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Correlation of Acoustic Radiation Force Impulse Imaging with Chronicity Markers in Native Renal Biopsy

Articoli originali

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ABSTRACT

Introduction. Acoustic Radiation Force Impulse (ARFI) is an ultrasound parameter which has shown promise in assessing liver stiffness, but there are limited data on the correlation of ARFI with chronicity markers in renal biopsies.

Objectives.

1. Determine ARFI values in ultrasound and correlate with chronicity markers in renal biopsy
2. Determine whether ARFI can be used as a non-invasive chronicity predictor compared to renal length, Resistive Index (RI), and cortical thickness.

Patients and Methods. Two hundred and fifty patients were enrolled in the study. The ultrasound variables ARFI, renal length, RI, and cortical thickness values were assessed by the radiologist prior to renal biopsy. The biopsy slides were graded as per the Mayo Clinic consensus report scoring system by an experienced pathologist.

Results. Among 250 study participants, 167 were males and 83 were females. IgA nephropathy was the most common pathology (n=47;19%), followed by diabetic nephropathy (n=42;17%), membranous nephropathy (n=35;14%), FSGS (n=27;11%), and MCD (n=19; 8%). The mean eGFR was 55.9 ± 42.12 ml/min/1.73 m^2. The average renal length was 10.086 ± 1.01 cm. The average cortical thickness was 0.707 ± 0.134 cm. Resistive index was 0.68 ± 0.09. Acoustic radiation force impulse had weak negative correlation (r=-0.286; p=0.0001) with total pathological score and weak positive correlation with eGFR (r=0.279; p=0.0001). RI was a better indicator for histologically evaluated chronicity with positive correlation coefficient (r=0.416; p=0.0005) compared to renal length, cortical thickness, and ARFI.

Conclusion. ARFI didn't corelate with the pathological score in renal biopsies. RI had better predictive value for chronicity in native renal biopsies.

KEYWORDS: ARFI, Resistive index, Cortical thickness, Renal length, Chronicity

Introduction

Chronic Kidney Disease (CKD) is a vexing global health issue, with its reported prevalence in India ranging from 1% to 13% [1]. Renal biopsy is considered the gold standard to assess the extent of glomerulosclerosis, interstitial fibrosis, tubular atrophy, and vascular sclerosis which influence the progression of CKD [1]. In low- to middle-income countries, biopsy assessment and the technical prowess for kidney biopsy are not easily accessible. Acoustic Radiation Force Impulse Imaging (ARFI) is a unique ultrasound technique which superimposes data involving tissue elasticity onto ultrasound-produced greyscale images. It has been found to be highly useful in assessing liver, breast, prostate, and thyroid pathologies [2, 3]. ARFI uses short-duration, brief focused acoustic pulses along the main ultrasound beam to induce tissue shear stress, which is dependent on tissue attenuation, acoustic beam intensity, and acoustic frequency [2]. These shear stresses are converted into shear waves whose speed is directly proportional to the density and elasticity of the tissue [2]. ARFI has been used previously in chronicity evaluation in kidney biopsy samples [2]. The majority of the studies [3] state that ARFI doesn't correlate with renal histological fibrosis, but a single study [2] mentions that ARFI correlates with histological renal fibrosis in chronic kidney disease with a sensitivity of 86% and specificity of 82%. Resistive index (RI) has been previously reported to correlate well with glomerulosclerosis, vascular sclerosis, and interstitial fibrosis in renal biopsies [4]. Renal length and cortical thickness have proved to be sensitive parameters for predicting chronicity and progression in chronic kidney disease and had a good correlation with estimated glomerular filtration rate (eGFR) [5, 6]. There is a paucity of South Asian data on the correlation of ARFI with chronicity markers in renal biopsies irrespective of aetiology and hence this study was designed to mitigate this research gap.

Objectives

1. Determine ARFI values in ultrasound and correlate with chronicity markers in renal biopsy.
2. Determine whether ARFI can be used as a non-invasive chronicity predictor compared to renal length, resistive index, and cortical thickness.

Methodology

This is a prospective observational study conducted at a tertiary care hospital involving 250 participants with written informed consent and ethics approval. All eligible patients undergoing native renal biopsy above 18 years of age who consented to the study were included. The research was done in compliance with relevant national and internal regulations governing human subjects over a period of 2 years. Patients with prior renal transplant, hydronephrosis, cyst, suspected renal artery stenosis, and unwilling participants were excluded. Indications for renal biopsy included nephrotic syndrome, sub-nephrotic proteinuria, unexplained renal failure, active urinary sediments, and rapidly progressive renal failure. All clinical characteristics along with laboratory results were documented on admission. Patients' age, gender along with lab parameters like creatinine, blood urea nitrogen, serum albumin, urine protein estimation by 24-hour urine protein were noted for study purposes. The Modification of Diet in Renal Disease (MDRD) 6 variable equation was used to estimate the estimated glomerular filtration rate (eGFR).

Ultrasound Parameter Assessment

The radiological variables like ARFI, renal length, cortical thickness, and RI were estimated 10 minutes prior to renal biopsy by a single experienced radiologist using a Philips EPIQ 7 ultrasound

machine with a 3 MHz transducer. Only the left kidney was chosen for all our study participants because it was more caudal and superficially positioned, facilitating renal biopsy. Quantitative elastography (ARFI) in unit measuring scale was used to estimate shear wave velocity in the region of interest, which is the lower pole of the renal parenchyma. For measuring shear wave velocity, the renal biopsy position (prone position) was used. ARFI readings were taken by asking patients to hold their breath for 10 seconds and 5 readings were taken at lower pole of the left kidney and ARFI was estimated by software installed in the ultrasound machine as depicted in Figure 1. The average of 5 readings were used for final data using the same protocol. After the ARFI values were obtained, renal length was measured between the topmost edge of upper pole and lowermost edge of lower pole and cortical thickness was measured from cortical peri-renal fat interface and sinus pyramidal apex interface. Renal RI was calculated as peak systolic velocity-end diastolic velocity/Peak systolic velocity at the level of the arcuate arteries near the corticomedullary junction. We used 60 healthy volunteers to establish the normal control value for ARFI before the actual study. Healthy volunteers were defined as individuals without comorbidities such as diabetes mellitus or hypertension. They had structurally normal kidneys on ultrasound, bland urine analysis, and eGFR > 90 ml/min/1.73 m^2 according to the MDRD 6 equation. Healthy volunteers were enrolled from the master health checkup program in our hospital after confirming the above-mentioned conditions and their ARFI values were measured by the same experienced radiologist using the same equipment which is utilised for the test volunteers. The healthy volunteers aged between 18 and 70 years.

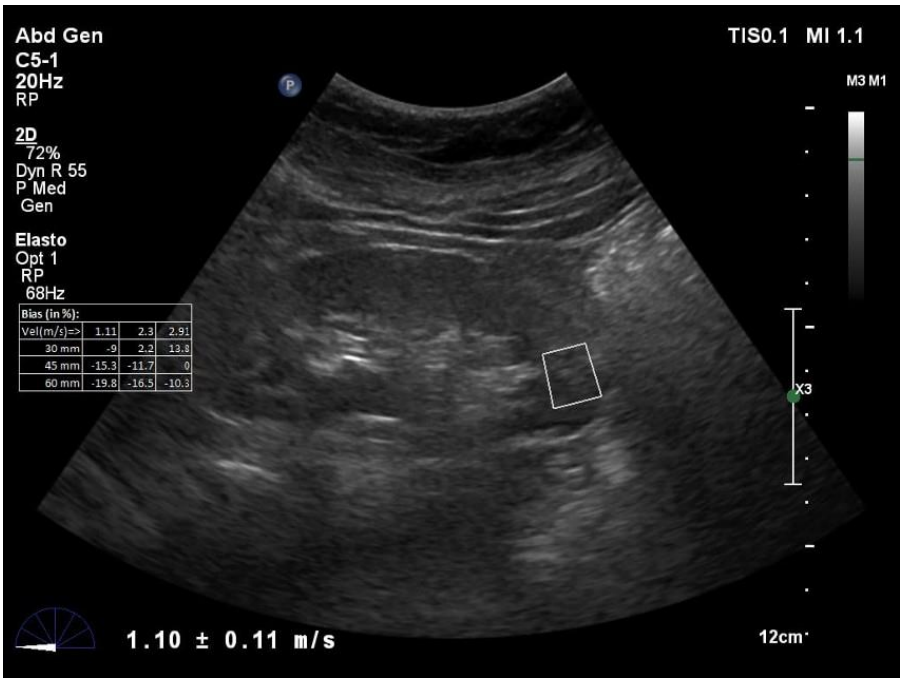

Figure 1: ARFI reading at lower pole of the study participant.

Renal Biopsy Procedure and Processing

Two cores of renal biopsy tissue were taken using an 18 G Bard Biopsy Gun under ultrasound guidance and subjected to light microscopy and immunofluorescence. All biopsies were stained with hematoxylin and eosin, Periodic acid Schiff, Jones methenamine silver, and Masson's Trichrome stain. Immunofluorescent staining involved fluorescein isothiocyanate conjugated polyclonal rabbit anti-human antibodies to IgG, IgM, IgA, C1q, C3, C4, lambda and kappa light chains. All biopsies were interpreted and reported by a single experienced in-house nephropathologist. The biopsy specimen containing less than 10 glomeruli was considered inadequate and not included in this study as per guidelines for renal biopsy adequacy proposed by Agarwal et al. [7]. The pathological classification

and reporting of renal biopsy specimens were based on the recommendations of Mayo clinic Consensus report on Pathological Classification, Diagnosis and reporting of glomerulonephritis proposed by Sethi et al. [8]. The detailed grading system used in this study is outlined in Table 1 and Table 2.

Compartment	Score 0	Score 1	Score 2	Score 3
Interstitial fibrosis	<10%	11-25%	26-50%	>50%
Tubular atrophy	<10%	11-25%	26-50%	>50%
Glomerulosclerosis	<10%	11-25%	26-50%	>50%
Vascular score	Intimal thickness is less than medial thickness	Intimal thickness is greater than medial thickness		

Table 1. Mayo Clinic Consensus Report Scoring System.

Grading	Score
Severe chronic changes	≥8
Moderate chronic changes	5-7
Mild chronic changes	2-4
Minimal chronic changes	0-1

Table 2. Mayo Clinic Consensus Report Grading System.

Statistical analysis

Continuous variables were estimated using mean, standard deviation or median. Continuous variables were evaluated using an independent sample t-test. Mann Whitney U test was used to evaluate non-normally distributed variables. Fishers' test/Chi-square test were used to evaluate categorical variables. Pearson's correlation coefficient was used to indicate association between different variables. Multiple comparison analysis between different groups and across the groups were done using ANOVA. ANOVA was used to determine any significant difference between the means of the groups of data. SPSS version 23.0 was used for data analysis. A p-value < 0.05 was considered significant.

Results

This was a prospective observational study that involved 250 random consenting individuals who underwent native renal biopsy.

Clinical and demographic characteristics

250 patients, all belonging to South Asian ethnicity, volunteered for the study. 38% (n=95) belonged to the age bracket between 46 and 60 years, 32% (n=79) belonged to the age group between 31 and 45 years, followed by 21% (n=54) of the patients in age group between 18 and 30 years. The remaining patients (n=22) were aged greater than 60 years.

Among the 250 patients in the study group, males were 65.2% (n=167) and 34.8% (n=83) were females. The study participants had IgA nephropathy (n=47; 19%) predominantly, diabetic nephropathy (n=42; 17%), Hypertensive Nephrosclerosis (HTN) (n=38, 15%), Membranous nephropathy (n=35; 14%), Minimal Change Disease (MCD) (n=19; 8%) focal segmental glomerulosclerosis (FSGS) (n=27; 11%) and others (15%).

Mean lab values of serum creatinine, albumin, blood urea nitrogen, and 24-hour urine protein of the research participants are provided in Table 3.

eGFR greater than 60 ml/min/m^2 was present in 94 study participants, 36 patients had an eGFR between 46 and 60 ml/min/m^2, 37 patients between 31 and 45 ml/min/m^2, 38 patients between 15 and 30 ml/min/m^2, and 45 patients between 0 and 14 ml/min/m^2.

Lab parameters	Mean values with standard deviation
Serum creatinine	2.40 ± 2.55 milligrams/deciliter
Serum albumin	3.52 ± 0.67 grams/deciliter
Serum blood urea nitrogen	62.06 ± 55.63 milligrams/deciliter
24-hour urine protein	2.62 ± 1.76 grams/day

Table 3. Lab values of study participants.

Renal Length

On ultrasound measurement, renal length greater than 10 cm was present in 128 patients (51.2%), followed by 92 patients (36.8%) with length between 9-10 cm, and finally 30 patients (12%) had length between 8-8.9 cm.

Resistive Index

176 patients (70.4%) had RI between 0.61-0.8, 47 patients (18.8%) with RI between 0 and 0.6 and 27 patients (10.8%) had RI between 0.81 and 1.1.

Cortical Thickness

Cortical thickness of 0.6-0.8 cm was present in 91 participants (76.4%), followed by 31 (12.4%) having 0.9-1 cm cortical thickness and 27 (10.8%) having cortical thickness less than or equal to 0.5 cm, and only 1 patient in the study with cortical thickness greater than 1 cm.

Acoustic Radiation Force Impulse

8 patients had ARFI value between 0 and 0.5 m/sec, 102 study participants had ARFI between 0.51 and 0.8 m/sec, 113 patients had ARFI value between 0.81-1 m/sec and 27 had values greater than 1 m/sec followed by as depicted in Figure 2. The healthy volunteers used for control values were in age bracket of 18-70 years of age. The average age of healthy volunteers was 44.236 ± 12.68 years. The control value of ARFI obtained on healthy volunteers was 1.4933 ± 0.10028 m/sec.

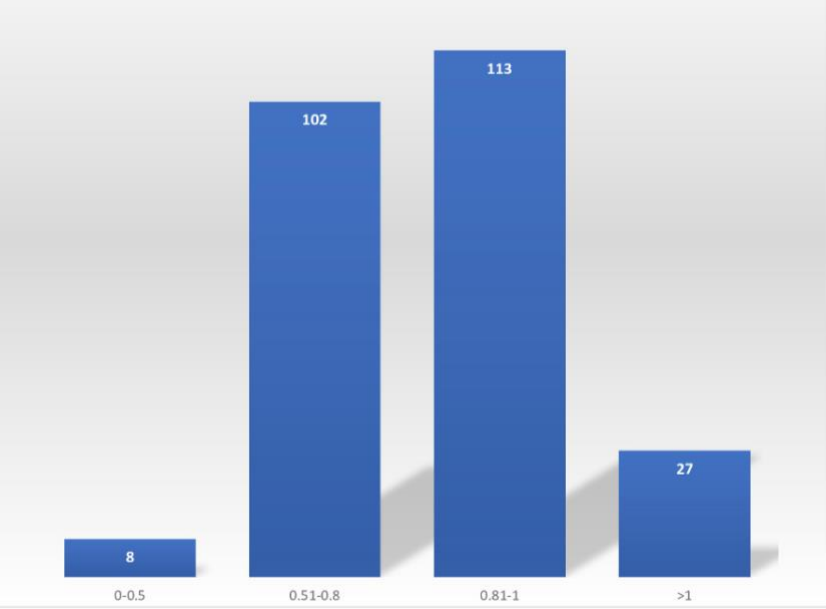

Figure 2. ARFI (m/sec) distribution in the study. *x axis-ARFI groups in m/sec. **y axis- Number of patients in ARFI groups

Depth from skin surface

The study participants were distributed as follows: 64% (n=160) had a depth between 4.1 and 6 cm, 26% (n=65) had a depth between 0 and 4 cm, and 10% (n=25) had a depth greater than 6 cm from the skin surface.

Renal Pathology Findings

The renal pathology was assessed in terms of chronicity by evaluating glomerulosclerosis, interstitial fibrosis, tubular atrophy, and vascular score on the pathology specimens and it was scored as per the recommendations of Consensus grading system [8].

Glomerulosclerosis

In the 250 participants, 41.60% (n=104) had glomerulosclerosis between 10-25%, 36.8% (n=92) had glomerulosclerosis < 10%, 18% (n=40) had glomerulosclerosis between 26-50%, and 5.6% (n=14) had glomerulosclerosis greater than 50%.

Vascular Score

88.8% (n=222) of participants had intimal thickness < medial thickness, and 11.2% (n=28) had intimal thickness greater than medial thickness.

Interstitial Fibrosis

There were 32.8% (n=82) of participants having interstitial fibrosis < 10% on biopsy, 32.4% (n=81) having interstitial fibrosis between 10-25%, 22% (n=55) having interstitial fibrosis between 26-50%, and 12.8% (n=32) having interstitial fibrosis greater than 50%.

Tubular Atrophy

In the study, 39.2% (n=98) of participants had 10-25% tubular atrophy on biopsy and 26% (n=65) had tubular atrophy less than 10%. This is followed by 22% (n=55) having tubular atrophy between 26-50% and 12.8% (n=32) having tubular atrophy greater than 50%.

Chronicity grading in renal biopsy

In the study, mild chronic changes were present in 35.60% (n=89) of patients, minimal chronic changes in 30.4% (n=76), moderate chronic changes in 61 patients (24.4%), and 9.6% (n=24) had severe chronic changes depicted in Figure 3.

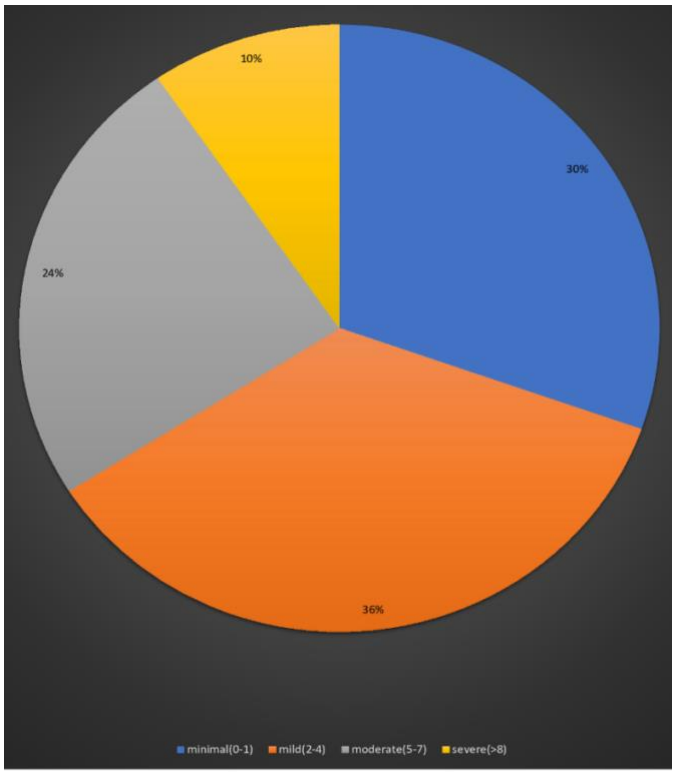

Figure 3. Chronicity Grading of Renal Biopsy on basis of total score.

Correlation of ARFI, resistive index, cortical thickness, and renal length with total pathological score

In the statistical analysis detailed in Table 4, ARFI was found to have weak negative correlation with total pathological score (r = -0.286). Resistive index had a better correlation among the various ultrasound parameters analysed (r = +0.416) albeit weak compared to ARFI, renal length (r = -0.312), and cortical thickness (r = -0.342).

Parameter	R value	p-value
ARFI	-0.286	0.0001
Resistive index	+0.416	0.0005
Cortical thickness	-0.312	0.0001
Renal length	-0.342	0.0001

Table 4. Correlation of ARFI, resistive index, cortical thickness and renal length with pathological score.

Correlation of ARFI, resistive index, cortical thickness and renal length with eGFR

ARFI was found to have weak positive correlation with eGFR, as described in Table 5. Among all the ultrasound parameters assessed, the resistive index had better weak correlation with eGFR (r = -0.412). Cortical thickness didn't have the statistical significance and correlation with eGFR. Renal length had very weak correlation (r = +0.167) with eGFR in this study.

Parameter	R value	p-value
ARFI	+0.279	0.0001
Resistive index	-0.412	0.0005
Cortical thickness	0.131	0.038
Renal length	0.167	0.008

Table 5. Correlations of ARFI, Resistive index, cortical thickness and renal length with eGFR.

Multiple Comparisons Dependent Variable: ARFI Least significant difference				
(I) grade	(J) grade	Mean Difference (I-J)	Std. Error	Sig.
Minimal chronic changes (0-1)	Mild chronic changes (2-4)	0.01152	0.02811	0.682
	Moderate chronic changes (5-7)	0.11730*	0.03094	0.000
	Severe chronic changes (≥8)	0.13333*	0.04214	0.002
Mild chronic changes (2-4)	Minimal chronic changes (0-1)	-0.01152	0.02811	0.682
	Moderate chronic changes (5-7)	0.10578*	0.02991	0.000
	Severe chronic changes (≥8)	0.12182*	0.04139	0.004
Moderate chronic changes (5-7)	Minimal chronic changes (0-1)	-0.11730*	0.03094	0.000
	Mild chronic changes (2-4)	-0.10578*	0.02991	0.000
	Severe chronic changes (≥8)	0.01604	0.04336	0.712
Severe chronic changes (>=8)	Minimal chronic changes (0-1)	-0.13333*	0.04214	0.002
	Mild chronic changes (2-4)	-0.12182*	0.04139	0.004
	Moderate chronic changes (5-7)	-0.01604	0.04336	0.712

Table 6. Performance of ARFI in between chronicity groups.

Performance of ARFI in between chronicity groups

ARFI couldn't differentiate between minimal and mild groups of chronicity scoring and also couldn't differentiate between moderate and severe chronicity groups on inter-group analysis as depicted in Table 6. However, ARFI values were higher in minimal chronic changes group compared to moderate chronic changes group. Mean ARFI values in different chronicity groups are mentioned in Table 7. A similar trend was noticed in minimal, moderate chronic changes compared to severe chronic changes group.

Chronicity groups	Number of patients	Mean ARFI (m/sec)	Std. Deviation
Minimal chronic changes (0-1)	76	0.885	0.18263
Mild chronic changes (2-4)	89	0.8735	0.1624
Moderate chronic changes (5-7)	61	0.7677	0.20374
Severe chronic changes (≥8)	24	0.7517	0.16857
Total	250	0.8395	0.1872

Table 7. Mean ARFI values in different chronicity groups.

Performance of ARFI in different grades of interstitial fibrosis and tubular atrophy

ARFI scores decrease as the grades of interstitial fibrosis increase in the renal biopsy specimen, as depicted in Table 8. ARFI couldn't differentiate between renal biopsies showing < 10% tubular atrophy and those with 10-25% tubular atrophy. Similarly, it couldn't distinguish between 26-50% tubular atrophy and >50 % tubular atrophy, as described in Table 9.

Descriptive statistics ARFI with interstitial fibrosis						
	N	Mean ARFI	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
<10%	65	0.8937	0.18363	0.02278	0.8482	0.9392
10-25%	98	0.8612	0.16891	0.01706	0.8274	0.8951
26-50%	55	0.7915	0.19645	0.02649	0.7383	0.8446
>50%	32	0.7453	0.18565	0.03282	0.6784	0.8122
Total	250	0.8395	0.18720	0.01184	0.8162	0.8628

Table 8. Trends of ARFI values with different grades of interstitial fibrosis.

Multiple Comparisons Dependent Variable: ARFI Tubular atrophy						
(I) tubular	(J) tubular	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
<10%	10-25%	0.03247	0.02899	0.264	-0.0246	0.0896
	26-50%	0.10224*	0.0332	0.002	0.0368	0.1676
	>50%	0.14838*	0.03913	0	0.0713	0.2255
10-25%	<10%	-0.03247	0.02899	0.264	-0.0896	0.0246
	26-50%	0.06977*	0.03053	0.023	0.0096	0.1299
	>50%	0.11591*	0.0369	0.002	0.0432	0.1886
26-50%	<10%	-0.10224*	0.0332	0.002	-0.1676	-0.0368
	10-25%	-0.06977*	0.03053	0.023	-0.1299	-0.0096
	>50%	0.04614	0.04029	0.253	-0.0332	0.1255
>50%	<10%	-0.14838*	0.03913	0	-0.2255	-0.0713
	10-25%	-0.11591*	0.0369	0.002	-0.1886	-0.0432
	26-50%	-0.04614	0.04029	0.253	-0.1255	0.0332

Table 9. Multiple comparisons between ARFI and tubular atrophy.

Discussion

This a prospective observational study of 250 patients who underwent ultrasound-guided left-sided renal biopsy from September 2017 to April 2019. It represents the largest reported South Asian population study compared to previous studies conducted by Wang et al. [9] and Guo et al. [10], which had 45 and 64 patients respectively. The merit of this work lies in the South Asian ethnic

diversity of the study population. We used 60 healthy volunteers to obtain the normal ARFI control value, adding scientific merit and novelty compared to previous studies [9, 10].

In our study, 65.2% (n=167) of participants were males, while 34.8% (n=83) were female, and the mean age was 43.192 ± 13.7008 years. The higher proportion of males in our research aligns with the hospital outpatient statistics and is consistent with a previous study [9].

The pathological grading in our research follows a standardized protocol as per the Consensus Report on Pathologic Classification, Diagnosis, and Reporting of GN [8]. This study stands out as one of the large-scale studies that adopted a standardized protocol for grading chronicity, irrespective of the acute and chronic aetiology warranting renal biopsy. The previous studies [9, 10] didn't employ standardized pathological guidelines for evaluating chronicity in renal biopsy, lacking a reliable scoring system – which is instead one of the merits of our study. This scoring system solely focused on the chronicity markers like glomerulosclerosis, interstitial fibrosis, tubular atrophy, and vascular sclerosis in renal biopsy, thereby obviating the need to classify the renal aetiology as acute or chronic and enabling smooth comparison with ultrasound variables.

This study comprised both acute, chronic, and proteinuric renal diseases. The predominant pathology observed on renal biopsy was IgA nephropathy (19%, n=47), followed by diabetic nephropathy (17%, n=42). The previous study [9] similarly showed the presence of IgA nephropathy (n=31), followed by membranous nephropathy (n=4). The cases of diabetic nephropathy enrolled in our study had some atypical presentations like rapid progression of azotaemia not explained by the natural clinical course of diabetes and microhaematuria which warranted renal biopsy in our study participants. The predominance of IgA nephropathy in our renal biopsies signifies the burden of IgA nephropathy as a predominant primary glomerular disease in South Asian population.

The average renal length in our study is 10.086 ± 1.01 cm. The average eGFR was 55.9 ± 42.12 ml/min/1.73 m^2 in our patient population. Resistive index in our study ranged from 0.68 ± 0.09. These findings were quite similar to earlier research [11], which had resistive index of 0.69 ± 0.10, and average renal length of 9.8 ± 1.1 cm. However, in contrast to the previous study [11], the resistive index had weak albeit significant correlation with eGFR in our study. Resistive index is an integrated ultrasound variable signifying arterial compliance, pulsatility, and peripheral resistance, which is predictive of vascular stiffness and sclerosis contributing to hypertension and CKD progression [12].

Splendiani et al. [13] demonstrated that RI > 0.70 was predictor of dismal renal prognosis. Their study showed that RI had excellent correlation with eGFR decline, with significant p-value ($p < 0.0001$). This contrasts with our findings, as RI and eGFR weakly correlated in our study. Previous research [14, 15] concluded that renal RI and eGFR had significant correlation, which contrasts our research findings, where we demonstrated a weak correlation of RI with eGFR.

The average cortical thickness was 0.707 ± 0.134 cm in our study. An earlier seminal study [16] evaluated the impact of ultrasound parameters with renal histology and studied the correlation of parameters like renal length, parenchymal thickness, cortical echogenicity on the chronicity observed in renal histopathology. His study [16] concluded that renal length was a good indicator for chronicity in renal biopsy. Our research showed a very weak agreement of renal length with total pathological score (r=-0.342) which contrasted with the previous study [16]. Renal length is susceptible to interobserver variation and is dependent on the pathology contributing to acute and chronic dysfunction thereby contributing to its unreliability in predicting chronicity [5, 17].

ARFI and the total pathological score had a weak negative correlation (r= -0.286; p=0.0001). It couldn't differentiate between minimal and mild group of chronicity scoring and also couldn't differentiate between moderate and severe chronicity group. It couldn't differentiate between renal

biopsies showing < 10% tubular atrophy and 10-25% tubular atrophy. Similarly, it couldn't distinguish between 26-50% tubular atrophy and >50 tubular atrophy groups on intergroup analysis. Our study findings were in partial agreement with the earlier study [9] which showed no correlation between ARFI and renal histopathological changes suggestive of fibrosis, and contrasted findings of Goya et al. [18]. ARFI didn't correlate strongly with eGFR in our study, which was dissimilar to findings of Asano K et al. [19]. This disparity in findings may be due to predominant diabetic patients in the previous studies [18, 19] thereby raising the possibility of influence of chronic pathology like diabetes mellitus on ARFI readings.

It was found that resistive index was better in predicting interstitial fibrosis and tubular atrophy and chronicity compared to cortical thickness, ARFI and renal length when chronicity score was used as a fixed variable in regression analysis. Resistive index correlated better with chronicity score among the ultrasound variables measured in our research protocol. On analysis using eGFR as a fixed variable, resistive index outperformed ARFI in correlating better with eGFR. These findings were discordant with the previous studies done by Cui G et al. [20] and Hu Q et al. [21].

ARFI is influenced by age and depth and they are considered independent variables influencing ARFI readings [22] which were not analysed in our study. But our study was an honest attempt to uniformly stratify chronicity into multiple groups irrespective of the acute or chronic aetiology emphasising that loss of kidney function, and progression to CKD is influenced by the chronicity markers like glomerulosclerosis, vascular sclerosis, interstitial fibrosis, and tubular atrophy [23].

Conclusion

ARFI imaging doesn't correlate with chronicity markers and total pathological score in renal biopsies and is not beneficial in differentiating various groups of chronicity in renal biopsies. Resistive index had better predictive value for chronicity in native renal biopsies compared to ARFI, renal length, and cortical thickness.

Merits of this research

The merits of this study include it being the largest study done in Southern Asia comparing ARFI with chronicity in renal biopsies with a standardized pathological grading system. This study uniformly stratifies chronicity by using total pathological score independent of acute and chronic aetiology for renal biopsy which is the novelty of this research.

Limitations

The limitation of this research includes non-analysis of factors affecting ARFI values including depth, age, and renal blood flow. We didn't evaluate the variation of ARFI with respect to poles and different regions of the same kidney. Our findings were restricted to the biopsied left kidney of the study participants, and we didn't analyse variations of ARFI values in the right kidney. Our study didn't analyse the effect of acute or chronic aetiology for renal dysfunction on ARFI values.

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