Clinical & Technical Application of Tilt & Recline in Wheelchair Prescription

K. Missy Ball MT, PT, ATP
Reproduction of presentation strictly prohibited
Property of presenter

Orientation Of Seating System In Space

• Tilt In Space
• Recline
• Other Seat To Back Angle Options

Orientation Of A Seating System In Space Can Affect:
Arousal (Reticular Activating System) (Lange 2000)
Ingestion/ Swallow (Hardwick 2002)
Respiration (Hardwick 2002, Cooper 2004, Lange 2006)
Digestion/ Elimination (Hardwick 1994)
Skeletal Alignment
Soft Tissue Flexibility/ ROM
Spasticity / Reflexes / Compensatory Patterns (Kreutz 1997)
Postural Stability
Functional Accessibility (Eating, UE activities, Transfers)
Skin Integrity
Comfort/ Endurance
Edema
Perceptual Orientation (Vestibular, Tactile, Visual) (Kreutz) 1997
Bone Integrity
Distinctions

**Tilt In Space**
- Allow change in orientation to gravity
- No change in Seat to Back angle
- No change in relationship of client to seating components

**Standard Recline**
- Allow change in orientation to gravity
- Change in Seat to Back angle
- Linear and Angular change in relationship between seating components and client

Tilt In Space Specifics

- Plane in which tilt occurs
- Direction of tilt
- Degree of tilt
- Location of tilt axis on frame
- Floating vs. stable pivot tilt
- Uses of each type of tilt
- Fixed vs. Adjustable Tilt

Body Planes

In Standing

Body Planes in Sitting
Motion Within Body Planes

Anatomical Planes | Motion
---|---
Sagittal | Forward or backward
Transverse | Rotational in nature
Coronal | Sideways

Plane & Direction of Tilt

- **Sagittal**
  - Anterior/Posterior Tilt
- **Frontal/Coronal**
  - Lateral Tilt

**Combination**
- Oblique Tilt

Location of Tilt Axis on Frame

- Posterior Axis Placement
- Anterior Axis Placement
- Central Axis Placement
- Floating Central Axis

Can impact on:
- Visual field – sight line
- Upper extremity reach
- Seat to floor height
- Knee clearance
- Balance of frame
Posterior Axis Location

Lowers seat height, reach and sight line

Anterior Axis Placement of Tilt

Sit to Stand Power Wheelchair Manual wheelchair

Lowers seat height, reach and sight line

Central Axis Placement of Tilt

- Fixed Pivot Point
- Floating Central Gravity Axis Tilt

Affects sight line, reach, rear seat to floor height and knee clearance less than posterior placement of axis
Advantages & Disadvantages of Each Type of Tilt

- Posterior Tilt
- Anterior Tilt
- Central Tilt
  - Fixed Pivot Point
  - Floating
- Lateral Tilt
- Combination or Oblique Tilt

Uses/Advantages Of Posterior Tilt

- Redistribute weight from buttock to posterior trunk
- Gravity assisted position for client with weakness of head/torso
- Gravity assisted position & pressure reduction for client with Hip Flexion contracture or Extensor Thrust
- Reduce gravity's influence on skeletal mal-alignment
- Assist client with venous return insufficiency or edema (ELR lift LE's above level of L atrium by 30cm)
- Assist client with orthostatic hypotension (head down)
- Allow access into and within van for taller client
- Improve visual regard/position for client with fixed kyphosis
- Functional posture for downhill power driving

Pressure Relief (Tilt Only)

<table>
<thead>
<tr>
<th>Angle</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;15° TS</td>
<td>No reduction in pressure</td>
</tr>
<tr>
<td>&gt;15° TS</td>
<td>Necessary to achieve weight shift</td>
</tr>
<tr>
<td>&gt;45° TS</td>
<td>Max. reduction in peak seating pressures</td>
</tr>
<tr>
<td>65° TS</td>
<td>Reduction in IT pressures</td>
</tr>
<tr>
<td>25° TS</td>
<td>Low shear</td>
</tr>
<tr>
<td></td>
<td>TS significantly reduced static seating pressure</td>
</tr>
</tbody>
</table>

(Aissaoui, Lacoste, & Dansereau 2001)
(Hobson 1992)
(Henderson, Price, Brandstater, Mandac 1994)
Research: Distinctive Tilting Behaviours with Power TS Systems
Sonenblum & Sprigle, Disabil & Rehab Assist Tech April 2011
- 45 Participants (most SCI, MS-4, CP-4, SB, MD)
- Monitored 1-2 wks
- Avg. 12.1 hrs./day in wheelchair
- Avg. seat to back angle 100°
- TS 77% used for comfort, discomfort or pain
- 73% used for pressure relief, although infrequently
- 48% for posture
- 61% for function
- 2/3 for rest
- 81% used Small(0-14°) & medium(15-29°) tilt
- Pressure relieving tilt < 1/hr., participants aware but did not follow through

Driving Downhill

Disadvantages of Posterior Tilt Axis
- Client’s body weight shifts rearward outside of wheelbase – can destabilize
- Visual field affected – upward eye gaze (lowers sight line)
- Functional forward reach impacted
- Knee excursion/elevation can interfere with countertops, table clearance
- Sensory processing issue: Low Threshold Vestibular or Tactile – can have negative impact
- Greater tilt possible threat to physically limited clients
65° Posterior Tilt

Can be threatening position, especially with sensory processing issues
Nonfunctional position

Anterior Axis Tilt

Anterior Axis Location
Anterior Axis Placement Disadvantages

<table>
<thead>
<tr>
<th>Anterior Tilt</th>
<th>Posterior Tilt</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Can fatigue – active</td>
<td>• Significant lowering of sight line</td>
</tr>
<tr>
<td>• Can slide forward on seat surface</td>
<td>• Limits forward reach</td>
</tr>
</tbody>
</table>

Knee Height remains constant for table & counter clearance

Uses For Anterior Tilt

• Short periods:
  1. Muscle reeducation
  2. Muscle strengthening
  3. Task specific activity
  4. Assist with standing from sitting posture

• Prolonged period
  • Foot propulsion for mobility
  • Knee height remains relatively unchanged

Anterior tilt can be achieved with posterior, anterior or central axis location

Equilibrium Responses In Sitting

Falling Forward  Falling to the Side  Falling Backward
Posterior Tilt  Anterior Tilt  Lateral Tilt
Anterior Tilt Capability

Motion Concepts Power
Freedom Designs CGX
Convaid Trekker

Central Axis Tilt Location

- Fixed Pivot Point
- Floating Central Gravity Axis Tilt

Comparison

<table>
<thead>
<tr>
<th>Typical Posterior TS</th>
<th>Central Gravity Axis Tilt/ Floating</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Center of mass displaces rearward</td>
<td></td>
</tr>
<tr>
<td>- Posteriorly tippy</td>
<td></td>
</tr>
<tr>
<td>- Need to consider weight of client</td>
<td></td>
</tr>
<tr>
<td>- Sensory processing issues</td>
<td></td>
</tr>
<tr>
<td>- Larger footprint to manage in environment</td>
<td></td>
</tr>
<tr>
<td>- Reduces forward reach</td>
<td></td>
</tr>
<tr>
<td>- Lowers sight line</td>
<td></td>
</tr>
<tr>
<td>- Knee Elevation - clearance issues</td>
<td></td>
</tr>
<tr>
<td>- Possibly Non functional position</td>
<td></td>
</tr>
<tr>
<td>- Center of mass stays center in frame</td>
<td></td>
</tr>
<tr>
<td>- Very Stable</td>
<td></td>
</tr>
<tr>
<td>- Can handle heavier client</td>
<td></td>
</tr>
<tr>
<td>- Extensor spasms</td>
<td></td>
</tr>
<tr>
<td>- Sensory processing issues</td>
<td></td>
</tr>
<tr>
<td>- Smaller footprint to manage in environment</td>
<td></td>
</tr>
<tr>
<td>- Sight line, knee excursion and reach less affected</td>
<td></td>
</tr>
</tbody>
</table>
Sensory Processing
Ability to synthesize, organize and process incoming sensory info to use for purposeful task

- SI
  - Registration
  - Selective Orientation
  - Interpret
  - Organize
  - Execute
  - Motor
  - Arousal
  - Awareness
  - Selectively attend
  - Cognitive
  - Emotional
  - Motor Plan

Sensory Threshold

<table>
<thead>
<tr>
<th>Low (Increased)</th>
<th>High (Decreased)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypersensitive</td>
<td>Hypo-sensitive</td>
</tr>
<tr>
<td>Sensory Avoider</td>
<td>Sensory seeker</td>
</tr>
</tbody>
</table>

Tactile, Vestibular, Visual, Auditory

Vestibular Threshold Issues:
Center of Gravity Tilt Frame
- Stability for Clients that bang
- Can be used with Dynamic Back
- An adjustable locking collar limits tilt for Vestibular Low TH
- 50° Posterior * -10° Anterior Tilt
Uses of Lateral Tilt

- Head positioning/balance
- Gastric emptying
- Decrease GE reflux
- Managing Saliva
  Sheila Buck, Kathy Fischer, Power To The People
- Accommodate severe fixed deformity
  (scoliosis or dislocated hip; center of gravity displaced laterally)

Equilibrium Responses In Sitting

- Falling Backward
- Falling Forward
- Falling to the Side

Lateral Tilt
Uses For Oblique Tilt
(Combination of posterior & lateral tilt)

- Facilitate gastric emptying/digestion
  (Hardwick, Handley, and Feichtinger 1994)
- Assist with management of esophageal reflux
- Assist with absorption issues related to skeletal malalignment
- Promote righting/equilibrium responses to facilitate muscle strengthening of trunk
- Assist with skeletal realignment
- Accommodate severe fixed deformity

Fixed vs. Adjustable Tilt

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Adjustable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighter Design</td>
<td>Heavier – TS adds 15 lbs</td>
</tr>
<tr>
<td>Lower Cost</td>
<td>Frequent positioning changes for:</td>
</tr>
<tr>
<td>No need for multiple position changes</td>
<td>Feeding/swallow</td>
</tr>
<tr>
<td></td>
<td>Postural control</td>
</tr>
<tr>
<td></td>
<td>Pressure reduction</td>
</tr>
<tr>
<td></td>
<td>Skeletal assistance</td>
</tr>
<tr>
<td></td>
<td>Functional access for school, work</td>
</tr>
<tr>
<td></td>
<td>Transfers in van or from chair</td>
</tr>
<tr>
<td></td>
<td>Rest</td>
</tr>
<tr>
<td></td>
<td>CV or respiratory needs</td>
</tr>
</tbody>
</table>

Manual VS. Power Tilt
Dependent on frequency of tilt changes and client’s ability to operate independently, as well as transportability and environmental access

Flexible Posterior Pelvic Tilt

- Fixed tilt in space
  - Reduce the effects of gravity

[Diagram showing upright seating and fixed tilt in space]
Regular Recline

- Seat to back angle changes
- > 90° to 178° angle
- Angular/linear relationship of seating components change
- Client’s relationship to seating components changes
- Forward migration tendency increases
- Sheer forces increase

Minimal Sheer Recline

- Reduction of sheer forces due to back glide occurring simultaneously with recline
- Less migration forward on seat
- Useful with structural deformity; custom contoured or modular seating
- Angle Range: 70° - 168°
- More costly/heavier
- Can achieve low seat to floor height on certain models
- Power & Manual

Uses For Recline: Open Seat to Back Angle

Management of bladder to avoid urinary retention
Client high risk for skin breakdown/tissue trauma in the gluteal region. Recline alone can increase shear (Hobson 1992, Aissaou et al, 2000), but reduce perpendicular pressure (TS & Recline best)
Postural hypotension (SCI, MS, Parkinson) Kreutz 1997
Respiratory compromise
Reduce gravity’s influence on weak or paralytic trunk
Limited hip flexion
Increase sitting tolerances with PFO, ASL, MS, cervical SCI
Comfort
Daily needs: sleeping, G-tube feedings, diapering, trach care
Assist with transfers
Manage edema or venous insufficiency
Contraindications for Recline Alone

• Limited range of motion at hips or knees
• Spasticity
  Reflexes: TLR, Extensor Thrust
  Spasms: SCI
• Consider shear issue

Closed Seat To Back Angle(< 90°)

• Accommodate significant hip flexion contracture
• Assist with structural kypho-scoliosis
• Inhibit/diminish extensor thrust affecting function
• Improve pelvic & trunk stability (dump) for active user (SCI)

Active User
Combination of Tilt & Recline

- Who & Why to use both
- Research
- When reclining, 1st tilt then recline to reduce shear from sliding forward

Client that could benefit from both

- Higher level SCI
- ALS
- MS
- CP
- PFO
- MD

Rationale for combination T5 & Recline

Frequent positioning changes needed for:

- Comfort (WC user sits up to 15 hrs/day (Ding 2008))
- Pressure relief/management (less shear)
- Improve postural stability
- Increase function through better alignment for task
- Bowel & bladder management
- Improvement in organ function (CV, GI, Resp)
- Transfers
- ROM/spasticity management

Power preferable to allow adjustments as needed
Manual available when independence not possible
Research - Pressure Management
- 50% SCI will develop pressure sore in their lifetime
- Annual US Cost for Pressure Ulcers in SCI $1.3 billion
- Tissue ischemia = result of external perpendicular pressure & shear to skin with occlusion of blood vessels
- When shear present, magnitude of load to cause ischemia is reduced by $\frac{1}{2}$ (Bennett, Kavner, Lee, Trainor 1979)
- Magnitude and duration of pressure critical (Kosiak 1959; Sprigle 2000)
- Ischemia does not lead to tissue issues for $>22$ hrs
- Tissue compression & deformation leads to cell death in few hrs Gawlitta 2007
- TS significantly reduced static seating pressure
- TS & Recline combined reduced pressure more than TS alone

Pressure Management
- Coggrave & Rose 2003
  Stated pressure relief lifts needed to last 2 minutes for tissues to return to unloaded state

Present Standard (although varies by source)
- Every 15-30 minutes perform pressure relief for 30 sec
  or every hour perform pressure relief 60 sec
- Cushion choice + multiple position changes

Research:
Effect of Wheelchair Tilt & Recline on Skin Perfusion over IT in SCI Arch Phys Med Rehab Nov 2010;91(11):1758-1764
- 11 wheelchair users, level of injury between C4-T12
- No current pressure issues
- 6 protocols of TS & Recline
  - 15°, 25°, & 35° tilt with 100° recline
  - 15°, 25° & 35° tilt with 120° recline
- Tissue perfusion changes recorded
  (Skin blood flow instead of interface surface pressure)
- Results: at least 35° TS with 100° recline or at least 25° TS with 120° recline showed significant increase in skin perfusion
  Skin perfusion vs. interface surface pressure or transcutaneous O2 tension
Research:
Usage of TS, recline, & elevation seating functions in the natural environment of wheelchair users

J Rehabil Res & Dev 2008;45(7):973-983

- 12 individuals (ages 18-70) (CP, SCI, MS, MD) in own power wheelchairs, no pressure sores, 8 employed / school
- Monitored usage for 2 weeks with seat data logger
- Users sat in wheelchair 11.8 +/- 3.4 hrs./day
- TS 64% each day
- Reclined position 76% (9 subjects)
- TS & Recline (same 9 subjects) 39% each day
- Minimal time spent in upright posture
- Subjects used small TS angles (<20*) & small recline angles (<110*); did not reposition q 15min per guidelines
- Possible reasons for multiple adjustments: comfort, improve stability, reduce seat interface pressure

Research

- TS & Recline Survey (Lacoste et al. 2003)
  - 97% of respondents used tilt &/or recline every day
  - 70% used for comfort, rest, decrease pain
  - <35% used for pressure management

In Summary:
Frame Tilt & Recline have numerous clinical applications
Seating & Mobility prescription needs to be individualized.
Prescription is dependent on:
  - the quality of assessment and
  - team's ability to translate those findings into correct equipment

Think:
FUNCTION
COMFORT
INDEPENDENCE
PRESSURE RELIEF