Early Motor Signs in Autism Spectrum Disorder

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Contributor: Annio Posar

Autism Spectrum Disorder (ASD) is a clinical condition characterized by social communication and interaction deficits, as well as by restricted interests and repetitive behaviors. A growing number of literature data suggest the presence of early impairments in the motor development of children with autism spectrum disorder, which could be often recognized even before the appearance of the classical social communication deficits of autism.

autism spectrum disorder early diagnosis motor signs

1. Introduction

Autism Spectrum Disorder (ASD) diagnosis is still clinical; apart from the core signs of autism, for some time a large number of heterogeneous signs of motor development impairment have been reported in infants and children with ASD. Some of the most relevant of these signs described in the literature during the past few years are reported: delayed motor development; persistent asymmetry when lying on the stomach at 4 months of age; righting from the supine to the prone position moving all the body en bloc not in a corkscrew fashion; abnormal patterns of crawling; walking asymmetry; sequencing instead of superimposition of one movement on the other for example during gait; unusual positions of arms; poor coordination; muscle tone and reflex abnormalities; choreiform movement of extremities; impaired finger-thumb opposition; stereotyped movements of the body, limbs, and fingers, including hand flapping; unusual gait patterns, including walking on tiptoes; poor motor imitation; impairment of postural control [1][2][3][4][5][6]. An approximate idea of the prevalence of motor impairment in ASD is given by Ming et al., who in 154 children found: hypotonia in 51% of cases, apraxia in 34%, walking on tiptoes in 19%, and gross motor delay in 9% [7]. These percentages, however, are probably underestimated, due to the relatively high median age (6 years) of the series studied, while over time the early motor signs tend to reduce [8] and however, they often go unnoticed compared to what are considered the core signs of autism. Yet, despite all these data, to this day, motor function impairments are not considered as diagnostic criteria of ASD, so much so that they are included only in the associated clinical features of ASD, according to DSM-5 [1]. Particularly during the last years, a growing number of data have suggested the presence of mostly mild early motor impairments and/or atypicalities in the development of children with ASD that could be often recognizable even before the appearance of the classical ASD social communication deficits.

2. Early Motor Impairment in ASD Children: Delay of Motor Development

Already during the first year of life, a delay of both gross and/or fine motor abilities has been reported by several authors. As suggested by Arabameri and Sotoodeh, a delayed age of acquisition of sitting without support (mean months: 7.64), standing without support (mean months: 13.22), and walking alone (mean months: 18.31) has been found in ASD children [9]. Reindal et al. studied the age of first walking and its relationship with ASD symptom severity in a sample of 490 children (23% females), subdivided into ASD (*n* = 376) and non-ASD (*n* = 114) groups. ASD children achieved independent walking significantly later than non-ASD children (mean: 14.7 versus 13.8 months, respectively). Age of first walking turned out to be significantly associated with ASD symptom severity, and females showed a non-significant later age of first walking. The authors concluded that in children with delayed independent walking ASD should be considered for differential diagnosis, perhaps especially in females [10]. Bolton et al., performed a prospective longitudinal cohort study about the offspring of 14,541 women. According to the parents' reports, children who later received a diagnosis of ASD already showed differences in fine motor skills, as well as in communication ones, from the age of 6 months [11]. Davidovitch et al. studied in the first 24 months of life the developmental trajectory of 335 low-risk (LR) infants who later received a diagnosis of ASD. They found that by 9 months of age ASD children started to fail the communication, as well as motor items compared to typical and delayed non-ASD children [12]. In the context of a longitudinal birth cohort study, Elberling et al., assessed infant mental health and development from birth to the age of 10 months. Mental health outcome was studied in 1585 individuals aged 5–7 years. Overall development problems and specific oral-motor development problems were found to be predictors of ASD [13].

3. Early Motor Impairment in ASD Children: Atypicalities of Motor Function

For the purposes of an early diagnosis of ASD, not only a possible delay in the acquisition of motor skills should be taken into consideration, but also and perhaps above all the possible presence of atypical motor patterns, which are clearly more difficult to observe than a mere developmental delay during the clinical practice particularly with younger children. From 9 weeks gestational age to 21 weeks post-term, so called general movements (GMs) are a pattern of spontaneous movements performed without external stimulation, at first with the appearance of writhing movements (elliptical in form), then, from around 9th week post-term, with the appearance of fidgety movements (circular in form). Alterations of GMs are generally suggestive of an impairment of the central nervous system. Phagava et al. performed a retrospective study by analyzing the home videos of 20 infants later diagnosed as ASD. Compared to controls, ASD infants showed more often a poor repertoire of writhing GMs (with a lack of variable sequences, amplitude, and speed) as well as abnormal or absent fidgety movements [4]. Einspieler et al., reviewed literature, finding that 17 out of 25 ASD individuals (68%) and 100% of 17 individuals with Rett syndrome showed abnormal GMs during the first 5 months of life [14]. Zappella et al., through a retrospective study of home videos, recorded between birth and 6 months of life, compared the early development of eight males with transient autistic behaviors (lost after the age of 3) and that of ten males later diagnosed with ASD. Abnormal GMs were found significantly more frequently in infants later diagnosed with ASD than in those with only transient autistic behaviors. This was while eye contact, responsive smiling, and pre-speech vocalizations as well as concurrent motor repertoire including postures did not differentiate between the two groups [15].

4. Modern Evaluation of Early Motor Function

A clinical evaluation of motor function performed retrospectively or prospectively possibly using standardized tools, however careful and thorough, may not recognize subtle early motor signs. This has led to the development of techniques capable of providing quantitative measures of motor behavior and allowing possible more objective methods of assessment of subtle early motor signs. Some examples follow. Martin et al. conducted a quantitative study of head movement dynamics in 42 children aged 2.5–6.5 years, respectively, 21 with and 21 without ASD, through automated, computer-vision based head tracking. ASD children, compared to those without ASD, showed greater yaw displacement, i.e., greater head turning, and higher speed of yaw and roll, i.e., faster head turning and inclination. Note that head movement differences were specific to a social condition [16]. Dawson et al. using computer vision analysis, assessed midline head postural control in 104 toddlers (age: 16–31 months), 22 of whom received a diagnosis of ASD, while watching movies including social and nonsocial stimuli. ASD toddlers showed a higher rate of head movement when compared to non-ASD toddlers, indicating difficulties in maintaining head midline position while engaging attentional systems [17].

5. Children at High Risk (HR) for ASD

Atypical motor development is often described also in infants at HR for ASD, even when (and this is the most likely occurrence) they are not later diagnosed with ASD. In a prospective/longitudinal study, Nickel et al. analyzed postural development of 22 HR infants, videotaped at age 6, 9, 12, and 14 months. These infants showed, compared to 18 age-matched LR infants, delay in achieving more advanced postures, moving freely within recently achieved postures (e.g., while sitting), and moving from one posture to another [18]. Achermann et al., through a three-dimensional motion capture technology, studied the way 10-month-old HR infants catch a ball rolling toward them, a task requiring adequate planning and execution. Several early motor measures were different in 39 HR infants in comparison with 19 controls. However, they were not related to autistic symptoms at 2 years, but to the following non-social, general development [19]. Other specific manual motor behaviors have been considered in HR individuals.

6. The Relationship between Motor and Social Communication Skills

From literature data growing evidence emerges that motor and communication (both verbal and non-verbal) skills are connected. Developmental changes in motor skills modify the way children interact with people and objects (e.g., by showing) and they may affect language development [20]. According to Leonard et al., the skill of exploring the environment, manipulating and sharing objects with others, stimulates the initiation of joint attention and modifies the types of parent's vocalizations and expressions received by the infant [21]. Bradshow et al. studied the relationships between motor and social communication skills in 199 infants aged 12 months: 86 HR for ASD and 113 LR for ASD (TD). Infants were subdivided into: walkers, standers, or pre-walkers. HR walkers showed higher social communication skills, but similar cognitive skills, in comparison with HR pre-walkers. On the contrary,

regardless of walking status, social communication and cognitive abilities were largely comparable for LR infants. Based on these results, the authors concluded that independent walking may foster the development of social communication skills in HR infants. Symbolic play, gestures, and language were all significantly better developed in HR walkers than in HR standers and/or pre-walkers, but it remains to be understood how the ability to walk can contribute to the development of these skills [22].

7. Treatment of Motor Impairment in ASD

As suggested by Lebarton and Landa, early motor interventions may reduce the negative impact of motor problems on early social communication skills [23]. West believes the current interventions for infants and toddlers that focus primarily on increasing social communication skills may be enhanced by promoting and integrating motor behaviors [24]. Even more recently, Elliott et al., pointed out that a fundamental motor ability intervention might produce improvements in ASD individuals not only at motor level, but even on social, listening, turn-taking, and transition skills [25]. And in fact, there are research data suggesting that early motor exploratory skills are associated with expressive vocabulary at age 1, 2, and 3.5 years, with cognitive skills in toddlerhood and childhood, and also with later academic skills [26]. For infants with clinically relevant early motor delays, intervention should focus on fundamental motor skills developing in the first year of life. Appropriate, parent-delivered interventions for motor skills may have positive effects also on other domains' skills such as face processing [26]. According to Tanner and Dounavi, the role of early fine and gross motor abilities for expressive and receptive language development has been largely documented, therefore the authors underline the importance, already in the pre-diagnostic phase, of an intervention that follows an interdisciplinary approach, including also physical therapy, and that favors the development of motor skills [27]. Treatment of infants with early motor deficits may be very important because achievements in these areas can modify infants' earliest experiences. But, as suggested by Leezenbaum and Iverson, instead of focusing on motor or social communication skills separately, it is probably more useful to broadly improve the infant's ability for exploratory experiences, emphasizing the reciprocal influence between infant and caregiver. This theory is sustained by research data about Early Start Denver Model, which follows a holistic approach in the treatment of very young ASD children [28].

8. Conclusions

Clinical experience and literature data suggest the presence of early heterogeneous motor dysfunctions in ASD patients that may even precede the onset of the core signs of autism. In the perspective of a timely diagnosis, the presence of early motor signs can be an important clue, especially in an individual considered at HR for autism. However, till now, motor signs have been considered only as associated clinical features of ASD, according to DSM-5 [1]. A pathogenetic role of early motor dysfunctions in the development of autism can be hypothesized. From this derives the importance of an early enabling intervention aimed at improving motor skills, which could also have favorable effects on other domains of development.

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