Experience with the Dynesys system

14th Argospine

Gilles G. Dubois, Clinique de l’Union
Agenda

1. Concept
2. Biomechanics
3. Disc healing
4. Clinical results
In the Natural Course of Spinal Degeneration...

…the functional tripod (disc and facets) goes through several stages of dysstability:
From failure of the paraspinal muscles
To failure of the disc
to arthritis of the facets, subsiding of the upper vertebra into the lower one
and finally stenosis or fused deformation

In the stages of degeneration where troubles are caused by discovertebral dyskinesis that is characteristic for the degenerative stages between failure of the disc and fused deformation, a dynamic neutralization of the dyskinesis provides distinct benefits:
It may slow down the degenerative cascade and even promote a healing of disc and endplate.
In the course of this evolution, discovertebral dyskinesia can be induced, less important in hypomobility (intradiscal gas)...
...and more affecting in the segments with normal disc heights where shifting of the vertebrae occurs (spondylolisthesis or retrolisthesis).
This instable phases also cause secondary compression phenomena like articular cysts - or due to dynamical stenosis.
Dynesys Design Rationale

• Neutralizes *discovertebral dyskinesis*

• Brings the *destabilized structures* in the vertebral tripod to a more anatomical condition

This results in a controlled range of motion while discovertebral dyskinesis is suppressed.
Agenda

1. Concept
   1. Biomechanics
      1. Disc healing
   2. Clinical results
Kinematics analysis

Methods:
- forces introduced by two anterior and two posterior cords
- magnetic tracking system
- measurement of the kinematics in the situations:
  - intact
  - after artificial instabilization
  - implant

Goal:
- study the effect of the implant on the kinematic of the human spine
Kinematics analysis
Maximal Flexion (normalized in respect to intact)

ROM [%]

flexion-extension in [Degree] | anterior-posterior in [mm] | caudal-cranial in [mm]
---|---|---
intact | Voydeville | DYNESYS | Fixator
1.5 | 1.5 | 1.7 | 1.3 | 0.6 | 0.4 | 0.3

Freudiger
Archives of orthopaedic and trauma surgery; 1999; vol 119
“Dynamic Neutralisation of the lumbar spine confirmed on a new lumbar spine simulator in vitro”
Kinematics analysis
Maximal Extension
(normalized in respect to intact)

ROM [%]

flexion-extension in [Degree] 0.1
anterior-posterior in [mm] 0.7
caudal-cranial in [mm] 0.6

Freudiger

Archives of oethopaedic and trauma surger; 1999; vol 119
“Dynamic Neutralisation of the lumbar spine confirmed on a new lumbar spine simulator in vitro”
Kinematics analysis

Courtesy of Goertzen et al.


“Dynamic stabilization of the lumbar spine and its effects on adjacent segments: an in vitro experiment.”
Kinematics analysis

Courtesy of Goertzen et al.

“Dynamic stabilization of the lumbar spine and its effects on adjacent segments: an in vitro experiment.”
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Courtesy of Goertzen et al.

Schmoelz W  
“Dynamic stabilization of the lumbar spine and its effects on adjacent segments: an in vitro experiment.”
Kinematics analysis

“Dynamic stabilization of the lumbar spine and its effects on adjacent segments: an in vitro experiment.”
“Influence of dynamic stabilization system on load bearing of a bridged disc: an in vitro study of intradiscal pressure”
Disc Pressure

RIGID

HYBRID

unaltered

L3

L4

L5

S1

20%↑

50%↓

65%↓

10%↑

50%↓

65%↓

Courtesy of Cavanilles-Walker JM, Roca J / Hospital Universitari Germans Trias i Pujol / Badalona, Spain

Niosi
Eur Spine Journal 2006, jun 15; 913-922
“Biomechanical characterization of the three dimensional kinematic behavior of Dynesys”

Schmoetlz
Journal of Orthopaedic disorders & technique
“Dynamic stabilization of the lumbar spine and its effects on adjacent segments: an in vitro experiment”

Cheng
Spine 2007; vol 32
“Immediate biomechanical effects of lumbar posterior dynamic stabilization above a circumferential fusion”
• Two level hybrid construct:
  
  – The increase of IDP at the upper adjacent segment to a dynamic instrumentation is less than in rigid constructs

  – The raise of IDP at the adjacent segment to a rigid instrumented segment can be neutralized when this is augmented with a dynamic stabilization device

Courtesy of Cavanilles-Walker JM, Roca J / Hospital Universitari Germans Trias i Pujol / Badalona, Spain

Nosisi  Eur Spine Journal 2006, jun 15; 913-922
   “Biomechanical characterization of the three dimensional kinematic behavior of Dynesys”

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   “Dynamic stabilization of the lumbar spine and its effects on adjacent segments: an in vitro experiment”

Cheng  Spine 2007; vol 32
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   1. Clinical results
6 years after dynamic neutralization, a marked improvement of the situation has taken place.

Kumar et al., *Spine* 2008
“Quantitative assessment of intervertebral disc glycosaminoglycan distribution by gadolinium-enhanced MRI in orthopedic patients”

Vaga et al., *European Spine Journal* 2009
“Regeneration of extracellular matrix”

“Cytokines and growth factors in the protuded intervertebral disc”
Healing Process

MRI preoperatively (top) and 5m postoperatively (bottom).

Dynamic Neutralization facilitated healing of the inflammatory lesions in the endplates of L4/L5.
dGEMRIC protocol

dGEMRIC → delayed Gadolinium Enhanced Magnetic Resonance Imaging of Cartilage

GAG → anionic molecules

anionic contrast agent subministration (Gd-DTPA)

contrast agent distributes in cartilage inversely to the concentration of negatively charged GAG

MRI measures GAG concentration

Courtesy of Claudio Lamartina / Galeazzi Istituto Milano / Italy
Methods – Data analysis

T1 pre-contrast

ΔT1

T1 post-contrast

subtraction

Courtesy of Claudio Lamartina / Galeazzi Istituto Milano / Italy
Results

DYNEYS 02

ΔT1 pre-intervento  ΔT1 6 mesi  ΔT1 2 anni

L3-L4

Dynesys

Courtesy of Claudio Lamartina / Galeazzi Istituto Milano / Italy
Cytokines and growth factors in the protruded intervertebral disc of the lumbar spine

TGF-β

IL-6

degenerative disc disease

NGF

coll.-I
Clinical series of 112 patients who underwent dynamic neutralization with the Dynesys system

- 14/112 patients (min. FU: 1 yr.) showed “interesting” MRI changes:
  - disappearance of the Modic’ sign
  - increase in the T2-weighted MRI signal intensity of the nucleus

- In 5 of these patients a bioptic sample of the treated disc was collected and histologically analysed
## Results overview

<table>
<thead>
<tr>
<th></th>
<th>DDD</th>
<th>Dynesys</th>
</tr>
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<tbody>
<tr>
<td># cell/unit area</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td># clusters/unit area</td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>alcian blue</td>
<td>+/−</td>
<td>++</td>
</tr>
<tr>
<td>coll.-I</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>coll.-II</td>
<td>+</td>
<td>+++</td>
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<tr>
<td>orientation of coll. fibres</td>
<td>+/−</td>
<td>++</td>
</tr>
<tr>
<td>chondroitin-4-sulphate</td>
<td>+</td>
<td>+++</td>
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<tr>
<td>S-100</td>
<td>++</td>
<td>++</td>
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<tr>
<td>NGF</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>IGF-1</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>IL-6</td>
<td>+++</td>
<td>−</td>
</tr>
<tr>
<td>IL-6R</td>
<td>+++</td>
<td>−</td>
</tr>
<tr>
<td>TGF-β</td>
<td>+++</td>
<td>−</td>
</tr>
<tr>
<td>α-actin</td>
<td>+++</td>
<td>−/+</td>
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</tbody>
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Courtesy of Nicola Specchia / Italy
Degenerated disc is made of a fibrous-cartilaginous tissue rich in micro-vessels, cells, cytokines and growth factors, and poor in PGs, water and type II-collagen.

Neutralized disc is made of a fibrous-cartilaginous tissue rich in PGs, water and type II-collagen, and poor in cells, cytokines, growth factors, and micro-vessels.

Neutralized disc seems to be similar to a normal disc.

Courtesy of Nicola Specchia / Italy
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Fusion and Adjacent Segment Disease

ASD rates


### Fusion and Adjacent Segment Disease

#### ASD Other revision rates

<p>| | | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Etebar</td>
<td>14%</td>
<td>4 years</td>
</tr>
<tr>
<td>Gillet</td>
<td>20%</td>
<td>5 years</td>
</tr>
<tr>
<td>Ghiselli</td>
<td>36%</td>
<td>10 years</td>
</tr>
</tbody>
</table>
Posterior Dynamic stabilization and Adjacent Segment Disease

ASD rates

(1) J.C Huot – Dynesys experience with 183 cases

Dynamic Stabilization of the lumbar spine

(2) Stoll - The dynamic neutralization system for the spine: a multi-center study of a novel non-fusion system

European Spine Journal, 2002, 11

(3) Stoll - The dynamic neutralization system for the spine: a multi-center study of a novel non-fusion system

GIEDA 2006, Paris
Adaptative treatment & Adjacent Segment Disease

- **Indications**
  - Topping-off above a fused segment

- **Clinical results**

<table>
<thead>
<tr>
<th></th>
<th>Pre-op</th>
<th>39.2 month Post op</th>
</tr>
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<tbody>
<tr>
<td>ODI</td>
<td>51.6%</td>
<td>28.6%</td>
</tr>
<tr>
<td>Back Pain (VAS)</td>
<td>7.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Leg pain (VAS)</td>
<td>6.0</td>
<td>2.3</td>
</tr>
</tbody>
</table>

ASD rates

(1) Schwarzenbach – Clinical results with Dynesys
ISSMISS 2005, Zurich
Thank you for your attention!

Hôtel Dieu, Toulouse