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# COMPARISON OF SERUM CREATININE VERSUS RENAL RESISTIVE INDEX IN DIAGNOSIS OF ACUTE KIDNEY INJURY IN PATIENTS OF SEPSIS

Medicine

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## ABSTRACT

Acute kidney injury (AKI) is a common disorder in high-risk patients, such as those with sepsis and trauma, and has an associated mortality of 20% to 50%.Sepsis-associated acute kidney injury is a common complication in hospitalized and critically ill patients, which increases the risk of developing chronic comorbidities and is associated with extremely high mortality.Many biomarkers such as serum cystatin C , neutrophil gelatinase-associated lipocalin, urinary kidney injury molecule and so on are potentially useful to predict AKI in critical care. However, most of these biomarkers have not been widely used in clinical practice, and the detection is time-consuming and cannot be performed at any time. Recently, the following new index have been proposed to early predict the occurrence of AKI: Doppler-based renal arterial resistive index (RRI).
The aim of this prospective study is to compare RRI and Serum Creatinine as an early biomarker of acute kidney injury in patient with sepsis. We have taken the sample of 80 patient for this study. RRI and serum creatinine were measured on day 1,3,5,7and 9. Out of 80 patients, 56 patients subsequently developed AKI. Our study shows that patients had raised RRI value earlier than serum creatinine. There is significant difference in mean values of RRI ( 0.70 ±0.07 )vs creatinine (1.15 ±0.4 mg/dL) on day 1 with p value <0.0001 and mean values of RRI(0.73 ±0.08) and serum creatinine 1.17 ±0.6 mg/dLon day 3 with p value <0.0001 . Increase in mean values of RRI on day 1 (0.70) and day 3 (0.73) are higher than mean value of serum creatinine on day 1(1.15) and day 3(1.17) which shows that RRI rises earlier than serum creatinine. RRI is found to be a better marker for early detection of AKI .

## KEYWORDS

Renal resistive index,Acute kidney injury,Sepsis

## INTRODUCTION

Acute Kidney Injury (AKI) is a serious and commonly encountered condition in modern clinical practice, especially among patients in critical care or those with preexisting health vulnerabilities. It is frequently observed in individuals suffering from severe infections, major trauma, or undergoing complex surgical procedures. AKI is characterized by a rapid decline in kidney function, impairing the body's ability to filter waste, maintain fluid and electrolyte balance, and regulate acid base homeostasis. The onset of AKI can occur within hours or days and is typically identified through changes in serum creatinine levels, reduced urine output, and other biochemical markers.

Despite medical advancements, Acute Kidney Injury (AKI)—particularly when associated with sepsis—continues to significantly impact patient outcomes in critical care settings. Current diagnostic methods, primarily based on serum creatinine and urine output, often fail to identify the condition at its earliest stages, delaying treatment and increasing the risk of complications. Therefore, there is an urgent need for more reliable, real-time, and non-invasive diagnostic tools to detect AKI early, especially in septic patients. The study aims to evaluate whether the Renal Resistive Index (RRI), measured through Doppler ultrasonography, offers superior sensitivity and timeliness compared to traditional markers like serum creatinine in the early detection of AKI in septic patients.Sepsis triggers a widespread inflammatory and immune response that can compromise kidney function even before clinical symptoms become apparent. This unpredictability makes early diagnosis difficult but essential for improving outcomes.Biomarkers such as serum cystatin C, neutrophil gelatinase-associated lipocalin, and urinary kidney injury molecule-1 have shown promise in predicting AKI but are limited by cost, availability, and turnaround time. In contrast, the Renal Resistive Index (RRI), assessed through Doppler ultrasound, is a non invasive, real-time tool that reflects changes in renal vascular resistance. Studies have demonstrated RRI's potential in identifying early hemodynamic shifts before overt kidney damage occurs, making it a compelling candidate for early AKI detection.

## AIM:

Aim of this study is to compare the role of serum creatinine and renal resistive index in diagnosis of acute kidney injury in patients of sepsis.

## OBJECTIVES:

To assess renal resistive index as a predictor of acute kidney injury in patients with sepsis.

To study the measurement of Doppler-based renal arterial RI in critically ill patients with sepsis.

To evaluate the cut-off value of renal arterial RI for development of AKI in patients with sepsis.

## METHODS

### Inclusion Criteria

Age ⩾18 years
Admission to the Intensive Care Unit (ICU)
Diagnosis consistent with clinical criteria for sepsis
Hemodynamic stability at the time of enrollment
Provision of written informed consent by the patient or their legal attendant

### Exclusion Criteria

Declined participation or did not provide informed consent
Anticipated ICU stay of less than 24 hours
Pre-existing renal conditions that may have impacted renal vascular resistance (e.g., unilateral kidney, renal stone disease, chronic renal failure, or renal artery stenosis)

Use of nephrotoxic drugs or administration of contrast material during the study period.

Patients having grade 2 & above hypertension, diabetic nephropathy.

### Ethical Considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee of SN Medical College, Agra

All participants or their legal representatives provided written informed consent.Confidentiality of patient data was maintained throughout the study.

Data were compiled and analysed using appropriate statistical software (e.g., SPSS). Descriptive statistics were used to summarize patient demographics and baseline characteristics. Receiver Operating Characteristic (ROC) curve analysis was performed to determine the cut off value of RRI in predicting AKI. Comparative analysis (e.g., t-tests or ANOVA) was used to compare the trends of RRI and serum creatinine over time. Correlation coefficients were calculated to assess the relationship between RRI values and serum creatinine levels.

**Study Design:** This study was designed as a prospective observational study

The Renal Resistive Index (RRI) is a Doppler ultrasound parameter used to assess resistance to blood flow within the kidneys. It is mainly utilized in evaluating renal pathologies such as acute kidney injury (AKI), chronic kidney disease (CKD), and transplant rejection.The patient should be positioned comfortably in a supine (lying on the back) or lateral decubitus (lying on the side) position.Expose the abdomen and flanks and apply ultrasound gel to the area.

A curvilinear probe (2 – 5 MHz) or a phased array probe is used.
The machine should be set to Doppler mode.

Gain, filter, and Pulse Repetition Frequency (PRF) settings must be optimized to obtain a clear waveform.

The Doppler gate is placed within the segmental, interlobar, or arcuate arteries of the kidney.

Typically, interlobar arteries are the most commonly used for this measurement.

First, identify the artery using Color Doppler.

Then use Pulse Wave (PW) Doppler to record a clear arterial waveform.

The waveform should clearly show both systolic and diastolicphases.

Two key values need to be recorded:
- Peak Systolic Velocity (PSV) – the highest point during systole.
- End Diastolic Velocity (EDV) – the value at the end of diastole.

Formula for RRI:

$$RRI = \frac{PSV - EDV}{PSV}$$

## RESULTS

**Table 1:**Comparison Changes in RRI and Serum Creatinine Among AKI Patients (N=56)

| Day | Serum Creatinine (mg/dL) | Renal Resistive Index (RRI) |
|---|---|---|
| Day 1 | 1.15± 0.4 | 0.70± 0.07 |
| Day 3 | 1.17± 0.6 | 0.73± 0.08 |
| Day 5 | 2.20± 0.9 | 0.77± 0.09 |
| Day 7 | 2.63± 0.8 | 0.78± 0.10 |
| Day 9 | 2.92± 0.8 | 0.79± 0.09 |
| f-value | 72.25 | 11.18 |
| p-value | <0.0001 | <0.0001 |
| CD at 5% | 0.10 | 0.01 |

**Figure 1:** RRI and Serum Creatinine Among AKI Patients

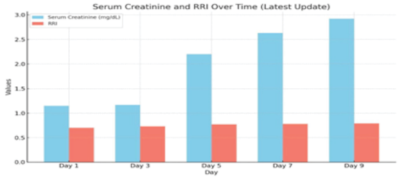



**Table 2 :**Sequential RRI Values Over Time (Days 1 – 9) among study participants

| Day | Mean RRI ± SD | p-value (vs. Day 1) |
|---|---|---|
| Day 1 | 0.70± 0.07 | – |
| Day 3 | 0.73± 0.08 | 0.023 |
| Day 5 | 0.77± 0.09 | <0.001 |
| Day 7 | 0.78± 0.10 | 0.008 |
| Day 9 | 0.79± 0.09 | 0.001 |

**Figure 2**

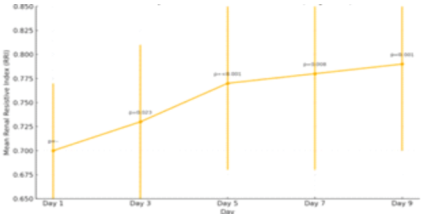



**Table 3:** Comparison of RRI Across AKI Stages (KDIGO Criteria) of among the study participants (n=80)

| AKI Stage | No. of Patients | Mean RRI ± SD | p-value |
|---|---|---|---|
| No AKI | 24 | 0.65 ± 0.05 | <0.001 |
| Stage 1 | 26 | 0.72 ± 0.04 | |
| Stage 2 | 17 | 0.78 ± 0.06 | |
| Stage 3 | 13 | 0.84 ± 0.08 | |

**Figure3:** Comparison of RRI Across AKI Stages

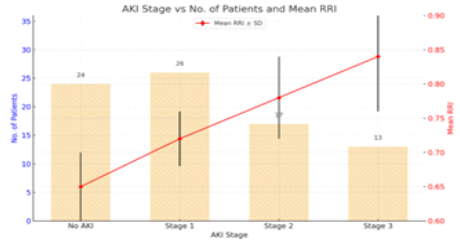
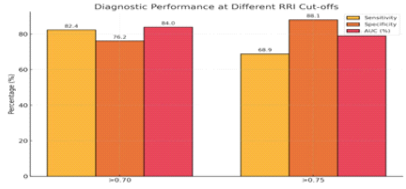



**Table 4:** ROC Analysis for RRI Predicting AKI of among study participants

| Cut-off RRI | Sensitivity (%) | Specificity (%) | AUC |
|---|---|---|---|
| >0.70 | 82.4 | 76.2 | 0.84 |
| >0.75 | 68.9 | 88.1 | 0.79 |

**Figure 4:** ROC Analysis for RRI Predicting AKI




## DISCUSSION

In this study it was observed (table-1) that out of 80 patients ,56 patients subsequently developed AKI. Incidence of AKI in sepsis is 70% in our study.Our study shows that patients has raised RRI value 3-4 days earlier than serum creatinine. There is significant difference in mean values of RRI ( 0.70 ±0.07 )vs s.creatinine (1.15 ±0.4 mg/dL) on day 1 with p value <0.0001 and mean values of RRI(0.73 ±0.08) and serum creatinine 1.17 ±0.6 mg/dLon day 3 with p value <0.0001 .

Increase in mean values of RRI from day 1 (0.70) to day 3 (0.73) are higher than mean value of serum creatinine from day 1(1.15) to day 3(1.17) which shows that RRI rises earlier than serum creatinine(Fig.1).RRI performs as a better marker to detect AKI and also, RRI permits detection of development of AKI 3-4 days earlier than the conventional renal function marker serum creatinine. RRI cut-off of >0.70 demonstrated a sensitivity of 82.4% and a specificity of 76.2%, with an area under the curve (AUC) of 0.84, indicating excellent diagnostic accuracy (p<0.001)(Table 4)

## CONCLUSION

This study evaluated the relationship between Renal Resistive Index (RRI) and clinical parameters in septic patients (N=80), The present study comprehensively evaluated the role of Renal Resistive Index (RRI) in the early identification and staging of Acute Kidney Injury (AKI) among critically ill patients. The study demonstrated a clear and statistically significant association between rising RRI values and progressive stages of AKI, with the mean RRI increasing from 0.65 in non-AKI individuals to 0.84 in those with Stage 3 AKI (p<0.001). Sequential monitoring over 9 days revealed that RRI rose consistently ahead of serum creatinine, reinforcing its utility as an early biomarker of renal dysfunction. Comparative trends between AKI and nonAKI groups further underscored the superior sensitivity of RRI in detecting renal injury before overt elevations in serum creatinine occurred. ROC analysis validated the diagnostic utility of RRI with a cut-off >0.70 showing a sensitivity of 82.4%, specificity of 76.2%, and AUC of 0.84—indicating excellent diagnostic performance.

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