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Brain & Development 36 (2014) 91–96

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

www.elsevier.com/locate/braindev

Original article

Abnormalities of joint mobility and gait in children with autism spectrum disorders

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Received 21 July 2011; received in revised form 12 February 2012; accepted 12 February 2012

Abstract

Aims: Abnormalities of gross motor function in children with autism are well known to clinicians but have not received much empirical documentation and, with the exception of stereotypies, are not among its diagnostic criteria. We recorded the characteristics of gait and prevalence of toe walking, the range of passive joint mobility, and age at walking in children with DSM IV autism spectrum disorders (ASDs) and in age- and gender-matched typically developing peers (mean age 4 years 6 months, range 22 months–10 years 9 months). Methods: We evaluated maximum range of mobility at the elbow, wrist, metacarpo–phalangeal, and ankle joints and videoed children walking and running. Two neurologists blind to diagnosis independently scored features of gait clinically. Results: Children with ASDs had significantly greater joint mobility ($p < .002$), more gait abnormalities ($p < .0001$), and on average walked 1.6 months later than their non-autistic peers. Interpretation: This study indicates that attention should be directed to motor abnormalities as well as sociability, communication, and restricted and repetitive behaviors in individuals with ASDs. Motor deficits add to children's other handicaps. They indicate that ASDs affect a broader range of central nervous system circuitry than often appreciated.

Keywords: Autism spectrum disorders; Abnormal gait; Toe walking; Passive joint mobility; Hypotonia

1. Introduction

Autism is a behaviorally defined disorder of the immature brain first described by Kanner in 1943 [1]. In this paper, we use autism to encompass the range of severity of abnormalities in individuals with autism spectrum disorder (ASDs), referred to as PDD (pervasive developmental disorder) in the American Psychiatric Association's Diagnostic and Statistical Manual of Psychiatric Disorders 4th Edition (DSM IV) and the International Classification of Diseases of the World Health Organization 10th Edition (ICD 10). The main focus of behavioral studies in autism has been its defining deficits in sociability and language, its narrow repetitive interests and activities, and its cognitive features. Much less studied are its ubiquitous motor deficits.

Kanner commented on the motor deficits in many of his patients, from absence of crawling and infants' failure to assume an anticipatory posture preparatory to being picked up, to "clumsiness in gait and gross motor performances." [2] Consistent with Kanner's early observations, some infants later diagnosed as autistic already have detectable disturbances of movement at age 4–6 months [3]. From the toddler years on [4], motor

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doi:10.1016/j.braindev.2012.02.005

abnormalities such as apparently purposeless repetitive movements (stereotypies) [5], clumsiness, toe-walking, other gait abnormalities, unusual postures, and hypotonia/increased joint mobility have been reported in a third to almost all children with ASD [6,7].

The purpose of the present study was to gather quantitative clinical data on passive joint mobility and the prevalence of gait abnormalities in young children with ASD. Our aim was to encourage future studies of the neurologic or biologic basis of such abnormalities.

2. Methods

2.1. Participants

Thirty-eight children on the autism spectrum, unselected for race or gender, were compared to thirty-eight typically developing children. The children with ASD were recruited over approximately 6 months from the private practices of Albert Einstein College of Medicine pediatric neurology faculty who had given a DSM-IV diagnosis of an ASD (autistic disorder, PDD-NOS [PDD-not otherwise specified], or Asperger disorder, excluding disintegrative disorder and Rett syndrome). Available typically developing peers were recruited to match the ASD children individually for age, race, and gender from the general pediatric practice of Dr. Irving Zoltan, an Einstein faculty member, the Einstein Jacobi Medical Center Pediatrics Clinic, and children of friends in the community. Birthdays of children under the age of 4 years were matched within 3 months, those of children over 4 years within 6 months. The mean age of children in the autism sample was 4 years 6 months (range 22 months to 10 years 9 months), and that of the peers 4 years 8 months (range 22 months to 10 years 7 months). There were 4 children under the age of 2 years, 57 children between the ages of 2 and 5, and 15 children between the ages of 6 and 10.

Criteria for exclusion from either group included (1) inability to cooperate with the testing, (2) birth at <36 weeks of gestation, (3) birth weight under 2500 g, (4) known or suspected genetic disorders causally linked to autism or that might affect neurological or muscular function, (5) a history of meningitis, encephalitis, brain injury, or other potentially encephalopathic illness, (6) any report of clinical seizures, (6) detection on neurological examination of even mild sensory-motor deficit such as spastic diplegia, weakness, or somatic hypersensitivity that might interfere with testing, No child was taking medication at the time of testing.

Psychometric data were not available for the children in either group. Although no attempt was made to select atypically bright participants, because ability to cooperate with testing was an entry criterion the ASD group was likely skewed toward higher-functioning children.

From originally 78 children recruited, one child with autism was excluded because of hearing loss and a suspected genetic disorder other than autism that could have contributed to an abnormality of gait or tone. One peer was excluded due to the examiner's suspicion of Asperger syndrome. There were 76 children all told, 28 boys and 10 girls in each group.

2.2. Procedure

The parent of each autistic or typically developing child available during the recruitment period who met the study criteria was offered the opportunity to participate. After full explanation of the study and signing of informed consent, the parent was asked a brief standardized set of questions regarding the child's birth, medical and developmental history which included age at walking. In order to protect privacy, we avoided videoing the child's face and recorded only first names. The Institutional Review Board for the Albert Einstein College of Medicine and affiliated Jacobi and Montefiore Medical Centers approved the study.

Passive joint mobility (distal tone) – The pediatric and physiatry literatures were searched for age norms for passive joint mobility and gait characteristics, but none satisfactory was found. Therefore we report comparison between children with ASD and typical controls of maximum passive joint mobility in degrees of angle measured with a goniometer, in the use of which a senior physical therapist trained M.S.-T. for this study.

1) Finger: The child's wrist was held straight (0°). The goniometer fulcrum was placed over the dorsal surface of the metacarpo–phalangeal joint of the index finger with its proximal arm over the metacarpal and distal arm over the proximal phalanx. The joint was maximally extended, then flexed, and the extension and flexion angles from zero were recorded.
2) Wrist: The forearm was placed on the table palm down with the hand extending beyond the table surface. With the wrist in neutral position, the goniometer fulcrum was placed laterally to the wrist at the triquetrium with its proximal arm alongside the ulna and distal arm over the 5th metacarpal. The joint was maximally extended, then flexed, and the angles were recorded.
3) Elbow: With the forearm extended palm-up, the goniometer fulcrum was placed laterally to the epicondyle of the humerus with its proximal arm alongside the humerus and distal arm alongside the radius. The joint was maximally extended, then flexed, and the angles recorded.
4) Ankle: With the knee flexed and foot at a right angle with neither inversion nor eversion of the foot, the goniometer fulcrum was placed beside