



The background image shows the modern, multi-story Tzaneio Hospital building in Piraeus, Greece. The building is white with many windows and a prominent sign on the roof that reads "ΤΖΑΝΕΙΟ ΝΟΣΟΚΟΜΕΙΟ". There are trees in the foreground and a clear blue sky.

Bracing for EOS

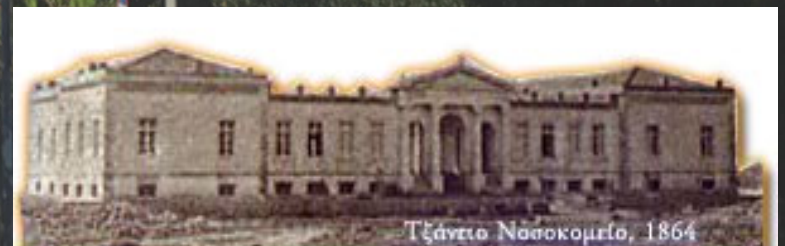
Dr Theodoros B. GRIVAS, MD PhD

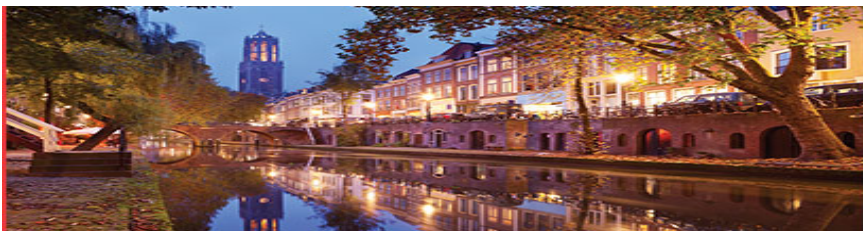
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**ICEOS
2016**
Utrecht Holland

10th International
Congress on Early
Onset Scoliosis
**November
17 & 18, 2016**

Department of Trauma and Orthopaedics, "Tzaneio" General Hospital of
Piraeus , Greece

**no
disclosures**



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Overview

- **Introduction**
- **General objectives of brace treatment in EOS**
- **Indications - contraindications**
 - For EOS (*IIS, JIS*)
 - Brace Indications for *congenital scoliosis*
 - Brace Indications for *neuromuscular scoliosis*
- **Bracing concepts and techniques**
- **Principle of correction** (*brace biomechanics -Value of in-brace correction – full /part time bracing*)
- **Physiotherapeutic Scoliosis Specific Exercises (PSSE)**
- **Assessment of outcomes**
- **Brace treatment management** (*The team role and the importance of compliance and brace wear monitoring*)
- **When switching to surgery from bracing ?**
- **progress in bracing best practice** (*imaging – construction – finite element models, QoL*)
- **Core/key message(s) of the lecture**
- **Suggested Literature**



Introduction

Today EOS non-operative measures mainly consist of: Casting, Bracing & PSSE (Physiotherapy)

1. now for bracing there is

- a. **evidence** (BrAIST study) that bracing significantly decreased the progression of AIS curves to the threshold for surgery,
- b. **a lot of documentation** for juvenile IS &
- c. **less for IIS**

2. the literature recently **aims to provide evidence** that *physiotherapeutic scoliosis specific exercises* (PSSE) influence the natural history of IS



General objectives of brace treatment in EOS

1. achieve maximum **spine growth & length**,
maintain it flexible & avoid fusion
2. **arrest curve progression** or possibly even
reduce it
3. achieve **optimal lung growth & respiratory
function**
4. **maintain or restore sagittal & coronal balance**
5. **minimize hospitalizations & procedures**



Brace Indications in IIS

In IIS casting should be considered as the preferred treatment

bracing **Indications** are most likely restricted

- **after serial cast treatment**
- **in infants** *in specific conditions*
 - a. who do not tolerate casting*
 - b. with gastro-esophageal reflux*
 - c. severe eczema*
 - d. severe sleep apnea*
- **where casting is not available**

Full-time brace treatment of progressive or persistent IIS may then be appropriate



bracing contra-indications in IIS -1

certain curve locations

upper thoracic curves

triple curves

curves at the lumbo–sacral junction

very large curves

thoracic lordosis

advanced chest deformity



bracing contra-indications in IIS - 2

medical & psychological conditions

- severe gastro - oesophageal reflux
- failure to thrive or anorexia nervosa
- patients w/ severe asthma
- Patients w/ difficulties w/ temperature regulation
- severe eczema or other skin conditions

In family 1.ambivalence toward treatment or

2.failure to be supportive of the braced child



Brace Indications in Juvenile IS

early bracing of moderate JIS curves

Cobb angle $> 20^\circ$

likelihood of curve progression

-By placing the growing spine under straighter mechanical load there is the assumption that progression is less likely during the preadolescent period of rapid growth

Emans 2011, Winter 2000, Haderspeck & Schultz 1981, Schultz 1984, Schultz & Hirsch 1974

(SoR : B) (SoE: IV) Negrini et al , Scoliosis, 2012



Brace Indications in Juvenile IS

2006

Scoliosis



Open Access

Methodology

Indications for conservative management of scoliosis (guidelines)

SOSORT guideline committee, Hans-Rudolf Weiss^{*†1}, Stefano Negrini^{†2}, Manuel Rigo³, Tomasz Kotwicki⁴, Martha C Hawes^{†5}, Theodoros B Grivas⁶, Toru Maruyama⁷ and Franz Landauer⁸

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Scoliosis 2006, 11:5 doi:10.1186/1748-7161-11-5

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The estimation of
the prognostic
risk (progression
factor)

(Lonstein & Carlson 1984)

$$\frac{\text{Cobb Angle} - (3 \times \text{Risser sign})}{\text{Chronological age}}$$



Brace Indications for congenital scoliosis

The treatment is primarily surgical Bracing usually is ineffective in congenital scoliosis

Non-operative treatment

1. observation of the curve or
2. bracing

Observation only for non-progressive balanced curves

Bracing may be indicated for :

- long flexible curves
- controlling compensatory lumbar curves
- helping to rebalance the spine
- for post-operative use until the fusion is solid



Brace Indications for *neuromuscular scoliosis*

usually is not helpful, &
when used is **functional bracing** externally supporting the spine allowing the patient to be more functional

The **aim** is to

1. maximize functional positioning by controlling some of the spinal collapse
2. improving posture &
3. facilitating seating

bracing is contraindicated

1. when **compromising what is left as a respiratory reserve**
2. **limit gastric motility, worsening the nutritional status**
3. **uncontrollable behavioral problems**



Brace Indications in EOS

EOS associated with

Syringomyelia,

Chiari malformation

Tethered spinal cord

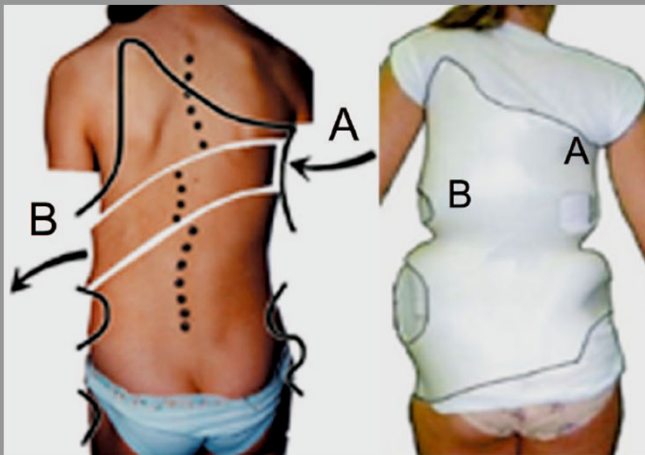
should also be considered for brace treatment



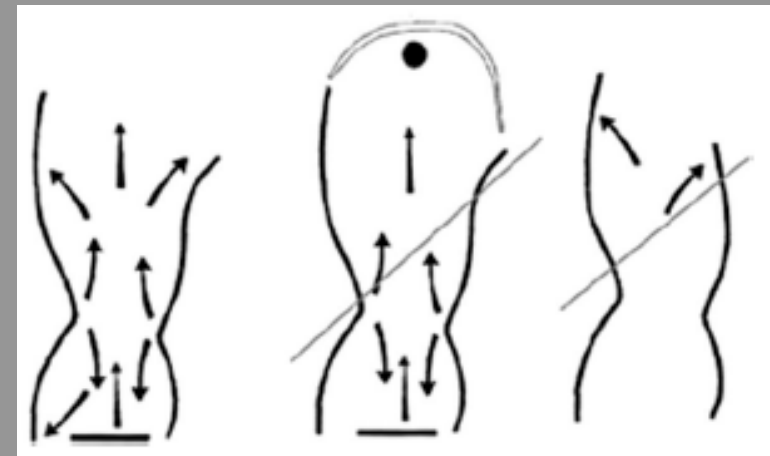
Brace Biomechanics

Passive mechanisms

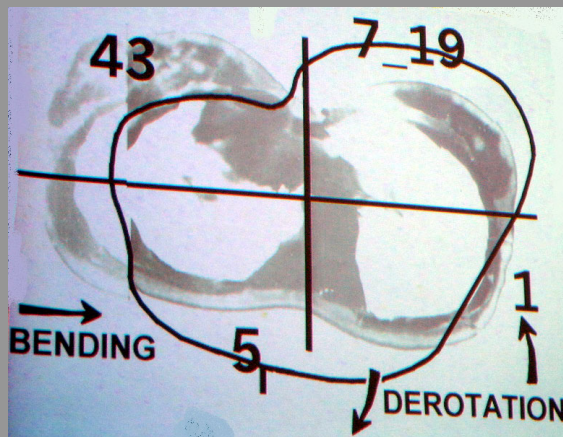
convex to concave tissue transfer



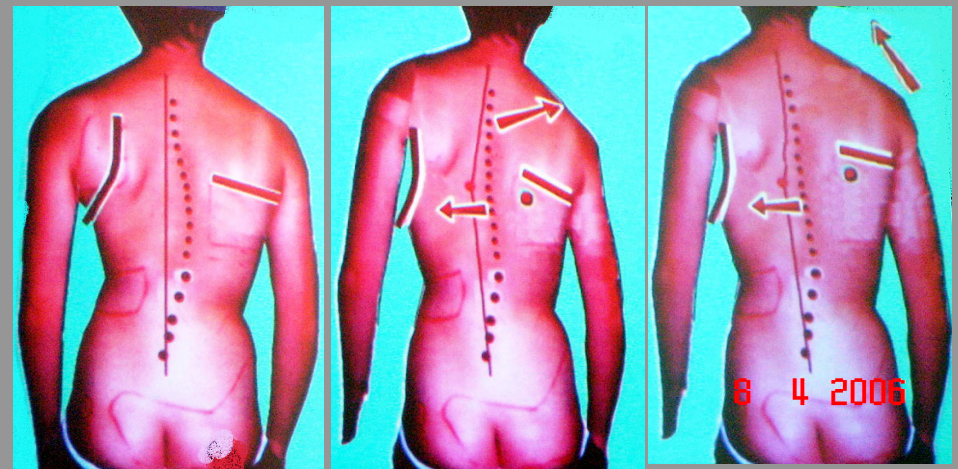
elongation & unloading



Derotation of the thorax



Bending

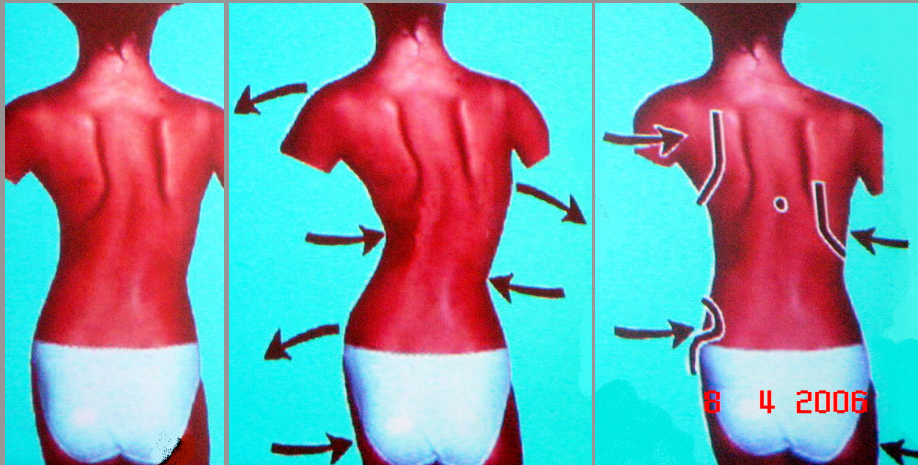




Brace Biomechanics

Active mechanisms

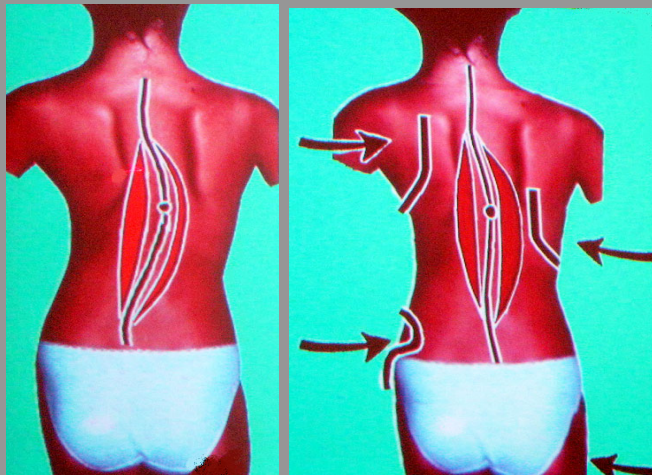
vertebral growth



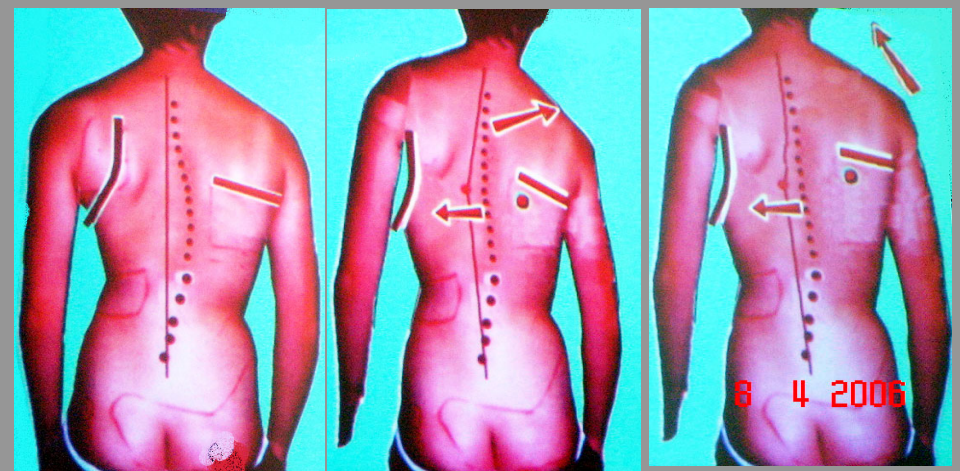
asymmetrically guided respiratory movements of R-G



"repositioning" of the trunk muscles



Bending & anti-gravitational effect





Bracing concepts and techniques

Manuals & technical details

1) European Bracing systems are available **online** at the Brace Technology thematic Series in ***Scoliosis & Spinal Disorders Journal***: <http://www.biomedcentral.com/collections/brace-technology>

2) North American bracing systems (Milwaukee, Boston, Charleston, Providence, and Charleston) are available **online** at the **SRS / brace manuals** http://www.srs.org/professionals/bracing_manuals/



Value of in-brace correction

1. distinguish an **effective** from an **ineffective** brace
2. understand the **biomechanics of the brace** – adjust **strap tension**
3. **flexibility** of the spine
4. the immediate “in brace” correction predicts the outcomes

50% **immediate “in brace” correction** is expected for thoracic or single T-L juvenile curves (Emans 2011)



Full vs. part-time bracing

Usually the prescription is **full time** (20-22 hours) & then **part time** is instituted w/ close observation:

1. *When the curve is controlled*
(reduced ≤ 15 degrees Cobb angle)
2. *When RVAD decrease toward zero or become negative* w/ bracing



Physiotherapeutic Scoliosis Specific Exercises (PSSE)

- a. for JIS – older EOS children & during bracing or
- b. as stand alone treatment in mild curves

Characteristics common to PSSE approaches include:

- auto-correction in 3D
- training in activities-of-daily-living (ADL)
- stabilizing the corrected posture
- patient education

Information for the various schools of PSSE are available online at the Rehabilitation schools for scoliosis thematic Series in *Scoliosis and Spinal Disorders* Journal:

<http://www.biomedcentral.com/collections/rehabilitation-schools>



Assessment of outcomes

a) the spinal deformity

Cobb angle, (PA radiographs in & out of the brace)
degrees of rotation,
sagittal & frontal plane balance

b) The thoracic deformity

double rib contour sign (BRCS)
rib index
RVA –RVAD Apical & segmental (T1-T12)
thoracic ratios

c) The aesthetics

TRACE index
POTSI,
ATSI

d) The quality of life

Using *disease specific measures of QoL* (questionnaires) (the Brace Questionnaire (BrQ), Scoliosis Research Society 22 (SRS-22), & Bad Sobernheim Stress Questionnaire (BSSQ))



When moving to surgery from bracing ?

It is suggest that **the decision to switch to surgical treatment** should be based

- 1.more **on progression & severity of the thoracic deformity *than the magnitude of spinal deformity***
- 2.if continued brace treatment will **cause a more extensive spinal fusion at a later stage**



Bracing treatment management

factors for treatment success

1. brace quality
2. patient selection (indications and limitation)
3. the team approach (SOSORT published guidelines on 'Standards of management of idiopathic scoliosis with corrective braces in everyday clinics & in clinical research')

The team consists of an
Orthopaedic surgeon,
Orthotist,
properly trained **physiotherapist**
psychologist
the family members

4. standardization of a curve classification system

Negrini et al. 2011 SOSORT guidelines: Orthopaedic and Rehabilitation treatment of idiopathic scoliosis during growth. Scoliosis. 2012; 7: 3.



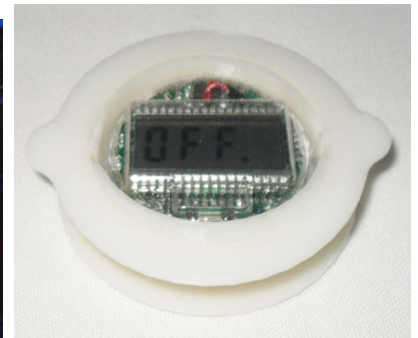
Bracing treatment management

The importance of compliance & brace-ware monitoring

Additionally the installation of a **monitoring device** in the brace increases dramatically the compliance and consequently the brace efficacy

For the **standards of management** SOSORT reported a set of **14 recommendations**, grouped in **6 Domains** namely:

1. Experience/competence
2. Behaviours
3. Prescription
4. Construction
5. Brace Check
6. Follow-up



Negrini et al. 2011 SOSORT guidelines: Orthopaedic and Rehabilitation treatment of idiopathic scoliosis during growth. Scoliosis. 2012; 7: 3.



The future

- **Imaging** (use of EOS machine –using low-dose acquisition 3-D images & ultrasound spinal imaging)
- **Brace Construction** (based on patient-specific finite element models (FEM), now is possible to biomechanically analyze the effectiveness of braces in 3D)
- **New QoL tools** (based on Rasch analysis, have been proposed recently, like the SRS-7 and ISYQOL)
- **explore biomechanically & clinically the viscoelastic characteristics of the deformed spine & thorax**



Core/key message(s) of the lecture

1. Orthotic treatment is a useful adjunct to cast treatment of IIS
2. There are non-operative treatment options for early stages of progressive EOS
3. The brace biomechanics knowledge is inextricably connected w/ brace indications for EOS treatment
4. Bracing usually is ineffective in congenital scoliosis
5. Bracing in neuromuscular scoliosis is usually not helpful but *when used is "functional bracing" allowing the patient to be more functional*
6. Bracing can cause irrevocable harm to the growing thorax if pressure is inappropriately applied or continued too long in spite of worsening thoracic deformity

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Thank you for your attention

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