DRAWING SKILLS IN CHILDREN WITH NEURODEVELOPMENTAL DELAY AGED 2-5 YEARS

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SUMMARY – In typically developing children, drawing development occurs in stages from uncontrolled strokes to complex drawing. In this study, we examined drawing development in children with neurodevelopmental delay (NDD). In order to do so, we observed the influence of age, intraventricular hemorrhage (IVH) and gender on the development of drawing skills. The sample consisted of 52 children with NDD, aged 2 years and 6 months to 5 years. All children were hospitalized for multidisciplinary team monitoring and developmental support. The evaluation of drawing development was administered by giving each child a blank A4 paper and the instruction to draw anything they wanted. All of the drawings were scored satisfactory or unsatisfactory. Descriptive statistics was employed on all relevant data to show results in frequencies and percentages. In order to determine differences between groups, the χ^2-test was administered. The results showed greatest difference in drawing in children aged from 3 years to 3 years and 11 months. Children with lower IVH had better drawing scores than children with higher IVH levels. According to gender dissimilarities, a difference was found showing girls to have better drawing skills than boys. All study results pointed to the importance of early rehabilitation and continuous structured work with children with NDD.

Key words: *Developmental disabilities; Child, preschool; Psychomotor performance; Cognition; Art; Writing; Early intervention (education)*

Introduction

In early childhood, graphomotor activity can be observed as drawing, whereas later, at school age, it is seen as handwriting ability. In order for a child to be a successful writer, he/she has to master a variety of integrated motor and cognitive functions (the skill of holding a writing tool, controlling his/her own movements, and gain experience by doing countless line and shape drawing practices) that are all encompassed in drawing as graphomotor activity[1]. Also, in order for a child to learn how to draw, it is necessary for him/her to develop both motor skills and drawing methods[2]. Hence, without mastering the drawing skills in early childhood, one would have immense difficulties in mastering the art of letter, word, and text writing[3].

Although cognitive and motor skills seem to be two distinct features, they are profoundly connected in almost all voluntary actions[4,5]. As intentional graphic activity in infants and toddlers emerges as early as one year of age, the development of complex graphomotor capacity expands. Besides hand-motor skills, in order to efficiently draw, the child needs to acquire motor planning and organization skills, visual perception, visual-motor control, representational abilities, attention directing, and many other proficiencies[1,6].

In healthy children, the development of drawing emerges through stages, and it occurs in a specific order[7]. According to many authors[2,7-9], these stages are divided into three larger groups of mark making,

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scribbling, and drawing. The shift from simple visual-motor actions[10], such as making marks on the paper, to the ability of producing recognizable representations and shapes, happens between 1 and 5-6 years of age. Firstly, the child experiments on the paper by making marks, discernible dots, formless markings, circular marks, and then shifts to controlled use of drawing tools[7]. The same authors recognize the age between 2 years and 6 months and 3 years as a period in which the shift between making controlled strokes and drawing first geometric objects takes place. Along the same line, some authors identify age three as a period in which the child draws circular shapes, at age four children draw squares, and at age five triangular and other more complex shapes[11].

In order for the child to succeed in making this transition to complex drawing, the development of his/her central nervous, as well as muscular system has to be intact. In children with neurodevelopmental delays (NDD), impairments are mostly connected to pre-, peri- or postnatal incidents such as preterm labor, low birth weight, level of intraventricular hemorrhage (IVH), postnatal infections, etc.[5,12-15]. The level of damage to the brain is usually administered by early post-term ultrasound through the large fontanel, and the degree of damage is determined through hemorrhage severity, where levels I-II are considered as mild damage and levels III-IV as severe damage to the child's brain[13,14,16,17]. The development of children with NDDs as a whole is often disrupted, either impaired or delayed[10,18]. These children represent a group of so called at-risk children for developing developmental disabilities such as motor deficiencies, cognitive impairments, speech difficulties, learning disabilities, psychiatric disorders, epilepsy, visual, or hearing deficiency[5,14,17,19]. The developmental outcome of at-risk children depends on complex mechanisms and various factors like brain plasticity, early stimulation, enriched environment, and others[20,21]. In order for their development to have the best possible result, early diagnostics and interventions are crucial[12,19,22,23]. Therefore, these children have to get special attention and developmental support by early habilitation treatments, and on-going monitoring[17].

Most of the children that exhibit NDD also show impairments in fine motor and visual-motor skills, coordination disorders and lack redundancy in movement strategies[24,25,26]. Thus, their ability to develop firstly drawing, and later on handwriting, in a manner like their peers, is also presumably impaired. Matijević Mikelić *et al*. studied mark making in children with neurodevelopmental risks[27] and observed that 72% of children aged 1-3 years showed normal pattern of mark making development, whereas the rest showed delays in this area of development[10,18]. Another study examining older, school aged children, found that children with congenital focal brain injury to the right side produced drawings with lacking spatial organization, while children with focal injury to the left side had well organized but poor in detail drawings[25,26]. Other authors describe difficulties with coordination[26], visual perception and representational abilities[6]as influencing drawing skills in children.

Moreover, there are different attitudes toward gender differences between girls' and boys' drawing skills. Several studies confirm gender differences favoring girls[5,28,29], and additionally support this argument with the knowledge of an increased prevalence of neurodevelopmental difficulties such as developmental coordination disorder in boys, suggesting that girls outperform boys in school-related writing tasks[26,30]. On the other hand, others dispute such suggestions claiming that gender differences are irrelevant[26].

Summing up everything stated above, our main goal was to investigate whether children with NDD, aged between 2 years and 6 months and 5 years and 0 months, also show impediment in drawing abilities. Another aim of the study was to see if larger impairments observed on brain ultrasound during infancy also indicate larger drawing development delays. Finally, the third objective was to see if there is gender difference in drawing development in children with NDD.

Subjects and Methods

In this retrospective study, hospital files of 52 children hospitalized between November 2012 and May 2014 were reviewed. All study children were hospitalized at University Department of Rheumatology, Physical Medicine and Rehabilitation, Sestre milosrdnice University Hospital Center, for developmental monitoring and support. As part of their hospitalization, each child received multidisciplinary

team assessment and rehabilitation. All children were diagnosed with a form of NDD, including early changes in muscle tone, or impairments such as tetraparesis, paraparesis or hemiparesis, and their files held substantial background information on family and personal history.

As part of the routine educational-rehabilitation assessment, during the stage of parent interview, each child receives a blank sheet of plain white A4 size paper and a pencil. The instruction to the child is always to draw something by his/her own choice. Drawings are assessed later on in the process of evaluation by either age-requirement for drawing of shapes[11], or Goodenough Draw a Person Test[31], depending on the drawing content. Every drawing obtains either satisfactory or unsatisfactory rating for age-appropriateness of the child's drawing skills. It is important to note that all children had sufficient motor abilities to hold a drawing tool and perform graphomotor task independently. Also, when analyzing drawing skills, the lineage quality was not accounted for due to diverse motor performance among children.

Ethics

All patients hospitalized at the University Department of Rheumatology, Physical Medicine and Rehabilitation, Sestre milosrdnice University Hospital Center are treated in accordance with the ethical standards of the institution, and also with the Helsinki Declaration of 1975, as revised in 1983. Since the habilitation is performed with under-age children, their parents or other guardians were informed on all the procedures that were administered to the child. Also, their name and other identity information were strictly confidential, and no photos were taken during these sessions.

Statistics

Descriptive statistics was employed on all relevant data to show results in frequencies and percentages. The χ^2-test was used to determine between-group differences.

Results

In this study, 52 children, 30 (58%) boys and 22 (42%) girls, aged from 2 years and 6 months to 5 years and 0 months (average age 3 years and 2 months) were included, the youngest child being 2 years 6 months and the oldest 5 years 0 months old. The children were then grouped in three groups according to the expected changes and shifts in drawing development: group 1 between 2 years and 6 months to 2 years 11 months (12 or 23% of children); group 2 from 3-0 to 3-11 years (21 or 40% of children); and group 3 from 4-0 to 5-0 years (19 or 37% of children). Data on the diagnoses, brain ultrasound and birth term findings of the sample are shown in Table 1.

All study children were diagnosed with an NDD in the form of impaired motor development due to which they were hospitalized; 21% of the children were diagnosed with dystonia syndrome, 6% with left hemiparesis, 65% with paraparesis, and 8% with tetraparesis.

Findings of drawing development by age in the group of NDD children are shown in Figure 1 and are expressed in percentages. In groups 1 and 3, the results showed a negligible difference between the subgroups of children with NDD who had satisfactory and unsatisfactory drawing development (50:50 percent in group 1, and 53:47 percent in group 3), whereas in group 2 there was a difference between the children with satisfactory and unsatisfactory development. In

Table 1. Diagnosis, brain ultrasound and birth term findings of study sample expressed as frequency and percentage

Diagnosis	Frequency	%	Brain ultrasound	Frequency	%	Birth term	Frequency	%
Hemiparesis left	3	6	No IVH	34	65	Premature	8	15
Paraparesis	34	65	IVH grade I	2	4	Term birth	43	83
Dystonia syndrome	11	21	IVH grade I/II	5	10	Post term	1	2
Tetraparesis	4	8	IVH grade II	10	19			
			IVH grade II/III	1	2			
Total	52	100	Total	52	100	Total	52	100

IVH = intraventricular hemorrhage

Table 2. Distribution of children's drawing skills (unsatisfactory, satisfactory) according to age groups and gender, expressed as frequency

	Boys		Boys total	Girls		Girls total
Age group	Unsatisfactory drawing	Satisfactory drawing		Unsatisfactory drawing	Satisfactory drawing	
2y6m to 2y11m	4	3	7	2	3	5
3y0m to 3y11m	12	1	13	4	4	8
4y0m to 5y0m	7	3	10	3	6	9
Total	23	7	30	9	13	22

this group, 76% of children showed unsatisfactory drawing development for their age, while 24% had satisfactory drawing development. The $\chi 2$-test was used to show statistical significance of between-group difference. Statistical value at the significance level of 0.01 was confirmed for $\chi 2=24.31$ ($p=0.00000053$).

Figure 2 shows percentage results of drawing skills in children with NDD by brain ultrasound findings. The results revealed that children having no IVH and children with first grade IVH showed best drawing skills among children with NDD, while children with most severe (grade II/III) IVH showed worst results in drawing development; all children from the grade II/III group showed unsatisfactory drawing skills. Also, children with grades I/II and II IVH exhibited unsatisfactory drawings in rather large proportions, 80:20% and 60:40%, respectively. Statistical difference between groups for $\alpha<0.05$ was confirmed with $\chi^2=12.57$ ($p=0.013$).

When viewing our findings based on gender, girls were found to have better drawing skills than boys. Altogether, 41% of girls from all age groups showed unsatisfactory drawing skills as compared with 77% of boys having difficulties in drawing and showing unsatisfactory results. Percentage results of drawing skills in children with NDD by gender are shown in Figure 3. In more detail, as illustrated in Table 2, when looking at the distribution of children's drawing skills by age group and gender, we found that worst results in both boys and girls were recorded in age group 2 (from 3 years to 3 years and 11 months). Also, the lowest number of drawing difficulties in children of both genders was observed in the youngest children from 2 years and 6 months to 2 years and 11 months (age group 1). There was also a statistically significant between-group difference confirmed with $\chi 2=24.55$ ($p=0.000000073$).

Discussion

In this study, we had three main goals. First, we wanted to investigate whether children with NDD,

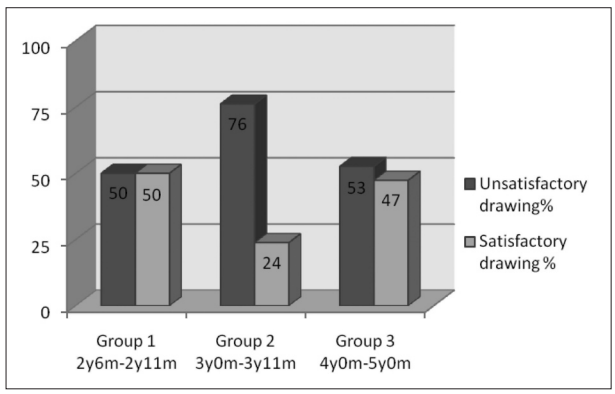

Fig. 1. Percentage results of drawing skills in children with neurodevelopmental delay according to age groups.

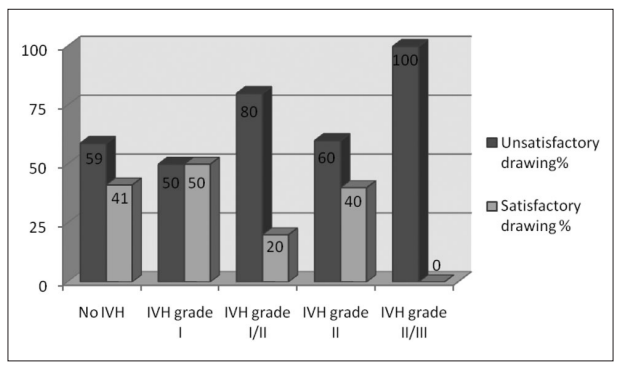

Fig. 2. Percentage results of drawing skills in children with neurodevelopmental delay according to brain ultrasound findings.

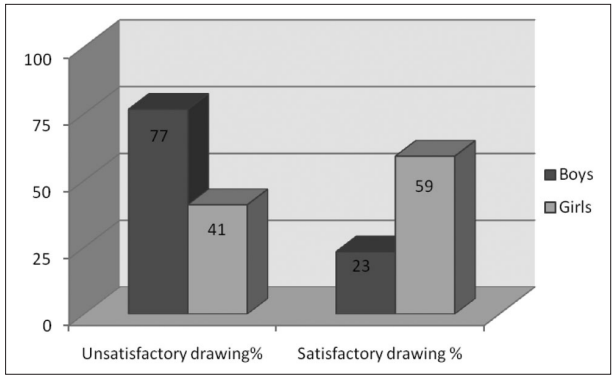

Fig. 3. Percentage results of drawing skills in children with neurodevelopmental delay according to gender.

aged between 2 years and 6 months and 5 years and 0 months, also show impediment in drawing abilities. The results obtained showed a large amount of drawing development difficulties in all children with NDD. As the term NDD covers many subgroups of children, including premature children, this finding concurs with the study that confirmed the delay in drawing development in 5-year-old children that were born very prematurely[5]. However, as the data point out, the greatest proportion of children with drawing skills that were not age-appropriate was found in the group aged from 3 years to 3 years and 11 months. This period in development corresponds to the developmental shift in drawing when the child moves from the stage of making controlled strokes to drawing first geometric objects[7]. This shift usually occurs between 2 and a half and 3 years of age, and children with NDD have established delays in at least one area. Hence, we suggest that children with NDD, besides general delay, also fall behind in drawing development, and the described shift occurs later.

In addition, the period of three years is the time when the environment puts greater expectations on children in comparison to children of younger age when the limits of acceptable behavior are much wider. This could be one of the reasons why the difference between children with satisfactory and those with unsatisfactory drawing abilities was lower in the group of younger children. These data are also consistent with previous studies[10]. The thesis described is further supported by better scores once again found in the oldest group of children (4-5 years). This suggests that children had made the shift necessary to start drawing geometric shapes, and with experience they become more skilful and continue to reach age-expected drawing skills. As found in the study by Stiles *et al*., children with one-sided focal brain injury can with time, practice and training obtain age-appropriate drawing results, even though the given ability was firstly impaired[26]. Thus, in order to be successful in any skill, previous experience is crucial[32].

Our second aim was to see if greater impairments observed on brain ultrasound during infancy also indicated larger drawing development delays. All children included in our study had NDD, and a fair proportion of them had IVH proven by brain ultrasound in infancy. As expected, we found that children with more severe IVH also had worse drawing results. It is important to bear in mind that children with different brain injuries are expected to have different developmental difficulties. For example, delay in the development of drawing skills can be a result of various impairments. So, children with right sided brain injury will have drawings that are poorly spatially organized, children with left sided injury will have drawings that are poor in detail[26], and children with both sided or more severe brain injuries may have various difficulties. Also, drawing delay may occur as a result of poor visual motor and visual spatial skills[6]. Hence, it is crucial to start supporting and stimulating drawing skills in children with NDD at the earliest possible age, thus taking advantage of the still very active neural plasticity processes[20]. By adding support to the child drawing skills development, the child may not overcome the impairment itself, but will learn how to compensate for the difficulty and develop drawing strategies to help him/her comply with environmental expectations[26,33].

Finally, the third objective was to see if there is a gender difference in drawing development in children with NDD. As the results showed, girls with NDD tended to have better scores and fewer difficulties in drawing development than boys with NDD. This is in line with other claiming that there are more cognitive and motor problems in boys with NDD[5,29], and additionally confirms difference in drawing skills between boys and girls, in favor of girls.

Based on the above described, despite a positive trend in older children, the number of children with NDD with difficulties in drawing development is still very high. As children have much better outcomes af-

ter brain injuries than adults, and in order to prevent and aid them with these complexities, it is important to include children with NDD in early intervention treatments. For these treatments to be as efficient as possible, they should be well structured and continuously implemented into and beyond the period of the expected shift in drawing development. In this manner, we can monitor and control all the skills necessary for mastering future academic skills with which children with minor NDD often struggle, including visual perception and representational abilities. Also, writing and drawing consist of the same psychomotor skills, and children who are successful in drawing have a good basis for letter writing development[3]. Therefore, teaching children to self-express and form ideas through drawings prior to writing can be a good stepping stone for doing well in other literacy assignments.

Activities that enhance drawing development in children are well researched and suggest different strategies in fostering the development of graphomotor skills in children. For example, cross-cultural studies that investigate differences in drawing skills between cultures that have more explicit instructions and more strict rules *versus* cultures that encourage creativity and free self-expression with broader limits in children's drawing[34] suggest that giving children structure and guidance in drawing activities will enhance drawing skills and also prolong time the child spends in drawing activities[7]. Moreover, to augment drawing in children, they need to get a variety of different drawing opportunities, and also to draw with a range of different tools and techniques[7]. Nevertheless, since the drawing consists of both cognitive and neuromotor processes, the habilitation should aim at both of these areas[5,17]. Physiotherapy shows good results in writing enhancement in dysgraphic children[24]. So, if taking drawing as an ability preceding writing, physical therapy should be a crucial part of early intervention programs in NDD children with drawing impairments.

To conclude, our study showed that a fair number of children with NDD in all age groups, both genders, and with various IVH levels struggle with drawing. In this manner, and for the development of future intervention and learning disabilities prevention programs, it is necessary to continue with graphomotor skills research in children. Conducting future studies that will show whether children with NDD also follow the same developmental pattern in drawing as healthy children, or comparing early drawing and early writing skills are just a tiny part of work left to be done in order to fully understand graphomotor development of children with NDD. All of this work is essential in order to further direct early intervention programs and encourage inclusion of children with NDD in habilitation and social integration.

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Sažetak

VJEŠTINA CRTANJA KOD DJECE S KAŠNJENEJM U NEUROMOTORNOM RAZVOJU U DOBI OD 2-5 GODINA

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Kod djece urednog razvoja crtež se razvija kroz nekoliko faza koje se pojavljuju specifičnim redoslijedom od nekontroliranih pokreta olovkom do crtanja kompleksnih oblika. U ovom radu željeli smo istražiti postoje li odstupanja u razvoju crteža kod djece s neurorazvojnim odstupanjem. Promatrani su utjecaj dobi, intraventrikularnog krvarenja različitih stupnjeva i spola na razvoj crteža. Uzorak ispitanika činilo je 52 djece u dobi od 2,6 do 5 godina. Sva djeca bila su hospitalizirana radi praćenja cjelokupnog razvoja i potpore od strane multidisciplinarnog tima. Svoj djeci bio je dijagnosticiran neki oblik neurorazvojnog odstupanja. Ispitivanje razvoja crteža provedeno je na način da su djetetu dani olovka i prazan A4 list papira na kojem je mogao izraditi crtež po vlastitom izboru. Svaki crtež ocijenjen je kao adekvatan ili neadekvatan za dob. Prikupljeni podaci obrađeni su deskriptivnom analizom i prikazani u tablicama i grafikonima pomoću postotaka i frekventnosti. Razlike između skupina dokazane su χ^2-testom. Rezultati su pokazali najveću razliku između zadovoljavajućeg i nezadovoljavajućeg razvoja crteža u skupini djece od 3 do 3,11 godina. Zatim, djeca koja nisu imala intraventrikularno krvarenje ili su imala krvarenje I. stupnja pokazala su najbolje vještine crtanja među djecom s neurorazvojnim odstupanjem, dok su sva djeca s krvarenjem II./III. stupnja imala veći broj neadekvatnih crteža za dob. Promatrajući razlike u crtežu s obzirom na spol zaključuje se da su vještine crtanja kod djevojčica bolje u odnosu na dječake. Dobiveni rezultati ukazuju na važnost rane rehabilitacije i kontinuirani strukturirani rad s djecom s neurorazvojnim odstupanjima.

Ključne riječi: *Razvojni poremećaji; Dijete, predškolsko; Psihomotorička sposobnost; Spoznaja; Umjetnost; Pisanje; Rana intervencija (edukacija)*