FOOT DEFORMITY & PAIN BY DISEASES OF CENTRAL NERVE SYSTEM

Chungnam National University Hospital
Soo-Kyung, Bok. M.D., Ph.D.
Foot deformity and pain

- Stroke/Traumatic brain injury
- Spinal cord injury / multiple sclerosis
- Parkinson’s ds
  - MSA (Multiple system atrophy)
  - PSP (Progressive supranuclear palsy)
Stroke & brain injury
Foot deformity in stroke & Brain injury

- Spastic equinovarus
  - Equinus
  - Varus
  - Claw toes

- Cavovarus foot
Equinovarus

- **Definition**
  - “a combination of a plantar-fixed, an inward angulation of the rearfoot and/forefoot (in the frontal plane)”

- **Incidence in stroke**
  - 10-20%

- **Muscular imbalance**
  - Muscle over-activity of the calf m (triceps surae, TP, FHL, FDL, FDB)
  - Weakness of the antagonists (TA, PL, PB)
  - Muscle contracture
Equinovarus

- Impaired walking capacity
  - Stance phase
    - Ankle instability
  - Swing phase
    - Foot clearance
    - Appropriate prepositioning at terminal swing

- Increased risk of falling
To assess whether a muscle imbalance between TA and EDL was associated with a varus deformity of the foot during swing phase of gait in stroke.

*The Foot, 2009*
Results

- 13 of 20 hemiplegia (65%) : foot dysfunction during swing phase
- Calf muscle : 60% varus group / 13% control
- Swing phase
  - EDL muscle duration ↓, amplitude ↓
  - TA muscle activity – slightly decreased

Varus deformity

- An inadequate activity of the calf m and TA-EDL imbalance
- Imbalance d/t modification in EDL activity but not TA

EDL should be selectively and intensively activated and strengthened

<The Foot, 2009>
Treatment

- Orthotics
  - AFO, FO, shoe modification
- Chemical denervation
  - Botulinum toxin
- Neurosurgical denervation (neurotomy of tibial nerve)
- Functional electrical stimulation
- Surgery
A 44-year old man with right spastic equinovarus

Gait analysis, FIM

The three phase treatment

- Botulinum toxin injection (3 yrs after stroke)
- Selective neurotomy of the right tibial nerve (4 yrs after stroke)
- Functional orthopaedic surgery (7 yrs after stroke)
  - Lengthening of calcaneal lig
  - Triple arthrodesis of the subtalar and transverse tarsal joints
  - Percutaneous tenotomy on toe flexors

<Disability and Rehabilitation, 2010>
- **Botulinum toxin injection**
  - Walking speed(-),
  - left step length(↑, asymmetric), step width(↓)
  - Very short (1 mon)

- **Selective neurotomy of the right tibial nerve**
  - Walking speed(-),
  - left step length(↑, more symmetrical), step width(↓)
  - Only temporary (8 mon)

- **Functional orthopaedic surgery**
  - Comfortable Walking speed(↑)
  - Step length : symmetrical, step width(↓)
  - Cast immobilization (3 months)

- **Conclusions**
  - BTI, TNN : a short-term, orthopaedic surgery : long-lasting effect
  - Walking barefoot without cane, stair up/down, walking outdoors

<Disability and Rehabilitation, 2010>
Effect of age, sex, and timing on correction of spastic equinovarus following cerebrovascular accident.
Namdari S, Park MJ, Baldwin K, Hosalkar HS, Keenan MA.

- **Methods**
  - A retrospective study 64 CVA pts with surgical corrections
  - Age, sex, duration, preoperative orthotic/ambulatory requirement

- **Results**
  - Deformity –correction, ambulatory score ↑
  - Preoperative orthotic and ambulatory requirement ↓

- **Conclusion**
  - Surgical correction of SEV is effective in post-CVA pts
  - Improvement in ambulation score regardless of age, sex, or duration from CVA to surgery

< FOOT & ANKLE INTERNATIONAL, 2009 >
Claw toes

- **Dystonic**
  - Still flexible at the joint
  - Earlier stages, well recovered pts
  - Noncorticospinal
  - Versatile, appearing after a few steps, walking backwards, without hypertonia of the toes flexors

- **Spastic (rigid)**
  - Fixed in unnatural position
  - Later stages, not fully recovered pts
  - Corticospinal
  - Appearing when standing up and getting worse during gait
Patients and method

- 39 hemiplegia hospitalized after a first stroke
- Evaluation, MMT, spasticity, PASS, FAC, Barthel index

Results

- Claw toes
  - 46% during the first year post stroke (5 sitting, 7 standing, 6 gait)
  - Early onset (<3 months)
- Equinus, varus foot: significant correlated
- Very impaired dorsiflexor, intermediate BI: high prevalence
- Etiology, the injured hemisphere, age: no correlation

Conclusion

- Claw toes – common, early on post-stroke, equinus, varus foot, average functional capacities

<Ann of Physical and Rehabilitation Med, 2010>
Cavovarus foot (I)

- **Muscle imbalance**
  - weak PB with **strong TP**, weak TA with **strong PL**
  - hindfoot varus and forefoot valgus
  - overload of the lateral border of the foot
  - ankle instability, peroneal tendinitis, stress fracture, metatarsalgia, secondary degenerative arthritis
Cavovarus foot (II)

- **Etiology**
  - Neurologic (HMSN, CP, stroke, SCI, ant. Horn cell ds)
  - Traumatic (talar neck malunion, compartment syndrome)
  - Residual clubfoot

- **Physical examination**
  - Inspection
  - ROM of joint
  - Coleman block test
    - Forefoot-driven hindfoot varus
    - Intrinsic or tibialis posterior muscle-driven hindfoot varus

- **Orthoses**
  - Metatarsal pad with metatarsal head cut, semirigid
  - A high boot or an off-the-shelf ankle brace
  - AFO d/t prevent foot drop
  - Night splint d/t progressive contracture
<Rt hemiplegia d/t Stroke>
Spinal cord injury/multiple sclerosis
Pes cavus and claw toes deformity in patients with spinal cord injury and multiple sclerosis (I)

- To study the prevalence of the foot deformity in SCI/MS
  To discuss the pathogenesis of these foot deformities

- 80 SCI (aged 25 to 68)
  - Duration 2 mon to 17 yr
  - 51 pts: spastic, (all but one – mobile equinus deformity)
    : 8 pts - pes cavus or claw toes
      - cervicl in two, dorsal in six
  - 29 flaccid pts: no pes cavus or claw toes

- 20 MS (aged 33 to 48)
  - Duration 3 to 17 yr
  - All pts: spastic and equinus
  - One: pes cavus, another: pes cavus + claw toes

<Paraplegia 16, 1978-1979>
Pes cavus and claw toes deformity in patients with spinal cord injury and multiple sclerosis (II)

- Extent of excitatory skin areas
  - Pes cavus and claw toe: proximal to the knee
  - Without foot deformity: distal to the knee

- EMG
  - Spasms in specific muscles
  - Order of recruitment: TA, hamstring, GCM, TP, EHL, RF

- Conclusion
  - Pes cavus, claw toes
    - 10%
    - Complication of severe spasticity
    - Predominant activity of TA + the reflex activity of the EHL

<Paraplegia 16, 1978-1979>
Parkinson’s ds, MSA, PSP
Joint and skeletal deformities

- Striatal hand
- Striatal foot
- Dropped head (anterocollis)
- Trunk flexion (camptocormia)
- Scoliosis
Striatal deformities (I)

- Originally described in 1864
- Pathology in the neostriatum (putamen and caudate)
- Misdiagnosis in absence of tremor, bradykinesia and rigidity
  - Hand deformities: Rheumatoid arthritis
  - Equinovarus foot deformity: orthopedic problem
  - Toe extension - Babinski sign
- Advanced PD, early stages of PD, other parkinsonian ds
Striatal deformities (II)

- **Synonym**
  - Dystonic foot response of parkinsonism, dystonic claudication, striatal toe, hitchhiker’s great toe, pseudo-rheumatoid deformity, pseudo-barbinski

- **Part of the primary disease process**

- **One of the earliest signs in untreated pt**

- **Pathogenesis**
  - Unknown
  - Combination of dystonia, decreased striatal dopamine, fibrosis with alterations in soft-tissue plasticity and visco-elasticity
- **Striatal hand**
  - Flexion of the MCP
  - Extension of PIP, flexion of DIP
  - Ulnar hand deviation

- **Striatal foot**
  - Great toe extension
  - Flexion of the remaining toes
  - Equinovarus foot
  - Pain, impaired the ability to stand and walk, skin ulcer
  - Striatal toes
### RA vs Stratal abnormalities

<table>
<thead>
<tr>
<th>Features</th>
<th>Rheumatoid arthritis</th>
<th>Striatal abnormalities</th>
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</thead>
<tbody>
<tr>
<td>Pathophysiological features</td>
<td>Proliferative synovitis, autoimmunity, microbial initiator</td>
<td>Non-inflammatory, dystonic features, soft-tissue elastic changes</td>
</tr>
<tr>
<td>Joints</td>
<td>Swollen, warm, painful, pannus formation</td>
<td>Painful, contractures</td>
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<tr>
<td>Radiographic changes</td>
<td>Joint effusions, juxta-articular osteopenia with erosions, narrowed joint space with loss of cartilage</td>
<td>Normal</td>
</tr>
<tr>
<td>Mobility</td>
<td>Morning stiffness, decreased range of motion (active and passive)</td>
<td>Fixed deformity, may respond to levodopa or botulinum toxin</td>
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<tr>
<td>Distribution</td>
<td>Generally symmetrical joint involvement, polyarticular</td>
<td>In most cases develops on one side with ipsilateral emergence of cardinal PD signs</td>
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<td>Genetics</td>
<td>Association with HLA DR4 or DR1</td>
<td>Seems to be more common in juvenile-onset PD</td>
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<td>Extra-articular features</td>
<td>Cutaneous and visceral rheumatoid nodules, increased serum rheumatoid factor, synovial cysts, vasculitis, episcleritis</td>
<td>Rigidity, bradykinesia, tremor</td>
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202 patients
- 36.1%: joint and skeletal deformities
- Striatal hand & foot: 13.4% (hand/foot = 8.4%/5.9%)
- Striatal deformities - 12.8%(PD), 26.3%(MSA), 5.3%(PSP)
- M=F, Younger
- An earlier age at onset of PD sx
- Higher mean Unified Parkinson’s Ds rating scale scores
- More often treated with levodopa
- Independent of disease duration
- Correlated with the side of initial parkinsonian symptoms, hand(100%), foot(83.3%)

Deformities: common, under-recognized, marked functional disability

<Movement disorder, 2006>
Treatment

- Anti-parkinsonian drug – less predictable
  - Levodopa ( incomplete resolution)
  - Anticholinergics, baclofen, benzodiazepines

- Botulinum toxin injection
  - Focal dystonia, striatal toes

- Orthopaedi surgical interventions
  - Split TA tendon transfer with extrinsic toe-flexor release and achilles tendon lengthening

- Neurosurgical treatment
  - Stereotactic pallidotomy, thalamotomy, deep-brain stimulation
<Parkinson’s ds>
Take home message

- **Stroke**
  - Varus during swing — EDL should be selectively strengthened
  - Equinovarus Tx — orthotheses, BTI, neurotmy, orthopaedic surgery
  - Claw toes — common, early onset
  - Cavovarus

- **SCI/MS**
  - Equinus, pes cavus, claw toes

- **Parkinson’s ds**
  - Striatal hand and foot
  - One of the earliest signs in untreated Pt
  - Part of the primary ds process
Thank you for your attention!