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Original Research Article

Renal artery Doppler for Assessing Fluid Responsiveness in Septic Patients

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Name of Author:
Mohamed Saad Abd Elmohsen Hamed[1], Mahmoud Mohammed Kenawy[2], Ehab Ahmed Mohammed Abdelmoneim[3], Kamel Abdelaziz Mohamed[4], Abdelazem Abdelfattah Khalil*[5]

Affiliation: [1,2,3,4]*Critical Care Department, Faculty of Medicine, Cairo University, Egypt*

Corresponding Author:
Abdelazem Abdelfattah Khalil

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Abstract: ***Background:*** The cornerstone of treating septic shock is fluid resuscitation; however, administering too much or too little fluid can exacerbate organ failure, especially acute kidney injury. It is still difficult to accurately quantify fluid responsiveness at the bedside. Renal artery Doppler ultrasonography can be used to measure the renal resistive index (RRI), which is a non-invasive indicator of fluid responsiveness in septic patients and reflects changes in systemic hemodynamics and renal perfusion. ***Aim:*** To assess changes in the renal resistive index within six hours of starting the usual treatment for septic shock, along with other therapeutic parameters. ***Methods:*** This prospective observational study included 60 adult patients diagnosed with septic shock admitted to Intensive Care Unit. All patients underwent standardized initial resuscitation according to sepsis management guidelines. Renal artery Doppler ultrasound was used to measure the renal resistive index on admission and at 30 minutes, 120 minutes, and 6 hours after fluid resuscitation. Hemodynamic parameters, laboratory data, urine output, and clinical scores were recorded. Patients were classified as fluid responders or non-responders based on hemodynamic response to fluid challenge. ***Results:*** Fluid responsiveness was observed in a significant proportion of patients. Responders demonstrated significantly lower baseline RRI values compared to non-responders, with a marked decrease in RRI following fluid resuscitation. RRI showed a significant inverse correlation with mean arterial pressure and urine output. ROC curve analysis revealed that RRI had good predictive accuracy for identifying fluid-responsive patients at different time points, with acceptable sensitivity and specificity. Multivariate logistic regression identified RRI as an independent predictor of fluid responsiveness in septic shock. ***Conclusion:*** Renal resistive index measured by Doppler ultrasonography is a reliable, non-invasive bedside tool for assessing fluid responsiveness in patients with septic shock. Serial RRI measurements can aid in guiding fluid resuscitation, optimizing hemodynamic management, and potentially preventing fluid overload and renal dysfunction.

Keywords: Septic shock; Fluid responsiveness; Renal resistive index; Renal artery Doppler; Critical care.

INTRODUCTION

Sepsis that is caused by disruption of the host's response to infection, results in hypoperfusion of organs and tissue. It is categorized as a septic system if vasoactive drugs are required because, after appropriate fluid management, syncope may develop due to decreasing blood pressure (1,2).

Septic shock is associated with a high mortality rate, which could rise dramatically if proper treatment interventions are not provided (3). Throughout the medical therapy of patients experiencing septic shock, it is important to assess both macrocirculatory indicators, such as mean arterial pressure (MAP) and central venous pressure (CVP), and microcirculatory parameters, such as urine output (UO) and lactate level. This is necessary to meet the objectives set forth for the resuscitation of such instances (3). The kidney is one of the main organs affected by septic shock. By reducing renal perfusion and causing inflammatory changes, septic shock damages the kidneys and reduces urine production (4).

One indicator that can be used to assess the kidneys' hemodynamics is the renal resistive index (RRI). Changes in intravascular volume and hemodynamics have an impact on the renal resistive index (5).

Renal resistive index and mean arterial pressure have been found to be negatively correlated in cases of acute kidney injury (AKI), although cardiac output and renal resistive index did not appear to be negatively correlated in cases of other critical disorders (5). However, some studies show that in septic shock patients, the renal resistive index significantly decreased, and the mean arterial pressure values increased from 65 to 75 millimeters of mercury administration following norepinephrine administration. This suggests that the renal resistive index is the most direct indicator of the ideal mean arterial pressure for renal perfusion and urine output retention.

Therefore, in situations of septic shock, the ideal mean arterial pressure—which can be calculated using the renal resistive index—is a systemic metric that shows the perfusion of tissues (4). The goal of the current study was to assess changes in the renal resistive index within six hours of starting the usual treatment for septic shock, along with other therapeutic parameters. It was hypothesized that when evaluating the augmentation of instances, the renal resistive index value would function as a measure of tissue perfusion.

MATERIALS AND METHODS

This cohort (longitudinal) study was conducted between January, 2023 and January, 2024 at ICU Department, Maadi Military Hospital on sixty patients who were admitted to the Emergency Department (ED) with a clinical suspicion of septic shock.

Inclusion criteria

1. Age more than eighteen years.
2. Suspected or confirmed infection.
3. The presence of 2 or more of the systemic inflammation response syndrome criteria, which include a heart rate that is above ninety beats per minute, a respiratory rate that is greater than twenty breaths per minute, a temperature that is greater than thirty-eight degrees Celsius or less than thirty-six degrees Celsius, and a white blood cell count that is greater than twelve thousand or less than 4000 cells/mm³ or greater than ten percent bands.
4. Quick SOFA Criteria (6):

a) Altered mentation.
b) Systolic blood pressure less than or equal one hundred millimeters of mercury.
c) Rate of respiration at least twenty-two per minute (Figure 1).

Exclusion criteria

1. A predetermined sickness that will likely result in death within a day.
2. Younger than eighteen.
3. Being pregnant.
4. immediate surgery need.
5. Terminal cancer.
6. Cases involving kidney disease, trauma, abdominal radiation or dialysis, cardiopulmonary resuscitation, deaths within the six-hour follow-up period, and cases without a clear ultrasound picture were not included in the study.
7. Obese & morbid obese.

Patient preparation

Before the scan, the patient fasted for at least six hours. It was advised to use anti-flatulence medications, such as disflatyl or activated charcoal, for 24 hours before the scan. Rectal enema may lessen abdominal distention, improving the acoustic window for kidney assessment.

Technique

The first and most crucial step in enabling a satisfactory evaluation of the kidneys was obtaining an appropriate acoustic window. Generally, good acoustic windows could be obtained in the renal triangle to the mid-axillary line; in the right kidney, the liver may occasionally be used as an acoustic window. The evaluation began with B-mode grayscale imaging, which provides important information about the kidneys' size, location, and echotexture. It also enables evaluation of the kidneys' shape and configuration, including parenchymal thickness, corticomedullary differentiation, and renal outlines, which enable assessment of the renal condition, including nephropathy, nephritis, stones, etc. The main renal arteries of both kidneys, including their origin, duplication, and presence of atherosclerosis, the renal vasculature, which assesses the uniform distribution of vascularity within the renal parenchyma beginning from lobar, interlobar, segmental, and arcuate vessels, and the presence of any renal vascular lesions such as arteriovenous fistula, AVM, and renal aneurysm, were all evaluated using color doppler imaging. To acquire precise flow velocities, pulsed wave spectrum doppler was used; the doppler angle should be less than 60°. The resistive index can be computed as previously described, and in the majority of ultrasound machines, it is automatically computed from the measurements PSV and EDV.

Methods

All septic shock cases admitted to the ED-ICU during the course of the current single-center, prospective observational study were included. According to the 3rd International Consensus Definitions for Sepsis & Septic Shock (Sepsis-3) (1), septic shock has been identified in the current study. According to the American College of Critical therapy Medicine Guidelines, all patients received standard therapy, which included EGDT resuscitation during the first six hours of septic shock (7). In some circumstances, an internal or subclavian jugular vein catheter as well as a urinary catheter have been placed. To maintain MAP at 65 millimeters of mercury, volume-responsive people were given a minimum effective dose of a vasopressor.

To maintain MAP at 65 millimeters of mercury, volume-responsive people were given a minimum effective dose of a vasopressor. The only vasopressor allowed in this study is norepinephrine. The UO, blood pressure, body temperature, heart rate, breathing rate, and central venous and blood gas pressure were recorded at the time of arrival, as well as thirty, one hundred and twenty, and six hours after the start of treatment. Each case was observed for six hours.

Age and sex have been recorded, and the Acute Physiology & Chronic Health Evaluation (APACHE) II and Simplified Acute Physiology Score (SAPS) II have also been evaluated. After starting treatment, the renal resistive index was measured at baseline (RRI0), thirty minutes later (RRI30), one hundred and twenty minutes later (RRI120), and six hours later (RRI6h). Doppler ultrasonography of the renal interlobular veins, performed by an emergency physician skilled in the use of a two-to-five megahertz curved probe, has been used to evaluate the RRI (8).

Ethical considerations

Every participant gave their informed consent. The study was approved by the Critical Care Department's ethical and scientific committee (Number MD _38_2022).

Statistical analysis

MedCalc version 20 (MedCalc, Ostend, Belgium) has been used for statistical analysis, data processing, and data entry. The paired t-test, Chi-square test, Student's t-test, factorial and repeated measures ANOVA, logistic regression analysis, and ROC curve analysis have all been used as assessments of significance. When the P-value was less than 0.05, statistical significance was taken into account.

RESULTS

The sixty cases of septic shock were divided into two separate groups based on fluid responsiveness: the fluid non-responsive group (23 cases) and the fluid responsive group (37 cases).

Table 1: Comparison among both groups in terms of Socio-demographic data utilizing Student's t & Chi square tests.

Variable		Fluid non-responsive group (23)	Fluid responsive group (37)	Student's *t* test
		Mean ± SD	Mean ± SD	P value
Age (years)		70 ± 7	67.4 ± 7.6	= 0.174
Variable		Fluid non-responsive group (23)	Fluid responsive group (37)	Chi square test
				P value
Gender	Female	10 (43.5%)	19 (51.4%)	= 0.5563
	Male	13 (56.5%)	18 (48.6%)	

* Percentage of Column Total.

There was statistically insignificant variance in terms of the age & gender between both groups. (**Table 1**).

Table 2: Comparison among both groups as regards Basic clinical data utilizing Chi square test.

Variable		Fluid non-responsive group (23)	Fluid responsive group (37)	Chi square test P value
CKD	+ve	6 (26.1%)	4 (10.8%)	= 0.1258
DM	+ve	12 (52.2%)	15 (40.5%)	= 0.3825
HTN	+ve	13 (56.5%)	4 (10.8%)	= 0.0002**
Origin of sepsis	GIT	2 (8.7%)	4 (10.8%)	= 0.9515
	Respiratory	14 (60.9%)	20 (54.1%)	
	Urinary	5 (21.7%)	10 (27%)	
	Others	2 (8.7%)	3 (8.1%)	

* Percentage of Column Total.

There was highly significant reduction in HTN, in Fluid responsive group; than Fluid non-responsive group (p-value less than 0.01), while there was insignificant variance as regards all the remaining basic clinical data (p -value less than 0.05)

(**Table 2**).

Table 31: Comparison among both as regards Baseline Hemodynamic data utilizing Student's t test.

Variable	Fluid non-responsive group (23)	Fluid responsive group (37)	Student's *t* test
	Mean ± SD	Mean ± SD	P value
Temperature (^{o})	37.17 ± 0.2	37.15 ± 0.2	= 0.686
RR (breath/min)	26.8 ± 1.3	26.9 ± 1.2	= 0.723
HR (beat/min)	147 ± 5	148 ± 4.2	= 0.427
MAP-0 (on arrival) (mmHg)	48.7 ± 3.7	57.8 ± 4.1	<0.001**
CVP-0 (on arrival) (mmHg)	7.8 ± 0.7	7.7 ± 0.7	= 0.640
APACHE II score	21.8 ± 4.9	22.7 ± 4.2	= 0.448
SAPS II score	42.2 ± 11.8	37 ± 11.3	= 0.093

There was highly significant elevation in MAP-0 (on arrival), in Fluid responsive group; than Fluid non-responsive group (p-value less than 0.01), while there was insignificant variance as regards all the remaining Baseline Hemodynamic data (p -value greater than 0.05) (**Table 313**).

Table 42: Comparison among both groups as regards Baseline Laboratory data utilizing Student's t test.

Variable	Fluid non-responsive group (23)	Fluid responsive group (37)	Student's *t* test
	Mean ± SD	Mean ± SD	P value
Hb (g/dL)	10.9 ± 0.6	11 ± 0.5	= 0.685
PLT (10^3/μL)	199 ± 36	215 ± 44	= 0.178
TLC (10^3/μL)	9.6 ± 0.9	9.5 ± 0.9	= 0.836
ALT (U/L)	53 ± 10.6	55 ± 11.3	= 0.546
AST (U/L)	64 ± 15.6	71 ± 15.5	= 0.106
Creat. (mg/dL)	1.98 ± 0.26	2.03 ± 0.37	= 0.580
pH	7.26 ± 0.04	7.27 ± 0.03	= 0.186
PCo2 (mmHg)	27.4 ± 3.7	28.3 ± 3.2	= 0.322
HCO3 (mmHg)	16.3 ± 3	16.8 ± 2.6	= 0.461

In terms of all baseline laboratory data, the comparative investigation among both groups indicated insignificant variance (p -value greater than 0.05). (
Table 424).

Table 53: Comparison among both groups in terms of Baseline Renal Duplex data utilizing Student's t test.

Variable	Fluid non-responsive group (23)	Fluid responsive group (37)	Student's *t* test
	Mean ± SD	Mean ± SD	P value
RRI-0 (on arrival)	0.7187 ± 0.01	0.6851 ± 0.02	<0.001**

There was highly significant reduction in RRI-0 (on arrival), in fluid responsive group; than fluid non-responsive group (p-value less than 0.001) (**Table 535**).

Table 64: Comparison among both groups in terms of Follow up data (after resuscitation) utilizing Student's t test:

Variable		Fluid non-responsive group (23)	Fluid responsive group (37)	Student's *t* test
		Mean ± SD	Mean ± SD	P value
On Arrival	**MAP-0**	50.6 ± 3.7	56.43± 4.1	< 0.001**
	CVP-0	5.1 ± 0.9	5.5± 0.7	= 0.01*
	RRI-0	0.73 ± 0.01	0.73± 0.02	< 0.001**
30 min data	**MAP-30 min**	53.6 ± 3.7	59.33 ± 4.1	< 0.001**
	CVP-30 min	9.1 ± 0.9	9.5 ± 0.7	= 0.01*
	RRI-30 min	0.7207 ± 0.01	0.7 ± 0.02	< 0.001**
120 min data	**MAP-120 min**	57.8 ± 2.5	66.33 ± 2.6	< 0.001**
	CVP-120 min	9.6 ± 1	10.33 ± 0.7	< 0.001**
	RRI-120 min	0.7257 ± 0.01	0.71 ± 0.02	= 0.002**
6h min data	**MAP-6h**	63.9 ± 3.6	74.08 ± 8	< 0.001**

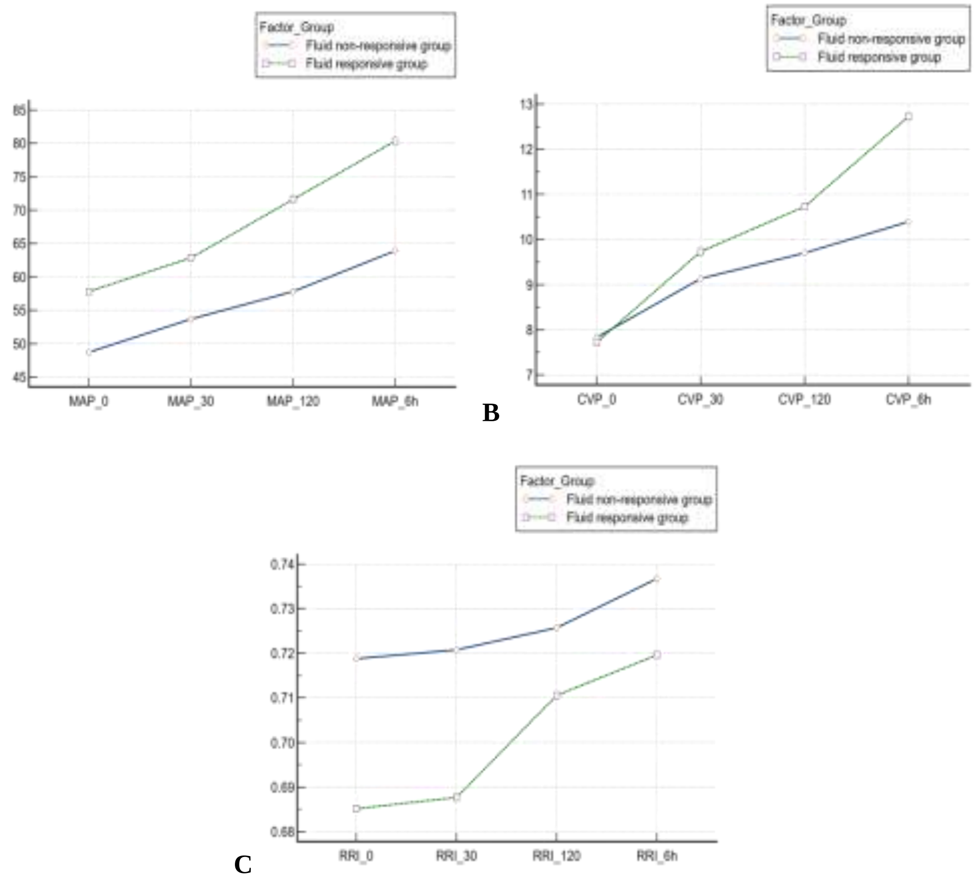
	CVP-6h	10.3 ± 1	11.83 ± 0.7	< 0.001**
	RRI-6h	0.7367 ± 0.01	0.72 ± 0.021	= 0.001**

The fluid responsive group had a highly significant increase in MAP-30 minutes and CVP-30 minutes compared to the fluid non-responsive group (p-value less than 0.05, respectively). And the fluid responsive group's RRI-30 minutes decreased significantly more than the fluid non-responsive group ($p < 0.001$) (**Table 646**).

The fluid responsive group had a highly significant rise in MAP-120 minutes and CVP-120 minutes compared to the fluid non-responsive group (p-value less than 0.05, respectively). A comparison of the two groups showed that the fluid responsive group had a much higher RRI-120-minute drop than the fluid non-responsive group ($p < 0.001$). (**Table 6**).

The fluid-responsive group had significantly higher MAP-6h and CVP-6h than the fluid-non-responsive group ($p < 0.05$, respectively). A comparison of the two groups showed that the fluid responsive group had a significantly higher RRI-6h than the fluid non-responsive group ($p < 0.001$). (**Table 6**).

When comparing the fluid responsive group to the Fluid non-responsive group, there was substantial increase in MAP during the serial pre- and post-resuscitation measures. **(**
A). We observed a significant elevation in CVP in the fluid-responsive group than the fluid non-responsive group.; during the serial pre- and post-resuscitation measurements (**(1B)21 B**). Also, there was a decrease in RRI in fluid responsive group than fluid non-responsive group during the serial pre- & post-resuscitation measurements (**Figure (1A): Comparison among both groups of cases in term of serial MAP estimation. (1B)2: Comparison of serial CVP evaluations among both groups of cases.**
(1C)31 C).



A B C

Figure (1A): Comparison among both groups of cases in term of serial MAP estimation. (1B)2: Comparison of serial CVP evaluations among both groups of cases.
(1C)3: Comparison among both group of cases in terms of serial RRI assessments

Table 75: Logistic regression model for the Factors affecting Fluid responsiveness utilizing Forward method.

Predictor Factor	Coefficient	OR	P value

(Constant)	86.35931		
MAP-0 (on arrival)	0.48263	1.62	0.01*
RRI-0 (on arrival)	-157.61510	3.53	0.016*

Other factors excluded from the model as (p value > 0.1). OR: odds ratio.

Logistic regression analysis demonstrates that the rise in MAP-0 (on arrival) had an independent effect on the likelihood of fluid responsiveness, with a statistically significant difference (p-value less than 0.05) once specific predictor variables were entered and the Forward technique was used. Following the application of the Forward technique and the addition of specific predictor factors, logistic regression analysis shows that the decrease in RRI-0 (upon arrival) independently influenced the likelihood of fluid responsiveness, exhibiting a statistically significant variance (p-value less than 0.05). (**Table 757**).

Table 86: Roc-curve of RRI to predict cases with Fluid responsiveness.

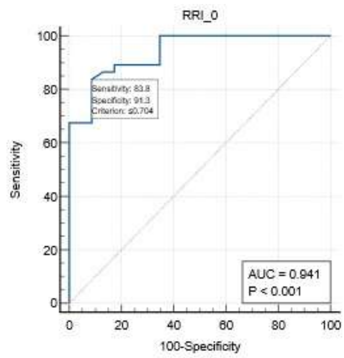
Variable	AUC	Best Cut off point (Criterion)	Sensitivity (%)	Specificity (%)	P value
RRI-0 (on arrival)	0.941	≤0.704	83.78	91.30	<0.0001**
RRI-30 min	0.936	≤0.706	81.08	91.30	<0.0001**
RRI-120 min	0.730	≤0.716	56.76	82.61	= 0.0004**
RRI-6h	0.737	≤0.727	62.16	82.61	= 0.0002**

ROC (Receiver operating characteristic), AUC= Area under curve.

Using ROC-curve analysis, RRI-0 (on arrival) at a cutoff point (≤0.704) accurately predicted patients with fluid responsiveness (94%), with sensitivity of 83% and specificity of 91% (p-value less than 0.01). Using ROC-curve analysis, patients with fluid responsiveness were predicted by RRI-30 min at a cutoff point (≤0.706) with excellent (ninety-three percent) accuracy, sensitivity = 81% and specificity = 91% (p-value <0.01). With a cutoff point of ≤0.716, RRI-120 min identified instances with fluid responsiveness with fair (73%) accuracy, sensitivity = 56%, and specificity = 82% (p-value less than 0.01) using ROC-curve analysis. Using ROC-curve analysis, RRI-6h at a cutoff point (≤0.727) identified instances with fluid responsiveness with fair accuracy (73%), sensitivity (62%), and specificity (82%) (p-value less than 0.01). (

Table 868 -

Figure (2A)42A-D).



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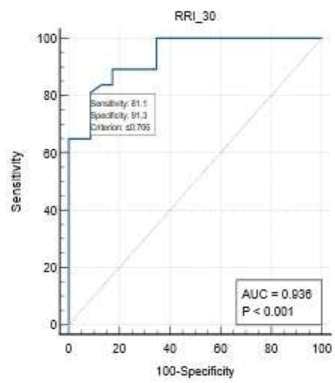

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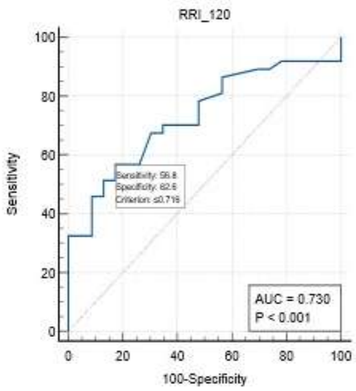

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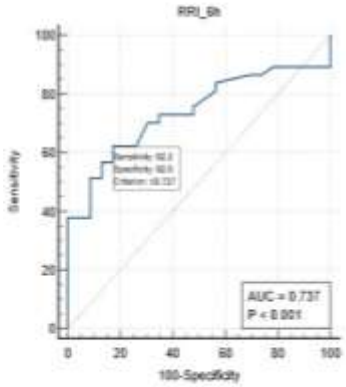

D

Figure (2A)4: ROC curve of RRI-0 (on arrival) (Fluid responsiveness).
(2B)5: ROC curve of RRI-30 min (Fluid responsiveness).
(2C)6: ROC curve of RRI-120 (Fluid responsiveness).
(2D)7: ROC curve of RRI-6h min (Fluid responsiveness).

DISCUSSION

In order to assess the Renal Resistive Index as a non-invasive method of predicting changes in fluid responsiveness during the treatment of septic shock patients, a cohort (longitudinal) study was conducted on sixty septic shock cases.

The study has covered 60 patients who were admitted to the emergency department with a clinical suspicion of septic shock. A minimum effective dose of a vasopressor was administered to volume-responsive individuals in order to keep their mean arterial pressure at 65 millimeters of mercury.

Every case's body temperature, UO, blood pressure, heart rate, respiration rate, blood gas pressure, and central venous pressure were measured at arrival and again thirty, one hundred and twenty, and six hours after the start of treatment. The duration of the follow-up operation was six hours.

Age and sex have been noted, along with the results of the acute physiology & chronic health assessment (APACHE) II and the simplified acute physiology score (SAPS) II. At baseline (RRI0) and thirty, 120, and six hours (RRI6h) after the start of treatment, the renal resistive index was measured.

An emergency physician skilled in using a two-to five-megahertz curved probe performed Doppler ultrasonography of the renal interlobular veins to measure the renal resistive index. Estimating the Renal Resistive Index's predictive potential as a non-invasive method to forecast shifts in fluid responsiveness during the treatment of septic shock cases was the main goal.

In order to predict changes in fluid responsiveness during the treatment of patients with septic shock, a secondary objective was to compare the Renal Resistive Index to the diameter of the inferior vena cava.

Regardless of its predictive significance for kidney disease, the renal resistive index should be considered a measure of systemic cardiovascular risk if it reflects the complex interactions between systemic circulation and renal microcirculation. More important components of the renal resistive index than renal vascular resistance include pulse pressure and vascular compliance. (9).

Based on fluid responsiveness, the 60 septic shock cases were divided into two separate groups: the fluid responsive group (37 cases) and the fluid non-responsive group (23 cases).

A comparison of the two groups shows that the fluid responsive group's HTN decreased significantly more than that of the fluid non-responsive group (p-value less than 0.01), which was consistent with Aminiahidashti et al., (4).

Aminiahidashti et al., (4) discovered that the non-survival group had a significantly higher incidence of underlying illnesses, such as diabetes, hypertension, and cancer.

A comparison of the two groups shows that the fluid responsive group had a significantly higher MAP-0 (on arrival) than the fluid non-responsive group (p-value less than 0.01), which was consistent with Schnell et al., (10), & Aminiahidashti et al., (4).

Schnell et al., (10) revealed that after FC, mean arterial pressure increased from thirty-seven millimeters of mercury (sixty-eight to seventy-nine) to eighty millimeters of mercury (seventy-five to eighty-six; p-value less than 0.0001), stroke volume increased from fifty milliliters (thirty to seventy-seven) to fifty-five milliliters (39–84; p-value less than 0.0001), and heart rate decreased from 115 beats per minute (95–128) to 112 beats per minute (92–122; p-value less than 0.01).

Aminiahidashti et al., (4) also revealed that there was a significant rise over time (p-value = 0.00) in the mean MAP of cases upon arrival and six hours after the start of therapy, which were 73.05 ± 8.84 & 93.67 ± 15.23, respectively. Upon arrival, the systolic blood pressure was 80.82 ± 12.63 millimeters of mercury; during the course of therapy, it increased to 107.75 ± 17.62 millimeters of mercury (p-value = 0.01).

A comparison of the two groups shows that the fluid responsive group had a significantly lower RRI-0 (on arrival) than the fluid non-responsive group (p-value less than 0.001), which was consistent with Rozemeijer et al., (11), & Aminiahidashti et al., (4).

In 2019, Rozemeijer et al. (11) found that severely ill patients without shock had a lower renal resistive index than those with non-responsive shock. High renal resistive index was also independently determined by lower membrane capacitance, preadmission renal impairment, and systemic circulation pressure indices.

Aminiahidashti et al., (4) shown that in patients experiencing septic shock, a decrease in the renal resistive index during resuscitation is correlated with an increase in mean arterial pressure. When treating patients with septic shock and evaluating their volume, the renal resistive index is used as a measure for microcirculatory perfusion.

Regarding follow-up data, we observed that during the serial pre- and post-resuscitation measurements, the fluid responsive group's RRI was much lower than that of the fluid non-responsive group. This was consistent with Gül et al., (12).

At baseline, Gül et al., (12) found a negative correlation between MAP and the renal resistive index. Furthermore, after a fluid challenge reaction, we found a significant inverse connection between MAP and renal resistive index.

Our findings were in opposition to those of Schnell et al., (10), who claimed that the differences in Doppler-based renal RI between FC responders and non-responders were negligible (0.72 [0.67–0.75] & 0.70 [0.65–0.75], respectively; p-value equal to 0.35). Following FC, the hemodynamic and RI changes in the groups with no acute renal injury, temporary acute kidney injury, and persistent acute kidney injury are also presented. After FC, negligible changes in RI have been observed in any of these three groups.

With a statistically significant variance (p-value less than 0.05), logistic regression analysis shows that the increase in MAP-0 (on arrival) considerably enhanced the probability of fluid responsiveness, which was consistent with Song et al., (13).

Song et al., (13) found that sepsis-induced acute kidney injury and fluid responsiveness were independently predicted by septic shock, high RI and ventral venous pressure, and low DBP at the time of sepsis diagnosis.

The findings of the logistic regression analysis showed that the decrease in RRI-0 (on arrival) had an independent effect (p-value less than 0.05) and considerably enhanced the chance of fluid responsiveness, which was consistent with Mulier et al., (14).

Mulier et al., (14) determined that, in non-responsive patients with acute kidney injury stage 2 (renal resistive index = 0.72) and stage 3 (RRI = 0.74), the renal resistive index was substantially higher than in cases without acute kidney injury (renal resistive index = 0.65), with p values of 0.001 and 0.006, respectively.

RRI-0 (on arrival) at a cutoff point (less than or equal to 0.704) used ROC-curve analysis to predict patients with fluid responsiveness with excellent (94%) accuracy, sensitivity = 83% & specificity = 91% (p-value less than 0.01), which fell in line with Ninet et al., (15) & Shen et al., (16).

Ninet et al., (15) claimed that the combined sensitivity and specificity were 0.83 and 0.84 in their meta-analysis. The ratios of summary positive and negative likelihood were 4.9 and 0.21, respectively. According to these results, in critically ill patients, a high RI may be a predictor of both fluid non-responsiveness and chronic acute renal injury.

Shen et al., (16) additionally stated that the receiver operating characteristic (ROC) curve showed that the sensitivity, specificity, and AUC for predicting acute kidney damage and fluid non-responsiveness were 0.889, 0.552, and 0.751, respectively, if the renal resistive index was less than 0.635.

CONCLUSION

Our research has demonstrated that shock patients have a higher RRI and reduced fluid responsiveness. Thus, in patients experiencing septic shock, a decrease in the renal resistive index value during resuscitation was associated with an improvement in fluid responsiveness and mean arterial pressure. RRI can therefore be used as a predictive tool to assess the number of septic shock cases and the circulatory perfusion during the therapeutic process.

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