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Validity of Spo_2/Fio_2 Ratio in Detection of Acute Lung Injury and Acute Respiratory Distress Syndrome

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Abstract

Introduction

One of diagnostic criteria for Acute Lung Injury (ALI) and Acute Respiratory Distress Syndrome (ARDS) is Pao2/Fio2 (PF) ratio ≤ 300 for ALI or ≤ 200 for ARDS. This criteria requires invasive arterial sampling. Measurement of Spo2/Fio_2 (SF) ratio by pulse oximetry test may be a reliable non invasive alternative to the PF ratio.

Materials and Methods

In a cross sectional study we enrolled 105 sample of patients with ALI or ARDS, to determine the Spo_2/Fio_2 (SF). Pao_2 was measured through arterial blood sampling and Spo_2 measured with pulse oximetry and documented within 5 minutes of each other.

Results

The relationship between SF and PF ratio was described by the following equation: SF=57+0/61PF (P<0/001). Spo_2/Fio_2 (SF) ratios of 181 and 235 can be substituted pao2/fio2 (PF) ratio of 200 and 300 in ARDS and ALI respectively. The ALI, SF cutoff of 235 had 57% sensitivity and 100% specificity, and ARDS, SF cutoff of 181 had 71% sensitivity and 82% specificity.

Conclusion

Spo_2/Fio_2 (SF) ratio is a reliable noninvasive marker to determine children with ALI or ARDS and can be used instead of it.

Keywords**:** ALI, ARDS, Pao2/Fio2 ratio, Pulse oximetry.

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Introduction

It is estimated that 30 to 60% of all Pediatric Intensive Care Unit (PICU) admitted patients require mechanical ventilation ,and of these patient up to 25% may have ALI and 5 to10% may have ARDS. It means that Acute lung injury (ALI) and ARDS are terrible syndromes with high mortality and morbidity(1,2). With implementation of lung-protective ventilation strategies, overall morbidity and mortality have improved significantly for both adult and children with ALI and ARDS (3, 4). Based on American European consensus conference (AECC) in 1994 one of diagnostic criteria for acute lung injury(ALI) and ARDS is $\frac{Pao_2}{Fio_2}$ (PF) ratio ≤ 300 for ALI or ≤ 200 for ARDS(5). But PF criteria requires arterial blood sampling (6,7). Concerns about anemia following blood sampling and a movement to minimally invasive approaches have led to reduction blood gas measurements in critically ill patients (8, 9).

Pulse oximetry is the most commonly utilized technique to monitor oxygenation, non-invasive and safe. It indirectly measures arterial hemoglobin O_2 Saturation by differentiating oxyhemoglobin form deoxygenated hemoglobin using their respective light absorption at wave lengths of 660 nm (red) and 940 nm (infra red)(10,11).

In most PICU, daily arterial blood sampling to calculate the PF ratio often is impossible, then calculation of SF ratio and replacement it to PF ratio for diagnosis of ARDS or ALI is non invasive and affordable (12). Using SF ratio determine the degree of hypoxemia non invasively and without the need for arterial blood sampling (7).

In this study we hypothesized that the continuously available and non invasive SF ratio can be used instead the PF ratio in diagnosis of ALI and ARDS.

Materials and Methods

In a cross sectional study 105 sample of children with ARDS or ALI who were admitted in PICU of Tabriz Children's Hospital between 2012 to 2014 were studied. In Patient with ARDS or ALI under Mechanical ventilation, Pao_2 was easured through arterial blood sampling and Spo_2 measured with pulse oximetry and documented within 5 minutes of each other. Inclusion criteria were children with ARDS or ALI with acute onset of disease and chest radiograph demonstrating bilateral pulmonary infiltrates. Exclusion criteria were children with pulmonary edema due to heart failure and congenital heart disease and anatomic anomalies of lung or air ways. Quantitative data were presented as mean ± standard deviation (SD), while qualitative data were demonstrated as frequency and percent (%). We used (χ^2) and (independent t test) for quantitative and qualitative data as well. P value of <0.05 was considered statistically significant. The relation between SF and PF was described by linear regression equation. Reciever Operating Characteristic (ROC) curves were plotted to determine the sensitivity and specificity of the SF threshold values correlating with PF of 200 (ARDS) and 300 (ALI).

Results

Results showed of 105 children enrolled in this study, 56 patients were female (53.3%) and 49 patients were male (46.7%) with a mean age of 33± 6 months (minimum 3 and maximum 140 months).

From total of 105 data pairs, 86 (81%) met the PF ratio criteria for RADS and 19(20%) met the PF criteria for ALI.

Sex had no significant relationship with SF ratio (P = 0.77) and PF ratio (P =0.06.)

In general, Spo_2/Fio_2 (SF) ratio could be predicted well from Pao2/Fio2(PF) ratio, using the linear regression equation: SF=57+0.61 PF. Based on this equation a PF ratio of 300 corresponds to SF ratio of 235 and PF ratio of 200 to SF ratio of 181(P <0.001). The ALI SF cut off of 235 had 57% sensitivity and 100% specificity and ARDS cut off of 181 had 71% sensitivity and 82% specificity (Figure.1).

The SF ratio had excellent discrimination ability for ARDS, Area Under the Curve (AUC=0.86) (Figure.2) and good discrimination ability for ALI and ARDS (AUC=0.89)(Figure.3).

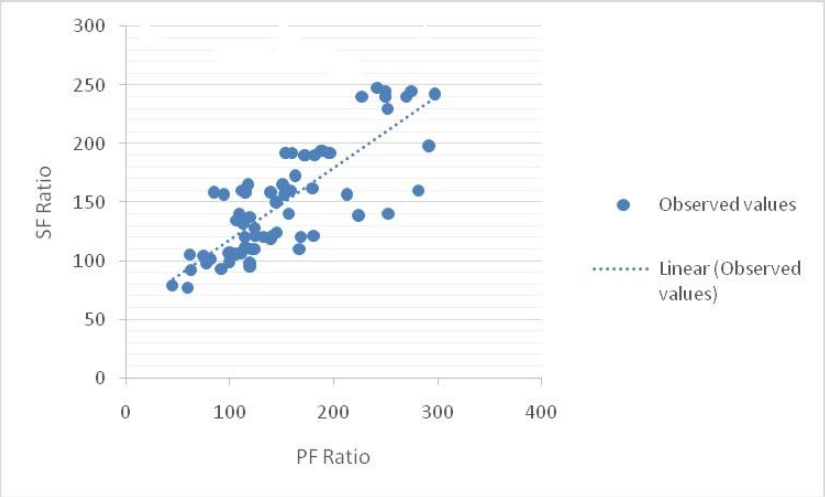

Fig.1: S/F ratio vs. P/F ratio scatterplot for the derivation data set. The line represents the best fit linear relationship SF=57+0/61PF (P<0/001)

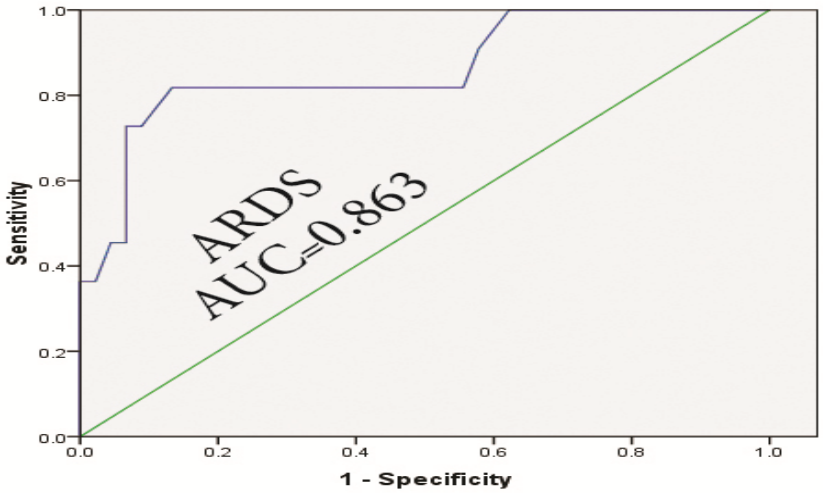

Fig.2: ROC curves for S/F vs. P/F ratios of ≤200 (ARDS)

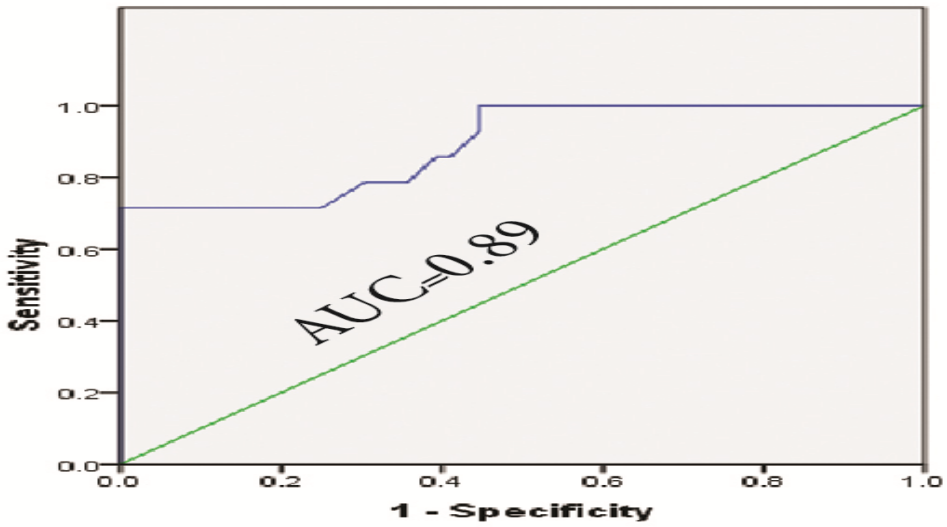

Fig.3: ROC curves for S/F vs. P/F ratios of ≤ 200 (ARDS) and S/F vs. P/F ratios of ≤ 300 (ALI) for the derivation data set

Discussion

Acute lung injury (ALI) and ARDS are significant causes of morbidity and mortality in patients admitted to Pediatric Intensive Care Unit (13). The routine use of pulse oximetry and capnography has led to reduce Arterial Blood Gas (ABG) measurements in most Pediatric Intensive Care Unit (14) , Pulse oximetry is now available in most children's hospital and used routinely and shows oxygenation status , easier and continuously than arterial blood sampling (15,16). Pulse oximetry prevents arterial blood sampling and cost for ABG analysis (17). Using SF ratio for diagnostic of ALI and ARDS lead to identification of undiagnosed cases of these syndromes (18).
In this study we included 105 patients with ALI or ARDS. Pao_2 and Spo_2 measured with the same Fio_2 and computed SF and PF ratio. Our study indicated that the relationship between SF and PF ratio was described with following equation SF=57+0.61 PF, and SF ratio threshold value for ALI was 235 and for ARDS and 181 corresponded of PF ratio 300 and 200.
In the similar study Khemani et al. found than SF cut off of 201 could predict PF criteria for ARDS with 84% sensitivity and 78% specificity and SF of 263 could predict ALI with 93% sensitivity and 43% specificity (19).

In adult patients, in study by Rice et al., they found that SF cut off of 235 could predict ARDS with 85% sensitivity and 85% specificity and SF cut off of 315 could predict ALI with 91%sensitivity and 56 % specificity (20).

Conclusion

This study indicates that Spo_2/Fio_2 (SF) ratio is a reliable, non invasive and available marker for diagnosis ALI or ARDS in critically ill children.

Conflict of interests: None

Acknowledgment

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