IOSR Journal Of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 13, Issue 2 Ser. I (Mar. – Apr. 2021), PP 07-10
www.Iosrjournals.Org

Classification of Ultrasound Kidney disease using Texture Analysis

Abdulrahman M. B. Arbab[*1], Ashraf M. M. Osman [2],M. E. M. Gar-Elnabi[1]
[1]Sudan University of Science and Technology. College of Medical Radiologic Science,P.O.Box 1908, Khartoum, Sudan
2 Alzaytona Specialized Hospital, Alsayed Abdelrahman Street, Khartoum, Sudan
Corresponding Author : Abdulrahman Arbab

Abstract:
Theaim of this study to classify the ultrasound kidney disease using texture analysis image processing among adults' patients. The data of this study was collected from 200 adults' patients both gender suffering from renal disorders and referred to ultrasound department in east coast kalba hospital – Sharjah province United Arab Emirates in period from December 2017 up to July 2018.
comparing of mean between classification function for normal, hypertensive, mild hypertensive and diabetic patients. And the mean value of each class was difference according the measurements. For normal class was higher at MLRtKD,PSVRtKD and ATLtKD measurements. For HT class was higher at BMI, CLLtKDN, MLLtKD and ATRtKD measurements. FOR MHT calss the measurements were higher at WLtKD, DLtKID, EDVRtKD and PSVLtKD. For DM class the measurements that it was dominant at was LRtKD, DRtKD and EDVLtKD measurements.
Scatter plot generated using discriminate analysis function for four classes represents of normal, hypertensive, mild hypertensive and diabetic patients, were the classification showed that the kidney disorder was classified well from the rest of the tissuesalthough it has characteristics mostly similar to surrounding tissue.
classification score matrix generated by linear discriminate analysis and the overall classificationaccuracy of renal disorders95.4%, were the classification accuracy of normal 98.6%, HT 94%,and MHT 93.8%, While the DM showed a classification accuracy of 92.9%.
Key wards: *Ultrasound, Kidney disease***,** *image processing, Classification function*

Date of Submission: 21-02-2021 Date of Acceptance: 05-03-2021

I. Introduction:

Ultrasonography is a non-invasive and inexpensive investigation modality with sufficientanatomical details necessary to diagnose renal diseases without exposing the patient toradiation or contrast and hence has replaced standard radiography in our country andabroad [1-3]. All these factors promote early detection and prediction of deranged renalfunction tests necessary for making a therapeutic decision.Sonography identifies renal length, thickness, and echogenicity of renal parenchyma apartfrom its importance in detailing a dilated collecting system [4]. These details assist inidentifying the extent of renal parenchymal damage and the possibility of its reversibility [5,6],and the decision to perform a renal biopsy [7]9]. According to a study, abnormal sonographicfindings were seen in 67% of cases of CKD [8].

Renal length estimation by ultrasound is an importantparameter in clinical evaluation of adult patient's kidney disease and healthy adult donors [9,10] and has replacedradiography as the common standard. Ultrasound is a useful,accessible, non-invasive, inexpensive method to reliablymeasure renal size[11].Some renal diseases can change the morphologicalcharacteristics of the kidney seen by ultrasound. Renal sizecan also be a decisive factor for performing renal biopsy oravoiding immunosuppressive therapy [10]. Estimating renal sizeby ultrasound can be done by measuring the length, totalvolume or cortical thickness. The most accuratemeasurement of renal size is the total renal volume, which iscorrelated with height, weight and total body area. Renal morphology can be determined by a number of means that include measuring renallength and volume and renal cortical thickness. Renal function can also be evaluated throughrenal length and cortical thickness, and important clinical decisions can be made on its basis.

Therefore, serial sonographic evaluations are done to find out the progression of renal disease orits normality [12]. Although renal parenchymal volume is quite an accurate measurement inpatients with end stage renal disease, measurement of renal longitudinal length is sufficient innormal patients [13].

The increasing prevalence of CKD is closely tied to the increase of at-risk populations withdiabetes, hypertension, and prediabetes. Indeed, diabetes is the leading cause of CKD and a globalhealth emergency, with

425 million individuals affected worldwide in 2017 and a projected 629million individuals affected by 2045 [14-16]. Hypertension is the second most frequent cause of CKD,affecting nearly one-third of US adults and 1.13 billion people globally in 2015 [17,18]. The estimatedpopulation size for prediabetes was 78.5 million among adults in the United States between 2011 and2014, and nearly one-tenth have been reported with CKD [19]. Even so, awareness of CKD and its majorrisk factors remains strikingly low among health care professionals and patients alike [20-22]. So, the aim of this study to classify the ultrasound kidney disease using texture analysis image processing among adults' patients.

II. Methodology:

The data of this study was collected from 200 adults' patients both gender suffering from renal disorders and referred to ultrasound department in east coast kalba hospital – Sharjah province United Arab Emirates in period from December 2017 up to July 2018.

Tools and equipment's: Ultrasound system general electric GE. Transducer: highest frequency curved linear array probe possible , start with 5 MHZ and work down to 2 or 3 MHZ for larger patients with color and doppler capabilities. A high sweep speed will improve accuracy of the measurements taken to the spectral trace.The patients variables were age, gender, kidney volume and resistance index of the right and left kidneys.

Scanning Technique:

the patient should be lie supine, for the right kidney have the patient lie supine and place the probe in the right lower intercostal space in the mid axillary line. And the liver as your acoustic window and aim the probe slightly posteriorly toward the kidney. Gently rock the probe up and down or side to side to scan the interior kidney. Obtain longitudinal (long axis) and transverse (short axis) views.

For the left kidney the patient has lie supine or in the right lateral decubiti position, place the prob in the lower intercostal space on the posterior axial line. The placement will be more cephement and posterior than when visualizing right kidney, and again rock the probe to scan the entire kidney to obtain longitudinal and transverse view.

Assessing the arteries within the kidney parenchyma to assess any alteration in the waveforms. The RI should be low resistance. The acceleration time (AT) should be < 70 msec. the probe is slowly moved superior and inferior to search for additional renal arteries. Any vessels identified must be traced to the kidney and confirm their identity. The kidneys will be atrophy with chronic renal failure and the length should be <9 cm, the RI > 0.8 cm for untreatable medical renal disease.

III. Results:

Table 1. shows the classification function that differentiates between normal, hypertensive,mild hypertensive and diabetic patients:

Classification Function Coefficients					
	qClasses				
	Normal	HT	MHT	DM	
BMI	1.383	1.947	1.702	1.946	HT
LRtKD	1.976	1.951	1.744	1.999	DM
DRtKD	1.320	1.040	1.304	1.328	DM
WLtKD	2.227	1.976	2.339	2.205	MHT
DLtKID	1.970	1.667	2.215	1.978	MHT
MLRtKD	0.431	0.091	0.422	0-.061	Normal
CLLtKDN	3.402	3.949	3.837	3.862	HT
MLLtKD	1.369	1.841	1.425	1.527	HT
PSVRtKD	.263	.149	.135	.181	N
EDVRtKD	-.106	-.030	-.208	-.152	MHT
ATRtKD	-.103	.005	-.139	-.036	HT
PSVLtKD	.143	.128	.202	.168	MHT
EDVLtKD	.498	.504	.592	.838	DM
ATLtKD	-.152	-.058	-.069	-.119	N

(Constant)	-316.045	-306.301	-325.353	-346.694	
Fisher's linear discriminant functions					

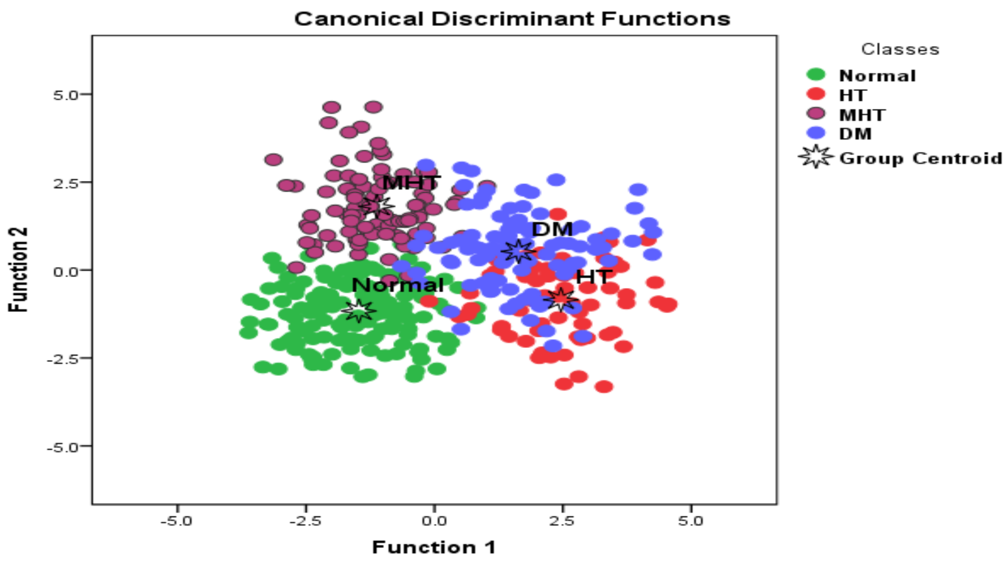

Fig .1 Scatter plot generated using discriminate analysis function for four classes represents: Normal, hypertensive, mild hypertensive and diabetic patients

Table 2. Showed the classification accuracy of the Predicted Group Membership for the four classes using linear discriminant analysis

Classes		Predicted Group Membership				Total
		Normal	HT	MHT	DM	
%	Normal	98.6	.7	0.0	.7	100.0
	HT	4.5	94.0	0.0	1.5	100.0
	MHT	6.2	0.0	93.8	0.0	100.0
	DM	4.1	2.0	1.0	92.9	100.0
95.4% of original grouped cases correctly classified.						

IV. Discussion:

Table 1. show compare of mean between classification function for normal, hypertensive, mild hypertensive and diabetic patients. And the mean value of each class was difference according the measurements. For normal class was higher at MLRtKD, PSVRtKD and ATLtKD measurements. For HT class was higher at BMI, CLLtKDN, MLLtKD and ATRtKD measurements. FOR MHT calss the measurements was higher at WLtKD, DLtKID, EDVRtKD and PSVLtKD. For DM class the measurements that it was dominant at was LRtKD, DRtKD and EDVLtKD measurements.

Scatter plot generated using discriminate analysis function for four classes represents of normal, hypertensive, mild hypertensive and diabetic patients, were the classification showed that the kidney disorder was classified well from the rest of the tissuesalthough it has characteristics mostly similar to surrounding tissue. fig .1

Table 1. show classification score matrix generated by linear discriminate analysis and the overall classificationaccuracy of renal disorders95.4%, were the classification accuracy of normal 98.6%, HT 94%,and MHT 93.8%, While the DM showed a classification accuracy of 92.9%.

V. Conclusion:

The aim of this study to classify the ultrasound kidney disease using texture analysis image processing among adults' patients. comparing of mean between classification function for normal, hypertensive, mild hypertensive and diabetic patients. And the mean value of each class was difference according the measurements. For normal class was higher at MLRtKD, PSVRtKD and ATLtKD measurements. For HT class was higher at BMI, CLLtKDN, MLLtKD and ATRtKD measurements. FOR MHT calss the measurements were higher at WLtKD, DLtKID, EDVRtKD and PSVLtKD. For DM class the measurements that it was dominant at was LRtKD, DRtKD and EDVLtKD measurements.

Scatter plot generated using discriminate analysis function for four classes represents of normal, hypertensive, mild hypertensive and diabetic patients, were the classification showed that the kidney disorder was classified well from the rest of the tissuesalthough it has characteristics mostly similar to surrounding tissue.

classification score matrix generated by linear discriminate analysis and the overall classificationaccuracy of renal disorders95.4%, were the classification accuracy of normal 98.6%, HT 94%,and MHT 93.8%, While the DM showed a classification accuracy of 92.9%.

References:

[1]. Insana MF, Hall TJ, Fishback JL: Identifying acoustic scattering sources in normal renalparenchyma from the anisotropy in acoustic properties. Ultrasound Med Biol. 1991, 17:613-26. 10.1016/0301-5629(91)90032-R

[2]. Rafique M: Value of routine renal and abdominal ultrasonography in patients undergoingprostatectomy. Int Urol Nephrol. 2006, 38:153-6. 10.1007/s11255-005-3830-0

[3]. Rosansky SJ: Renal function trajectory is more important than chronic kidney disease stage formanaging patients with chronic kidney disease. Am J Nephrol. 2012, 36:1-0.10.1159/000339327

[4]. Maoujoud O, Ahid S, Cherrah Y: The cost-utility of treating anemia with continuouserythropoietin receptor activator or epoetin versus routine blood transfusions among chronichemodialysis patients. Int J Nephrol Renovasc Dis. 2016, 2016:35-43. 10.2147/IJNRD.S96027

[5]. Rosenfield AT, Siegel NJ: Renal parenchymal disease: histopathologic-sonographiccorrelation. Am J Roentgenol. 1981, 137:793-8. 10.2214/ajr.137.4.793

[6]. Rosenfield AT, Taylor KJ, Crade M, DeGraaf CS: Anatomy and pathology of the kidney by grayscale ultrasound. Radiology. 1978, 128:737-44. 10.1148/128.3.737

[7]. Levey AS, Becker C, Inker LA: Glomerular filtration rate and albuminuria for detection andstaging of acute and chronic kidney disease in adults: a systematic review. JAMA. 2015,313:837-46. 10.1001/jama.2015.0602

[8]. Päivänsalo M, Huttunen K, Suramo I: Ultrasonographic findings in renal parenchymaldiseases. Scand J Urol Nephrol. 1985, 19:119-23. 10.3109/00365598509180238

[9]. Yong Kang K, Joon Lee Y, Chul Park S, Woo Yang C, Soo Kim Y,Sung Moom I, et al. A comparative study of methods of estimatingkidney length in kidney transplantation donors. Nephrol DialTransplant 2007;22(8):2322-7.

[10]. Ablett MJ, Coulthard A, Lee RE, et al. How reliable are ultrasoundmeasurements of renal length in adults? Br J Radiol 1995;68:1087-9.

[11]. Gavela T, Sánchez Bayle M, Gómez Mardones G, Gallego S,Martínez-Pérez J, Moya MT. Ecographic study of kidney size inchildren. Nefrologia 2006;26(3):325-9.

[12]. Cheong B, Muthupillai R, Rubin MF, Flamm SD: Normal values for renal length and volume asmeasured by magnetic resonance imaging. Clin J Am Soc Nephrol. 2007, 2:38-45.10.2215/CJN.00930306

[13]. Mazzotta L, Sarteschi LM, Carlini A, Antonelli A: Comparison of renal ultrasonographic andfunctional biometry in healthy patients and in patients with chronic renal failure. [Article inItalian] . Arch Ital UrolAndrol. 2002, 74:206-9.

[14]. International Diabetes Federation. IDF Diabetes Atlas.https://www.diabetesatlas.org/en/. Accessed November

[15]. 13, 2019.

[16]. Alicic RZ, Rooney MT, Tuttle KR. Diabetic kidney disease: challenges, progress, and possibilities.Clin J Am SocNephrol. 2017;12(12):2032-2045.doi:10.2215/CJN.11491116

[17]. Thomas MC, Cooper ME, Zimmet P. Changing epidemiology of type 2 diabetes mellitus and associated chronickidney disease.Nat Rev Nephrol. 2016;12(2):73-81. doi:10.1038/nrneph.2015.173

[18]. Fryar CD, Ostchega Y, Hales CM, Zhang G, Kruszon-Moran D. Hypertension prevalence and control among

[19]. adults: United States, 2015-2016.NCHS Data Brief. 2017-2016;2017(289):1-8.

[20]. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in blood pressure from 1975 to 2015: a pooled

[21]. analysis of 1479 population-based measurement studies with 19.1 million participants.Lancet. 2017;389

[22]. (10064):37-55. doi:10.1016/S0140-6736(16)31919-5

[23]. Ali MK, Bullard KM, Saydah S, Imperatore G, Gregg EW. Cardiovascular and renal burdens of prediabetes in theUSA: analysis of data from serial cross-sectional surveys, 1988-2014.Lancet Diabetes Endocrinol. 2018;6(5):392-403. doi:10.1016/S2213-8587(18)30027-5

[24]. Dharmarajan SH, Bragg-Gresham JL, Morgenstern H, et al; US Centers for Disease Control and Prevention CKDSurveillance System. State-level awareness of chronic kidney disease in the US.Am J Prev Med. 2017;53(3):

[25]. 300-307. doi:10.1016/j.amepre.2017.02.015

[26]. Tuot DS, Diamantidis CJ, Corbett CF, et al. The last mile: translational research to improve CKD outcomes.ClinJ Am Soc Nephrol. 2014;9(10):1802-1805. doi:10.2215/CJN.04310514

[27]. Boulware LE, Troll MU, Jaar BG, Myers DI, Powe NR. Identification and referral of patients with progressive

[28]. CKD: a national study.Am J Kidney Dis. 2006;48(2):192-204. doi:10.1053/j.ajkd.2006.04.073

Abdulrahman Arbab, et. al. "Classification of Ultrasound Kidney disease using Texture Analysis." *IOSR Journal of Applied Physics (IOSR-JAP)*, 13(2), 2021, pp. 07-10.