

An investigation into adaptive seating systems that use sacral pad and kneeblocks for children with severe forms of cerebral palsy

Dr Rachael McDonald

Lecturer in Paediatric Occupational Therapy
Research

The Institute of Child Health and Great Ormond
Street Hospital for Children NHS Trust

Background

- Research project to investigate;
 - orthogonal (90°-90°-90°) seating systems that use a sacral pad and kneeblock
 - developed using biomechanical theory and
 - commonly used throughout the UK.
- Evidence for the use of seating systems tends to be descriptive and non controlled
- 6 visit case controlled trial to examine
 - Postural alignment and function
 - Biomechanical elements of force, pressure and posture

Analytical Methods

- Force applied through a kneeblock
- Skin interface pressure measured through sacral pad
- Static postural alignment

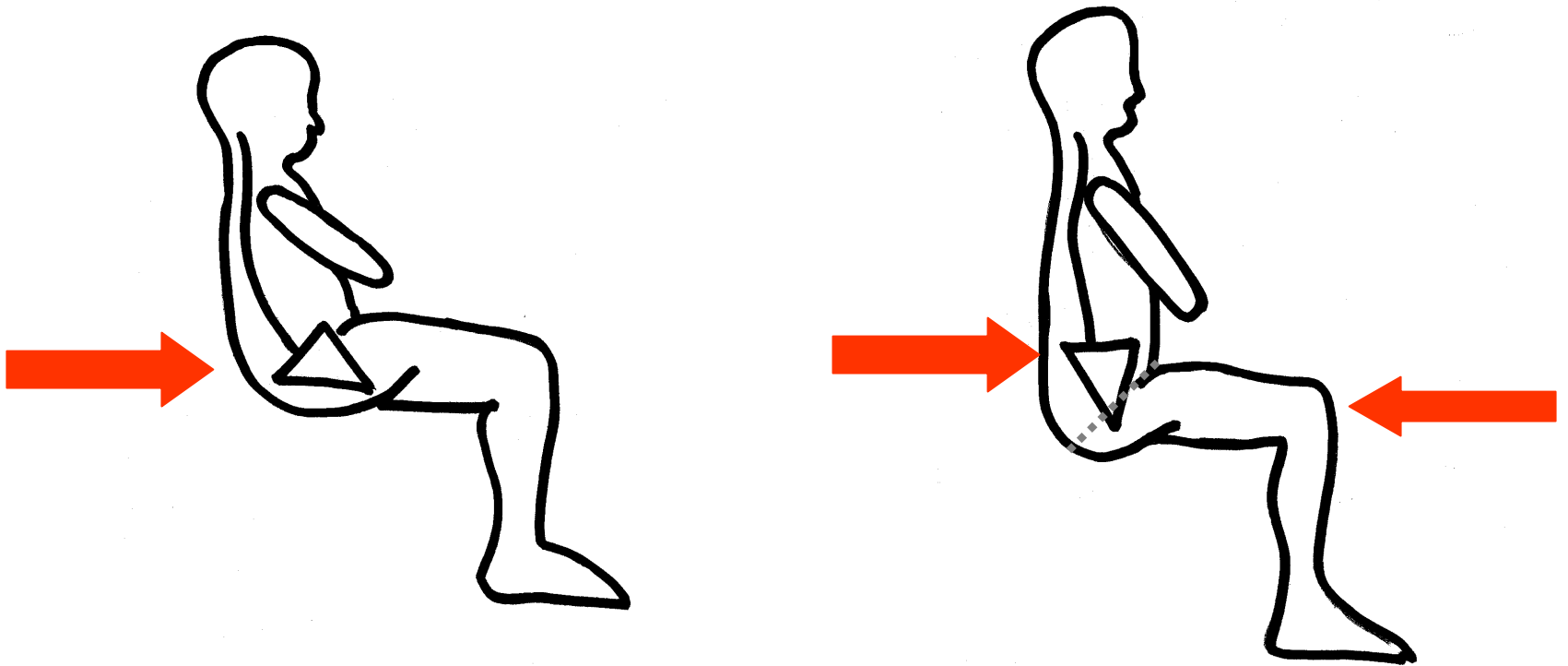
- Assessment of Seated Function
- Questionnaire

Rationale for using sacral pad and kneeblock

- Orthogonal ($90^0-90^0-90^0$) seating systems using a sacral pad and kneeblock – A reminder

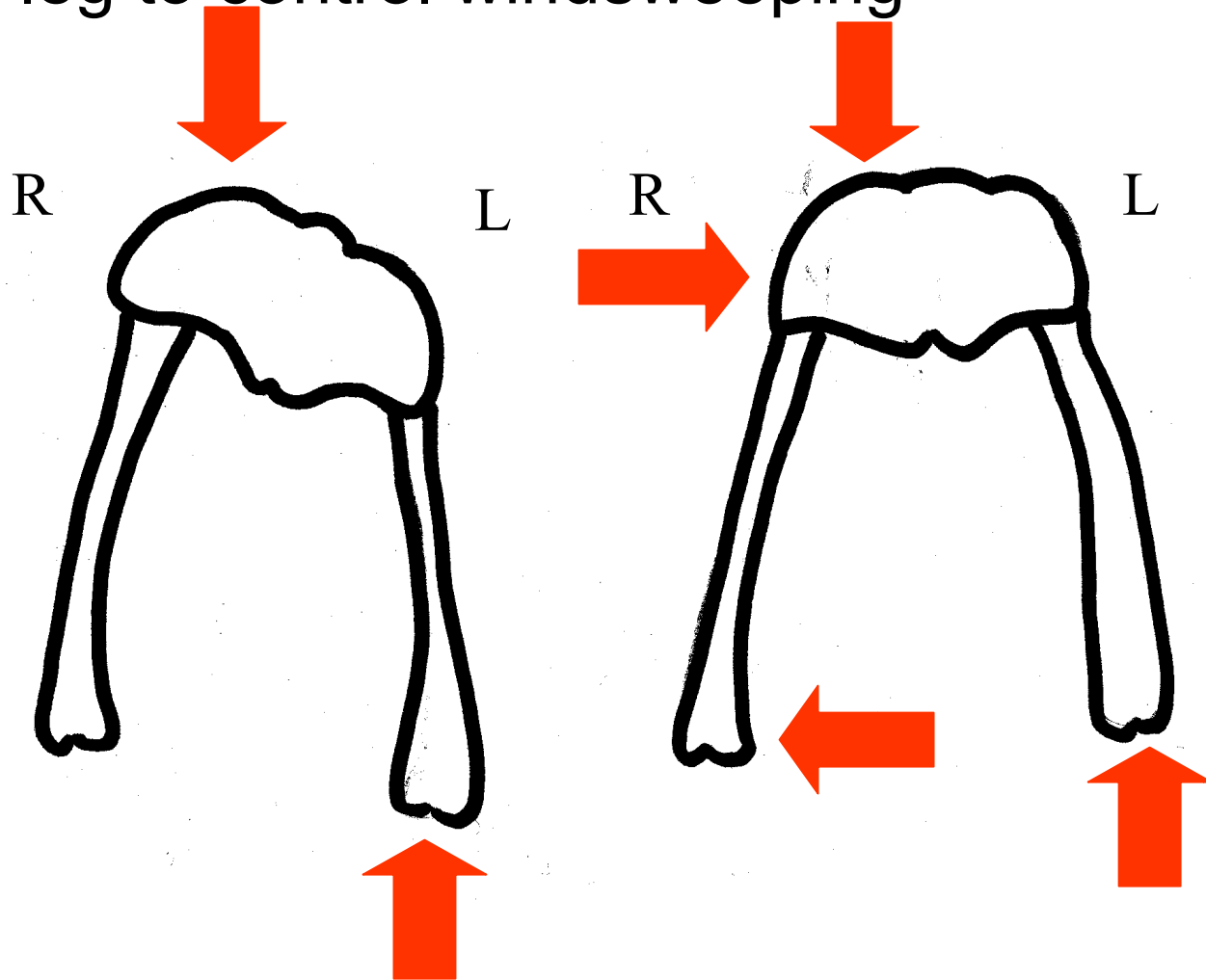
Correction of Pelvic Tilt

Force from sacral pad, equal and opposite force from kneeblocks – to control pelvic tilt



Controls Pelvic Rotation

Forces correct pelvic rotation and then abduct adducted leg to control windsweeping



So in theory.....

- Pelvic position (tilt and rotation) and therefore postural alignment should improve with the application of sacral pad and kneeblock
- There should be a relationship between force measured at the kneeblock and pressure measured at the sacral pad

Research Questions/Hypotheses

- Whether the force exerted through the kneeblock of children with cerebral palsy changes following a period of removal of the kneeblocks.
- Whether the pressure exerted on the sacral pad by children with cerebral palsy changes following a period of removal of the kneeblocks.
- Whether postural alignment changes following kneeblock removal for children with cerebral palsy

Research Questions – continued

- To determine whether force through the kneeblock is linearly related to pressure at the sacral pad.
- To determine whether force through the kneeblock is correlated to postural alignment.
- To establish children's individual postural configuration using theoretical biomechanical analysis.

Study Design

- 6 visit case controlled trial to see whether removal of the kneeblocks between visits 3 and 4 would effect the three domains of force, pressure and postural alignment
 - Visits 1 & 2 lead in or placebo visits
 - Visit 3 kneeblocks removed
 - Visit 4 kneeblocks replaced
 - Visit 5 & 6 lead out visits
- Postural assessment completed and analysed under 2 conditions (kneeblocks on and kneeblocks off) at visits immediately before and after kneeblock removal

Methods

- Kneeblock force measurement device
 - Strain gauges attached to the front of the left and right kneeblocks
- IPM-12 – Oxford Pressure Monitor at Sacral pad
 - Modified sacral pad by placing gel pad over sensing array to get one measure of pressure

Seated Postural Control Measure (SPCM)

- Designed to evaluate change in postural control as a result of adaptive seating intervention
- Measurement of angular deviation from a pre-defined neutral position
 - Divided into categories, but degrees used for this project
- Also has a 12 item assessment of seated function

Participants

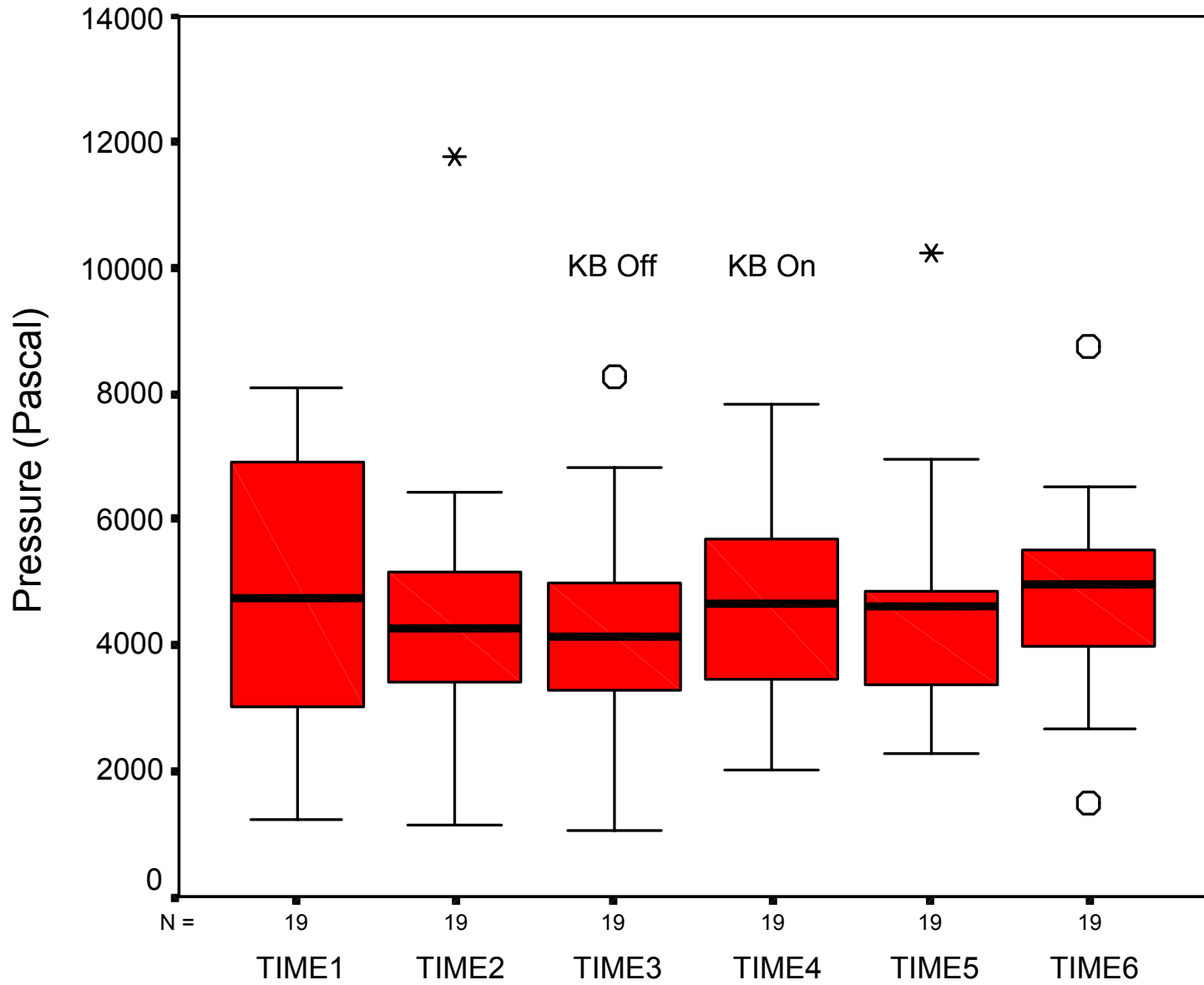
- Numbers – 33 recruited
 - 30 completed trial
 - 23 suitable for statistical analysis
- Type and distribution of cerebral palsy
 - All 4 limb distribution
 - N=5 predominant dystonia, n=18 predominant spasticity
- Age range (commencement of trial)
 - 7 y 4 mo – 14 y 3 months
- Weight
 - 16.3 – 57 kg

Analysis

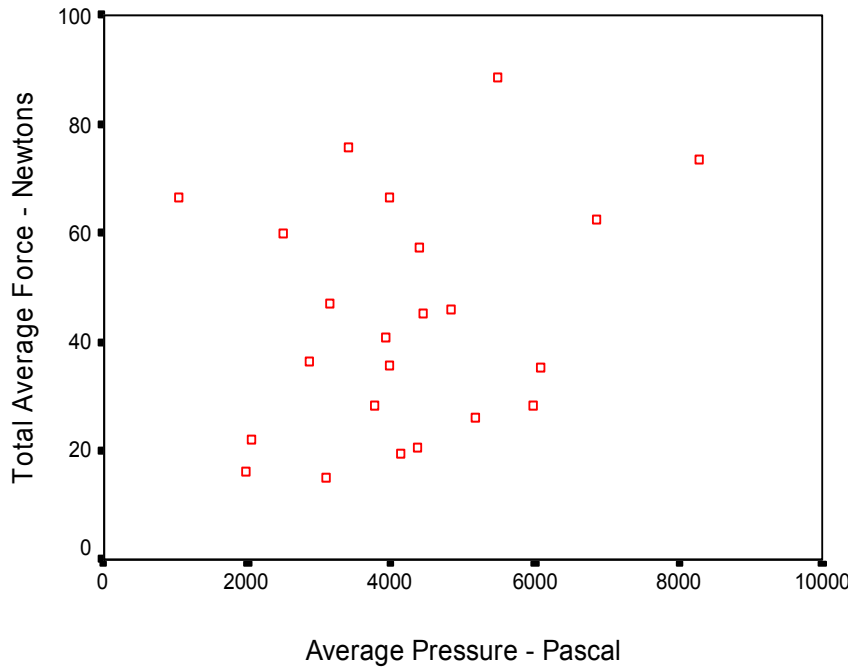
- Force, pressure and postural change over 6 visits individually analysed using Repeated Measures Analysis of Variance (ANOVA)
- Posture - immediate effect of kneeblocks on and off at visits 3 and 4 analysed using t-test
- Correlation - force and pressure, force and posture analysed using Pearson's correlation

Results – Case Controlled Trial

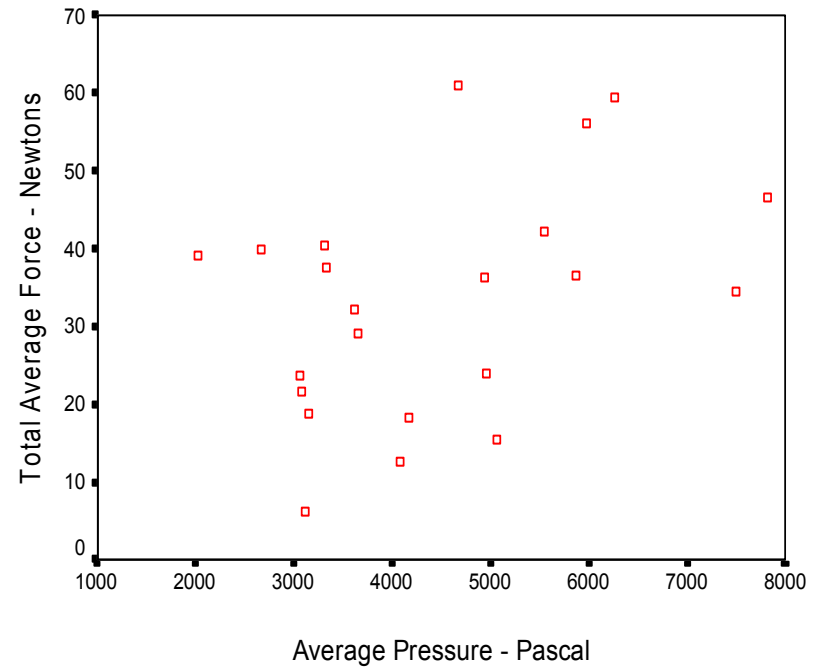
- Repeated Measures ANOVA
 - No statistically significant change in force or pressure over the 6 visit period except left side force
 - No statistically significant change in posture except left hip rotation, left knee flex/extension and left ankle plantar/dorsiflexion.
- Correlation
 - No relationship between force applied through the kneeblock and pressure measured at the sacral pad
 - No relationship between force exerted on the kneeblock and postural alignment



Visit 3

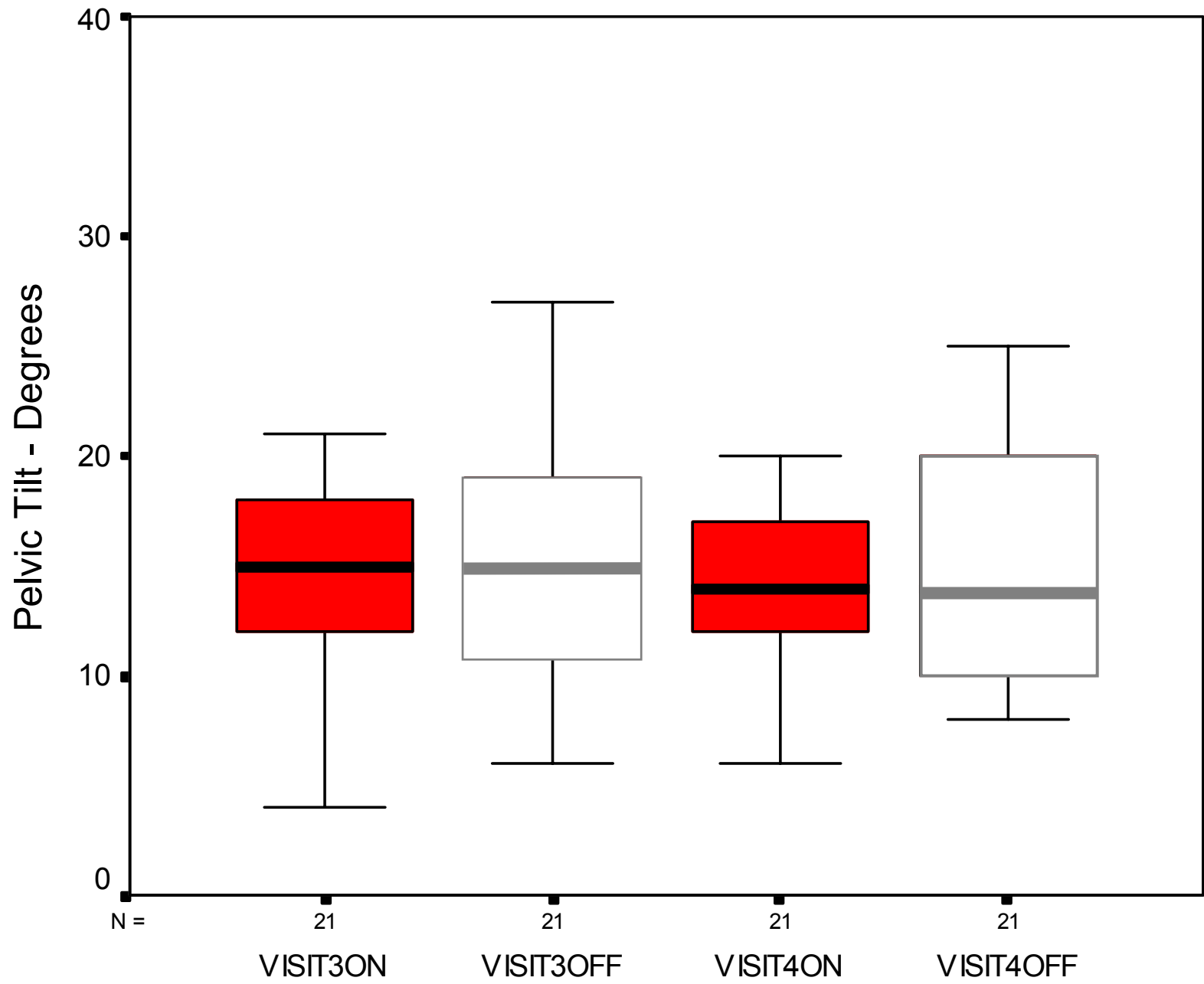


Visit 4



Kneeblocks On and Off

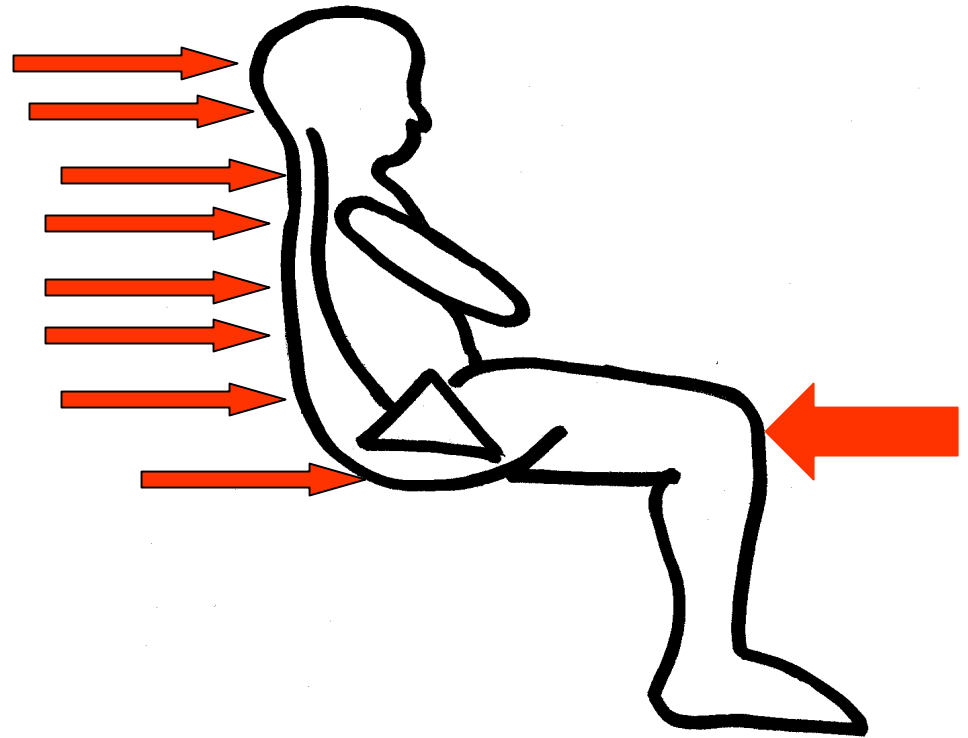
- Statistically significant results for hip rotation on both right (visit 3 & 4) and left (visit 4 only) sides
- Statistically significant results for hip abduction on both right (visit 3 & 4) and left (visit 4 only) sides
- Statistically significant result for left knee flex/extension (visit 3 only)
- No statistically significant differences between kneeblocks on and kneeblocks off for pelvic tilt or pelvic rotation



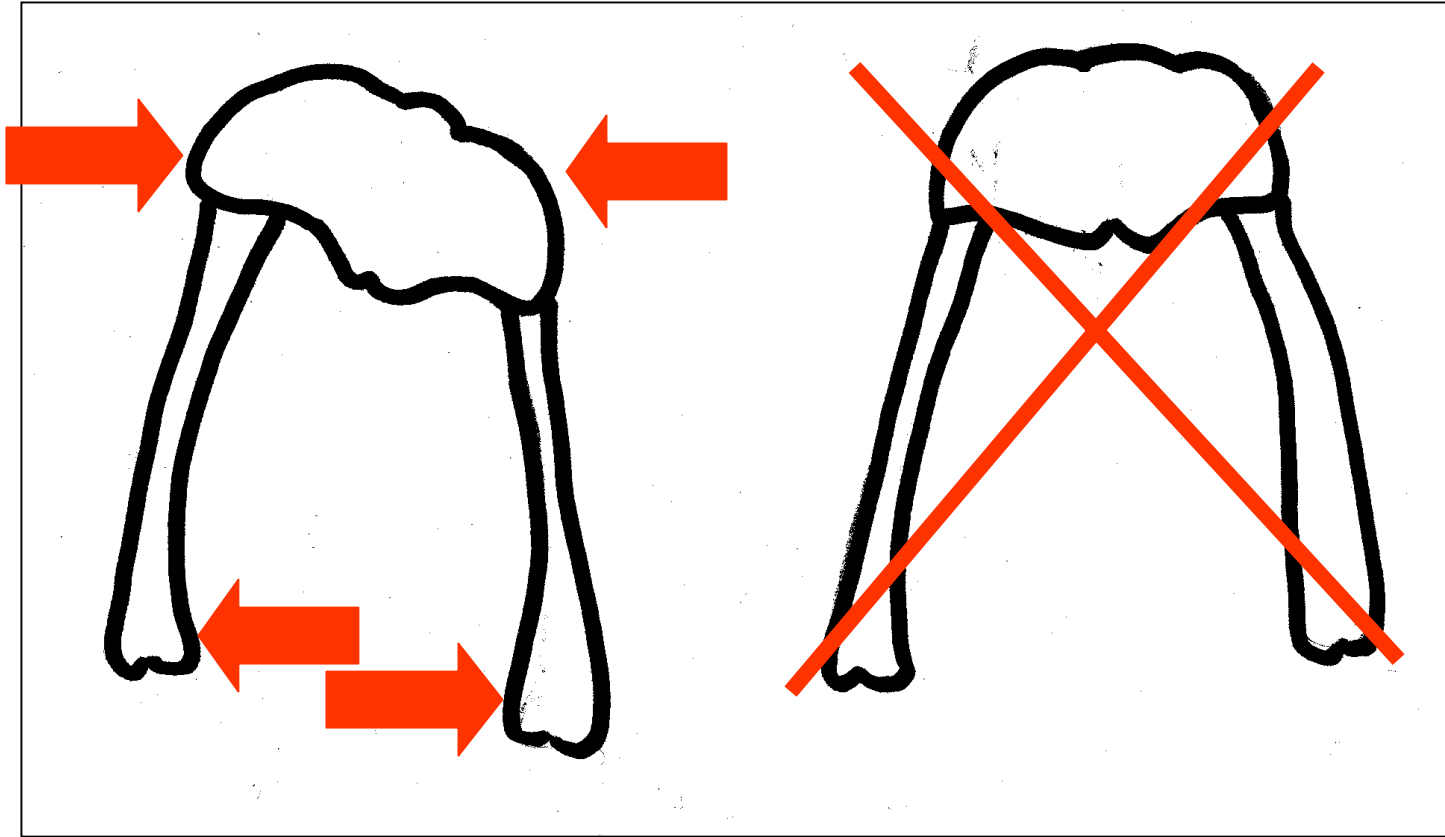
Static Biomechanical Analyses

- Theoretical analyses performed for 33 children with force, pressure, postural alignment and body segment parameters from one visit (3) only
 - Pelvic obliquity tendency to increase for 17/33 children
 - Pelvic tilt tended to increase for 17/33 children
 - Tendency to increase Pelvic Rotation in 11/33 children
 - Only one hip held in abduction (other leg held in adduction) 19/33 children

- Force at kneeblocks might be countered throughout the back or seat of the chair and not by the sacral pad



The kneeblocks may be abducting children's legs without correcting pelvic rotation



Limitations of the Project

- Study Design
 - One researcher - likelihood of bias increased
 - Not continuous monitoring of the children
 - No randomisation or blinding
- Wide variability of children involved
- Small numbers
- Measurement tools
 - Reliability remains a problem for SPCM
 - Force rather than pressure at sacral pad for direct comparison

Conclusions

- Kneeblock and sacral pad system
 - do keep children's legs apart
- No evidence found that sacral pad and kneeblock are controlling the pelvis – does not mean that no evidence exists, but that no evidence was found in this study

Opinion

- Applying biomechanics suitable for typically developing children may not be effective for all children with cerebral palsy
- Disabled children are more complex than their non-disabled counterparts – mechanical neuromuscular considerations need to be addressed in addition to bony biomechanics

Future Direction

- Improved reliable and valid measurement systems *must* be a priority for future research in this area
- Provision for seating should be individually monitored and analysed – and regularly reviewed
- *Eventually* – with improved measurement systems - individual biomechanical analyses of children's posture as a clinical tool

Withdrawals and non-statistically analysed participants

- 2 children underwent surgery and withdrew
- 2 children replaced their kneeblocks
 - Child with dystonia stated it made him feel too unstable with kneeblocks removed
- 4 children did not remove kneeblocks and therefore underwent biomechanical analysis only
 - 2 children with dystonic or mixed motor patterns were unable to manage without kneeblocks due to instability
- 4 children – modifications to the kneeblock force transducer made and underwent biomechanical analysis only.

Relationship between Force and Pressure in Children without Disabilities

