal section were counted and the distance between the margo medialis and margo lateralis of the kidney was measured on the median image with RadiAnt DICOM Viewer (Fig. 1c).

Measurement of the angle of the length of the kidney with the transverse plane (BTDYA). Coronal kidney images were counted and the angle of the coronal length of the kidney to the transverse plane was measured on the median image using RadiAnt DICOM Viewer (Fig. 1d).

Measurement of the distance of the superior pole of kidney from the median plane (BESMDU). Kidney images taken in coronal section were counted and the distance of the superior pole of kidney from the median plane was measured on the median image using RadiAnt DICOM Viewer (Fig. 1e).

Measurement of the distance of the inferior pole of kidney from the median plane (BEIMDU). Kidney images taken in coronal section were counted and the distance of the inferior pole of kidney from the median plane was measured on the median image using RadiAnt DICOM Viewer (Fig. 1f).

Measurement of the distance between the superior pole of kidney (BESAU). Coronal section kidney images were counted and the distance between the superior extremitas of the right kidney and the superior extremitas of the left kidney was measured on the median image using RadiAnt DICOM Viewer (Fig. 1g).

Measurement of the distance between the inferior pole of kidney s (BEIAU). Kidney images taken in coronal section were counted and the distance between the extremitas inferior of the right kidney and the extremitas inferior of the left kidney was measured on the median image with RadiAnt DICOM Viewer (Fig. 1h).

Measurement of kidney stone size. Kidney images in the coronal section were examined and the sections where the stone was seen were determined. The size of the stone was determined by measuring the distance between the two farthest points in the image where the stone was the largest. In addition,

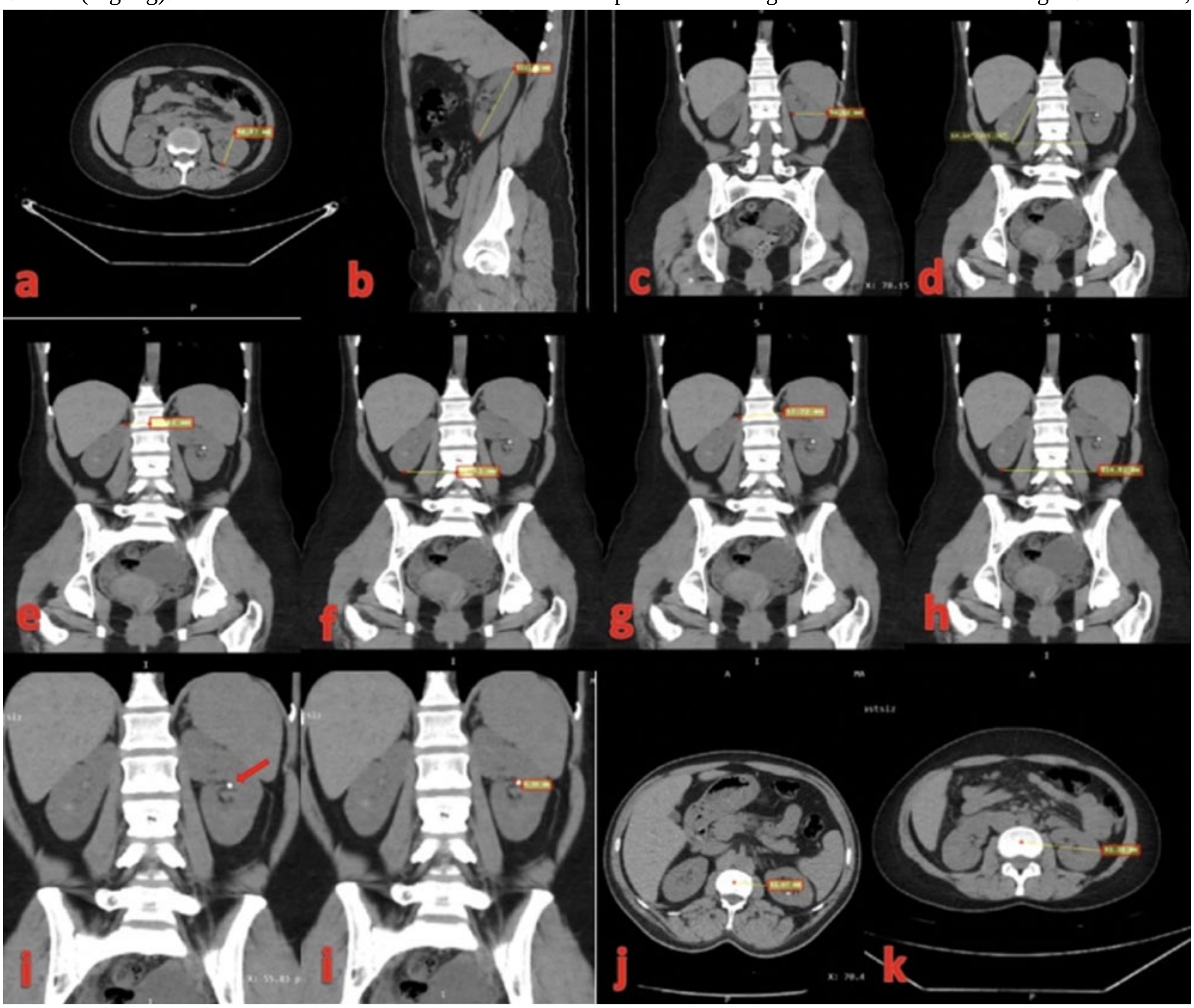

Fig. 1 Morphometric measurements of kidney. Measurement of the thickness of the kidney: (Fig. 1a); Measurement of the length of the kidney: (Fig. 1b); Measurement of the width of the kidney: (Fig. 1c); Measurement of the angle of the length of the kidney with the transverse plane (BTDYA): (Fig. 1d). Measurement of the distance of the extremits superior of the kidney from the median plane (BESMDU): (Fig. 1e). Measurement of the distance of the extremity inferior of the kidney from the median plane (BEIMDU): (Fig. 1g). Measurement of the distance between the extremity superior of the kidneys (BESAU): (Fig. 1g). Measurement of the distance between the extremity inferior of the kidneys (BEIAU): (Fig. 1h). Measurement of kidney stone size: (Fig. 1i). Measurement of the distance from the midpoint of the corpus of the vertebra to the nearest edge of the kidney (VCBEKM): (Fig. 1j). Measurement of the distance from the midpoint of the corpus of the vertebra to the farthest edge of the kidney (VCBEUM): (Fig. 1k).

the determination of the size of the stone by measurements made from sagittal and axial images was completed with RadiAnt DICOM Viewer (Fig. 1i).

Measurement of the distance from the midpoint of the corpus of the vertebra to the nearest edge of the kidney (VCBEKM). The kidney images obtained in the axial section were counted and the distance from the midpoint of the corpus of the vertebral body to the nearest edge of the kidney was measured from the median image using RadiAnt DICOM Viewer (Fig. 1j).

Measurement of the distance from the midpoint of the corpus of the vertebra to the farthest edge of the kidney (VCBEUM). Kidney images from the axial section were counted and the distance from the midpoint of the corpus of the vertebral body to the farthest edge of the kidney was measured from the median image using RadiAnt DICOM Viewer (Fig. 1k).

Volume Measurements

ITK-SNAP and RadiAnt DICOM Viewer programs were used to determine kidney volumes.

Volume Measurement with ITK-SNAP Program. ITK-SNAP software is a widely used tool in medical image analysis and is especially preferred for segmentation of 3D images and volume calculations. In this method, CT images were analyzed in axial, frontal and sagittal planes and renal margins were drawn manually or semi- automatically. Once these boundaries were identified and marked, the program automatically calculated the kidney volume. Thanks to the advanced segmentation features of ITK-SNAP, kidney volumes were determined with high precision (Lo Giudice *et al*., 2020; Tincopa *et al*., 2022).

Volume Measurement with Ellipsoid Method. RadiAnt DICOM Viewer images were analyzed in three different planes. The images were counted and the median image was viewed in axial, frontal and sagittal planes and the kidney was detected in these three planes. The thickness, length and width of the kidney were measured by RadiAnt DICOM Viewer program. Then the volume of the kidney was calculated by applying the following formula (Higashihara *et al*., 2015).

Free Hand Volume Measurement. Kidney images in the coronal section were examined sequentially. In manual volume calculation, the areas of the kidney were started to be calculated from the beginning of the image and the calculation of these areas was performed with RadiAnt DICOM Viewer. Areas were calculated in all sections where the kidney was seen and the arithmetic mean of the calculations was taken and multiplied by the section thickness (0.3).

Volume Measurement with ITK-SNAP Program. ITK-SNAP software is a widely used tool in medical image analysis and is especially preferred for segmentation of 3D images and volume calculations. In this method, CT images were analyzed in axial, frontal and sagittal planes and renal margins were drawn manually or semi-automatically. Once these boundaries were identified and marked, the program automatically calculated the kidney volume. Thanks to the advanced segmentation features of ITK-SNAP, kidney volumes were determined with high precision (Lo Giudice *et al*., 2020; Tincopa *et al*., 2022).

Volume Measurement with Ellipsoid Method. RadiAnt DICOM Viewer images were analyzed in three different planes. The images were counted and the median image was viewed in axial, frontal and sagittal planes and the kidney was detected in these three planes. The thickness, length and width of the kidney were measured by RadiAnt DICOM Viewer program. Then the volume of the kidney was calculated by applying the following formula (Higashihara *et al*., 2015).

Free Hand Volume Measurement. Kidney images in the coronal section were examined sequentially. In manual volume calculation, the areas of the kidney were started to be calculated from the beginning of the image and the calculation of these areas was performed with RadiAnt DICOM Viewer. Areas were calculated in all sections where the kidney was seen and the arithmetic mean of the calculations was taken and multiplied by the section thickness (0.3).

In this study, all measurements on the right and left kidneys of each individual were repeated three times by two different workers to improve the accuracy of the measurements. This multiple measurement approach minimizes the error rate and increases the reliability of the results. The scientific consistency and applicability of the data obtained is very important, especially in clinical applications and diagnosis of diseases.

Statistical Analysis

The data used in the study were analyzed using the SPSS (Statistical Program in Social Sciences) program. The conformity of the data to normal distribution was checked with the Kolmogorov-Smirnov Test (Alpar, 2016). In comparison tests, 0.05 was accepted as the significance level (p). Since the data were not normally distributed ($p>0.05$), the analysis was continued with nonparametric test methods. Descriptive statistics for quantitative variables include minimum and maximum values, means and standard deviations. Mann-Whitney U test was used as a nonparametric alternative to test the differences though two independent groups (Kalaycı, 2010).

RESULTS

Descriptive statistics of the patient and control groups and mean, standard deviation, median, minimum and maximum values for each variable are given (Table I).

When the right kidney volume measurements of the patient and control group male subjects were compared, a statistically meaningful increasement was found in volume ITK- SNAP and volume ellipsoid measurements ($p<0.05$). There was no statistically important dissimilarity though the groups in volume manual measurement ($p>0.05$) (Table II). When the left kidney volume measurements of the patient and control group male subjects were compared, there was a statistically significance dissmilarity in volume ITK-SNAP and volume manual measurements ($p<0.05$). There was no statistically important dissimilarity though the groups in volume ellipsoid measurement ($p>0.05$) (Table II).

When the right kidney volume measurements of the patient and control group female subjects were compared, a statistically meaningful increment was found in volume manual measurement ($p<0.05$). No statistically significance dissimilarity was found the groups in Volume Itk- Snap and Volume ellipsoid measurements ($p>0.05$) (Table III). When the left kidney volume measurements of the patient and control group female subjects were compared, it was statedt hat there was no statistically important difference though the groups in volume Itk- Snap, volume elle and volume ellipsoid measurements ($p>0.05$) (Table III).

Table I. Descriptive statistics of variables for patient and control groups.

Variables	Patient		Control	
	Mean±SD	Median (Min-Max)	Mean±SD	Median (Min-Max)
VOLUME ITK-SNAP (ml)	228.39±70.2	224.43(117.62-514.36)	183.85±59.22	172.95(94.57-371.55)
VOLUME HAND (ml)	193.97±53.16	188.19(97.83-310.06)	167.71±42.83	162.09(91.73-296.69)
VOLUME ELIPSOID (ml)	177.12±54.93	171.62(91.97-375.85)	153.65±47.96	150.08(75.32-409.51)
THICKNESS (cm)	6.27±1.23	6(3.9-9.3)	5.83±0.91	5.7(3.9-8.7)
LENGTH (cm)	10.12±1.19	10.07(7.59-12.97)	10.08±1.29	10.19(6.65-12.82)
WIDTH (cm)	5.21±0.81	5.23(3.73-8.22)	4.82±0.66	4.91(2.56-6.34)
WTDPNR (degrees)	68.49±10.51	66.9(54.5-119)	67.65±5.25	67.3(56.4-92.3)
BESMDU (cm)	3.92±1.34	3.86(1.01-8.72)	3.41±1.2	3.46(1.21-6.45)
BEIMDU (cm)	7.63±1.63	8.01(4.04-10.12)	6.84±1.72	7.05(1.66-9.82)
BESAU (cm)	8.7±2.07	8.53(6.23-16.21)	7.82±1.45	7.55(5.19-12.06)
BEIAU (cm)	15.83±2.34	16(6.49-19.14)	14.72±1.76	14.69(10.99-18.35)
STONE SIZE (cm)	2.01±1	1.95(0.37-4.78)	0±0	0(0-0)
VCBEKM (mm)	51.25±8.42	50.99(35.18-71.83)	49.39±6.55	50.94(36.77-68.72)
VCBEUM (mm)	111.09±15.98	112.61(79.56-134.22)	92.35±9.6	92.57(75.81-128.67)

Mean; average, Min; lowest score, Max; highest score, SD; standard deviation. Angle of the length of the kidney with the transverse plane (BTDYA). Angle of the extremitas superior of the kidney with the median plane distance (BESMDU). Distance of the extremitas inferior of the kidney from the median plane (BEIMDU) of the kidneys. Distance between the superior extremities of the kidneys (BESAU). Distance between the extremitas inferior of the kidneys (BEIAU). Distance from the middle of the corpus of the vertebra to the nearest edge of the kidney (VCBEKM). From the center of the corpus of the vertebra distance to the farthest edge of the kidney (VCBEUM).

Table II. Comparison of kidney volumes in male subjects according to side.

	Male Right (Mean±ss)		p	Male Left (Mean±ss)		p
	Patient	Control		Patient	Control	
VOLUME ITK- SNAP (ml)	254.39±92.82	170.62±53.64	**0.001***	264.8±45.25	193.18±53.41	**0.001***
VOLUME HAND (ml)	219.34±50.46	191.26±41.27	0.062	210.38(160.06-298.12)	183.58(125.65-296.69)	**0.021***
VOLUME ELIPSOID (ml)	189.41(111.31-375.85)	166.55(83.57-265.65)	**0.036***	193.48(117.08-294.47)	170.82(99.95-409.51)	0.093

Data are given as mean ± standard deviation or median (minimum-maximum) according to the normality of the distribution*: Independent sample t test **Mann Whitney U test.

Table III. Comparison of kidney volumes in female subjects by side.

	Women Right			Women Left		
	Patient	Control		Patient	Control	p
VOLUME ITK- SNAP (ml)	210.72(133.34-340.03)	170.56(98.99-371.55)	0.159	174.52(139.83-280.97)	180.24(94.57-350.45)	0.892
VOLUME HAND (ml)	166.26±29.72	143.23±26.58	**0.014***	162.43±47.07	144.14±24.44	0.134
VOLUME ELIPSOID (ml)	150.72±28.91	132.26±29.64	0.053	158.08±53.74	138.08±27.75	0.150

Data are given as mean ± standard deviation or median (minimum-maximum) according to the normality of the distribution .*: Independent sample t test **:Mann Whitney U test.

When the right kidney morphometric measurements of the patient and control group male subjects were compared, a statistically meaningful increasement was found in width, BESAU and VCBEUM values (p<0.05). No statistically important dissimilarity was seen in thickness, length, BTDYA, BESMDU, BEIMDU, BESAU and VCBEKM measurements (p>0.05) (Table IV). When the left kidney morphometric measurements of male patients and control group were compared, a statistically meaningful increase was found in thickness, BEIMDU, BEIAU and VCBEUM measurements (p>0.05). There was no statistically important dissimilarity in length, width, BTDYA, BESMDU and VCBEKM measurements (p>0.05) (Table IV).

When the right kidney morphometric measurements of the patient and control group female subjects were compared, a statistically significance increasement was found in width and VCBEUM values (p<0.05). There was no statistically meaningful difference in thickness, length, BTDYA, BESMDU, BEIMDU, BESAU, BEIAU and VCBEKM measurements (p>0.05) (Table V). When the left kidney morphometric measurements of the female patients and control group were compared, a statistically important increasement was determined in the VCBEUM measurement (p>0.05). There was no statistically significance dissimilarity in thickness, length, width, BTDYA, BESMDU BEIMDU, BESAU, BEIAU and VCBEKM measurements (p>0.05) (Table V).

Table IV. Comparison of renal morphometric measurements in male subjects by side.

	Male Right			Male Left		
	Patient	Control	p	Patient	Control	p
THICKNESS (cm)	6.68±1.24	6.15±0.88	0.130	6.87±1.15	5.81±1.03	**0.004***
LENGTH (cm)	10.53±1.11	10.45±1.32	0.846	10.1±1.29	10.37±1.32	0.522
WIDTH (cm)	5.4(3.97-8.22)	4.96(3.73-5.64)	**0.033***	5.61(3.97-6.95)	5.28(2.56-6.34)	0.365
WTDPNR (degrees)	65.55(54.5-119)	64.45(56.4-72.2)	0.756	69.7(60.5-119)	69.15(62.3-92.3)	0.946
BESMDU (cm)	3.76(2.13-8.72)	3.76(1.89-5.39)	0.797	4.67±1.18	4.06±1.36	0.142
BEIMDU (cm)	8.56(4.04-10.12)	7.89(2.99-9.4)	0.099	8.35±1.36	7.27±1.7	**0.034***
BESAU (cm)	8.85(6.82-14.49)	8.56(6.4-9.9)	0.534	9.37±1.49	8.5±1.03	**0.037***
BEIAU (cm)	17.03±1.28	15.5±1.71	**0.003***	16.98±1.57	15.42±1.66	**0.004***
STONE SIZE (cm)	2.27±1.12	0±0	-	1.9±0.65	0±0	-
VCBEKM (mm)	51.9(38.2-71.83)	51.74(36.92-68.72)	0.499	49.61(36.83-62.78)	52.78(36.96-57.42)	0.387
VCBEUM (mm)	112.73(81.72-134.22	91.51(79.02-128.67)	**0.001***	108.44(81.99-133.44)	93.5(75.81-122.05)	**0.004***

Data are given as mean ± standard deviation or median (minimum-maximum) according to the normality of the distribution *: Independent sample t test **Mann Whitney U test. Angle of the length of the kidney with the transverse plane (BTDYA). Angle of the extremitas superior of the kidney with the median plane distance (BESMDU). Distance of the extremitas inferior of the kidney from the median plane (BEIMDU). of the kidneys. Distance between the superior extremities of the kidneys (BESAU). Distance between the extremitas inferior of the kidneys (BEIAU). Distance from the middle of the corpus of the vertebra to the nearest edge of the kidney (VCBEKM). From the center of the corpus of the vertebra distance to the farthest edge of the kidney (VCBEUM).

Table V. Comparison of renal morphometric measurements in female subjects by side.

	Women Right			Women Left		
	Patient	Control	p	Patient	Control	p
THICKNESS (cm)	5.85(3.9-8.4)	5.7(4.8-8.4)	0.935	5.61±1.04	5.36±0.47	0.334
LENGTH (cm)	9.88±1.06	9.57±1.02	0.363	9.98±1.27	9.94±1.38	0.934
WIDTH (cm)	4.99±0.73	4.49±0.52	**0.017***	5.01±0.66	4.75±0.54	0.188
WTDPNR (degrees)	66.79±5.25	66.76±5.06	0.985	68.19±6.5	68.22±3.93	0.988
BESMDU (cm)	3.47±1.19	2.79±1.05	0.065	3.63±1.37	3.13±1.07	0.202
BEIMDU (cm)	7.13±1.59	6.14±1.86	0.080	7.57(4.22-9.1)	6.46(4.17-9.38)	0.159
BESAU (cm)	7.3(6.23-16.21)	7.15(5.19-12.06)	0.136	7.33(6.23-16.21)	7.08(5.19-12.06)	0.072
BEIAU (cm)	15(6.49-19.14)	13.87(10.99-17.28)	0.078	15(6.49-17.28)	13.77(10.99-17.28)	0.113
STONE SIZE (cm)	2.11±0.88	0±0	-	1.78±1.25	0±0	-
VCBEKM (mm)	50.5(38.74-66.34)	49.11(37.74-54.38)	0.105	52.83(35.18-71.83)	51.79(36.77-54.89)	0.516
VCBEUM (mm)	109.57±17.6	90.83±6.65	**0.001***	114.05±14.42	93.06±6.41	**0.001***

Data are given as mean ± standard deviation or median (minimum-maximum) according to the normality of the distribution *: Independent sample t test **Mann Whitney U test. Angle of the length of the kidney with the transverse plane (BTDYA). Angle of the extremitas superior of the kidney with the median plane distance (BESMDU). Distance of the extremitas inferior of the kidney from the median plane (BEIMDU) of the kidneys. Distance between the superior extremities of the kidneys (BESAU). Distance between the extremitas inferior of the kidneys (BEIAU). Distance from the middle of the corpus of the vertebra to the nearest edge of the kidney (VCBEKM). From the center of the corpus of the vertebra distance to the farthest edge of the kidney (VCBEUM).

Correlation analysis

The volume of male right kidneys measured by Itk-Snap method was found to have a moderate positive correlation with kidney width (r=0.547), a weak positive correlation with BEIMDU (r=0.352), a moderate positive correlation with stone size (r=0.669), and a weak positive correlation with VCBEUM (r=0.348) (Table VI). The volume of male right kidneys measured by volume manual method was found to have a moderate positive correlation with kidney thickness (r=0.600), a strong positive correlation with kidney width (r=0.709), a moderate positive correlation with BESMDU (r=0.529), a moderate positive correlation with BEIMDU (r=0.538) and a moderate positive correlation with stone size (r=0.432) (Table VI). The volume of male right kidneys measured with the volume ellipsoid method was positively correlated strongly with kidney thickness (r=0.717), positively correlated strongly with kidney width (r=0.785), positively correlated moderately with BESMDU (r=0.566), moderate positive correlation (r=0.586), weak positive correlation (r=0.316), and moderate positive correlation (r=0.394) with stone size (Table VI).

Table VI. Correlation of right kidney morphometric measurements in male patients according to volume measurement methods.

		VOLUME ITK -SNAP (ml)	VOLUME ELLE (ml)	VOLUME ELIPSOID (ml)
	r	0.269	0.600	0.717
THICKNESS (cm)	**p**	0.094	**0.001***	**0.001***
	r	0.102	0.218	0.229
LENGTH (cm)	**p**	0.530	0.177	0.155
	r	0.547	0.709	0.785
WIDTH (cm)	**p**	**0.001***	**0.001***	**0.001***
	r	0.141	-0.033	-0.145
WTDPNR (degrees)	**p**	0.387	0.838	0.371
	r	0.252	0.529	0.566
BESMDU (cm)	**p**	0.117	**0.001***	**0.001***
	r	0.352	0.538	0.586
BEIMDU (cm)	**p**	**0.026***	**0.001***	**0.001***
	r	0.213	0.209	0.298
BESAU (cm)	**p**	0.186	0.196	0.062
	r	0.257	0.311	0.316
BEIAU (cm)	**p**	0.109	0.051	**0.047***
	r	0.669	0.432	0.394
STONE SIZE (cm)	**p**	**0.001***	**0.005***	**0.012***
	r	0.022	0.059	0.135
VCBEKM (mm)	**p**	0.891	0.719	0.405
	r	0.348	0.076	0.031
VCBEUM (mm)	**p**	**0.028***	0.640	0.848

*p<0.05; **p<0.001; ***: Spearman's rho correlation coefficient. Angle of the length of the kidney with the transverse plane (BTDYA). The angle of the extremitas superior of the kidney with the median plane. Angle of the length of the kidney with the transverse plane (BTDYA). Angle of the extremitas superior of the kidney with the median plane distance (BESMDU). Distance of the extremitas inferior of the kidney from the median plane (BEIMDU) of the kidneys. Distance between the superior extremities of the kidneys (BESAU). Distance between the extremitas inferior of the kidneys (BEIAU). Distance from the middle of the corpus of the vertebra to the nearest edge of the kidney (VCBEKM). From the center of the corpus of the vertebra distance to the farthest edge of the kidney (VCBEUM).

The volume of male left kidneys measured by Itk-Snap method showed a moderate positive correlation with kidney thickness (r=0.417), a weak positive correlation with BEIMDU (r=0.349), a weak positive correlation with BEIAU (r=0.371) and a moderate positive correlation with stone size (r=0.612) (Table VII). The volume of male left kidneys measured by volume manual method was found to have a strong positive correlation with renal thickness (r=0.705), a moderate positive correlation with renal width (r=0.551), a moderate positive correlation with BESMDU (r=0.575), a moderate positive correlation with BEIMDU (r=0.646), a moderate positive correlation with BEIAU (r=0.469) and a weak positive correlation with stone size (r=0.351) (Table VII). The volume of male left kidneys measured by the volume ellipsoid method was found to have a strong positive correlation with kidney thickness (r=0.711), a moderate positive correlation with kidney width (r=0.600), a moderate positive correlation with BESMDU (r=0.540), a moderate positive correlation with BEIMDU (r=0.650), and a moderate positive correlation with BEIAU (r=0.564) (Table VII).

Table VII. Correlation of left kidney morphometric measurements in male patients according to volume measurement methods.

		VOLUME ITK (ml)	VOLUME ELLE (ml)	VOLUME ELIPSOID (ml)
THICKNESS (cm)	r	0.417	0.705	0.711
	p	**0.007**[*]	**0.001**[*]	**0.001**[*]
LENGTH (cm)	r	0.012	0.178	0.208
	p	0.942	0.271	0.199
WIDTH (cm)	r	0.222	0.551	0.600
	p	0.168	**0.001**[*]	**0.001**[*]
WTDPNR (degrees)	r	0.043	-0.132	-0.178
	p	0.794	0.418	0.273
BESMDU (cm)	r	0.148	0.575	0.540
	p	0.362	**0.001**[*]	**0.001**[*]
BEIMDU (cm)	r	0.349	0.646	0.650
	p	**0.027**[*]	**0.001**[*]	**0.001**[*]
BESAU (cm)	r	0.094	0.202	0.218
	p	0.563	0.211	0.176
BEIAU (cm)	r	0.371	0.469	0.564
	p	**0.018**[*]	**0.002**[*]	**0.001**[*]
STONE SIZE (cm)	r	0.612	0.351	0.301
	p	**0.001**[*]	**0.026**[*]	0.059
VCBEKM (mm)	r	-0.077	-0.223	-0.178
	p	0.637	0.166	0.273
VCBEUM (mm)	r	0.137	-0.112	-0.064
	p	0.401	0.491	0.693

*p<0.05; **p<0.001; ***: Spearman's rho correlation coefficient. The angle of the length of the kidney with the transverse plane (BTDYA). The angle of the extremitas superior of the kidney with the median plane. Angle of the length of the kidney with the transverse plane (BTDYA). Angle of the extremitas superior of the kidney with the median plane distance (BESMDU). Distance of the extremitas inferior of the kidney from the median plane (BEIMDU) of the kidneys. The distance between the superior extremities of the kidneys (BESAU). Distance between the extremitas inferior of the kidneys (BEIAU). Distance from the middle of the corpus of the vertebra to the nearest edge of the kidney (VCBEKM). From the center of the corpus of the vertebra distance to the farthest edge of the kidney (VCBEUM).

Table VIII. Correlation of right kidney morphometric measurements in female patients according to volume measurement methods.

		VOLUME ITK (ml)	VOLUME ELLE (ml)	VOLUME ELIPSOID (ml)
THICKNESS (cm)	r	0.112	-0.004	0.161
	p	0.490	0.982	0.322
LENGTH (cm)	r	-0.249	0.325	0.258
	p	0.122	0.041	0.108
WIDTH (cm)	r	0.066	0.657	0.588
	p	0.685	**0.001**[*]	**0.001**[*]
WTDPNR (degrees)	r	-0.164	0.154	-0.211
	p	0.311	0.341	0.192
BESMDU (cm)	r	0.043	0.165	0.276
	p	0.790	0.309	0.085
BEIMDU (cm)	r	0.145	0.292	0.404
	p	0.371	0.067	**0.010**[*]
BESAU (cm)	r	-0.039	0.175	0.125
	p	0.810	0.281	0.443
BEIAU (cm)	r	0.025	0.331	0.374
	p	0.877	**0.037**[*]	0.018
STONE SIZE (cm)	r	0.329	0.402	0.320
	p	**0.038**[*]	**0.010**[*]	**0.044**[*]
VCBEKM (mm)	r	0.202	0.106	-0.108
	p	0.212	0.515	0.509
VCBEUM (mm)	r	0.166	0.197	0.115
	p	0.307	0.222	0.481

*p<0.05; **p<0.001; ***: Spearman's rho correlation coefficient. Angle of the length of the kidney with the transverse plane (BTDYA). Angle of the extremitas superior of the kidney with the median plane. Angle of the length of the kidney with the transverse plane (BTDYA). Angle of the extremitas superior of the kidney with the median plane distance (BESMDU). Distance of the extremitas inferior of the kidney from the median plane (BEIMDU) of the kidneys. The distance between the superior extremities of the kidneys (BESAU). Distance between the extremitas inferior of the kidneys (BEIAU). Distance from the middle of the corpus of the vertebra to the nearest edge of the kidney (VCBEKM). From the center of the corpus of the vertebra distance to the farthest edge of the kidney (VCBEUM).

Volume The volume of the right kidneys of women measured by Itk-Snap method was weakly positively correlated with the stone size of the kidney (r=0.329) (Table VIII). The volume of the right kidneys of women measured by volume manual method was found to have a moderate positive correlation with kidney width (r=0.657), a weak positive correlation with BIAU (r=0.331) and a moderate positive correlation with stone size (r=0.402) (Table VIII). The volume of female right kidneys measured with the volume ellipsoid method showed a moderate positive correlation with kidney width (r=0.588), a moderate positive correlation with BEIMDU (r=0.404) and a weak correlation with stone size (r=0.320) (Table VIII).

The volume of female left kidneys measured by Itk-Snap method was found to have a weak positive correlation (r=0.370) with the WTWR of the kidney (Table IX). The volume of female left kidneys measured by volume manual method showed a moderate positive correlation with kidney thickness (r=0.472), moderate positive correlation with kidney length (r=0.684), weak positive correlation with BESMDU (r=0.381), moderate positive correlation with BEIMDU (r=0.440) and weak positive correlation with VCBEUM (r=0.317) (Table IX). The volume of female left kidneys measured with the volume ellipsoid method showed a moderate positive correlation with the thickness of the kidney (r=0.507), a moderate positive correlation with the length (r=0.538) and a weak positive correlation with the width (r=0.377) (Table IX).

Table IX. Correlation of left kidney morphometric measurements in female patients according to volume measurement methods.

		VOLUME ITK (ml)	VOLUME ELLE (ml)	VOLUME ELIPSOID (ml)
THICKNESS (cm)	r	0.307	0.472	0.507
	p	0.054	**0.002***	**0.001***
LENGTH (cm)	r	-0.250	0.684	0.538
	p	0.119	**0.001***	**0.001***
WIDTH (cm)	r	0.141	0.212	0.377
	p	0.386	0.189	**0.017***
WTDPNR (degrees)	r	0.370	0.032	-0.148
	p	**0.019***	0.846	0.363
BESMDU (cm)	r	0.043	0.381	0.156
	p	0.791	**0.015***	0.337
BEIMDU (cm)	r	0.008	0.440	0.276
	p	0.960	**0.005***	0.084
BESAU (cm)	r	0.123	-0.115	-0.032
	p	0.448	0.481	0.846
BEIAU (cm)	r	-0.044	0.137	0.099
	p	0.788	0.399	0.542
STONE SIZE (cm)	r	0.162	0.229	0.226
	p	0.319	0.155	0.162
VCBEKM (mm)	r	-0.262	-0.024	-0.084
	p	0.102	0.883	0.607
VCBEUM (mm)	r	-0.024	0.317	0.304
	p	0.881	**0.046***	0.056

*p<0.05; **p<0.001; ***: Spearman's rho correlation coefficient. Angle of the length of the kidney with the transverse plane (BTDYA). Angle of the extremitas superior of the kidney with the median plane. Angle of the length of the kidney with the transverse plane (BTDYA). Angle of the extremitas superior of the kidney with the median plane distance (BESMDU). Distance of the extremitas inferior of the kidney from the median plane (BEIMDU) of the kidneys. The distance between the superior extremities of the kidneys (BESAU). Distance between the extremitas inferior of the kidneys (BEIAU). Distance from the middle of the corpus of the vertebra to the nearest edge of the kidney (VCBEKM). From the center of the corpus of the vertebra distance to the farthest edge of the kidney (VCBEUM).

DISCUSSION

Kidney stone disease is a urinary system disease that is frequently encountered in the historical process and tends to recur. In addition to metabolic, genetic and environmental factors, anatomical factors such as renal anomalies also constitute an important risk in the etiology of this disease (Ross & Pawlina, 2013). While the prevalence of kidney stones in the United States is 122 per 100,000 people, this rate was found to be approximately 14.8 % in a study conducted in Turkey (Romero *et al*., 2010). This shows how important changes in kidney volume and size are in terms of quality of life, clinical diagnosis and treatment processes (Hwang *et al*., 2011).

In our study, morphometric and volume measurements between the groups with and without kidney stones were performed using CT. While Duygun & Cıkmaz (2020), conducted their study on kidney stones on 35 participants, our study was conducted on 80 individuals with kidney stones. Aydogan *et al*. (2014) determined the right kidney length as 99.49 ± 18 mm and the left kidney length as 95.40 ± 11.91 mm in their study on patients with kidney stones. Hwang *et al*. (2011), found left kidney length to be 11.5 ± 0.9 cm and right kidney length to be 11.4 ± 2 cm in healthy individuals. Duygun & Çıkmaz (2020), reported that right and left kidney lengths in patients with kidney stones (right 107.47 mm, left 107.21 mm) were statistically significantly lower than the control group (right 112.48 mm, left 114.08 mm).

In our study, the right and left kidney lengths of the participants according to gender status; the right kidney length of male subjects with kidney stones was 10.53 ± 1.11 cm and the left kidney length was 10.1 ± 1.29 cm, while the right kidney length was 10.45 ± 1.32 cm and the left kidney length was 10.37 ± 1.32 cm in the control group. The right kidney length of female subjects with kidney stones was 9.88 ± 1.06 cm and the left kidney length was 9.98 ± 1.27 cm; the right kidney length of female subjects in the control group was 9.57 ± 1.02 cm and the left kidney length was 9.94 ± 1.38 cm. These values were found to be close to the studies in the literature, but no statistically important dissimilarity was found in terms of the presence or absence of kidney stones, which is consistent with the existing literature. We also provided more detailed information to the existing literature by determining kidney lengths according to gender. Glondy *et al*. (2009), found values of 55.8 mm on the right side and 51.2 mm on the left side in kidney thickness measurements obtained from axial images on 1040 healthy individuals. Duygun & Çıkmaz (2020), reported that there was no statistically meaningful difference though the right and left kidney measurement values of patients with kidney stones (right 50.96 mm, left 48.38 mm) and the measurement values of the control group (right 51.74 mm, left 49.18 mm). In our study, right and left kidney measurements were evaluated according to gender in the control and study groups in the thickness measurements made on the axial section. Accordingly, the right kidney thickness of male subjects with kidney stones was 6.68 ± 1.24 cm and the left kidney thickness was 6.87 ± 1.15 cm; in the control group, the right kidney thickness of male subjects was 6.15 ± 0.88 cm and the left kidney thickness was 5.81 ± 1.03 cm. The right kidney thickness of female subjects with kidney stones was 5.85 ± 1.13 cm and the left kidney thickness was 5.61 ± 1.04 cm; the right kidney thickness of female subjects in the control group was 5.7 cm and the left kidney thickness was 5.36 ± 0.47 cm. These measurements show values close to the studies in the literature. In addition, more detailed information was presented to the existing literature by determining kidney thicknesses according to gender. There was a statistically significance dissimilarity though the control and study groups in left kidney measurements in male subjects ($p<0.05$). Glodny *et al*. (2009), determined the width of the right kidney as 51.3 mm and the width of the left kidney as 53.3 mm in the kidney width measurement of healthy individuals. Duygun & Çıkmaz (2020), on the other hand, found that the right and left kidney width measurement values of patients with stones (right 56.26 mm, left 56.86 mm) were higher compared to the control group (right 53.66 mm, left 53.70 mm). In our study, the right and left kidney width measurement values in the control and study groups according to gender were as follows: right kidney width of male subjects with kidney stones was 5.04 cm and left kidney width was 5.61 cm; right kidney width of male subjects in the control group was 4.96 cm and left kidney width was 5.28 cm. The right kidney width of female subjects with kidney stones was 4.99 ± 0.73 cm and the left kidney width was 5.01 ± 0.66 cm; the right kidney width of female subjects in the control group was 4.49 ± 0.52 cm and the left kidney width was 4.75 ± 0.54 cm. These values were found to be close to the studies in the literature and more detailed information was presented to the existing literature by determining the kidney widths according to gender. There was a statistically meaningfuldissimilarity though the control and study groups in terms of right kidney width in male subjects ($p<0.05$). Similarly, a statistically substantial dissimilarity was found though the control and study groups in terms of right kidney measurements in female subjects ($p<0.05$). The measurements show a general increase in thickness, length and width measurements in individuals with kidney stones.

There are many studies on renal volume in the literature. Computed tomography is reported to be more sensitive than other methods in terms of volume measurements (Rule *et al*., 2010). Geraghty *et al*. (2004), emphasized that computed tomography is the most effective method for volumetric evaluation of organs in living organisms. He states that computed tomography is accurate enough for volume measurement of organs or anatomical structures. Kidney morphometry and volume measurements are considered an important parameter in the evaluation of clinical cases. These clinical cases include acute and chronic kidney diseases and recurrent urinary tract infections (Han & Babcock, 1985). Several studies have shown that renal volume is closely correlated with functional parameters of the kidney (Dias *et al*., 2015). Furthermore, renal volume is considered to be the most sensitive indicator of kidney size (Lee *et al*., 2011). Duygun & Çıkmaz (2020), did not find a statistically meaningful dissimilarity in each group of 50 kidneys with and 50 kidneys without stones in their measurements of renal parenchymal volume using CT images in Sectra Workstation IDS7 version 18.2.18.4066 software. In our study, we evaluated the renal volume values according to the presence or absence of stones by using three different measurement methods. As a result of these measurements, according to the volume itk-snap measurement method, we found a statistically meaningful difference in the right and left kidneys of male subjects compared to the control and study group ($p<0.05$). There was no statistically important dissimilarity in the right and left kidney of female subjects compared to the control and study group (p> 0,05). According to the volume manual measurement method; no statistically meaningful result was defined in the right kidney of male individuals compared to the control and study group (p> 0,05). However, a statistically important though was obtained in the left kidney of male subjects compared to the control and study group ($p<0.05$). We found a statistically meaningful dissimilarity in the right kidney of female subjects compared to the control and study group ($p<0.05$), but we did not find a statistically meaningful dissimilarity in the left kidney of female subjects compared to the control and study group ($p> 0.05$). According to the volume ellipsoid method; we obtained a statistically substantial result in the right kidney of male individuals compared to the control and study group ($p<0.05$), but we did not find a statistically significant result in the left kidney of male individuals compared to the control and study group ($p> 0.05$), and we did not find a statistically substantial dissimilarity in the right and left kidney of female individuals compared to the control and study group ($p> 0.05$). In the existing literature, we did not find any study that measured kidney volume with different methods and compared these methods with each other. Dias *et al*. (2015), measured kidney volume as 162.5 ml and Shin *et al*. (2009), measured kidney volume as 205 ml, Cheong *et al*. (2007), determined kidney volume as 202 ml for men and 154 ml for women in their study on kidney volume using MR images. Makusidi *et al*. (2014), determined the right kidney volume as 98 cm3 and the left kidney volume as 105 cm3. Emamian *et al*. (1993), found the mean right kidney volume to be 134 cm3 and left kidney volume to be 146 cm3. In their study, Gülpınar *et al*. (2019), found that the mean volume for the left kidney was 143 ml and the mean volume for the right kidney was 135 ml. In their study, they determined that the mean volume for the right kidney was 125 ml and the mean volume for the left kidney was 134 ml in women. For men, the mean volume for the right kidney was 149 ml and the mean volume for the left kidney was 155 ml. In our study, we used three different methods to measure the volume of the kidneys. The general averages of these methods are as follows: In volume push-snap volume measurement, 254.39 ± 92.28 ml in the right kidney study group of male individuals, 170.62 ± 53.64 ml in the control group, 264.8 ± 45.25 ml in the left kidney study group, 193.18 ± 53.41 ml in the control group, 210.72 ml in the right kidney study group, 170.56 ml in the control group, 174.52 ml in the left kidney study group, 180.24 ml in the control group. In volume manual volume measurement, 219.34 ± 50.46 ml in the right kidney study group, 191.26 ± 41.27 ml in the control group, 210.38 ml in the left kidney study group, 183.58 ml in the control group, 166.26 ± 29.72 ml in the right kidney study group, 143.23 ± 26.58 ml in the control group, 162.43 ± 47.07 ml in the left kidney study group, 144.14 ± 24.44 ml in the control group. In volume ellipsoid volume measurement, 189.41 ml in the right kidney of male subjects in the study group, 166.55 ml in the control group, 193.48 ml in the left kidney study group, 170.82 ml in the control group, 150.72 ± 28.91 ml in the right kidney of female subjects in the study group, 132.26 ± 29.64 ml in the control group, 158.08 ± 53.74 ml in the left kidney study group, 138.08 ± 27.75 ml in the control group. In our study, kidney volume was determined for all groups using three different volume measurement methods. In these three volume calculations, we found that the volume Itk-Snap measurement was close to the measurements in the literature. It was determined that the kidney volume measurements in the literature were close to each other and sometimes different. Safak *et al*. (2005), found the relationship of normal standards of kidney size with gender and body composition in 712 healthy children. It was found that the length of the right kidney was shorter than the left kidney. In Duygun & Çıkmaz study (2020), a statistically meaningful dissimilarity was determined in terms of sinus renalis volume and kidney thickness among morphological and volumetric values of the right and left kidney. Konus¸ *et al*. (1998), found an important difference though the longitudinal dimensions of the right and left kidneys. In our study, we concluded that the left kidney was longer than the right kidney in right and left kidney lengths. In the Fritz *et al*. (2003), study, the left kidney was found to be larger than the right kidney. However, no significant dissimilarity was observed though left and right kidney volumes. In our study, we found that the left kidney was longer than the right kidney, and unlike this study, we concluded that there was a difference though the volumes of the right and left kidneys.

In our study, we found a statistically significant difference ($p<0.05$) in the measurements of BESAU, VCBEUM in the right kidney of male individuals, BEIMDU, BESAU, BEIAU, VCBEUM in the left kidney of male individuals, VCBEUM in the right kidney of female individuals, and VCBEUM in the left kidney of female individuals. There was no statistically meaningful dissimilarity though the groups in other measurements.

CONCLUSION AND RECOMMENDATIONS

Kidney stone disease can severely affect an individual's quality of life and lead to potentially serious complications. Therefore, the treatment of kidney stone patients should be carefully managed. In this study, we examined the morphometric measurements of individuals with and without kidney stones using computed tomography images. The results show that kidney stones have an effect on kidney morphometry and volume measurements. The study aims to contribute to the diagnosis and treatment of kidney stone disease. The data obtained in this study reveal that gender and the presence of kidney stones have significant and significant effects on renal morphometric measurements. The fact that the kidney volumes of male participants were significantly higher than those of female participants suggests that gender plays an important role on kidney structure. In the light of these findings, since kidney stones increase kidney volumes in men, this should be taken into account in diagnosis and treatment processes. A better understanding of the differences in renal morphometric measurements due to gender and renal side differences may contribute to the development of individualized medical approaches. Therefore, studies on renal volume and morphometry, taking into account the presence of gender and renal side (right/left), will help to plan the diagnosis, treatment and follow-up processes of patients more effectively. According to the results, significant differences were found in some morphometric measurements between individuals with and without kidney stones. For example, statistically meaningful differences were observed in volume measurements on the volume values of kidney stones. In addition, differences were also found in kidney volume according to the presence or absence of stones. We think that the morphometric data obtained will be useful in clinical practice in the process of evaluating kidney stone patients and formulating treatment plans. In conclusion, this study evaluated the effect of kidney stone disease on morphometric measurements and showed some differences. However, the clinical significance of these findings and their impact on treatment require further research. The findings of this study may be considered in the management of kidney stone disease and in determining treatment approaches. In patients with kidney stones, it is important to evaluate the morphometric characteristics of the stone in detail and to formulate treatment plans according to these characteristics.

In future studies, these findings should be confirmed and generalized with the results of studies with larger sample groups. Such studies may help to effectively manage kidney stone disease and improve the quality of life of patients.

Limitations

This study has some limitations. First, the size of the sample group used in the data collection process is limited, which limits our ability to generalize. The use of larger and more diverse sample groups may increase the applicability of the results to a wider population. This research was conducted only on individuals in a specific time period and in a specific geographical area. Therefore, it should be noted that the results may differ over time and in different geographical regions. The retrospective design of the study should be taken into consideration. A prospective and long-term follow-up study may help us to better understand the clinical significance of the findings and their impact on treatment. Despite these limitations, we believe that the findings make an important contribution. Future studies are needed to obtain more comprehensive and definitive results taking these limitations into account.

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DEMIREL, E.; UZUN, G. B.; AKÇIÇEK, M.; ÇIÇEK, I. B.; ARPACI, M. F. & PEKMEZ, H. Investigación del efecto de los cálculos renales sobre la morfometría y el volumen renal. *Int. J. Morphol., 44(2)*:xxx-xxx, 2026.

RESUMEN: Los cálculos renales son una de las enfermedades del sistema urinario más antiguas y comunes conocidas a lo largo de la historia. Hoy en día, representan un problema de salud creciente a nivel mundial. Las mediciones de las características anatómicas de los riñones, como el volumen, la longitud, el ancho y el grosor, son de gran importancia para el diagnóstico y el tratamiento de la litiasis renal. El objetivo de este estudio fue analizar las mediciones morfométricas mediante imágenes de tomografía computarizada (TC) de individuos con y sin cálculos renales, y así proporcionar información para el diagnóstico y el tratamiento de esta enfermedad. Nuestro estudio se realizó en el Departamento de Radiología del Hospital Universitario de Formación e Investigación Malatya Turgut Özal, y se obtuvo la autorización del Comité de Ética número 2023/33. Las mediciones se realizaron mediante TC abdominal sin contraste (CT2). Se examinaron 80 personas con cálculos renales y 40 sin ellos; 60 mujeres y 60 hombres. El análisis estadístico de los datos se realizó con el programa SPSS. Se observó un aumento estadísticamente significativo en los valores del ancho VCBEUM de las mediciones morfométricas del riñón derecho tanto en las mujeres del grupo de pacientes como en las del grupo control ($p<0,05$). Al comparar las mediciones del volumen del riñón derecho entre los hombres del grupo de pacientes y del grupo control, se observó un aumento estadísticamente significativo en las mediciones de volumen Itk-Snap y volumen elipsoidal ($p<0,05$). En conclusión, nuestro estudio proporciona información sobre las mediciones morfométricas y volumétricas de los riñones de personas con y sin cálculos renales. Estos hallazgos contribuyen a la literatura existente sobre la litiasis renal y aportan información valiosa para futuras investigaciones y la práctica clínica en el diagnóstico y tratamiento de esta enfermedad.

PALABRAS CLAVE: Riñón; Cálculo renal; Morfometría renal; Volumen renal.

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