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Research Article

HEPATORENAL SYNDROME IN DECOMPENSATED CIRRHOSIS USING DUPLEX SCAN OF RENAL VESSELS

Dr. Sonali Chaturvedi[1*], Dr. R Karthikeyan[2], Dr.R.Murali[3]

[1*]3rd year, Department of Medical Gastroenterology GMKMCH, Salem Tamil Nadu
[2]Associate Professor, Department of Medical Gastroenterology GMKMCH, Salem Tamil Nadu
3Associate Professor, Department of Medical Gastroenterology GMKMCH, Salem Tamil Nadu

Corresponding author: Dr. Sonali Chaturvedi
DM 3rd year, Department of Medical Gastroenterology GMKMCH, Salem Tamil Nadu
Present/permanent address: 95 D, 2nd Floor, 5th cross mayor Nagar, Peramanur, Salem, Tamil Nadu, India, 6360067

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ABSTRACT

Introduction and Objectives: Hepatorenal syndrome (HRS) is a functional renal failure frequently occurring in patients with decompensated cirrhosis, characterized by severe renal vasoconstriction and poor prognosis. Traditional renal function tests are often unreliable in cirrhotic patients, highlighting the need for non-invasive diagnostic methods.To evaluate the role of renal Duplex Doppler ultrasonography, particularly the renal resistive index (RI), in the early detection and prediction of HRS in patients with decompensated cirrhosis.

Materials and Methods: This cross-sectional study included 100 patients with decompensated cirrhosis admitted to a tertiary care hospital in south India, between December 2023 and November 2024. Clinical examinations, laboratory investigations, abdominal and renal Duplex ultrasounds were performed. Correlations between Duplex parameters, clinical scores (MELD, Child-Pugh), and HRS development were analysed.

Results: Higher RI values, especially at the renal hilum (RI-H), were significantly associated with HRS, advanced Child-Pugh classes, and higher MELD scores. RI-H was an independent predictor of HRS (OR = 95.2, p = 0.0017). However, ROC analysis showed that RI-H alone had low sensitivity (37.8%) despite moderate specificity (76.2%), limiting its diagnostic power.

Conclusion: Renal Duplex ultrasound is a simple, non-invasive tool that can aid in the early detection of renal hemodynamic disturbances and predict HRS in decompensated cirrhosis. Early identification of at-risk patients may help improve clinical outcomes, though RI should be interpreted alongside clinical and laboratory parameters.

Keywords: Hepatorenal syndrome (HRS), decompensated cirrhosis, renal duplex ultrasound, renal resistive index (RI).

INTRODUCTION

Hepatorenal syndrome (HRS) is a functional form of acute kidney injury (AKI) that is frequently seen in patients with advanced liver disease, particularly cirrhosis. HRS is characterized by severe renal vasoconstriction, leading to a reduced glomerular filtration rate (GFR) and the retention of sodium and water. Peripheral vasodilation in liver disease triggers the activation of various hormonal and neurohormonal vasoconstrictors, which further contribute to the reduction of renal blood flow. Despite these changes, renal imaging and histology often appear normal, complicating the diagnosis of HRS. The progression of AKI in these patients signals a poor prognosis, with high mortality risk. Traditional renal function tests, particularly serum creatinine, can be unreliable in liver disease due to decreased creatinine production, malnutrition, aging, and muscle loss, which result in falsely low GFR estimates. [1,2]

Cirrhosis is a leading cause of morbidity and mortality worldwide. As cirrhosis progresses from compensated to decompensated stages, complications such as ascites, spontaneous bacterial peritonitis, variceal bleeding, and HRS further decrease survival. The incidence of HRS ranges from 7% to 45%, with mortality rates around 60%, even with treatment. [3] HRS is classified into HRS-AKI (acute kidney injury) and HRS-CKD (chronic kidney disease), with HRS-AKI accounting for approximately 11% of AKI cases in hospitalized cirrhotic patients, especially those with refractory ascites. [4,5] Hepatorenal syndrome typically occurs due to reduced renal perfusion and glomerular filtration, making it a “functional” form of renal failure, and it is the most common cause of azotemia in cirrhotic patients. [6] In HRS, renal histology is generally normal or shows minimal changes, complicating its diagnosis and early detection. [7]

Recent advances in non-invasive imaging techniques, such as Duplex Doppler ultrasonography, have improved our understanding of renal function in cirrhotic patients. Duplex Doppler is a reliable method to assess renal blood flow and arterial resistance. The renal resistive index (RI), which is measured at the arcuate or interlobar arteries, reflects vascular resistance and is typically elevated in cirrhotic patients with HRS. Notably, the RI can be elevated even in non-azotemic cirrhotic patients, making it a promising early marker of renal dysfunction. Studies have shown that the RI correlates with the severity of renal impairment and may assist in detecting functional renal impairment before biochemical changes, such as increases in serum creatinine, become evident. [8, 9]As renal dysfunction contributes significantly to mortality in decompensated cirrhosis, early detection and intervention are crucial. The combination of Duplex scan findings, including the RI, with traditional diagnostic approaches offers a potential strategy for improving the management and outcomes of patients with HRS in cirrhosis. [10, 11]In our study, we conducted an analysis of the renal resistive index using Duplex Doppler ultrasonography to evaluate its role in the early detection and prognosis of HRS in patients with decompensated cirrhosis.

MATERIALS AND METHODS

This study was designed as a cross-sectional study to evaluate the role of renal duplex ultrasonography in the early detection and prediction of hepatorenal syndrome (HRS) in patients with decompensated cirrhosis. The study was conducted at the Department of

Medical Gastroenterology, GMK Medical College & Hospital, Salem, from December 2023 to November 2024. A total of 100 patients aged 18 to 60 years, diagnosed with decompensated cirrhosis of the liver, were selected for the study. These patients were admitted to the Medical Gastroenterology department, with inclusion regardless of the underlying cause of cirrhosis (such as ethanol, HBV, HCV, etc.). Exclusion criteria included pregnancy, diabetes mellitus, glomerulonephritis, hypertension, chronic kidney disease (CKD), or any other renal conditions that could interfere with the diagnosis of hepatorenal syndrome. Ethical approval for this study was obtained from the Institutional Ethical Committee of GMK Medical College & Hospital.

Data were collected from the patients through clinical examination and laboratory investigations. A detailed history and clinical examination were performed, including vital signs and signs of hepatic decompensation. Laboratory tests such as complete blood count (CBC), liver function tests (LFT), renal function tests (RFT), and coagulation profile (PT/INR) were carried out. Imaging studies, including abdominal ultrasound and renal duplex ultrasound, were performed. The abdominal ultrasound was used to assess the presence of ascites, focal lesions, and liver size, while the renal duplex ultrasound was used to evaluate renal blood flow, renal artery resistance, and the renal-aortic ratio (RAR).

During the study, all patients were followed up until discharge.The data collected were analyzed using descriptive statistics, including means, standard deviations (SD), and ranges for continuous variables, and frequencies and percentages for categorical variables. A chi-square test was used for comparing categorical variables, and unpaired t-tests were performed for continuous variables. Spearman's rank correlation test was used to examine relationships between continuous variables.

RESULTS

The present study investigated Hepatorenal Syndrome (HRS) in patients with decompensated cirrhosis using various clinical, biochemical, and ultrasonographic parameters. Table 1 shows that the average age of the patients was 59.72 ± 8.1 years, with a gender distribution of 54% male and 46% female. The clinical and kidney function results in Table 2 indicated that the median MELD score was 19 (IQR = 7), reflecting moderate liver dysfunction. The median serum creatinine was 1.28 mg/dl (IQR = 0.85**)**, and the median eGFRwas 56.01 ml/min/1.73m² (IQR = 44.8)**,** suggesting moderate renal impairment in the cohort. Table 3 presents ultrasonographic features, showing that 12% of patients had Portal Vein Thrombosis (PVT)**,** 46% had marked ascites, and 34% exhibited ascitic echoes. The echogenicity was noted in 18% of the patients, and focal lesions were found in 16%, with 80% having combined focal lesions. The correlation analysis in Table 4 revealed that the MELD **s**core had a strong positive correlation with HRS **(**r = 0.605, p < 0.0001**)**, and both serum creatinine **(**r = 0.8, p < 0.0001**)** and urea **(**r = 0.62, p < 0.0001**)** were significantly correlated with HRS. Conversely,eGFR **(**r = -0.756, p < 0.0001**)** andCr clearance **(**r = -0.755, p < 0.0001**)** showed negative correlations with HRS, indicating worsening kidney function with the development of HRS. In Table 5**,** regression analysis identified the MELD score as a significant predictor for HRS **(**odds ratio = 1.38, p < 0.0001), with Renal Index (RI) also emerging as an important predictor, specifically the RI (H) **(**odds ratio = 95.2, p = 0.0017**).**Table 6 showed that 50% of patients experienced variceal bleeding**,** 44% had hepatic encephalopathy**,** and 34% experienced HRS and Spontaneous Bacterial Peritonitis (SBP)**.** Finally, Figure 1 presents the ROC curve for the Renal Artery Resistive Index (RAV_H)**,** showing a poor diagnostic

performance with an AUC of 0.53**,** sensitivity of 37.8%**,** and specificity of 76.2%**.** The cut-off value for RAV_H was >1.26, indicating that while it can help rule out HRS, its low sensitivity limits its effectiveness as a diagnostic marker. Overall, these results highlight the importance of clinical scores like MELD and renal function parameters in predicting HRS, with ultrasonographic markers like RIcontributing to the diagnostic assessment but requiring further investigation due to their limited sensitivity.

Table 1: Age and Gender Distribution among Patients

Age	**59.72±8.1**
Gender	
Male	54 (54%)
Female	46 (46%)

Table 2: Clinical Scores and Kidney Function Tests

Variable	**Median**	**IQR**
Child Score	10	2
MELD	19	7
Serum Creatinine (mg/dl)	1.28	0.85
Blood Urea (mg/dl)	57.9	50.5
Serum Na (mEq/l)	136	11
Serum K (mEq/l)	4	1
eGFR (ml/min/1.73m²)	56.01	44.8
Cr Clearance (ml/min)	58.76	37.13

Table 3: Complications among Patients

Complication	**Number of Patients**	**Percentage (%)**
Variceal Bleeding	25	50%
Hepatic Encephalopathy	22	44%
Spontaneous Bacterial Peritonitis (SBP)	17	34%
Hepatorenal Syndrome (HRS)	17	34%
Hepatocellular Carcinoma (HCC)	10	20%

Table 4: Ultrasonographic Features of the Patients

Feature	**Number**	**Percent (%)**
PVT (Portal Vein Thrombosis)		
No	88	88%
Yes	12	12%
Ascites		
No	4	4%
Mild	6	6%
Moderate	6	6%
Severe	34	34%
Marked	46	46%
Ascites Echoes		

No	66	66%
Yes	34	34%
Echogenicity		
No	82	82%
Yes	18	18%
Number of Focal Lesions		
0	80	80%
1	16	16%
3	4	4%

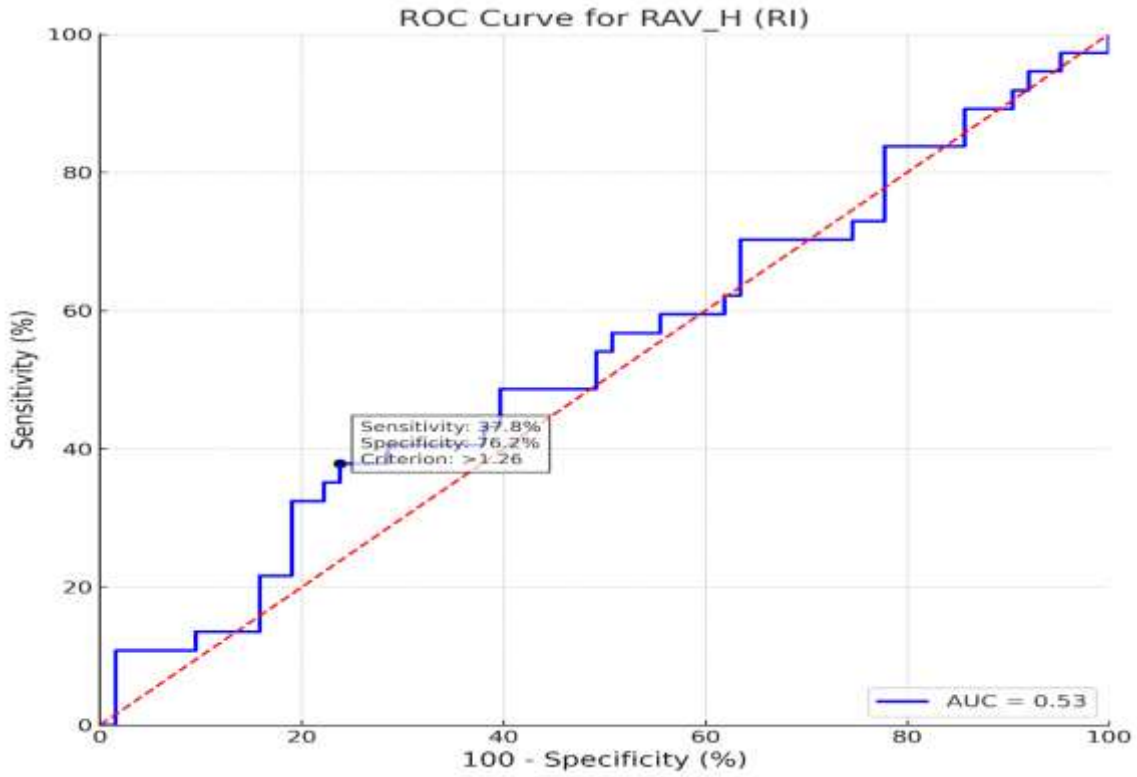
Table 5: Correlation of Hepatorenal Syndrome and Patients' Variables

HRS	Correlation Coefficient	p-value
MELD	0.605	<0.0001
HCC	0.274	0.054
Focal Lesions	0.269	0.059
CREAT (mg/dl)	0.8	<0.0001
UREA (mg/dl)	0.62	<0.0001
eGFR (ml/min/1.73m²)	-0.756	<0.0001
Cr Clearance (ml/min)	-0.755	<0.0001
PO4 (mg/dl)	0.368	0.001
Mg (mg/dl)	0.48	0.001
UA (mg/dl)	0.422	0.002
PVT	0.385	0.006
K Long D (mm)	-0.474	0.001
K Volume (mm)	-0.537	<0.0001

Table 6: Regression Analysis for Hepatorenal Syndrome

HRS	Coefficient	Odds Ratio	95% CI	p-value
MELD	0.328	1.38	1.14–1.7	<0.001
PSV (O) cm/s	-0.018	0.934	0.95–1.01	0.229
PSV (H) cm/s	-0.0005	0.99	0.97–1.06	0.6234
RI (H)	18.37	95.2	49–181	0.002
RI (Interlobar)	-8.8	0.000	0–0.04	0.001
RI (H) Multivariable	58.8	35.4		0.0337

Figure 1: The receiver operating characteristic (ROC) curve analysis for RAV_H (Renal Artery Resistive Index) demonstrated a poor diagnostic performance in predicting hepatorenal syndrome (HRS).



DISCUSSION

The present study focused on Hepatorenal Syndrome (HRS) in patients with decompensated cirrhosis, assessed using Duplex scan of renal vessels. The study population had a mean age of 59.72 ± 8.1 years, which is consistent with the study by Anil Kumar and Lovely Kaushal (2019)[8], where the mean age of the cirrhosis cohort was between 51-60 years.

The presence of ascites and hepatic encephalopathy (HE) was also noted in our study. 46% of patients had marked ascites, with 34% developing HRS. This aligns with Mohamad SherifMogaweret al. (2021) [14], where 46% of patients had ascites, and 12% developed HRS. Furthermore, hepatic encephalopathy was prevalent in 22% of patients in the study by K. Senthil et al. (2023) [12], which also noted a significant association with HRS in those with elevated RI.

In the present study, the MELD score had a strong correlation with HRS ($r = 0.605$, $p < 0.0001$), which aligns with K. Senthil et al. (2023) [12], where the MELD score showed a significant correlation with the development of HRS and RI. Similarly, in the study by Yasser M Fouad et al. (2009)[13], RI was higher in patients with hepatorenal syndrome (HRS) than in patients with diuretic responsive ascites and compensated cirrhosis. In our study, serum creatinine was also strongly correlated with HRS ($r = 0.8$, $p < 0.0001$), suggesting impaired renal function in patients with HRS, similar to the findings of Yasser M Fouad et al. (2009)[13], where creatinine clearance was significantly lower in HRS patients.

Ultrasonographic features, such as Portal Vein Thrombosis (PVT), were present in 12% of the cohort, similar to findings by Mohamad SherifMogaweret al. (2021)[14], where PVT was seen in 6 patients (12%). The study by Anil Kumar and Lovely Kaushal (2019)[8] also reported a significant association between renal resistive index (RI) and the severity of liver disease, with patients exhibiting higher RI values as the disease progressed. This was echoed in our study, where the Renal Artery Resistive Index (RI) showed significant positive correlations with HRS, particularly at the hilum (RI-H) ($p = 0.0017$). Additionally, the regression analysis demonstrated RI-H as an independent predictor for HRS (odds ratio = 95.2, $p = 0.0017$), reinforcing findings from K. Senthil et al. (2023)[12], where RI showed a strong positive correlation with MELD scores and was an independent predictor for HRS.

The ROC curve analysis (Figure 1) revealed that RAV_H had a low sensitivity (37.8%) and moderate specificity (76.2%) in predicting HRS, similar to Yasser M Fouad et al. (2009)[13], where RI showed poor diagnostic performance in predicting hepatorenal syndrome but could help identify patients without it. The AUC of 0.53 for RAV_H in our study aligns with Anil Kumar and Lovely Kaushal (2019)[8], where the predictive value of RI increased with disease severity, demonstrating moderate predictive ability.

Finally, Prabhakar et al. (2025)[15] observed a strong correlation between renal resistive index (RI) and hepatorenal syndrome in cirrhotic patients, echoing our findings that RI can serve as an indicator for HRS but should be used in conjunction with other diagnostic tools, particularly in severe cirrhosis cases where RI values were significantly elevated.This study underscores the value of clinical scores, renal function tests, and ultrasonographic parameters like RI in diagnosing HRS in decompensated cirrhosis. However, RAV_H showed limited diagnostic accuracy and must be interpreted with caution, as corroborated by previous studies.

CONCLUSION

In our study, renal Duplex ultrasound proved to be a useful, simple, and non-invasive method for early detection of renal hemodynamic changes in liver cirrhosis patients. We found that higher renal resistive index (RI) values were significantly associated with the presence of hepatorenal syndrome (HRS), higher MELD scores, and advanced Child-Pugh classes. RI at the renal hilum (RI-H) was an independent predictor of HRS. Early identification of patients at risk through Duplex ultrasound can help guide timely interventions and improve clinical outcomes.

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REFERENCES

1. Sasso R, AbouYassine A, Deeb L. Predictors of development of hepatorenal syndrome in hospitalized cirrhotic patients with acute kidney injury. J Clin Med. 2021; 10(19):5621.
2. Surya H, Kumar R, Priyadarshi RN, Surya Prakash S, Kumar S. Renal resistive index measurements by ultrasound in patients with liver cirrhosis: magnitude and associations with renal dysfunction. World J Radiol. 2024; 16(6):221-231.
3. Badura K, Frąk W, Hajdys J, Majchrowicz G, Młynarska E, Rysz J, Franczyk B. Hepatorenal syndrome—novel insights into diagnostics and treatment. Int J Mol Sci. 2023; 24:17469.
4. Amin AA, Alabsawy EI, Jalan R, Davenport A. Epidemiology, pathophysiology, and management of hepatorenal syndrome. SeminNephrol. 2019; 39(1):17-30.
5. Pandey S, Dhande RP, Mishra GV. Doppler profiles of renal and hepatic hemodynamics in patients with cirrhosis of the liver. J DattaMeghe Inst Med SciUniv 2022; 17:751-6.
6. Villanueva Bendek I. Hepatorenal syndrome: UpToDate. Rev ColombNefrol. 2014; 1(2):115-126.
7. Mindikoglu AL, Pappas SC. New developments in hepatorenal syndrome. ClinGastroenterolHepatol. 2018; 16(2):162-177.
8. Kumar A, Kaushal L. Renal Doppler indices in chronic liver disease and its role in predicting hepatorenal syndrome. Int J Sci Stud. 2019; 7(7):74-82.
9. Yau ZS, Sidi M, Garba I, Lawal Y, Suwaid MA. Renal Doppler velocimetric indices among adult seropositive viral hepatitis patients attending tertiary care facility in Kano state, Nigeria. Niger J Basic Clin Sci 2024; 21:33-7.
10. Angeli P, Merkel C. Pathogenesis and management of hepatorenal syndrome in patients with cirrhosis. J Hepatol. 2008; 48(Suppl 1):S93-S103.
11. Raisinghani J, Anuradha J, Kapoor SL. Review of literature: Renal abnormalities in liver disease. Int J Health Sci. 2022; 6(S2):7971-7984.
12. Senthil K, Manikandan V, Saravana Madhav S, Sathish SS. Renal resistive index as early diagnostic indicator of hepatorenal syndrome in decompensated liver disease. Int J Acad Med Pharm. 2023; 5(6):937-941.
13. Fouad YM, Mokarrab H, Elgebaly AF, El Amin H, Abdel Raheem EM, Sharawy MA, Shatat ME. Renal duplex doppler ultrasound in patients with HCV related liver cirrhosis. Trop Gastroenterol. 2009; 30(4):213-218.
14. Mogawer MS, Nassef SA, AbdElhamid SM, Elkholy S, Abd El Aziz NE, Al-Jarhi UM, Abdellatif AA. Role of renal duplex ultrasonography in evaluation of hepatorenal syndrome. Egypt Liver J. 2021; 11:34.
15. K P, AN A, Reddy SY. Renal resistive index as a prognostic indicator in patients with hepatic cirrhosis: An analytical cross-sectional study. Cureus. 2025; 17(4): e82700.