Third Course “Gait Analysis and Clinics: a focus to a clinical cases”

Trama Project

March 10th - 14th 2008

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Institution: IRI-Teletón- Santiago
Cerebral Palsy:
Description of the pathology and Functional clinical scales

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Santiago
Definition:

- It is a syndrome, characterized by a motor disorder (movement, tone and posture), secondary to a brain injury, not progressive, which is produced in an immature brain, in the pre, peri or postnatal period until 3 to 5 years old.
“However, the term not progressive, can contribute to a misunderstanding of the secondary musculo-skeletal pathology, which is not static, but definitely progressive.

- Boyd, Graham, 1997
Epidemiology:

• From the decade of 70, is the most prevalent pathology, in the IRI Santiago. Today, it reaches 36.3% of the incomes dg (November 2007).

• Decade of '70: Better perinatal care and appearance of neonatal UCI.

Decade of the´90s and beyond: Survival of children with very low birth-weight.
Incidence:

- Prematurity and low birth weight:
  - Developed countries: incidence of 5 – 7% of newborn child.
  - Developing countries: 10-19% of new borns.
  - Chile, in 1989, 6.3%.

Damages origin or causes are: asphyxia, intraventricular or subependimal haemorrhage.
Etiology:

- Risk factors are related to:

  **Pre-natal period**: HTA - Diabetes - Cholestasia intrahepatic - Erythroblastosis fetal - congenital infections (TORCHS) - genetic syndromes.


  **Post-natal period**: Injuries - Infections - AVE - toxic-metabolics affections or diseases. Remaining 20% are causes not specified.
Anatomopathology of cerebral damage: Preterm infants

- Intrinsic Vulnerability of the Preterm Brain child to an ischemic and haemorrhagic injury. This predisposes to:
Anatomopathology of cerebral damage: Preterm child

2 - Parenchymal complications of Intraventricular Hemorrhage:


LPV + IHPV: Clinic: Triplegia.
Periventricular Hemorrhagic Infarction

Periventricular Leukomalacia
Anatomopathology of cerebral damage: Well born child

- Cerebrovascular lesions result from: Hipoxic-hypoperfusion insults to the entire brain.
  - Focal infarct secondary to an embolic occlusion of a cerebral artery.
Anatomopathology of cerebral damage: well born child

- This creates or causes the following damages:
  Brain damage parasagittal. Clinic: Cuadriparesy.

Damage from basal Ganglia. Clinic: extrapiramidal commitment + spastic.

Damage Arterial-focal occlusive or stroke. Clinic: will depend on the territory injured.
Musculoeskeletetic Progression in Cerebral Palsy

Static SNC Injury

Progressive Deformity musculoskeletal

- Upper motor neuron syndrome.
- Spasticity and weakness.
- Failure in the longitudinal bone growth.
- Muscle contracture.
- Bone Torsion.
- Articulate Instability.
- Dislocation of joints and degenerative changes.
Progression of gait commitment in Cerebral Palsy

Due to changes associated with age or with the clinic intervention, frequently you can observe the following changes:

- The muscle commitment becomes increasingly proximal.
- The compensatory mechanisms are becoming less effective.
- In the long term, occur musculoskeletal pathologic changes.
- It happens a consequent increase of lordosis and hips hyperflexion.
Clinic

• Depends on anatomic commitment:
  ✤ **Spastic (70%)**: piramidal tract commitment.
  ✤ **Diskinetic or atetosic (5%)**: choreoatetosis or distonia, commitment of extrapiramidal tract.
  ✤ **Ataxic (5%)**: cerebellum commitment.
  ✤ **Mixed (20%)**: commitment of more than one tract.
Topographic Classification:

- **Hemiplegia** (25%): hemi-body commitment. (one half of the patient body)

- **Diplegia** (30%): commitment of four limbs, principally the lower ones.

- **Paraplegia**: impairment only at the lower limbs.

- **Tetraplegia** (15%) or **cuadriplegia**: impairment of the 4 limbs.

- **Triplegia**: injury of the two lower limbs and one upper limb.
Hemiplegia
Diplegia
Tetraplegia
Dysquinesia
Ataxia
Clinic Evaluation Scales
Evaluation Index

Spasticity
- Ashworth
- Escale of Tardieu
- Scale of muscular spams

Articular Ranges
- Thomas Ely popliteo angle FD/FP

Motor Function
- Scale of muscular strength
- Gait and movement analysis tridimensional
  - Clinic
  - Laboratory
  - EMG dinámico

Independence
- Wee-FIM
- PEDI
- FIM
- Barthel

Independence, autonomy and participation
Scales of General Functional Evaluation
(Wee - Functional Independence Measure):

- Measure of the children functional independence.
- System to measure the daily functional development, in patients with discapacity.
- Contains 18 elements related with selfcare, motion and cognition aspects.
- Applied to children and teenagers from 6 months to 21 years old, with development functional retards.
Measure of Children functional Independence (WeeFIM)

- **Self care**
  - A. Food
  - B. Selfclean
  - C. Bathroom
  - D. Upper dressing
  - E. Lower dressing
  - F. Water closet Use

- **Sphincter Control**
  - G. Management of bladder
  - H. Management of intestine

- **Transferences**
  - I. Chair - Wheel chair
  - J. Water closet
  - K. Bathtub - shower

- **Locomotion**
  - L. Gait /Wheel chair/ crawl
  - M. Stairs

- **Comunication**
  - N. Understanding
  - O. Expresion

- **Social knowledge**
  - P. Social Interaction
  - Q. Problems -Solving
  - R. Memory

The Independence of each article qualified from 1 to 7

Measure of functional independence for Wee-FIM children, and for FIM adults

**Selfcare**

**Transfer**

**Cognition**

**Total points:** 18 to 126

Measure the functional development of patient and the assistance require. Permits the evaluation to a groupal level and institutional. Following and prediction.
GMFM: ¿What GMFM means? (Gross Motor Function Measure)?

• Clinic measure to evaluate the changes at the gross motor function of children with Cerebral Palsy.

• Measure relevant aspects regarding clinical point of view and which present a high potential change.

• 2 versions: GMFM-88 and GMFM-66.

• Observation and standarized.

• Do not require to compare with patterns of healthy children.
Evaluation of Gross Motor Function (GMFM)

Gross Motor Abilities based on a development goals

A. Lying, rolling
B. Seated
C. Crawling, kneeling
D. Standing
E. Walking, running, jumping

Puntaje
No start 0
Complete <10% de la tarea 1
Complete the work 10% -100% 2
Complete the work 3

Russell DJ, et al Dev Med Child Neurol. 1999
Item Map by Difficulty Order

Client ID: 3
Name: Susie Q
Assessment Date: 03 April 1989
Date of Birth: 07 July 1987
Age: 1y 8m

More Difficult

GMFM-66 Score: 41.81
Standard Error: 1.14
95% Confidence Interval: 39.38 to 43.84

Less Difficult

GMFM-66 Score with 95% Confidence Intervals

Fig. A3.3. Item map by difficulty order: initial assessment.
New system of Palsy Cerebral Classification (GMFCS)

- Create a data base and a registry, which allow us to compare the results, a treatment program and a clinic investigation.

- Classifies the gross motor function of Cerebral Palsy children in 5 levels.

- Validated for children for older than 2 years old.

- After this age, children are kept in the same track, which allows to predict motor function over time.

- There are 5 curves of motor growing.
Curves of motor growing
### Before 2 years old

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<thead>
<tr>
<th>Habilitations</th>
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<th>Nivel II</th>
<th>Nivel III</th>
<th>Nivel IV</th>
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:: Klgo. Claudio Rozbaczylo :: Klgo. Rommy Bartholomaus
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<th>Habilitations</th>
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Between 4 and 6 years.

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| Use of wheel chair                  |         |          |           |          |         |
| run and jum                          | XX      |          |           |          |         |
| go up stairs                         |         |          |           |          |         |
| Independent                         | XX      |          |           |          |         |
| holded                               | XX      | X adult  |           |          |         |

& go in and out of a chair holded to a stable base.

# Have difficulty in driving a cart and balance reactions in biped.
Nivel I: They have trouble regarding speed regulation, balance and movement coordination.

Nivel II: Walking with difficulty on irregular surface, slope and agglomerations.

Nivel III: They can walk with a movility device, outdoor on flat surfaces, and they use a wheel chair on an irregular surfaces or in long distances.

Nivel IV: They maintain skills reached before 6 years, preferably using a wheel chair.
Specific Evaluation Scales
Measurement of muscle strength

- Difficult to evaluate.
- We have to estimate the degree of strength or weakness, which is hidden by spasticity.
- Measurement interfered by the antagonists co-contraction.
- Evaluation in different positions, functional activities and facilitated.
Measurement of muscular strength

- It was done through the Medical Research Council Scale.

- Instrument most widely used to assess muscle strength.

- Ordinal scale based on manual muscle testing.

- Developed in the UK over 30 years ago.
Medical Research Council

- **0**: no visible or palpable contraction.
- **1**: contraction observed by a palpation or we can observe a minimum and brief degree of contraction.
- **2**: The patient is capable of moving the joint through the full arc if it eliminates gravity.
- **3**: The patient is capable to move the joint through the full arc, against the gravity, but the patient is unable to do it, if he pursues a minimal resistance.
- **4**: The patient overcome the gravity against a moderated resistance along the articular arc.
- **5**: Normal Strength.
Ashworth Scale modified

- There is a correlation between the graduation of this scale and the role or need of treatment.
- It’s simple, low cost, validated and is widespread throughout the world.
- It is used to determine criteria for severity, treatment and results evaluation.
Ashworth Scale modified

• **1:** Slight increase of muscular tone (MT), slight hitching and liberation (release) with minimal resistance to the end.

• **1+:** Slight increase of MT, slight hitching followed by a minimal resistance throughout the movement.

• **2:** Increase of MT, but the segment moves easily.

• **3:** Substantial increase of MT, the passive mobilization is difficult.

• **4:** Stiffness in flexion or extension.
The difference between V1 and V3 allows us to establish the degree of dynamic shortening versus the structured retraction.

Therefore, it may be a forecast index to estimate the ROM gain or profit to treat spasticity.
Special Analysis and ROM

- They allow a “functional projection” and a clear therapeutic guidance.
- Examples:
  - Thomas
  - Ely
  - Silfverskjold
  - RE/RI cadera
Gait Analysis Laboratory tridimensional computarized

- Objective and integral Gait Analysis.
  - Measurement of time parameter and distance.
  - Record kinematic.
  - Reactions of force and kinetic.
  - EMG dinamic.
  - Visual register with video on two planes.

- Lets understand the interactions between trunk, hip, knee and ankle.
- Lets talk an universal language.
- Planning treatments.
- Monitoring Results.
- Validation of therapeutic interventions.
Gait Patterns in:

- Diplegia
- Hemiplegia
HEMIPLEGIA
Gait Patterns (Gage)

**Type 1: Drop foot**
- The drop foot is more evident at the swing phase.
- La dorsiflexion of ankle is normal during the stance phase.

**Type 2: True Equinus**
- Ankle in plantar flexion (true equinus) through most of its stance phase.
- Variable degree of drop foot at swing.

**Pathology**
- Weakness of the anterior tibial, without contracture or calf spasticity.

**Pathology**
- Contracture or spasticity gastrosoleus muscle.
HEMIPLEGIA
Gait Patterns (Gage)

Type 3:
**Jump Knee**
- The ankle dorsiflexion prevented during stance phase.
- The knee is flexed and rigid.

**Pathology**
- Contracture and/or spasticity gastrosoleus.
- Contracture and/or spasticity isquiotibialis and anterior rectus.

Type 4:
**Equinus / jump knee**
- Hip flexed and adducted
  - Equinus.
  - Knee rigid and flexed.
  - Hip flexed.
  - Anterior inclined pelvic with
    - Adduction of hip and internal rotation.

**Pathology**
- Retraction and/or spasticity of
  - Triceps sural, isquiotibialis, adductors and hip flexors.

Type IV hemiplegia
- Equinus / jump knee
- Pelvic rotation, hip flexed, adducted, internal rotation

Visión General de la Espasticidad Pediátrica

Rodda J.
**DIPLEGIA**

**Gait Patterns (Sutherland)**

**Type I:**
**Real equinus**
- Plantar flexion ankle during stance phase.
- Extension of knee and hip.

**Pathology**
- Contracture and/or spasticity Gastrocnemio.

**Type II:**
**Jump knee**
- Equinus ankle.
- Knee and hip flexion.
- Anterior pelvic inclined.
- Increased lumbar Lordosis.

**Pathology**
- Contracture and/or spasticity of Gastrocnemio.
- Contracture and/or spasticity of knee and hip flexors.
- + / - anterior rectus activity.
DIPLEGIA

Gait Patterns (Sutherland)

**Type III:**
Equinus apparent
(with or without stiff knee)
- Equinus decreasing
  (The ankle have a normal angle of dorsiflexion).
- Increasing of knee and hip flexion.

**Pathology**
- Muscles of calf become weak.
- Coupling incompetent of PF-KE.
- Excessive flexion of knee and hip in the stance phase.

**Type IV:**
Crouch gait:
- Excessive dorsiflexion of ankle.
- Excessive flexion of knee and hip.

**Pathology**
- Exaggerated tibial move forward.
- The mechanism declined PF-KE.
Normalcy Index (NI)

The objective of the NI is to find a single numeric value that reflects the extent to which the gait of the patient, with Cerebral Palsy, deviates from a normal average. More higher value, better functional commitment.

It consists of 16 parameters: temporo-spatial and kinematics, selected by clinical factors and convenience (Normal Value: 16-32).

Useful for evaluating results of therapeutic actions (medical or surgical) and compared with normal parameters, but is NOT a diagnostic index, its value NOT identifies the origin of the disturbance, OR NOT aimed at the therapeutic choice.
Normalcy Index

Considered parameters:
- Toe-off time.
- Gait speed.
- Cadence.
- Pelvic tilt average.
- Pelvic tilt range.
- Pelvic rotation average.
- Minimum hip flexion.
- Hip flexion range.
- Hip peak abduction, in swing phase.
- Average of the hip rotation, in stance phase.
- Knee flexion, at the initial contact.
- Moment of peak of knee flexion.
- Knee flexion range.
- Peak Dorsiflexion, in stance phase.
- Peak dorsiflexion, in swing phase.
- Angle average of the foot progression.
Severity of commitment:

- **Mild** (30%): walk alone, independent in AVD, normal language, normal or limit intellectual coefficient. Integrates a normal life without further treatments.
  IRI: 28%.

- **Moderated** (30-50%): requires technical assistance to achieve gait and AVD independence. There are some communication problems, IC normal or mild RM. Requires aid to integrate normal life.
  IRI: 30%.
Commitment Severity

- **Severe** (50-70%): the motor impediments, mental and/or sensory prevent the child achieving full independence in self care. Even with different and continued treatments, their integration is partial.
  IRI: 25%

- **Grave** (70-100%): maximum commitment in all areas of development, little environmental nexus. Without opportunities of social integration.
  IRI: 12%
Pathologies or Associated Deficiencies:

- Mental Retard.
- Sensorial changes (visuals or auditives).
- Language changes.
- Convulsive Syndrome.
- Learning problems.
- Emotional problems.
- Nutrition changes.
- Dental changes.
- Frequent breathing diseases.
Diagnosis

• Ideally the diagnosis should be as early as possible, usually, the Cerebral Palsy diagnosis, is established within two years old. The diagnosis of clinical commitment after 4 years old.

• High index of suspicion, as opposed to risk factors (prenatal, natal and postnatal).

• Firsts manifestations:
  RDSM, during period of nursing.
  Hypotonic Syndrome.
Evolution

• Although it is not an evolutionary pathology in the brain anatomical injury, is a dynamic chart, as their manifestations change with growth, producing:
  • Tone changes.
  • Muscular retractions.
  • Bone deformities (limbs and spine).
  • Functional changes.
THANK YOU