Idiopathic toe walking: a multidisciplinary approach

Marybeth Barkocy, PT, DPT, PCS
Teresa Ziomek, MOTR/L

With contributions from ExplorAbilities Therapy Center physical therapists and students
APTA Clinical Practice Guideline Group on ITW
Learning objectives

• Differentiate between musculoskeletal, neuromuscular, and sensory contributions to toe walking.

• Recognize assessments to determine impairments in the musculoskeletal, neuromuscular, and sensory systems in children who toe walk.

• Identify evidence based and/or clinically relevant assessments and interventions targeted to musculoskeletal, neuromuscular, sensory, and visual system impairments in children who exhibit toe walking.
Case 1 intro

- Daniel
- 9 years old
Case 2 intro

- MB's Kiddo
- 5 years old
Evidence-based practice

Special thanks to Shannon Brausch, PT, DPT, Sally LeCras, PT, DPT, PCS, Nancy Muir, PT, DPT, PCS, and Julie Bouck, PT, MPT, for their 2017 APTA CSM presentation on Idiopathic Toe Walking Evidence Updates, as well as the clinical practice guideline group.

Sackett BMJ 1996;312:71-72
Summary of general research

- Evidence that toe walking is a normal deviation of gait development in 1 to 3 year olds is lacking.
- Referrals are often made to PT after a child is 2 years old.
- Children do not typically “outgrow” toe walking.
- There are long term sequelae of toe walking, if not treated or resolved.
Summary of general research

MSK and NM research

- Primarily type I fibers in gastrocnemius (usually more Type II) (Eastwood, 1997)

- Three times more likely to develop tendoachilles tightness; ankle joint stiffness; higher incidence of other muscle tightness (like hamstrings); strength and bone density normal (Englebert, 2011)

- Hallmarks of gait include lack of heel strike at initial contact, premature heel rise, reversal of 2nd rocker, shortened loading response, early gastrocnemius activity in stance, excessive hip flexion and knee extension in stance, excessive hip flexion in swing for foot clearance (Crenna, 2004; Leung, 2014)
Sensory Processing Research: General Processing

Using the Short Sensory Profile (SSP) and Sensory Profile (SP):

- 73% of toe walkers (TW) “Probable difference” or “Definite difference” vs. 7% of non TW (Ganley & Behnke, 2016; Len & Rao, 2012)

- Children with ITW scored “Probable Difference” in two quadrants: Sensory Seeking and Low Registration (Williams, Tinley, Curtin, Wakefield, & Nielson, 2014; Williams, Tinley, & Curtin, 2011)

- Children with ITW had notable differences in Sensory Modulation (Williams, Tinley, & Curtin, 2011)
Sensory Processing Research: Tactile

- Differences in vibration threshold Mean vibration threshold (Ganley & Behnke, 2016; Williams, Tinley, Curtin & Nielson, 2012; Williams, Tinley, Curtin, Wakefield, & Nielson, 2014)

- Walking surface may influence gait pattern in children with ITW (Fanchiang, Geil, Wu, Chen, & Wang, 2016)

- Improved heel strike when ambulating barefoot on pea gravel vs carpet or tile (Fanchiang, Geil, Wu, Chen, & Wang, 2016)

- Using the Sensory Integration and Praxis Test (SIPT), children with ITW demonstrated sensory processing difficulties with tactile processing being the most impacted (Len & Rao, 2012)
Using the Sensory Integration and Praxis Test (SIPT)

- Significant differences in Standing Walking Balance subtest (Williams, Tinley, Curtin, Wakefield, & Nielson, 2014)
- Significant difference in post-rotary nystagmus (Williams, Tinley, & Curtin, 2011)

Using the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2)

- ITW group “below average” on Bilateral Coordination, Balance, and Upper-Limb Coordination (Williams, Tinley, Curtin, Wakefield, & Nielson, 2014)
- ITW group scored lower on Balance (Williams, Tinley, & Curtin, 2011)
### Additional Research: Neuropsychiatric Differences

Engstrom, 2012

- **Purpose**: cross-sectional study to assess the incidence of neuropsychiatric symptoms in children with ITW compared to children without ITW
- **Sample**: 51 children (4 - 14 years) with ITW

- Motor skills 39%
- Executive Function 17/6%
- Perception 25.5%
- Memory 23/5%
- Language 23.5%
- Learning 25.9%
- Social 25.5%
- Emotional behavioral problems 21.6%
Additional Research: Coordination Deficits

- Using the BOT-2, ITW group “below average” on Bilateral Coordination, Balance, and Upper-Limb Coordination (Williams, Tinley, Curtin, Wakefield, & Nielson, 2014)

- Using the BOT-2, By 8 years old, ITW group scored “average” on all but Upper-Limb Coordination (Williams, Tinley, Curtin, Wakefield, & Nielson, 2014)


- Parent and child report of coordination problems: (Morris, 2007)
Upcoming Resources and Research

- American Physical Therapy Association (APTA) Clinical Practice Guideline
- Intervention research
- UNM Research Autism and TW
PICO Questions:

• In children 2 to 21 years referred to physical therapy for toe walking, what are the most appropriate evidence-based tests and measures for differential diagnosis and examination?

• In children aged 2 to 21 years with a primary diagnosis of ITW, what is the natural history and prognosis with or without treatment?

• In children 2 to 21 years with a primary diagnosis of ITW, what are the evidence-based plan of care and intervention recommendations?
## Clinical Practice Guideline

<table>
<thead>
<tr>
<th>Intended audience</th>
<th>Objectives of CPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pediatric PT</td>
<td>• Decrease variation in care</td>
</tr>
<tr>
<td>• Pediatric OT</td>
<td>• Improve outcomes for children</td>
</tr>
<tr>
<td>• Referral Sources</td>
<td>• Earlier referral</td>
</tr>
<tr>
<td>• Pediatric SLP</td>
<td>• Differential diagnosis</td>
</tr>
<tr>
<td>• Podiatrists</td>
<td>• Clearer picture of treatment options for the parents</td>
</tr>
<tr>
<td>• Orthotist</td>
<td></td>
</tr>
<tr>
<td>• Orthopedist</td>
<td></td>
</tr>
<tr>
<td>• Early Intervention Specialists</td>
<td></td>
</tr>
<tr>
<td>• Psychologists</td>
<td></td>
</tr>
<tr>
<td>• Chiropractors</td>
<td></td>
</tr>
<tr>
<td>• Developmental Optometrists</td>
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</tr>
</tbody>
</table>
Are you a registered or licensed Health Professional who diagnoses, treats or refers children with idiopathic toe walking for treatment?

We are investigating treatment strategies for idiopathic toe walking. All registered or licensed health professionals are invited to participate in this research. For more information on the aims, eligibility to participate and contact details of researchers, please click on the following link:

http://tinyurl.com/itwHPsurvey

This research has been approved by Monash University Human Ethics: 17-9631
Local ASD TW study

Local study for children with Autism who are toe walking - Individualized therapy program and treatment provided by UNM faculty in Physical Therapy (Dr. Marybeth Barkocy) and Orthotist (Jacque Newman). Call study coordinator for details. (505)272-9870
Insert Isaiah videos here
Why treat ITW: Physical symptoms

- Weight bearing skeleton will adapt form to function, especially in young children
  - Hypertrophy of talar neck
  - Underdeveloped calcaneus

- Pain
  - Calf pain and increased calluses and corns on balls of feet.

- Soft tissue problems
  - Tendency towards pes cavus (Burns, 2005)
  - Fixed achilles tendon tightness and calf contractures

- Neurodevelopmental impairment, (Martin, 2016)

- Strong evidence for increase ankle sprains with gastroc tightness (Tabrizi, 2000)

- Balance? Vestibular seeking? Back pain?
Why treat ITW: Participation and psychological reasons

- Participation restrictions: especially with peers at school
- Self-consciousness
  (The Oxford Ankle Foot Questionnaire: Morris, 2007)
- Quality of life is impacted
  (Williams, 2015)
Why treat ITW: Sensory Processing

- “The tactile receptors of the skin may be stimulated through pressure at the ball of the foot or lessened by the reduction of surface contact by raising the heel off the ground.”

- “Proprioceptive input may be changed at knee, ankle, and even to joints by unconsciously repositioning the foot posture.”

- “The vestibular input may be increased by the vertical stimulation of the bouncy type gait that results from toe walking.”

- “These results indicated that the children within this idiopathic toe walking cohort displayed a number of sensory needs that may motivate the toe walking gait to influence or provide increased sensory input.” (Williams, Tinley, Curtin, Wakefield, & Nielson, 2014)

- “The upright human body is unstable and its balance is continuously stabilized through the integration of visual, vestibular, proprioceptive, and other sensory inputs.” (O’Connor & Kuo, 2009)
# Differential Diagnosis:
Ruling out diagnoses needing referral

**ITW**
- Diagnosis of exclusion
- Condition in which a child ambulates with a bilateral toe-toe gait without any known reason or pathology
- Habitual toe walking

**Non-ITW**
- ASD
- Cerebral Palsy
- Tethered Cord Syndrome
- Charcot Marie Tooth (CMT)
- Duchenne or Becker Muscular Dystrophy (DMD or BMD)
- Spinal Muscular Atrophy (SMA)
- Talipes Equinovarus (Clubfoot)
Toe Walking Tool

This valid and reliable tool was designed to identify healthy idiopathic toe walkers and exclude children who have a medical condition resulted in toe walking

Questionnaire sections:

1. Demographics.
2. Indicators of trauma.
3. Indicators of neuromuscular influence.
4. Indicators of neurogenic influence.


Clinical presentation, diagnosis, prognosis

- Prematurity, admission to NICU, and low birth rate are associated have greater rates of ITW (Baber, 2016)

- Family history increases rates of ITW (42-61% of children with ITW) (Pomarino, 2016 & Engstrom, 2012)

- Differences in sensory processing have been identified, especially related to the tactile, vestibular, visual, and proprioceptive systems (Ganley, 2016 & Williams, 2014)
Screening checklist: Liesa Persaud
(not validated but seems to be clinically accurate)

Permission by Liesa Persaud granted to share with NM Peds Study Group 2017 from her TW Course

http://www.knowtochange.com/about-liesa/
Classification of toe walking severity

Table 1.
Classification of Idiopathic Toe Walking Based on Gait Analysis (Alvarez et al.).

<table>
<thead>
<tr>
<th>Toe Walking Severity Group</th>
<th>Primary Criteria and Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Presence of Ankle Rocker</td>
</tr>
<tr>
<td>Type 1</td>
<td>Yes</td>
</tr>
<tr>
<td>Type 2</td>
<td>Yes or no</td>
</tr>
<tr>
<td>Type 3</td>
<td>No</td>
</tr>
</tbody>
</table>

Commonly recommended treatment

(1) observation until age 2–3 years

(2) conservative management via stretching, bracing, serial casting, and botulinum toxin injection for dynamic toe walkers without fixed heel cord contractures

(3) consider surgical heel cord lengthening for cases with fixed heel cord contractures with poor response to nonsurgical treatment

Clinical Assessment of Participation PT and OT

- Interviews
  - Parents
  - Child

- Child questionnaire
  - COSA

- Parent questionnaires
  - PODCI
  - QOL measures
  - COPM

Using PedsQL 4.0, compared with non TW peers, children with ITW ...

- Parents of children with ITW reported significantly lower values on Total, Psychosocial, and Emotional subscales:

- Children with ITW self-reported significantly lower values on Physical, Psychosocial, and School subscales.

(Williams 2015)
Referral to other professionals

- Occupational Therapy
- Physical Therapy
- Speech language:
  - Higher incidence of speech/language delays, so ask about this in history and refer if concerned (Shulman, 1997)
- Neuroptometric rehab
- Orthotist
- Orthopedist
- Neurologist
- Developmental pediatrician

Occupational and physical therapy evaluations found 4 of 12 (33%) had fine motor delays, 4 of 10 (40%) had visuomotor delays, and 3 of 11 (27%) had gross motor delays. (Shulman, 1997)
ExplorAbilities in house referrals

- Sensory Screen for ITW
  - Does the child get car sick?
  - Does the child pull away from being touched (type? Hug? Tickle?)
  - Does the child withdraw from tactile input to hands or feet such as food, shaving cream, sand, grass?
  - Does the child not like to walk in the grass or sand barefoot?
  - Does the child have significant difficulty with haircuts, hair combing, teeth brushing?
  - Does the child put their hands over their ears when exposed to loud noises or react in a strong way?
  - Does the child spend more time in movement play than peers?
  - Does the child seek out crashing, pushing, big hugs?
  - Is the child easily distracted by visual input in the environment?
  - Does the child strongly dislike tags on clothing or having strong clothing preferences?
Additional Sensory Resources

- STAR Institute for Sensory Processing Disorder
  - [https://www.spdstar.org](https://www.spdstar.org)

- SPIRAL Foundation (Sensory Processing Institute for Research and Learning)
  - [http://www.thespiralfoundation.org/](http://www.thespiralfoundation.org/)

- SIGN Sensory Integration Global Network
  - [https://www.siglobalnetwork.org/](https://www.siglobalnetwork.org/)
PT Clinical Assessment of Function

- Gait
  - OGS
  - Percentage of TW steps/distance
  - Foot print analysis
  - Parent report % of time toe walking
  - BOT2 Running speed and agility

- Balance skills:
  - BOT-2 balance section
  - Single leg balance
  - Standing balance

- Motor skills
  - Stairs
  - Squat
  - Heel walking
PT assessments of gait for TW

Measurement of toe walking, in process:
Children’s Hospital Denver
## Toe walking severity scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>% time TW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>76 - 100%</td>
</tr>
<tr>
<td>Grade 2</td>
<td>51 - 75%</td>
</tr>
<tr>
<td>Grade 3</td>
<td>26 - 50%</td>
</tr>
<tr>
<td>Grade 4</td>
<td>10 - 25%</td>
</tr>
<tr>
<td>Grade 5</td>
<td>Walking plantigrade but with early heel rise (occasional TW, &lt; 10% accepted)</td>
</tr>
<tr>
<td>Grade 6</td>
<td>Walking with normal heel strike</td>
</tr>
</tbody>
</table>
Pomarino Classification System
by clinical features

**Type I:** This group of toe walkers is born with a short triceps surae muscle, which produces the tiptoe walking pattern. They are recognized by having a heart shaped calf (Figure 1) deep wrinkles (Figure 2) over the Achilles tendon area, and a fat deposit on the forefoot (Figure 3) under the second and third metatarsal bones. Other common features are a pointy heel, a pes cavus, and a short adductor magnus muscle.
• Type II: This group has a positive family predisposition, they present with a “V” sign over the Achilles tendon area (Figure 4), and the gastrocnemius muscle is hypertrophied (Figure 5).

• Type III: This group usually can support the heel on the ground while walking. Frequently between 4 and 5 years of age, the tiptoe gait pattern resolves spontaneously. The pattern may continue to appear in some situations such as fear, anxiety, tiredness, or stress.

Observational Gait Scale

Assesses knee and foot/ankle with emphasis on stance phase of gait

Limitations:
- Not validated for use in children with ITW
- Does not assess trunk or hip posture


<table>
<thead>
<tr>
<th>Gait Parameter</th>
<th>Definition</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee Position in Midstance</td>
<td>Grouded: Severe = &gt;15°, Moderate = 10-15°, Mild = &lt;10°, Neutral</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Recursion: Mid = &lt;5°, Moderate = 5-10°, Severe = &gt;10°</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Initial Foot Contact</td>
<td>Toe</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Forefoot</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Foot-flat</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Heel</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Foot Contact at Midstance</td>
<td>Toe/toe (equinus)</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Foot-flat/early heel rise</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Occasional heel/Foot-flat</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Heel/toe (normal roll over)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Timing of Heel Rise</td>
<td>No Heel Contact</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Before 25% Stance</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Between 25-50%</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>At Terminal Stance</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>No Heel Rise</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hindfoot at Midstance</td>
<td>Varus</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Valgus</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Base of Support</td>
<td>Frank Scissoring</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Narrow Base</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Wide Base</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Normal Base (width of shoulders)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Gait Assistive Devices</td>
<td>Walker with Assistance</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Walker Independent</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Crutches, Canes</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>None, independent for 10m/30ft</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Change</td>
<td>Worse</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Better</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total (perfect score = 22 per limb)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
50 Foot Walk Test for ITW

- Number of toe walking steps divided by number of steps taken gives you a percentage

- Excellent concurrent validity and interrater reliability

- Can also use accelerometer to count steps, so you just count toe walking steps


**PT Clinical Assessment of Impairments**

<table>
<thead>
<tr>
<th>Posture:</th>
<th>ROM:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Outtoeing? (occasionally intoeing)</td>
<td>• R1 and R2 ankle DF with knee ext</td>
</tr>
<tr>
<td>• Pronation?</td>
<td>• R1 and R2 ankle DF with knee flex</td>
</tr>
<tr>
<td>• Hip flexion?</td>
<td>• Hamstrings, hip flexors</td>
</tr>
<tr>
<td>• Knee hyperextension?</td>
<td>• LE assessment: LLD, torsional deformities, calcaneal alignment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strength:</th>
<th>Tone/Spasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>• BOT-2 strength section</td>
<td>• MAS, Tardieu</td>
</tr>
<tr>
<td>• Anterior tibialis weakness?</td>
<td>• Hypertonia Assessment Tool</td>
</tr>
<tr>
<td>• Core weakness?</td>
<td>• Clonus</td>
</tr>
<tr>
<td>• Gluteus maximus and medius weakness?</td>
<td>• Tone assessment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motor coordination</th>
<th>Balance/postural control</th>
</tr>
</thead>
<tbody>
<tr>
<td>• BOT-2 bilateral coordination</td>
<td>• Righting, equilibrium reactions</td>
</tr>
<tr>
<td></td>
<td>• Ankle strategy?</td>
</tr>
</tbody>
</table>

| | Balance with eyes closed vs. open? |
| | (vision vs. proprioception) |
OT Clinical Assessment of Function

- **Tactile**
  - Does the child’s TW change depending on the surface?
  - Is the child bothered by tags on clothing?
  - Is the child selective about clothing textures or food textures?
  - Does the child prefer or dislike to be barefoot?
  - Is the child bothered by seams in clothing, especially socks?

- **Proprioception:**
  - Does the child avoid physical activities?
  - Does the child often bump into objects or people while walking in the environment?

- **Vestibular:**
  - Does the child get car sick?
  - Does the child enjoy spinning more or less than his/her peers?
  - Become dizzy easily?

- **Vision:**
  - Does the child get car sick?
  - Does the child frequently rub his/her eyes?
  - Does the child become tired when reading?
OT Clinical Assessment of Impairments

- Tactile, Vestibular, Proprioception, Vision
- Child Sensory Profile 2 (CPS 2)
- Sensory Processing Measure
- Sensory Integration Praxis Test
OT Clinical Assessment of Impairments

- Vestibular and Vision:
  - Post rotary nystagmus (Mailloux, Z., et al, 2014)

- Vestibular and Proprioception
  - Tonic Labyrinthine Reflex (TLR) Prone Extension (Gregory-Flock & Yerxa, 1984)
  - Tonic Labyrinthine Reflex (TLR) Prone Extension and Supine Flexion (Sellers, 1988)
  - Asymmetrical and Symmetrical Tonic Neck Reflex (Goddard, 2005)

- Proprioception:
  - BOT-2 Bilateral Coordination
  - Comprehensive Observations of Proprioception (COP)
    http://sensorymetrics.net/COPForm

- Vision
  - BOT-2 Upper Limb Coordination
  - Tracking vertically and horizontally
  - Convergence and divergence
  - Asymmetrical and Symmetrical Tonic Neck Reflex (Goddard, 2005)
### Case 1 Examination, Evaluation, and Plan of Care

<table>
<thead>
<tr>
<th>Examination:</th>
</tr>
</thead>
</table>
| Sensory testing/questions  
Child Sensory Profile  
Tracking  
Convergence/Divergence  
PRN  
TLR  
ATNR  
BOT-2 |

<table>
<thead>
<tr>
<th>Plan of Care:</th>
</tr>
</thead>
<tbody>
<tr>
<td>OT 1 hour/week; Optometry referral</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
</tr>
</thead>
</table>
| • Impaired VOR, gets car sick  
• Rubbed eyes during tracking, jerky eye movements during convergence  
• Prefers to be in socks, bothered by tags, prefers to be clean  
• Poor postural control  
• Poor body awareness (imitating body positions and knowing when his heel came in contact with |
# Case 2 Examination, Evaluation, and Plan of Care

<table>
<thead>
<tr>
<th>Examination:</th>
<th>Evaluation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROM</td>
<td>▪ ankle DF with knee ext R -13, L-14</td>
</tr>
<tr>
<td>Strength</td>
<td>▪ Hamstrings moderately tight</td>
</tr>
<tr>
<td>Posture/Alignment</td>
<td>▪ TFA R 17, L 15 = outtoeing</td>
</tr>
<tr>
<td>Balance</td>
<td>▪ Constant toe walking</td>
</tr>
<tr>
<td>Gait</td>
<td>▪ Can stand with heels down with knee hyperextension, hip flex, and outtoeing; unable to hold static standing on toes</td>
</tr>
<tr>
<td>Sensory processing screen</td>
<td>▪ Poor single leg balance, unable to squat, hesitant down stairs,</td>
</tr>
<tr>
<td>BOT-2</td>
<td></td>
</tr>
<tr>
<td>Plan of Care:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PT 1 hour/week; OT referral</td>
</tr>
</tbody>
</table>
## PT Interventions

- Stretching
- Night splinting
- Ther ex/Strengthening
- Joint mobilizations
- Balance training (especially standing balance and posterior weight shifting)
- Gait training/Treadmill training
- Motor Control/Motor Learning Strategies
- Taping (not in this case)
- NMES (not in this case)
- Augmented Auditory Feedback
- Biofeedback (faded verbal feedback from PT)
- Orthotics (AFOs or ITW inhibiting)
- Serial casting
- Shoe modifications (not in this case)
- Sensory strategies
- HEP
  - ExplorAbilities HEP
Evidence based interventions

- motor control interventions (Clark, 2010)
- augmented auditory feedback (Marcus, 2010; Persicke, 2014)
- observation (Hirsch, 2004; Dietz, 2012)
- serial casting, (LeCras, 2011; Fox, 2006; Griffen, 1997; Brouwer, 2000; Pistilli, 2015)
- orthoses (Herrin, 2015)
  - Serial casting increases passive ankle dorsiflexion range, improves EMG gait variables, and is a safer and less costly intervention than surgery in children with ITW
- surgery (Strickler, 1998; van Kuijk, 2014)
Good evidence for casting and surgery in the treatment of idiopathic toe walking, with only surgery providing long-term results beyond 1 year.

Botox combined with casting does not provide better outcomes compared with casting alone.

Ankle-foot-orthoses restrict toe walking when worn, but children revert to equinus gait once the orthosis is removed. (but no long term studies! 6 weeks?)

EB Guideline Cincinnati Children's Hospital Medical Center, 2011

### Treatment Recommendations: DF PROM KE ≤ 0 degrees

<table>
<thead>
<tr>
<th>Treatment Emphasis</th>
<th>Serial Casting up to 6 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
<td>↑ DF PROM KE to ≥ 10 degrees</td>
</tr>
<tr>
<td>Treatment Strategies</td>
<td>Consider knee immobilizers in addition to serial casts to increase gastrocnemius muscle length gains</td>
</tr>
<tr>
<td>Additional Considerations</td>
<td>If DF PROM KE ≤ 0 following serial casting, consider referral to PM&amp;R for Botox</td>
</tr>
</tbody>
</table>

### Treatment Recommendations: DF PROM KE 5 – 10

<table>
<thead>
<tr>
<th>Treatment Emphasis</th>
<th>Night splinting progressing towards daytime articulated AFOs as tolerated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>↑ DF PROM KE to ≥ 10 degrees, ↑ Spontaneous heel-toe gait pattern and presence of 2nd rocker during stance phase, ↑ Balance skills</td>
</tr>
<tr>
<td>Treatment Strategies</td>
<td>Stretching, strengthening, manual therapy, joint mobs, gait/treadmill training, balance training, augmented auditory feedback, orthotics, including night splint and HEP</td>
</tr>
</tbody>
</table>

### Treatment Recommendations: DF PROM KE 5 – 10

<table>
<thead>
<tr>
<th>Treatment Emphasis</th>
<th>Articulated AFOs for daytime use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>Maintain/increase ankle DF PROM KE, ↑ Heel-toe walking to ≥ 75%, ↑ OGS score improvement</td>
</tr>
<tr>
<td>Treatment Strategies</td>
<td>Articulated AFOs, possible night splinting, stretching, strengthening, manual therapy, joint mobs, gait/treadmill training, auditory feedback, balance training, HEP</td>
</tr>
<tr>
<td>Additional Considerations</td>
<td>Foot orthotic may be needed to maintain foot integrity, Consider functional use/quality of movement during gross motor skills</td>
</tr>
</tbody>
</table>

### ITW Intervention Priorities

- Obtain 10 degrees ankle DF PROM KE (stretching, night splints, serial casting)
- Strengthening core and lower extremities, postural training, locomotor training, balance training, articulated AFOs during the day
- Wean from daytime articulated AFOs, transition to HEP

Brausch, LeCras, Muir Bouck 2017 APTA Combined Sections Meeting
PT Interventions

ROM: Serial casting, stretch splinting

- Following casting, 66% of patients had improved gait on patient and clinician determined outcomes, with the majority of children ceasing to toe-walk. Ankle dorsiflexion significantly improved in those children who were successfully treated (p = 0.001). (Fox, 2006)
- Night splinting HEP showed kinematic gait changes (Lara, 2016)

Orthotics/insoles

- Insoles to gradually retrain the foot to make full contact with the ground (Pomarino, 2016)
PT Interventions

Motor Control Training

Balance Training/ ankle strengthening
PT Interventions

Gait training

Home exercise program

Dinosaur PT http://blog.dinopt.com/toe-walking/

ExplorAbilities HEP
OT Interventions

- Integration of tactile input
- Integration of vestibular input
- Integration of proprioceptive input
- Integration of vision
- Integration of senses
OT Interventions: Tactile

- Therapressure Brushing Protocol
- Use of tactile media (rice, beans, water beads, Kinetic Sand)
- Vibration (Williams, Michalitsis, Murphy, Rawicki & Haines, 2016)
OT Interventions: Vestibular

- Swing
- Scooter board
- Therapy ball
- Therapeutic Listening Protocol
OT Interventions: Proprioception

- Body sock
- Lycra swing
- Yoga
- Cloth tunnels
- Aquatic therapy
OT Interventions: Vision and Coordination

- Eye Games: Easy and Fun Visual Exercises
- Developing Ocular Motor and Visual Perceptual Skills: An Activity Workbook
- [http://eyecanlearn.com/](http://eyecanlearn.com/)
OT Interventions: Putting it all together

- Bal-A-Vis-X
- S’Cool Moves
- Combining activities
Case 1 Interventions and Progress

- Improved score on the BOT-2 in upper limb coordination from a standard score of 10 to standard score of 20 placing him within an average range
- Decrease in eyes less fatigue
- Decreased report of car sickness
- Increase in fluidity of visual pursuits
- Increase in body awareness
Case 2 Progress

RECALL goals and assessment of progress.

1. 100% Heel toe gait pattern in orthotics
   GOAL MET
2. ROM ankle Dorsiflexion. GOAL MET

<table>
<thead>
<tr>
<th></th>
<th>RLE</th>
<th>LLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/20/12</td>
<td>+20°</td>
<td>+19°</td>
</tr>
<tr>
<td>5/4/12</td>
<td>+20°</td>
<td>+21°</td>
</tr>
<tr>
<td>5/9/10</td>
<td>+20°</td>
<td>+22°</td>
</tr>
</tbody>
</table>

   GOAL MET
   -mom reports no pain noted.

Patient goals cont...

4. Stand on either foot 5 sec. GOAL MET
   RLE: 10 sec   LLE: 6 sec (consistently 2 sec)

5. Squat with knees flexed to 90 degrees to pick up object from floor. GOAL MET

6. Ambulate ↑↓ 6” step reciprocally w/ feet pointed forward. GOAL MET
The Problem

- Impairments such as ROM, balance, body awareness can improve, but....

- Recurrence rates of toe walking are high with all above stated interventions, including botox (Engstrom, 2010 and Strickler, 1998)

- More research needs to be done on orthoses for retraining gait patterns (Herrin, 2016: FOs tolerated better than AFOs, but did not improve toe walking as well)

- Early identification and intervention are best before secondary impairments form! ("He/she will "outgrow" it.....")
Surgery vs. Conservative management

- Systematic review: Due to heterogeneity of patient groups, sample size and follow-up, no firm conclusions on a favorable role of surgery or cast treatment could be drawn in the treatment of ITW or equinus contracture. (VanBemmel, 2014)

- 8 Idiopathic toe walkers who were treated surgically for triceps surae contractures showed significant improvements in key kinematic and kinetic gait analysis variables at 1 year post-operative that were maintained at 5 years post-operative. Overall, subjects were satisfied with outcomes of the surgery, unrestricted in activities, and reported minimal pain. (McMulkin, 2016)

- 15 children: Achilles tendon lengthening improves ankle kinematics without compromising triceps surae strength; however, plantarflexion power does not reach normal levels at 1 year after surgery. (Hemo, 2006)

- But we all know kids who have returned to toe walking, resumed tightness, and did not tolerate surgery well......

- Non-surgical treatment should be considered first, with surgical options reserved for resistant cases (Kiebzak, 2016)
References


Dietz G, Khunsree S. Idiopathic toe walking: to treat or not to treat, that is the question. *Iowa Orthop J*. 2012;32:184-188.


References Cont.


