

Cerebral Doppler Resistance Index (RI) is associated with regional cerebral oxygenation

1 | INTRODUCTION

There is growing interest focusing on the transitional changes within the first 72 hours of birth. Understanding physiological changes within this foetal-to-neonatal transition period has the potential to identify pathological changes and consequently establish interventions to reduce morbidity and mortality in preterm infants. Monitoring of regional cerebral oxygenation with near-infrared spectroscopy (NIRS) during the first 72 hours demonstrated that low regional cerebral oxygenation is associated with increased risk of cerebral injury, prolonged hospitalisation, mortality and poor neurological outcome or death.^{1,2} Regional cerebral oxygenation depends on oxygen delivery and consumption, whereas oxygen delivery relies on arterial oxygen saturation (SpO₂), haemoglobin content and cerebral perfusion. A widely used parameter to assess cerebral perfusion, measured with cranial Doppler sonography, is the Resistance Index (RI) of larger cerebral arteries. We aim to investigate whether there is an association between RI in anterior cerebral artery (ACA) and the regional cerebral oxygenation in preterm infants of 34 weeks of gestation within the first 24 hours after birth.

2 | METHODS

This is a post hoc analysis of data collected during the 'Avoiding Hypotension in Preterm Neonates' (AHIP) study (ClinicalTrials.gov identifier: NCT01910467), a single-centre prospective randomised controlled study. The trial was conducted at the Division of Neonatology, Department of Paediatrics, Medical University of Graz, between October 2013 and December 2016, and approved by the Regional Committee on Biomedical Research Ethics (EK-Nr: 25-237 ex 12/13). Written informed parental consent was obtained prior the study. The antepartum medical history was collected before birth, and demographics (eg gestational age, birthweight) were documented in each neonate.

A NIRO-200NX was used to measure the regional cerebral oxygenation (cTOI) within 6 hours after birth. The transducer was positioned on the left forehead secured with cohesive conforming bandage (Peha-haft, Harmann) in each infant. SpO₂ and heart rate

(HR) were measured with the IntelliVue MP 30 Monitor (Philips) at preductal level at the right hand/wrist. All measurements were performed continuously for 24 hours. All variables were stored continuously in a multichannel system 'alpha-trace digital MM' (BEST Medical Systems) for subsequent analysis. Values of the SpO₂ and HR were stored every second, and the sample rate of cTOI was 2 Hz. During the 24 hours of NIRS measurement, a cranial ultrasound was performed by a neonatologist to examine brain structure and development of potential brain injury, including measurement of RI in ACA with cranial Doppler sonography (Vivid 7 Pro, General Electric).

2.1 | Statistical analysis

Data are presented as mean and standard deviation (SD) for normally distributed continuous variables and median (interquartile range, IQR) when the distribution was skewed. Mean values of cTOI and SpO₂ are calculated for 60 minutes at time point (30 minutes before and 30 minutes after) of the cranial ultrasound examination. Correlation analyses are performed to investigate, if there were associations between RI and cTOI, as well as between RI and SpO₂ or HR. Correlation analyses are performed using Spearman's rank correlation coefficient or Pearson's correlation when appropriate. A *P*-value <.05 is considered statistical significant. The statistical analyses are performed using SPSS Statistics 23.0.0 (IBM Corporation; Armonk, NY, USA).

3 | RESULTS

A total of 108 preterm infants were included in the original randomised controlled study. Eighty preterm infants, in whom RI values of the ACA were available, were included in the present retrospective analysis. The mean (SD) gestational age and birthweight were 32.7 (1.9) weeks and 1845 (485) g, respectively. The mean (SD) cTOI was 69.4 (9.5) %, RI 0.74 (0.10), SpO₂ 95.8 (2.6) % and HR 142 (12) beats per minute. There was a statistically significant negative correlation between RI and cTOI ($P = .0001/\rho = -0.438$) (Figure 1). However, there were no significant correlations between RI and SpO₂ ($P = .336/\rho = -0.120$) and RI and HR ($P = .372/\rho = -0.113$).

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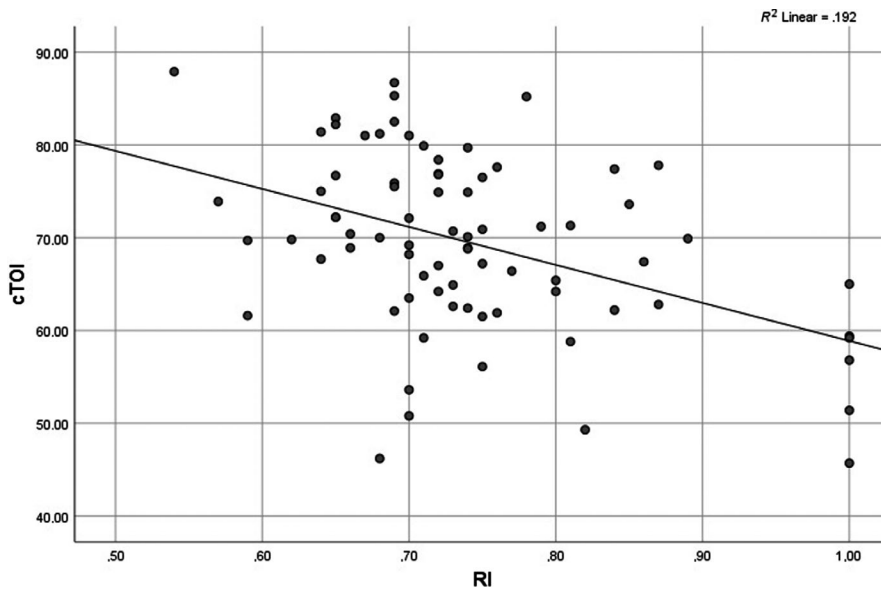


FIGURE 1 Correlation between cTOI and RI ($P = .0001/\rho = -0.438/N = 80$)

4 | DISCUSSION

This is the first study demonstrating a correlation between RI in the ACA and regional cerebral oxygenation in preterm infants. Increasing RI was associated with decreasing regional cerebral oxygenation. RI might be influenced by shunting via the ductus arteriosus and foramen ovale. Shunting via the ductus arteriosus might cause a steal phenomenon resulting in lower cerebral perfusion with lower oxygen delivery. Reduced regional cerebral oxygenation has already been demonstrated in preterm infants with hemodynamically significant patent ductus arteriosus throughout the first 3 days after birth.^{3,4} Furthermore, within the first 24 hours after birth, shunting via the ductus arteriosus and the foramen ovale has been associated with decreased regional cerebral oxygenation.⁵ However, RI in the larger cerebral arteries might also be influenced by other factors including cardiac output and vascular resistance. Unfortunately, we did not perform echocardiography to assess the influence of shunts or cardiac output on RI, which is the major limitation of the current study.

However, there might be clinical implications from our results. In particular, preterm infants with high RI might have lower regional cerebral oxygenation; hence, advanced monitoring of regional cerebral oxygenation using NIRS might identify preterm infants at risk for cerebral hypoxia.

5 | CONCLUSION

In preterm infants during the first 24 hours after birth, there is an association between RI in ACA and regional cerebral oxygenation. Higher RI values were associated with lower cerebral tissue oxygenation in preterm infants.

KEYWORDS

preterm infants, regional cerebral oxygenation, resistance index

CONFLICT OF INTEREST

None.

FUNDING INFORMATION

Funding provided by Jubilaeumsfond, Oesterreichische Nationalbank (Grant No. 15351), GP received the funding. <http://www.oenb.at/en/About-Us/Research-Promotion/The-OeNB-Anniversary-Fund.html>. Georg M. Schmolzer is a recipient of the Heart and Stroke Foundation/University of Alberta Professorship of Neonatal Resuscitation, a National New Investigator of the Heart and Stroke Foundation Canada and an Alberta New Investigator of the Heart and Stroke Foundation Alberta. The funders had no role in study design, data collection and analysis, decision to publish or preparation of the manuscript.

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