Paraplegia: 

Exercise and Health Considerations

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What is paraplegia?

- Paraplegia is impairment of motor and/or sensory function to the lower extremities, and sometimes the lower trunk.

Complete Paraplegia: Total damage resulting in complete paralysis.

Incomplete Paraplegia: Partial damage leaving some motor and sensory function.
Major Causes

a) Traumatic or physical damage to the area surrounding spinal cord (i.e. Car accident, sport injury)
b) Congenital and other impairments:
   - Spinal tumors
   - Spina bifida—“split spine”
   - Scoliosis—abnormal curvature
Location of impairment depends on the level of spinal cord damage:

- **T1-T4**: poor abdominal control
- **T5-T10**: trunk strength increases with lower injury
- **L1-L5**: Full upper body control

*Anything in cervical region will result in quadriplegia*
4 Types of Incomplete Paraplegia:

1. Anterior Chord Syndrome: Damage toward front of spinal cord
2. Posterior Chord Syndrome: Damage toward back of spinal cord
3. Central Chord Syndrome: Damage in center of spinal cord
4. Brown-Sequard Syndrome: Damage localized to one side of spinal cord
Brown-Séquard Syndrome

Example level: cervical spinal injury

Below injury level, motor weakness or paralysis on one side of the body (hemiparaplegia). Loss of sensation on the opposite side (hemianesthesia).

Anterior Cord Syndrome

Example level: cervical spinal injury

Below injury level, motor paralysis and loss of pain and temperature sensation. Proprioception (position sense), touch and vibratory sensation preserved.

Posterior Cord Syndrome

Example level: cervical spinal injury

Below injury level, motor function preserved. Loss of sensory function: pressure, stretch, and proprioception (position sense).

Central Cord Syndrome

Results from cervical spinal injuries. Greater motor impairment in upper body compared to lower body. Variable sensory loss below the level of injury.
ASIA Impairment scale

A = Complete. No sensory or motor function is preserved in the sacral segments S4-S5.

B = Incomplete. Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5.

C = Incomplete. Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3.

D = Incomplete. Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade greater than or equal to 3.

E = Normal. Sensory and motor function is normal.
Facts

- Paraplegics can use cars with adapted hand controls due to normal upper body strength
- 36,000 Canadians live with spinal cord injuries
- Most common cause is motor vehicle collisions, followed by falls and industrial accidents
- 52% of spinal cord injured individuals are considered paraplegic and 47% quadriplegic
- 56% of injuries occur between the ages of 16 and 30
Symptoms

• Full or partial loss of movement and/or sensation—cannot detect heat, cold, or touch
• loss of bowel and bladder control
• exaggerated reflex activities or spastic activity during muscle lengthening
• pain or stinging associated with nerve damage
• Respiration capacity and endurance compromised with upper spinal injuries (i.e. T1-T9)
• Inhibited sexual Function
• Pressure sores
Benefits of Exercise with spinal cord injuries

- Increase muscular strength to perform daily activities and independence
- Exercise can prevent other diseases such as obesity, type II diabetes, and coronary heart disease which stem from inactivity
- Electrical stimulation of paralyzed extremities increases energy combustion and metabolic function
- Reduction in pressure sores from remaining sedentary
- Increase in overall wellbeing, temperature regulation, sleeping pattern
Benefits continued:

- Stimulating paralyzed lower extremity muscles improves bone mineral density in legs and has favourable metabolic effects (even beyond that associated with only working out arm muscles)
- Options are limited to either exercising with non-paralyzed muscle groups, or doing electrically induced exercise of the paralyzed muscles
- Paraplegics respond to exercise training in much the same way as a non-handicapped person
Prior to Exercise

- SCI individuals are at greater risk of injury if the exercise program is not carefully planned
- An exercise program for someone with SCI is also dependent on the level of the spinal cord lesion and individual differences
- As with an able bodied individual, before exercise begins, there must be an assessment of cardiorespiratory fitness and the completion of a Physical Activity Readiness Questionnaire (PAR-Q)
Common Misconceptions

1. Exercise will worsen spasticity and contractures
2. Exercise is unsafe for someone with SCI
3. There is an extremely high risk of adverse events during physical activity in people with SCI
4. Because SCI individuals have so many associated problems, exercise is relatively unimportant
Autonomic Dysreflexia

- AD is a neurological emergency that can occur in people with SCI that is at or above the level of T6
- Anyone supervising an SCI individual during exercise must be aware of this condition
- AD can be triggered by many potential causes such as any painful or irritating stimulus (overfilled bladder, distended bowel) below the level of the SCI
Autonomic Dysreflexia

- AD is characterized by:
  - Extreme elevation in blood pressure
  - Significant sweating above the level of the injury
  - Cold, pale skin below level of injury
  - Slow pulse
  - Facial flushing
  - Nausea

- AD results from the activation of the sympathetic nervous system below the level of SCI

- Impairment in the compensatory effect of parasympathetic discharge below level of SCI – results in a failure to put a break on sympathetic stimulation
Exercise Programs

• Evidence based guidelines for individuals with SCI have been developed by SCI Action Canada in 2011
• Exercises for those with SCI are divided into three categories:
  1. Aerobic – to maintain cardiovascular health
  2. Resistance/Strength training
  3. Flexibility (important in order to improve range of motion and reduce spasticity)
Aerobic Exercise

• Guidelines:
  ▫ 3–5 sessions per week
  ▫ 20 minutes in duration
  ▫ Intensity of 50-80% of VO$_2$max

• Exercises can include:
  ▫ Arm cranking
  ▫ Wheelchair propulsion
  ▫ Wheelchair sports (basketball)
  ▫ Pool exercise
  ▫ Cycling
  ▫ Walking for incomplete injuries
Resistance Training

• Guidelines:
  ▫ 2 sessions per week
  ▫ 3 sets of 8-12 reps per exercise
  ▫ Alternate muscle groups on training days

• Exercises can include:
  ▫ Overhead press with medicine ball (deltoids)
  ▫ Pull-downs on a machine (latissimus dorsi)
  ▫ Straight arm dips (trapezius)
  ▫ Chest press (pectoralis major)
  ▫ Straight arm punches (serratus anterior)
  ▫ Resistance Bands
  ▫ Household tasks
Flexibility

• Guidelines:
  ▫ Can serve as either warm up or cool down after exercise
  ▫ 15-30 seconds per stretch
  ▫ Lower extremity muscles should be passively stretched in order to reduce spasticity and contractures
  ▫ Stretches to the upper body musculature are the same as for an able bodied individual
  ▫ However, caution is necessary for lower back stretch in those with a T12 or higher injury because of loss of trunk strength and trunk control
Functional Electrical Stimulation

- Technique of eliciting muscle contraction through application of low levels of electrical current
  - Minimizes atrophy and increases muscle strength, endurance, and bone density
  - Advances in technology can even allow for pedaling of a bike using FES on leg muscles (aerobic activity!)
  - FES is not suitable for people with severe spasticity, contractures or osteoporosis
Powered Exoskeleton

- Augment or replace walking movement
- Other treatments such as braces require too much energy for some patients, and these robotic exoskeletons provide more balance
- Many different companies involved
- $130,000
Available Resources

ORGANIZATIONS

• Canadian Paraplegic Association (CPA)
  ▫ Wide variety of information including exercise recommendations
• Canadian Paralympic Committee (CPC)
  ▫ Provides a listing of opportunities for individuals to become involved in parasports across Canada
• Canadian Wheelchair Sports Association (CWSA)

EXERCISE FACILITIES

• Variety Village (Toronto)
  ▫ Exercise programs designed specifically for individuals with handicaps
• Toronto Rehabilitation Institute
  ▫ Offers services to people with SCI including therapeutic recreation programs
• Accessible Sport Council London
  ▫ Provides information on accessible sport opportunities in London and the surrounding area
Questions???

1. What are the causes of paraplegia?
2. What Level of spinal injury usually results in full upper body control?
3. Exercise will worsen spasticity; T or F?
4. What are some symptoms of Autonomic Dysreflexia?
5. By what method are paraplegic patients able to participate in cycling and walking aerobic activities?
Functional Electrical Stimulation

- https://www.youtube.com/watch?v=xh0KrmGOH48