A Comparison of the Birth Characteristics of Idiopathic Toe Walking and Toe Walking Gait Due to Medical Reasons

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Objective To determine and compare the birth history or postnatal complications of idiopathic toe walking (ITW) and toe walking known to be associated with a medical condition.

Study design This was a retrospective chart review of parent-reported birth histories of children who presented to a dedicated toe-walking clinic between 2010 and 2014. This cohort comprised children diagnosed with ITW and children with a medical reason for their toe-walking gait. Data were compared with Australian Perinatal statistical normative data.

Results Ninety-five children (60 males, 63%) were diagnosed with ITW, with a mean (SD) age of 5.8 (2.9) years. Children with an ITW gait were found to have greater rates of prematurity (OR 2.4; 95% CI 1.43-4.03), greater rates of admission to a special care nursery or neonatal intensive care unit (OR 1.98; 95% CI 1.23-3.18), and lower birth weights (OR 6.6; 95% CI 3.48-12.5) than the normative population. Children with a medical reason for toe walking (n = 28, 68% males) also had greater rates of prematurity (OR 2.4; 95% CI 0.94-6.09) than the normative population and more instrumented births than the ITW cohort (OR 1.56; 95% CI 0.64-3.77). No association was found between assisted-birth intervention and the ITW cohort compared with the normative population or group with a medical cause for toe walking.

Conclusions ITW gait was associated with greater rates of complications during and after delivery. Such complications have been associated previously as risk factors for neurologic insult affecting motor development. *(J Pediatr 2016;171:290-3)*.

Toe walking is defined as the absence or inability to obtain heel strike during the stance phase of the gait cycle and is a common variation of normal gait development in children younger than 3 years of age.[1-3] Toe walking has been associated with cerebral palsy, muscular dystrophy, autism spectrum disorders, and global development delay.[4] When a child toe walks without a medical condition after the age of 3 years, a diagnosis of idiopathic toe walking (ITW) is made. The current prevalence of ITW in children is reported to be between 2% and 12%.[5] ITW has been suggested to have an autosomal-dominant pattern of inheritance.[6,7]

ITW is a diagnosis of exclusion, and careful history-taking and physical examination aid the clinician in ruling out medical conditions known to cause toe walking.[2,4,8] Previous studies in the literature have focused on the influence of musculoskeletal structure on ITW gait[1,2,9] and also have found a strong association with neurologic impairments, including speech and language problems, gross motor delays, and sensory processing difficulties.[9-12]

Motor delays and sensory-processing difficulties also have been associated with complications at birth or in the postnatal period. Complicated births may involve assisted intervention with forceps, vacuum, or emergency cesarean delivery. Postnatal complications, such as low birth weight, admission to special care nursery (SCN), or neonatal intensive care unit (NICU), are potential risk factors for neurologic insult of the infant.[13] The rates of birth or postnatal complications have not been investigated in the ITW population. This study aimed to identify any association between birth complications, birth weight, and a diagnosis of ITW or, toe walking associated with a medical reason (TWmr).

Methods

This study was a retrospective chart review of health care records. The Human Research Ethics Committees of Monash Health (14328L) and Monash University (CF15/1364) approved this study.

ITW	Idiopathic toe walking
NICU	Neonatal intensive care unit
Norm	Australian maternal and perinatal dataset
SCN	Special care nursery
TWmr	Toe walking associated with a medical reason

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All health care records of children who attended a dedicated outpatient toe-walking clinic from January 2010 to December 2014 were reviewed. This outpatient clinic was established in 2010 and provides a multidisciplinary assessment and diagnostic service for children who toe walk. In this clinic, a pediatrician, pediatric neurologist, or pediatric rehabilitation physician; pediatric physical therapist; and pediatric podiatrist assessed each child. The aim of this clinic was to assess children with suspected ITW or toe walking with unclear etiology for their toe-walking gait. This clinic provides diagnoses only and refers patients to other medical specialties, physical therapy, or podiatry services for any subsequent treatment on the basis of subsequent diagnosis.

This clinic uses a parent-reported questionnaire to document the child's birth, medical, and developmental history. The birth history questions within this questionnaire were replicated from a previously developed toe-walking screening tool.[4] It is also clinical practice to record the child's birth history within the assessment notes if the parent had not completed this questionnaire at the time of appointment. The diagnosis of ITW within this clinic is from history, physical examination, and, in some cases in which the team was unsure of diagnosis, brain imaging with computed tomography, magnetic resonance imaging, or blood tests. These were conducted to eliminate any obvious neurologic or pathologic reasons for the toe walking gait.

A data-collection sheet was developed to capture the following information from the health record of each child attending the clinic: age at clinic appointment, sex, cause of toe-walking gait, gestation less than or greater than 37 weeks, delivery type (vaginal or cesarean), forceps- or vacuum-assisted vaginal birth, birth weight (grams), and admission to a SCN or NICU. The Australian maternal and perinatal dataset (Norm) was used for the normative population data.[13] This data set was extracted from mandatory collection of birth information in each Australian state and territory.[13]

Data were analyzed by the use of Stata SE v.13 (StataCorp, College Station, Texas).[14] Data were divided into 3 groups: ITW, TWmr, and Norm. Demographic data were presented as frequencies (%) and means (SD). Categorical data were compared between the 3 groups in a pair-wise fashion with the χ^2 statistic. ORs also were calculated to gauge the strength of association between each predictor variable and group membership. The cut-off for statistical significance was $P < .05$, and an OR with 95% CI not inclusive of the unity was considered significant.

Results

A total of 161 health care records were reviewed, of which 123 were included. Exclusions of 38 records were the result of incomplete data of birth history or unconfirmed diagnosis at the time of review. There were 95 children (n = 60 males, 63%) diagnosed with ITW, with a mean (SD) age of 5.8 (2.9) years. There were 28 children (n = 19, 68% males) who had a medical condition known to cause toe walking, with a mean (SD) age of 6.1 (3.4) years. Children within the TWmr group had diagnoses of cerebral palsy (n = 3, 11%), autism spectrum disorder (n = 20, 71%), or other conditions known to be associated with toe-walking gait (n = 5, 18%).

A number of key differences were evident between the ITW and the Norm group and between the 2 toe-walking groups (**Table**). The ITW group and the TWmr cohort had greater rates of prematurity than the Norm cohort (ITW vs Norm: OR 2.4, 95% CI 1.43-4.03; TWmr vs Norm: OR 2.4, 95% CI 0.94-6.09). The ITW group had a lower rate of instrumented vaginal birth compared with the TWmr group (OR 1.56, 95% CI 0.64-3.77). There were no differences in rates of assisted birth techniques between the ITW and the Norm dataset.

The ITW group also had greater rates of admission to a SCN or NICU, the provision of additional care at the postnatal period (OR 1.98, 95% CI 1.23-3.18), and lower birth weights than those in the Norm dataset (OR 6.6, 95% CI 3.48-12.5). There were significantly lower numbers of children from the ITW group born in the 3000- to 3500-g birth weight bracket compared with the Norm dataset (OR 0.60, 95% CI 0.37-0.98). There were no other differences between the 3 groups in admissions for additional postnatal care or birth weight analysis.

Discussion

Unlike previous investigations, our study identifies birth characteristics of children with an ITW gait. This key finding of children with ITW having greater rates of complications during or immediately postdelivery is important to better understand why this gait pattern may be present.

Low birth weight has been well established as a strong risk factor for poor neurodevelopmental outcomes in infants with or without a neurologic diagnosis.[15-18] Poor neurodevelopmental outcomes and brain structural changes in preterm infants admitted to SCN or NICU also have been observed.[19-21] Yet, it is not known at what stage these children obtain this neurologic insult. The high rates of admission to SCN or NICU in the ITW cohort indicated that there were likely to be complications experienced before or during the delivery or immediately after birth, which may have affected brain development. The greater rate of admissions to the SCN or NICU also could have been a result of the cohort's high rates of prematurity and low birth weight, which required greater medical care.

The ITW and TWmr cohort had significantly greater rates of prematurity compared with the Norm dataset. A strong association between prematurity and poor neurodevelopmental outcomes has been established previously.[22-24] Prematurity may have resulted from poor fetal or maternal health. Immature cerebral blood supply and impaired cerebral autoregulation have been proposed to cause ischemic damage to the cerebrum in the preterm infant.[25,26] This immature blood supply results in the risk of hypoxia attributable to immature lungs and respiratory disturbances.[25] Ischemic damage and hypoxia from prematurity may result