J. Phys. Ther. Sci.
24: 535–540, 2012

Developmental Characteristics of Infants According to their Gestational Age and Birth Weight

Eunju Lee, PhD, PT[1)], Hyolyun Roh, PhD, PT[2)]

[1)] Major in Physical Therapy, Department of Rehabilitation Science, Graduate School Daegu University

[2)] Department of Occupational Therapy, Kangwon National University: 3 Hwangio-ri, Samcheok-si, Gangwondo, 245-907 Republic of Korea. TEL: +82 33-540-3481, FAX: +82 33-572-8620, E-mail: withtry@kangwon.ac.kr

Abstract. [Purpose] This study investigated to look at developmental characteristics of infants at a post-conceptual age of around 40 weeks and compared them with weight and gestational age. [Subjects and Methods] The subjects were 51 full-term and preterm infants, classified into three different subgroups according to birth weight groups (appropriate for gestational age; low birth weight; very low birth weight) and gestational age groups (38 weeks or older; between 32 and 37 weeks; less than 32 weeks). Infants were measured for movement and posture using the Test of Infant Motor Performance and the assessment was performed at the postconceptional age of 40 weeks (mean age: 39.75 weeks). [Results] Head in Midline (O-1) had differences according to birth weight only, and Isolated Rt. Ankle Movement (O-7) had differences according to gestational age only. Only the three gestational age groups showed in head control-posterior neck muscles (E-3). Therefore, developmental characteristics were little different according to birth weight or gestational age. [Conclusion] Regardless of the birth weight or gestational age, there appeared to be no differences in the development evaluation results.

Key words: Birth weight, Developmental characteristics, Gestational age

(This article was submitted Jan. 12, 2012, and was accepted Feb. 12, 2012)

INTRODUCTION

The birth rate of low birth weight (LBW) infants in Korea has been gradually on the rise: 3.1% in 1996, 4.1% in 2004, and 4.9% in 2008[1)]. Follow up studies have shown that infants born very preterm with very low birth weight (VLBW) are at high risk of cerebral palsy (CP) and other developmental deficits[2–5)]. Although not all premature infants and LBW infants develop disabilities or deficits, they may have problems, such as tension imbalance or inappropriate joint motion range and movement, or experience developmental delays due to immature regulation of alertness and improper automatic postural response[6)]. In particular, infants who are premature and also have LBW are regarded as high-risk infants, and they have a different developmental process than term infants.[5)] Based on the fact that 13.9 out of 1,000 premature infants and 90.4 out of 1,000 VLBW infants had CP, Swaiman et al.[7)] examined developmental problems based on birth weight. Latal[8)] investigated developmental issues according to gestational age, based on the fact that 10 to 15% of infants born at less than 30 weeks of gestational age had CP and 30 to 60% had cognitive impairment. The need for early intervention for those classified as premature infants according to their gestational age or birth weight has been presented, and precise diagnosis in order to apply intervention in a timely manner is required[9)]. From the perspective that environmental or physiological risk factors may cause developmental delays or disorders, diagnosis of normal or abnormal motor development has a very crucial meaning[10)].

Many studies of the diverse developmental problems of premature infants have reported that their developmental conditions differ according to their birth weight[7, 8)]. Howard et al.[11)] assessed physical growth and motor and cognitive development of an extremely low birth weight (ELBW) group whose birth weight was less than 800 g and a control group of term infants when they were 2 and 5 years old. They found that the physical growth variables of weight, height, and head circumference of the ELBW group were smaller than those of the control group. In addition, the Stanford-Binet IQ test and Peabody motor quotient results were lower in the ELBW group than in the control group. Birth weight is reported to have greater significance than gestational age when making prognoses of premature infants, because evaluation of gestational age may be uncertain in obstetric gynecological terms[12)]. Therefore, we need to examine the differences between evaluations of the development of infants by birth weight and gestational age.

According to Campbell[13)], pediatric therapists are looking for tests to evaluate the quality of movement, postural control and alignment, balance and coordination, and functional ability measures to provide information based on the evolution of infants with a slower movement development rate. Movement is a way an infant establishes control over the world, communicates needs, and explores the environment. Movement is a basis for early learning, as well as being important in its own right for developing and maintaining musculoskeletal integrity[14]. The Test of Infant Motor Performance (TIMP) was developed by Campbell and colleagues[14]. It was designed to assess the postures and movements of prematurely born infants from 32 weeks gestational age up to about 4 months after term-equivalent age, or for full-term infants up to 4 months of age, as they interact with people, objects, and their environment. Items of the TIMP were taken from neurologic and developmental tests. It consists of 59 items divided into two sections: Elicited and Observed. The TIMP's diagnostic efficiency values compare favorably with data obtained in other tests of neurological integrity and can be used to predict motor outcome of infants at younger ages than other developmental tests[10]. Accordingly, this study investigated the developmental characteristics of infants at a post-conceptual age of around 40 weeks using TIMP and compared them with birth weight and gestational age.

METHODS

The subjects of this study were 51 (25 males, 26 females) full-term and preterm infants hospitalized at the nursery of Busan S Hospital from March 2010 to January 2011. The subjects of this study were the 34 subjects of our previous study[5], plus an additional 17 subjects. They were infants who received conventional nursing treatments in the nursery, and the assessments were performed at a post-conceptual age of 40 weeks. The stability of the infants' vital signs was confirmed by pediatric specialists. The gestational age of the full-term infants was 37 weeks or older, and they were healthy, without any disease at birth. In this study, the average gestational age of the full-term infant group at birth was 39.24 weeks. The experimental group consisted of premature infants whose gestational age was less than 37 weeks, with no congenital or chromosomal anomaly and less than second-degree intraventricular hemorrhage (IVH) without any special brain damage. The average age of the experimental group after fertilization was 40 weeks.

The 51 infants were classified into three groups according to birth weight. The same infants were also divided into three groups, according to gestational age. The three birth weight groups were appropriate for gestational age (AGA), low birth weight (LBW), and very low birth weight (VLBW). The birth weights of the AGA group, LBW group, and VLBW group were 2,500 g or heavier, 2,500 to 1,500 g, and less than 1,500 g, respectively. The three gestational age groups were 38 weeks or older, between 32 and 37 weeks, and less than 32 weeks. Table 1 shows delivery type, gestational age, mother's age, birth weight, birth height, birth head circumference, Apgar 1, and Apgar 2 of the subjects.

TIMP (ver. 5.0) was used in this study. It is a testing tool that aims to diagnose infants at risk of delayed motor development due to sensitivity to motor execution level and maturity change, to predict future motor execution, and to measure mediation effects. Forty-two items are measured, with a maximum possible score of 142 points. The average measurement time takes 33 minutes (SD±12). For the 13 observed items, 1 is attributed if the motion for each item is observed, and 0 is attributed if not. For the 29 elicited items, the examiner induces the motion, and the generated response is scored from 0 to 6 for each item. At the time of TIMP development, its reproducibility was 0.89 ($p<0.01$), and the inter-examiner reliability was 0.949, with single-examiner reliability in the range of 0.980–0.996.

For this study, three physiotherapists with over five years of experience in pediatric physiotherapy and over one year of experience in early physiotherapy mediation in infant ICU instructed themselves via CD-ROM following the guidelines of the TIMP Test User's Manual (version 5.0). All observations and executions were made at Brazelton's[16] stages 3 and 4, which are recommended as the most appropriate awareness states for assessing the actions of infants. One physiotherapist, with over three years of experience in early physiotherapy in infant ICU and over 10 years of experience in pediatric physiotherapy, performed the assessment. The assessment was videotaped, and all three physiotherapists were present for the scoring. The inter-examiner reliability was within the 0.95 range. Ethical approval was given by the Pusan Marie Hospital Committee of Medical Ethics, and consent was obtained from the infants' mothers prior to inclusion in the study.

Data were analyzed using SPSS v.12.0 for Windows. Differences were considered to be statistically significant

Table 1. Characteristics of the Subjects

Group		N	Sex		Delivery type		GA	MA	BWt	BHt	BHC	A/S(1)	A/S(5)
			M	F	C-sec	NSVD	(month)	(year)	(kg)	(cm)	(cm)		
BWt	AGA	19	10	9	12	7	38.4 ± 1.0	31.6 ± 4.3	3.1 ± 0.3	49.4 ± 1.7	33.9 ± 1.5	7.7 ± 0.8	8.7 ± 0.6
	LBW	16	11	5	12	4	34.4 ± 1.6	31.3 ± 3.5	2.1 ± 0.3	44.7 ± 2.4	31.5 ± 1.7	5.3 ± 1.6	7.4 ± 1.1
	VLBW	16	4	12	14	2	29.9 ± 3.1	30.4 ± 3.7	1.2 ± 0.2	37.9 ± 3.0	26.8 ± 1.9	4.8 ± 2.8	6.2 ± 3.1
GA	38 weeks or older	17	8	9	10	7	38.6 ± 0.7	31.9 ± 4.4	3.1 ± 0.3	49.4 ± 1.7	33.8 ± 1.5	7.7 ± 0.8	8.7 ± 0.6
	younger than 37 weeks	19	15	4	15	4	35.0 ± 1.4	31.1 ± 3.5	2.1 ± 0.4	44.7 ± 3.4	31.7 ± 2.1	5.7 ± 1.6	7.8 ± 1.1
	younger than 32 weeks	15	2	13	13	2	29.1 ± 2.0	30.4 ± 3.6	1.2 ± 0.3	38.1 ± 3.3	26.7 ± 1.9	4.3 ± 2.7	5.7 ± 3.1

C-sec, Caesarean section; NSVD, normal spontaneous vaginal delivery; GA, gestational age; MA: mother's age; BWt, birth weight; BHt, birth height; BHC, birth head circumference; A/S(1), Apgar score (1min); A/S(5), Apgar score (5min) for values of $p<0.05$. The frequency and mean value of the subjects' general characteristics were calculated. For the TIMP results, cross-analysis was performed on the relationship between each group and the observed items. One-way analysis of variance (ANOVA) was conducted on the relationship between each group and the elicited items and Scheffe's test was used as a post hoc test.

RESULTS

This study examined the developmental characteristics of term infants and premature infants according to with their birth weights and gestational ages. The results are as follows.

Table 2 shows the scores of the 13 observed motor performance items (O). There were statistically significant differences among the three birth weight in head in midline (O-1), isolated left ankle movement (O-8), and fidgety movement (O-10) ($p<0.05$). There were statistically significant differences among the three gestational age groups in isolated left/right ankle movement (O-7, 8) and fidgety movement (O-10) ($p<0.05$). Therefore, O-8 and O-10 were items that showed statistically significant differences among the three groups classified according to both birth weight and gestational age. Total observed scores were 8.5 ± 0.9 in the birth weight group and 8.1 ± 0.7 in the gestational age group, but they were not statistically significant. Therefore, developmental characteristics according to the two classification methods were not greatly different from each other.

The grading results of elicited items (E) are presented in Table 3. There were statistically significant differences among the three groups classified according to both birth weight and gestational age in the following observed items: head rotation side to side (E-1), head control-supported sitting (E-2), head control-anterior neck muscles (E-4), head control-lowered from sitting (E-5), defensive reaction-head and neck response (E-12), left rolling elicited from the legs (E-17), left rolling elicited from the arms (E-18), pull to sit (E-19), lateral straightening of the head and body with arm support (E-20), lateral hip abduction reaction (E-21), prone suspension (E-22), and head lift in prone position (E-23) (Table 2).

Only the three gestational age groups showed statistically significant differences in head control-posterior neck muscles (E-3). Total elicited score was significantly different among the three groups classified according to both gestational age and birth weight. Therefore, developmental characteristics were little different in the three groups classified according to birth weight and gestational age.

DISCUSSION

This study classified term infants, whose post-conceptual age was about 40 weeks, and premature infants according to birth weight and gestational age and examined their developmental characteristics using TIMP. The observed Scale on TIMP (Ver. 5.0) dichotomously scores behaviors reflecting infants' spontaneous attempts to change position or to orient the body in various ways, to selectively move individual body segments, and to perform the qualitative types of movements mentioned earlier[17].

In this study, head in midline, isolated left ankle movement, and fidgety movement among the observed scales of TIMP were different among the three groups classified according to both gestational age and birth weight. Among the developmental characteristics displayed in the groups classified according to gestational age and birth weight, only head in midline (O-1) was significantly different among the three birth weight groups but there was no significantly different item among the three gestational age groups. Head in midline (O-1) is a measure of the ability to independently maintain the head. Head control, the infant's ability to independently control head position in a variety of spatial orientations and in response to a variety of sensory stimuli, is an important aspect of postural development in the early months of life and is frequently impaired in children with cerebral palsy[15]. Isolated right ankle movement (O-9), which is considered to be an assessment of symmetry between the right and left side, was significantly different only among the three gestational age groups. In a study that observed preterm infants born at about 30 weeks of gestational age, the rate of symmetric posture in their legs and arms was 68% and 43%, respectively[18] with observation time standard at 100%. These results are in close agreement with Lee et al. [5] , who reported the full-term infants presented greater symmetry than preterm infants.

Isolated left ankle movement (O-8) and fidgety movement (O-10) are items that are hard to perform, and are performed by infants with high TIMP scores[15]. Responses of individuals with low birth weights or short gestational ages are weak, showing a difference from individuals with adequate weight or normal gestational ages. In a study that observed premature infants born at post-menstrual gestational age of 30 weeks, their arms largely had a bending posture, while their legs had close to an extension posture[18]. In the observed scales, O-11, O-12, and O-13 are items that may be observed during the 7th to 10th weeks after birth[17]. The response level for these items was very weak in all the subjects of this study, showing no difference.

The second part of the TIMP test is the Elicited Scale. Performance of these items reflects the infant's ability to solve movement "problems" posed to elicit evidence of developing postural control in a variety of spatial orientations[15]. Items E-1 through E-5 are associated with the head, and all of the five items were significantly different among the three gestational age groups. Head control-posterior neck muscles (E-3) was not different among the three birth weight groups.

At the age of 39 weeks, all the full-term infants could sit without support. In contrast, half of the pre-term infants could not sit without support, and the majority of them could not rotate the trunk in this position[19]. The preterm infants had more difficulty maintaining a long-lasting position when prone, and soon expanded the areas of load bearing, demanding less participation of the head and limbs to explore the environment[20]. Vision is known to be related to cognitive development[21], and in this study, head held in midline without visual stimulation (E-8), and head held in midline with visual stimulation (E-9) were not different

Table 2. A comparison of TIMP observed items

Items	BW						GA					
	AGA (n=19)		LBW (n=16)		VLBW (n=16)		38 weeks or older (n=17)		younger than 37 weeks (n=19)		younger than 32 weeks (n=15)	
	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
1. Head in Midline: Head is held within 15° of midline for at least 2 seconds*	14 (73.7)	5 (26.3)	9 (56.3)	7 (43.8)	5 (31.3)	11 (68.8)	12 (70.6)	5 (29.4)	11 (57.9)	8 (42.1)	5 (33.3)	10 (66.7)
2. Individual Rt. Finger Movement: Individual finger movement is noted in the Rt. hand without other joint movements(any position)	0 (0)	19 (100)	1 (6.3)	15 (93.8)	0 (0)	16 (100)	0 (0)	17 (100)	0 (0)	19 (100)	1 (6.7)	14 (93.3)
3. Individual Lt. Finger Movement: Individual finger movement is noted in the Lt. hand without other joint movements(any position)	0 (0)	19 (100)	2 (12.5)	14 (87.5)	1 (6.3)	15 (93.8)	0 (0)	17 (100)	1 (5.3)	18 (94.7)	2 (13.3)	13 (86.7)
4. Fingers objects or surfaces with Rt hand (any position)	2 (10.5)	17 (89.5)	1 (6.3)	15 (93.8)	3 (18.8)	13 (81.3)	0 (0)	17 (100)	3 (15.8)	16 (84.2)	3 (20)	12 (80)
5. Fingers objects or surface with Lt hand (any position)	2 (10.5)	17 (89.5)	2 (12.5)	14 (87.5)	3 (18.8)	13 (81.3)	0 (0)	17 (100)	4 (21.1)	15 (78.9)	3 (20)	12 (80)
6. Bilateral Hip and Knee Flexion: Demonstrates bilateral hip and knee flexion so that the feet clear the support surface	1 (5.3)	18 (94.7)	2 (12.5)	14 (87.5)	2 (12.5)	14 (87.5)	0 (0)	17 (100)	2 (10.5)	17 (89.5)	3 (20)	12 (80)
7. Isolated Rt. Ankle Movement:Demonstrates isolated Rt. ankle movement without other joint movements (any position) **	1 (5.3)	18 (94.7)	2 (12.5)	14 (87.5)	4 (25.0)	12 (75.0)	0 (0)	17 (100)	2 (10.5)	17 (89.5)	5 (33.3)	10 (66.7)
8. Isolated Lt. Ankle Movement: Demonstrates isolated Lt. ankle movement without other joint movements (any position)***	1 (5.3)	18 (94.7)	1 (6.3)	15 (93.8)	6 (37.5)	10 (62.5)	0 (0)	17 (100)	1 (5.3)	18 (94.7)	7 (46.7)	8 (53.3)
9. Reciprocal Kicking: Demonstrates reciprocal kicking with both legs off the support surface	5 (26.3)	14 (73.7)	7 (43.8)	9 (56.3)	10 (62.5)	6 (37.5)	5 (29.4)	12 (70.6)	7 (36.8)	12 (63.2)	10 (66.7)	5 (33.3)
10. Fidgety Movement: Demonstrates ongoing flow of small, minute movement occurring in every part of body and showing great variety with frequent changes of direction***	13 (68.4)	6 (31.6)	16 (100)	0 (0)	15 (93.8)	1 (6.3)	11 (64.7)	6 (35.3)	19 (100)	0 (0)	14 (93.3)	1 (6.7)
11. Ballistic movement of the arm or legs (swipes or swats)	19 (100)	0 (0)	16 (100)	0 (0)	16 (100)	0 (0)	17 (100)	0 (0)	19 (100)	0 (0)	15 (100)	0 (0)
12. Oscillation of arm or leg during movement. A Movement cycle lasts 0.5-1sec	17 (89.5)	2 (10.5)	16 (100)	0 (0)	16 (100)	0(0)	16 (94.1)	1 (5.9)	18 (94.7)	1 (5.3)	15 (100)	0 (0)
13. Reaches for Person or Object: While supine or sitting, reaches for and contacts a person or object presented at the midline	18 (94.7)	1 (5.3)	16 (100)	0 (0)	16 (100)	0(0)	16 (94.1)	1 (5.9)	19 (100)	0 (0)	15 (100)	0 (0)
Total observed Score				8.5 ± 0.9						8.1 ± 0.7		

*: p<0.05 in the BW; **: p<0.05 in the GA; ***: p<0.05 in the BW& p<0.01 in the GA; FT: Full term; PT: Preterm

Table 3. A comparison of TIMP elicited items

items	AGA[a] (n=19)	LBW[b] (n=16)	VLBW[c] (n=16)	38 weeks or older [d] (n=17)	younger than 37 weeks [e] (n=19)	younger than 32 weeks [f] (n=15)
1. Head Rotation Side to Side	1.0 ± 0.2	0.9 ± 0.5	0.5 ± 0.5	1.0 ± 0.0	0.8 ± 0.5	0.5 ± 0.5
		** a,b > c			*** f > e, d	
2. Head Control-Supported Sitting	2.0 ± 0.6	1.4 ± 0.8	1.0 ± 0.6	2.1 ± 0.3	1.3 ± 0.8	1.0 ± 0.7
		*** c,b < a			*** f, e > d	
3. Head Control-Posterior Neck Muscles	2.0 ± 0.5	1.7 ± 0.8	1.5 ± 0.8	2.1 ± 0.3	1.6 ± 0.8	1.5 ± 0.8
					* f, e > d	
4. Head Control-Anterior Neck Muscles	1.9 ± 0.7	0.8 ± 0.6	0.6 ± 0.5	2.1 ± 0.3	0.7 ± 0.6	0.5 ± 0.5
		*** c,b < a			*** f, e > d	
5. Head Control-Lowered from Sitting	1.8 ± 0.6	0.9 ± 0.7	0.4 ± 0.7	2.0 ± 0.0	0.7 ± 0.8	0.5 ± 0.5
		*** c,b < a			*** f, e > d	
6. Rt. Inhibition of Neonatal Neck Righting	0.9 ± 0.5	0.9 ± 0.5	1.1 ± 0.9	0.9 ± 0.5	0.9 ± 0.6	1.1 ± 0.8
7. Lt. Inhibition of Neonatal Neck Righting	0.8 ± 0.5	0.9 ± 0.4	1.0 ± 0.8	0.9 ± 0.5	0.9 ± 0.6	1.0 ± 0.8
8. Head in Midline without Visual Stimulation	1.8 ± 0.7	1.5 ± 1.2	2.3 ± 1.0	2.1 ± 0.2	1.5 ± 1.1	2.2 ± 1.2
9. Head Held in Midline with Visual Stimulation	0.7 ± 0.5	1.0 ± 0.6	0.5 ± 0.6	0.7 ± 0.5	1.0 ± 0.6	0.7 ± 0.2
10. Rt. Supine Neck Rotation	0.68 ± 0.48	0.69 ± 0.48	0.50 ± 0.63	0.71 ± 0.47	0.63 ± 0.50	0.53 ± 0.64
11. Lt. Supine Neck Rotation	0.7 ± 0.5	0.8 ± 0.6	0.5 ± 0.6	0.7 ± 0.5	0.7 ± 0.6	0.5 ± 0.6
12. Defensive Reaction-Head and Neck Response	2.7 ± 0.8	2.9 ± 0.3	2.0 ± 1.2	2.8 ± 0.4	2.7 ± 0.8	2.0 ± 1.2
		** c < a, b			* f, e > d	
13. Defensive Reaction-Arm Movement	1.0 ± 0.2	1.2 ± 0.5	1.1 ± 0.8	1.0 ± 0.0	1.2 ± 0.6	0.9 ± 0.7
14. Hip and Knee Flexion	2.0 ± 0.4	1.8 ± 0.8	1.6 ± 0. 9	2.1 ± 0.2	1.8 ± 0.7	1.5 ± 0.9
					***f, e > d	
15. Rt. Rolling: Elicited from the Legs	2.4 ± 0.9	2.4 ± 1.0	2.3 ± 0.8	2.5 ± 0.7	2.3 ± 1.1	2.2 ± 0.8
16. Lt. Rolling: Elicited from the Legs	2.7 ± 0.9	2.7 ± 0.7	2.3 ± 0.8	2.8 ± 0.8	2.7 ± 0.8	2.1 ± 0.7
					*** f, e>d	
17. Rt. Rolling: Elicited from the Arms	2.5 ± 0.6	2.5 ± 0.9	1.9 ± 0.9	2.7 ± 0.5	2.4 ± 0.9	1.8 ± 0.9
		*			* f, e > d	
18. Lt. Rolling: Elicited from the Arms	2.7 ± 0.6	2.7 ± 0.8	2.1 ± 0.7	2.8 ± 0.4	2.6 ± 0.8	2.1 ± 0.7
		*			* f, e > d	
19. Pull to Sit	2.3 ± 1.0	1.7 ± 0.5	1.1 ± 0.8	2.6 ± 0.5	1.6 ± 0.7	1.0 ± 0.8
		*** c, b < a			*** f > e >d	
20. Lateral Straightening of the Head and Body with Arm Support	0.7 ± 0.5	0.1 ± 0.3	0.0 ± 0.0	0.8 ± 0.4	0.1 ± 0.3	0.0 ± 0.0
		*** c, b < a			*** f, e > d	
21. Lateral Hip Abduction Reaction	0.6 ± 0.5	0.3 ± 0.5	0.0 ± 0.0	0.7 ± 0.5	0.2 ± 0.4	0.0 ± 0.0
		*** c, b < a			*** f, e > d	
22. Prone Suspension	1.8 ± 0.5	1.5 ± 0.5	1.1 ± 0.5	2.0 ± 0.0	1.4 ± 0.6	1.1 ± 0.6
		*** c, b < a			*** f, e > d	
23. Head Lift in Prone	1.8 ± 0.5	1.4 ± 0.6	1.2 ± 0.7	2.0 ± 0.0	1.4 ± 0.7	1.1 ± 0.6
		** c, b < a			*** f, e > d	
24. Crawling	1.3 ± 0.6	1.2 ± 0.8	1.1 ± 0.9	1.4 ± 0.5	1.2 ± 0.8	1.0 ± 0.9
25. Rt. Head Turn in Prone to Sound	1.1 ± 0.3	0.9 ± 0.3	1.1 ± 0.5	1.1 ± 0.2	1.0 ± 0.3	1.1 ± 0.5
26. Lt. Head Turn in Prone to Sound	1.2 ± 0.4	1.1 ± 0.4	1.1 ± 0.5	1.1 ± 0.3	1.1 ± 0.5	1.1 ± 0.4
27. Standing	1.5 ± 0.6	1.6 ± 0.5	1.3 ± 0.7	1.6 ± 0.5	1.4 ± 0.8	1.4 ± 0.5
28. Rt. Lateral Head Righting	1.8 ± 0.6	1.6 ± 0.5	1.4 ± 0.6	1.9 ± 0.5	1.5 ± 0.6	1.5 ± 0.6
29. Lt. Lateral Head Righting	1.7 ± 0.5	1.6 ± 0.5	1.4 ± 0.6	1.8 ± 0.4	1.5 ± 0.5	1.5 ± 0.6
Total elicited Score	46.0 ± 9.5	40.6 ± 6.8	34.6 ± 10.5	48.8 ± 3.0	38.8 ± 9.1	33.9 ± 10.8
		** c, b < a			*** f, e > d	

*: p<0.05, **: p<0.01, ***: p≤0.001.

among the three groups classified according to both gestational age and birth weight. Head control is an important aspect of postural development in the early months of life[5].

Right/left rolling elicited from the arms (E-17/18), pull to sit (E-19), and right/left head turn in prone position to sound (E-25/26) are difficult items to assess, and they may evaluate lateral righting of the head and trunk[15]. Diagonal and rotational components of movement require advanced levels of skill relative to sagittal-plane movements of flexion and extension[15]. In this study, E-18 and E-19 were different among the three groups classified according to both gestational age and birth weight, while E-25 and E-26 were not. E-25 and E-26 are measures of response to auditory stimuli, and they are difficult items to assess therefore, the performance of term infants and normal weight infants appears to be weak.

This study classified premature infants and term infants according to gestational age and birth weight and compared their degrees of development. Regardless of birth weight or gestational age, there appeared to be no differences in the development evaluation results. However, we consider it necessary to examine which classifications, gestational age or birth weight, may lead to more accurate prognoses by looking at long-term developmental degrees of infants.

REFERENCES

1) Korea National Statistics Office, 2008.
2) Foulder-Hughes LA, Cooke RW: Motor, cognitive and behavioural disorders in children born very preterm. Dev Med Child Neurol, 2003, 45: 97–103. [Medline] [CrossRef]
3) Sullivan MC, McGrath MM: Perinatal morbidity, mild motor delay and later school outcomes. Dev Med Child Neurol, 2003, 45: 104–112. [Medline] [CrossRef]
4) Colvin M, McGuire W, Fowlie PW: Neurodevelopmental outcomes after preterm birth. BMJ, 2004, 329: 1390–1393. [Medline] [CrossRef]
5) Lee EJ, Kak HB, Oh TY, et al.: Comparison of motor development of preterm and full term infants. J Phys Ther Sci, 2011, 23: 745–748.
6) Mahoney MC, Cohen MI: Effectiveness of developmental intervention in the neonatal physical therapy. Pediatr Phys Ther, 2005, 17: 194–208. [Medline] [CrossRef]
7) Swaiman KF, Wu Y: Cerebral palsy. In: Pediatric neurology principles and practice. 4th ed. Philadelphia: Mosby, 2006, pp 88–102.
8) Latal B: Prediction of neurodevelopmental outcome after preterm birth. Pediatric Neurology. Pediatr Neurol, 2009, 40: 413–419. [Medline] [CrossRef]
9) Flegel J, Thuhi HAK: Predictive validity of the test of infant motor performance as measured by the Bruininks-Oseretsky Test of motor proficiency at school age. Phys Ther, 2002, 82: 762–771. [Medline]
10) Kolobe TH, Bulanda M, Susman L: Predicting motor outcome at preschool age for infants tested at 7, 30, 60, and 90 days after term age using the test of infant motor performance. Phys Ther, 2004, 84: 1144–1156. [Medline]
11) Kilbride HW, Thorstad K, Daily DK: Preschool outcome of less than 801gram preterm infants compared with full-term siblings. Pediatrics, 2004, 113: 742–747. [Medline] [CrossRef]
12) Hack M, Fanaroff AA: Outcomes of children of extremely lowbirth weight and gestational age in the 1990's. Early Hum Dev, 1999, 53: 193–218. [Medline] [CrossRef]
13) Campbell SK: Framework for the measurement of neurologic impairment and disability. In contemporary management of motor control problems. Proceedings of the II STEP Conference. Alexandria. Phys Ther, 1991: 143–154.
14) Campbell SK: The child's development of functional movement. In: Campbell SK, Vander Linden DW, Palisano RJ, eds. Physical Therapy for Child. Philadelphia: WB Saunders Co, 1994, pp 3–37.
15) Campbell SK, Kolobe TH, Osten ET, et al.: Constrtict validity of the Test of Infant Motor Performance. Phys Ther, 1995, 75: 585–596. [Medline]
16) Brazelton TB: Neonatal Behavioral Assessment Scale. 2nd ed. Clinics in developmental Medicine No. 68. Philadelphia: Lippincott, 1984, pp1–15.
17) Hadders-Algra M, Prechtl HF: Developmental course of general movements in early infancy, I: descriptive analysis of change inform. Early Hum Dev, 1992, 28: 201–213. [Medline] [CrossRef]
18) van Oostenbrugge RJ, Vles JS: Posture in low-risk pre-term infants of 30 weeks postmenstrual age. Brain Dev, 1995, 17: 253–255. [Medline] [CrossRef]
19) de Groot L, Hopkins B, Touwenb B: Muscle power, sitting unsupported and trunk rotation in pre-term infants. Early Hum Dev, 1995, 43: 37–46. [Medline] [CrossRef]
20) Gaetan EM, Moura-Riveiro M: Developmental study of early posture control in preterm and full term infants. Arq Neuropsiquiatr, 2002, 60: 954–958. [Medline] [CrossRef]
21) Ramenghi LA, Ricci D, Mercuri E, et al.: Visual performance and brain structures in the developing brain of pre-term infants. Early Hum Dev, 2010, 86: 73–75. [Medline] [CrossRef]