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Changes of neurodevelopmental outcome after congenital heart disease surgery: 2-years follow up

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BACKGROUND
Recently, advances in cardiac surgery techniques and intensive care of infant patients led the increase of long-term survival rate of patients with congenital heart disease. Despite these advances, the possibility of neurological damage is still high in children undergoing cardiac surgery. There have been several reports of neurodevelopmental outcomes in children after cardiac surgery, but the results differed from study to study. Also, there are few studies investigating serial changes of outcomes by aging.

OBJECTIVE
The purpose of this study was to assess the neurodevelopmental outcomes of patients who underwent cardiac surgery in infancy in a single center in Korea.

METHODS
This study was designed as a retrospective study. The information were collected by medical chart review. A total of 119 patients who underwent cardiac surgery before the age of 1 from January 2007 to December 2018 were screened. We evaluated the following characteristics : sex, birth weight, gestational age at birth, presence of any kind of syndrome, cardiac diagnosis, age at surgery, preoperative brain US or MR finding, brain hemorrhage grade, maternal profile (age, education). We used the Bayley scale assessment tool to analyze the developmental delay. The assessment was made two times to watch the neurodevelopmental outcomes serially.

RESULTS
The clinical characteristics of patients are listed at Table 1. Bayley scale of infant development in patients without any syndromes is shown at Table 2. Bayley scale of infant development in patients with any syndrome is shown at Table 3. In 81 patients without any syndromes, psychomotor development index(PDI)s were ≥ 1 SD below the population mean for 74.42% of patients and 25.58% showed normal development in the first evaluation. In the second evaluation, 36.05% showed normal development and 63.95% showed delayed development (p = 0.47). In the case of mental development

index(MDI), 41.86% and 47.67% showed normal development in the first and the second evaluation, respectively(p = 0.10). Among the children with any syndrome, PDI in normal range was shown at no patients in the first evaluation and 1 patient in the secondary evaluation (p = 0.64). In the case of MDI, 5 patients were at normal range in the first evaluation, but only 3 patients were at normal range in the second evaluation (p = 0.31).

CONCLUSION

The number of patients in the range of normal development were increased at the second evaluation compared to the first evaluation, although not statistically significant. Still, more than half of the patients had developmental delay even in the second evaluation. Therefore the necessity of early screening and early rehabilitation intervention is emphasize.

Table 1. Characteristics of subjects (n=119)

	n	%
Male	60	50.42
Female	59	49.58
Birth weight (g)		
Normal (>=2500)	43	36.13
LBW (<2500)	26	21.85
VLBW (<1500)	12	10.08
ELBW (<1000)	38	31.93
Gestational age at birth (wks)		
Preterm	67	56.30
Term	52	43.70
Patients with non-syndromic	81	68.07
Patients with syndrome	38	31.93
Cardiac diagnosis		
VSD	10	11.63
PDA	44	51.16
ASD	4	4.65
Cyanotic heart diseases*	61	70.93
Preop. Brain US or MRI lesion (n=79)		
Non specific	54	62.79
IVH	7	8.14
PVH	23	26.74
Etc**	27	31.40
Hemorrhage grade (n=19)		
I	10	11.63
II	6	6.98
III	0	0.00
IV	7	8.14
Maternal education		
Less than college	28	23.53
Complete college	91	76.47

	Value
Age at surgery (days)	90.16 ± 79.576
Age at first BSID assessment	12.77 ± 2.930
Age at second BSID assessment	27.05 ± 5.491
Maternal age	34.29 ± 4.033

LBW, low birth weight; VLBW, very low birth weight; ELBW, extremely low birth weight; BSID, bayley scale of infant development : second edition scores;
*Cyanotic congenital heart disease : Tetra of fallot, Coarctation of aorta, Single ventricle, Transposition of the great arteries;
**Subependymal cyst, Cerebellar hemorrhage. subependymal nodule, hydrocephalus;
Note : Values are presented as mean ± SD or number

Table 2. Bayley scale of infant development in patients without any syndromes (n=81)

	1st evaluation		2st evaluation	
	n	%	n	%
BSID-II				
PDI				
≥ 85 : Normal	22	25.58	31	36.05
≥ 70 : Mild DD	19	22.09	18	20.93
≥ 50 : Significant DD	24	27.91	18	20.93
< 50 : Severe DD	16	18.60	14	16.28
MDI				
≥ 85 : Normal	36	41.86	41	47.67
≥ 70 : Mild DD	23	26.74	17	19.77
≥ 50 : Significant DD	15	17.44	8	9.30
< 50 : Severe DD	7	8.14	15	17.44

DD, developmental delay; PDI, psychomotor developmental index; MDI, mental developmental index;
Note : Values are presented as number

Table 3. Bayley scale of infant development in patients with any syndrome (n=38)

	1st evaluation		2st evaluation	
	n	%	n	%
BSID-II				
PDI				
≥ 85 : Normal	0	0.00	1	2.63
≥ 70 : Mild DD	4	10.53	2	5.26
≥ 50 : Significant DD	7	18.42	7	18.42
< 50 : Severe DD	27	71.05	28	73.68
MDI				
≥ 85 : Normal	5	13.16	3	7.89
≥ 70 : Mild DD	9	23.68	5	13.16
≥ 50 : Significant DD	9	23.68	7	18.42
< 50 : Severe DD	15	39.47	23	60.53

DD, developmental delay; PDI, psychomotor developmental index; MDI, mental developmental index;
Note : Values are presented as number