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RENAL ANGINAL INDEX AS A PREDICTOR OF ACUTE KIDNEY INJURY IN CRITICALLY ILL CHILDREN.

Pediatrics Medicine

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ABSTRACT

Introduction: Acute Kidney Injury is prevalent in critically ill children in PICU setting where Serum Creatinine is usually used as a biomarker. Creatinine levels rise slowly after significant renal damage, hence there is a need for alternate biomarker that can detect AKI earlier to prevent complications. Renal Anginal Index is a score calculated based on Risk and Injury criteria. A positive renal anginal index(>/= 8) can predict AKI early on helping in successful intervention phase.

Aims And Objectives:

- Primary objective: To predict Acute Kidney Injury using Renal Anginal Index in critically ill children.
- Secondary objective: To determine the prevalence of AKI in critically ill children admitted to JSS hospital.

Methodology: Renal Anginal Index (>=8) was calculated in critically ill children admitted to PICU. Chi square test, ROC, Odd's ratio was used to analyse data. **Results:** AKI was positive in 38.4% cases, out of which 91.7% was RAI positive. RAI had a good sensitivity, specificity, PPV and NPV and hence can be used for early prediction of AKI in children. **Conclusion:** Renal Anginal Index can be used as an early and reliable predictor of Acute Kidney Injury in critically ill children to prevent morbidity and mortality.

KEYWORDS

Renal Anginal Index, Acute Kidney Injury, Critically Ill Children, Picu, Creatinine.

INTRODUCTION

AKI: Abrupt decrease in functioning of kidney leading to a fall in GFR, increased blood levels of nitrogenous wastes, imbalance in fluid and electrolyte regulation. [1]AKI can vary from a minute increase in creatinine levels to Anuria.[1]

The incidence of AKI is 2-5% amongst all hospital admissions.[1]
It is about 25-33% in children needing PICU admission.[1-4]
Fluid loss is a common Pre renal cause of AKI.It is corrected by timely fluid replacement. [1]
Multiple Organ involvement alters the structure of kidneys which may cause irreversibleinjury.[1]
AKI staging is done using KDIGO criteria.[5]

KDIGO – Kidney Disease Improving Global Outcomes criteria[5]

Tab 1.KDIGO STAGING OF AKI[5]

STAGE	SERUM CREATININE	URINE OUTPUT
1	1.5-1.9 times baseline OR >/= 3mg/dl increase	<0.5ml/kg/hr for 6-12 hours
2	2.0-2.9 times baseline	<0.5ml/kg/hr for> 12 hours
3	3.0 times baseline OR Increase in Serum creatinine to 4mg/dl OR Initiation of Renal Replacement Therapy OR In patients <18 years ,decrease in eGFR to <35ml/min per 1.73 metre square.	<0.3ml/kg/hr>24 hours or Anuria > 12 hours.

Severe AKI increases mortality and morbidity by causing chronic renal damage. Therefore, early intervention can protect against irreversible loss of kidney function.[6-8]
Limitations of serum Creatinine used to assess renal function are:[9]

1. Poor specificity in:

a) Pre renal causes.
b) Protein rich diet.
c) Drugs leading to tubular secretion of creatinine- Example Trimethoprim, salicylates etc.

All of the above may lead to increase in SCr without actual kidney damage.

2. It has poor sensitivity as SCr rises slowly despite acute tubular injury due to compensation by other nephrons.[9,10]

Renal Angina Index (RAI):[11,12]

Children with AKI do not present with distinct signs and symptoms which causes delayed diagnosis of AKI.[11,12]

RAI is a score calculated by a combination of risk factors like PICU admission, need for mechanical ventilation and inotropes with clinical parameters of renal injury like fluid overload, urine output.[7,12-16]

It is a predictive tool used to assess the risk of developing AKI.[7,12-16]
RAI is calculated by multiplying Risk Score with Injury score.
Renal Anginal Index is positive when the score is >/= 8.

Tab 2. Renal Anginal Index Scoring

RISK		SCORE
Admission to PICU		1
Solid organ/Stem cell transplantation		3
Mechanical Ventilation or Vasoactive support or both		5
INJURY		
Serum creatinine relative to baseline	FO-Fluid Overload in % (Input-Output)	Score
Decreased/No change from Baseline	< 5	1
>1-1.49 times baseline	5-10	2
1.5-1.99 times baseline	11-15	4
>/= 2 times baseline	>15	8

Hospital-based studies have derived that a positive RAI (>/=8) at admission was a strong predictor of AKI on day 3. Also these studies have shown that RAI performed better than baseline serum creatinine and percentage fall in estimated Creatinine clearance (eCrCl) from baseline in predicting AKI.[4,17-18]

OBJECTIVES

Primary objective:

To predict Acute Kidney Injury using Renal Anginal Index in "critically ill" children who are admitted to PICU,JSS Hospital.

Secondary objective: To know the prevalence of AKI in "critically ill" children admitted to JSS hospital.

METHODOLOGY

Study Design: Prospective Observational Study.

Study Duration: 2 years.

Sampling technique: Type Of Sampling: Purposive Sampling.

Sample size: A sample size of 125 was obtained using the below formula.

Formula for calculation of sample size:[20]

$$n=\frac{(Z_{1-\alpha/2})^2 X S_N X 1-S_N}{L \; X Incidence}$$

Source of study: Paediatric Intensive Care Unit at JSS hospital.

Study setting and Method of collection of data:
Ethical committee clearance and consent from parents was obtained.

Critically ill children from 1 month to 18 years who were obtaining admission in PICU, JSS were enrolled. Data including anthropometry, demography, admission diagnosis, comorbidities, vital and clinical examination findings were made a note of.

2ml of blood was drawn. CH and RFT were sent at admission (Day 0). Serum Creatinine was done after 24 hours (Day 1),48 hours(Day 2), 72 hours(Day 3).

During PICU stay parameters like inotrope administration, mechanical ventilation, fluid overload and urine output were taken into consideration.

Renal Anginal Index-RAI was calculated for all the critically ill children included in the study on getting admitted to PICU.

RAI score > or = to 8 was considered as positive.AKI was determined by KDIGO classification.[2]

Study Population and source of data:
The study participants included children between 1 month to 18 years admitted in the paediatric intensive care unit of JSS hospital, Mysuru.

Subject Eligibility:
Inclusion Criteria:
All critically ill children admitted in PICU aged 1month to 18 years and estimated PICU stay of 72 hours or more.

Exclusion Criteria:
Children known to have a pre-existing chronic kidney disease were excluded.

Study Assessments of end points:
Usefulness of RAI as a tool to predict AKI in children who are critically ill and to find the AKI prevalence in these children.

Statistics:
Data was analysed using SPSS version 20.0 after entering the data in excel sheet.

Descriptive statistics were presented as percentage, bar graphs and Pie charts.

Inferential statistics were analysed using T test, Pearson Chi Square test and Odd's ratio.

A p value <0.05 with Confidence Interval of 95% was taken as significant.

Test parameters were analysed using Sensitivity, Specificity, Positive predictive value, Negative predictive value and Area Under Receiver Operator Curve (ROC).

RESULTS:

Renal Anginal Index(RAI)
RAI >/= 8 is considered positive.RAI < 8 is considered negative.

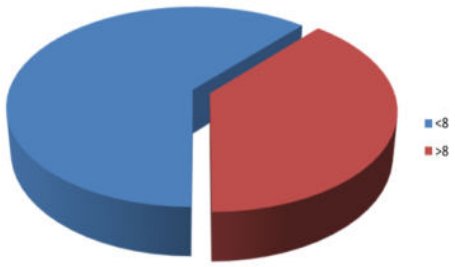

Fig 1
Among 125 children , RAI was positive (>/=8) in 48(38.4%) children and negative RAI (< 8) in 77 (61.6%) children.

Prevalence and Grading of Acute Kidney Injury

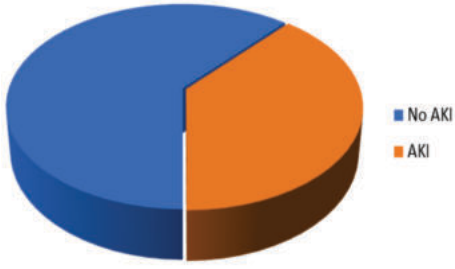

Fig 2
Of 125 critically ill children, 48 (38.4%) had AKI as per KDIGO criteria.
77 (61.6%) had no AKI.
Prevalence of AKI is 38.4%.
Grading of AKI was done as per KDIGO criteria.
38 (79%) of the 48 children had Grade 1 AKI.
8 (16.6%) had Grade 2 AKI.
2 (4.1%) had Grade 3 AKI.
Co-relation of Acute Kidney Injury with Renal Anginal Index.

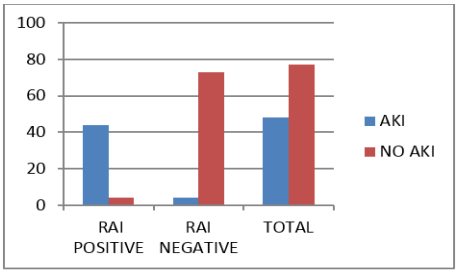

Fig 3
Out of 48 children who had AKI, 44 had a positive RAI. RAI positivity is 91.7% in children with AKI.Of 77 children who did not have AKI , 73 had a negative RAI.RAI negativity is 94.8% in children without AKI.Parameters to assess Diagnostic Accuracy of RAI.

Tab 3.Parameters to assess Diagnostic Accuracy of RAI.

Statistic	Value	95% CI
Sensitivity	91.67%	80.02% to 97.68%
Specificity	94.81%	87.23% to 98.57%
Positive Likelihood Ratio	17.65	6.77 to 45.99
Negative Likelihood Ratio	0.09	0.03 to 0.22
Disease prevalence (*)	38.40%	29.84% to 47.52%
Positive Predictive Value (*)	91.67%	80.84% to 96.63%
Negative Predictive Value (*)	94.81%	87.70% to 97.90%
Accuracy (*)	93.60%	87.78% to 97.20%

The Sensitivity of RAI is 91.67%and Specificity is 94.8%.
PPV of RAI is 91.6%and NPV of RAI is 94.8%.
Accuracy of RAI as predictor of AKI is 93.6%.
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Value of p which is less than 0.05 is significant. Here it is 0.009, hence there is significant association between RAI and AKI by Chi square test.

Receiver Operator Curve for Renal Anginal Index(Sensitivity vs 1-Specificity).

Tab 4. Chi-Square Test

Test Statistics		
	RAI_	AKI
Chi-Square	6.728	6.728
Degree of freedom(df)	1	1
P value	.009	.009

For a Confidence interval of value of p which is less than 0.05 is significant. Here it is 0.009, hence there is significant association between RAI and AKI by Chi square test.

Interpretation of the ROC:

Values that give curves closer to the 1 on y axis indicate a better performance. Hence values of AUC (Area under the curve) closer to 1 (100%) indicate a better diagnostic value of the test.

Here AUC is 0.935 (nearer to 1) and hence RAI can be used as a good diagnostic test in children with AKI as derived by the ROC.

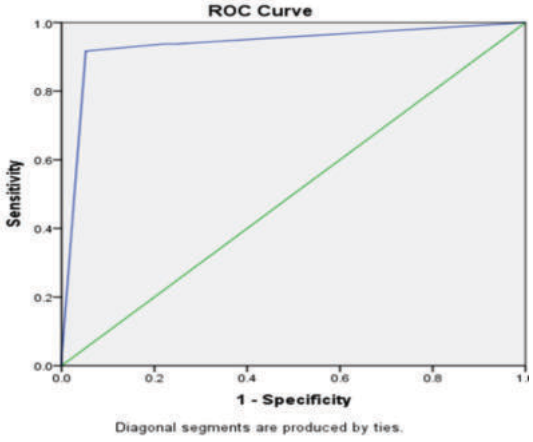

Fig 4 :ROC curve

DISCUSSION

Our study is done in critically ill children of Paediatric Intensive Care Unit, Paediatrics Department of JSS Hospital and Medical College, Mysuru during the period of December 2020 to November 2022.

This study evaluated the "RAI as a tool to predict Acute Kidney Injury in critically ill children" and "The prevalence of Acute Kidney Injury" in these children.

In the present study, RAI was calculated in 125 children needing PICU admission, JSS Hospital, Mysuru.

Inclusion and exclusion criteria were followed as mentioned above. Percentage of RAI positivityOf the total 125 children, Renal Anginal Index RAI was positive(>/=8) in 48 (38.4%) and negative in 77 children(61.6%).

Prevalence of AKI. Of the 125 children, 48 are found to have AKI and 77 did not which is about 38.4%.

Hence the prevalence of AKI was 38.4%.

Grading of AKI was done as per KDIGO criteria.

38 (79%) of the 48 children had Grade 1 AKI.

8 (16.6%) had Grade 2 AKI.

2 (4.1%) had Grade 3 AKI.

Hence majority of children(79%) had Grade 1 AKI.

Corelation between AKI and RAI.

Of the 125 children, RAI was positive in 48 and negative in 77, which is 38.4%.

In 48 children who had AKI, 44 had a positive RAI (>8) which is about 91.7%.

Remaining 77 who did not have AKI, 73 had negative RAI (<8) which is 94.8%.

Chi square test done to check the co-relation between RAI and AKIrevealed a significant p value of 0.009 with 95 % Confidence Interval. (p value <0.05 is taken as significant.)

Sensitivity of RAI is 91.6%

Specificity of RAI is 94.8%.

PPV of RAI is 91.6%.

NPV of RAI is 94.8%.

Accuracy of RAI as predictor of AKI is 93.6%.

Area under the ROC is 0.93 which is significant as it is closer to 1.

DISCUSSION

Comparision With Other Studies:

Suma Et al[18]

"Total 285 patients were included. RAI was positive(≥8) in 141 (49.4%) patients. AKI was observed on day 3 in 47 (33.3%) patients who had apositiveRAI, of whom 24 (17.0%) had severe AKI. Patients with positive RAI(>8) also showed significantly prolonged duration of PICU stay and mechanical ventilation."

Basu Et al[4]

"Among 1590 patients,286 patients (18%) had positive RAI. At day 3, severe acute kidney injury occurred in 368 (23%) patients. Out of which 121 patients had RAI positive. That is 42 % of RAI positivepatients had severe AKI on Day 3."

Gawadia Et al [17]

"Among 162 enrolled children, 86 (53%) had positive RAI and 76 (46%) had RAI negative. Of the 86 children who were RAI positive on Day 0, 62 (72.1%) developed severe AKI on Day 3 in contrast to 2 of 76 (2.6%) children who were RAI negative."

"Positive RAI was found to have a Sensitivity of 96.9%, a Specificity of 75.5%, a Positive Predictive Value of 72% and a Negative Predictive Value of 97.4%, AUC was 0.9." "This study concludes that RAI can be used as reliable tool to predict Severe AKI in critically ill children and is better compared to other markers like creatinine."

In Our study RAI was positive in 38.4% of critically ill children.

RAI positivity was 49.4% in Suma Et al,18% in Basu Et al and 53% in Gawadia Et al.

Of the 48 children who had AKI,44 (91.7%) had a positive RAI (>/=8) , which is higher compared to other studies.

The Sensitivity was 91.7%, Specificity was 94.8% and AUC was 0.93 which was comparable to results ofGawadia Et al.

CONCLUSION

"Our study revealed that positive Renal Anginal Index (>8) in critically ill children had a significant positive correlation with AKI."

"RAI as a predictive tool had high sensitivity, specificity, PPV and NPV in predicting AKI in children who are critically ill."

"The prevalence of AKI in these children was 38.4% in our study."

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