# A Novel Approach to Correct Knee Flexion Angle for Cerebral Palsy

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# Cerebral Palsy

2-3 children are diagnosed for every 1,000 births around the world [2]

Movement and posture disorder due to damage of immature brain [3]

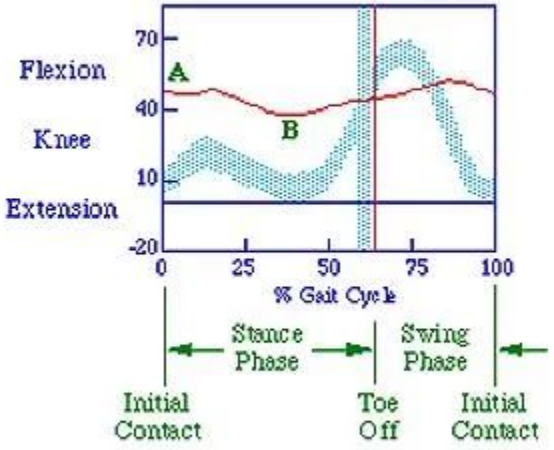
Adverse gait, physiological, and psychological impacts [4]

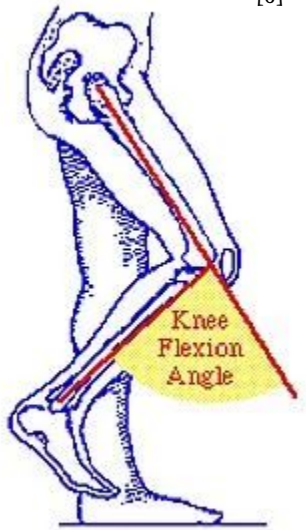
- ➔ Spastic Cerebral Palsy is the most common type
- ➔ Incorrect information sent to motor units to control muscle movement due to motor cortex damage [5]
- ➔ Lack of coordination, involuntary movement

# Knee Problems

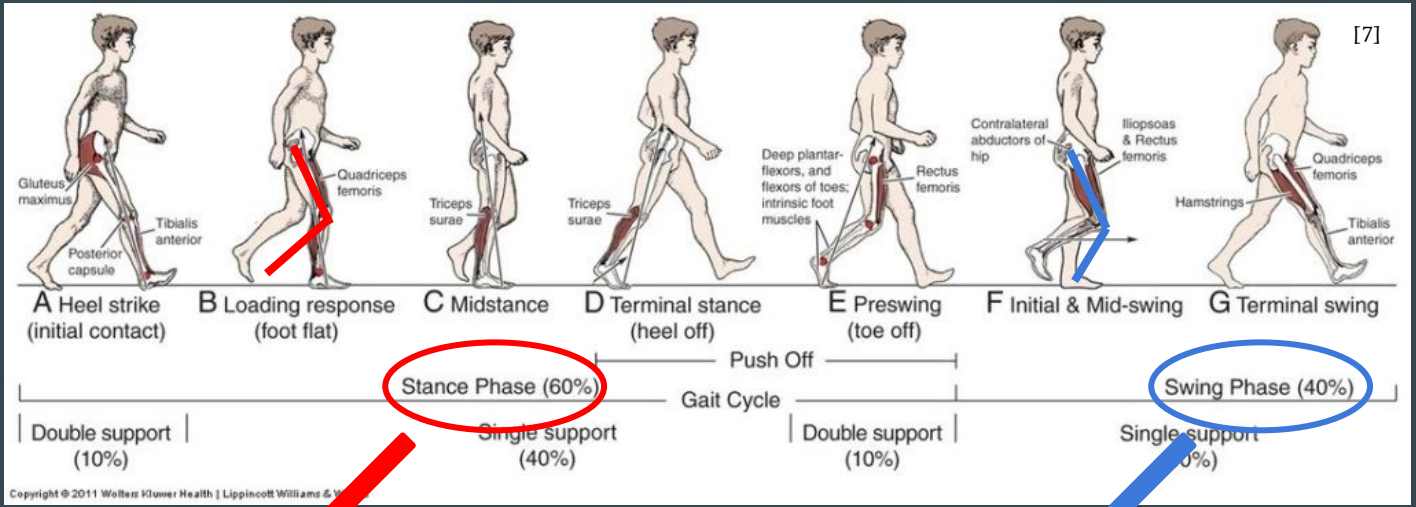
- Stiff Knee Gait
  - Decreased flexion angle
  - Swing phase of gait
  - Causes ground clearance issues and abnormal gait
- Flexed Knee Gait
  - Increased flexion angle
  - Stance phase of gait and standing
  - Causes abnormal gait, knee degradation, and pain

[6]



# Muscles activated during the Gait Cycle




Flexed Knee Gait

- Hamstring spasticity
- Quadricep weakness
- Patella tendon lengthening
- Soleus weakness

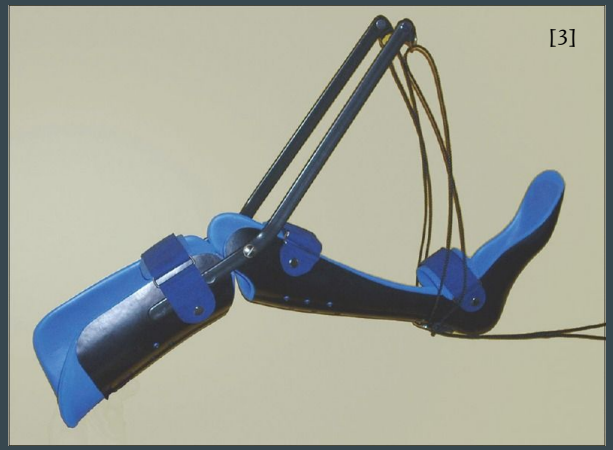
Stiff Knee Gait

- Rectus femoris spasticity

# Traditional Treatment Options

## Nonoperative Treatments

- Physiotherapy
- Orthosis
- Neuromuscular blocks




## Operative Treatments

- Hamstring Lengthening with ST Transfer
- Distal Femur Extension Osteotomy
- Guided Growth

# Cutting-Edge Approaches

## Functional Electrical Stimulation (FES)

- Creates localized action potentials to initiate muscle contractions [9]
- Manually-adjusted FES approach to improve gait in CP [10]
- Spinal cord injury [9]
- Poststroke gait [11]

## Brain-Computer Interfaces (BCI)

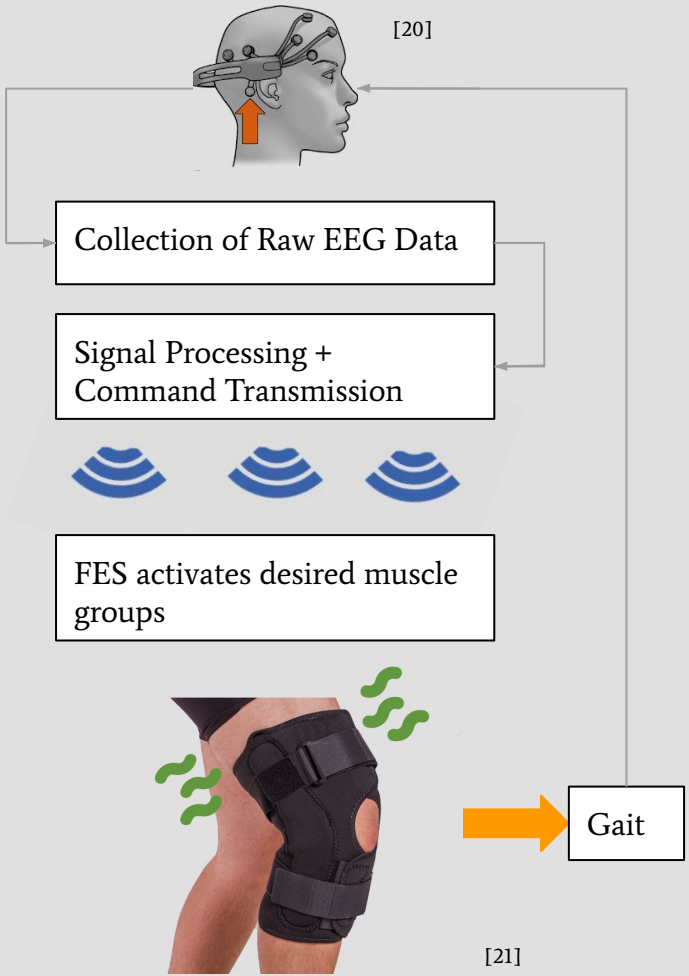
- A communication pathway between the brain and an external device [12] [13]
- Paralysis [14]
- Parkinsons [15]
- Kinesthetic motor imagery [16]

Preliminary successes of **BCI and FES integration f**or ankle movement of Parkinson's disease [17]

# Our Proposal

- Non-operative treatments are often insufficient [3]
- Issues recur after surgical CP treatment for hip[18], knee [3], and ankle [19]
- Progress in FES and BCI technology development

➔ **We propose an investigation into a novel approach to use BCI and FES to reconnect the brain to muscles for improved gait in cerebral palsy**



# Aim 1: Determine FES muscle stimulation strategies

**Goals**

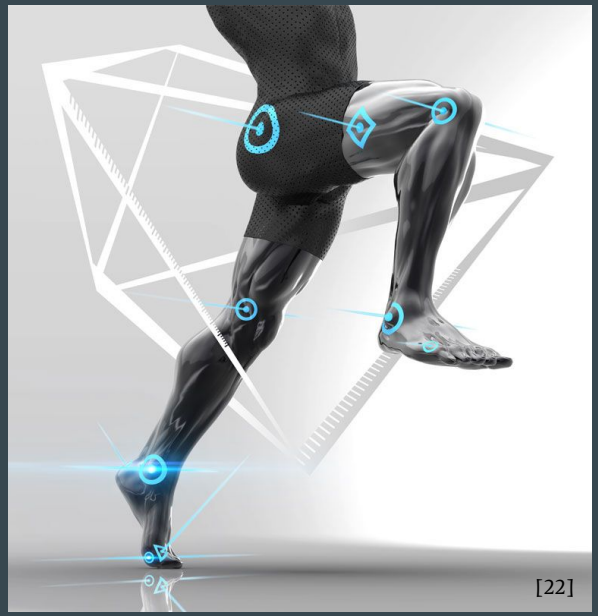
- Characterize activated muscles through electromyography (EMG)
- Optimize individualized coordination of FES devices
- Evaluate FES effects on knee flexion angles

**Approach**

- 25 subjects with crouch gait
- 50 unassisted gait cycles
- Motion Capture Software

**Expected Results**

- Factors affecting gait will be unique to the individual [3]
- FES device will modulate the activation of key muscle groups [9]


[22]

**Hypothesis**

FES technology will improve the knee flexion angles and improve gait.

# Aim 2: Optimize BCI model to control FES system

**Goals**

- Correlate EEG data to identified gait phases
- Optimize BCI platform for FES stimulation of specific muscle groups

**Approach**

- Non-invasive data collection: 32-channel headset
- 50 labeled three minute unassisted walking samples

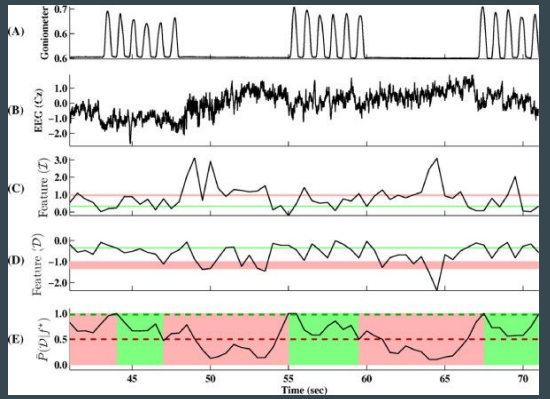
**Expected Results**

- Identifiable stop and start points [23]
- Primary evidence for leg extension in primary motor cortex [24]

**Hypothesis**

A patient-specific  BCI model will allow for successful stimulation of the correct muscle groups during the gait phase.

[25]

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# Aim 3: Evaluate the efficacy of the BCI-FES system

**Goals**

- Analyze holistic effects of BCI-FES system on gait

**Approach**

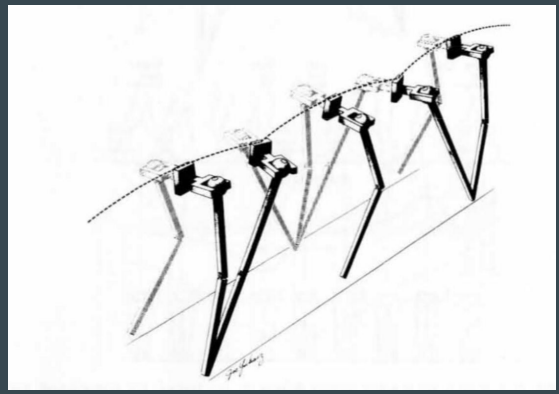
- Motion capture system for analysis of gait smoothness
  - Hip movement variation
  - Stride-to-stride lengths
- Radiographic images to evaluate knee degradation
- Visual Analog Scale (VAS) to monitor knee pain

**Expected Results**

- BCI-FES system can successfully interact to change gait [17]
- BCI-FES system will allow for smoother gait [11]

**Hypothesis**

BCI-FES system will improve gait mechanics and aesthetics and will reduce knee degradation and associated pain.



[27]


[3]

# In Summary

- Cerebral palsy is a widespread condition that limits motor function
- Current treatment methods are improving but are not sufficient
- Integrating BCI and FES could reconnect the control system for gait for cerebral palsy patients

[28]

***The potential to develop a long-term solution for cerebral palsy gait problems from cutting-edge research is worth your investment!***

# Questions?

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