Neurodevelopmental Outcomes after Staged Palliation for Hypoplastic Left Heart Syndrome – Impact of Cerebral Tissue Oxygen Saturation

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Background: Patients undergoing the Norwood procedure are at risk for impaired neurodevelopmental outcome. Perioperative cerebral hypoxia might be causative. We evaluated the impact of cerebral tissue oxygenation on neurodevelopmental outcome.

Methods: Neurocognitive testing was performed in 22 patients with hypoplastic left heart syndrome (HLHS) at a median age of 4.0 (3.1-5.0) years. Verbal IQ, performance IQ and full scale IQ were evaluated with the Hannover-Wechsler-Intelligence scale (HAWIVA-III). The German “Kognitiver Entwicklungstest für das Kindergartenalter” (KET-KID), which is composed of a global scale for cognitive development, a verbal and a nonverbal scale, was applied to assess cognitive functions. Cerebral oxygen saturation (cSO2) was recorded for 24 hours before and 48 hours after the Norwood procedure. Mean preoperative cSO2 values and the mean cSO2 of the first 4 postoperative hours were calculated. The duration of cSO2 below 40% was determined.

Results: Median verbal IQ was 100 (78-127), performance IQ was 93 (84-112) and median full scale IQ was 96 (81-111). Full scale IQ was below average in 4 cases; additional 5 cases had results in the low normal range. Median percentile ranks of the KET-KID were 38 (0-88) for the global scale, 48 (0-96) for the verbal and 39 (0-77) for the nonverbal scale. Results on the global scale were below average in 5 patients; another 5 had results in the low normal range. Overall, HAWIVA-III or KET-KID results were below average in 6 patients. In 13 patients with results in the low normal range or results below average, preoperative cSO2 and early postoperative cSO2 were lower compared to remainder (61 ±4% vs. 65 ±3%, p=0.013 and 42 ±5% vs. 49 ±7%, p=0.015). The duration of cSO2 below 40% was not different (40 (0-290) vs. 180 (0-400) minutes, p=0.385). Preoperative cSO2 correlated with the verbal (r=0.46, p=0.033) and full scale IQ (r=0.46, p=0.030) and with the global (r=0.59, p=0.005), verbal (r=0.55, p=0.010) and nonverbal (r=0.45, p=0.039) scale of the KET-KID.

Conclusions: Overall, HAWIVA-III and KET-KID results of HLHS patients after Fontan completion were in the normal range. Lower preoperative and early postoperative cerebral tissue oxygen saturations were associated with worse test results.