EXCITING NEW REHABILITATION INTERVENTIONS FOR PERSONS WITH SPINAL CORD INJURY

Christopher Formal, MD
March 14, 2019
OUTLINE

• Systems for extremity electrical stimulation
• Ventilation options
• New forms of gait training

* Please note that the videos were removed due to the size of the video files
Systems for extremity (and trunk) electrical stimulation

• Basic science—
• Nerve and muscle are both electrically excitable
• Electrically stimulating a nerve causes an action potential, and the
• Contraction of an innervated muscle
• Direct muscle stimulation can cause contraction of the muscle
• Innervated muscle is much easier to stimulate than denervated muscle
Why go through the trouble?

• Electrical stimulation of muscle will bring about strengthening—even if otherwise paralyzed
• Cardiovascular exercise
• Function
Ventilation options

• Basic science:
  • The essential respiratory problem after SCI may not primarily involve the lungs
  • The issue is loss of muscle function to ventilate
Nerve or muscle can be stimulated

- Nerve via phrenic stimulation—PNS
- Muscle via diaphragm pacing system--DPS
Phrenic nerve pacing

Implanted system; nothing through the skin

Challenging surgery

Diaphragm must be conditioned
Diaphragm Pacing System
DPS

- Relatively easy to place...
- Diaphragm must be conditioned
- A “bridge”, or a “destination”
- Parameters are managed externally
- “Percutaneous”
Denervated diaphragm

- No phrenic nerve to stimulate
- Denervated diaphragm can’t be stimulated
- Approach: nerve grafts to innervate the diaphragm—THEN nerve stimulation or DPS
Why go through the trouble?

• Less tethering
• Less noise
• Satisfaction of using body’s own machinery to ventilate
• Improved sense of taste and smell
New forms of gait training

- Basis science:
- Stegasaurus
- Chicken
- Perhaps a less discrete spinal center in higher animals and humans—“spinal stepping center”
- Hess’s law
- Spinalized cats underwent treadmill training and developed rudimentary stepping
Why go through the trouble?

• Traditional exercise and gait training doesn’t allow free movement of the arms; they don’t swing in sync with the lower limbs

• Velocity more natural

• Input through the lower limbs is optimized