

## Overview of Pathologic Gait in Cerebral Palsy

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## Issues to be addressed

- Aetiology of gait problems in CP
- Classification in Hemiplegia
- Common gait patterns in Diplegia
- Contribution of Gait Analysis in management
- Prognosis

## Gait Problems in CP

### A.

Muscle tone abnormality  
Co-ordination and selective control

### B.

Delay in motor development  
Development of secondary deformity

### C.

Compensations

## Which Cerebral Palsy to treat?

	Hemiplegia	Diplegia	Total body
Spasticity	✓	✓	✓
Dyskinesia	?	?	?
Ataxia	x	x	x
Mixed	?	?	?

## Musculoskeletal Deformity in Cerebral Palsy

- Natural history of deformity in CP:
  - abnormal muscle tone
  - dynamic muscle contracture
  - fixed (static) muscle contracture
  - joint contracture
  - bone deformity

## Reduced ambulation vs Abnormal Forces

- **Lack of stimulation**
  - osteoporosis + altered structure
  - risk of fracture
  - secondary deformity
- **Failure to remodel**
  - persistent foetal alignment
- **Bone Age**

## Natural History

- Contractures      flexible vs fixed  
                         dynamic vs static
- References from Dev Med Child Neurol:  
                         Ziv et al 1984  
                         Tardieu et al 1988  
                         Booth and Theologis 2001

## Aims of Treatment

- Prevent / treat pain
  - Achieve / maintain maximum function
  - ? Cosmesis
- ⇒ Prevent / treat musculoskeletal deformity

## Orthopaedic Problems in CP

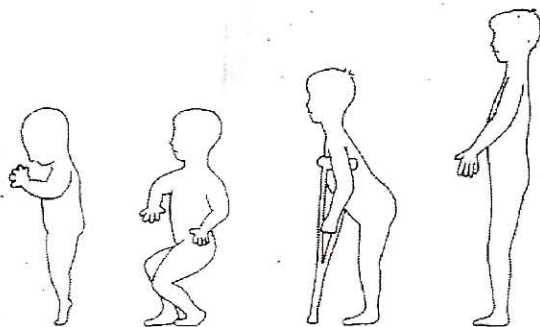
	hemiplegia	diplegia	quad/total body
Scoliosis	x	rare	60-70%
Hip dislocation	rare	15%	>50%
Knee contractures	15%	✓	✓
Foot deformity	✓	✓	✓
Upper limb	✓	x	✓
Leg length discrep.	✓	some	irrelevant
Gait problems	some	✓	irrelevant

## Treatment of Gait in CP

- Complex gait patterns
- Understanding of joint interactions
- Bi-articular muscles
- Single-stage surgery and rehabilitation

### → Use of Gait Analysis

## The Birthday Syndrome - Mercer Rang



## Hemiplegic Classification

- Winters et al (1987) JBJS 69-A: 437-441
- Patterns I to IV with increasing severity

### **Type I**

equinus in  
swing



### **Type II**

equinus in stance  
and swing

secondary knee  
hyperextension



### **Type III**

knee involvement  
(spastic hamstrings  
and rectus)

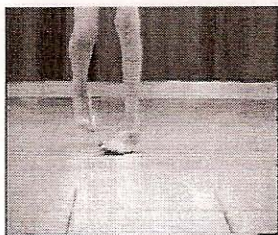


### **Type IV**

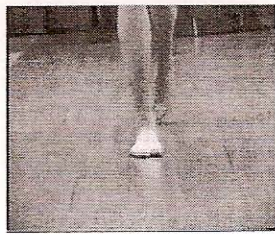
hip involvement  
(spastic psoas and  
adductors)



### **Foot deformity in Hemiplegia**



pre-op



post-op

### **Gait Analysis in Diplegia**

- Baseline at age 5-6 years to plan long-term management
- Most children are candidates for surgery
- Age for surgery 7-12 (8-10) years



## Contribution of Gait Analysis I

- Dynamic vs static problems:  
*video, kinematics*
- Proximal problems influencing the foot  
*kinematics, kinetics*
- Lever-arm dysfunction  
*kinetics*
- Identification of problematic muscle activity  
*EMG*

## Contribution of Gait Analysis II

- Severity of involvement / prognosis  
*kinematics, energy cost, temporal*
- Neurological pattern (spasticity vs dystonia)  
*kinematics, kinetics (consistency)*
- Stability of the foot in stance, pain aetiology  
*plantar pressure, kinetics*
- Motion within the foot during gait  
*foot kinematics*

## Contribution of Gait Analysis III

- **Outcome measure of treatment !**

*video*  
*kinematics*  
*kinetics*  
*foot kinematics*  
*energy consumption*  
*foot plantar pressure*  
*EMG*

## Diplegic Gait: Sagittal

- Pelvic tilt and "double bump" → *graphique kinématique*
- Hip deviations *graphique*
  - incomplete extension (stance)
  - reduced range
  - reduced/delayed peak flexion (swing)
- Knee patterns *graphique*
  - crouch
  - jump
  - recurvatum
  - stiff

## Diplegic Gait: Sagittal

- Ankle patterns
  - equinus throughout
  - midfoot break / apparent dorsiflexion
  - contact pattern and rockers disturbed
  - plantarflexion in swing

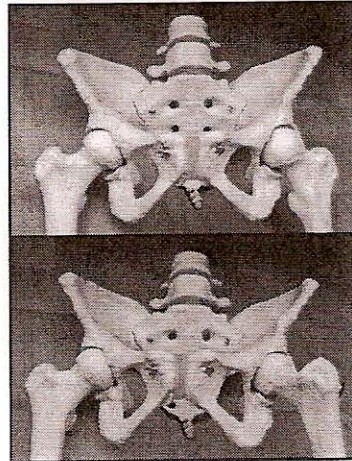
## Diplegic Gait: Coronal

- Pelvic obliquity
  - functional lld
  - true lld
  - scoliosis
  - hip problem
  - adductor spasticity
- Hip abduction / adduction

*length of stance*  
*longueur des membres*  
*ll d*

### Diplegic Gait: Transverse

- Pelvic retraction      neurological asymmetry compensation
- Hip internal rotation      femoral anteversion compensation
- Tibial torsion
- Foot progression



Effect of  
femoral  
anteversion

### Case Studies

### Conclusions

- Complex patterns
- Bone, joint and muscle interactions
- Systematic approach in studying gait essential