Original Article

# Diagnostic Performance of Renal Shear Wave Elastography in Chronic Kidney Disease: A Case-Control Study from a Tertiary Care Radiology Centre

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## Abstract

**Background:** Chronic kidney disease (CKD) is characterized by progressive renal fibrosis leading to irreversible loss of renal function. For assessing fibrosis, renal biopsy is the gold standard, but it is invasive and associated with complications. Shear wave elastography (SWE) is a non-invasive ultrasound technique that quantifies tissue stiffness and helps predict renal fibrosis. The objective is to evaluate renal cortical stiffness using SWE in patients with CKD and evaluate its diagnostic accuracy compared with controls. **Material and Methods:** A hospital–based case–control study conducted in the Department of Radiodiagnosis at Government Mohan Kumaramangalam Medical College over 12 months. SWE followed conventional renal ultrasound. Laboratory parameters, including serum creatinine and estimated glomerular filtration rate (eGFR), were recorded. Receiver operating characteristic (ROC) analysis was performed to determine the diagnostic accuracy of SWE. **Results:** The mean renal cortical stiffness in CKD patients was 13.4 ± 2.8 kPa, significantly higher than in controls (7.0 ± 1.9 kPa , p <0.001). ROC analysis demonstrated an optimal cutoff value of 9.5 kPa, yielding a sensitivity of 87.1% and a specificity of 82.9%. Renal stiffness showed a positive correlation with serum creatinine (r = 0.61, p <0.001) and a negative correlation with eGFR (r = −0.65, p <0.001). **Conclusion:** Good accuracy of renal SWE in detecting renal fibrosis of CKD and correlation with renal functional parameters. It may serve as a valuable non-invasive technique for assessing renal fibrosis.

**Keywords:** Renal Elastography, Shear Wave Elastography (SWE), Renal Fibrosis, Ultrasound, Chronic Kidney Disease (CKD).

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## Introduction

Chronic kidney disease (CKD) represents a major global health challenge affecting nearly 10–13% of the adult population worldwide.[1] The disease is characterized by progressive deterioration of renal function and structural changes within the renal parenchyma. Irrespective of the underlying etiology, renal fibrosis is the final common pathway leading to end-stage renal disease.[2]

Early identification of renal fibrosis is important because it allows timely intervention to slow disease progression. Currently, renal biopsy is considered the gold standard for assessing fibrosis; however, it is invasive and carries potential complications, including bleeding, infection, and sampling error.[3] There is increasing interest in developing reliable non-invasive techniques for assessing renal parenchymal changes.

Ultrasound elastography is an emerging imaging modality that measures tissue stiffness by evaluating the propagation of shear waves through tissues.[4] Increased tissue stiffness often corresponds to fibrosis or structural changes. Elastography has been widely validated for assessing liver fibrosis and has shown promising results in other organs, including the thyroid, breast, and prostate.[5]

More recently, shear wave elastography (SWE) has been investigated for evaluating renal parenchymal stiffness. Several studies have reported higher stiffness values in CKD patients than in healthy individuals, suggesting that SWE may reflect underlying fibrotic changes in the kidney.[6,7] Furthermore, elastography measurements have been shown to correlate with renal function parameters such as serum creatinine and estimated glomerular filtration rate (eGFR).[8]

Despite these promising findings, the clinical utility of renal elastography remains under investigation, and additional studies are required to establish its diagnostic accuracy. The present study was conducted to evaluate renal cortical stiffness using SWE in patients with CKD and to determine its diagnostic performance in differentiating diseased kidneys from normal kidneys.

## Materials and Methods

**Study Design and Setting:** This hospital-based case–control study was conducted in the Department of Radiodiagnosis at the

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government Mohan Kumaramangalam Medical College over 12 months.

**Sample Size:** Sample size was calculated based on the expected sensitivity of 85% reported in previous studies [6]. Using a 95% confidence interval and a precision of 8%, the minimum required sample size was estimated at 67 patients. To improve statistical power, 70 CKD patients and 70 controls were included.

**Study Population:** Participants were divided into two groups, Cases-Patients diagnosed with CKD & Controls-patients attending the Master Health checkup with normal renal function

**Inclusion Criteria**

**Cases:** Age more than 18 year & Diagnosed CKD (eGFR <60 ml/min/1.73 m² for >3 months)

**Controls:** Normal renal function tests. No history of renal disease

**Exclusion Criteria:** Renal tumors or cystic kidney disease, Renal transplantation, Acute kidney injury, Pregnancy, Poor acoustic window

**Ultrasound and Elastography Technique:** Ultrasound examinations were performed using a high-resolution ultrasound GE Logiq P9 system equipped with shear wave elastography and a 3-5 MHz convex transducer. The procedure consisted of two steps: 1) Conventional ultrasound evaluation for Renal length, Cortical echogenicity, & Corticomedullary differentiation & 2) Shear wave elastography, in which participants were examined in the supine or lateral decubitus position. A region of interest was placed in the renal cortex, avoiding large vessels and the collecting system. For each kidney, three measurements were obtained, & Mean stiffness value (kPa) was calculated.

**Laboratory Investigations:** Serum creatinine, Blood urea & estimated glomerular filtration rate (eGFR)

The study protocol was reviewed and approved by the hospital's Institutional Ethics Committee.

**Statistical Analysis:** Data analysis was performed using SPSS version 25.

Independent Student's t-test for group comparison, Pearson correlation for association analysis, and Receiver Operating Characteristic (ROC) curve for diagnostic performance. p-value <0.05 was considered statistically significant.

## Results

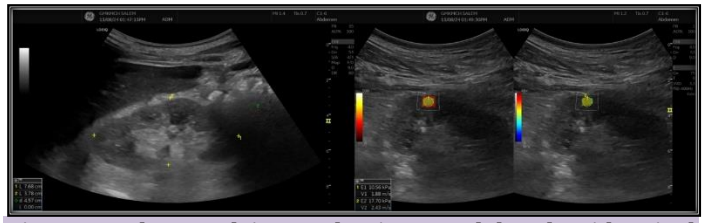

**Figure 1: Ultrasound image showing Renal length with raised cortical echoes and shear wave Elastography assessment in cortex.**

**Table 1: Demographic Characteristics**

| Variable | CKD Patients (n=70) | Controls (n=70) | p value |
|---|---|---|---|
| Mean age (years) | 52.4 ± 13.2 | 49.7 ± 11.8 | 0.21 |
| Male | 44 (62.9%) | 40 (57.1%) | 0.49 |
| Female | 26 (37.1%) | 30 (42.9%) | 0.49 |

No significant demographic difference was observed between groups.

**Table 2: Laboratory Parameters**

| Parameter | CKD | Controls | p value |
|---|---|---|---|
| Serum creatinine (mg/dL) | 3.1 ± 1.4 | 0.9 ± 0.2 | <0.001 |
| eGFR (ml/min) | 38.6 ± 12.7 | 96.4 ± 15.2 | <0.001 |

CKD patients showed significantly impaired renal function.

**Table 3: Renal Elastography Values**

| Parameter | CKD Patients | Controls | p value |
|---|---|---|---|
| Renal cortical stiffness (kPa) | 13.4 ± 2.8 | 7.0 ± 1.9 | <0.001 |

Renal stiffness was significantly higher in CKD patients.

**Table 4: Diagnostic Performance of SWE**

| Parameter | Value |
|---|---|
| Cutoff value | 9.5 kPa |
| Sensitivity | 87.1% |
| Specificity | 82.9% |
| Positive predictive value | 83.6% |
| Negative predictive value | 86.5% |
| Overall accuracy | 85.0% |
| Area under ROC curve | 0.89 |

**Table 5: Correlation Analysis**

| Parameter | Correlation coefficient (r) | p value |
|---|---|---|
| Serum creatinine vs stiffness | +0.61 | <0.001 |
| eGFR vs stiffness | −0.65 | <0.001 |

## Discussion

The present study demonstrated that renal cortical stiffness, as measured by shear-wave elastography, was significantly higher in patients with CKD than in healthy individuals. The observed mean stiffness value of 13.4 kPa in CKD patients was nearly twice that measured in controls, suggesting increased renal parenchymal rigidity associated with fibrosis. Our findings are consistent with those reported by Samir et al., who observed significantly elevated renal stiffness in CKD patients compared with normal individuals.[6]

Similarly, Jiang et al. reported that SWE could accurately differentiate CKD patients from healthy subjects.[7]

The ROC analysis in our study showed an AUC of 0.89, indicating excellent diagnostic performance. Using a cutoff value of 9.5 kPa, the sensitivity and specificity were 87.1% and 82.9%, respectively. These findings are comparable to previous studies, which reported sensitivity values ranging from 80% to 92% and specificity values between 75% and 90% for detecting renal fibrosis using elastography.[8,9]

In our study, there is a significant correlation between renal stiffness and renal function parameters. Renal stiffness showed a positive correlation with serum creatinine and a negative correlation with eGFR, suggesting that increased stiffness reflects worsening renal function. Similar findings were reported in previous studies evaluating elastography in CKD patients.[6,8]

Although elastography offers several advantages, including non-invasive assessment and real-time measurement, certain limitations, such as difficulty in measuring obese patients, exist. The absence of histopathological confirmation in our study limits the direct correlation of stiffness values with the degree of renal fibrosis.

The results of the present study show that SWE may serve as a useful technique for evaluating renal parenchymal changes.

**Limitations:** A single-centre study and a lack of histopathological correlation were the limitations of this study.

## Conclusion

Renal shear wave elastography demonstrated significantly increased cortical stiffness in patients with chronic kidney disease compared with controls without renal disease. SWE demonstrated high diagnostic accuracy, with sensitivity and specificity of 100%. SWE may be a useful non-invasive imaging tool for assessing renal fibrosis and monitoring CKD progression.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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