FES for the Trunk: Enhancing Your Seating & Mobility Program

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Learning Objectives

Describe evidence to support the use of functional electrical stimulation (FES) for postural control and pressure injury prevention or management.

Describe at least 3 benefits of FES cycling with stimulation to postural musculature that impact seating.

Identify 3 muscle groups FES can be applied to in order to enhance an individual's seating and positioning needs.
Current Practice for Seating & Mobility for Individuals with SCI

**Seating**
- Comprehensive seating assessment and recommendations.
- Pressure injury prevention through recommending appropriate surfaces, promoting weight shift protocols, healthy diet, skin protection behaviors, etc.
- Less reimbursement/ insurance coverage for postural components of seating system.

**Therapy**
- FES cycling for neuromuscular reeducation, improved circulation, and spasticity management.
- Dynamic balance intervention- use of trunk NMES during static sitting or to support postural control during dynamic reaching.
- Training in compensatory strategies for reaching, environment access, etc.

**Additional**
- Shorter length of stay with transition to outpatient (shorter approved days in OP as well).
- Increased risk of contractures in individuals with tetraplegia- negatively effects seating posture, breathing, mobility, etc.
FES- Evoked Contraction & Cycling

Reverse muscle atrophy

Improve local blood circulation

Increase range of motion

Reduce muscle spasms

Muscle re-education
FES Cycling Basics

Volition (CNS)

Neural activation (PNS)

Muscle contraction

Health benefits

FES
Short Term Benefits of FES
1 session 12 weeks

Muscle anatomy/physiology
- Griffin et al 2009, Field-Fote 2001

Glucose/insulin metabolism
- Griffin et al 2009, Jeon et al 2002

Cardiorespiratory function
- Ptasinski 2013 – RT300, Ptasinski 2010, Kahn et al 2010

Quality of life/self-perception
- Sharif 2014 – RT600; Dolbow, Gorgey, Ketchum and Gater 2013

Mobility/motor measures
- Sharif 2014, Ditor 2012, Griffin et al 2009

Seated pressure
- Dolbow, Gorgey, Dolbow and Gater 2013

Spasticity
- Krause et al 2008

Sensory or cognitive function
- Griffin et al 2009

Arm/hand function
- Ptasinski et al 2013
Long Term Benefits of FES
Greater than 3 months

- **Muscle anatomy/physiology**

- **Glucose/insulin metabolism/body composition**

- **Bone structure**
  - Hammond, Metcalf, McDonald and Sadowsky 2014 – RT300; Dolbow, Dolbow, Gorgey, Adler and Gater 2013 – RT300; Castello et al 2012; Frotzler 2008

- **Quality of life/self-perception**

- **Mobility/motor measures**
  - Jones et al 2014

- **Spasticity**
  - Sadowsky et al 2013

- **Sensory or cognitive function**
  - Sadowsky et al 2013
Evidence for FES Cycling & Posture

- FES to back and abdominal muscles → improved trunk control when compared to control group for children with spastic diplegic cerebral palsy (Karabay et al., 2012).

- FES to trunk provides more stable trunk and erect sitting posture in individuals with chronic SCI (Rath et al., 2018).

- FES applied to abdominals and erector spinae bilaterally during unsupported sitting can facilitate trunk stiffness in able-bodied participants (Milosevic et al., 2015).
Evidence for FES Cycling & Pressure Injury Prevention

• FES to erector spinae while seated in wheelchair allows for unilateral pressure redistribution (Vanoncini et al, 2010).

• FES applied to trunk and gluteal muscles during sitting corrects anterior/posterior pressure distribution improving tissue health for sacral sitters (Wu et al, 2013).

• FES cycling program for individuals with SCI provides strong trends towards a reduction in average and maximal seated pressure (Dolbow, et al, 2013).
Function is not static.
Environments are not static.
People are not static...
...so why only focus on seated interventions that are static.

- Dynamic sitting intervention
- Seating System
- Postural control and re-education
Benefits of FES Cycling with Postural Stimulation

- Neuromuscular re-education
- Improved circulation
- Spasticity management
- Increased trunk stability
- Decreased tendency toward sacral sitting
How Can it Impact Seating?

- Improved trunk stability + decreased sacral sitting
- Increased tissue perfusion + decreased pain
- Increased pressure redistribution + access to the environment + ability to breathe
How Can It Impact Mobility?

By maximizing the potential for active stabilization we can limit the burden placed on passive systems to provide both function and alignment.

Active stabilization can also enhance the quality of performance and reduce maladaptive compensation in situations when asymmetric postures are needed to complete dynamic tasks.
But aren’t we trying to eliminate asymmetry?

• The performance of complex tasks is dependent on this relationship between symmetry and asymmetry.

• Function requires us to move fluidly between both static and dynamic states in a way that does not sacrifice either mobility or stability.

• So how can promote this development of active stabilization and reduce the reliance on static interfaces to improve functional posture?
Our Study

Feasibility and efficacy of the addition of electrical stimulation to postural musculature, including abdominal, gluteal, and erector spinae muscles, during FES upper or lower body cycling during inpatient rehabilitation.

Will also explore the initial effects of the above program on postural alignment and sacral tissue perfusion in order to supplement the participants’ custom wheelchair seating system.
Participants

• Patients who have sustained a spinal cord injury and have a level of injury between C1-T6 ASIA Impairment Scale (AIS) A or B classification on admission as indicated on an updated ISNSCI (International Standards for Neurological Classification of Spinal Cord Injury)
• No more than 6 months post-injury
• Inpatient rehabilitation
• Control group= Meet above criteria, however, are unable to participate in FES cycling due to meeting one of the many contraindications/exclusion criteria.
Participants:

Exclusion Criteria

- SCI below level of T6
- INSCI level on admission of C or D
- Lower motor neuron spinal cord injuries
- Autonomic dysreflexia response to surface electrical stimulation
- Stage 4 sacral or ischial pressure injury
- Unstabilized fractures over areas of stimulation
- Pregnancy
- Cardiac history or seizure disorder
- Current diagnosis of a deep vein thrombosis in extremity of stimulation
- Active heterotopic ossification in extremity begin stimulated
- History of cancerous tumor in areas of stimulation
Initial Protocol

• 30 minutes 2x per week
• 2 weeks: initial feasibility
• 4 week: Reassessment
• UE cycling typical muscle set-up
• LE cycling typical muscle set-up
• + Trunk musculature “always on” throughout cycling (bilateral erector spinae, gluteals, and abdominals)
• Practitioners will complete a 1-page checklist for each session.
Tools

• Tape measure
• Goniometer
• Inclinometer
• Vernier caliper
• Digital camera
• Stop watch for set-up time measurement
• FSA BodiLink Interface Pressure Mapping System
• RT300 functional electrical stimulation bikes
• 2x3.5” self-adhesive electrodes for rectus abdominus, erector spinae and gluteus maximus in addition to electrodes for selected muscle groups
Research Procedures: Standardized Seating Apparatus

A seated reference device off of which the absolute body segment angles in the frontal, sagittal, and transverse planes as well as the interface pressure mapping values will be obtained pre- and post-electrical stimulation interventions with use of digital reference photos and graph paper reference lines.

Specific Apparatus as follows:
- 90 degrees knee flexion
- 1 degree seat slope
- 10 degrees thigh from seat parallel
- 8 degree backrest angle open
- 18x18 Jay Go cushion
Research Procedures: Measurements

• Pre & post measurements in Standardized Seating Apparatus:
  • Sagittal Plane: sagittal pelvic angle; sagittal upper trunk angle; sagittal trunk angle
  • Frontal Plane: frontal pelvic angle; frontal sternal angle; frontal trunk angle
  • Transverse Plane: transverse trunk ankle; transverse pelvic angle
Sagittal Plane

Fig. 2.20: Sagittal upper trunk angle

Fig. 2.16: Sagittal trunk angle

Fig. 2.15: Sagittal pelvic angle
Frontal Plane

Fig. 2.27: Frontal sternal trunk

Fig. 2.25: Frontal pelvic angle

Fig. 2.28: Frontal trunk angle
Fig. 2.36: Transverse trunk angle

Fig. 2.35: Transverse pelvic angle

Transverse Plane
Research Procedures: Measurements

- Utilizing the FSA BodiLink Interface Pressure Mapping System
- Pressure Mapping Values:
  - Symmetry
  - Sacral Peak Pressure Index
  - Bilateral Ischial Tuberosity Peak
  - Pressure Indices
  - Dispersion Index
Analysis

Feasibility measures:
- Total time for set-up
- Muscle groups utilized
- Patient subjective reports

RT 300 outcome measures:
- Power output
- Applied resistance
- Duration
- Need for support duration (time on/off motor)

Pre- and Post- digital reference photos and postural measurements in seated testing apparatus

Pre- and Post- Interface FSA Pressure Mapping System
Hypotheses
Re: Seating Needs

Reduced need for external postural supports for a more dynamic seating system

Reduced burden on users seating system
Future Implications

- Incorporation of functional outcome measures.
- Effect on propulsion biomechanics.
- Pre and post assessment in “n of one” type case reports to address specific client needs.
- Evaluation of additional FES focused interventions.
- Application to motor incomplete population (specifically AIS C level wheelchair users).
- Continuum from inpatient to outpatient to in-home users.
By maximizing the potential for active stabilization we can limit the burden placed on passive systems to provide both function and alignment.

Initiation of dynamic intervention that can be utilized throughout the continuum of care.

Referring wheelchair seating clinic to/from conventional therapy.
Questions?

Restorative Therapies resources:
www.restorative-therapies.com
Clinical Training Center (CTC) Training Courses, Baltimore, MD
Online Training for Clinicians through RTILink.com

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