

Efficacy and Effectiveness of Adaptive Seating on Sitting Posture and Postural Control in Children with Cerebral Palsy

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Outline of Presentation



- Purpose
- Definitions
- Background
- Research Question
- Methodology
- Overall Results
- Study Results & Discussion
- Limitations
- Clinical Implications
- Conclusions
- Future Directions



Purpose

- To examine the current literature to determine the effectiveness and efficacy of adaptive seating on sitting posture and postural control in children with cerebral palsy (CP).



Definitions



- **Adaptive seating**

- Any modifications to seating devices with the purpose of improving sitting posture and/or postural control in mobility-impaired individuals¹

- **Posture**

- A position of the limbs or the body as a whole^{2,3}

- **Postural control**

- The ability to control the body's position in space to obtain stability and orientation^{2,3}

BACKGROUND



Cerebral Palsy

- **Cerebral palsy**

- A broad term used to describe a group of non-progressive disorders of posture and movement⁴

- **Incidence**

- 1 in 500 children in Canada⁵

- **Causes**

- Multi-factorial
- Attributed to factors during fetal or infant brain development⁴



Cerebral Palsy



- **Clinical features**

- Decreased muscle strength
- Abnormal muscle tone
- Inability to maintain postural control
- Abnormal sensation, cognition, communication and/or behaviour

- **Classification**

- Severity
- Motor disorder
- Secondary motor impairments

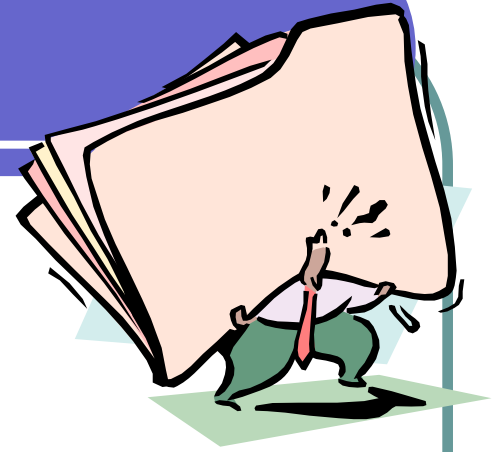
Interventions

- **Postural control interventions**
 - Balance training protocols/devices
 - Ankle foot orthoses
 - Neurodevelopmental treatment
 - Whole-body Lycra[®] garments
 - Adaptive seating



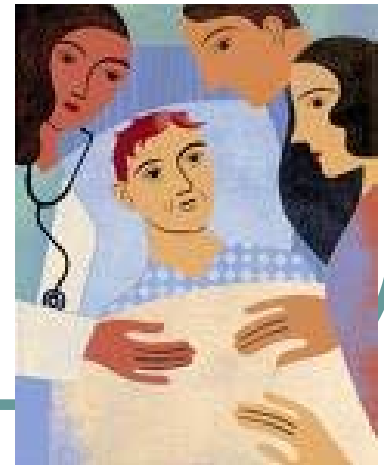
Previous Reviews

- Roxborough⁶ (1995) – 8 studies
 - 3 positive results
 - pulmonary function
 - active trunk extension
 - performance on the Bayley Mental Scale
- Harris and Roxborough⁷ (2005) – 12 studies
 - 7 positive results for postural outcomes



ICF Model

- Why is the ICF important for the field of CP?
 - Promotes a holistic approach to treatment
 - Educates family about the importance of relating function with socialization



Research Questions



Primary Question

- What is the effect of adaptive seating on sitting posture and postural control in children between 0 to 20 years of age, who are non-ambulatory with varying types and severity of CP?



Secondary Question

- What is the effect of improved sitting posture and/or postural control on participation and functional performance of activities in children with CP?

METHODOLOGY



Search Strategy



Inclusion Criteria

- **(P)** Children with CP between 0 and 20 years of age
- **(I)** Adaptive seating
- **(C)** N/A
- **(O)** Sitting posture and/or postural control
- English language articles appearing in a peer-reviewed journal (Jan 1980 – Dec 2006).

Search Strategy



Exclusion Criteria

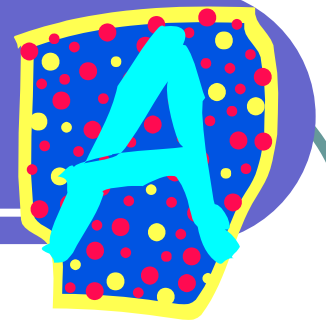
- **(P)** Children had co-morbidities
- **(I)** Co-interventions or non-seating related adaptive devices
- **(O)** Standing postural control
- A survey, anecdote, letter, or comment

Search Strategy



1. MEDLINE
2. CINAHL
3. EMBASE
4. PUBMED
5. Database of Reviews of Effectiveness (DARE)
6. The Physiotherapy Evidence Database (PEDro)
7. OT Seeker
8. Cochrane Controlled Trials Register
9. Cochrane Database of Systematic Reviews
10. Web of Science
11. Dissertation abstracts
12. Education Resources Information Centre (ERIC)

Search Strategy



Key Terms

- Child
- Children
- Cerebral palsy
- Adaptive seating
- Assistive device
- Orthoses
- Positioning
- Seating
- Wheelchair
- Chair
- Infant equipment
- Posture
- Body posture
- Postural control
- Postural dysfunction
- Sitting posture

Search Strategy



Grey Literature

- Reference lists
- Contacting experts in the field

Hand search (1995-2005)

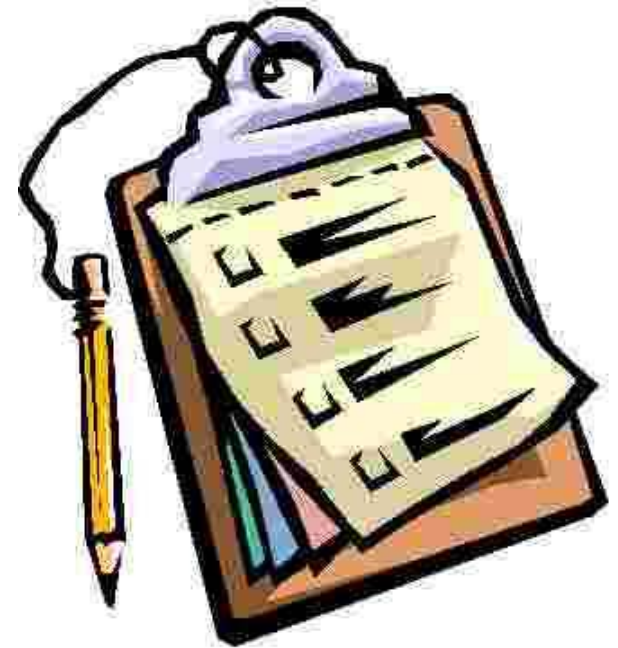
- Journal of Pediatric Orthopedics
- Pediatric Physical Therapy
- Developmental Medicine and Child Neurology



Data Extraction

Our data extraction form included:

- Study designs
- Sample size
- Participant characteristics
- Interventions
- Outcome Measures
- Results
- Conclusions
- Relevant notes



Quality Assessment



Assessment Tools

- Group designs:
 - AACPDm Quality Assessment Scale
- Single subject designs:
 - The Quality, Rigor, or Evaluative Criteria

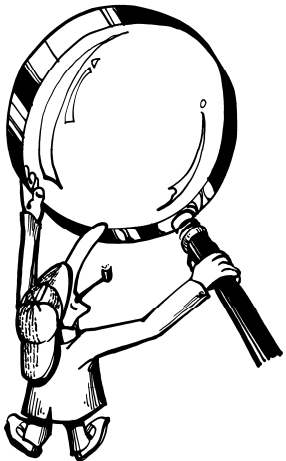
Description

- 7-item scales
- Scores are interpreted as: strong (6 or 7), moderate (4 or 5), or weak (3 or less)

Level of Evidence

Sackett's Level of Evidence for Group Design

I	Systematic review of randomized controlled trials (RCTs) Large RCT (with narrow confidence intervals) ($n > 100$)
II	Smaller RCTs (with wider confidence intervals) ($n < 100$) Systematic reviews of cohort studies “Outcomes research”
III	Cohort studies (concurrent control group) Systematic reviews of case control studies
IV	Case series Cohort study without concurrent control group Case-control study
V	Expert opinion Case study or report Bench research Expert opinion based on theory or physiologic research Common sense/anecdotes



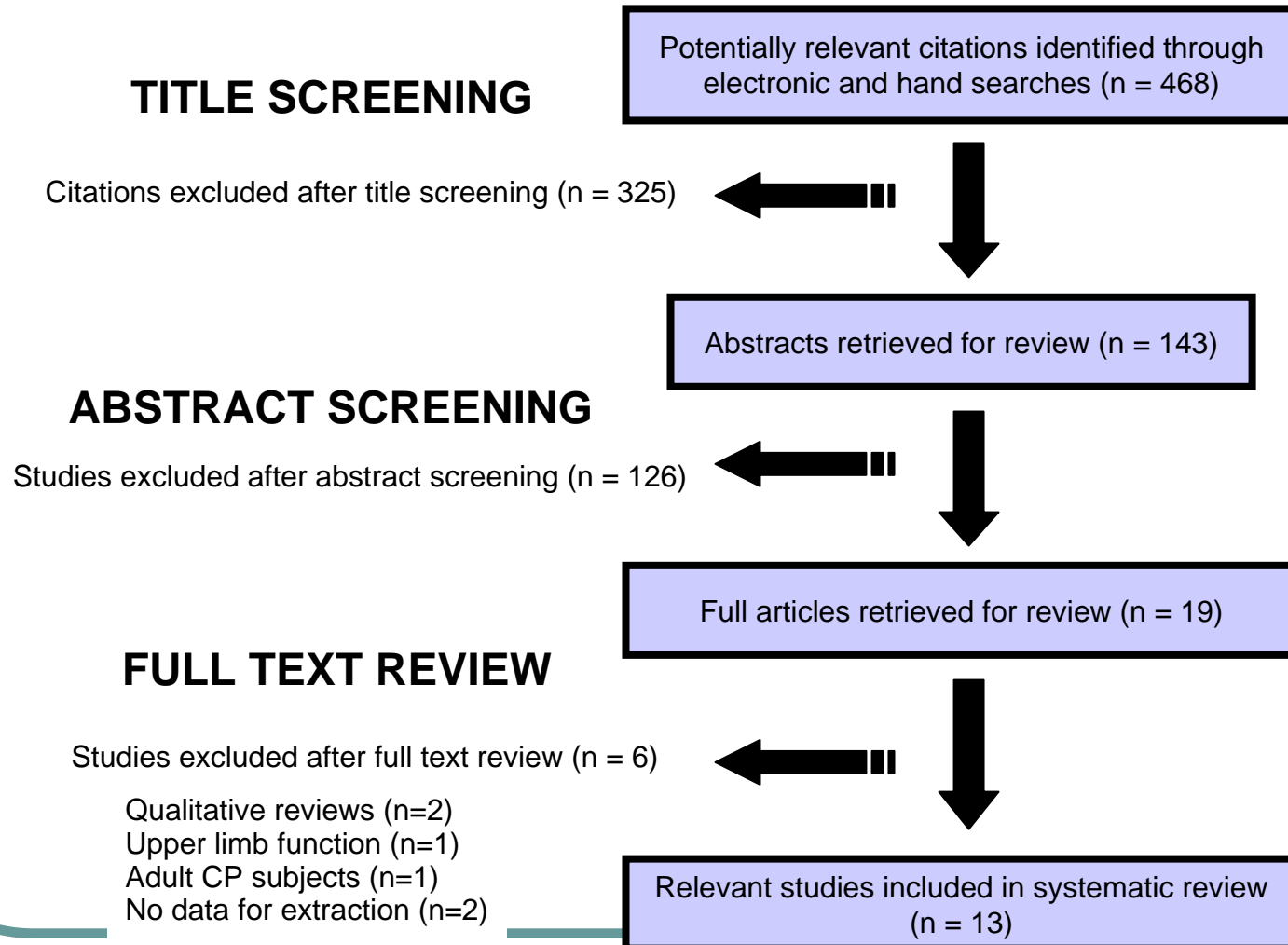
Level of Evidence



AACPDM Level of Evidence for Single Subject Design

I	N-of-1 randomized controlled trial
II	ABABA design Alternating treatments design Multiple baseline designs (concurrent or non-concurrent; across subjects, settings, or behaviours)
III	ABA design
IV	AB design (with replication on \geq subject)
V	AB design (with 1 subject only)

Flow Chart



OVERALL RESULTS



Study Characteristics



Research Design	10 group designs 1 single subject design 2 case studies
Methodological Quality	0 to 7 (median: 4)
Level of Evidence	II to V (median: IV)

Participant Characteristics

No. Subjects	2 to 23 (total: 152)
Age	12 mos to 20.8 yrs
Motor Impairments	Diplegia (n=7), triplegia (n=2), tetrapelgia (n=6)
Motor Disorders	Spastic (n=12), dystonia (n=2), athetosis(n=2)
Severity of CP	Mild, moderate, severe



Interventions

- Saddle seats (n=3)
- Seat/backrest inclinations (n=4)
- Seat inserts (n=2)
- External supports (n=1)
- Modular seating system (n=4)



Outcomes

Outcomes	Studies	ICF Model
Sitting posture	6	Body structure
Sitting postural control	11	Body structure and function
Upper limb function	4	Activity
Mobility	1	Activity
Performance of ADLs	1	Activity
Social skills	2	Participation

STUDY RESULTS & DISCUSSION



Overview

- **Body Structure and Function**

- Interventions:

- A) Saddle Seating
 - B) Seat/Backrest Positional Angles
 - C) Seat Inserts
 - D) External Supports
 - E) Modular Seating Systems

- **Activity and Participation**

- Outcomes:

- A) Upper Extremity Function
 - B) Mobility
 - C) Social Skills & ADLs

Grades of Recommendations

A	Level 1 studies
B	Level 2 or 3 studies
C	Level 4 studies
D	Level 5 studies



Body Structure & Function

Sitting Posture & Postural Control



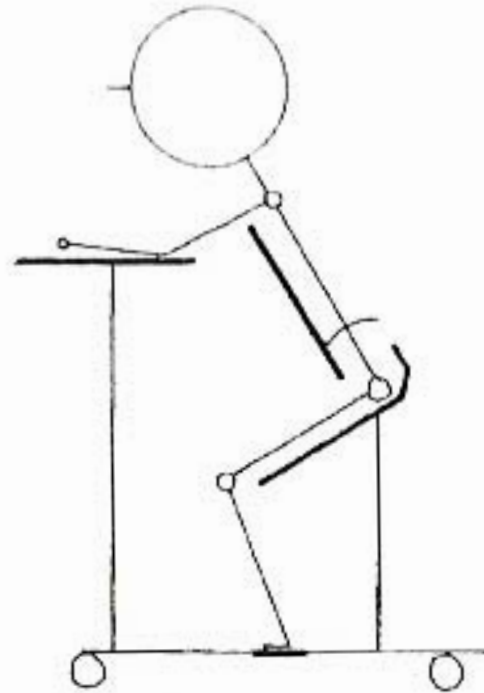
Saddle Position



- **Saddle-shaped seat**

- Maintains **abduction** and **outward rotation** of the **hips**
- Incorporates a **forward slope** to facilitate anterior rotation of the pelvis
- Encourages a **midline posture**
- Increases **dynamic and equal weight bearing** through the lower extremities

Saddle Position



Pope et al.⁸ (1994)

Saddle Position

- Pope et al.⁸ (1994)

- **Description:**

- Level IV evidence; 4/7 quality

- **Findings:**

- variable results - no to little improvement in sitting posture and postural control

- **Major limitations:**

- Small sample size (n=9)
- Lack of control of confounding variables eg. Environment
- Poor adherence to intervention



Saddle Position

- Reid⁹ (1996)

- **Description:**

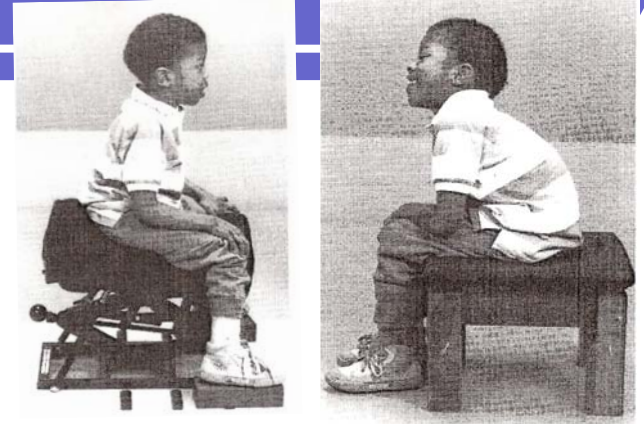
- Level IV evidence; 4/7 quality

- **Findings:**

- Significant decrease in abnormal postural responses = improved sitting postural control
- Significant increase in spinal extension = improved sitting posture

- **Major limitations:**

- Did not control for postural cueing
- Did not operationally define mild and moderate CP



Saddle Position

- Stewart & McQuilton¹⁰ (1987)
 - **Description:**
 - Level V evidence; 0/7 quality
 - **Findings:**
 - Qualitative observation showed improved sitting postural control
 - **Major limitations:**
 - No reports of inter or intrarater reliability
 - Lack of details re: methods and intervention

Saddle Position

Author	Level of evidence	Quality	Results
Pope ⁸	IV	4	Variable
Reid ⁹	IV	4	Improved
Stewart ¹⁰	V	0	Improved

Saddle Position

- Overall recommendations:
 - **Grade C:** mixed evidence
 - **Grade D:** one study lends support



Positional Angles

- Anteriorly- vs. Posteriorly tipped bases?
 - **Anteriorly tipped seat bases:**
 - more upright and stable sitting posture
 - reduce kyphosis
 - maintain lumbar lordosis
 - decrease posterior pelvic rotation
 - shift the centre of gravity forward
 - **Posteriorly tipped seat bases:**
 - reduce EMG activity of hyperactive muscles
 - facilitates the development of functional movement in sitting



Positional Angles

- Sochaniwskyj¹¹ (1991)
 - **Description:**
 - Level III; 3/7 quality
 - **Findings:**
 - 10° anterior tilt:
 - significantly increased back extension
 - 15° anterior tilt:
 - significantly decreased sitting postural control
 - greatest EMG activity of erector spinae muscles
 - **Major limitations:**
 - Non-equivalent control group
 - Poor construct validity



Positional Angles

- McClenaghan et al.¹² (1992)
 - Description:
 - Level III; 5/7 quality
 - Findings:
 - Quiet sitting: 5° posterior tilt improved lower limb stability; 5° anterior tilt decreased head stability
 - Active sitting: no differences
 - Major limitations:
 - High inter-subject variability
 - No interrater reliability reported



Positional Angles

- Miedaner¹³ (1990)
 - **Description:**
 - Level III; 2/7 quality
 - **Findings:**
 - 20° forward tilted bench improved trunk extension in sitting
 - **Major limitations:**
 - No interrater reliability reported

Positional Angles

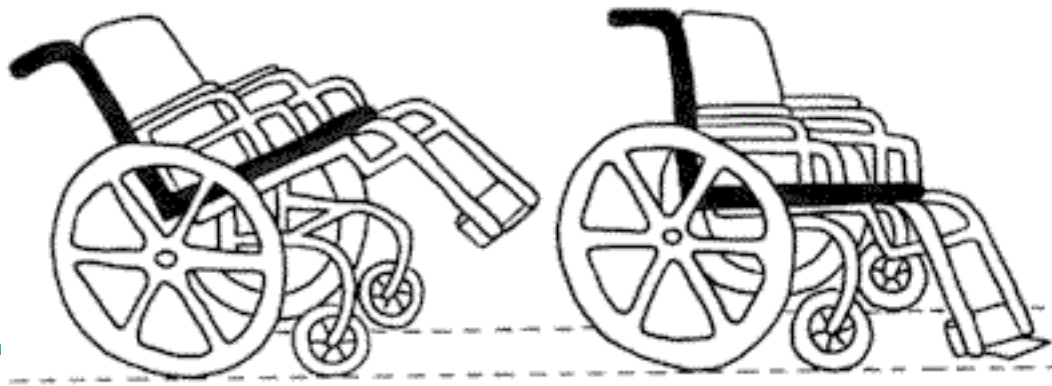
- Nwaobi¹⁴ (1983)
 - **Description:**
 - Level V; 4/7 quality
 - **Findings:**
 - Lowest EMG muscle activity when back rest at 90° and seat inclined at 0°
 - **Major limitations:**
 - Only looked at low back extensors
 - Only recorded EMG muscle activity for 60 seconds

Positional Angles

Author	Level of evidence	Quality	Results
Sochaniwskyj ¹¹	III	3	Improved with 10° anterior tilt
McClenaghan ¹²	III	5	Improved with 5° posterior tilt
Miedaner ¹³	II	2	Improved with anterior tilt
Nwaobi ¹⁴	V	4	Improved with neutral position

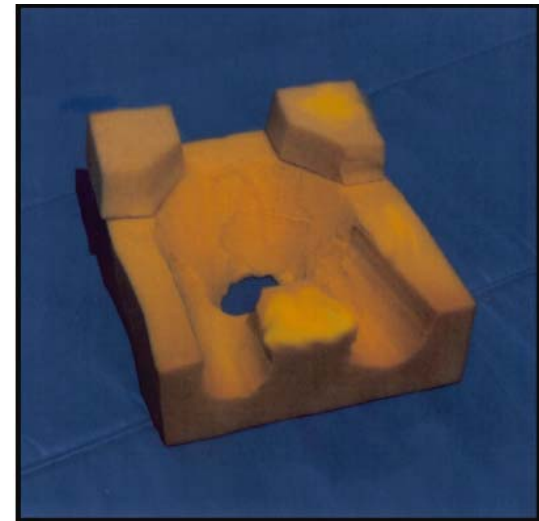
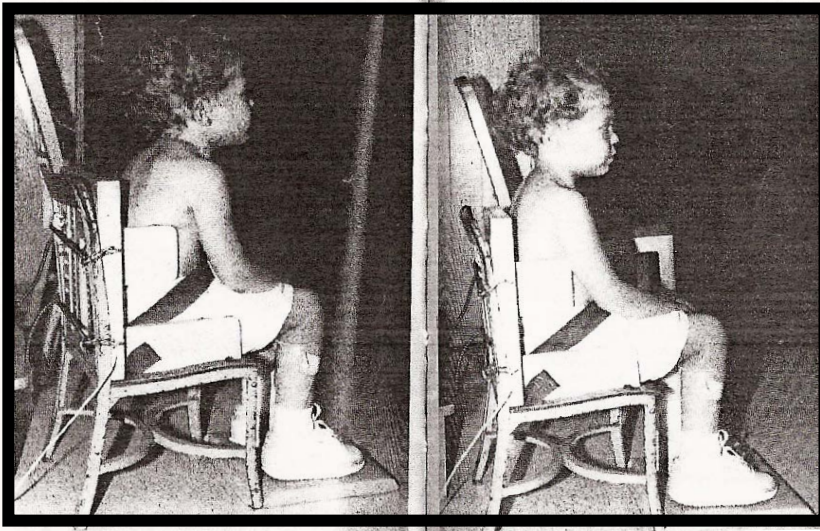
Positional Angles

- Overall recommendations:
 - **Grade B:** mixed: two studies supported anterior tilt; one study supported posterior tilt
 - **Grade D:** one study supported neutral position

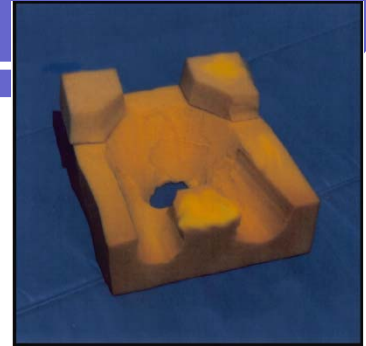


Seat Inserts

- Added to a child's adaptive seating device to improve postural control
 - Contoured foam seating (CFS)
 - Biofeedback



Seat Inserts



- Washington et al.¹⁵ (2002)
 - **Description:**
 - Level II; 7/7 quality
 - Contoured foam seating that is custom molded
 - **Findings:**
 - Significant increase in time spent in midline = improved sitting postural control
 - Parental report of improved postural alignment
 - **Major limitations:**
 - Small convenience sample (n=2)
 - Clinician who made CFS had 12 years of experience

Seat Inserts

- Bertoti¹⁶ (1988)

- **Description:**

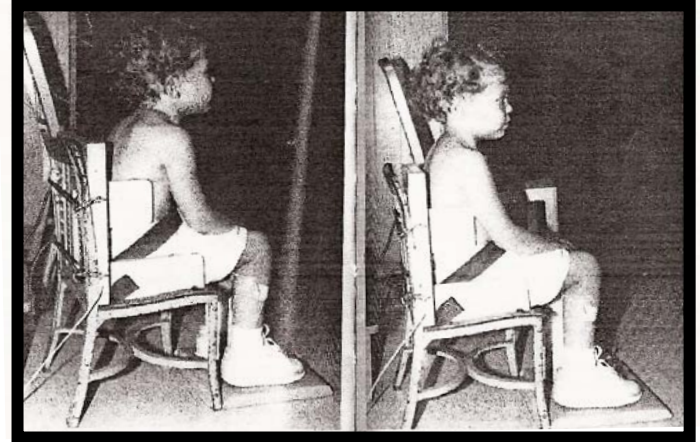
- Level IV; 3/7 quality
- Biofeedback seat insert

- **Findings:**

- Subjective report of improved sitting posture

- **Major limitations:**

- Subjects were children with “normal intelligence”
- ?? Amount of use needed to optimize gains, feasibility of compliance, long term effects



Seat Inserts

Author	Level of evidence	Quality	Results
Washington ¹⁵	II	7	Improved
Bertoti ¹⁶	IV	3	Improved

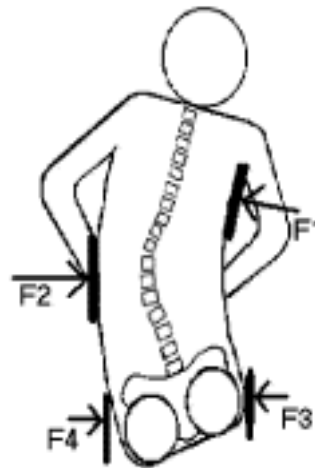
Seat Inserts

- Overall recommendations:
 - **Grade B:** one study supports use of CFS
 - **Grade C:** one study supports use of biofeedback



External Supports

- Lateral supports arranged in a 3-point force system
- 2 parallel forces opposed by a single force acting in the opposite direction



External Supports

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

- Holmes et al.¹⁷ (2003)

- **Description:**

- Level IV; 5/7 quality
- 3-point lateral supports system

- **Findings:**

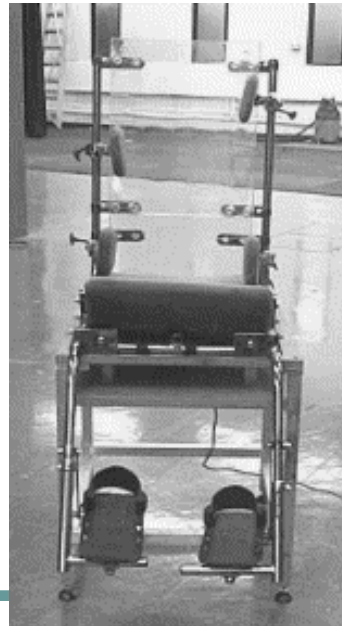
- Significantly improved scoliosis = improved sitting posture

- **Major limitations:**

- only measured in 2-D, but scoliosis is 3-D
- ?? Long term effects, adherence

External Supports

- Overall recommendations:
 - **Grade C:** one study supports 3 point lateral support force system



Modular Seating Systems

- Combination of positional adjustments and orthoses
- Allows for a functional sitting position



Modular Seating Systems

- **“Maxit” or “Real” Chair**
 - **Symmetrically weight bearing** on ischial tuberosities
 - Line of gravity of the **upper body anterior to axis of rotation** at the ischial tuberosities
 - **Hips fixated with a belt** under the seat
 - Legs separated by an **abduction orthosis**
 - Seat base either **horizontal or anteriorly tipped**

Modular Seating Systems

- Myhr & von Wendt¹⁸ (1990)

- **Description:**

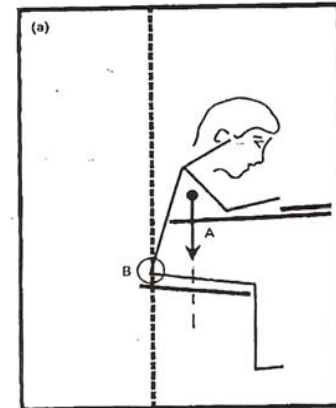
- Level V; 2/7 quality
- Modular seating system

- **Findings:**

- longest duration of head control & least number of pathological movements = improved postural control

- **Major limitations**

- Small sample size (n=2)
- Not standardized intervention
- Poor construct validity



Modular Seating Systems

- Myhr & von Wendt¹⁹ (1991)

- **Description:**

- Level IV; 6/7 quality
- “Maxit” or “Real” Chair

- **Findings:**

- Significantly improved overall sitting postural control

- **Major limitations:**

- Non standardized intervention
- Sitting Assessment Scale – no reports of validity or reliability
- Use of Spearman correlation coefficient



Modular Seating Systems

- Myhr et al.²⁰ (1995)

- **Description:**

- Level IV; 6/7 quality
- 5 yr follow-up study

- **Findings:**

- 8 of 10 children:
 - maintained functional sitting position
 - significant improvement in sitting postural control
- 2 children:
 - deteriorated and trunk control worsened

- **Major limitations:**

- Same methods a/a, thus limitations are similar



Modular Seating Systems

- **Ther Adapt Posture Chair**

- Consists of adjustable:

- Seat height
- Kneepads
- Lumbar support



- Used to obtain a stabilized sitting posture

Modular Seating Systems

- Miedaner¹³ (1990)

- **Description:**

- Level III; 2/7 quality

- **Findings:**

- Ther Adapt Posture Chair improved trunk extension in sitting

- **Major limitations:**

- Intervention was not specified and standardized



Modular Seating Systems

Author	Level of evidence	Quality	Results
Myhr (1990) ¹⁸	V	2	Improved
Myhr (1991) ¹⁹	IV	6	Improved
Myhr (1995) ²⁰	IV	6	Improved
Miedaner	II	2	Improved

Modular Seating Systems

- Overall recommendations:
 - **Grade B:** one study support the use of Ther Adapt Posture Chair
 - **Grade C:** one study lends support to use of the "Maxit" or "Real" chair; one study reported long term improvements
 - **Grade D:** one study supports a modular seating system

Activity and Participation



Upper limb function, Mobility, Social Skills and Performance of ADLs



Upper Limb Function

- **Saddle seat** (Pope et al.⁸, Reid⁹)
 - No significant impact on improving:
 - fine motor
 - dexterity
 - upper limb function



Upper Limb Function

- **Seat Positional Angles** (McClenaghan et al.¹²)
 - 5° anterior tilt:
 - significant increase in thumb-press performance
 - 5° posterior tilt:
 - Reduction in linear tapping performance
- **CFS** (Washington et al.¹⁵)
 - No clear effects

Upper Limb Function

- Overall recommendations
 - More research is needed to examine the link between improved posture and postural control on increased upper limb ability



Mobility

- **Saddle seat (Pope et al.⁸)**
 - Overall increase in mobility
- **Overall recommendations**
 - More research is needed to examine the activity component of the ICF



Social Skills & Performance of ADLs

- **CFS** (Washington et al.¹⁵)
 - Subjective reports of improved:
 - social interactions
 - functional independence
 - feeding ability
 - functional performance



Social Skills & Performance of ADLs

- Overall recommendations
 - More objective measurements are needed to capture the magnitude of change in these outcomes

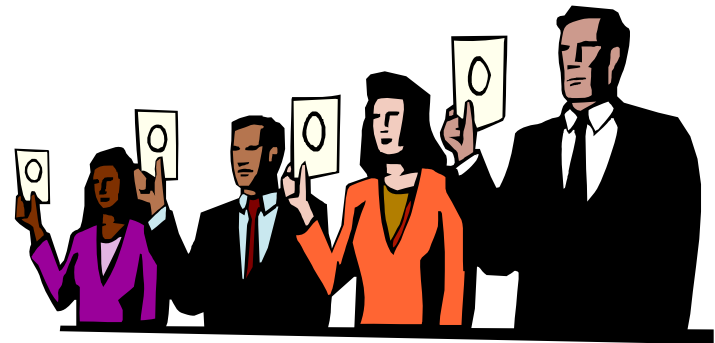


CLOSING REMARKS

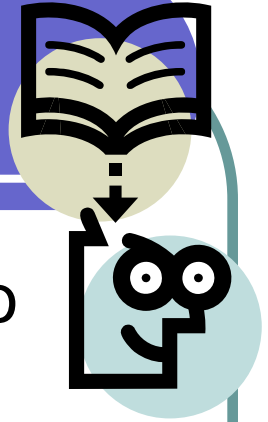


Limitations of Current Review

- Heterogenous population
 - Difficult to compare in terms of severity, age, type of CP and motor impairment
- No standardization of outcome measures
- Low-level of evidence (Level II to V)
- Publication bias
- Lack of current research
- English language



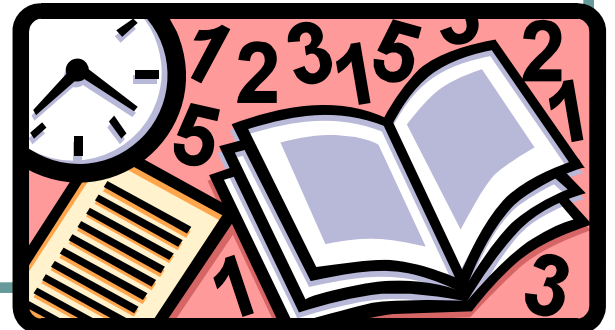
Clinical Implications



- Adaptive seating should be **individualized** to meet the needs of each child
- Therapists should be **patient** as developing an appropriate seating device requires **multiple adjustments over a series of visits**
- Appropriate use of adaptive seating can lead to improvements at the **body structure/function, activity, and participation** components of the ICF model.

Conclusions

- No single intervention has been shown to be more effective than others in improving sitting posture and/or postural control
- Limited evidence to suggest whether improved sitting posture and/or postural control will lead to improved functional abilities
- More research is needed



Future Directions



- Studies with stronger levels of evidence and rigorous research designs
- Use of validated classification systems to describe the motor function (e.g. Gross Motor Function Classification Scale)
- Standardized outcome measures for postural control
- Studies that examine the link between postural control to functional skills and level of participation.

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Thank you! Any questions?



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Background: ICF Model

- Definition of ICF Components (ref):
 - **Body Functions:** physiological and psychological functions of body systems
 - **Body Structures:** anatomical parts of the body such as organs, limbs and their components
 - **Activity:** the execution of a task or action by an individual.
 - **Participation:** involvement in a life situation.
 - **Environmental Factors:** physical, social, cultural, institutional or attitudinal in nature
 - **Personal Factors:** Gender, age, education and lifestyle

Results

Outcomes



Outcomes	Measures
Sitting posture	Subjective reports Trunk, hip, and knee ROM Spinous process angle measurements
Sitting postural control	Subjective reports Displacement of head, trunk, and lower limbs Number of pathological movements EMG activity of back extensors Sitting Assessment Scale Level of Sitting Ability Scale The Sitting Assessment Scale for Children with Neuromotor Dysfunction

Results Outcomes



Outcomes	Measures
Upper limb function	Visual observation Performance in fine motor and dexterity tasks
Mobility	5 point scale
Social skills and performance of ADLs	Subjective reports