A Novel Classification System for Patients with Persistent ITW

Sancy Childers[1]; Sean Brown, MA[2]; Anita Bagley MPH, PhD[2]; Jon R. Davids, MD[2]

[1]UC Davis School of Medicine, [2]Shriners Hospital for Children

INTRODUCTION

❖ By the age of 3, most children develop a mature gait pattern, defined as plantigrade use of the foot with weightbearing through both the heel and metatarsal heads.

❖ Children with idiopathic toewalking (ITW) are otherwise neurologically normal but preferentially walk on their tiptoes. ITW resolves in most cases by 6 years of age.

❖ Children with persistent ITW (ITWp) may develop ankle contractures and foot skeletal deformities.

❖ The Alvarez criteria was established in 2006 and has since been the standard classification for ITWp based on gait analysis.

WHAT ARE KINEMATICS AND KINETICS?
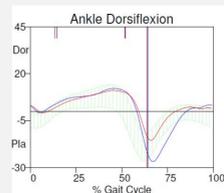
Kinematics

Kinetics

❖ Kinematics describes range of motion and can be observed in a subject's gait in a hallway and further objectified in a motion analysis lab.
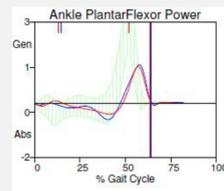
❖ Kinetics are the forces that cause the body to move and are measured in a lab.

OBJECTIVES

❖ Develop a more encompassing classification system for ITW patients to qualify the gait abnormalities observed in ITWp.

METHODS

❖ This was a single-center, retrospective record review of 16 patients: children with non-neurological conditions, diagnosed with ITWp, (Age: mean 10.6, range 6-14) with completed kinematics and kinetics.

❖ Patients with diagnosed ITWp that had Motion Analysis Center data collected (kinematics and kinetics) were first attempted to be categorized using the Alvarez criteria. Any patient that could not be accurately categorized or fit the criteria for multiple classification types, were analyzed as "uncategorizable".

❖ Definitions:
  ❖ First rocker is present if the kinematics show an ankle plantarflexion wave and the kinetics show an internal dorsiflexion moment in loading response.
  ❖ Plantarflexion bias is observed in the kinematics from initial contact to 50% of the gait cycle spent in plantarflexion.
  ❖ Double bump is observed in kinetics and the magnitude of the 1st and 2nd bumps qualified.

RESULTS

Using kinematic and kinetic data, the Alvarez criteria failed to classify 48.43% of limbs measured.

Alvarez Classification Extremities Totals				
	Type 1	Type 2	Type 3	Uncategorizable
Pre op	0	3	14	15 (46.9%)
Post op	14	2	0	16 (50%)

Table 1. ITWp patient's classification using the Alvarez criteria.

The problems encountered while trying to classify:
❖ Absent 1st rocker with otherwise normal kinetics and kinematics.
❖ Otherwise normal kinematics and kinetics with a double bump.
❖ Abnormal kinematics or kinetics without a double bump.
❖ Plantarflexion bias in stance and swing with 1st and 2nd bumps larger.

Using the new classification system, 100% of patients with ITWp were able to be classified.

Modified Alvarez Classification Extremities Totals							
	Type 1a	Type 1b	Type 1c	Type 2	Type 3a	Type 3b	Uncategorizable
Pre-Op	0	0	0	4	15	13	0
Post-Op	14	7	5	6	0	0	0

Table 2. ITWp patient's classification using the new classification criteria.

Updated Classification	
1	Normal kinematics and kinetics
2a	Present 1st rocker, 1+ abnormal kinematic and/or kinetics
2b	No 1st rocker, normal kinematics and kinetics
3	No 1st rocker, 1+ abnormal kinematics and kinetics
4a	No 1st rocker, plantarflexion bias in stance and swing, double bump (2nd larger)
4b	No 1st rocker, plantarflexion bias in stance and swing, double bump (1st larger)

Table 3. Updated classification criteria.

Examples:
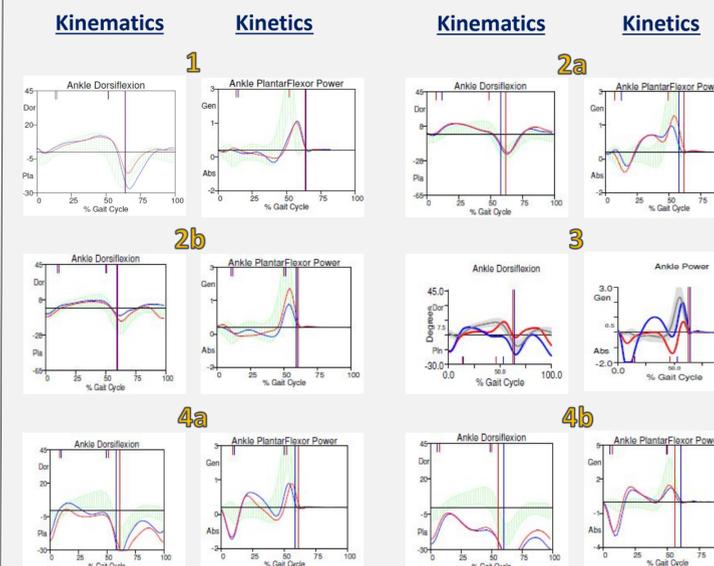
Figure 1. Kinematic and kinetics examples for the new classification system.

CONCLUSIONS

❖ The Alvarez criteria failed to accurately categorize 48.53% of patients studied with ITWp. This is because patients either did not meet the criteria for any of the three categories or could fit the definitions for multiple classification types.

❖ The new system was able to classify 100% of patients; every patient studied fit discretely into only one category.

NEXT STEPS

The next steps will be to demonstrate the efficacy of the updated classification system on a larger sample size and to compare pre- and post-operative kinematics, kinetics, and foot radiographs to discern if surgery to improve walking in children with ITWp led to improvement in gait.

ACKNOWLEDGEMENTS

REFERENCES

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