BNS University
Critical Care Departement
The Egyptian Journal of Intensive Care and Emergency Medicine

Relation between renal resistive index and renal function in septic patients developing acute kidney injury received hemodialysis either transient or permanent

Islam A Nour[1]

[1]Critical care department, faculty of medicine, Beni-Suef University

Abstract:

Introduction:

Acute kidney injury (AKI) is a common clinical problem encountered in critically ill patients, frequently in the setting of multiple organ failure, and is an independent risk factor for increase hospital stay and mortality risk. Renal resistive index (RRI) can be measured by renal Doppler ultrasound, RRI reflects changes in blood flow profile of the intrarenal arcuate or interlobar arteries. RRI=(peak systolic velocity−end diastolic velocity)/(peak systolic velocity) in order to detect the relation between renal resistive index and renal function in AKI septic patients received hemodialysis either transient (< 3 sessions) or permanent (> 3 sessions). 40 AKI septic patients received hemodialysis were subjected to renal duplex measurements on admission and after 48h and patients were followed till hospital discharge to detect the relation between RRI and renal functions. 27 patients (67.5%) with RRI (0.5 ± 0.1) had transient hemodialysis and 13 patient (32.5%) with RRI (0.9 ± 0.1) had permanent hemodialysis. There was a statistically significant positive correlation between RRI after 48 hours and serum creatinine level (p. < 0.05).

Conclusion:

We detected a statistically significant positive relationship between renal resistive index and renal functions.

Keywords: Acute kidney injury, renal resistive index, sepsis.

Introduction:

Recently, AKI represents 57% of the ICU patients, while sepsis represents 41% of the cases. AKI mechanisms include decrease kidney perfusion, vasoconstriction of intrarenal vessels, inflammation, oxidative stress, and nephrotoxicity (1). Intrarenal vasoconstriction and small vessels endothelial damage are important pathophysiological pathway, leading to decreased large vascular and small vascular flow, which leads to more ischemia (2). Doppler ultrasound is quickly gaining area as imaging tool in critical patients. The performance of ultrasound on heart, lung, and abdomen in patients after cardiac arrest, major surgery, and during shock has become the standard policy. However, ultrasound on kidney is not commonly performed. Normal ranges are between 0.50 and 0.70, with less than 5% difference between both kidneys (3–5). Previously, elevated RRI was related to hemodynamic changes such as systolic blood pressure and diastolic blood pressure, pulse pressure, and pulse wave velocity, which is a measure for arterial stiffness (6–9)

Aim:

To detect the relation between renal resistive index and renal function in AKI septic patients received hemodialysis either transient or permanent.

Patients and methods

This observational cohort study was conducted on 40 critically ill patients admitted to the critical care department in Beni-Suef university hospital, having AKI, Sepsis and required renal replacement therapy. Patients were randomly selected from critically ill septic patients admitted to the intensive care unit, Beni- Suef University Hospital, during the period from October 2020 till April 2021. The study was approved by the ethical committee of Faculty of Medicine, Beni-Suef University. The study included adult critical patients with sepsis according to the clinical criteria of sepsis (according to quick sequential organ failure assessment (qSOFA) score), fulfilling more than or equal to 2 of the three criteria: systolic blood pressure less than or equal to 100 mmHg, respiratory rate more than or equal to 22/min, and decreased mentation (e.g. confusion, lethargy,

agitation, and coma) in the presence of a source of infection. Patients who developed AKI and required dialysis were randomized (according to kidney disease improving global outcomes (KDIGO) definition). AKI definition is by any of the following: serum creatinine increase by more than or equal to 0.3 mg/dl (≥26.5 μmol/l) within 48 hour or increase in serum creatinine to more than or equal to 1.5 times baseline occurred within the previous 7 days, or urine output decreased less than 0.5 ml/kg/hour for 6 hours. The study excluded patients with any of the following: end-stage renal disease on dialysis, ureteric obstruction, perinephric fluid collection, abdominal compartmental syndrome, extreme hypotension, kidney transplantation, and congenital deformities of the kidney, whether anatomical or vascular. All patients included in this study were subjected to full clinical evaluation, standard routine laboratory and hemodynamic monitoring, and urine output monitoring every 6 hours.

Renal arterial duplex measurements

RI is a sonographic index of intrarenal arteries and is measured as follows: (maximum systolic velocity−minimum-diastolic-velocity)/maximum systolic velocity. The normal range of RI is 0.50–0.70.For adults, RI value of 0.70 indicates normal renal vascular resistance (RVR), and all measures above 0.70 indicate increased RVR [10]. RRI was measured for all patients on admission and follow-up was done after 48 h, and the patients were followed till hospital discharge to detect correlation to outcome. Mortality risk assessment was measured by the acute physiology and chronic health evaluation (APACHE III) score.

Results

The study population demographic data showed 18 (45%) patients were male and 22 (55%) were females. Their age ranged from 14 to 83 years, with a mean ± SD age of 51.55 ± 18.82 years. Moreover, 19 (47.5%) patients were diabetics and 26 (65%) were hypertensive. The mean APACH III score was 10.15±4.34. Regarding the number of dialysis sessions, 27 (67.5%) patients had transient dialysis (less than three sessions of dialysis) and 13(32.5%) patients had more than three sessions of dialysis.

There was statistically significant positive correlation between renal resistive index and serum creatinine level (p. <0.05)

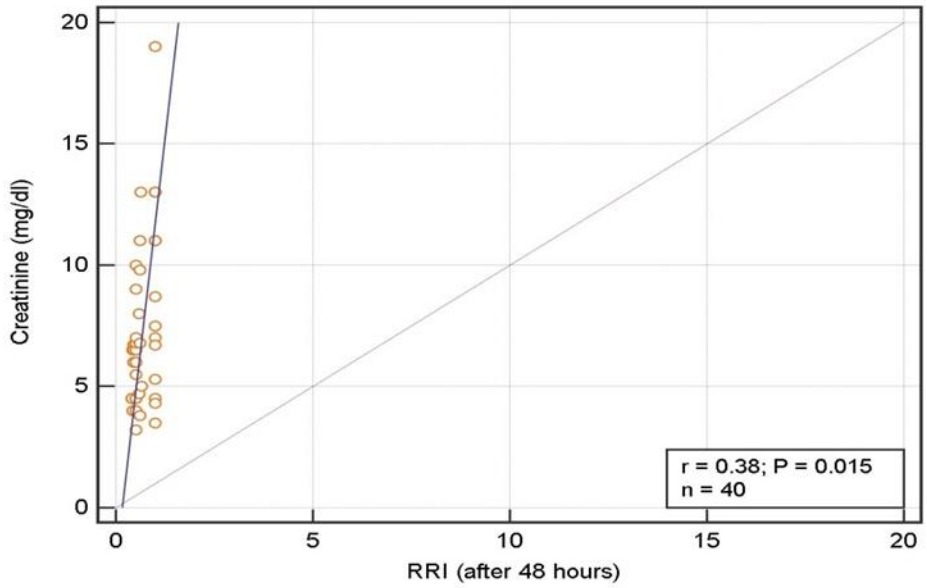
At a cut off level of RRI > 0.64 after 48 hours, there is statistically significant predictive value for permanent dialysis (P.<0.05), with sensitivity 92.3% and Specificity 96.3%.

Table 11:

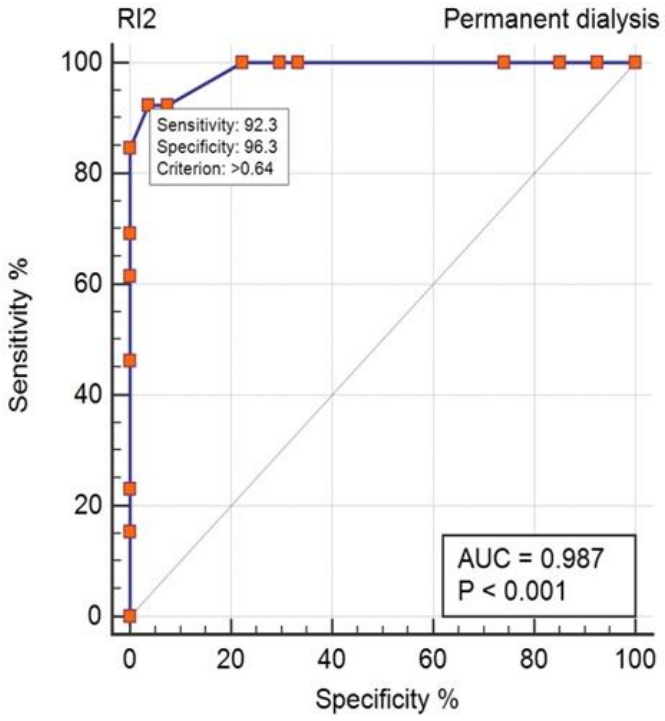
Laboratory result		**Renal resistive index (RRI)**	
		Admission	**After 48 hours**
Na (mEq/L)	R P.value	0.231 0.1512	0.238 0.1391
K (mmol/L)	R P.value	-0.064 0.6937	0.030 0.8558
Urea (mg/dl)	R P.value	0.120 0.4597	0.132 0.4176
Creatinine (mg/dl)	R P.value	0.285 0.0743	0.381 0.0152*
Lactate (mmol/L)	R P.value	0.405 0.0094*	0.486 0.0015*
TLC (thousand/µl)	R P.value	0.088 0.5909	0.106 0.5154
Platelets (thousand/µl)	R P.value	0.259 0.1061	0.320 0.0444*

There was significant positive correlation between RRI on admission and lactate level (P.< 0.05).

There was significant positive correlation between RRI after 48 hours and each of creatinine, lactate level (P.< 0.05).



Figure(11): Correlation between RI after 48h and creatinine



Predictive value of RI after 48 h for persistent AKI by ROC curve analysis. AKI, acute kidney injury; RI, resistive index; ROC, receiver operating characteristic.

Discussion:

The aim of our study was to detect the relation between renal resistive index and renal functions.

In our study RRI was in a positive correlation with serum creatinine ($P < 0.05$) and mean creatinine in patients with persistent AKI was significantly higher ($P < 0.04$). Similar to our results, **Mohamad Sherif Mogawer et al. (2021)[10]** conducted a study on 50 patients suffering from child C liver cirrhosis and known normal baseline serum creatinine within one year before AKI. They showed that RI can predict hepato-renal syndrome (HRS) with 100% sensitivity and 67% specificity (cut off value > 0.77). There was statistical significant positive correlation between RI and serum creatinine ($P < 0.001$). Also similar to our results, **Hossam El-Din A. Mahmoud et al. (2020)[11]** conducted a study on 150 patients with non-alcoholic fatty liver disease to detect predictive value of RRI in early renal affection. There was a significant positive correlation between RRI and serum creatinine ($P < 0.001$). Similarly, **Ayman Mohamed EL-Lehleh et al. (2017)[12]** conducted a study on 60 patients with and without liver cirrhosis to detect the role of RI in assessment of functional renal impairment in patients with liver cirrhosis. There was significant positive relationship between RI and serum creatinine ($R = 0.818$, $P < 0.001$).

In contrary to our results Michael Darmon et al. (2011) (13) who conducted a study on 51 critically ill patients to detect diagnostic accuracy of RRI for recovery of AKI in critical patients. There was no relationship between RI and serum creatinine and the baseline serum creatinine level was not significantly higher in patients who had persistent AKI. This means that high renal RI may be related to impaired renal functions and prolonged renal dysfunction.

In conclusion, we detected a positive relation between renal resistive index and renal functions.

References:

1- **Basile D, Anderson M, Sutton T A.** Pathophysiology of Acute Kidney Injury. Compr Physiol, 2012; 2: 1303–1353.

2- **Gomez H, Ince C, De Backer D, et al.** A Unified Theory of Sepsis Induced Acute Kidney Injury. Shock, 2014; 41: 3–11.

3- **Ponte B, Pruijm M, Ackermann D, et al.** Reference values and factors associated with renal resistive index in a family-based population study. Hypertension, 2014; 63: 136–142.

4- **Spatola L, Andrulli S.** Doppler ultrasound in kidney diseases: a key parameter in clinical long-term follow-up. Journal of Ultrasound 19, 2016. pp. 243–250.

5- **Darmon M, Schnell D, Zeni F.** Doppler-Based Renal Resistive Index: A Comprehensive Review. In: Vincent JL, editor. Yearbook of Intensive Care and Emergency Medicine. Berlin, Heidelberg: Springer; 2010. pp. 331–338.

6- **Pape L, Offner G, Ehrich J.** Renal arterial resistance index. N Engl J Med, 2003; 349: 1573–1574.

7- **Ohta Y, Fujii K, Arima H, et al.** Increased renal resistive index in atherosclerosis and diabetic nephropathy assessed by Doppler sonography. J Hypertens, 2005; 23: 1905–11.

8- **National Kidney Foundation.** K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Am J Kidney Dis. 2002; 39: S1–S266.

9- **Geraci G, Mulè G, Geraci C, et al.** Association of renal resistive index with aortic pulse wave velocity in hypertensive patients. Eur J Prev Cardiol. 2015; 22: 415–422.

10- **Mogawer M.S, Nassef S.A.R, Elhamid S.M.A. et al.** Role of renal Duplex ultrasonography in evaluation of hepatorenal syndrome. Egypt Liver Journal. 2021; 11, 34.

11- **Mahmoud H.ED.A, Yousry W.A, Saleh S.A. et al.** Renal resistive index in non-alcoholic fatty liver disease as an indicator of early renal affection. Egypt Liver Journal. 2020; 10, 6.

12- **EL-Lehleh A, El Abd N, Abd El Mageed S, Sadiek R.** The Role of Renal Resistive Index in Assessment of Functional Renal Impairment in Patients with Liver Cirrhosis. Afro-Egyptian Journal of Infectious and Endemic Diseases. 2017; 7(1), 8-19.

13- **Darmon M, Schortgen F, Vargas F, et al.** Diagnostic accuracy of Doppler renal resistive index for reversibility of acute kidney injury in critically ill patients. Intensive Care Med. 2011 Jan;37(1):68-76.