



**Second course:  
Motion analysis and clinics: why to set-up a MAL?**

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**From lab to clinical practice...**



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**Gait laboratory ≠ diagnosis test**







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**Objectives of the movement ( gait ) lab**

- Study characteristics of normal gait
- Detecting significant deviations from normal gait (clinical ? - statistical ?? )
- If the deviations are primary, secondary symptoms or compensatory mechanisms
- When deviations may be improved ( decisión - making )
- To assess the outcome of the treatments

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**Why do we order diagnostic tests**

<p><b>1. Diagnostic factors</b></p> <p>Modify pretest probability of disease Rules in or rule out disease</p>	<p><b>4. Doctor-related factors</b></p> <p>Clinical experience and confidence in clinical judgment Knowledge regarding test properties Attitudes to risk taking/fear of uncertainty/reassurance Fear of litigation e defensive testing</p>
<p><b>2. Therapeutic and prognostic factors</b></p> <p>Decide on appropriate treatment Predict subsequent clinical course and assess prognosis</p>	<p><b>5. Policy and organization-related factors</b></p> <p>Test availability Policy and clinical guidelines Use of structured test ordering form Referral process</p>
<p><b>3. Patient-related factors</b></p> <p>Patient acceptability and side effects of test Impact of diagnosis (or lack of diagnosis)</p>	




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Rarely is gait analysis used to make a medical diagnosis.

Most commonly, it is requested to quantitate the mobility state of a medical disorder and determine the neuromuscular-skeletal contributions to that state.

As such, it provides quantitative information to "help" prescribe treatment and assess its outcome.

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**Properties diagnostics tests**



Validity and reliability

**Validity:** The extent to which the results of a measurement correspond to the real situation = accuracy

**Reliability:** The extent to which repeated measurements a phenomenon is stable, falling close to one another. = Precision, consistency

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"Accuracy is telling the truth ( validity) ...

Precision ( fiability ) is telling the same story over and over again."

Yiding Wang

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**Reliability**

The value of any diagnosis test depends on its ability to yield the same result when reapplied to stable patients

Poor reproducibility can result from problems with the test itself. A second cause for different test results in stable patients arises whenever a test requires interpretation

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### Validity of a Measure

A good measure must not only be reliable, but also valid

A valid measure measures what it is intended to measure

A measure cannot be valid unless it is reliable, but a reliable measure may not be valid

There are many kinds of validity ( face, construct, etc )

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### Validity and Reliability

Low reliability  
High validity

Low reliability  
Low validity

High reliability  
High validity

High reliability  
Low validity

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### Gait lab reliability

There are many sources of variability from gait analysis:

- the patients ,
- the motion laboratories,
- data acquisition,
- data interpretation

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Variability arising from lack of standardization is being addressed in collaborative efforts, which was implemented across the 12 gait labs in the Shriner's system in North America.

Following the implementation of the protocol, there was only a moderate decrease in the variability across the 12 sites, and significant differences remain that the authors concluded must be addressed before the data can be considered comparable

Assessment of the kinematic variability between 12 shriners motion analysis laboratories  
George Gotorra, David Heberts, and Barry Goodeb

Figure 1: Sources of Kinematic Variability

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Variability in Gait Analysis Interpretation  
David L. Skaggs, M.D., *Journal of Pediatric Orthopaedics* 20:759-764 © 2000

Gait analysis data from seven patients were reviewed by 12 experienced gait laboratory physicians from six institutions. Reviewers identified problems and made treatment recommendations based on the data provided

Agreement among physicians for the most commonly diagnosed problems was slight to moderate (kappa range, 0.14-0.46). Physicians agreed on identification of soft tissue more than bony problems (intraclass correlation, 0.56 vs 0.37).

Variability regarding surgical recommendations for soft-tissue procedures (kappa range, 0.20-0.64) was similar to that for diagnosis of both soft-tissue and bone problems, although recommendation for hamstring lengthening showed substantial agreement (kappa, 0.64). There was less agreement in recommendation of osteotomies (kappa range, 0.13-0.22).

Although gait analysis data are themselves objective, this study demonstrates some subjectivity in their interpretation. The interobserver variability reported here is similar to that reported for established classification systems of various orthopedic conditions.

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TABLE 7. Number of problems identified and intraclass correlation for soft-tissue vs. bone surgical recommendations

	Number of surgeries recommended per side, per patient	Intraclass correlation
Soft tissue	1.76 (range, 1.1-2.7)	0.649
Bone	0.64 (range, 0.1-1.8)	0.193

<sup>a</sup> p = 0.000, comparison of soft-tissue vs. bone recommendations.

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**Gait lab Making - decision**

The clinical value of a test will ultimately depend on whether it is able to improve patient outcome.

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**An assessment of gait analysis in the rehabilitation of children with walking difficulties**  
 Technology Assessment Report  
 Disability and Rehabilitation, 2000 ; vol. 22.


Thirteen work  $\neq$  case series, one case control



Conclusions - Computerized gait analysis is a potentially useful technology in the management of children with walking disabilities, but its efficacy is not established. It should be regarded as a developing technology and its clinical application linked to systematic collection and assessment of outcomes data.

While there is a considerable literature on use of computerized gait analysis techniques in research, evidence about their clinical usefulness appears to be limited. There is an absence of data on the incremental benefit of computerized gait analysis in terms of patient outcomes following treatment. Also, information on comparative costs is lacking.

However, until good quality evidence of benefit emerges, gait analysis in the management of those with walking disabilities should be regarded as investigational and operated on that basis.

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**Value of gait analysis in the assessment of surgery in cerebral palsy.**  
 Lee EH, Arch Phys Med Rehabil 1992; 73:642-646.


Case control study



In that study, 15 diplegic children received surgery based on gait analysis findings and 8 received surgery based on clinical analysis alone.

13 of 15 children showed improved in gait outcomes in the gait analysis group compared with only three of eight in the control group.

It was concluded that this provided support for use of gait analysis techniques in clinical practice.

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**Other studies**

Schwartz MH. Comprehensive treatment of ambulatory children with cerebral palsy: an outcome assessment. *J Pediatr Orthop* 2004; 24:45-53

Saraph V. Multilevel surgery in spastic diplegia: evaluation by physical examination and gait analysis in 25 children. *J Pediatr Orthop* 2002;22:150-157.38

Chang FM . Effectiveness of instrumented gait analysis in children with cerebral palsy: comparison of outcomes. *J Pediatr Orthop* 2006; 26:612-616.




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**The role of gait analysis in the orthopaedic management of ambulatory cerebral palsy**  
**Unni G. Narayanan**

“ Until this evidence is established, many paediatric orthopaedic surgeons and funders of healthcare will remain resistant to the use and funding of gait analysis. The status quo will prevail, with wide area variation in the rates of utilization of gait analysis, and with ambulatory children with CP either being deprived of a useful assessment tool in many centres or being subjected to an unnecessary evaluation that is both expensive and time-consuming in others .The time is ripe for longitudinal comparative cohort studies and clinical trials to provide the evidence to resolve this controversy once and for all.”

Curr Opin Pediatr 19:38–43. 2007

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**Validity diagnosis test**

Validating a test is a process through which scientists and practitioners can find out whether the results of a test are meaningful.

**PREDICTIVE VALIDITY**

The extent to which a procedure allows accurate predictions about a subject's future behavior

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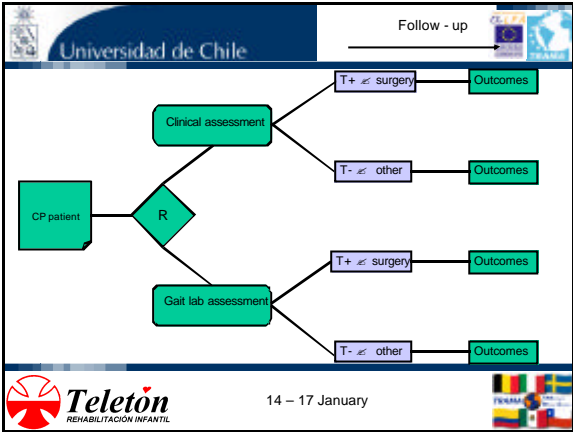
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### Outcomes of Orthopaedic Surgery Using Gait Laboratory Versus Observational Gait Analysis in Children With Cerebral Palsy

**Principal Investigator:** Umri Narayanan, MD The Hospital for Sick Children, Toronto Canada

**Study Design:** Treatment, Randomized, Double-Blind, Active Control, Parallel Assignment, Efficacy Study

**Primary Outcome Measures:**  
Change in Gross Motor Function Measure (GMFM-66) from baseline to 12 months

**Secondary Outcome Measures:**  
Change in each of these measures, from baseline to 12 months:  
 Pediatric Outcomes Data Collection Instrument (PODCI)  
 the Gillette Functional Assessment Questionnaire (FAQ)  
 the Functional Mobility Scale (FMS)  
 the Activity Scale for Kids (ASK)  
 the Normandy Index (quantifies the magnitude of gait deviation from normal)  
 O2 consumption and O2 Cost during walking  
 Gait velocity  
 Stride length

**ClinicalTrials.gov**  
A service of the U.S. National Institutes of Health

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Thanks you

Grazie

Merci

Tack




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