Archives of Pediatrics
Leport B, et al. Jezierska J. Arch Pediatr 7: 216.
www.doi.org/10.29011/2575-825X.100216
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Research Article

Positional Head Deformities is not Associated with an Increase of the Psychomotor Development at 24 Months of Age

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Citation: Leport B, Duflos C, Papalardo P, Daude H, Picot M, et al., (2022) Positional Head Deformities is not Associated with an Increase of the Psychomotor Development at 24 Months of Age. Arch Pediatr 7: 216. DOI: 10.29011/2575-825X.100216

Received Date: 01 August 2022; **Accepted Date:** 10 August 2022; **Published Date:** 12 August 2022.

Abstract

Objective: To screen the psychomotor development at 24 months of age in children in whom a positional head deformity (PHD), plagiocephaly or brachycephaly, was detected at birth or in the first months of life. **Methods:** This retrospective study included children with a PHD detected during a specialist consultation in a tertiary centre. In clinical practice, the standardized Ages and Stages Questionnaire at 24 months (ASQ-24) was filled in by the parents at home and sent back to the hospital. The questionnaire results and the children's perinatal characteristics were studied to determine whether PHD influenced their psychomotor development and identify confounding factors that could affect psychomotor development. **Results:** Based on the ASQ-24 scores, psychomotor development in at least two ASQ domains was delayed in 13 of the 158 included children (8.23%), a rate not different from what found in the general population at 24 months (5-8%). Among the perinatal characteristics, only intra-uterine growth restriction was associated significantly with psychomotor delay. **Conclusion:** PHD presence does not associate at the risk of psychomotor delay at 24 months according to the ASQ24 test used in the general population of the same age.

Keywords: Positional Head Deformities; Plagiocephaly; Brachycephaly; Psychomotor Development; Sudden Infant Death Syndrome.

Introduction

There is a scientific consensus on measures to prevent sudden infant death syndrome (SIDS), particularly sleeping in the supine decubitus position. Since the 1990s, "Back to sleep" campaigns to promote the supine sleeping position have reduced SIDS incidence by more than 50% [1]. The concomitant increase in the incidence of positional head deformities (PHD; plagiocephaly and brachycephaly) up to 600% suggests a causal link [2-5]. However, other risk factors of PHD development have been identified, among which the most important is the limitation of the infant's free and spontaneous physical movements. This knowledge allowed putting in place effective PHD prevention measures [6] while respecting the need of sleeping in supine decubitus.

PHD prevalence in < 1-year-old infants ranges between 16% and 48%, in the function of the chosen diagnostic criteria [7]. Therefore, it is important to determine whether PHDs can have other consequences besides cosmetic ones. Among the possible consequences, mandibular asymmetry [8], dental malocclusion [9], visual [10] and auditory [11] problems have been described. Moreover, many authors highlighted the association

between PHDs and psychomotor developmental delays [12-19], although a causal link was never demonstrated. These authors rather suggested that the presence of a PHD can be considered a marker of the risk of developmental delay. Conversely, other authors did not find any association [20, 21].

To our knowledge, psychomotor development has never been analysed in French infants/toddlers with a PHD. Our study aimed to screen psychomotor development at 24 months in children with a PHD (primary objective). The secondary objective was to compare the perinatal characteristics of toddlers with a psychomotor delay at 24 months with those without delay to identify possible confounding factors that could affect psychomotor development.

Materials and Methods

This observational, retrospective, monocentric, questionnaire-based study was carried out following the Declaration of Helsinki at the Paediatric Plastic Surgery Department of Montpellier University Hospital between December 2013 and November 2020. In France, children with a suspected PHD are referred for a specialist consultation (level 3) (mostly before 12 months of age) by their general practitioner or pediatrician, following their physical therapist's advice, or due to the parent's concerns about their head shape. At the Paediatric Plastic Surgery Department of Montpellier University Hospital, two follow-up visits are proposed after this first consultation for children with PHD: one at the age of 18 months to confirm gait acquisition, head posture and congenital torticollis resolution (if present at the first visit), and another at the age of 36 months to monitor head growth and remodeling. During these visits, the following data are collected: symmetry or asymmetry of head rotation, shoulder positioning on the horizontal plane, head circumference, cranial vault asymmetry index (CVAI), and PHD type [22-24] [frontal-occipital plagiocephaly (FOP), occipital plagiocephaly (OP), or posterior brachycephaly (PB)]. The skull deformity is measured with an anthropometric caliper. The CVAI is the ratio between the long and short cranial diagonal diameter [25, 26]. It is calculated by dividing the difference between the two diagonals divided by the value of the greater diagonal. A CVAI $\geq$ 4 % was considered as asymmetric. The head circumference is measured with a measuring tape. Between the 18-month and 36-month visits, the ASQ-24 (version 3) is sent by post to the parents on the child's second birthday, with a pre-stamped return envelope. Once sent back to the department, the ASQ-24 responses are analysed by a speech therapist and the surgeon who follows the child. If the score is below the normal range, the child's pediatrician is contacted for organizing a psychomotor assessment. The ASQ-24 is a psychomotor development screening tool created in 1980 and revised in 1991, 1994 and 1997. It is adapted to the infant's age (from 4 to 48 months) and has been designed to be completed by the parents at home. Its validity as a screening tool (87.4% of sensitivity and 95.7% of specificity) has been validated by several groups and in different cultures [22]. This test allows assessing the child's skills in five domains of psychomotor development: communication, gross motor skills, fine motor skills, problem-solving, and individual/social skills. Each domain includes six questions to which the parents answer "yes" if the child can perform the activity (10 points), "sometimes" if the child performs the activity occasionally (5 points), and "no" if the child does not perform the activity (0 points). Therefore, for each domain, the score ranges from 0 to 60 points. The scores for each domain are compared to the threshold score for that domain. If the score for one or more domains is below the threshold, a psychomotor delay is suspected, and the child should be referred to specialist consultation. The second part of the ASQ-24 includes nine questions on the infants' hearing, vision, health, behaviour, and other potential parental concerns. In function of the answers, the infant may be referred for specialist assessment with a follow-up, if necessary.

For this study, all children with a PHD (plagiocephaly or/and brachycephaly), who had the 18-month visit and whose parents completed the ASQ-24 when the child was aged between 23 months and 25 months ± 15 days were included in the analysis. Exclusion criteria were the presence of craniosynostosis, the absence of PHD, and incomplete health records at the 18-month visit. All ASQ-24 questionnaires received during the study period were analysed.

Besides PHD, a developmental delay could be explained also by the child's perinatal history, such as the presence moulded baby syndrome [23] or of another pathology. Therefore, the perinatal history of each included child was collected from the record of the first consultation written by the surgeon.

Anonymized data (ASQ-24 scores and perinatal clinical characteristics) were recorded in Excel by two different authors. For the primary outcome analysis (percentage of children with a psychomotor delay at 24 months based on the ASQ-24), categorical variables were described with numbers and percentages, and their 95% confidence intervals (CI). For the secondary outcome analysis (perinatal characteristics that could affect psychomotor development), quantitative variables were described with numbers, means ± standard deviation (SD), median, 1st and 3rd quartiles and extreme values. The normality of data distribution was assessed with the Shapiro-Wilk test. The characteristics of children with psychomotor delay in at least two ASQ-24 domains were compared with those of children without psychomotor delay using the Wilcoxon Mann-Whitney test for quantitative variables, and the Chi-2 test (or Fisher's exact test if $n < 5$) for qualitative variables. Missing data were not considered in these analyses. All statistical tests were two-sided with a type I error of 0.05. Analyses were performed with the SAS software (REF).

Results

During the study period (December 2013 to November 2020), among the 252 ASQ-24 questionnaires sent to the parents, 162 were sent back to the hospital (response rate: 64.3%). Concerning, the other 90 questionnaires, 81 were not returned by the parents, and 9 were sent to the wrong address. Finally, only 158 questionnaires were retained for the analysis: three were excluded because filled in after the age of 24 months and one because it was not completely filled in.

The deformity was present at birth in 42.5% of the 158 children and in the other children, the mean age at detection was 1.6 months ± 1.2. In

16.9% of children, signs of moulded baby syndrome were recorded. At the first visit, the PHD type was FOP in 41.5% of infants, OP in 33.1% of infants, and PB in 28.8% of infants (plagiocephaly and brachycephaly were combined in 3.5% of infants). The flat occipital area was on the right side of the skull in 51.2% and on the left side in 48.7% of patients. Torticollis was present in 74.8% of infants. According to the parents, 86.5% of infants slept on their back, 10.1% in the prone position, and 20.2% on the side (with possible changes). An associated pathology was recorded in 47.6% of infants: head or face anomaly in 23.5% of infants (cephalohaematoma, metopic ridge, macrocephaly or microcephaly, craniotabes, stagnation or rapid increase of the head circumference, □sugarloaf□ deformation of the head at birth, mandibular asymmetry, brachygnathism), skeletal anomaly in 9.6% of infants, hypotonia or other neurological abnormality that could affect mobility in 4.1% of infants, visceral anomaly in 5.5% of infants, and intra-uterine growth restriction (IUGR) in 2.7% of infants.

At the 18-month visit, the PHD was still present in 87.3% of toddlers. The mean CVAI was 5.9% (range: 0 - 15.63%). The PHD distribution was: 37.0% of OP, 31.0% of FOP, and 32.7% of PB. At 18 months, the flat occipital area was on the right side of the head in 54.5%, on the left in 40.9%, and bilateral in 4.5% of children. In most children, head rotation and shoulder positioning on the horizontal plane were normal (89.2% and 94.5%, respectively) by clinical examination. Moreover, 92.9% of infants could walk. Concerning PHD management, 85.4% of infants received physiotherapy, associated with osteopathy in > 50%. Ten children (6.9%) had only osteopathic treatment, one child wore a helmet, and nine children (6.2%) did not receive any treatment.

Analysis of the ASQ-24 results indicated that 115/158 children (72.8%) did not present any psychomotor delay, 30/158 (19.0%) presented a delay in one domain and 13/158 (8.2%) in two or more domains (Table 1). Communication was the most affected developmental domain, followed by personal/social skills, problem-solving, gross motor skills, and fine motor skills (Table 1).

Variable		N	%	95% CI
Communication - Summary	0	133	84.1	77.3; 89.3
	1	25	15.8	10.7; 22.6
	TOTAL	158		
Gross Motor Skills - Summary	0	145	91.7	86.0; 95.3
	1	13	8.2	4.6; 13.9
	TOTAL	158		
Fine Motor Skills - Summary	0	149	94.3	89.1; 97.2
	1	9	5.7	2.8; 10.8
	TOTAL	158		
Problem-solving - Summary	0	144	91.1	85.3; 94.9
	1	14	8.8	5.1; 14.7
	TOTAL	158		
Individual/Social Skills - Summary	0	143	90.5	84.5; 94.4
	1	15	9.5	5.6; 15.4
	TOTAL	158		
Presence Of Psychomotor Delay (≥ 2 Domains)	0	145	91.7	86.0; 95.3
	1	13	8.2	4.6; 13.9
	TOTAL	158		
Number Of Affected Domains	0	115	72.8	65.0; 79.4
	1	30	19	13.3; 26.1
	2	3	1.9	0.5; 5.9
	3	5	3.1	1.1; 7.6
	5	5	3.1	1.1; 7.6
	TOTAL	158		

Table 1: ASQ-24 results (n = 158 questionnaires); in each summary section; 0 = no delay and 1 = delay.

The 8.2% children with delays in two or more domains of the ASQ-24 were screened as having a psychomotor delay for the subsequent analyses. Their perinatal characteristics were compared with those of children without any psychomotor delay (i.e. only in one domain or none; n = 145). These results are summarized in (Table 2) for the qualitative variables and in Table 3 for the quantitative variables. An associated pathology was found in 69.2% of children with psychomotor delay and in 45.4% of children without delay (p = 0.10). Only IUGR was significantly associated with psychomotor delay: 15.4% of children with psychomotor delay and 1.5% of children without delay had IUGR (p = 0.04). Other pathologies tended to be more frequent (not significant) in children with psychomotor delay: hypotonia or other neurological anomalies that could affect mobility (15.4% versus 3.0%, p = 0.09), and visceral anomaly (15.4% versus 4.5%, p = 0.15). The severity of the CVAI was not different with or without the presence of a delay.

		Whole Sample (N = 158)		**Without Delay** (N = **145**)		**With Delay** (N = **13**)		
Variable		**N**	**%**	**N**	**%**	**N**	**%**	**P Value**
Sex	Girl	64	40.5	62	42.7	2	15.4	0.06
	Boy	94	59.5	83	57.3	11	84.6	
	TOTAL	158	100	145	100	13	100	
Twins	No	131	91.6	122	92.4	9	81.8	0.23
	Yes	12	8.4	10	7.6	2	18.2	
	TOTAL	143		132	100	11	100	
At Term	No	16	11.1	13	9.8	3	25	0.13
	Yes	128	88.9	119	90.2	9	75	
	TOTAL	144		132	100	12	100	
Presentation	Bridge	15	14.3	15	15.5	0	0	0.23
	Head	90	85.7	82	84.5	8	100	
	TOTAL	105		97	100	8	100	
Labour Induction	No	111	78.2	102	77.8	9	81.8	1
	Yes	31	21.8	29	22.2	2	18.2	
	TOTAL	142		131	100	11	100	
Delivery Method	Caesarean	31	24.6	28	24.1	3	30	0.71
	Vaginal	95	75.4	88	75.9	7	70	
	TOTAL	126		116	100	10	100	
Instrumental Vaginal Delivery	No	111	80.4	104	81.9	7	63.6	0.23
	Yes	27	19.6	23	18.1	4	36.4	
	TOTAL	138		127	100	11	100	
Type of Instrument	Forceps	12	52.2	10	50	2	66.7	1
	F + V	1	4.3	1	5	0	0	
	Ventouse	10	43.5	9	45	1	33.3	
	TOTAL	23		20	100	3	100	

Head Deformation at Birth	No	77	57.4	72	57.6	5	55.6	1
	Yes	57	42.6	53	42.4	4	44.4	
	TOTAL	134		125	100	9	100	
Moulded Baby Syndrome	No	118	83.1	107	81.7	11	100	0.12
	Yes	24	16.9	24	18.3	0	0	
	TOTAL	142		131	100	11	100	
Premature Membrane Rupture	No	127	91.4	120	92.3	7	77.8	0.17
	Yes	12	8.6	10	7.7	2	22.2	
	TOTAL	139		130	100	9	100	
Maternal Pathology	No	123	86.6	112	86.1	11	91.7	1
	Yes	19	13.4	18	13.9	1	8.3	
	TOTAL	142		130	100	12	100	
Neonatal Pathology	No	76	52.4	72	54.5	4	30.7	0.1
	Yes	69	47.6	60	45.5	9	69.3	
	TOTAL	145		132	100	13	100	
Macrocephaly	No	134	92.4	123	93.2	11	84.6	0.26
	Yes	11	7.6	9	6.8	2	15.4	
	TOTAL	145		132	100	13	100	
Craniofacial Anomaly	No	111	76.5	101	76.5	10	76.9	1
	Yes	34	23.5	31	23.5	3	23.1	
	TOTAL	145		132	100	13	100	
Neurological-Motor Defects	No	139	95.8	128	97	11	84.6	0.09
	Yes	6	4.2	4	3	2	15.4	
	TOTAL	145		132	100	13	100	
Skeletal Anomalies	No	131	90.3	118	89.4	13	100	0.22
	Yes	14	9.7	14	10.6	0	0	
	TOTAL	145		132	100	13	100	
Visceral Anomalies	No	137	94.5	126	95.5	11	84.6	0.15
	Yes	8	5.5	6	4.5	2	15.4	
	TOTAL	145		132	100	13	100	
IUGR	No	141	97.2	130	98.5	11	84.6	0.04
	Yes	4	2.8	2	1.5	2	15.4	
	TOTAL	145		132	100	13	100	

Torticollis	No	36	25.2	32	24.4	4	33.3	0.5
	Yes	107	74.8	99	75.6	8	66.7	
	TOTAL	143		131	100	12	100	
Occipital Plagiocephaly	No	95	66.9	87	66.9	8	66.7	1
	Yes	47	33.1	43	33.1	4	33.3	
	TOTAL	142		130	100	12	100	
Frontal-Occipital Plagiocephaly	No	83	58.5	76	58.5	7	58.3	1
	Yes	59	41.5	54	41.5	5	41.7	
	TOTAL	142		130	100	12	100	
Posterior Brachycephaly	No	101	71.1	93	71.5	8	66.7	0.74
	Yes	41	28.9	37	28.5	4	33.3	
	TOTAL	142		130	100	12	100	
Flat Occipital Area	Right	20	51.3	18	51.4	2	50	1
	Left	19	48.7	17	48.6	2	50	
	TOTAL	39		35	100	4	100	
Sleeping in Dorsal Decubitus	No	12	13.5	10	12.5	2	22.2	0.35
	Yes	77	86.5	70	87.5	7	77.8	
	TOTAL	89		80	100	9	100	
Sleeping in Ventral Decubitus	No	80	89.9	73	91.3	7	77.8	0.22
	Yes	9	10.1	7	8.7	2	22.2	
	TOTAL	89		80	100	9	100	
Sleeping in Lateral Decubitus	No	71	79.8	66	82.5	5	55.5	0.08
	Yes	18	20.2	14	17.5	4	44.5	
	TOTAL	89		80	100	9	100	
Physical Therapy	No	21	14.6	18	13.7	3	23.1	0.41
	Yes	123	85.4	113	86.3	10	76.9	
	TOTAL	144		131	100	13	100	
Symmetric Head Mobility at 18 Months	No	13	10.1	12	10.2	1	9.1	1
	Yes	116	89.9	106	89.8	10	90.9	
	TOTAL	129		118	100	11	100	
Shoulder Positioning on the Horizontal Plane at 18 Months	No	7	5.5	7	5.9	0	0	0.41
	Yes	122	94.5	111	94.1	11	100	
	TOTAL	129		118	100	11	100	

Head Circumference at 18 Months (SD)	-2	13	11.6	12	11.6	1	11.1	0.52
	-1	9	7.9	9	8.6	0	0	
	0	72	63.8	66	63.6	6	66.7	
	1	9	7.9	9	8.6	0	0	
	2	10	8.8	8	7.6	2	22.3	
	TOTAL	113		104	100	9	100	
Head Deformation Still Present at 18 Months	No	17	12.7	17	13.9	0	0	0.17
	Yes	117	87.3	105	86.1	12	100	
	TOTAL	134		122	100	12	100	
Occipital Plagiocephaly at 18 Months	No	73	62.9	65	62.5	8	66.7	1
	Yes	43	37.1	39	37.5	4	33.3	
	TOTAL	116		104	100	12	100	
Frontal- Occipital Plagiocephaly at 18 Months	No	80	68.9	73	70.2	7	58.3	0.51
	Yes	36	31.1	31	29.8	5	41.7	
	TOTAL	116		104	100	12	100	
Posterior Brachycephaly at 18 Months	No	78	67.2	70	67.3	8	66.7	1
	Yes	38	32.8	34	32.7	4	33.3	
	TOTAL	116		104	100	12	100	
Flat Occipital Area at 18 Months	Bilateral	2	4.5	2	4.8	0	0	1
	Right	24	54.5	23	54.7	1	50	
	Left	18	41	17	40.5	1	50	
	TOTAL	44		42	100	2	100	
Who Filled in The ASQ-24?	Clinician	1	0.7	1	0.7	0	0	0.63
	Mother	122	83	112	83.6	10	76.9	
	Father	13	8.8	11	8.2	2	15.4	
	Both Parents	11	7.5	10	7.5	1	7.7	
	TOTAL	147		134	100	13	100	

Table 2: Comparison of perinatal characteristics (qualitative variables) in children with PHD and with/without psychomotor delay (≥2 ASQ domains) at 24 months; IUGR: Intra-Uterine Growth Restriction.

Children with psychomotor delay were more likely to be boys (84.6% *vs* 57.8%, p = 0.06), to have been born before term (25% *vs* 9.8%, p = 0.13), and to be twins (18.1% *vs* 7.58%, p = 0.23). Premature rupture of the membranes also tended to be more frequent in the psychomotor delay group (22.2% *vs* 7.6%, p = 0.17). Conversely, moulded baby syndrome was detected in 18.3% of children in the group without psychomotor delay and in none of the group with delay (p = 0.12). At 18 months, the skull deformity was still present in 100% of children with psychomotor delay and in 86.0% of children in the group without delay (p = 0.17). Moreover, 44.4% of children in the psychomotor delay group slept in the lateral decubitus position compared with 17.5% in the group without delay (p = 0.08). There was no association between PHD type and psychomotor delay.

Analysis of the quantitative variables (Table 3) indicated that children with psychomotor delay were more likely to be the second born in the family (1.9% *vs* 1.5%, p = 0.06) and tended to be older at the first visit (mean age: 9.6 months *vs* 7.7 months, p = 0.14). There was no association between the CVAI at 18 months and psychomotor delay (5.9% in the psychomotor delay group versus 5.8% in the group without delay, p = 0.65).

Variable		Whole Sample (N = 158)	Without Delay (N = 145)	With Delay (N = 13)	P Value
Age at First Visit (Months)	Mean (± SD)	7.9 (± 4.6)	7.7 (± 4.6)	9.6 (± 4.4)	0.14
	Median (Q25; Q75)	7.0 (5.0; 9.0)	7.0 (5.0; 9.0)	7.5(6.0; 14.0)	
	[Min; Max]	[1.0; 34.0]	[1.0; 34.0]	[5.0; 18.0]	
	N	146	134	12	
Birth Order	Mean (± SD)	1.5 (± 0.7)	1.5(± 0.7)	1.9(± 0.8)	0.06
	Median (Q25; Q75)	1.0 (1.0; 2.0)	1.00 (1.0; 2.0)	2.0(1.0; 3.0)	
	[Min; Max]	[1.0; 5.0]	[1.0; 5.0]	[1.0; 3.0]	
	N	134	123	11	
Weight at Birth (G)	Mean (± SD)	3108 (± 609)	3124 (± 575)	2943 (± 909)	0.74
	Median (Q25; Q75)	3130 (2780; 3490)	3130 (2780; 3490)	3260 (2200; 3440)	
	[Min; Max]	[885; 4560]	[1110; 4560]	[885; 4285]	
	N	125	114	11	
Head Circumference at Birth (cm)	Mean (± ET)	34.0 (± 2.1)	34.0(± 2.1)	33.5 (± 3.0)	0.95
	Median (Q25; Q75)	34.0 (33.0; 35.0)	34.00 (33.0; 35.0)	34.0 (33.0; 35.0)	
	[Min; Max]	[25.5; 44.0]	[25.5; 44.0]	[26.0; 37.0]	
	N	120	110	10	
Length at Birth (cm)	Mean (± SD)	48.5 (± 3.9)	48.5 (± 3.7)	48.1 (± 5.6)	0.93
	Median (Q25; Q75)	49.0 (47.0; 50.0)	49.0 (47.0; 50.0)	49.0 (47.0; 51.0)	
	[Min; Max]	[32.0; 54.0]	[32.0; 54.0]	[34.0; 54.0]	
	N	117	107	10	
Age at Head Deformity Appearance (Months)	Mean (± SD)	1.6 (± 1.2)	1.5 (± 1.2)	2.0 (± 1.7)	0.54
	Median (Q25; Q75)	1.0 (0.5; 2.0)	1.0 (0.5; 2.0)	1.0 (1.0; 4.0)	
	[Min; Max]	[0.5; 6.0]	[0.5; 6.0]	[1.0; 4.0]	
	N	52	49	3	

CVAI	Mean (± SD)	5.9 (± 3.2)	5.9 (± 3.2)	5.9 (± 3.3)	0.77
	Median (Q25; Q75)	5.4 (3.7; 7.9)	5.4 (3.8; 8.0)	4.8 (3.6; 6.9)	
	[Min; Max]	[0.0; 15.6]	[0.0; 15.6]	[2.7; 14.0]	
	N	119	108	11	

Table 3: Comparison of perinatal characteristics (quantitative variables) in children with PHD with and without psychomotor delay (≥ 2 ASQ domains) at 24 months; CVAI = cranial vault asymmetry index.

Discussion

The results of this study suggest that there is no association between PHD and psychomotor delay screened at 24 months. Indeed, in this study of 158 children with PHD, only 13 children (8.23%) presented a psychomotor delay (at least two domains of the ASQ-24). In the general population of the same age, delay in two or more domains is observed in 5-8% of infants [13, 22]. Moreover, nine of these thirteen children (69%) had an associated pathology (oesophageal atresia, macrocephaly, IUGR, hypotonia, epilepsy, foetal distress at delivery, heart anomaly). Similarly, among the 30 children with a delay in a single ASQ-24 domain (19.0% of the study), 15 infants (50%) had an associated pathology (macrocephaly, microcephaly, IUGR, talus deformity or metatarsus varus, hip dysplasia, mandibular or maxillary anomaly, hypotonia, genetic disorder, cryptorchidism, vertebral trauma at delivery) that may interfere with the psychomotor development, independently of the PHD. The severity of cranial asymmetry does not seem to influence the presence or absence of psychomotor retardation.

For the secondary outcome, only IUGR was significantly associated with psychomotor delay. Other perinatal characteristics tended to be associated, but not significantly, with psychomotor delay (in decreasing order of importance): male sex, higher-order birth, sleeping in lateral decubitus, hypotonia or other neurological problems that may affect mobility, moulded baby syndrome, prematurity, late first visit, presence of a visceral anormality, premature rupture of the membranes at birth, persistence of the PHD at 18 months, and twinhood. Given the small number of children with psychomotor delay in the study, it would not be possible to order to confirm these associations.

In the study by Hutchinson et al. [27] 36% of 287 infants followed due to a PHD presented a delay in one or more domains of the ASQ and 19% of infants in two or more domains. This higher rate of psychomotor delay can be explained by the fact that in this previous study, infants were only few months old (median age: 22 weeks). Indeed, the follow-up of the same study at 3-4 years of age [13] showed an improvement in the ASQ scores: only 11% of children had a delay in one or more domains, and 4% in two or more domains. The ASQ scores of our 24-month-old children were between the scores of this previous study at 22 weeks and 3-4 years [13, 27]. Most studies that reported an association between PHD and psychomotor delay were carried out in studies of infants who were only few months old [16, 18, 19, 27, 28]. Therefore, it could hypothesized that some psychomotor delays may self-correct during motor skill acquisition in childhood. This could explain the low delay rates at the age of 24 months in our study. Furthermore, in studies that found an association between PHD and psychomotor delays, psychomotor development was tested before PHD treatment [16-18]. The vast majority of children in our study (85.4%) received appropriate treatment (e.g. physiotherapy). It is possible that any developmental delay might have been corrected by the early PHD management. Schertz et al. [29] found that in infants with torticollis, motor development is delayed at the first visit (mean age: 2.9 months) but is normalized in most cases at the age of 1 year. Physical therapy sessions can be used to treat torticollis. Moreover, one of the objectives of physical therapy is to promote prone positioning ("tummy time") during the sessions and also at home, because it has been shown that too little time in the prone position when awake affects psychomotor development [20, 30]. In the literature, the developmental delays detected in school-aged children with history of PHD concerned mainly cognitive areas [12, 14, 15]. Indeed, developmental delay in gross and fine motor skills is detected more often in younger children with PHD, while cognition and language are more affected in older children [12, 28, 31]. In agreement, in our 24-month-old study, communication and individual/social skills were the most affected.

A limitation of this retrospective study based on clinical data is the lack of a local control population, which prohibits any possible comparison. The ASQ test is a scientifically validated test for screening psychomotor delay, but it was developed in 1980 and was last revised in 1997, before the generalization of the supine sleeping position [27]. The choice of the ASQ is questionable because is more akin to a screening assessment than a diagnostic assessment. In addition, some questions seem old-fashioned in the light of the evolution of the modern environment. Another limitation is the lack of further information after a psychomotor delay has been reported to the pediatrician and if a psychomotor examination has been performed.

It has been shown that infants sleeping on their back reach motor developmental milestones later than prone-sleeping and side-sleeping infants [23-34] although they catch up by the age of 18 months [34]. It is also possible that some of the exercises proposed in this test are no longer appropriate for the current pediatric population (tying shoelaces, stacking blocks, stringing beads). Therefore, it would be interesting to compare the results of our study with the results of a group of 24-month-old children representing the general pediatric population of that age. Similarly, it could be interesting to determine the percentage of children with PHD in a study of children with psychomotor delay.

Conclusion

We did not find any association between PHD and psychomotor delay at 24 months of age in this study of 158 children. Among the children's perinatal characteristics, only IUGR was significantly associated with psychomotor delay. The presence of an associated pathology could contribute to the psychomotor delay observed in children with PHDs, therefore the presence of a PHD could be used as a marker of risk of psychomotor delay.

Acknowledgments

The authors thank all the parents who filled in and sent back the questionnaire.

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