INVITED COMMENTARY

Effect of Kangaroo Mother Care on Cerebral Hemodynamics in Preterm Infants

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Kangaroo mother care (KMC) has evolved as *sine qua non* intervention to meet the preterm baby's fundamental needs of warmth, nutrition, and protection from infection. KMC re-establishes the synchrony between mother and fetus interrupted by preterm birth. Maternal sensory inputs regulate the physiology of the newborn and attain homeostasis. Research suggests that for all mammals, the maternal environment is the primary requirement for regulation of all physiological needs (homeostasis), and maternal absence leads to dysregulation and adaptation to adversity. The cardio-respiratory instability seen in separated infants in the first 6 hours is consistent with mammalian "protest-despair" biology, and "hyper-arousal and dissociation" response patterns described in human infants. Thus, zero separation achieved with KMC facilitates normal biology and neurodevelopment [1].

Cerebral hemodynamics is very unique in preterm population – cerebral autoregulation and cerebral blood flow (CBF) being sensitive to the changes in the mean blood pressure (MBP), oxygenation, heart rate (HR) and carbon dioxide variability. Impaired cerebral auto-regulation, increasingly observed with decreasing gestational age and birth weight, results in pressure passive cerebral circulation and imbalance in the normal physiologic reflex worsens the possibility of neurologically intact outcomes. Immaturity of the autonomic nervous system, especially the parasympathetic control of CBF is particularly underdeveloped in preterm infants. Intact cerebrovascular autoregulation is found in clinically stable preterm infants, CBF being unaffected by fluctuations of MBP within the physiologic range of 25 to 60 mm Hg [2]. CBF autoregulation is functional in normotensive but not in hypotensive very low birth weight (VLBW) and extremely low birth weight (ELBW) infants in immediate neonatal period. Studies have shown that the ability of newborn brain to respond to changes in perfusion pressure is not only limited as compared to adults, its range is further quite diminished in sick and critically ill infants [2]. This creates an increased vulnerability to both ischemic and hemorrhagic brain injuries and increased risk of long term neurological insults. A fluctuating pattern of blood pressure, characterized by marked, continuous alterations in both systolic and diastolic flow velocities, are associated with similar trends in the CBF velocity tracings and a high risk of subsequent occurrence of intraventricular hemorrhage (IVH). Because of the pressure-passive cerebral circulation in sick premature infants, hypotension can lead to a parallel decrease in cerebral blood flow. It is important to note that carbon dioxide – CBF reactivity is more robust than pressure-flow reactivity. Moderate hypocarbia results in the reduction in CBF while moderate hypercarbia results in increase in CBF and also abolishes the autoregulatory response due to marked vasodilation resulting in ischemic brain injury.

The impact of KMC on cerebral hemodynamics in preterm neonates has been an area of research interest. The maintenance of normal temperature, heart rate, blood pressure, oxygen, carbon dioxide, and glucose are vitally important to maintain cerebral hemodynamics [3]. KMC stabilizes these cardiorespiratory parameters and positively influences the physiological stability. KMC in stable preterm infants has resulted in fewer bradycardic events, fewer desaturations and apneic events. The improvement in oxygenation can be attributed to the upright position of KMC which increases the efficiency of the diaphragm and pulmonary function [4]. The lesser variation of HR, respiratory rate, and stable oxygen saturation while in KMC contributes to the better hemodynamic stability and sudden fluctuations of blood pressure are prevented since there is positive regulation of serum cortisol and β-endorphins. KMC has also shown to improve the perfusion index and reduce HR variability [5,6]. KMC enhances peripheral perfusion through vaso-relaxation by releasing acetylcholine from parasympathetic nerves and induces vaso-relaxation by regulating the release of nitric oxide (NO) in arteries through M3 acetylcholine receptors on the

endothelium. Higher heart rate variability is a result of an immature autonomic nervous system and a dominant sympathetic nervous system in a preterm that tends to overshoot during auto-regulation and chronic exposure to stress. KMC is thought to enhance parasympathetic signaling by improving the myelination of the vagal branches leading to better regulation of HR, cardiac output and autonomic responses [7]. Near-infrared spectroscopy, before, during, and after KMC, have shown stable mean cerebral regional oxygen saturation (rSO2) throughout KMC duration [8].

Transcranial color Doppler sonography is a bed side tool for non-invasive real-time assessment of CBF in newborns. Color Doppler imaging of the middle cerebral artery (MCA) helps to evaluate alterations in CBF. The study by Chaudhari, et al. [9] in this issue of *Indian Pediatrics*, analyzed the impact of KMC on cerebral hemodynamics in hemodynamically stable preterm population. It was intriguing to find an improvement in CBF velocities along with an improvement in physiological stability after 60 minutes of KMC. This benefit of KMC on changing Doppler parameters in MCA can also be attributed human skin having slow conducting unmyelinated (type C) afferents that respond to touch and skin to skin contact during KMC. Activation of these fibers stimulates the insular cortex (limbic system) to produce mediators (endorphins, neuropeptide and calcitonin gene-related peptide), which in turn enhance postsynaptic NO synthase. Nitric oxide induces smooth muscle relaxation and plays a pivotal role in regulating blood flow in the microvasculature including the cerebral blood vessels of preterm neonate [10]. This recent study evaluating the impact on neonatal cerebral hemodynamics serves as a bridge to our understanding of the real-time impact of KMC on these long term scientifically docu-mented benefits [9].

On world prematurity day 2022, UNICEF is promoting KMC method under the theme – "A Parent's embrace: a powerful therapy, Enable skin to skin contact from the moment of birth." Hence the effect modification by immediate KMC on cerebral hemodynamic parameters that occur during the first 24 hours after birth in stable preterm infants as well as clinically unstable infants needs to be further explored along with subsequent long term neurodevelopment outcome to strengthen the evidence base for promoting KMC and protecting the vulnerable preterm brain.

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