ELSEVIER

Brain & Development 29 (2007) 565–570

BRAIN & DEVELOPMENT
Official Journal of the Japanese Society of Child Neurology

www.elsevier.com/locate/braindev

Original article

Prevalence of motor impairment in autism spectrum disorders

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Received 14 October 2006; received in revised form 4 March 2007; accepted 16 March 2007

Abstract

Autism spectrum disorders (ASD) are manifest as impairments in social interaction, language and speech development, and the appearance of repetitive behaviors with restricted interests. Motor impairments in individuals with ASD have been categorized as "associated symptoms". The objective of this study was to describe the prevalence of motor deficits in ASD. Specifically, using retrospective clinical record review, we report the prevalence of hypotonia, motor apraxia, reduced ankle mobility, history of gross motor delay, and toe-walking, as well as the improvement of these symptoms with age, in a cohort of 154 children with ASD. The possible association of motor deficits with epilepsy or developmental regression was also assessed. To address whether the motor deficits in children with ASD were properly identified and treated, we evaluated whether the children with the motor deficits were more likely to receive physical and/or occupational therapies as compared to the children with ASD who did not show motor deficits. Hypotonia was the most common motor symptom in our ASD cohort (51%) and this appeared to improve over time, as suggested by the significant reduction in prevalence in older children ($p = 0.002$). Likewise, motor apraxia (34%) showed a tendency to be more prevalent among younger children as compared with older children ($p = 0.06$). Historical intermittent toe-walking was found in 19% of children while reduced ankle mobility was a rare occurrence. Gross motor delay was reported in 9% of children, all of whom gained motor independence by the time of examination. Except for gross motor delay, ASD children with fine motor deficits were not more likely to receive interventional services, as compared with ASD children without the motor deficits. The results suggest that fine motor control and programming deficits are common co-occurrence of children with ASD in this cohort. The reduced prevalence of these motor deficits in older children suggests improvement over time, whether through natural progression, results of interventional therapy, or the combination of the two. However, ASD children with the motor deficits were not more likely to receive service than those without the motor deficits.

Keywords: Autism spectrum disorders; Motor deficits; Hypotonia; Apraxia; Prevalence

1. Introduction

Children with autism spectrum disorders (ASD) present with deficits in social interaction, language and communication, often accompanied by repetitive behaviors and restricted interests. To date, motor impairments observed in individuals with ASD have been categorized as "associated symptoms". While the etiology and precise pathophysiologic mechanisms of ASD remain to be elucidated, many studies point to abnormal neurotransmission, particularly in serotonergic, dopaminergic, GABAergic systems [1–8]. Abnormal neurotransmission in these systems may potentially affect motor performance. In addition, although pathological studies are few in number, they consistently report abnormalities in brain regions known to mediate motor function,

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doi:10.1016/j.braindev.2007.03.002

including cerebellum and subcortical white matter [9,10]. Since both the neurotransmitter systems and affected brain structures are known to be involved in sensorimotor performance, we evaluated the hypothesis that, in addition to the core behavioral symptoms of ASD, other neurodevelopmental problems involving motor dysfunction may also manifest in children with ASD.

Although ASD is not associated with severe motor disturbances, many studies have reported motor deficits including alterations in motor milestone development [11], clumsiness, motor incoordination, disturbances in reach-to-grasp movement [12–14], deficits in gross and fine motor movement [15], and impaired postural control [16,17]. In addition, intrusive and abnormal movements appear in ASD including repetitive hand flapping, stereotypy, and self-injurious behaviors [18–21].

In a comprehensive neurological study of 176 children with autism, Rapin [22] found that about 25% of the subjects exhibited hypotonia. In addition, she reported that about 30% of the high functioning autistic children exhibited limb apraxia while about 75% of the low functioning children with autism exhibited the limb apraxia. Likewise, stereotypic behavior was evident in over 40% of the low functioning and 65% of the high functioning children with autism. The observations of apraxia and stereotypic behavior in low functioning autistic individuals was borne out in a more recent replication as well [23].

Ghaziuddin and Butler [12] compared a group of children with Asperger's syndrome to groups with autistic disorder or pervasive developmental disorder not otherwise specified. Coordination disorders were found in all three groups though children with Asperger's syndrome were found to be less impaired than the two other groups. Leary and Hill [24] reviewed different types of motor disturbances associated with autistic disorder and discussed motor deficits as an impairing feature for the development of adequate communicative and interactive skills in these children. Finally, Noterdaeme et al. [15] examined gross and fine motor function, coordination, oral motor function and balance in children with high functioning autism, speech disorders, and normal control (all children had IQ $>$ 85). They found children with autism and speech disorders had significantly more motor deficits, suggesting motor deficits are, indeed, concurrent with autism.

However, the extent to which motor symptoms are specific to subtypes of ASD is not clear. Moreover, little is known about their prevalence and developmental outcome. The goal of this study was to determine the prevalence of hypotonia, motor apraxia, toe-walking, and delayed gross motor milestones in ASD subtypes. Their occurrence in age groups, and their association with ASD subtypes and other clinical co-occurrence were examined in a cohort of 154 children with ASD.

2. Methods

All participants were children with ASD evaluated by the pediatric neurologist (XM) through the Autism Center at UMDNJ-New Jersey Medical School. There was a larger cohort of 218 subjects seen at the Autism Center. Only 154 subjects who had complete neurological examination between 1999 and 2003 by the author (XM) were included for data analysis. The diagnosis of ASD (autism, PDD-NOS or Asperger's syndrome) was made or confirmed based on DSM-IV criteria. Autism Diagnostic Interview-Revised, Autism Diagnostic Observation Schedule-Generic, and/or Childhood Autism Rating Scale were used for confirmation of diagnosis in approximately 2% of the children, performed in our center or elsewhere. Children with ASD whose etiology was known were excluded from data analysis. Children with Rett's syndrome or disintegrative disorders were also excluded.

Motor deficits included in this study were hypotonia, motor apraxia, toe-walking, delayed gross motor milestone, and reduced ankle mobility. Hyptonia, motor apraxia (including oral and limb muscle), or reduced ankle mobility were physical findings documented by physical examination performed by the pediatric neurologist during office visits. Hypotonia was defined as reduced resistance during passive movement in the limbs, manifested as increased joint mobility to passive stretch in both distal (e.g., fingers) and proximal (e.g., sitting in the shape of W). Apraxia was defined as impairment of the ability to execute skilled movements and gestures, despite having the desire and the physical ability to perform them. Apraxia may manifest as excessive drooling, inability in pucker lips, inability in using a scissor etc. Toe-walking was determined by historical report from the parents, therapists' records, other physician's records, or by physical examination performed by the pediatric neurologist during office visits. Toe-walking had to be present, whether intermittent or persistent, for an estimated minimum of 6 months during the child's life. Gross motor milestone delay was determined by history according to Denver II Developmental Material [25]. Gross motor milestones included were independent sitting, walking well, walking up steps, jumping up, etc. Reduced ankle mobility was defined as reduced degree of ankle dorsi-flexion with passive stretching of the muscle without producing pain [26]. The prevalence of hypotonia, apraxia, and reduced ankle mobility were recorded in children age 2–6 years old and 7–18 years old. The age of six was chosen as the break point for this comparison because it was the median age of this cohort. Epilepsy, defined as two or more unprovoked seizures, was also recorded. Finally, whether or not the children received or were receiving physical and/or occupational therapy was also recorded.