ALPINE 2023 REHAB CONFERENCE

Alpine HOME MEDICAL

MUSCLE TONE, TONE MANAGEMENT AND DYNAMIC SEATING INTERVENTION

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SEATING DYNAMICS

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Learning Outcomes

1. The participant will be able to define muscle tone and related pathophysiology
2. The participant will be able to list 3 common positioning challenges seen at the pelvis and general intervention strategies
3. The participant will be able to list 3 common positioning challenges seen at the pelvis and general intervention strategies
4. The participant will be able to describe how Dynamic Seating interventions can benefit clients with increased muscle tone

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What we are covering:

- What is muscle tone?
- Tone management strategies and impact on positioning
- Dynamic Seating intervention for clients with increased tone
- General positioning strategies for clients with increased tone

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Positioning a Client with High Tone

- If a client has increased muscle tone, this will impact what seated position is selected and what seating strategies will be used to achieve and maintain this position.

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DEFINITIONS

Muscle Tone, Pathophysiology, Movement Disorders, Reflexes, Diagnoses

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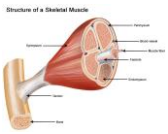
Muscle Tone

- Definition:
  - The muscle in a steady partially contracted state caused by the successive flow of nerve impulses
  - The amount of tension or resistance to movement in a muscle
  - Muscle resistance to passive stretch



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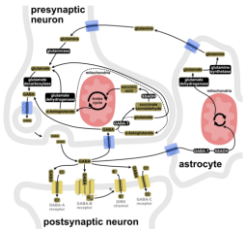
Muscle Tone

- Muscle Tone is controlled by two factors:
  - Inhibitory signals from the brain to the spinal cord, release GABA to make muscles relax
  - Excitatory stimulating signals from the muscles to the spinal cord telling themselves to contract
  - If signal balance is normal, muscle tone is normal



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Muscle Tone

- Hypotonia: decreased muscle tone
- Hypertonia: increased muscle tone
- Rigidity: tone is increased in both the flexors and extensors and is non-velocity dependent
- Spasticity: muscle spasms are increased by movement
- Velocity dependent: quickly moving a limb elicits the stretch reflex and increase in muscle tone

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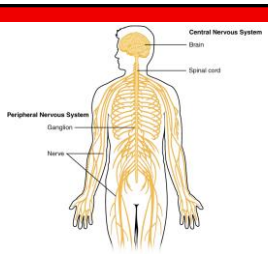
Muscle Tone

- Etiology: a lack of inhibition from the CNS results in excessive contraction of the muscles, due to damage in the brain or spinal cord



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Pathophysiology

- Effect on growth
  - Pull of tight muscle on growing bone can lead to long bone length asymmetries and bone rotation
  - Rotation of the femur can lead to hip dislocation

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Pathophysiology

- Spinal asymmetries
  - Tonal asymmetries in the trunk can lead to spinal asymmetries, particularly in growing children and even more so during growth spurts

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Pathophysiology

- Range of motion
  - Tight muscles pull joints into a flexed position
  - If joints do not move to full range often enough or for long enough periods of time, range is lost
  - Range loss is particularly common during growth
  - Range loss is often worse and can occur quickly with very high tone and rigidity

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Pathophysiology

- Stability, muscle balance, co-contraction
  - We stabilize and balance by co-contraction
  - Co-contraction allows us to balance flexors and extensors
  - If muscle tone is high in flexors, extensors will be less active, impacting stability and balance
    - i.e., trunk control

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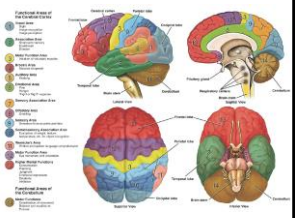
Pathophysiology

- Functional implications
  - Increased tone, depending on areas and severity of involvement, can impact:
    - Ambulation
    - Gross motor control
    - Fine motor control
    - Stability and balance
    - Trunk and head control
    - Feeding and swallow
    - Just about everything…



Dana Foundation

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Movement Disorders

- Movement Disorders commonly seen with increased muscle tone
  - Athetosis
  - Dystonia
  - Chorea
  - Ataxia

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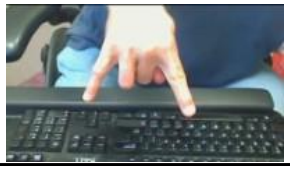
Athetosis

- Slow, writhing motions of the fingers, hands and around the mouth
- More continuous movements than dystonic movements
- 5% of people with CP
- May be due to damage to the basal ganglia



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Dystonia

- Sustained muscle contractions that result in twisting movements and abnormal postures
- 25 – 35% of people with CP
- May affect only one region, adjacent body regions, one side of the body or all of the body
- May be due to damage to the basal ganglia

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Chorea

- Involuntary, abrupt, rapid, brief, and unsustained irregular movement
- "dance-like"
- 5% of people with CP
- Damage to a different region of the basal ganglia, internal globus pallidus output is reduced

Start at 1.30

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Ataxia

- Abnormality of coordination
- Particularly affects walking

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Pathophysiology

- Movement disorders are non-progressive (with the exception of some metabolic disorders)
- Stability in positioning is key to optimizing function
- Cognition is often average to above average in clients with athetosis and dystonia

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Reflexes

- Reflexive or obligatory patterns commonly seen with high muscle tone
  - ATNR
  - STNR
  - Rooting
  - Stepping
  - Etiology, Pathology, Functional implications

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Reflexes

- Etiology
  - Present in infancy, often to aid in certain tasks such as nursing
  - Not "integrated" either due to brain damage or as a result of lack of typical motor development and movement
- Pathology
  - Non-progressive
  - Persistent obligatory patterns can lead to orthopedic changes and range of motion losses
- Functional Implications
  - Obligatory patterns may limit volitional control
  - ATNR impacts visual regard of anything directly in front of the client
  - Seating implications

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Diagnoses

- Diagnoses that include high muscle tone:
  - Cerebral Palsy (CP)
  - Traumatic Brain Injury (TBI)
    - Including NAT, near drowning
  - Multiple Sclerosis (MS)
  - Certain Metabolic disorders
  - Isolated high tone:
    - Spinal cord injury (SCI)
    - Stroke (CVA)

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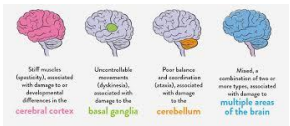
Cerebral Palsy

- Damage to the brain before, during or shortly after birth
- Often hypoxic or anoxic injury
- Neural Plasticity
- Types of CP are defined by area of involvement



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Cerebral Palsy

- Muscle Tone
  - Muscle tone can be **high**, **low** or **mixed**
  - Tone is **velocity dependent** and typically relaxes at rest or during sleep
  - Increased stretch reflex
  - Movement disorders and reflexive patterns of movement are common

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Traumatic Brain Injury

- Injury to the brain due to trauma
- Includes hypoxic and anoxic events
- Includes NAT, post drowning

- Muscle Tone
  - Muscle tone is **high** and **non-velocity dependent**
  - **Rigidity**

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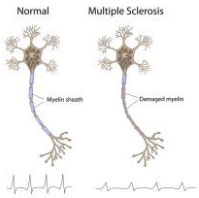
Multiple Sclerosis

- Demyelination along CNS nerves, axons spared.
- Myelin is lost leaving scarred or sclerotic areas called lesions or plaques
- If motor nerves are damaged, high tone can result
- High tone, non-velocity dependent, rigid



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Metabolic Disorders

- Certain metabolic disorders lead to damage of inhibitory pathways, resulting in **high or low tone**
- Typically, high tone is **non-velocity dependent** and **rigid**
- Movement disorders and abnormal reflexes may be present

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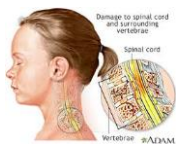
Spinal Cord Injury

- Isolated areas of high tone may be seen, particularly in a partial injury
- **High tone** or **muscle spasms** may be "triggered" by positional changes such as opening the seat to back angle or reclining.
- **Clonus** may be present



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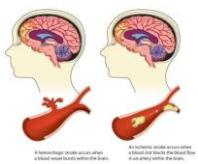
CVA

- **Spasticity** may be seen on the involved side, as well as **flaccidity**
- **Non-velocity dependent**
- Can be **rigid**



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MEDICAL INTERVENTIONS

Impacting positioning for clients with increased muscle tone

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Medical Interventions

- Tone Reduction
- Orthopedic Surgeries
- Orthotics
- Seating Implications of each

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Tone Reduction

Oral Medications
- Baclofen
- Tizanidine
- Diazepam
- Others

- Global impact on tone
  - May reduce overall extension within seating system
  - May lead to lower tone in trunk and neck

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Tone Reduction

Injections
- Phenol
  - Temporarily destroys part of a motor nerve
- Botox
  - Temporarily destroys certain muscle receptors in the muscle belly

- Targeted impact on tone
  - May impact one area of sitting posture
  - May have an overflow impact on other areas of the body

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Surgeries

- Orthopedic
  - Tendon releases / tenotomy
    - Hamstrings
    - Adductors
    - Achilles
  - VDROs
  - Spinal fusions

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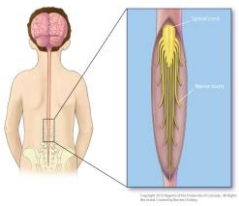
Surgeries

- Dorsal Rhizotomy
  - Selective dorsal roots are cut
  - Primarily affects lower extremities
- Reduced tone in lower extremities
  - May see overflow in other areas of the body



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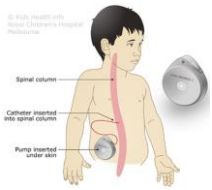
Surgeries

- Baclofen Intrathecal Pump
  - Global results, more so below level of insertion
  - Requires less medication, so less side effects



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Orthotics

- AFO
  - May 'break up' tone by providing ankle flexion
- TLSO
  - Provides proximal support so that the trunk doesn't have to work so hard
  - Important to determine whether this will be worn in the seating system or not

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DYNAMIC SEATING INTERVENTIONS

For people with increased muscle tone

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Dynamic Seating

- **Movement** which occurs within the seating system and/or wheelchair frame
  - Movement can occur at the hips, legs, or neck
    - Dynamic Back
    - Dynamic Footrests
    - Dynamic Head Support Hardware

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Intentional or Unintentional force

Rocking movement

Extension and Dystonia

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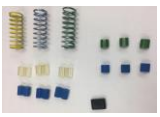
Absorb Force and Return Energy

- Dynamic components **absorb force and return energy** to assist the client back to a starting position
  - The dynamic component may be an elastomer, spring, or hydraulic
  - Force from the client compresses the component, which absorbs the force, and stores this as energy – physics time!
  - The stored energy assists the client back to upright as forces are reduced



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Without Loss of Position

- Dynamic components absorb force and return energy to assist the client back to a **starting position**
  - The design of the component is key in returning to the starting position, rather than resulting in a loss of position
    - Pivot points

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Primary Clinical Scenarios

- To diffuse force that could otherwise lead to client injury, equipment breakage, decreased sitting tolerance, increased agitation, decreased function, further increases in extension, and energy consumption.

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Primary Clinical Scenarios

- To allow movement to provide sensory input, increase alertness, and decrease agitation.

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Primary Clinical Scenarios

- To improve postural control, stability, and function.

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Specific Clinical Applications

1. To protect the wheelchair user from injury
2. To protect wheelchair and seating hardware from breakage
3. To increase sitting tolerance and compliance
4. To enhance vestibular input
5. To facilitate active range of motion
6. To increase alertness
7. To decrease agitation
8. To decrease fatigue
9. To increase function
10. To increase strength and postural control
11. To reduce active extension
12. To reduce energy consumption

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Dynamic Backs

- Movement occurs only at the back
- Can often be combined with other dynamic options to provide movement in other areas

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Seating Dynamics Dynamic Back

- Seating Dynamics
  - Dynamic rocker back
  - Resistance is adjustable through a set of elastomers
  - Lock-out
    - Use during transportation, over rough terrain, or during feeding, as needed

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Seating Dynamics Dynamic Back

- Seating Dynamics
  - Dynamic rocker back

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Dynamic Footrests

- Movement may occur in multiple directions
  - Telescoping downward
  - Knee elevation
  - Ankle plantar / dorsi flexion
  - Footplates rotating outward
- Can often be combined with other dynamic options to provide movement in other areas

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Dynamic Footrests

- Seating Dynamics
  - Dynamic footrest
  - Telescopes 1 ½"
    - 3 springs, varying resistance. Medium is default.
    - Use alone for clients who may otherwise lose the position of their pelvis
      - Tight hamstrings

Optional knee pad

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Dynamic Footrests

- Seating Dynamics
  - Dynamic footrest
  - Optional Knee Extension 30 degrees
    - Elastomers. Medium default. Can be changed to Soft.
  - Optional dynamic dorsi/plantar flexion, 10 degrees each direction
    - Elastomers, resistance cannot be changed

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Dynamic Footrests

- Seating Dynamics
  - Dynamic footrest

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Dynamic Head Support Hardware

- Movement may occur in multiple directions
  - Bi-directional
  - Multi-directional
  - Important to avoid neck hyperextension
- Can often be combined with other dynamic options to provide movement in other areas

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Dynamic Headrest Options

- Seating Dynamics Dynamic Headrest
  - Hardware moves along midline or the Y Axis, 10 degrees
    - Resistance can be changed using different elastomers
      - Blue (medium) is standard, Green (firm) on request
    - Responds to posterior and rotational movements
    - Can be used with lateral component hardware and/or sub-occipital pad adapter
    - Includes lock-out feature
      - Use during transport, over rough terrain, or feeding, as needed

Lock-out

Lateral component hardware

Sub-occipital pad adaptor

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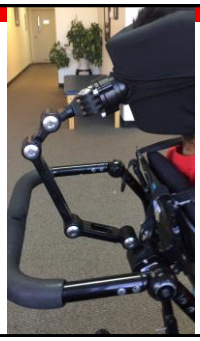
Dynamic Headrest Options

- Seating Dynamics Dynamic Headrest



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GENERAL POSITIONING CHALLENGES & STRATEGIES

For people with increased muscle tone

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Positioning Challenges and Strategies

- Posterior pelvic tilt
- Pelvic rotation
- Pelvic obliquity
- Pelvic anterior tilt
  - Not common in this population

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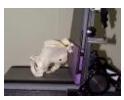
Posterior Pelvic Tilt

- Possible Causes:
  - Low abdominal/trunk tone
  - Tight hamstrings
  - Seat depth too long
  - Limited range of motion, particularly limited hip flexion
  - Sliding forward on seat
  - Extensor thrust
  - Sling seat and back



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Posterior Pelvic Tilt

- Cause:
  - Low abdominal/trunk tone
  - Can occur with high tone in extremities
- Interventions:
  - Provide support to **posterior** superior surface of pelvis to block rearward rotation – seat and back
  - Back shape to support posterior pelvis and allow trunk extension above pelvis
  - Anteriorly sloped seat or drop footrests to allow hip extension
    - Pulls pelvis into anterior tilt

Ride Designs
Custom 2 cushion

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Back Shape

- In combination with the cushion, posterior support at the pelvis
  - Determine desired upper leg to pelvic angle
- Trunk extension above level of pelvis
- Still available as a 'bi-angular' back from manufacturers making linear systems
- Often incorporated into a back shape
- Lumbar build-up
  - May accomplish goal, though may push client forward

Tarta back

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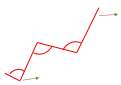
Posterior Pelvic Tilt

- Cause:
  - Tight hamstrings
- Interventions:
  - Open seat to back angle
  - Decrease thigh to calf angle



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Posterior Pelvic Tilt

- Cause:
  - Limited Range of Motion, particularly limited hip flexion.
- Interventions:
  - Accommodate non-reducible limitation in hip flexion by opening seat to back angle
  - Accommodate asymmetries with contoured or molded positioning system

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Posterior Pelvic Tilt

- Cause:
  - Sliding or extending forward on seat.
- Interventions:
  - Provide anti-thrust or aggressively contoured seat
  - Stabilize pelvis using appropriately angled pelvic belt or anterior pelvic stabilizer
  - Change upholstery type

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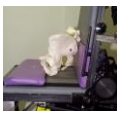
Anti-thrust cushion

- Curb doesn't need to be high
- Too high can unweight ITs and close seat to back angle

- Many off the shelf cushions combine materials to provide both pressure relief and positioning
- Most incorporate an anti-thrust design



Stealth Products TRU-Comfort 2 SPP cushion

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Posterior Pelvic Tilt Hip Belt Position

- 60 degree angle typically maintains neutral pelvic tilt

Stealth Positioning padded dual pull pelvic belt

Courtesy of Bodypoint

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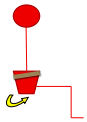
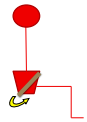
Hip Belt Position

- 30 degrees pulls the pelvis into a posterior tilt
- 45 degrees allows the pelvis to slide under the belt





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Posterior Pelvic Tilt Hip Belt Position

- 60 degree angle maintains neutral pelvic tilt

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Pelvic Rotation

- Cause:
  - Range of motion limitations in hip:
    - Abduction
    - Adduction
    - Hip flexion
    - Windswept posture ⟶
- Intervention:
  - Align pelvis in neutral and accommodate any residual asymmetrical lower extremity posture

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Pelvic Rotation

- Cause:
  - non-reducible limitations in spine, pelvis and/or femoral mobility (i.e. rotational scoliosis)
- Intervention:
  - Pelvis may need to assume asymmetrical posture in order to keep head and shoulders in neutral position, facing forward ⟶

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Pelvic Rotation

- Causes:
  - Tone and/or reflex activity
  - ATNR
- Interventions:
  - Lower extremity abduction, hip and knee flexion, ankle dorsiflexion
    - To "break up" tone
  - Pull pelvic belt back on **forward** side of pelvis

If right side of pelvis is forward, ensure the pelvic belt pulls back on the right side

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Pelvic Obliquity

- One side of the pelvis is higher
- Causes:
  - Scoliosis
  - ATNR
  - Surgeries
  - Discomfort
  - Cushion tipped on sling seat

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Pelvic Obliquity

- Best pelvic positioning placement is over the lap, just in front of the ASIS, to pull the leg down on the high side, which in turn pulls the pelvis down
  - Contra-indicated for poor hip integrity
- If rotation or posterior tilt are also present, a 4 point belt may be indicated to control each plane

Stealth Positioning 4 point pelvic belt

Therafin pelvic belt at 90 degrees

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Pelvic Obliquity

- Interventions:
  - Reducible
    - Wedge
      - Under low side to accommodate

Spex Seating

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Pelvic Obliquity

- Interventions:
  - Non-reducible
    - Wedge
      - Under high side to accommodate…

Invacare Matrx InTouch

Level pelvis | non-reducible obliquity, ½" wedge | non-reducible obliquity, 1" wedge

Goal: to fill in space and distribute pressure

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Positioning Challenges: Trunk

- Lateral Trunk Flexion - Scoliosis
- Forward Trunk Flexion - Kyphosis
- Trunk Extension - Lordosis
- Trunk Rotation

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Forward Trunk Flexion

- Kyphosis can be at various levels of the spine
- Kyphosis may be reducible (flexible), partially reducible or non-reducible (fixed)
- May be combined with neck hyperextension

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Forward Trunk Flexion

- Possible Causes:
  - Flexion at hips
  - Flexion at thoracic area
  - Flexion at shoulder girdle with gravitational pull downward
  - May occur from increased or floppy tone, abdominal weakness, poor trunk control, weak back extensors
  - Increased tone (i.e. hamstrings) pulling pelvis back into posterior tilt
  - Posterior pelvic tilt
  - Habitual seating in an attempt to increase stability

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Forward Trunk Flexion

- Interventions:
  - If reducible:
    - Anterior trunk support
    - Posterior trunk support

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Forward Trunk Flexion

- Anterior Trunk Supports
  - Chest strap
  - Shoulder straps
  - Shoulder retractors
  - Butterfly vests
  - Abdominal supports
  - TLSO

Bodypoint

Stealth Products

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Forward Trunk Flexion

- Posterior Trunk Support
  - Correct posterior pelvic tilt
  - Increase trunk extension with biangular back shape

Rehabilitech

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Forward Trunk Flexion

- Interventions:
  - If non-reducible:
    - Open seat to back angle to match pelvis angle
    - Contoured back
    - Tilt seating system to allow upright head

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Trunk Rotation

- Often seen in combination with lateral flexion
- Often seen in combination with pelvic rotation
- Possible Causes:
  - Pelvic rotation
  - Lateral trunk flexion causes

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Trunk Rotation

- Interventions:
  - See pelvic rotation interventions
  - If reducible:
    - Use anterior supports on forward side
    - Y-strap

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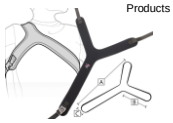

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Trunk Rotation

- Interventions:
  - If non-reducible:
    - Consider placing pelvis asymmetrically in seating system so that trunk and head face forward
    - Molded back to distribute pressure

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Lateral Trunk Flexion

- Scoliosis may be C curve, S curve and/or rotational
- Scoliosis may be reducible, partially reducible or non-reducible

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Lateral Trunk Flexion

- Possible Causes:
  - Increased tone on one side
  - Musculature imbalance, may have pelvic involvement
  - Decreased trunk strength or decreased tone, causing asymmetrical posture
  - Habitual posturing for functional activity or stability
  - non-reducible scoliosis

Worse with effort

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Lateral Trunk Flexion

- Interventions:
  - If reducible:
    - Generic contoured back
    - Lateral trunk supports (may need to be asymmetrically placed, one lower at the apex of lateral convexity)
      - Lateral pelvic support may also be required (3 point control)
    - Anterior trunk supports to correct any rotation (see forward trunk flexion interventions)

Stealth Products

AEL

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Non-reducible Spinal Asymmetries

- Spinal asymmetries often present in combination with one another and may be partially or completely non-reducible
- Curvatures of the spine directly impact the shape of the rib cage
- Goals:
  - Accommodate and support asymmetries
  - Pressure distribution
  - Minimize future progression
  - Comfort
  - Optimize trunk and head control and balance

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Lateral Trunk Flexion

- Interventions, continued:
  - If non-reducible:
    - Refer to physician to explore medical or surgical procedures, x-rays
    - TLSO
    - Aggressively contoured or molded back to allow for non-reducible curvature of spine and/or rib cage
    - Horizontal tilt under seat to right head, if pressure distribution is good

Motion Concepts

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Seating Challenges
Lower Extremities: Hips

- Hip flexion
- Hip extension
- Hip adduction
- Hip abduction
- Windswept tendency

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Hip Flexion

- Possible Causes:
  - Decreased range of motion of hip flexors
  - Fixing with hip flexors due to lack of hip extension or stability
  - Poor positioning
  - Poor range of motion management

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Hip Flexion

- Interventions:
  - If reducible:
    - Superior thigh pads or strapping thighs or feet superiorly
    - Padded lap tray (underside)
  - If non-reducible:
    - Do not overcorrect and cause anterior pelvic tilt

Bodypoint Ankle Huggers

Therafin shoe holder with straps

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Hip Extension

- Possible causes:
  - Decreased range of motion of hip extensors
  - Increased extensor tone
  - Poor positioning
  - Poor range of motion management ⟶

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Hip Extension

- Interventions:
  - If reducible:
    - Open seat to back angle
  - If non-reducible:
    - Open seat to back angle
    - Increase knee flexion, if hamstrings are tight
    - Contoured seating system

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Hip flexion and extension asymmetries

- If one hip needs to be flexed and one extended, this can be accommodated

Invacare Matrx InTouch Stabilite OM Cushion with right leg wedge

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Hip Adduction

- Possible Causes:
  - Extensor tone
  - Decreased range of motion of hip adductors
  - Sling seat
    - Internal rotation

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Hip Adduction

- Interventions:
  - Contoured seat
  - Leg troughs
  - Medial knee supports
  - Anterior knee supports
  - Strapping

Stealth Products TRU-Comfort 2 SPP cushion

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Medial Knee Support

- The groin is not a weight bearing surface!
- We have other strategies to keep the pelvis back

Too big and too far back

Stealth Products, adjustable to accommodate leg length discrepancy

Stealth Products, flip down

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Hip Abduction

- Possible Causes:
  - Decreased range of motion of hip abductors
  - Initial low tone
  - Surgeries
  - Poor positioning

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Hip Abduction

- Interventions:
  - Contoured seat
  - Leg troughs
  - Lateral knee supports
  - Lateral pelvic/thigh supports

Stealth Products lateral knee supports

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Hips: Windswept Posture

- One leg is abducted and externally rotated
- One leg is adducted and internally rotated
- Possible Cause:
  - Pelvic rotation
  - Range limitations
  - Sleep positioning

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Windswept Posture

- Typically, a result of sleep positioning

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Hips: Windswept Posture

- Interventions:
  - Pelvic rotation interventions
  - Hip adduction and abduction interventions

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Seating Challenges: Head

- Poor head control
- High tone extremities + low tone trunk and neck = poor head control
  - Interventions: tilt; posterior, lateral, and anterior support, as needed

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Assessment

- To position the head, we first need to perform a seating assessment
- The position of the head is extremely dependent on the position of the pelvis and trunk
- Seat to back angle and position in space allows the client to “balance” the head

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Posterior Head Supports

- Many posterior head rests or head supports are on the market
- None will be effective if the client’s head never touches it!
- Tilt can be used to enlist gravity in the battle
- Ensure that pelvis and trunk are in an optimal position to facilitate head control

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Take Home Message:

- Positioning clients with high muscle tone can be very challenging
- Optimal seating can inhibit muscle tone and optimize function
- Increased muscle tone, movement patterns and reflexive patterns are closely related
- Tone management intervention impacts seating
- Dynamic Seating can be a critical part of a wheeled seating solution!

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