The Difficulty Identifying Intoeing Gait in Cerebral Palsy

Abstract:

R O’Sullivan, D Kiernan, M Walsh, T O Brien
Gait Laboratory, Central Remedial Clinic, Vernon Ave, Clontarf, Dublin 3

In-toeing in children with cerebral palsy can lead to functional difficulties during gait. This may require surgical management to restore a normal foot progression angle. For this reason it is important to identify the presence of internal rotation and to establish where the abnormal rotation is occurring. This can be done relatively easily in otherwise healthy subjects by examining foot progression angle as the subject walks towards the assessor. In cerebral palsy the often severely affected gait pattern and potential asymmetry at the pelvis means that in-toeing may be more difficult to identify. Gait laboratory data of 245 subjects with cerebral palsy were studied retrospectively. Of these 102 (41.63%) demonstrated in-toeing relative to the pelvis of one or both limbs. Eleven diplegic subjects (25.32%) in-toed bilaterally giving a total of 113 in-toe- ing limbs for analysis. Of those, 17 (50%) hemiplegic limbs and 20 (25.32%) diplegic limbs demonstrated a foot progression angle within normal limits due to compensations at the pelvis.

Introduction

Children with cerebral palsy often walk with an internal rotation of the lower limb. In the normal population intoeing seldom requires treatment and is often considered a variant of normal growth patterns. In contrast internal rotation in the cerebral palsy population often needs to be addressed either conservatively or surgically depending on the severity. For this reason it is important to identify firstly the presence of any excessive internal rotation of the lower limb and then establish where the abnormal rotation is occurring. The three most common causes of intoeing in the normal population are bony and due to internal tibial torsion, metatarsus adductus and femoral neck antversion. This can usually be assessed through a combination of visual assessment of gait and clinical examination. Examining foot progression angle (FPA) relative to the line of forward progression as the subject walks forwards the assessor determines the presence of an estimation of the degree of intoeing. Internal rotation of the patella points to excessive internal rotation at the level of the hip while a normal, forward pointing patella means the internal rotation is occurring distal to the knee. Appropriate clinical examination of hip rotation range of movement, femoral antversion, transmalleolar angle and foot line can help confirm where the excessive rotation lies.

In patients with cerebral palsy the complex nature of the pathology and often severely affected gait pattern means that both the presence and cause of in-toeing are more difficult to identify. Potential asymmetry at the pelvis means that visual examination of FPA alone may not be sufficient to identify internal rotation of the lower limb. In the less affected subject who does not demonstrate asymmetry at the pelvis internal rotation at any level in the lower limb will lead directly to an internal FPA relative to the line of forward progression (Figure 1) which can readily be visualized. In contrast retraction of the pelvis can compensate for internal rotation and disguise an internal FPA (Figure 2) meaning the in-toeing is not as obvious to the eye. For this reason in the cerebral palsy population it appears more accurate to define in-toeing as excessive internal rotation of the foot relative to the pelvis rather than relative to the line of forward progression. The purpose of this study was 1) to establish the prevalence of true excessive in-toeing relative to the pelvis during gait in patients with cerebral palsy seen in this gait laboratory and, 2) to establish how many of these show an internal FPA compared to both average normal values and relative to the line of forward progression.

Methods

A retrospective study of all patients who had attended the Gait Laboratory over a five year period was conducted. Criteria for inclusion in this study were a diagnosis of cerebral palsy; no previous surgical history and a full barefoot 3-dimensional gait analysis using the CODA mpx-30 system. This is a 3-D pre-calibrated system, which captures infra-red light signals from markers placed on anatomical landmarks in accordance with the model outlined by Charnwood Dynamics Ltd. Prior to storage in the gait laboratory database kinematic files are reviewed for known marker placement problems e.g. cross talk. Where possible, subjects walked independently. Where this was not possible subjects used their normal walking aids or, if marker identification was compromised, walked with hand support of a therapist in front of them. Only the subjects first assessment in this period was included.

The application of these inclusion criteria produced a study sample of two hundred and forty five patients. We used the data collected from 33 normal subjects (mean age 13.1, range 5-14 years) as a control group and this gave the mean and standard deviation of normal average foot rotation relative to the pelvis and relative to the line of forward progression during gait. Based on this data those patients with cerebral palsy showing excessive in-toeing during gait were identified. Excessive dynamic in-toeing was defined as average foot rotation relative to pelvis of less than 4.26° external rotation (2 SD from the mean of 33 normals). An internal FPA compared to average normal was defined as an angle less than 6.26° external (2 SD from the mean of 33 normals). An internal FPA relative to the line of forward progression was defined as any internal angle relative to the x-axis of the laboratory (i.e. line of forward progression).

Figure 1: Diagrammatic representation of the lower limb segments and...
the pelvis in the frontal plane (left) and the transverse plane (right)
Left leg (blue) is in-toeing relative to the pelvis and with a neutral pelvis is also in-toeing relative to the line of forward progression.

Figure 2: Diagrammatic representation of the lower limb segments and the pelvis in the frontal plane (left) and the transverse plane (right)
Left leg (blue) is still in-toeing relative to pelvis but secondary to retraction on the pelvis on that side a normal foot progression angle is achieved.

Results
A total of 245 patients (mean age 8.89, range 3-50 years, 137 males, 108 females) with a diagnosis of Cerebral Palsy (hemiplegia 47.35%, diplegia 52.65%) were reviewed. One hundred and two patients (mean age 9.35 yrs, 60 males, 42 females) walked with at least one limb displaying excessive in-toeing during gait.

Prevalence of Excessive In-toeing
The prevalence of in-toeing during gait among cerebral palsy patients attending during this five year period was 41.63%. Among hemiplegics it was 29.31% (34/116 patients) while in the diplegic population it was 52.7% (66/129 patients). In the hemiplegic group the prevalence among those with left sided involvement was 38.46% (25/65 patients) while the prevalence in those with a right-sided hemiplegia was 17.65% (9/51 patients). In the diplegic group excessive in-toeing was a unilateral feature in 57 (83.82%) cases (left side 73.68%, right side 26.32%) while 11 (16.18%) showed excessive in-toeing bilaterally. The prevalence in males and females was 43.8% and 38.9% respectively. Table 1 shows the foot progression angle (FPA) of those limbs displaying in-toeing relative to the pelvis.

Discussion
This study reports the prevalence of in-toeing among the cerebral palsy population reviewed in our gait laboratory. Our centre is the national referral centre for physical disabilities in Ireland and the gait laboratory is the only clinical gait analysis service available in this country. All ambulatory cerebral palsy patients attending our centre are assessed in the gait laboratory and we also accept nationwide referrals. For this reason the population reviewed in this laboratory can be considered a representative sample of the population of cerebral palsy as a whole. Therefore the prevalence reported in this study gives a good overview of in-toeing in the cerebral palsy population. We found that 41.63% of the cerebral palsy population who attended our laboratory in a five year period displayed excessive in-toeing during gait. There was a higher prevalence in diplegics compared to hemiplegics (52.7% and 29.31% respectively).

Svenningsen et al. and Bleck et al. have reported a prevalence of in-toeing in the normal population of 16% and 16.4% respectively. This is less than half the prevalence (41.63%) found in the cerebral palsy population in this study.

In-toeing is often thought to be a bilateral problem in patients with diplegic cerebral palsy and in-toeing in the normal population has been shown to be predominantly bilateral. In-toeing was found to be predominantly a unilateral phenomenon in the diplegic population. Our previous work examining internal hip rotation in cerebral palsy showed similar findings. Unilateral in-toeing has been shown to be more common on the left side compared to the right in the normal population. Similarly, we have shown that in-toeing is more common on the left limb in hemiplegics and in unilaterally in-toeing diplegics. Authors who studied the normal population offered no explanation for this phenomenon and we are also unable to explain this. In-toeing in this study was defined objectively using full 3-dimensional gait analysis. This allowed the angle of the foot relative to the pelvis to be examined. A review of normative data from our control group gave the mean and standard deviation of normal foot relative to pelvis. In-toeing subjects were identified based on this data. Traditionally in-toeing is identified in the clinical setting through a visual estimation of the foot progression line as the subject walks towards the examiner or by examining the angle of the foot relative to a straight reference line on the floor. A potential error arises with both of these methods in the presence of pelvic rotation. A retracted pelvis can compensate for and disguise an internally rotated lower limb. 50% of hemiplegic subjects who in-toed relative to the pelvis had a FPA within normal limits and the same is true in over one quarter of diplegic subjects. It is interesting to note that the incidence of excessive pelvic retraction in hemiplegic and diplegic subjects is very similar to these figures (46.3% and 30.4% respectively).

It is recognized that while we objectively identified in-toeing based on normative data, we do not know how our definition of in-toeing correlates with clinically significant in-toeing. We have not reported how many of those found to be in-toed relative to the pelvis had significant internal rotation at any anatomical level requiring significant treatment surgically or conservatively. The results of this work highlight the need for full assessment of the patient both statically and dynamically in a Gait Laboratory to identify the exact level of the in-toeing particularly if surgical correction is being considered.

Correspondence: R O’Sullivan
Gait Laboratory, Central Remedial Clinic, Vernon Ave, Clontarf, Dublin
3
Email: rosullivan@crc.ie

References
2. Wesely MS, Barenfeld PA, Eisenstein AL. Thoughts on in-toeing and out-toeing: twenty years experience with over 5000 cases and a review of the literature. Foot Ankle 1981;2:49-57
4. Li YH, Leong JYC. In-toeing gait in children. HKMJ 1999; 5:360-366

The Difficulty Identifying In-toeing Gait in Cerebral Palsy 2

Comments: