ASSESSMENT OF LUMBAR SPINE POSTURE DURING SITTING ON A DYNAMIC SITTING DEVICE (FLEXCHAIR®)

Does the registration of the device match the actual low back alignment?

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Introduction

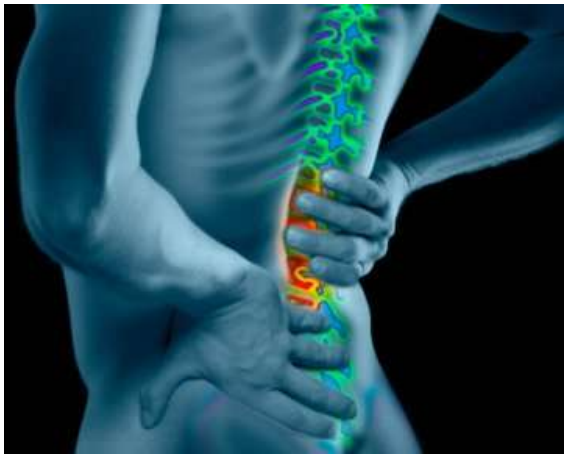
- Today‘ s mechanized, technologically oriented conditions allow and even promote an unprecedentedly sedentary lifestyle
  - Many important health problems are affected by this imbalance

Eaton (2003); Callaghan & McGill (2001)

Introduction
Sitting and Low Back Pain (LBP)

- Prolonged sitting is frequently associated with the aggravation of LBP
- Major aggravating activity for LBP

Dankaerts et al (2006)



Introduction

Spine posture and biomechanical loading

- Proposed negative effects of prolonged sitting include:
  - Compromised disc nutrition
  - Static loading of spinal structures secondary to a lack of spinal movement

Krämer (1977)

- Slumped sitting postures cause:
  - Increased disc pressure and tension on posterior passive structures

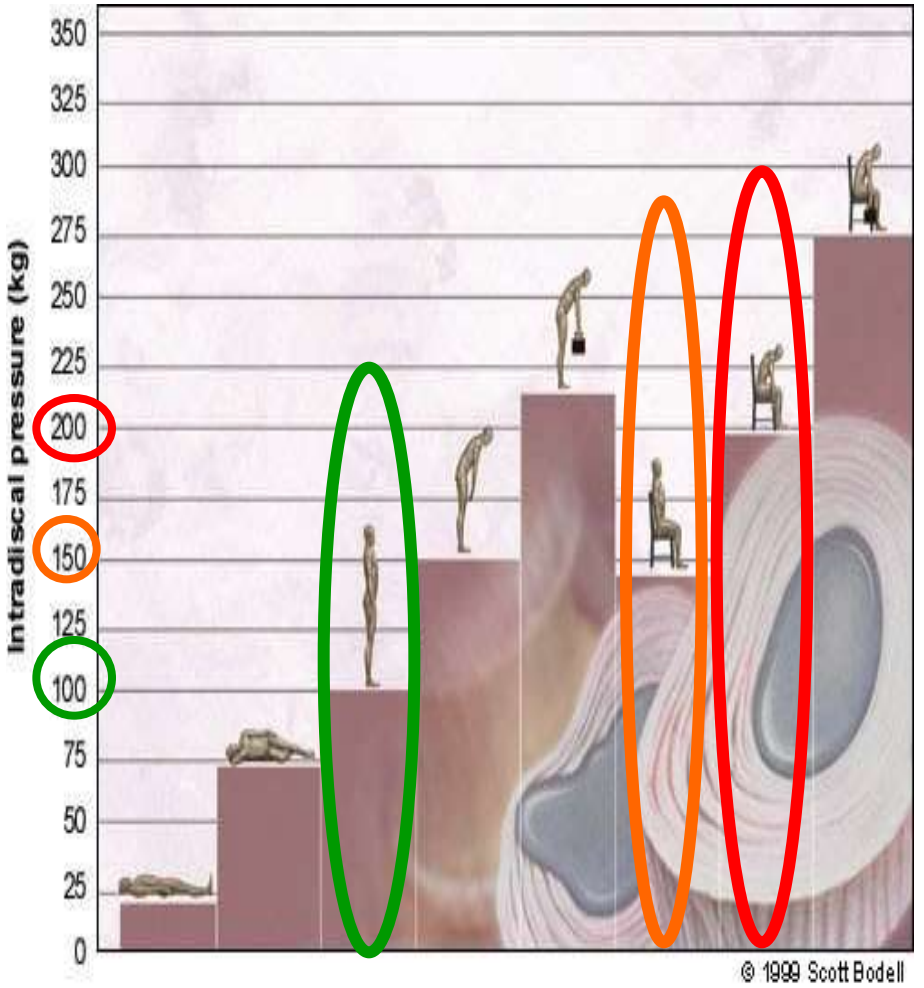
Callaghan & McGill (2001)

Introduction

Spine posture and biomechanical loading

- Sitting: higher disc pressure than standing or lying

  Nachemson (1970)



- Recent findings show:
  - Proof of often similar IDP in standing and upright sitting postures
  - Axial compression in sitting, measured in vitro, is unlikely to pose a threat to *non-degenerate discs*
  - If sitting is a greater threat for development of LBP than standing, the mechanism is unlikely to be raised IDP

Claus et al (2007)

Introduction

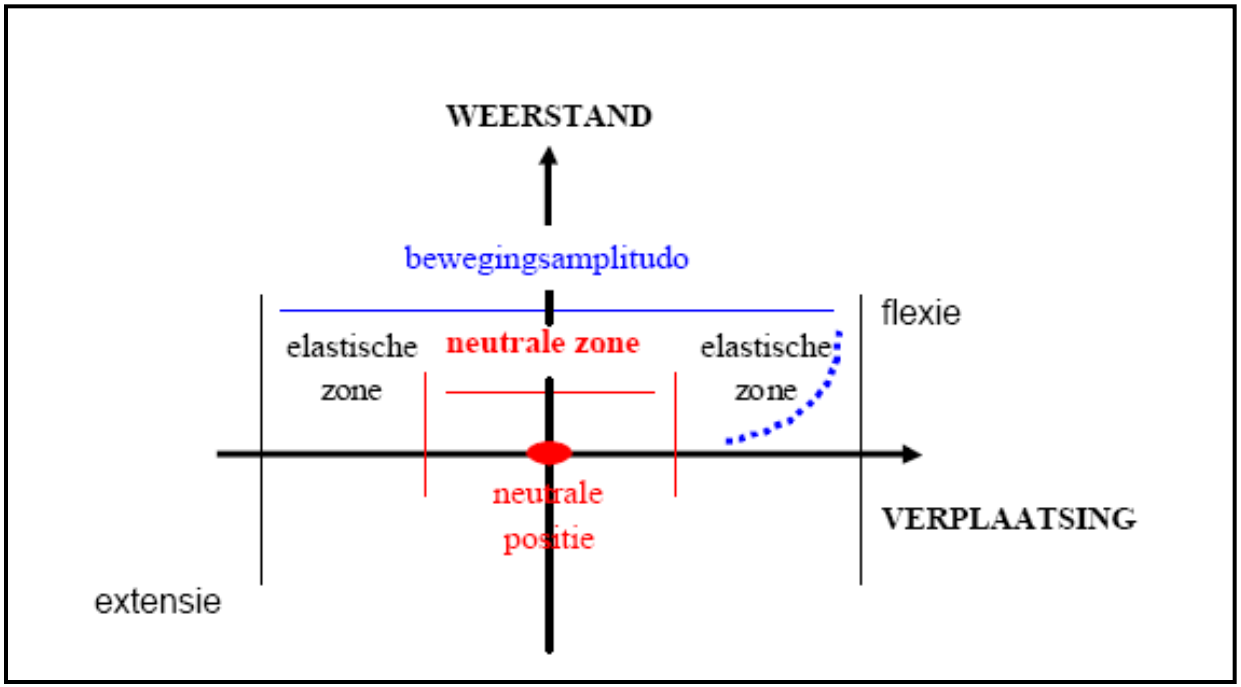
Neutral spine or lumbo-pelvic upright sitting

- Def. ‘neutral zone’ = part of physiological intervertebral motion
  - Measured from the neutral position
  - Within which the spinal motion is produced with a minimal internal resistance
  - Zone of high flexibility or laxity

Panjabi (1992)

Introduction

Neutral spine or lumbo-pelvic upright sitting



Introduction

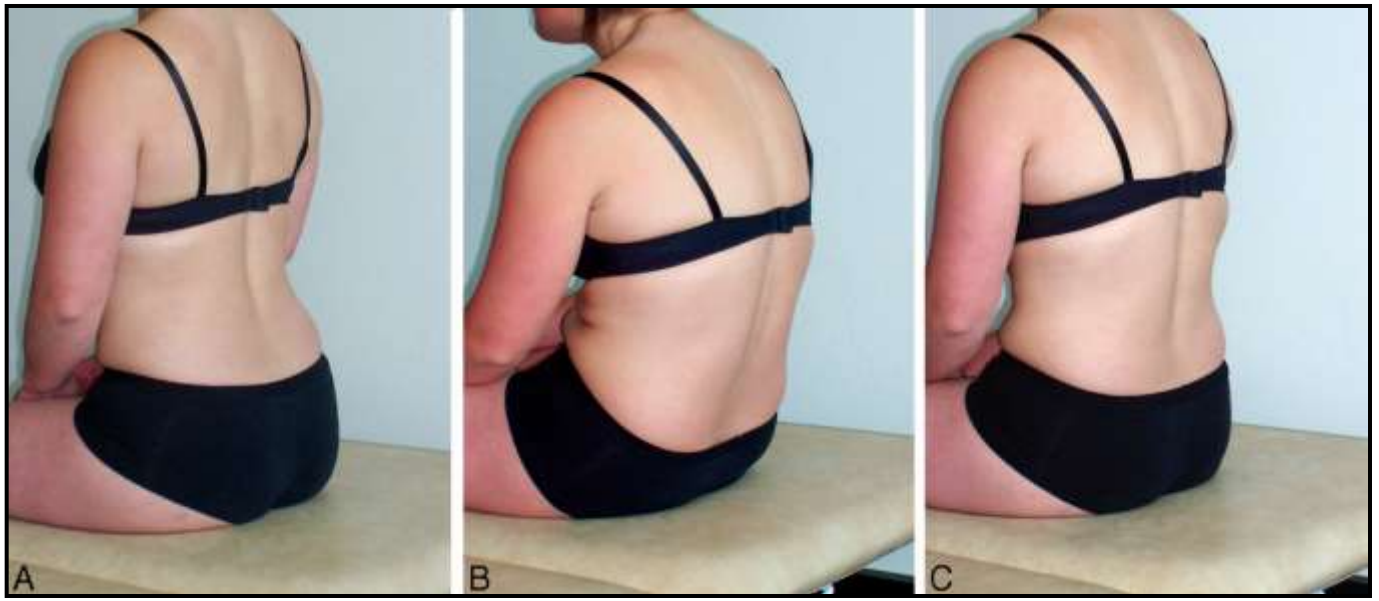
Neutral spine or lumbo-pelvic upright sitting

- Most commenly advocated ‘ideal sitting posture’ = neutral spine or lumbo-pelvic upright sitting
  - Def. ideal sitting posture:
    * Anterior rotation of pelvis
    * Lumbar spine in a ‘neutral’ lordosis
    * Relaxation of thorax

O’Sullivan et al (2002)

Introduction

Neutral spine or lumbo-pelvic upright sitting



(A) Thoracic upright sitting. (B) Slump sitting. (C) Lumbo-pelvic upright sitting

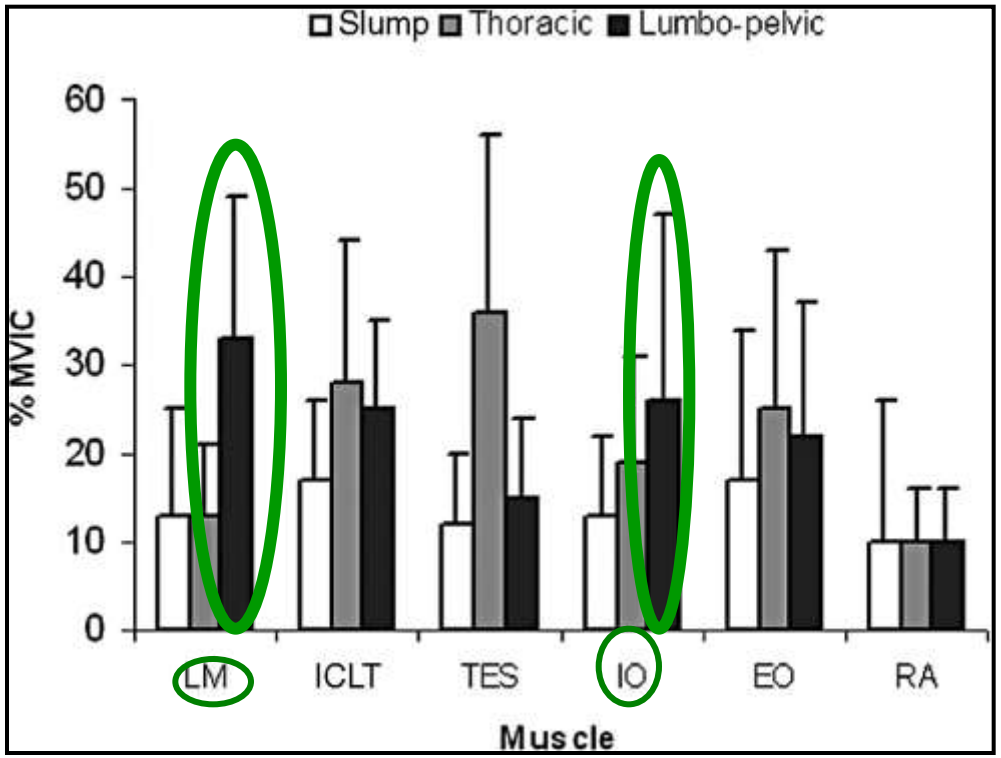
O'Sullivan et al (2006)

Introduction

The importance of lumbo-pelvic upright sitting

- In sitting, spine posture highly influences patterns of trunk muscles activity

O' Sullivan et al (2002); Dankaerts et al (2006)



Introduction

CLBP and Activation Patterns

CLBP patients: sit closer to end range

Dankaerts et al (2006)

- Extension Pattern:
  - Sit more hyperlordotic
  - Demonstrate increased muscle activity of sLM and IO vs controls
- Flexion Pattern:
  - Adopt a more slouched posture
  - Demonstrate decreased muscle acitivity of sLM and IO vs controls

Introduction

Proprioceptive control with LBP

- Loss of proprioceptive control has been associated with LBP populations

Gill & Callaghan (1998)
Koumantakis et al (2002)
O'Sullivan et al (2003)

Introduction
Repositioning Sense

- Patients with poor sitting posture lack control over lumbo-pelvic region in sitting
  - Ex: CLBP patients with a flexion pattern disorder, while seated: decreased repositioning sense compared to no-LBP controls

O'Sullivan et al (2003)

Introduction

Summary of the problem

- Problems associated with sitting and LBP

  - Sitting = common aggravating factor
  - LBP patients adopt a more end range posture
  - Lack of repositioning sense

→ Hypothesis: patients could benefit from biofeedback

Introduction

Solution of the problem: Dynamic sitting?

- During sitting on an unstable device, subjects have opportunity to move pelvis and lumbar spine. This allows adjustments to be made and stimulates a more ***dynamic*** way of sitting.

Introduction
Unstable sitting devices

- Stimulation provided by an unstable surface facilitates activation of spinal stabilizing muscles around a neutral spine position by continuous fine postural adjustments (Farell et al 2000)

  – Examples:
    * Stability ball

      (Gregory et al 2006, McGill et al 2006)
    * Saddle chair

      (Gadge & Innes 2007)
    * Sitfit®

      (O'Sullivan et al 2006)

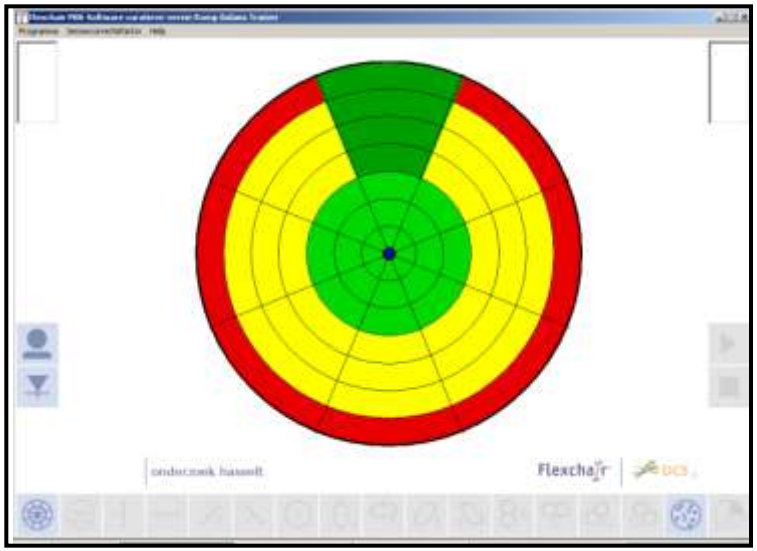
Introduction

The Flexchair®

- Dynamic sitting

- Biofeedback

combined with



Flexchair® (FC®)

- Dynamic/Active Sitting device

  promotes 'neutral sitting'?

- Registration

  online/longitudinal

- Training device

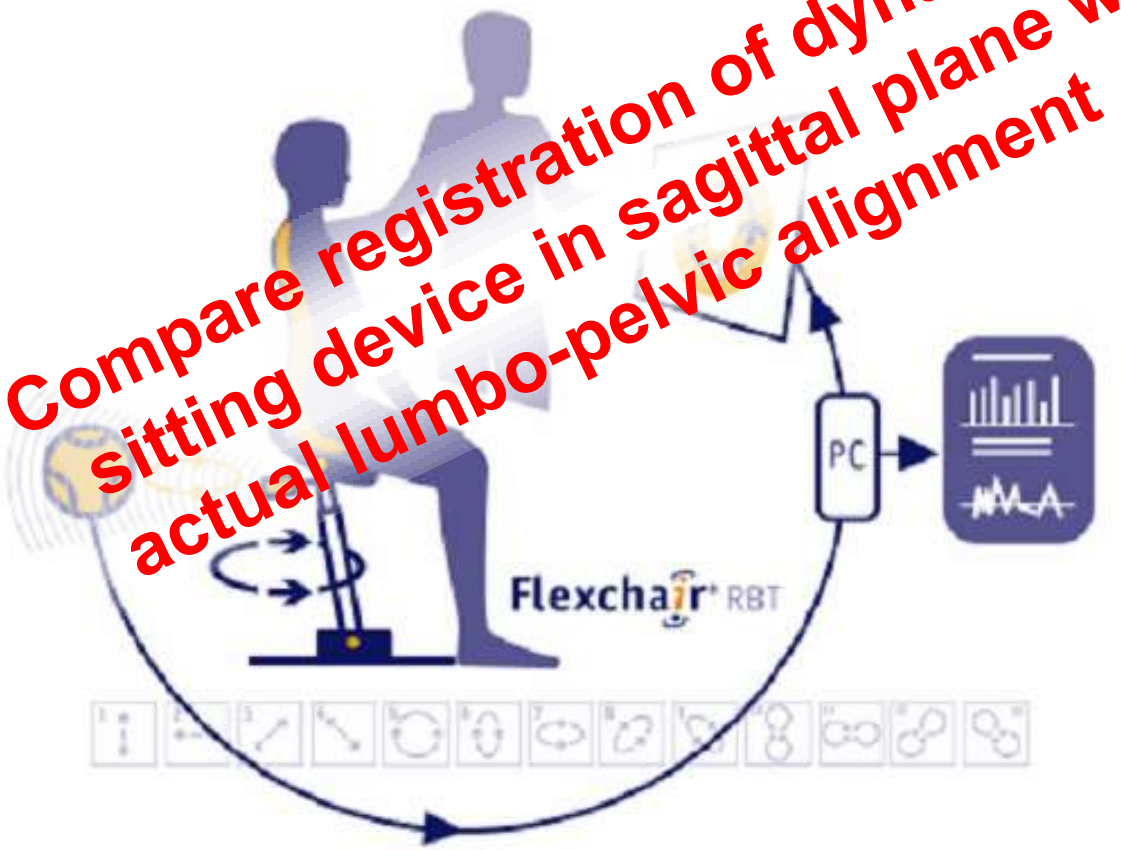
  intrinsic lumbar muscles (proprioception)

Synchronisation

- Low back alignment = FC® registration?

Introduction
Aim of Study

- Dynamic sitting +biofeedback: ***Flexchair®***



Introduction

Aim of Study

- Compare registration of dynamic sitting device in sagittal plane with actual lumbo-pelvic alignment

Second aim: to express actual range of motion at lumbar spine (L1-S2)

- ROM Flexchair® vs ROM standing vs sitting on a flat surface

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Methods

Subjects

- Fifteen healthy (no-LBP) subjects
- Exclusion criteria:
  - LBP over the last two years
  - Required medication and/or consulted with a health professional
  - Sick leave because of LBP
  - Pregnant
  - BMI >28 kg/m²
  - Recent pelvic or abdominal surgery
  - Pain in the test postures
  - Spinal disorder

Methods

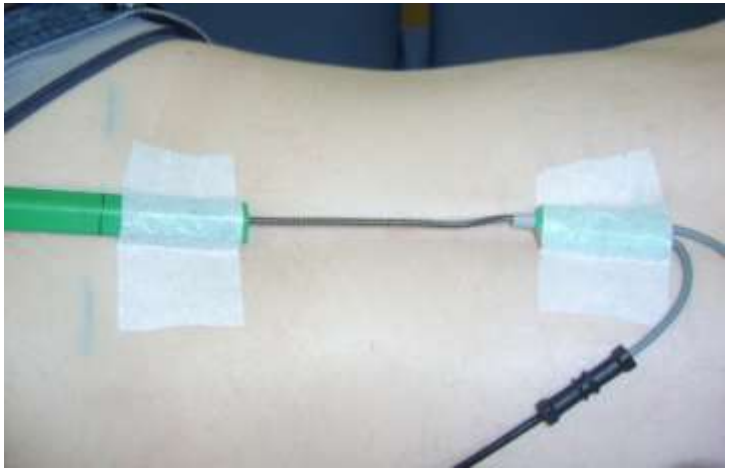
Dynamic Sitting Device (Flexchair®)

- Flexchair® accelerometer

- Three-dimensional cant mechanism
  - Suede saddle
  - Two axis

Methods
Data Collection

- Anterior/posterior low back alignment
  - A twin axis flexible electrogoniometer (EG) (Biometrics Ltd, Cwmfelinfach, Gwent, UK)
  - Centre of endblocks were placed on spinous processes of L1 and S2



Methods

Experimental Protocol: Procedure 1

Methods

Experimental Protocol: Procedure 2

Methods

Experimental Protocol: Procedure 3

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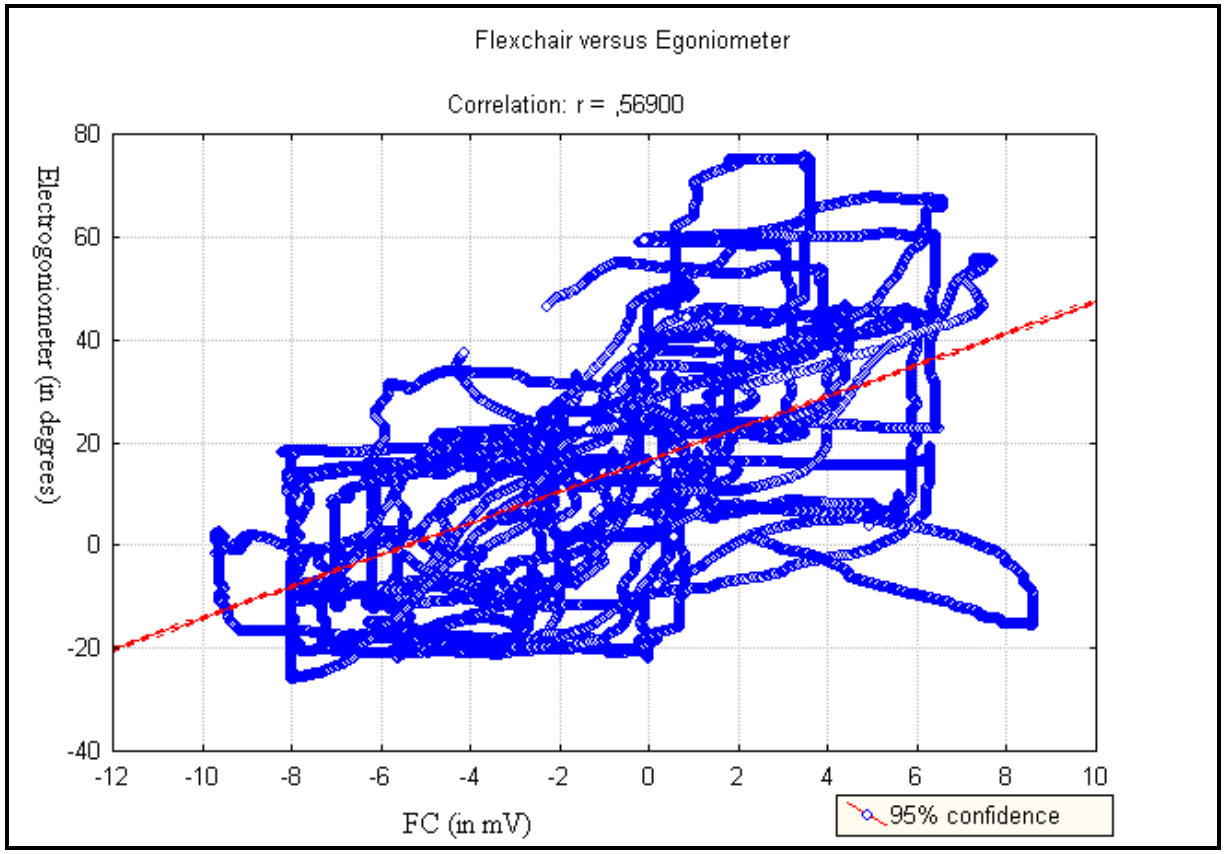
Results

Analysis 1: Correlation of FC® and EG

- Correlation of r = 0.569



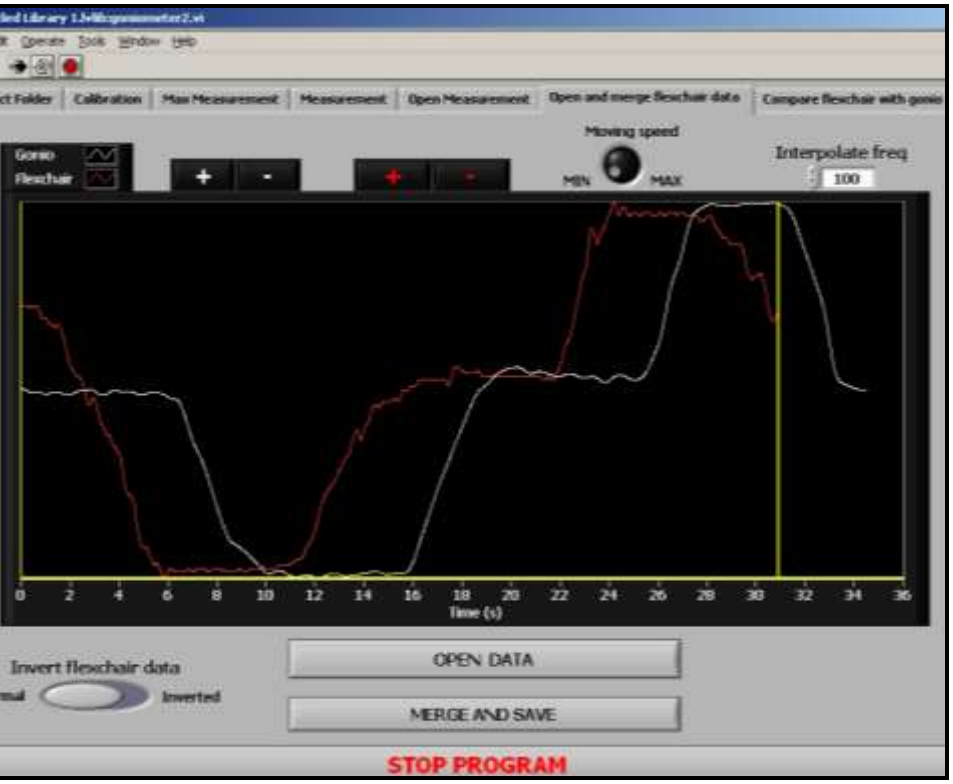
Results

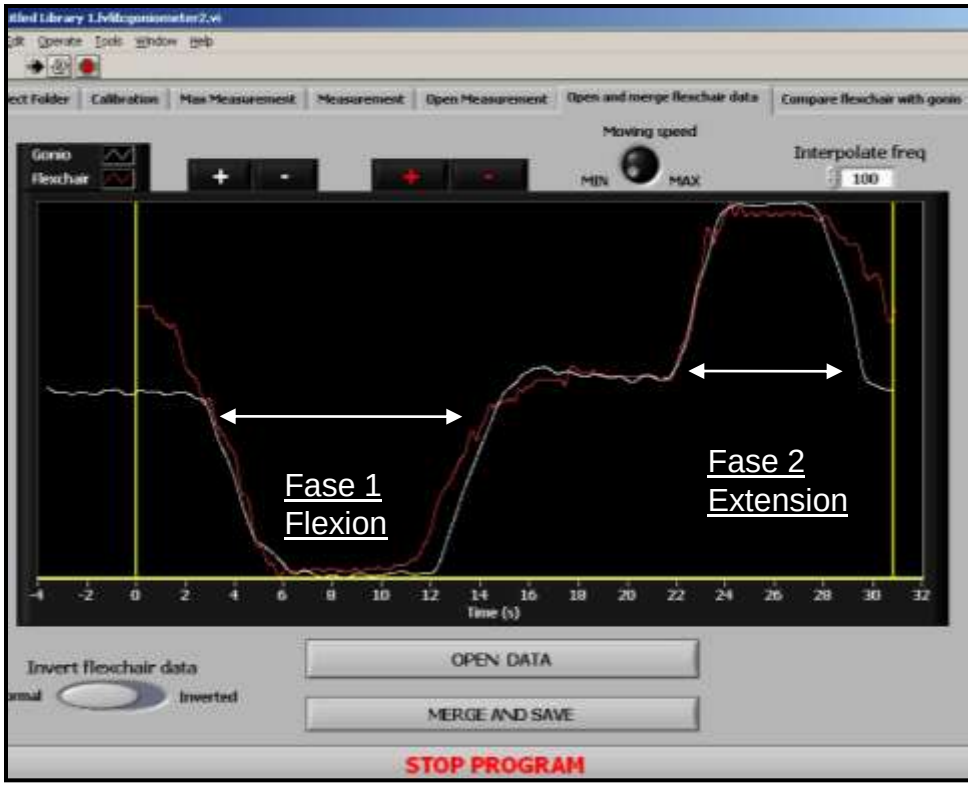
Analysis 1: Correlation of FC® and EG

- Customized software
  - Placing both graphs over each other
  - High correlation coefficients
    (min. 0.83, max. 0.97)

Results

Analysis 1: Correlation of FC® and EG





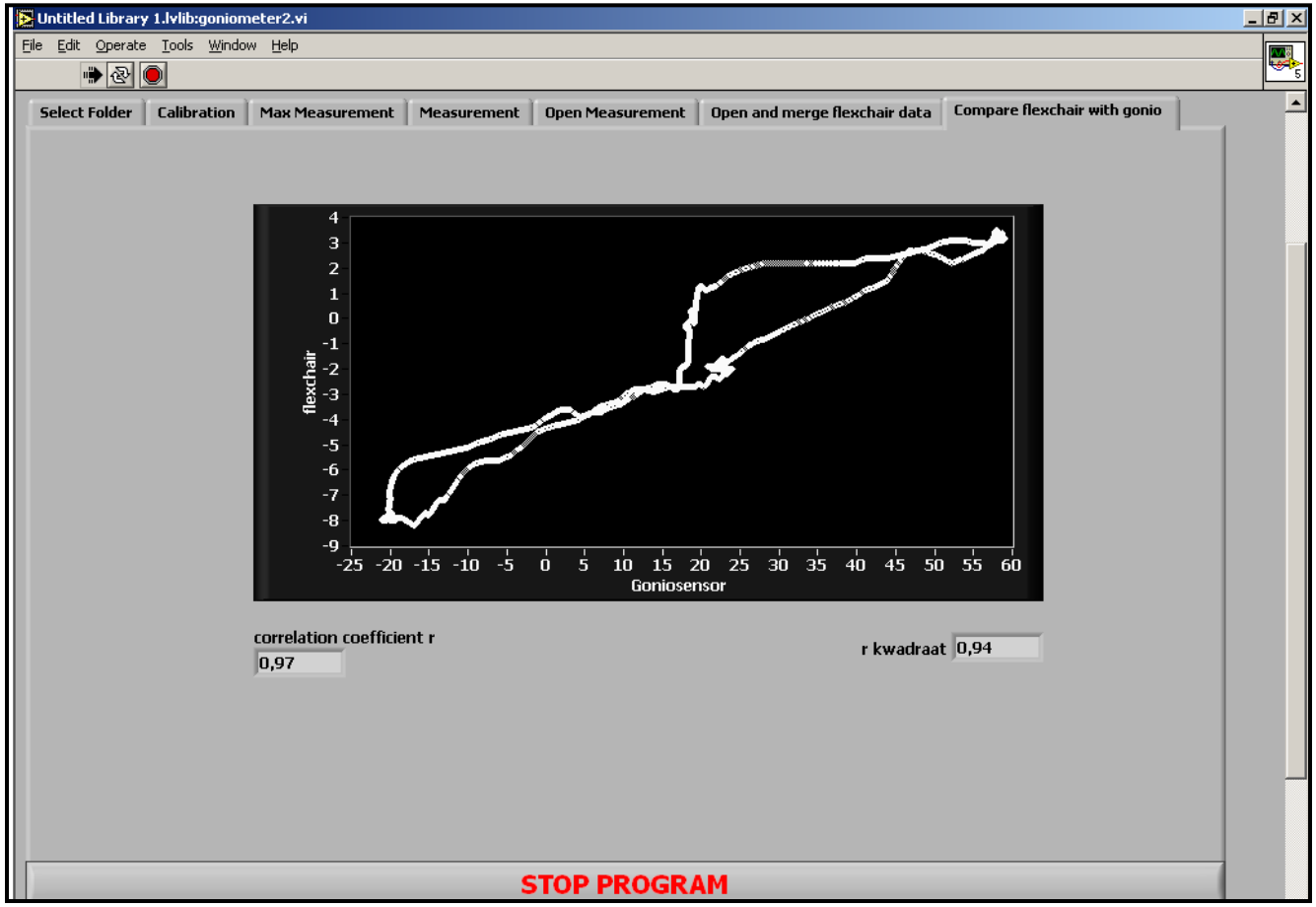
Example of applying customized software

Red graph = Flexchair®

White graph= Electrogoniometer

Results

Analysis 1: Correlation of FC® and EG



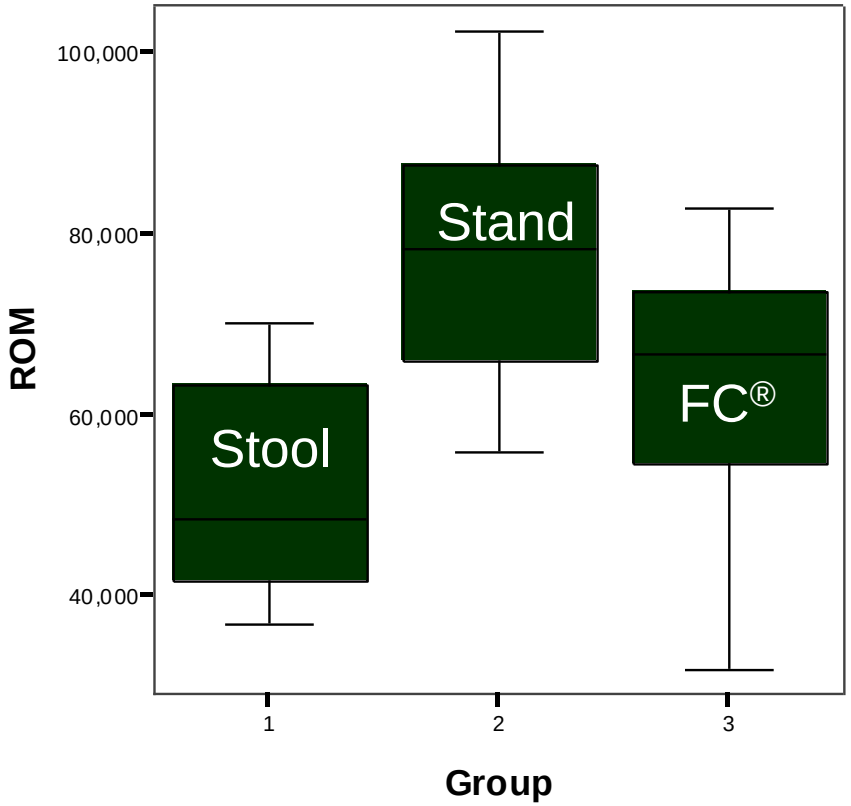
Correlation coefficient of 0.97

Example of applying customized software

Results

Analysis 2: difference in ROM

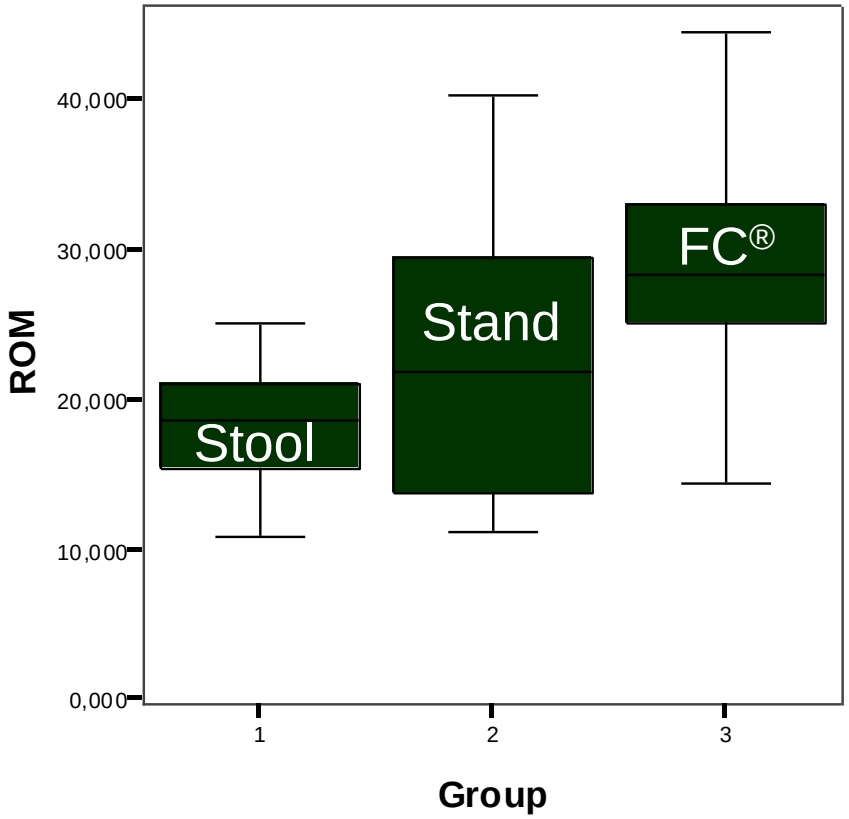
Total ROM at lumbar spine (in degrees)



Results

Analysis 2: difference in ROM

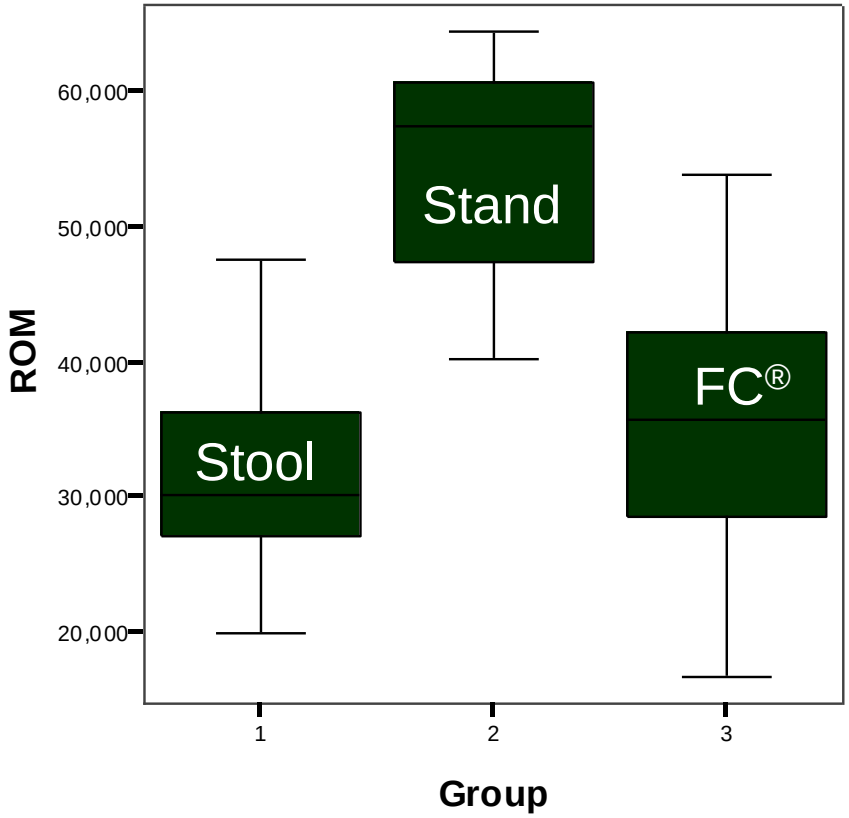
ROM Extension



Results

Analysis 2: difference in ROM

ROM Flexion



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Discussion

Analysis 1: Correlation of FC® and EG

- Supporting evidence: registration of dynamic sitting device matches actual low back alignment

Moderate correlation (r=0.57)

- Software: possible to outline graphics of EG and FC® onto each other

High correlation (r= min. 0.83, max. 0.97)

Discussion

Analysis 1: Correlation of FC® and EG

- Analysis was justified:
  - Visual inspection: delay in movement of chair vs movement of low back during 2nd phase
    * Lower back moves first and Flexchair® shows inertion to movement of lower back
    * Flexchair®: moving against gravity → more difficult

Discussion

Analysis 2: difference in ROM

- ROM in standing is larger then in sitting on a flat surface and on Flexchair®, because of fixation of pelvis
- Dynamic sitting device allows a larger mobility in the lower back compared to a normal, flat sitting device
- Use of neutral zone from calibration: people with a lack of repositioning sense could have had false flexion/extension ratios

Discussion

Limitations and recommendations

- Limitations:
  - Use of an external device to measure movement
  - Limitation of electrogoniometer (length of coil)

- Further research :
  - Use of FC® for evaluation and rehabilitation of specific low back muscle performance characteristic (e.g.: proprioception) in patients with LBP
  - Use of feedback mechanism during prolonged sitting and its influence on LBP
  - Development of a marker to match both data on a more accurate starting point

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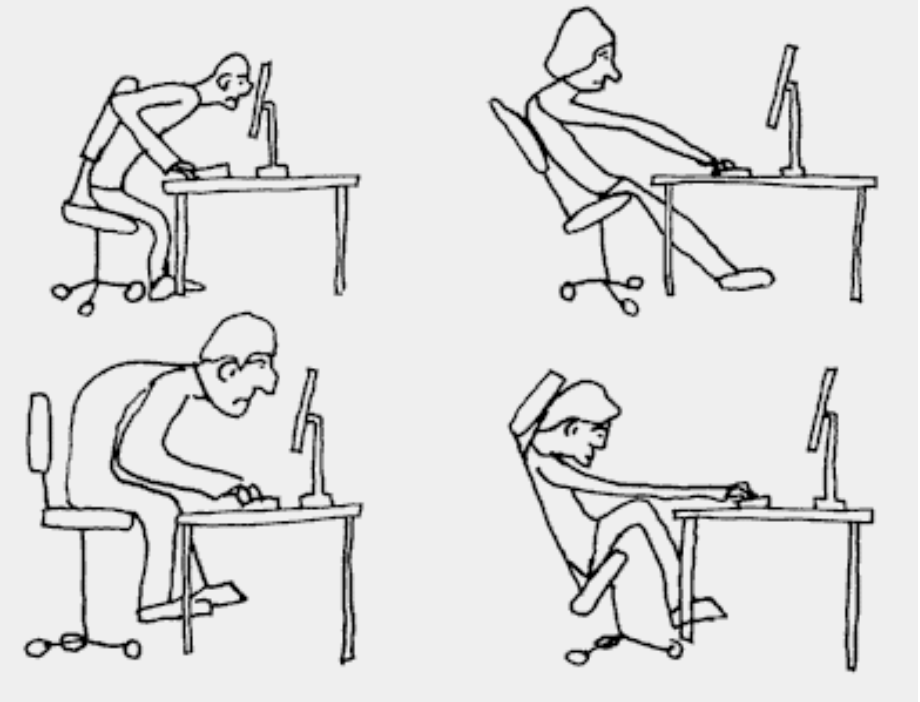
Conclusion

- 1st time evidence:
  - Moderate to high correlation between registration of Flexchair® during a dynamic sitting task in sagittal plane and actual low back alignment
  - No significant difference between total ROM while sitting on a flat surface and sitting on FC® (significant difference in extension)

Conclusion

- Future work investigating Flexchair® as a novel dynamic sitting and training device in a more clinical setting is justified



Flexchair®

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