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Title

Reliability and Utility of a Novel Classification Scheme for Gait Deviations in Children with Persistent Idiopathic Toe Walking

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Introduction

- ❖ Neurotypically developing children who toe walk usually spontaneously resolve by school age, those who do not are considered to have Persistent Idiopathic Toe Walking (ITWp) and may develop ankle contractures and foot skeletal deformities.
- ❖ Alvarez et al. proposed a classification scheme in 2006. When it was applied to our cohort, it failed to classify many subjects due to ambiguity in the classification scheme definitions.

Methods

- ❖ This was a single-center, retrospective record review of 65 neurologically normal children (mean age 11.1, range 6.0-19.4) diagnosed with ITWp, with completed kinematic and kinetic motion analysis.
- ❖ Utility (percent classifiable) was determined for the novel Shriners Hospital for Children (SHC-ITWp) and Alvarez classification schemes.
- ❖ Intra- and inter-rater reliability were determined for a subset of patients using the SHC-ITWp (30 limbs pre- and post-op).

Definitions

SHC-ITWp Classification Criteria	
	Ankle Sagittal Kinematics/ Kinetics
1	Present kinetic 1 st rocker Kinematics/kinetics: No abnormalities
2a	Present kinetic 1 st rocker Kinematics/ kinetics: Additional 1 or more abnormality
2b	Absent kinetic 1 st rocker Kinematics/ kinetics: No other abnormalities
3	Absent kinetic 1 st rocker Kinematics/ kinetics: Additional 1 or more abnormality
4a	Absent kinetic 1 st rocker Kinematics: Plantarflexion bias in stance and swing Kinetics: Moment double bump (2 nd peak larger)
4b	Absent kinetic 1 st rocker Kinematics: Plantarflexion bias in stance and swing Kinetics: Moment double bump (1 st peak larger)

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Results

Utility of the SHC-ITWp classification scheme was determined by applying it and Alvarez classification to the entire cohort of 65 patients with initial studies and 26 with post-operative studies.

Application of the SHC-ITWp Classification Scheme							
	Type 1a	Type 1b	Type 1c	Type 2	Type 3a	Type 3b	Uncategorizable
Initial (130 limbs)	3	1	2	9	55	60	0
Post-Op (52 limbs)	20	11	12	8	1	0	0

Application of the Alvarez Classification Scheme				
	Type 1	Type 2	Type 3	Uncategorizable
Initial (130 limbs)	3	8	60	59 (45%)
Post-Op (52 limbs)	23	6	0	23 (44%)

- ❖ The SHC-ITWp classification scheme accurately classified 100% of limbs (130 of 130 limbs prior to intervention, 52 of 52 limbs following surgery).
- ❖ The Alvarez classification scheme was only able to classify 61 of 130 limbs (55%) prior to intervention and 29 of 52 limbs (56%) following surgery.

Reliability of the SHC-ITWp classification scheme was determined by frequency of agreements for intra- and rater-agreement. The shaded fields indicate perfect agreement.

Frequency of Intra-Rater Agreement							
		Rater 1 2 nd Pass					
Rater 1 1 st Pass		1	2A	2B	3	4A	4B
1		14					
2A			6		1		
2B				5			
3				1	6		
4A						14	
4B							13

Frequency of Inter-Rater Agreement							
		Rater 2					
Rater 1		1	2A	2B	3	4A	4B
1		11	3				
2A		1	5				
2B				5	1		
3			1		5	1	
4A						13	1
4B							13

- ❖ Intra-rater agreement was 96.7% with a weighted kappa of 0.98.
- ❖ Inter-rater agreement was 86.7% with a weighted kappa of 0.93.

Discussion

- ❖ The Alvarez classification exhibited marked deficiencies when applied to a large cohort of subjects with ITWp.
- ❖ The SHC-ITWp classification scheme resolved the issues presented by Alvarez by modifying the criteria initially presented.
- ❖ First, we subdivided the classification groups to more accurately represent disease severity, the variety of type 2's described in Alvarez are now separated out into type 2a, 2b, 3 and distinct from type 1.
- ❖ Second, the classification types are now discrete, patients no longer qualify for multiple types.
- ❖ Finally, we added classification types (2a and 3) that include 1+ abnormal kinematics and/or kinetics to take into account gait abnormalities observed in children with ITWp.

Conclusion

- ❖ The SHC-ITWp exhibited excellent utility and reliability in classifying the limbs of children with ITWp.
- ❖ The SHC-ITWp accurately classified 100% of limbs; both prior to intervention and following surgery. In contrast, the Alvarez classification scheme exhibited poor utility, as it was only able to classify 55% prior to intervention and 56% following surgical intervention.
- ❖ The SHC-ITWp also exhibited excellent reliability with intra-rater agreement of 97% and inter-rater agreement of 87%.

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