

# CONSERVATIVE TREATMENT OF SCOLIOSIS

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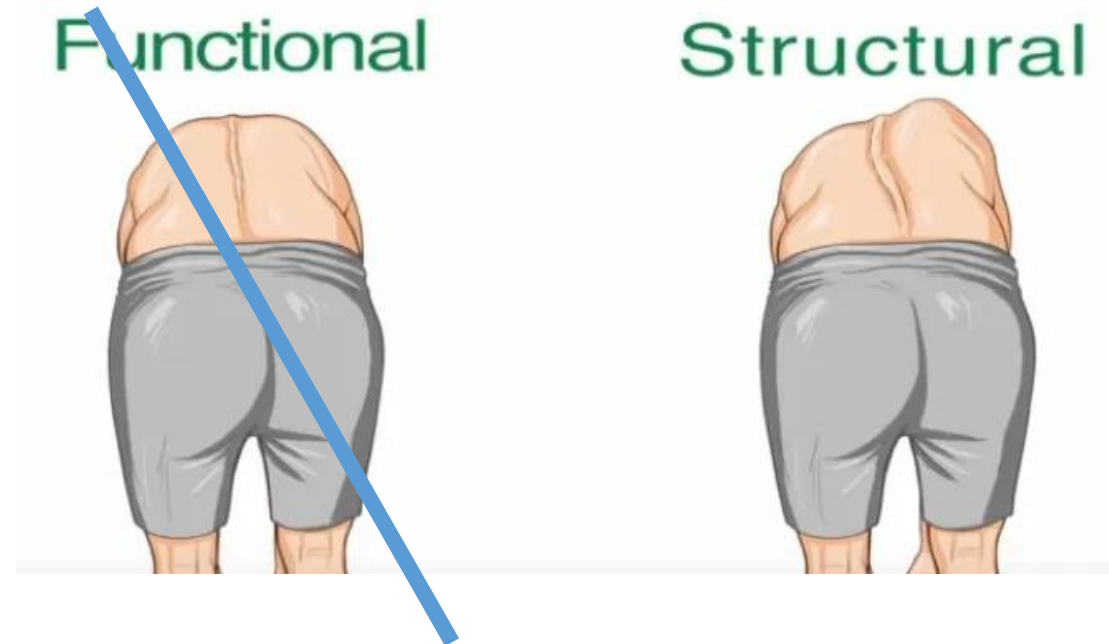


# DISCLOSURE

There are no conflicts of interest and  
nothing to disclose.

# Structural scoliosis

- Differentiate from functional (nonstructural) scoliosis - due to extraspinal causes
- 3D deformity – taking care of all three planes
- 80% idiopathic scoliosis – no specific cause
- 20% secondary scoliosis – due to different pathologies (e.g. neuromuscular scoliosis, congenital deformities)



# Idiopathic scoliosis

## □ Etiology unclear

- Genetics
- Collagen function
- Oestrogen receptors
- Systemic disorders
- Melatonin levels
- Calmodulin levels



**What Causes Scoliosis?**

# Idiopathic scoliosis

## *Definition and epidemiology*

- Cobb angle above  $10^\circ$  and/or vertebral rotation
- *Periods of growth spurt:*
  1. the first months of life, generally between 6 and 24 months,
  2. between the age of 5 and 8 years,
  3. at puberty (height peak growth), generally at age 11 to 14 years of life
- More girls are affected (5.4:1 for curves between  $20^\circ$ -  $30^\circ$ , 7:1 for curves above  $30^\circ$ )
- 10% of diagnosed cases require conservative treatment
- approximately 0.1–0.3% require operative correction of the deformity



# Idiopathic scoliosis

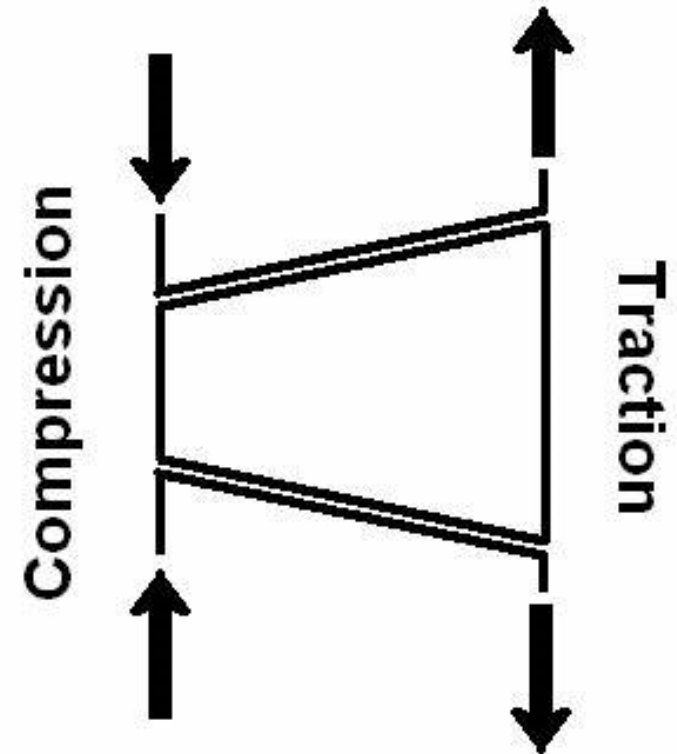
## *Patogenesis and pathomechanism*

### ✓ RASO effect

- disproportionate growth of the anterior and posterior columns
- contributing cause of the lordosis and the hypokyphosis in the thoracic spine.
- a positive correlation between the severity of the scoliotic curve and the extent of the anteroposterior disproportionate growth

### ✓ Hueter-Volkman law

- increased mechanical compression acting on growth plates impairs skeletal growth and reduced loading increases growth
- Dorsal shear force concept



# Assessment of scoliosis

- Anamnesis
- Physical examination and clinical assessment
- Radiological assessment



# Assessment of scoliosis

## *Anamnesis*

- Anamnesis
- Family history
- Onset of scoliosis
- Birth and developmental history
- Menarche in girls
- Exclusion of other diseases and health issues

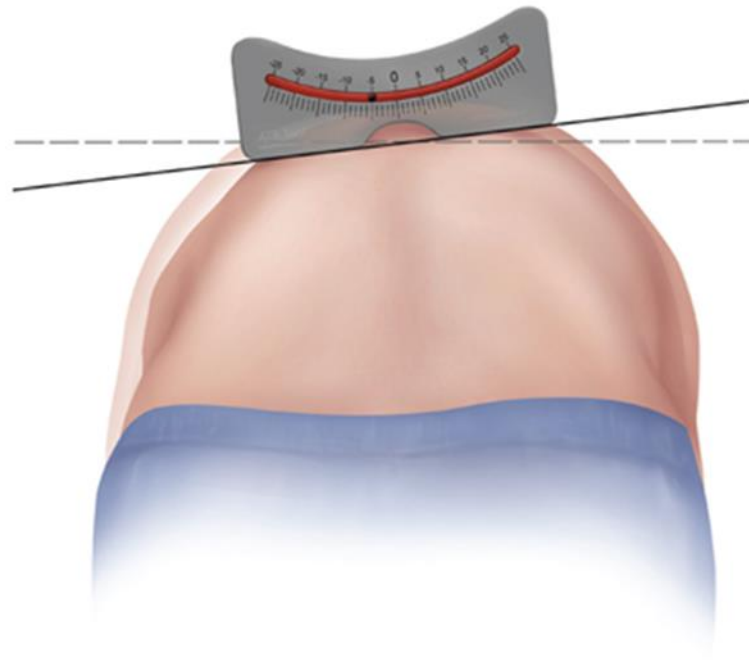




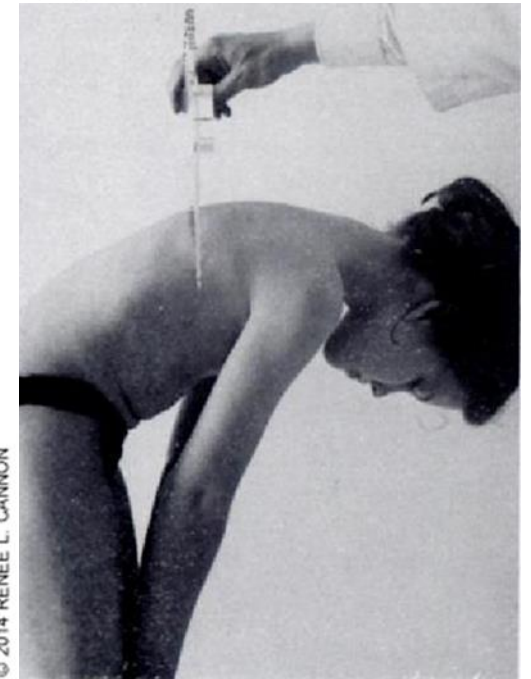
# Assessment

## *Physical examination*

- Height and weight assessment
- Observation – clinical signs, plumbline
- Adam's forward bending test
- Neurologic assessment
- Upper and lower extremity assessment, including:
- joint laxity/hypermobility
- leg length evaluation



5-7°



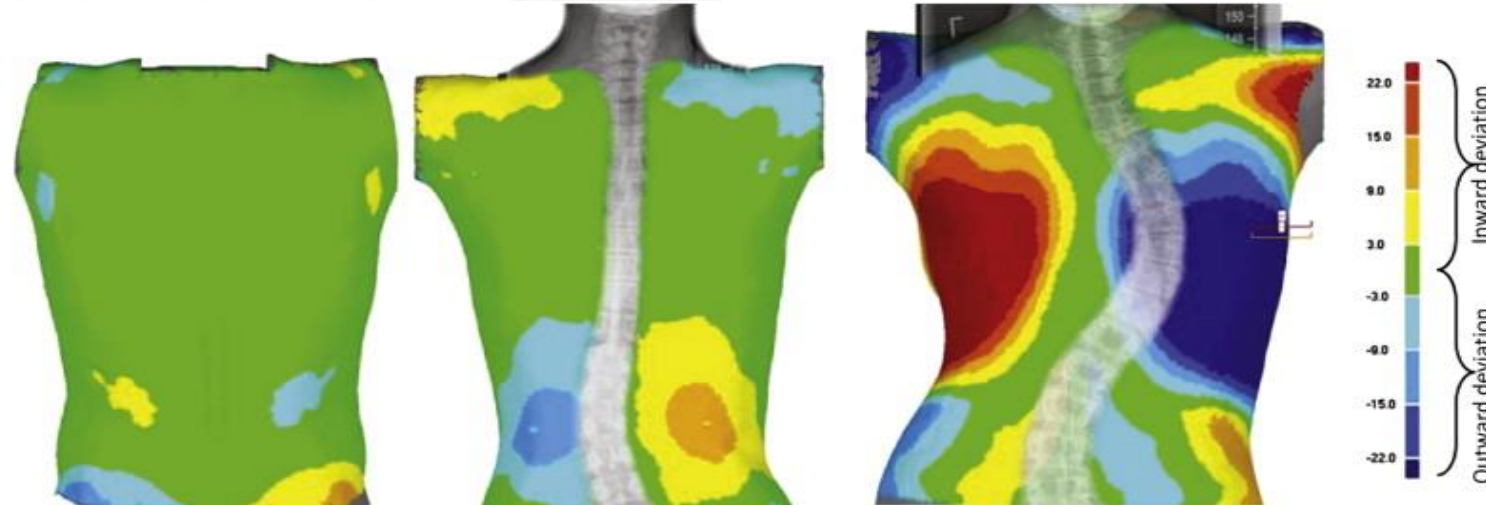
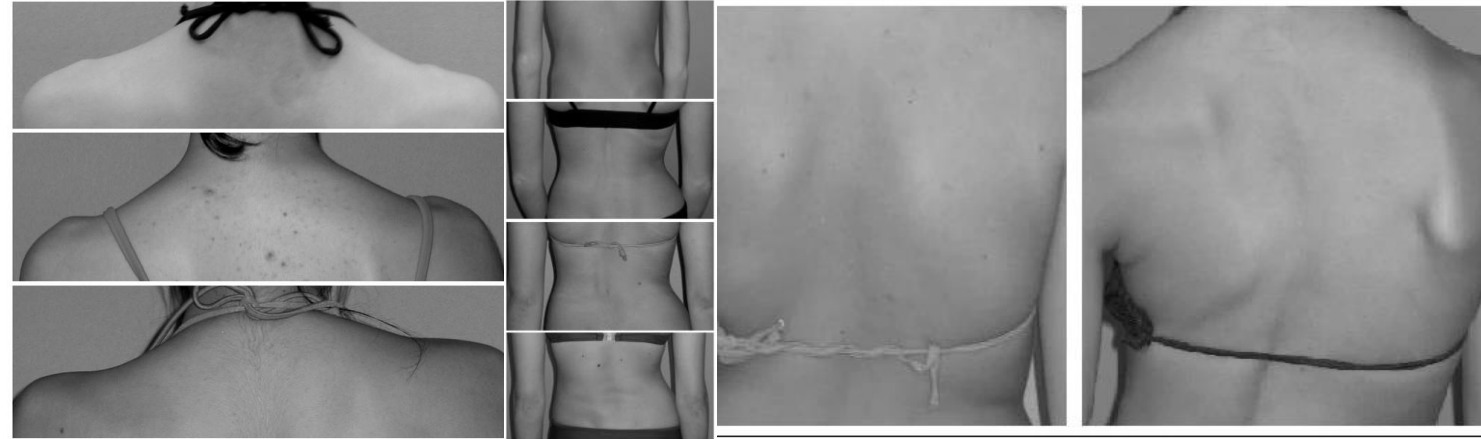
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5 mm

# Assessment

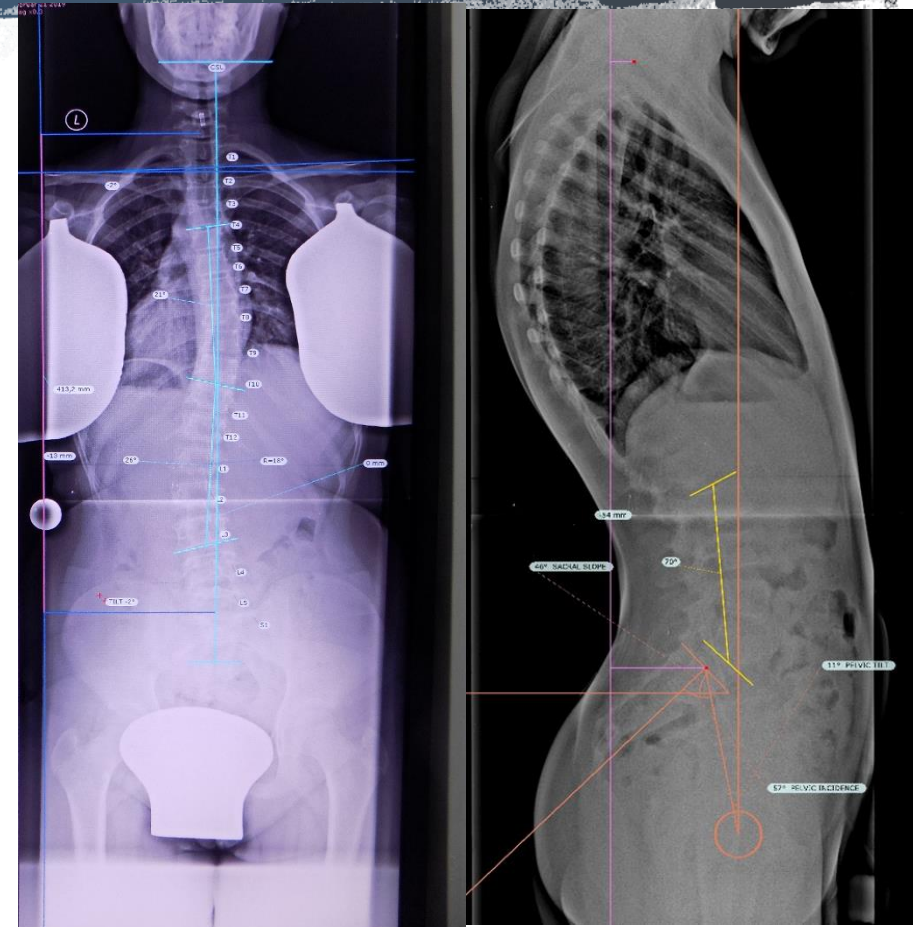
## *Diagnostic tools*

- Screening and surface assessment  
(TRACE, POTSI, photography)
- Surface topography
- Radiological assessment
- Ultrasound (Scolioscan) to reduce radiation



# Radiological assessment

- Reference standard for scoliosis diagnosis
- X-ray at first evaluation in both projection, the postero-anterior and the lateral one
- Every 6 – 12 months
- In-brace X ray
- Important radiological parameters:
  1. Cobb angle – curve type and severity
  2. Vertebral rotation (Perdriolle or Raimondi)
  3. Metha angle in infantile scoliosis
  4. Risser sign/Sanders classification



# Scolioscan – ultrasound

- Possibility of screening and follow up of scoliosis with ultrasound
- Scolio-angle – correlation with Cobb angle
- Possible 3D reconstruction
- No radiation!



# Classifications of idiopathic scoliosis

Chronological		Angular			Topographic		
Age at diagnosis (years.months)		Cobb degrees			Apex		
					from	to	
Infantile	0-2.11	Low	Low	5-15	Cervical	-	Disc C6-7
Juvenile	3-9.11		Low to moderate	16-24	Cervico-thoracic	C7	T1
Adolescent	10-17.11	Moderate	Moderate	25-34	Thoracic	Disc T1-2	Disc T11-12
Adult	18-		Moderate to severe	35-44	Thoraco-lumbar	T12	L1
		Severe		45-59	Lumbar	Disc L1-2	-
		Very severe		60 or more			

# King and Lenke classification

## Curve type

Type	Proximal thoracic	Main thoracic	Thoracolumbar/lumbar	Description
1	Nonstructural	Structural (major)	Nonstructural	Main thoracic (MT)
2	Structural	Structural (major)	Nonstructural	Double thoracic (MT)
3	Nonstructural	Structural (major)	Structural	Double major (DM)
4	Structural	Structural (major)	Structural (major)	Triple major (TM) <sup>5</sup>
5	Nonstructural	Nonstructural	Structural (major)	Thoracolumbar/lumbar (TL/L)
6	Nonstructural	Structural	Structural (major)	Thoracolumbar/lumbar-main thoracic (TL/L-MT)

## Structural criteria (Minor curves)

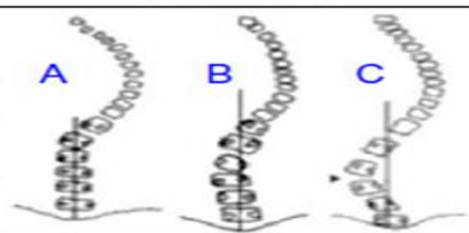
Proximal thoracic	– Side bending Cobb $\geq 25^\circ$ – T2-T5 kyphosis $\geq +20^\circ$
Main thoracic	– Side bending Cobb $\geq 25^\circ$ – T10-L2 kyphosis $\geq +20^\circ$
Thoracolumbar/lumbar	– Side bending Cobb $\geq 25^\circ$ – T10-L2 kyphosis $\geq +20^\circ$

## Location of apex (SRS definition)

Curve	Apex
Thoracic	T2-T11/12 disk
Thoracolumbar	T12-L1
Thoracolumbar/lumbar	L1/2 disk-L4

## Modifiers

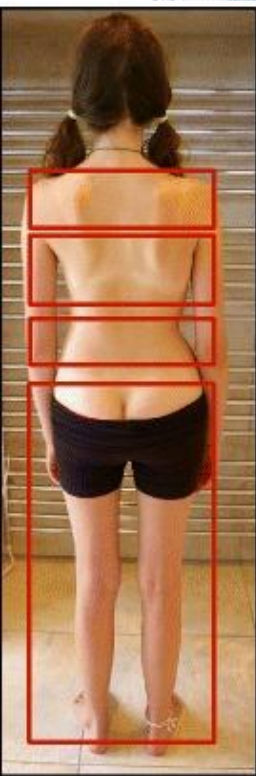
Lumbar spine modifier	CSVL to lumbar apex
A	CSVL between pedicles
B	CSVL touches apical body(ies)
C	CSVL completely medial



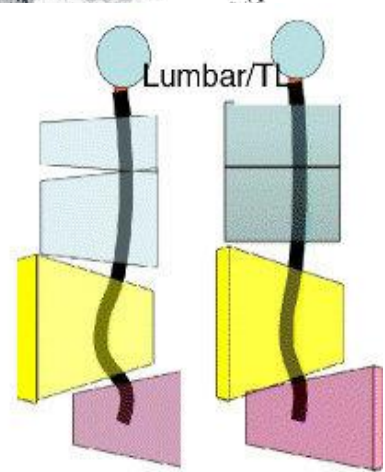
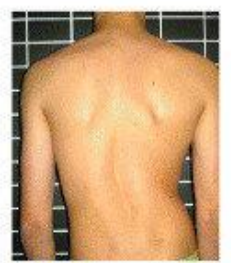
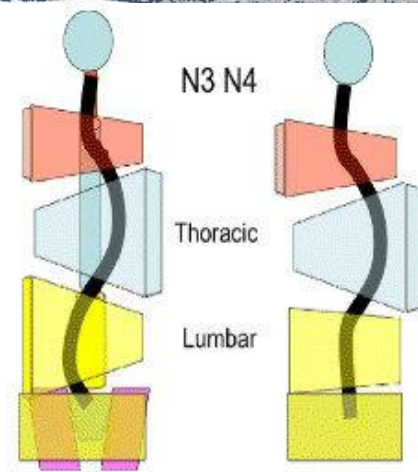
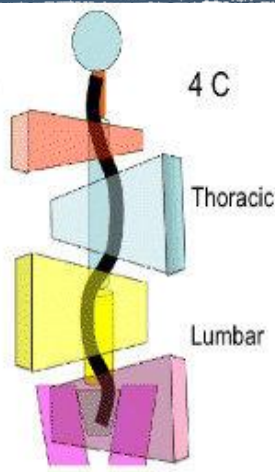
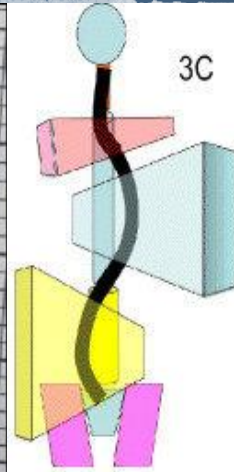
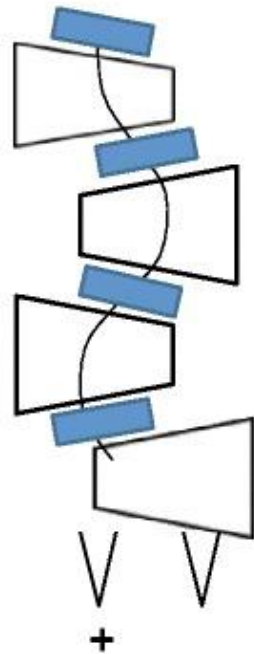
Thoracic sagittal profile T5-T12	
- (hypo)	<10°
N (normal)	10°–40°
+ (hyper)	>40°

Curve type (1–6) + lumbar spine modifier (A, B, C) + thoracic sagittal modifier (-, N, +)

# Clinical classification of scoliosis



- Shoulder block **S**
- Thoracic block **T**
- Lumbar block **L**
- Hip - pelvic block **H**



A

B

C

D

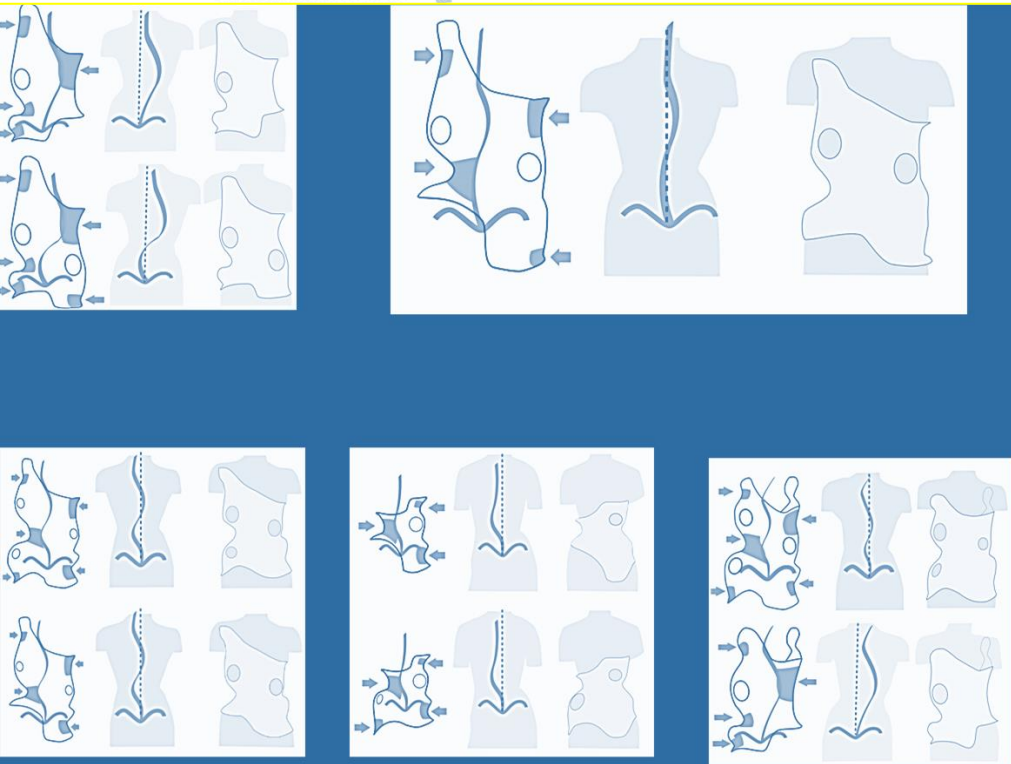
A

B

C

D

# Brace classification of scoliosis



## Sobernheim Brace Classification according to functional pattern

Code	Diagram	Spine X-ray	Brace Model	Notes
<b>S1</b> Lenke 1A,2 King IV; Schroth T-Type/primary curve is thoracic (T re 14-16); SRS single long thoracic; Rigo A1, A2, A3				<p>Kirchka opis: Prisposabljena je za funkcionalni tipičan tipu prve kolumnarne skolioze sa izrazitim oblikom kumpensatornog nagiba karlice prema kolumnarnom skolioznom izlasku. Skolioza je bila prisposobljena za kumpensatorni nagib karlice prema kolumnarnom skolioznom izlasku. Karlica: Trapezoidni nagib karlice prema kolumnarnom skolioznom izlasku sa nagibom ka kolumnarnom skolioznom izlasku. Vertikalna os: Vertikalna os kolumnarne skolioze. Lenke: Lenke 1A,2. Rigo: Rigo A1, A2, A3.</p>
<b>S2</b> Lenke 1,2; King III,V; Schroth L-Type/primary curve is thoracic (T re 14-16); SRS single thoracic only, with compensatory; nonstructural or minor lumbar; Rigo A1, A2, A3, C1, C2				<p>Kirchka opis: Prisposabljena je za funkcionalni tipičan tipu prve kolumnarne skolioze sa izrazitim oblikom kumpensatornog nagiba karlice prema kolumnarnom skolioznom izlasku. Skolioza je bila prisposobljena za kumpensatorni nagib karlice prema kolumnarnom skolioznom izlasku. Karlica: Trapezoidni nagib karlice prema kolumnarnom skolioznom izlasku sa nagibom ka kolumnarnom skolioznom izlasku. Vertikalna os: Vertikalna os kolumnarne skolioze. Lenke: Lenke 1,2. Rigo: Rigo A1, A2, A3, C1, C2.</p>
<b>S3</b> Lenke 4,5,6; King I,II; Schroth L-Type/primary curve is lumbar (L, T, L, & HT re); SRS thoracic and lumbar double, thoracic and thoracolumbar double, thoracolumbar major and thoracic minor; Rigo B1, B2				<p>Kirchka opis: Prisposabljena je za funkcionalni tipičan tipu prve kolumnarne skolioze sa izrazitim oblikom kumpensatornog nagiba karlice prema kolumnarnom skolioznom izlasku. Skolioza je bila prisposobljena za kumpensatorni nagib karlice prema kolumnarnom skolioznom izlasku. Karlica: Trapezoidni nagib karlice prema kolumnarnom skolioznom izlasku sa nagibom ka kolumnarnom skolioznom izlasku. Vertikalna os: Vertikalna os kolumnarne skolioze. Lenke: Lenke 4,5,6. Rigo: Rigo B1, B2.</p>
<b>S4</b> Lenke 1,2,3,4 A; King III,V; Schroth T-Type/primary curve is thoracic (T re 14-16); SRS single thoracic with upper thoracic, double thoracic; Rigo D				<p>Kirchka opis: Prisposabljena je za funkcionalni tipičan tipu prve kolumnarne skolioze sa izrazitim oblikom kumpensatornog nagiba karlice prema kolumnarnom skolioznom izlasku. Skolioza je bila prisposobljena za kumpensatorni nagib karlice prema kolumnarnom skolioznom izlasku. Karlica: Trapezoidni nagib karlice prema kolumnarnom skolioznom izlasku sa nagibom ka kolumnarnom skolioznom izlasku. Vertikalna os: Vertikalna os kolumnarne skolioze. Lenke: Lenke 1,2,3,4 A. Rigo: Rigo D.</p>
<b>S5</b> Lenke V; Schroth L,H KT(+,-); (L,H re); SRS single lumbar, single thoracolumbar; Rigo E1, E2				<p>Kirchka opis: Prisposabljena je za funkcionalni tipičan tipu prve kolumnarne skolioze sa izrazitim oblikom kumpensatornog nagiba karlice prema kolumnarnom skolioznom izlasku. Skolioza je bila prisposobljena za kumpensatorni nagib karlice prema kolumnarnom skolioznom izlasku. Karlica: Trapezoidni nagib karlice prema kolumnarnom skolioznom izlasku sa nagibom ka kolumnarnom skolioznom izlasku. Vertikalna os: Vertikalna os kolumnarne skolioze. Lenke: Lenke V. Rigo: Rigo E1, E2.</p>



# Main goals of conservative treatment

1. To stop curve progression at puberty (or possibly even reduce it)
2. To prevent or treat respiratory dysfunction
3. To prevent or treat spinal pain syndromes
4. To improve aesthetics via postural correction

➤ Improve quality of life

➤ **Absolute goal: avoid surgery**

# SOSORT consensus

Rank	Aim	Percentage of responders
1	Esthetics	100%
2	Quality of life	91%
3	Disability	91%
4	Back Pain	87%
5	Psychological well-being	84%
6	Progression in adulthood	84%
7	Breathing function	84%
8	Scoliosis Cobb degrees	84%
9	Need of further treatments in adulthood	81%

# Prognostic factors

Possible determinants of a higher risk of scoliosis progression:

- ✓ positive family history
- ✓ laxity of skin and joints (connective tissue defect),
- ✓ impaired sagittal profile: flattening of physiological thoracic kyphosis (impedes efficient bracing),
- ✓ angle of trunk rotation exceeding  $10^{\circ}$ ,
- ✓ growth spurt – menarche in girls, Tanner staging

# Progression in adulthood

- Below 30 ° statistically no further progression
- Over 30° of scoliosis, the risk of progression in adulthood increases, as well as the risk of health problems and reduction of quality of life.
- Over 50°, there is a consensus that it is almost certain that scoliosis is going to progress in adulthood (about 1 ° per year) and cause health problems and reduction of quality of life.



# Treatment of idiopathic scoliosis

- Conservative treatment
- Operative treatment - required for deformities over  $45 \pm 5^\circ$  Cobb angle



# Conservative treatment of idiopathic scoliosis

- depends on type of scoliosis and it includes:
  1. Observation – monitoring of mild curves, „wait and see“ method
  2. Physical therapy – evidence based physiotherapeutic specific scoliosis exercises
  3. Bracing – for moderate and severe scoliosis with risk of progression

Negrini et al. *Scoliosis and Spinal Disorders* (2018) 13:3  
DOI 10.1186/s13013-017-0145-8

Scoliosis and Spinal Disorders

REVIEW

Open Access

## 2016 SOSORT guidelines: orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth



Stefano Negrini<sup>1,2</sup>, Sabrina Donzelli<sup>3\*</sup>, Angelo Gabriele Aulisa<sup>4</sup>, Dariusz Czaprowski<sup>5,6</sup>, Sanja Schreiber<sup>7,8</sup>, Jean Claude de Mauroy<sup>9</sup>, Helmut Diers<sup>10</sup>, Theodoros B. Grivas<sup>11</sup>, Patrick Knott<sup>12</sup>, Tomasz Kotwicki<sup>13</sup>, Andrea Lebel<sup>14</sup>, Cindy Marti<sup>15</sup>, Toru Maruyama<sup>16</sup>, Joe O'Brien<sup>17</sup>, Nigel Price<sup>18</sup>, Eric Parent<sup>19</sup>, Manuel Rigo<sup>22</sup>, Michele Romano<sup>2</sup>, Luke Stikeleather<sup>20</sup>, James Wynne<sup>21</sup> and Fabio Zaina<sup>3</sup>

# Multidisciplinary approach



- ✓ PRM specialists
- ✓ ortopedic surgeons
- ✓ physiotherapists
- ✓ orthotists
- ✓ psychologists
- ✓ patient and family







# PSSE

## physiotherapeutic specific scoliosis exercises

- Individual according to curve pattern, combination of clinical and radiological evaluation
- PSSE should consist of the following:
  - Auto-correction in 3D
  - Training in activities of daily living (ADL)
  - Stabilizing the corrected posture
  - Patient education
- Specific PSSE have been associated with different brace designs (side-shift as a complement to Milwaukee, Schroth to Chêneau brace, and SEAS to Sforzesco brace)

# PSSE

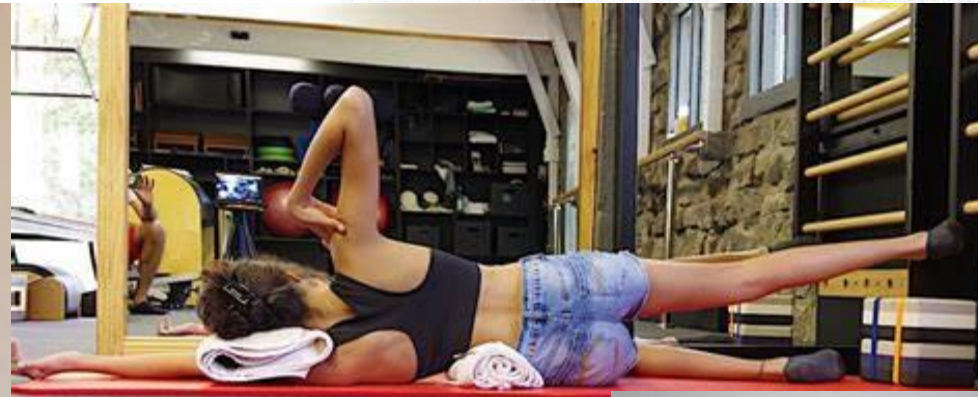
## physiotherapeutic specific scoliosis exercises

- slow the progression (deterioration) of scoliosis and/or reduced curve severity measured by the Cobb angle
- some studies also showed improved neuromotor control, respiratory function, back muscle strength, and cosmetic appearance
- have positive effect on the scoliosis outcome
- also applied during brace treatment and pre- and postoperative treatment



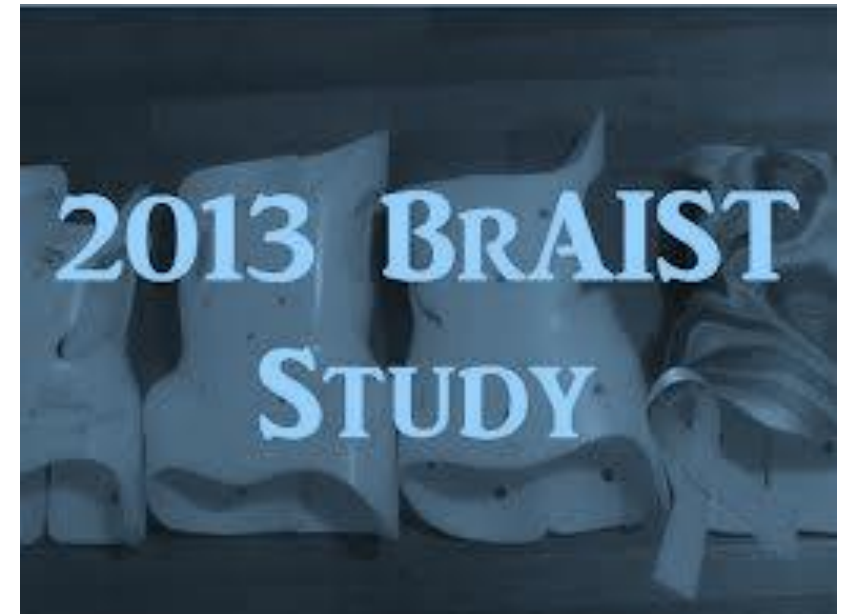
# PSSE

## Different approaches with the same goal



# Bracing

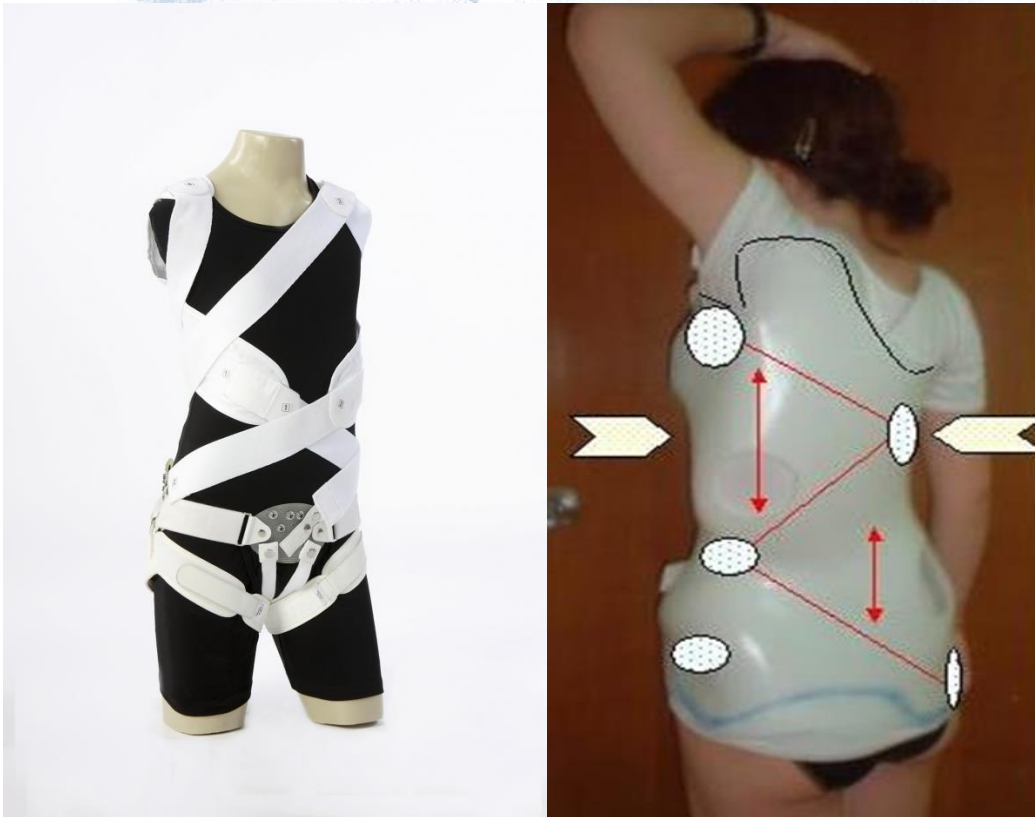
- Curves from  $20\pm 5^\circ$  of Cobb angle when there is a significant risk of further progression (early onset, low maturity, etc)
- ***Bracing works!***
- BrAIST study: rate of treatment success 72% after bracing, as compared with 48% after observation.
- treatment ends with skeletal maturity (Risser 4/5)
- gradual brace weaning



# Bracing

- **Soft Bracing (SB):** it includes mainly the SpineCor brace, but also other similar designs
- **Night Time Rigid Bracing (8–12 h per day) (NTRB):** wearing a brace mainly in bed (Charleston brace)
- **Part Time Rigid Bracing (12–20 h per day) (PTRB):** wearing a rigid brace mainly outside school and in bed.
- **Full Time Rigid Bracing (20–24 h per day) or cast (FTRB)**

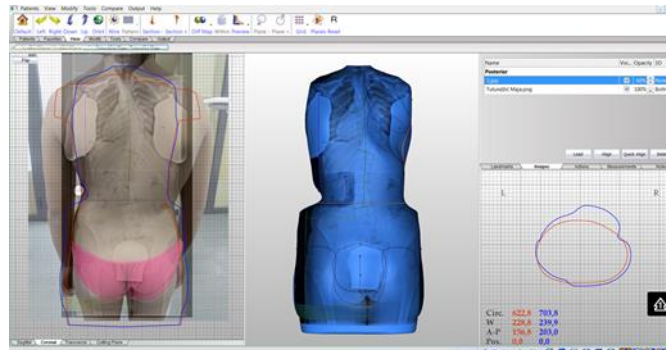
# What kind of brace?



- soft braces (SpineCor)
  - rigid braces
- 3 – point system with 3D correction
  - Different correction system (pad placement and direction of vector force)
- no brace is better than the other

# Rigid braces

- plaster model
- CAD/CAM technology
  - CAD: computer aided design
  - CAM: computer aided manufacturing



# Prognostic factors in brace treatment

## Brace itself:

- Brace quality
- In – brace correction

## Other factors:

- type of scoliosis
- skeletal maturity (Risser sign)
- dosage
- compliance
- physical therapy in and out of brace
- family history,
- geographical distribution
- team approach
- genetics



**Bracing Outcomes in Adolescent Idiopathic Scoliosis Are Associated with Biological Endophenotypes**

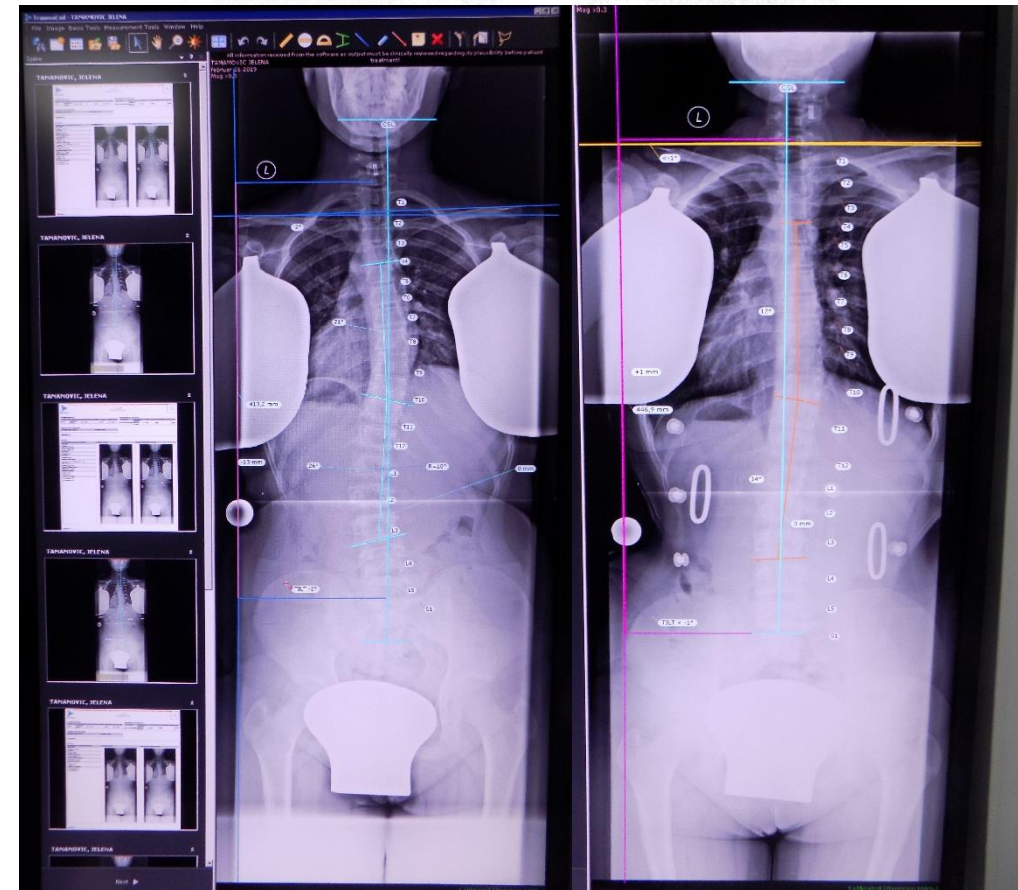
Moreau A.<sup>1,2,3</sup>, Beauséjour M.<sup>4,5</sup>, Parent S.<sup>4,5,6</sup>, Labelle H.<sup>4,5,6</sup>, J. J.<sup>4,5</sup>, Akoume M-Y.<sup>1,7</sup>, Franco A.<sup>1</sup>, Mac-Thiong J-M.<sup>4,5,6</sup>, Roy-Beaudet A.<sup>4,5</sup>, Aubin C-É.<sup>4,8</sup>

<sup>1</sup>Viscogliosi Laboratory in Molecular Genetics of Musculoskeletal Diseases, Sainte-Justine



# In- brace correction and brace quality

- In – brace correction one month after brace application
- Indicator of brace quality and possible predictor of final outcome
- 30 – 50% of correction as predictor of good results
- Out of brace x-ray after couple of months can be better predictor than in-brace x – ray (Negrini et al, 2020)



# Brace check and follow up

- Brace check after application
- Gradual adaptation to brace
- Follow up every 3 – 6 months
- The brace has to be changed for a new one as soon as the child grows or the brace loses efficacy



# In-brace correction depends on...

7 - 9 y

median	Cobb < 25°	Cobb 26°-40°	Cobb >41°
65.4%	68.91%	38.9%	28.42%
median	Cobb < 25°	Cobb 26°-40°	Cobb >41°
87.56%	95.97%	63.12%	34.72%
median	Cobb < 25°	Cobb 26°-40°	Cobb >41°
58.83%	74.95%	41.79%	31.67%
median	Cobb < 25°	Cobb 26°-40°	Cobb >41°
50.2%	67.25%	38.91%	28.69%
median	Cobb < 25°	Cobb 26°-40°	Cobb >41°
42.17%	57.47%	36.58%	27.78%

10 - 12 y

13 - 14 y

>15 y

- Curve severity
- Curve type
- Age
- Skeletal maturity (Risser)

# Other factors aside from brace

- Other factors beyond the instrument (brace) play a role in final results:
  - ✓ dosage,
  - ✓ compliance to treatment ,
  - ✓ PSSE in and out of brace



# Compliance to treatment

- correlation between dosage and effects of brace intervention
- possible major factor in explaining some of the results of bracing
- no progression in 82% of patients who wore the brace more than 12 h per day, compared with 31% who wore the brace fewer than 7 h per day
- objective monitoring of hours of brace wear with heat sensors
- more hours of daily brace weaning, the more the deformity collapses (“concertina effect”)

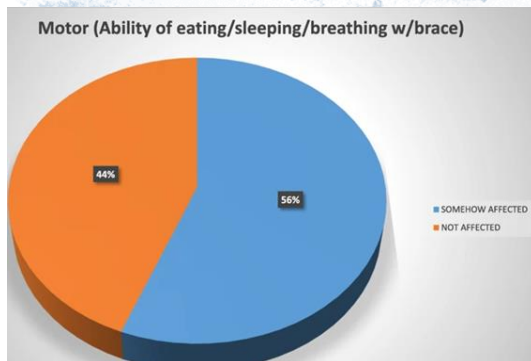


# Lung function in brace treatment

- Scoliosis causes impairment of lung function
  1. Scoliosis over  $50-60^\circ$  cause lung function abnormalities, mainly of the restrictive type
  2. Scoliosis over  $90^\circ$  greatly predisposes to cardiorespiratory failure
  3. Duration of scoliosis correlates with the degree of disability



# Lung function in brace treatment



- No negative effect of bracing on lung function!

- Some patients can feel discomfort in brace



- Corrective breathing in brace - positive effect especially in larger curves

- Spirometry in and out of brace

Identification:	20019007/0013	Date of birth:	26.01.1995
Sex:	male	Smoker:	---
Height:	175,0 cm	Weight:	75,0 kg
BMI:	24,49	Age:	41 Years
Operator:	NATASA	Physician:	---

SPIROMETRIJA			
	Pred	Act1	%(A1/P)
VC IN	[L] 4,88	4,77	97,8
FVC	[L] 4,07	5,11	109,2
FEV1	[L] 3,85	4,38	113,9
FEV1 % VC IN	[%] 79,83	91,80	115,0
FEV1 % FVC	[%] 85,81	85,81	---
FEV0,5	[L] 3,35	---	---
PEF	[L/s] 9,13	10,11	110,7
MEF 75	[L/s] 7,90	8,21	103,9
MEF 50	[L/s] 5,01	5,90	109,8
MEF 25	[L/s] 2,16	2,48	115,0
MMEF 75/25	[L/s] 4,33	4,94	114,1
PIF	[L/s]	6,42	---
FIV1	[L]	4,87	---
R occ	[kPa*s/L]	0,32	---
G occ	[L/(kPa*s)]	---	---
P alv	[kPa]	---	---
Date	07.04.09	---	---
Time	09:31:29	---	---



Michael Rexing,  
BadSobernheim  
/Frankfurt

# Team role in bracing

- Experience of MD and CPO in brace construction and PT in physical treatment and patients education
- Interdisciplinary team: MD, CPO and PT
- Multidisciplinary approach: cooperation between all professionals involved in the treatment of scoliosis patients





# Patient outcome questionnaires

- Quality of life and body image assessment
- Bracing as stressful experience
- SRS – 22
- SRS - 7 as short alternative to SRS – 22
- PEDsQoL questionnaire
- SAQ questionnaire

## SRS-22r1 Patient Questionnaire

Patient Name: \_\_\_\_\_ Date of Birth: \_\_\_\_\_  
Mo Day Year

Today's Date: \_\_\_\_\_ Age: \_\_\_\_\_  
Years Months

Medical Record #: \_\_\_\_\_

Instructions: We are carefully evaluating the condition of your back, and it is **IMPORTANT THAT YOU ANSWER EACH OF THESE QUESTIONS YOURSELF. PLEASE CIRCLE THE ONE BEST ANSWER TO EACH QUESTION.**

1. Which of the following best describes the amount of pain you have experienced during the past 6 months?

None  
Mild  
Moderate  
Moderate to severe  
Severe

2. Which one of the following best describes the amount of pain you have experienced over the last month?

None  
Mild  
Moderate  
Moderate to severe  
Severe

3. During the past 6 months, have you been a very nervous person?

None of the time  
A little of the time  
Some of the time  
Most of the time  
All of the time

# Sport and scoliosis

- not prescribed as a treatment for idiopathic scoliosis
- patients with scoliosis should actively take part in sport activities (show higher self-esteem and have better psychological outcomes)
- patients with scoliosis to remain active in sports activities, especially since participation does not seem to affect the occurrence or degree of scoliosis
- It is recommended that competitive activities that greatly mobilize the spine are avoided in patients with scoliosis at high risk of progression



# Sport during brace treatment

- It is recommended that, during all treatment phases, physical education at school is continued
- It is recommended that sports activities are continued also during brace treatment because of the physical (aerobic capacity) and psychological benefits these activities provide
- It is recommended that, during brace treatment, contact or highly dynamic sport activities are performed with caution

# Secondary scoliosis

- heterogeneous group of spinal deformities with known aetiology
- Age of onset, natural history, pattern of progression, and symptoms may vary greatly depending on the underlying disease
- comorbidities interfere with the treatment, purpose of bracing is not to correct the spine, but to stabilize the trunk of the patients, reduce the pain and enable them better sitting position.

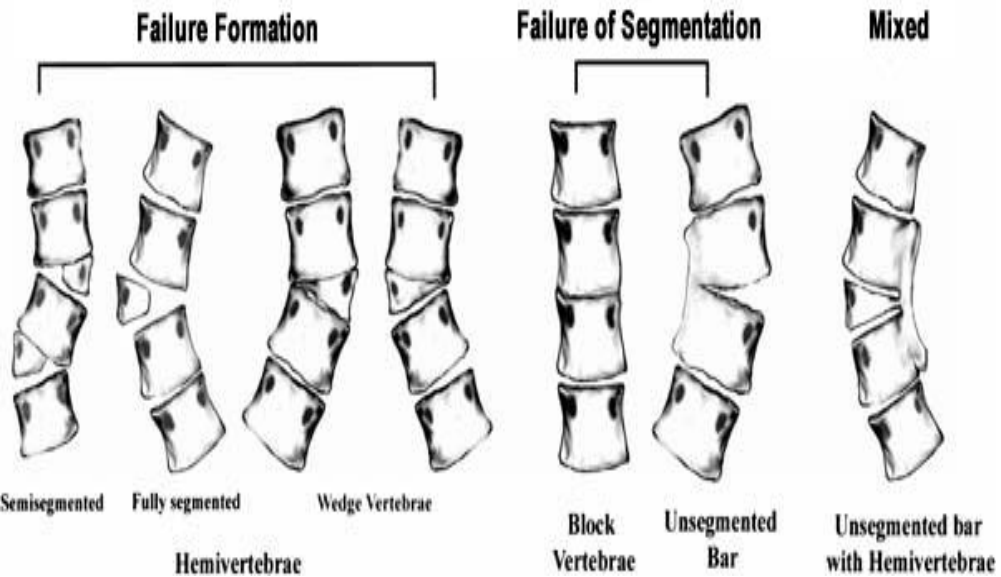


# Neuromuscular scoliosis

- Compared with idiopathic scoliosis, neuromuscular scoliosis is much more likely to produce curves that progress, and continue progressing into adulthood
- Curve progression and trunk imbalances are more severe in patients who are not able to walk).
- Bracing for smaller curves (most curves from neuromuscular scoliosis do not benefit from bracing)
- Wheelchair modifications (for non-ambulators) to improve function
- Physical therapy

Diagnosis	Incidence of Scoliosis
Cerebral palsy (2 limbs involved)	25%
Myelodysplasia (lower lumbar)	60%
Spinal muscle atrophy	67%
Friedreich ataxia	80%
Cerebral palsy (4 limbs involved)	80%
Duchenne muscular dystrophy	90%
Myelodysplasia (thoracic level)	100%
Traumatic paralysis (<10 years)	100%

# Congenital scoliosis



- Due to improper formation or separation of vertebrae
- No known cause
- Usually requires monitoring by a spine specialist
- requires surgery in many cases



# Bracing in secondary scoliosis

- Semi - rigid or soft braces
- No correctional pads
- Trunk rebalance



# Operative treatment in secondary scoliosis

- Surgical goals are:
- Prevent curve progression
- Improve sitting balance and tolerance (in non-ambulators)
- Reduce pain





# Conclusions

- Conservative treatment (PSSE and bracing) works!
- Many factors influence the treatment outcome
- Multidisciplinary approach is crucial
- Deformity can affect health and quality of life



**THANK YOU  
FOR YOUR  
ATTENTION**

