Idiopathic Toe Walking: A Gait Laboratory Review

Abstract:
R O’Sullivan, T O'Brien
Gait Laboratory, Central Remedial Clinic, Vernon Ave, Clontarf, Dublin 3

Abstract

Idiopathic toe walking (ITW) is defined as one who is neurologically normal but demonstrates a preference for walking on the toes. It is a diagnosis of exclusion so differential diagnoses such as cerebral palsy, neuropathy or sympathetic must be ruled out. A review of 102 patients attending a gait laboratory with a presumptive diagnosis of ITW found that gait analysis data agreed with this diagnosis in 81 (79.4%) of cases while the remaining 21 (20.6%) were not typical of this diagnosis. The features found to be significantly different between the groups were Babinski response, foot stretch of the gastrocnemius, knee flexion at initial contact and asymmetry at the ankles during gait. This study highlights that clinical gait analysis can be a useful, non-invasive means of diagnosing idiopathic toe walking and recommending appropriate intervention based on clinical and dynamic assessment of calf tightness.

Introduction

Toe-walking is the inability to heel strike during the initial contact of gait and the absence of full foot contact during stance phase. Toe-walking is regarded as a normal variation in children up to 3 years of age. Beyond this a diagnosis of idiopathic toe-walking (ITW) must be considered. Hall et al first described a group of 20 neurologically normal patients who presented with tightness of the tendo-aachilles and a tendency to walk on their toes. Subsequent reports documented many cases of ITW without static contracture and so the classic presentation of ITW is now described as one who is otherwise neurologically normal, possesses normal muscle strength and selective stepping behaviour. It is estimated to occur in 7% to 24% of the childhood population. A review of eighty children with ITW found that 32% had a family history of ITW, 28% were born prematurely and 16% had psychomotor delay.

For those who meet the matching criteria associated with ITW, gait analysis can help guide intervention based on the degree of calf contracture measured both clinically and dynamically with GA. While it is thought that ITW eventually resolves spontaneously in a majority of children, the relationship between persistent toe-walking and the development of ankle equinus and excessive external tibial rotation and so interventions should be considered in the young child. Studies examining the gastrocnemius-soleus complex with ITW have shown that the gastrocnemius is involved. The ITW ankle pattern was characterised by initial dorsiflexion in swing phase followed by sudden plantarflexion to the barefoot. It appears that there may be a relationship between persistent toe-walking and the development of ankle equinus and excessive external tibial rotation. The ITW ankle pattern is associated with a more severe degree of ITW and so interventions should be considered.

Methods

A retrospective study of all patients who had attended the Gait Laboratory between 2003 and 2013 was conducted. Clinical and dynamic gait analysis (GA) of ITW was undertaken using 3-dimensional GA using the CODA mpx-30 system. Application of these criteria produced a study sample of 102. Based on GA, clinical exam and patient history the original gait laboratory report concluded whether the patient was typical of ITW or not. The study sample was subdivided into two groups on this basis. Clinical and dynamic gait variables were retrospectively examined in each group. The variables selected were those relevant to ITW. The clinical variables examined were gastrocnemius length on fast and slow stretch, hamstring length and Babinski reflex. Based on these measurements the presence of spasticity in the gastrocnemius was defined as a difference between a slow and fast stretch. The Babinski reflex was considered positive if there was a flexion of plantarflexion and so interventions should be considered. The ITW ankle pattern was characterised by initial dorsiflexion in swing phase followed by sudden plantarflexion to the barefoot. It appears that there may be a relationship between persistent toe-walking and the development of ankle equinus and excessive external tibial rotation. The ITW ankle pattern is associated with a more severe degree of ITW and so interventions should be considered.

Results

A total sample of 102 patients was reviewed. The average age of those referred was 7.6–3.2 (range 4-16 years). The majority were male (74 male, 28 female). Gait analysis agreed with a diagnosis of ITW in 81 cases (79.4%) while 21 (20.6%) were not considered to be typical of the diagnosis. Referrals to the gait laboratory were from orthopaedic surgeons, consultant neurologists, consultant paediatricians, general practitioners or physiotherapists. The breakdown of ITW referrals by profession along with how often the gait laboratory assessment agreed with the diagnosis of ITW is presented in Table 1. The clinical variables examined were gastrocnemius-soleus complex with ITW versus those who had an atypical presentation are summarised in Table 1 and 2. The Babinski reflex was considered positive if there was a flexion of plantarflexion and so interventions should be considered. The ITW ankle pattern was characterised by initial dorsiflexion in swing phase followed by sudden plantarflexion to the barefoot. It appears that there may be a relationship between persistent toe-walking and the development of ankle equinus and excessive external tibial rotation. The ITW ankle pattern is associated with a more severe degree of ITW and so interventions should be considered.

Discussion

The average age and the dominance of children in the study population are consistent with previous studies.12,13 The breakdown of those referring potential ITW to the laboratory is probably reflective of the condition and population involved. Treatment of these children often involves stretching or lengthening of the calf muscles so it is not surprising that referrals from this profession would be expected. The number of referrals from this profession would be expected. The number of referrals from this profession would be expected. The number of referrals from this profession would be expected. The number of referrals from this profession would be expected. The number of referrals from this profession would be expected. The number of referrals from this profession would be expected.
those referred (81/102). In this group planning appropriate treatment and monitoring the outcome is the priority. Parents can also be assured that the child presents as a typical ITW and baseline gait data is recorded against which any persisting concerns can be measured.

The treatment recommended following GA is consistent with published protocols. Treatment typically begins conservatively with stretching of the plantar flexors, casting and/or botulinum toxin and for those who do not respond surgical lengthening of the gastro-soleus complex is often performed. The advantage of treatment recommendations post gait analysis is that intervention can be individualised to the degree of ankle tightness assessed both clinically and dynamically during gait. This individual recommendation to assesses of intervention particularly in the case of a return to toe-walking. This is important as outcomes following treatment are variable in the literature and it is reported that, while short-term results may be positive, relapse may occur following conservative treatment [20]. Identifying those with a typical ITW presentation and those with suggestions of a more sinister differential diagnosis can be difficult in light of the range of potential differential diagnoses and particularly in a busy clinical setting. Diagnosis based on GA is made after a careful consideration of clinical exam in conjunction with kinematic, kinetic and surface electromyography. Our clinical data highlights the difficulty of assigning a diagnosis on this basis alone. Both groups were equally tight on a stretch of the gastrocnemius and there was no difference between the groups in hamstring range. The presence of abnormal neurological signs is often assessed using the Babinski response and assessing for spasticity in a muscle (increased tightness on a fast stretch versus slow). While those with non typical-ITW presentations were more likely to have a positive Babinski response, the majority had a normal response suggesting that on its own this sign is not sensitive enough. The non typical-ITW group were significantly tighter on a fast stretch of the gastrocnemius. However, while statistically significant the 3.9 difference is unlikely to be clinical meaningful and the non typical-ITW group were no more likely to present with spasticity.

There were significant differences in the kinematics between the groups. Interestingly there was no difference between the groups in terms of the degree of toe-walking (ankle ground contact, maximal ankle dorsiflexion in stance) though the symmetry of toe-walking was a significant feature. Those with a typical-ITW presentation did so more symmetrically than the non-typical group. The 6.2 of asymmetry would be difficult to appreciate on visual inspection of gait but is readily assessed and apparent on kinematic graphs. The non typical-ITW group had more flexed knees at ground contact compared to typical-ITW. This is consistent with previous work which found that ITW typically demonstrate normal knee, patterns whereas those with a differential diagnosis of spastic diplegia were more likely to demonstrate knee flexion. Again the difference between the groups (6.6 versus 11.1) would most likely be difficult to appreciate on visual inspection. EMG and kinetic features associated with ITW have also been described and these are also considered as part of a clinical gait analysis but are not described in this study. The diagnosis of ITW in this study was established based on GA and clinical data only. A follow-up study of those thought to be typical ITW is recommended both to examine long-term outcomes post treatment but also to examine the sensitivity of the initial GA in diagnosing ITW and establish if any subsequent differential diagnoses were made.

This study highlights the contribution clinical GA can make in confirming a typical ITW presentation and recommending treatment based on the degree of ankle tightness on both clinical and dynamic gait assessment. The gait analysis also serves as a baseline against which any future concerns can be measured.

Correspondence: T Obrien
Gait Laboratory, Central Remedial Clinic, Vernon Ave, Clontarf, Dublin 3
Email: profsoibrien@hotmail.com

References


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