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?

doctor Pieter-Jan Flamaing
Esther Groenen

o.l.v. Prof. Dr. W. Dankaerts, promotor
Prof. Dr. M. Granitzer, copromotor
Prof. Dr. R. Meesen, copromotor
Prof. Dr. L. Van Etten, copromotor
CONTENTS

1. INTRODUCTION

2. METHODS

3. RESULTS

4. DISCUSSION

5. CONCLUSION
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

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)
• 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)
• 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

![Diagram showing the relationship between resistance (weitstand) and movement (flexie) with different zones for elastic and neutral positions.]
Most commonly 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

Introduction

Neutral spine or lumbo-pelvic upright sitting

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

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

Introduction

CLBP and Activation Patterns

CLBP patients: sit closer to end range


• 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 activity of sLM and IO vs controls
• Loss of proprioceptive control has been associated with LBP populations

  Gill & Callaghan (1998)
• 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

• 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
• 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.
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?
• Dynamic sitting + biofeedback: *Flexchair®*

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

1. INTRODUCTION

2. METHODS

3. RESULTS

4. DISCUSSION

5. CONCLUSION
• 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
CONTENTS

1. INTRODUCTION

2. METHODS

3. RESULTS

4. DISCUSSION

5. CONCLUSION
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
Total ROM at lumbar spine (in degrees)
Results
Analysis 2: difference in ROM

ROM Extension

![Graph showing ROM extension with groups labeled Stand, Stool, and FC®. The graph compares ROM values across different groups.](phl.be)
Results
Analysis 2: difference in ROM

ROM Flexion

<table>
<thead>
<tr>
<th>Group</th>
<th>Stool</th>
<th>Stand</th>
<th>FC®</th>
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CONTENTS

1. INTRODUCTION
2. METHODS
3. RESULTS
4. DISCUSSION
5. CONCLUSION
• 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 2\textsuperscript{nd} phase
    * Lower back moves first and Flexchair® shows inertion to movement of lower back
    * Flexchair®: moving against gravity $\rightarrow$ more difficult
Discussion
Analysis 2: difference in ROM

- ROM in standing is larger than 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
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
CONTENTS

1. INTRODUCTION
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3. RESULTS
4. DISCUSSION
5. CONCLUSION
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.