The Importance of Core Stability in Manual Wheelchair Propulsion

Heather Schriver, PT, DPT, ATP
Theresa Berner, ORR/L, ATP
Objectives

- By the end of the presentation attendee will define core stability and how it effects manual wheelchair users
- By the end of the presentation the attendee will be able to assess a person for core stability and understand the need for a referral to PT for stability training.
- By the end of the presentation the attendee will describe how therapy services can improve core stability through training.
- By the end of the presentation the attendee will be able to describe different manual wheelchair set ups based on the user’s core stability presentation.
Core Stability

- Core stability refers to the control of the trunk and pelvis to allow optimal use of the extremities
Core Stability in athletes

- Began with work in baseball pitchers
- Discovered that if people can keep their trunk more stable they are better able to use their extremities
- In minor leagues the pitchers with better core stability also had less frequent shoulder injury than their counterparts with less pelvic control
Manual Wheelchair users

- Pitching athletes need to be able to use their entire body to translate force from their legs into their pitching arm.
- Manual wheelchair users need to be able to use their arms to translate force into their chair and move their wheelchair forward.
- With improved core stability they are able to use their body, not just their arms to translate their wheelchair.
Core Stability in Manual Wheelchair Users

Surface electromyography activity of trunk muscles during wheelchair propulsion

Yu-Sheng Yang, et al

- Study looked at muscle activation muscles, and position of the trunk in able body population with manual wheelchair propulsion – surface electrodes use and normalized with each subject’s maximal voluntary contraction

EO= External Oblique
IO= Internal Oblique
RA= Rectus Abdominis
LT=Longissimus Thoracis
IL=Iliocostalis Lumborum
MU=Multifidus
Surface electromyography activity of trunk muscles during wheelchair propulsion

- Data collected at slow (0.9m/s), and fast (1.8m/s) steady state speeds and during the acceleration phase (ACC)
- Smart wheel data was used to compare with body position and core muscle activation
- Looked a core muscle activation during
  - Push phase of the push cycle and
  - Recovery phase of the push cycle
Surface electromyography activity of trunk muscles during wheelchair propulsion

Slow condition (0.9 m/s)  Fast Condition (1.8 m/s)  Acceleration condition
Core Stability in Manual Wheelchair Users
Biomechanical Analysis of Functional Electrical Stimulation on Trunk Musculature During Wheelchair Propulsion

Yang, et al

- Used continuous electrical stimulation to trunk musculature to stabilize the core during manual wheelchair propulsion
- Trunk control was noted as present or absent

Inclusion
- SCI between the levels of C6 and T12, ASI A, B, or C
- use a manual wheelchair as a primary mode of mobility;
- between the ages of 18 and 65 years.

Exclusion
- previous history of upper extremity pain interfering with wheelchair propulsion
- presence of a heart or lung condition that is worsened by pushing a wheelchair
- pregnancy
Biomechanical Analysis of Functional Electrical Stimulation on Trunk Musculature During Wheelchair Propulsion

- Stimulated Multifidus and Rectus abdominus
- Recorded muscle activation of shoulders

Propelled wheelchair at no stimulation, low stimulation and high stimulation
Biomechanical Analysis of Functional Electrical Stimulation on Trunk Musculature During Wheelchair Propulsion

- The only outcome measure that showed significant difference was the gross mechanical efficacy
  - Participants showed a difference between the high intensity and the off situations
- Participants had experienced disuse atrophy and may have benefited from training to build muscle bulk
Trunk Stability in Manual wheelchair Users

Implanted Electrical Stimulation of the Trunk for Seated Postural Stability and Function After Cervical Spinal Cord Injury: A Single Case Study

Triolo, et al

- surgically implanted multichannel electric stimulator to activate muscles in the hips and trunk
  - lumbar erector spinae, quadratus lumborum, gluteus maximus
Core Stability in manual wheelchair Users

- Therapist have formal assessments used to assess core stability
  - Throaco-Lumbar control scale
    - Designed to look at the functioning of the musculature in the trunk following spinal cord injury
  - ABLE scale
    - Designed to look at balance from a sitting position all the way through to a standing position

- Even if you are unfamiliar with formal testing, you can look at core stability seated on a mat table
  - Assess users ability to utilize their upper extremities with and without back support
  - Identify their posture when sitting with and without support
Identify posture in wheelchair
Identify posture without back support
Referral to Physical Therapy (PT)

- PT is beginning to make advancements in recovery of patients
  - May be true recovery, may be improved body awareness that is leading to increased muscle activation.

- Locomotor training, treatment of patients on a treadmill with assistance to move their legs and pelvis to generate a walking pattern with mat work to follow focusing on deficits noted on treadmill

- Standard PT, can work on core stability seated without back support, and in different position on the mat table
Locomotor Training (LT)
Limitations to Core Stability training, used in both standard PT and LT

- People will can improve with their core stability, but will probably not recover fully
- Even when seated we use the musculature in our hips to maintain stability of our pelvis
- This is where seating comes into play
Recommendations for seating set up

- Current research has recommendations for seating setup to optimize shoulder position and allow preservation for upper limb function.
Clinical Practice Guidelines

- Published in 2005
- A consortium of professionals including practitioners, researchers, and educators
- Consolidates research findings and relates them directly to clinical practice
- 35 recommendations in 6 specific categories

www.pva.org
Free Download:

- [http://go.osu.edu/PVA_CPG](http://go.osu.edu/PVA_CPG)
- Direct link

- [www.pva.org](http://www.pva.org)
- Paralyzed Veterans of America Homepage
Categories Reviewed

- Ergonomics
- Equipment Selection, Training and Environmental Adaptations
- Exercise
- Management of upper limb injuries and pain
- Treatment of chronic musculoskeletal pain to maintain function
Summary of Recommendations

Initial Assessment of Acute SCI
1. Educate health-care providers and persons with SCI about the risk of upper limb pain and injury, the means of prevention, treatment options, and the need to maintain fitness.
2. Routinely assess the patient’s function, ergonomics, equipment, and level of pain as part of a periodic health review. This review should include evaluation of:
   - Transfer and wheelchair propulsion techniques.
   - Equipment (wheelchair and transfer device).
   - Current health status.

Ergonomics
3. Minimize the frequency of repetitive upper limb tasks.
4. Minimize the force required to complete upper limb tasks.
5. Minimize extreme or potentially injurious positions at all joints.
   - Avoid extreme positions of the wrist.
   - Avoid positioning the hand above the shoulder.
   - Avoid potentially injurious or extreme positions at the shoulder, including extreme internal rotation and abduction.

Equipment Selection, Training, and Environmental Adaptations
6. With high-risk patients, evaluate and discuss the pros and cons of changing to a power wheelchair system as a way to prevent repetitive injuries.
7. Provide manual wheelchair users with SCI a high-strength, fully customizable manual wheelchair made of the lightest possible material.
8. Adjust the rear axle as far forward as possible without compromising the stability of the user.
9. Position the rear axle so that when the hand is placed at the top dead-center position on the pushrim, the angle between the upper arm and forearm is between 100 and 120 degrees.
10. Educate the patient to:
    - Use long, smooth strokes that limit high impacts on the pushrim.
    - Allow the hand to drift down naturally, keeping it below the pushrim when not in actual contact with that part of the wheelchair.
11. Promote an appropriate seated posture and stabilization relative to balance and stability needs.
12. For individuals with upper limb paralysis and/or pain, appropriately position the upper limb in bed and in a mobility device. The following principles should be followed:
    - Avoid direct pressure on the shoulder.
    - Provide support to the upper limb at all points.
    - When the individual is supine, position the upper limb in abduction and external rotation on a regular basis.
    - Avoid pulling on the arm when positioning individuals.
    - Remember that preventing pain is a primary goal of positioning.
13. Provide seat elevation or possibly a standing position to individuals with SCI who use power wheelchairs and have arm function.
14. Complete a thorough assessment of the patient’s environment, obtain the appropriate equipment, and complete modifications to the home, ideally to Americans with Disabilities Act (ADA) standards.
15. Instruct individuals with SCI who complete independent transfers to:
    - Perform level transfers when possible.
    - Avoid positions of impingement when possible.
    - Avoid placing either hand on a flat surface when a handgrip is possible during transfers.
    - Vary the technique used and the arm that leads.
Wheelchair Set up

OPPORTUNITIES OF ADJUSTMENTS FOR REAR WHEEL:

- Horizontal plane
- Vertical plane
- Sagittal plane
Horizontal Plane

- CPG 8. Rear wheel should be adjusted as far forward as possible without compromising stability.
  - Reduced rolling resistance
  - Hand contact angle with the hand rim is increased
  - Propulsion requires less muscle effort with smoother joint patterns and lower stroke frequency
Vertical Plane

- CPG 9. Rear axle be positioned vertically so that when the hand is placed at top dead center of the push rim, the angle between the upper arm and forearm is between 100 and 120 degrees.
  - Center of middle finger at the center of the axle.
Sagittal Plane

- Camber settings and orientation of wheel next to chair

- Increased Camber:
  - Increased lateral stability but decreased rear wheel stability
  - Increased turning but decreased straight pushing
  - Decreased accessibility
Sagittal Plane

- Top of the wheel should be as close to person's body as possible
- Adjustable camber tubes best option
- Good range is between 3 and 6 degrees
Wheelchair Skills and Joint Protection

- CPG 10. Once chair is set up to optimal position, push techniques are essential.

- Educate client to:
  - Use long smooth strokes that limit high impact on the push rim
  - Allow the hand to drift downward naturally, keeping it below the push rim when not in actual contact with that part of the wheelchair.
Use Long Smooth Strokes

- Understand stroke patterns from the clinical guidelines
- Visually observe
- Record with video for future reference
- Maintain documentation
Ergonomics

CPG 3. Minimize the frequency of repetitive upper limb tasks.

CPG 4. Minimize the force required to complete upper limb tasks.

CPG 5. Minimize extreme or potentially injurious positions at all joints.

- Avoid extreme positions of the wrist.
- Avoid positioning the hand above the shoulder.
- Avoid potentially injurious or extreme positions at the shoulder, including extreme internal rotation and abduction.
Ergonomics

  - Modeled various upper extremity positions relative to the wheel during propulsion
  - Supported the information regarding importance of wheel position that is documented in the CPG.
  - Additional information on the fore and aft position of the wheel dictates that a hub–should angle between −10 and −2.5 is most optimal; CPG says “as far forward as possible without compromising the stability of the user…”
  - More rearward axle increase muscle demand and metabolic costs
Education & Training


- Intervention groups demonstrated improvements in Contact Angle and Stroke Frequency compared with control group.
- Contact angle feedback is a more intuitive training variable.
- Reduction in peak rate of rise of force may be a result of increased contact angle.
Conclusion

- It is important to consider trunk stability for manual wheelchair users
- Assess trunk posture both in and out of the chair
- People with poor core stability may benefit from PT training to improve their core stability
- Use the set up of the chair to compensate for lack of stability when core stability can’t be improved.
References


