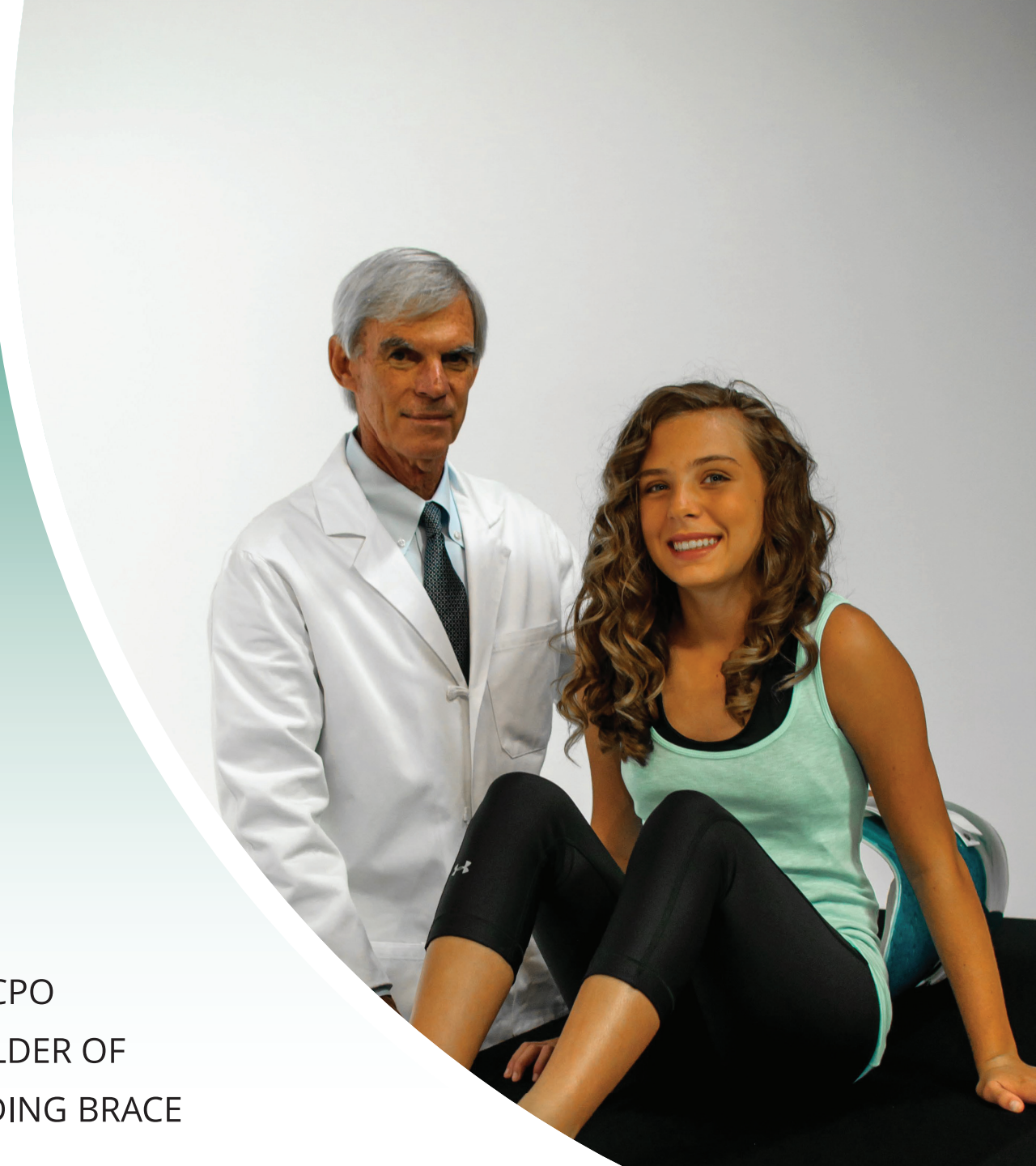


# SCOLIOSIS TREATMENT & THE CHARLESTON BENDING BRACE



- C. RALPH HOOPER, JR., CPO
- INVENTOR/PATENT HOLDER OF
- THE CHARLESTON BENDING BRACE

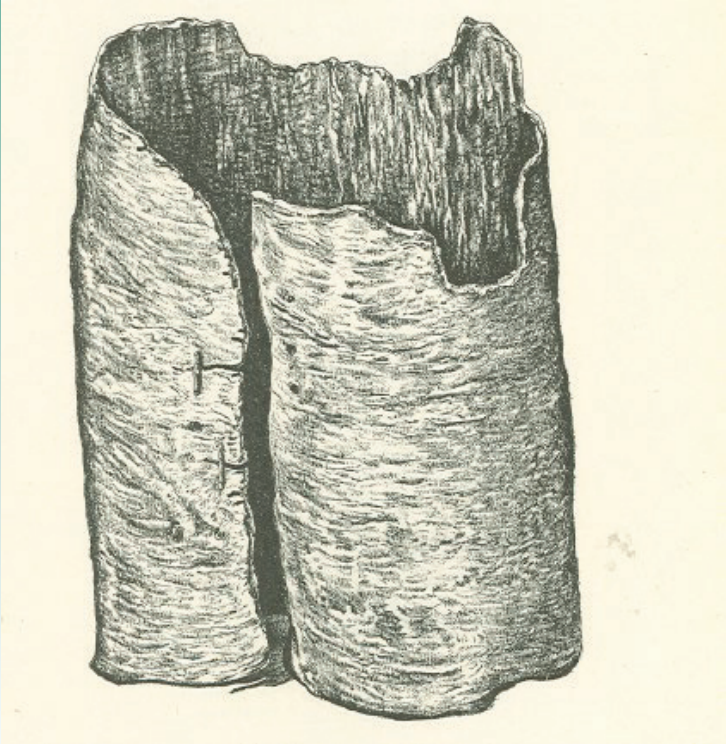


**Simply defined, scoliosis is a  
sideways curve of the spine that  
measures greater than 10 degrees.**

# Causes of Scoliosis

- Idiopathic
  - Infantile < age 2 yrs
  - Juvenile 2-10 yrs
  - Adolescent > age 10yrs
- Neuromuscular
- Congenital
- Other
  - Thoracogenic
  - Post-irradiation
  - Syndromes

## How did we get here?



Lumbosacral corsets can be traced back to the Minoan period some 2000 BC- Arthur Evans (The Palace of Minos at Knossos)

The pictured back brace is circa 900 AD.



# History of Treatment of Scoliosis

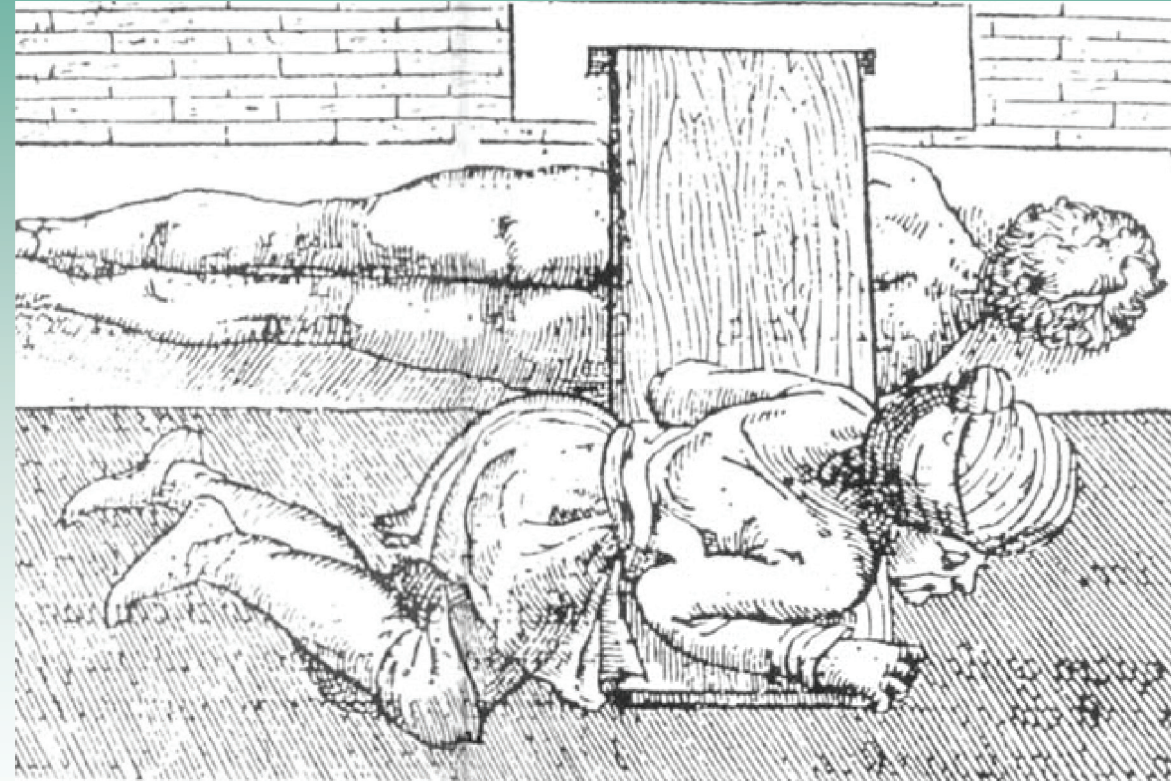
- **Hippocrates (460-370 BC) and Galen (130-200 AD)**
- The innovation of the board, the application of axial traction and even the principle of trans-abdominal correction for correction of spinal deformities have their origin in Hippocrates
- Galen, who lived nearly five centuries later impressively described scoliosis, lordosis and kyphosis, provided etiologic implications and used the same principles as Hippocrates for their management, while his studies influenced medical practice on spinal deformities for more than 1500 years.



# The Hippocratic Board

The patient would lie on a bench, at an adjustable angle, and ropes would be tied around his arms, waist, legs or feet, depending on the treatment needed. Winches would then be used to pull the ropes apart, correcting curvature in the spine or separating an overlapping fracture.

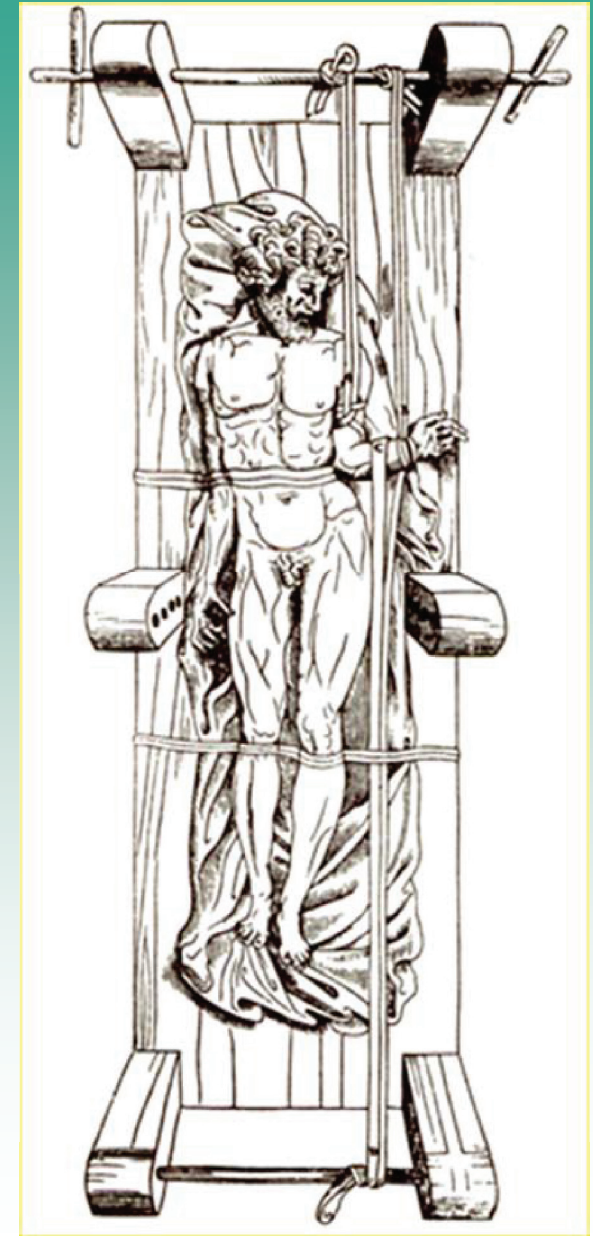
VAX-D ( Vertebral Axial Decompression)





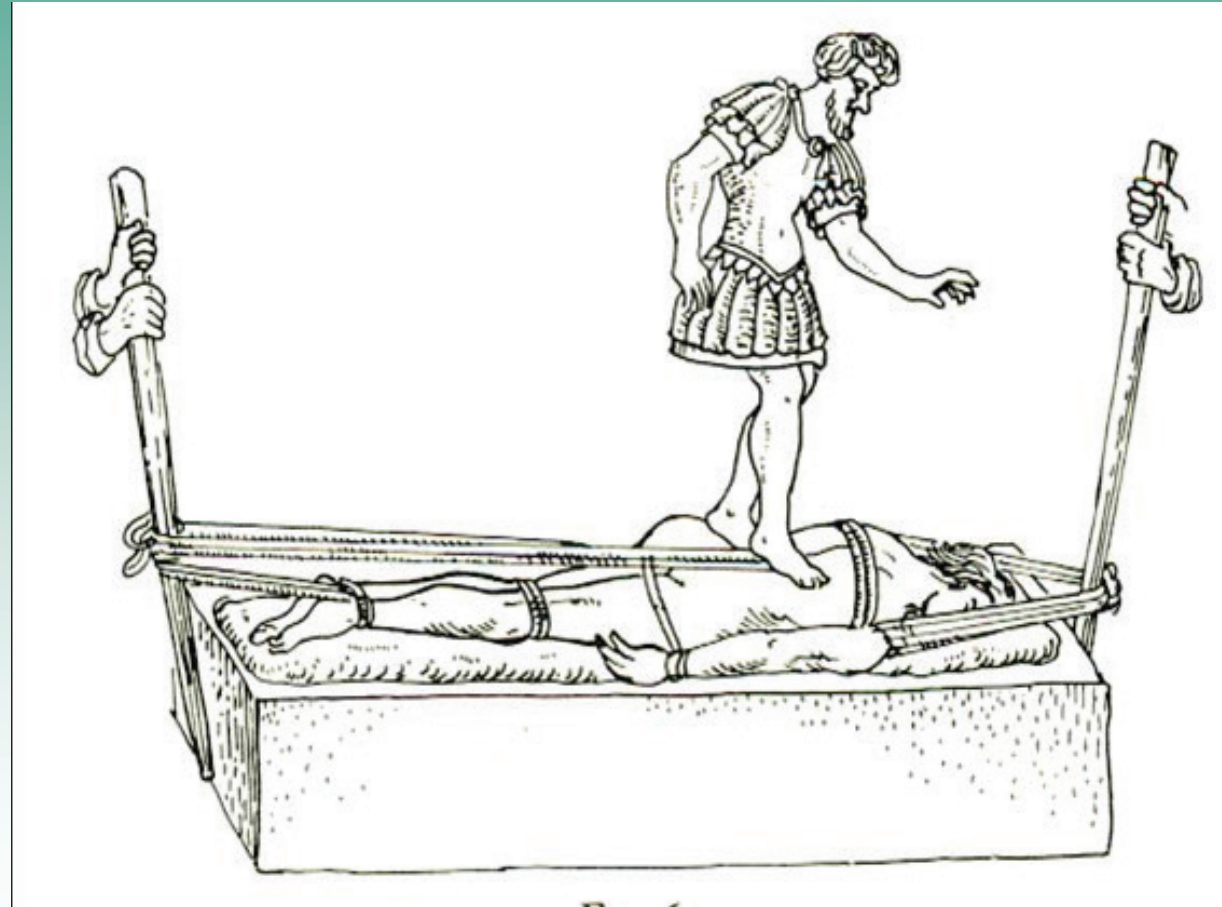
# Hippocrates

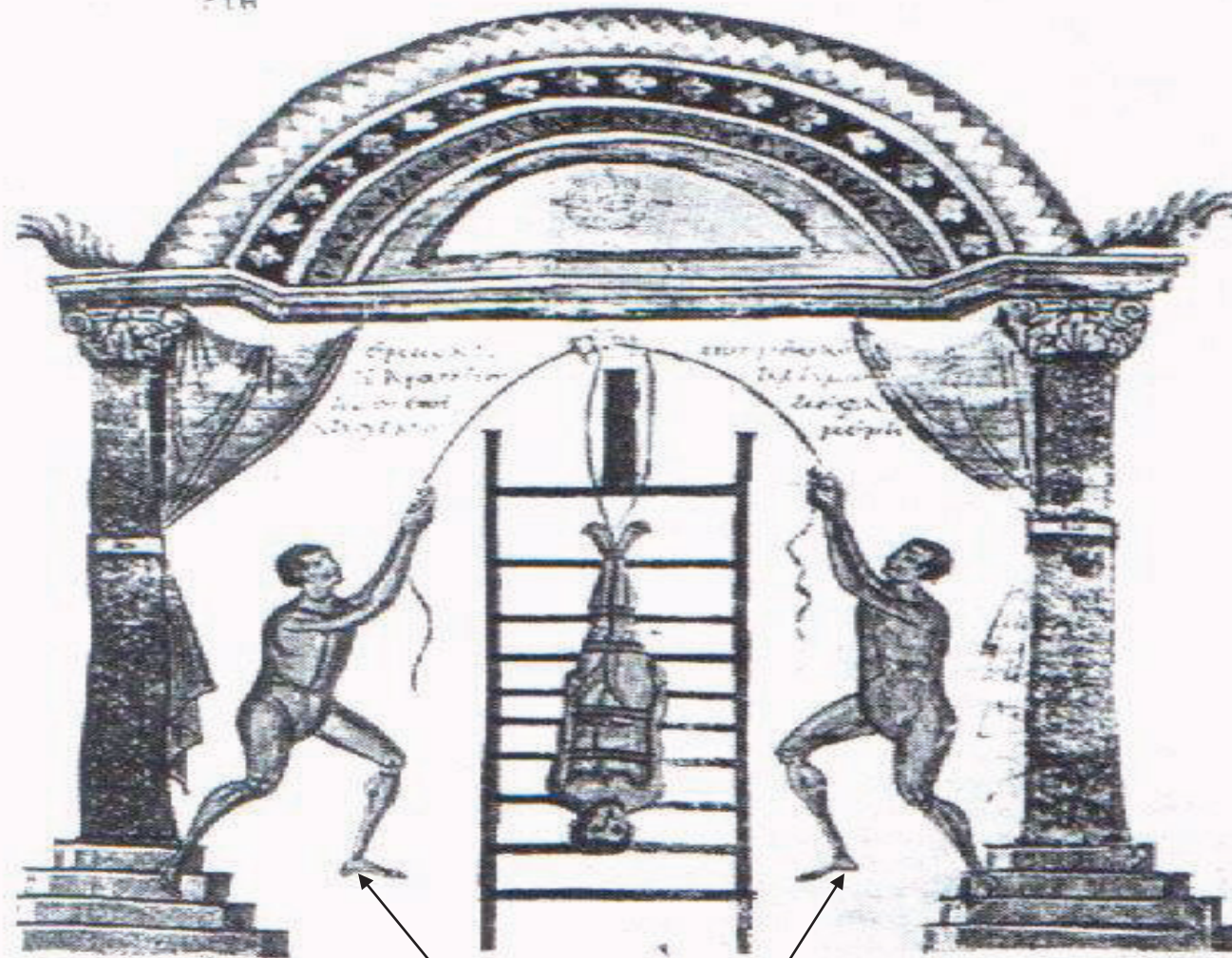
A schematic representation of the application of corrective forces for spinal deformities by the use of straps and bands, properly adjusted on the Hippocratic board



# Galen Approach

Drawing showing Galen's method of correction of spinal deformity on a device similar to the Hippocratic board by applying pressure on the patient's back.

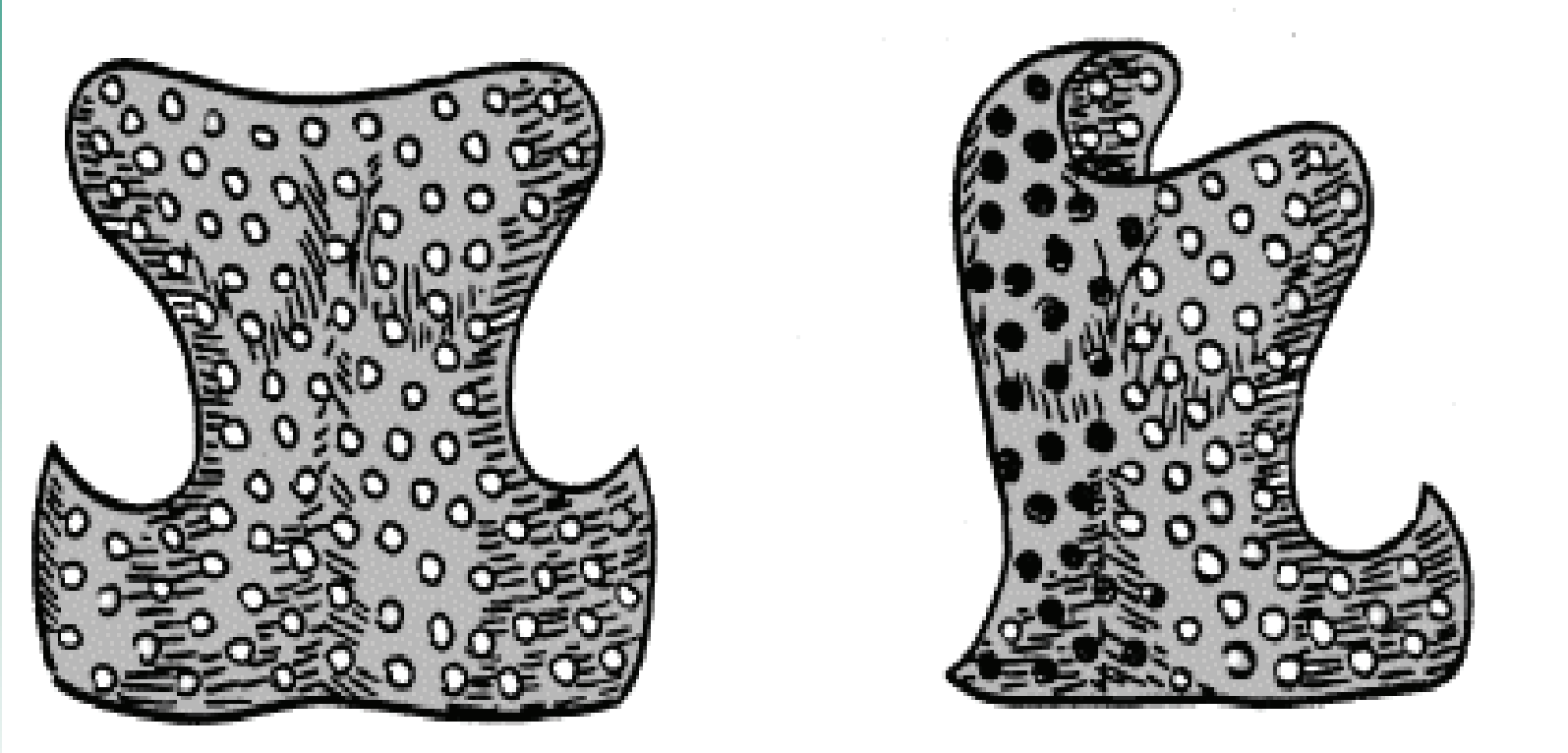




ORTHOTIST ?

Figure 2. The Hippocratic ladder for correction of spinal deformities. From the illustrated comments of Apollonius of Kitium on the

# Ambrose Pare 1510-1590



- First orthosis for scoliosis
- Metal corset made by an armorer



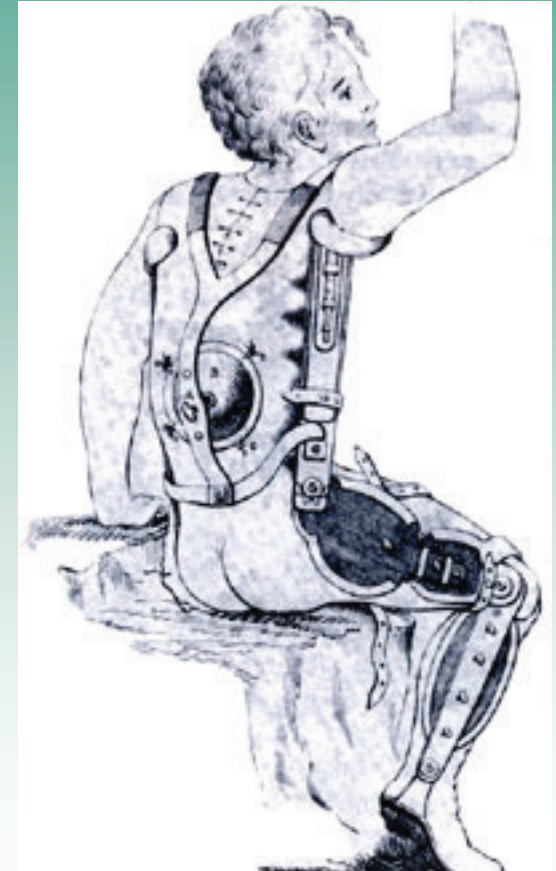
# Nicolas Andre

- 1741 coined the term “orthopedia” which means “straight child”
- Focused on the idea that scoliosis was due to muscle imbalance and poor posture
- He advocated for some of the first ergonomically designed tables and chairs.
- 
- Also used corsets and braces as treatment
- Scoliosis of the Spine- Brown University



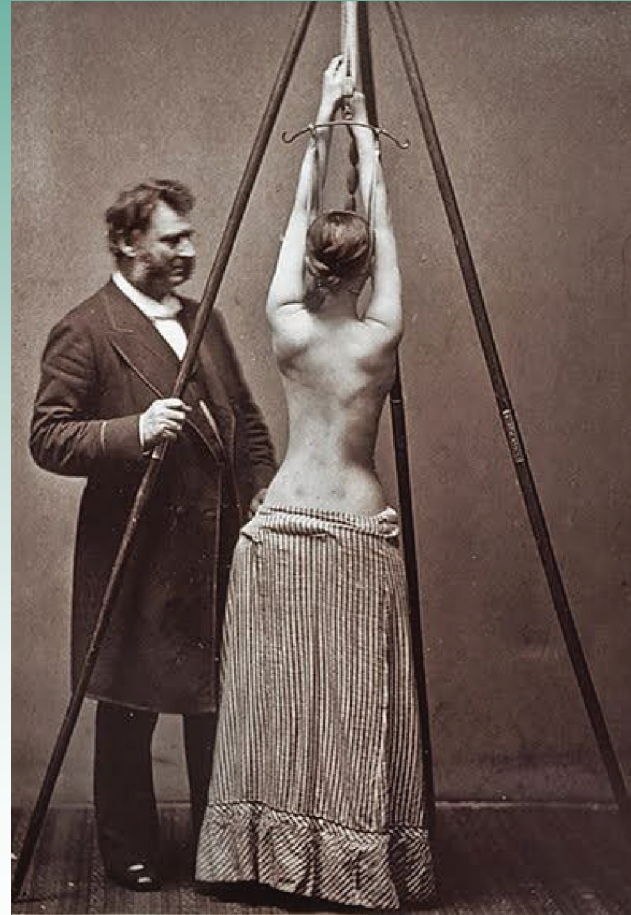
# Francois LeVacher and Jean-Andre Venel

- LeVacher 1768
  - Jurymast Brace
  - First to use Axial Distraction while upright
- Venel 1780
  - Father of Orthopedics
  - Hospital for children's skeletal Deformities
  - First brace to apply horizontal corrective forces with extensive force.



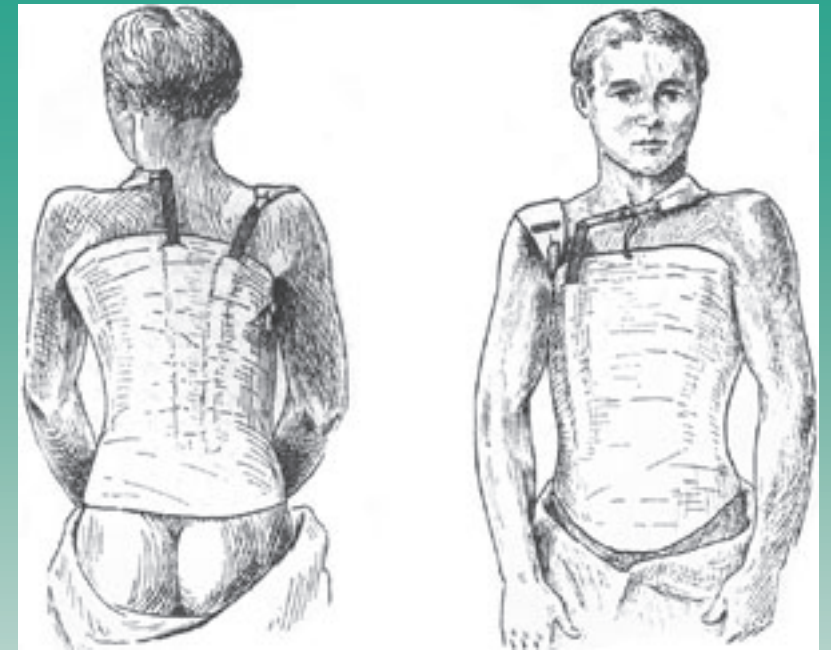
# Lewis Sayre

Lewis Sayre and his  
suspension device for  
the treatment of  
**scoliosis** (1877)

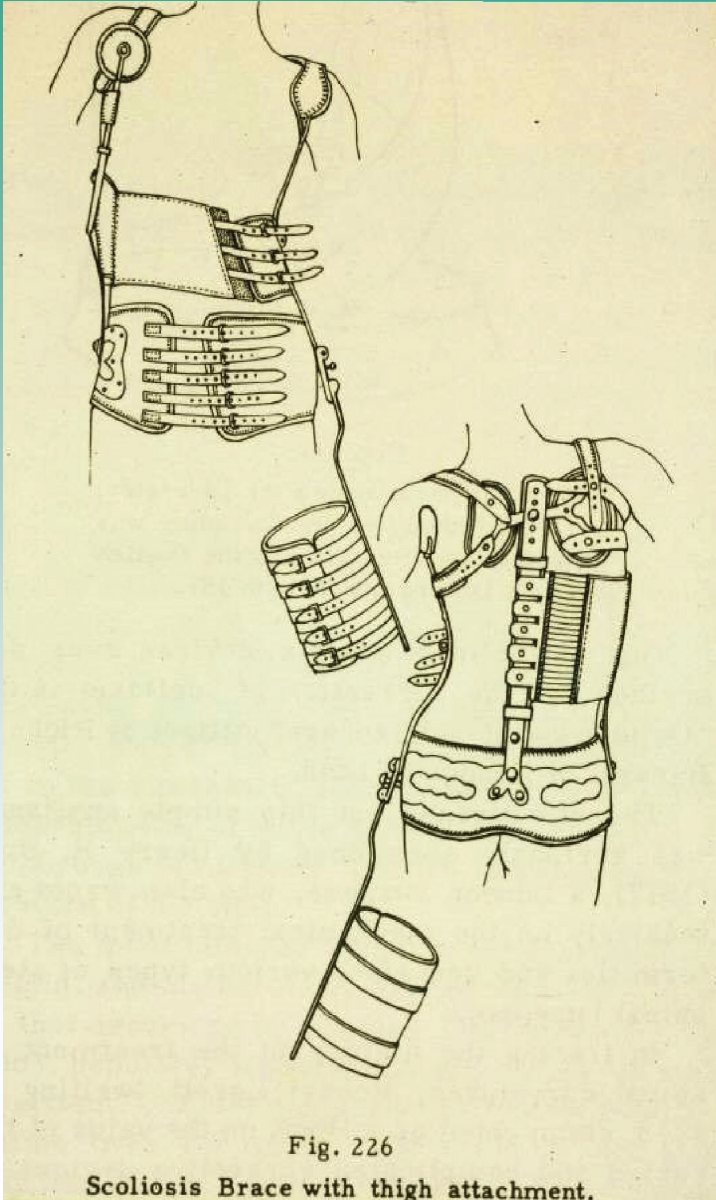


# Lewis Sayre

- 1880's started using plaster casts while standing in a vertical position
- First to apply both lateral and rotational methods of correction
- Bradford and Brackett later developed horizontal frames for cast application.

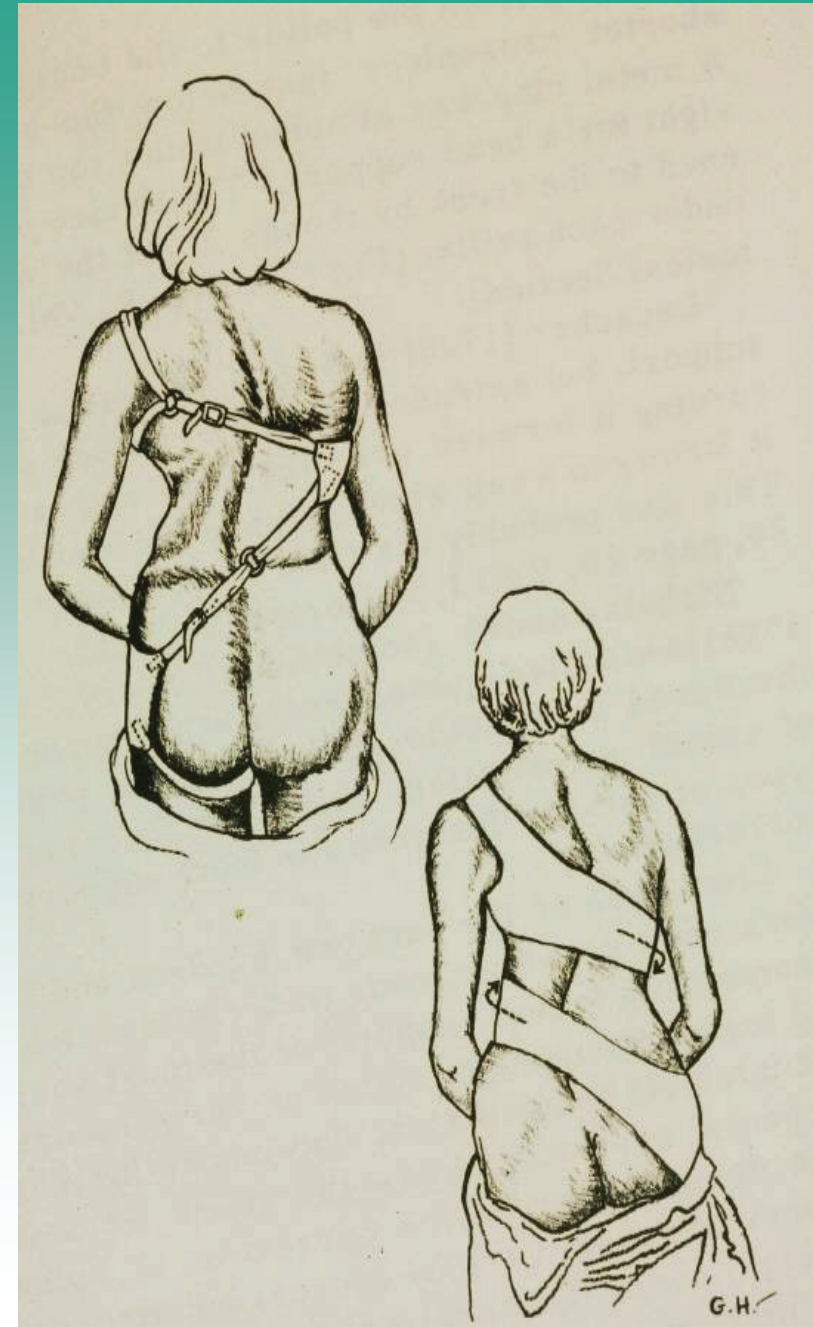






- Early braces used three-point fixation
- Most
  - used a pelvic mold
  - Recognized need to flatten lumbar lordosis

- Detorting Body Belt
- Described by Lange 100 years ago
- Precursor of SpineCor?





## Early TriaC brace?

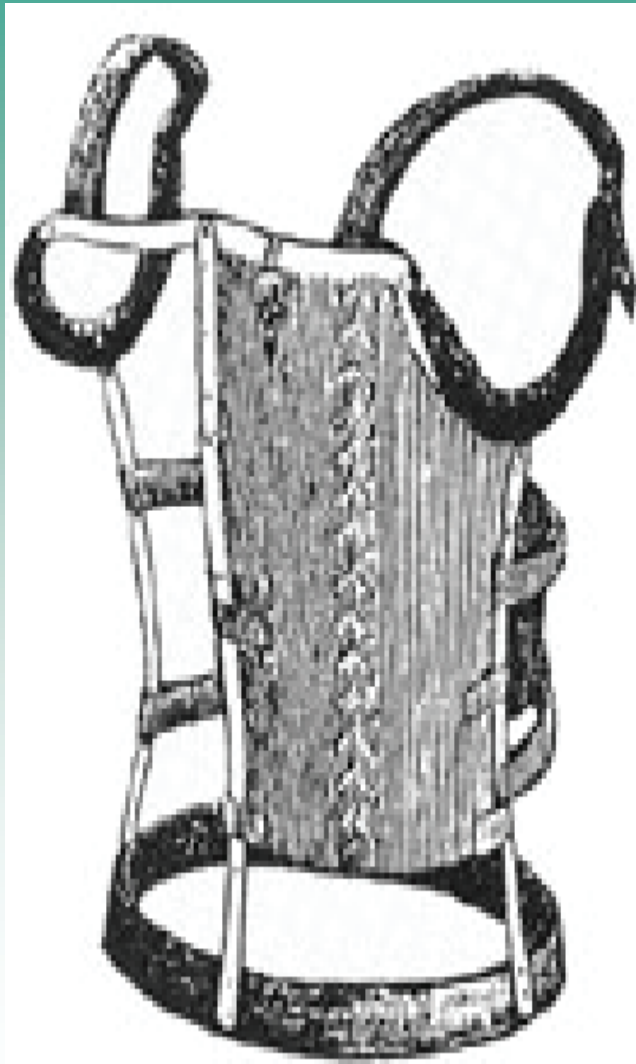


FIG. 738.

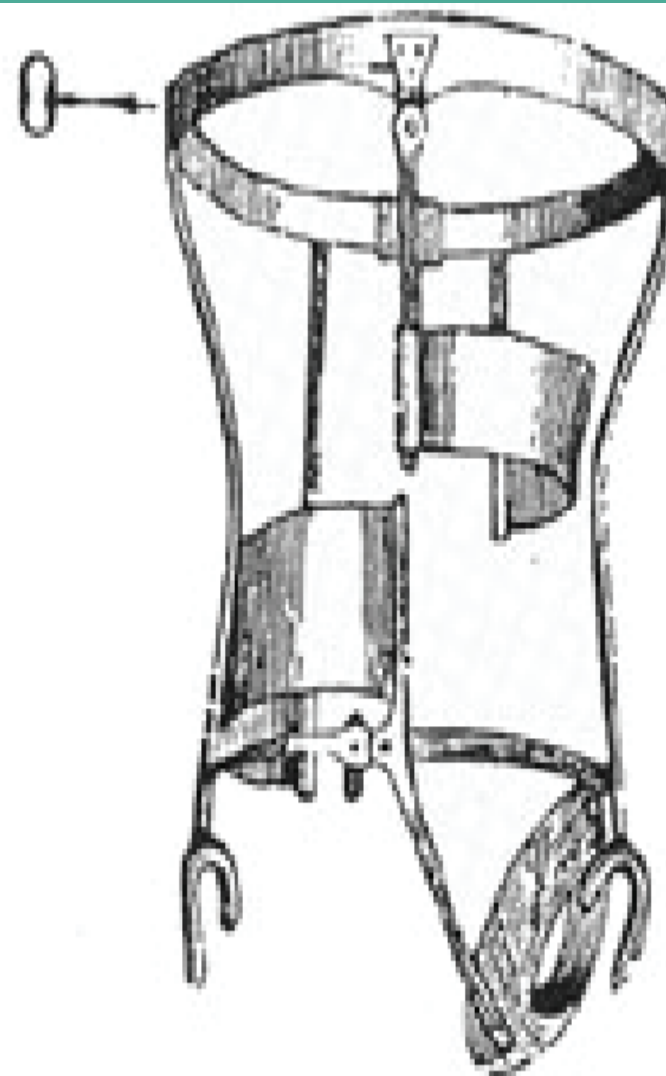


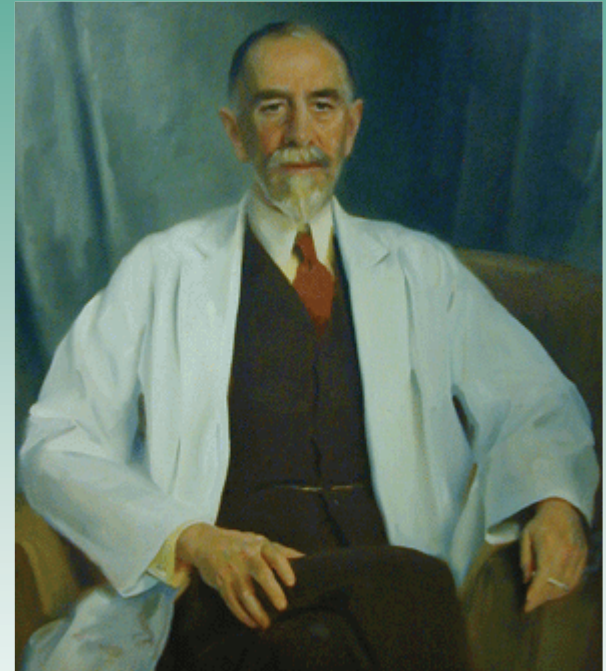
FIG. 739.

## **Jules Guérin –1865**

- Surgical attempt to correct curvature by percutaneous myotomies of the vertebral musculature.
- Surgically severed musculature and tendons in over 1300 patients.
- Revisions were frequent and results were considered horrific.
- Later he was banned from France and went to Belgium

# Spinal Fusion

- In 1895, evaluation of scoliosis changed with the advent of X-Rays as a form of non invasive evaluation
- Surgeons were implanting steel rods in the spine as early as 1902 but in 1911 Robert Hibbs formalized the formal spinal fusion
- 50% of the cases showed no correction
- 30% saw an increase in deformity



# Paul Harrington

- 1955 Harrington developed a new distraction system that straightened the spine while holding it rigid while fusion took place.
- A ratchet system with hooks that attach to the vertebrae at both the top and bottom of the curve.



# Correction of Structural Changes in Scoliosis by Corrective Plaster Jackets and Prolonged Recumbency

BY ALVIN M. ARKIN, M.D.\*, NEW YORK, N.Y.

*From the Orthopedic Services of Monmouth Memorial Hospital, Long Branch, New Jersey, Bellevue Hospital and Mount Sinai Hospital, New York*

In earlier papers<sup>1,2</sup> it was pointed out that the structural changes in progressive scoliosis could be the result of asymmetrical pressure upon the growing vertebral epiphyseal plates produced by the action of gravity on the functionally curved spine in the upright position. This led to the suggestion that a rational form of



FIG. 1

Lateral recumbency in plaster jacket. The side of the original concavity is downward.

## Bending casts

- Effective form of non-operative treatment
- Required cast changes every six months
- Two years of recumbency

• JBJS 46A:33, 1964



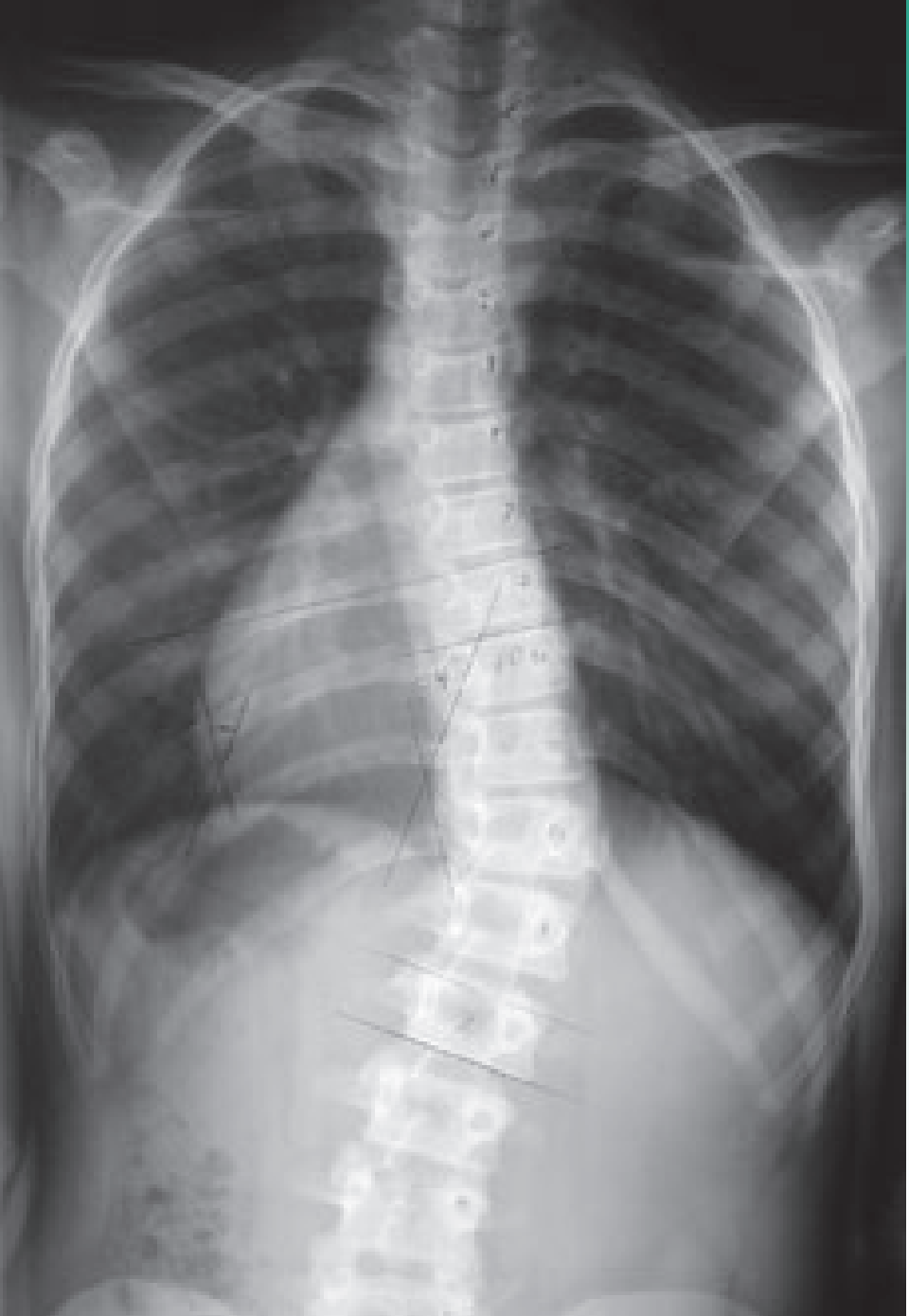


What has changed in the Last hundred or so years ?

- More knowledge
- Advances in Technology
- Better materials
- Better fitting

Our methods are very similar, maybe we just understand a little more?





SRS Indications for Bracing  
Curves between  $25^{\circ}$ - $40^{\circ}$   
Significant growth remaining

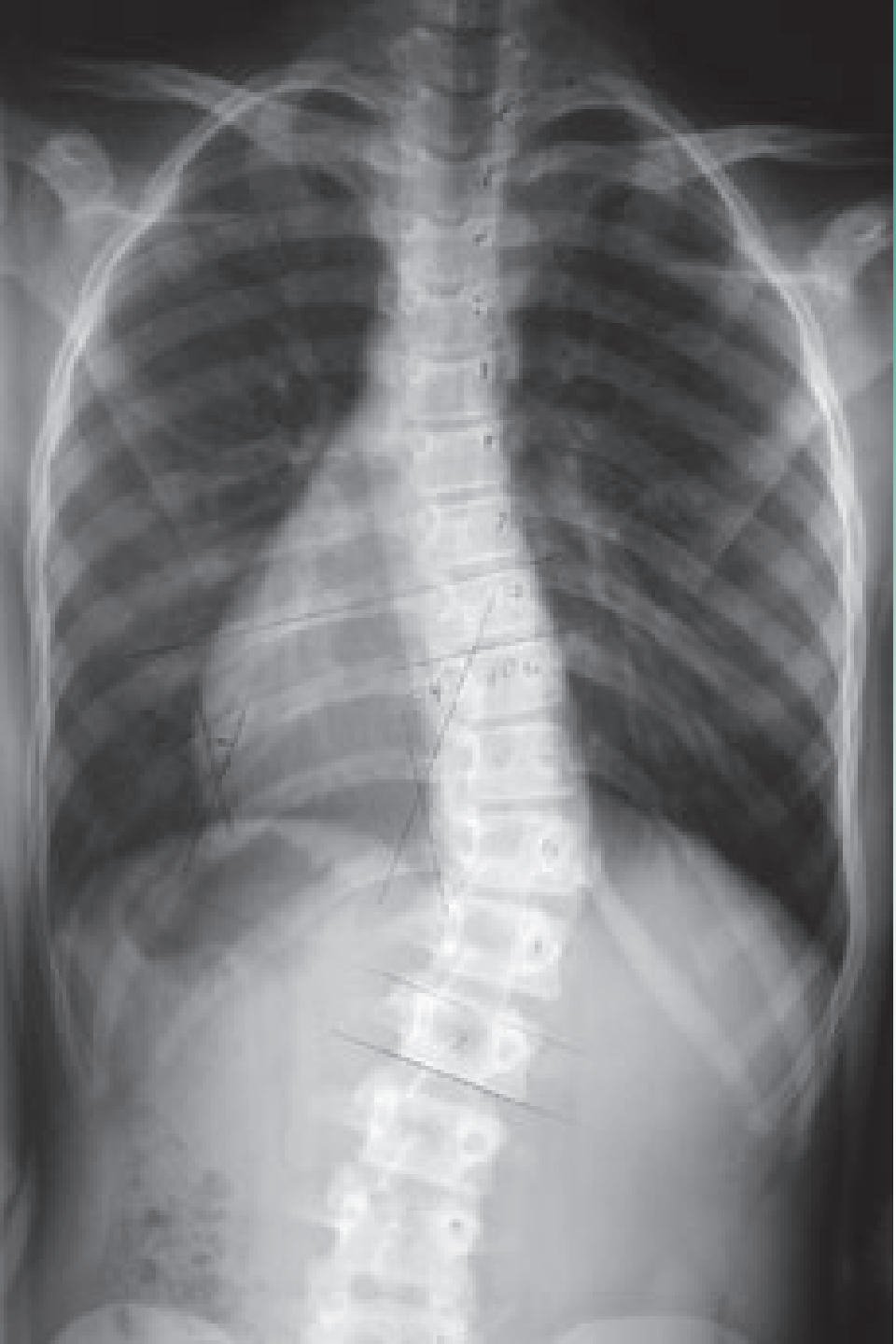
**Richards, et.al.  
Spine 30:2068, 2005**

**WHY DO WE OBSERVE UNTIL  
25 DEGREES?**



# CHOICES





Age 13+3

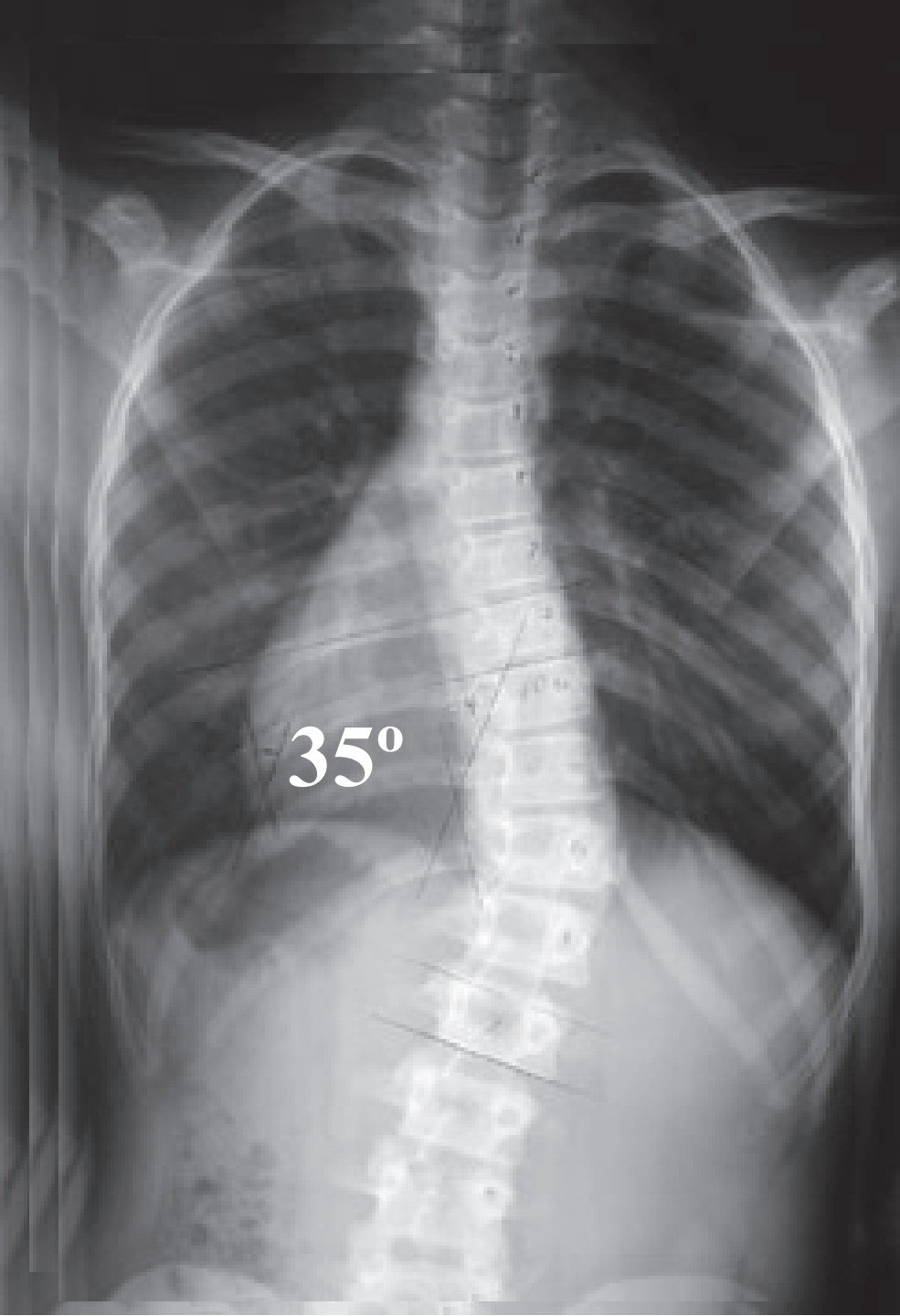
35° Right Thoracolumbar

Pre-menarchal

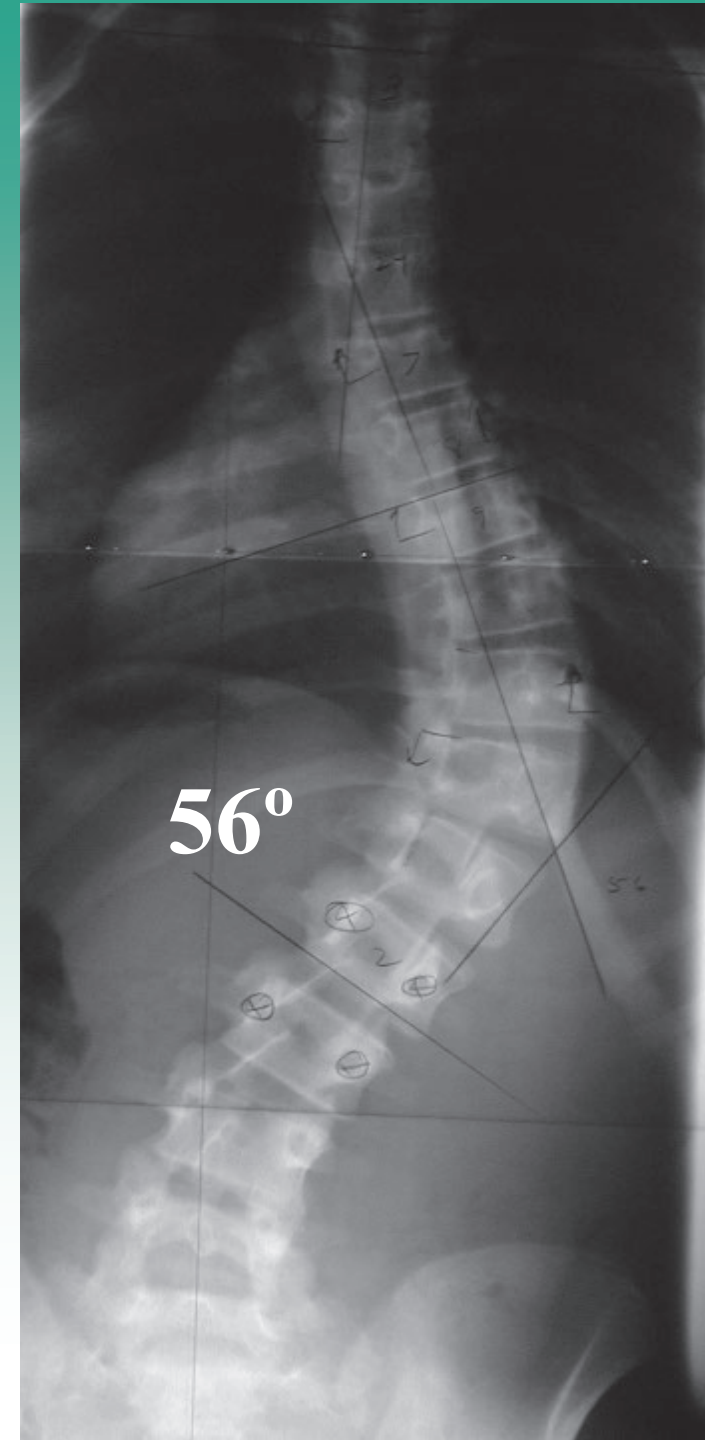
Risser 0

- Milwaukee
- Wilmington
- Boston
- Charleston Bending Brace
- Providence
- SpineCor –Montreal
- Chêneau
- Gomez
- TriaC

**CHOICES HAVE CONSEQUENCES**



**1 yr later**  
**TLSO**  
**23 hrs/day**





A qualitative study published out of Greece in 2006 found that braced adolescents reported experiencing stress, fear, anger, and shame related to their brace-wearing

(SAPOUNTZI-KREPIA ET AL. 2006)

A study out of Italy in 2008 found that adolescent females with scoliosis had a significantly higher rate of eating disorders (anorexia nervosa, bulimia nervosa, and eating disorder-not otherwise specified) than the general population

(Alborghetti, Scimeca, Costanozo, & Boca, 2008)

MacLean et al. reported that 84% of 31 patients receiving brace therapy experienced emotional distress but that the distress decreased in proportion to the duration of brace therapy.

MacLean et al. Stress and coping with scoliosis. Psychological effects on adolescents and their families.

J Pediatric Orthopaedics 1989, 9:257-61

Fallstrom K, Cochran T, Nachemson A: Long term effects on personality development in patients with adolescent idiopathic scoliosis. Influence of type of treatment. *Spine* 1986

MacLean WE, Green NE, Pierre CB, Ray DC: Stress and Coping with scoliosis, Psychological effects on adolescents and their families. *Journal of Paediatric Orthopaedics* 1989

Reichel D, Schanz J: Developmental psychological aspects of scoliosis treatment. *Pediatric Rehabilitation* 2003

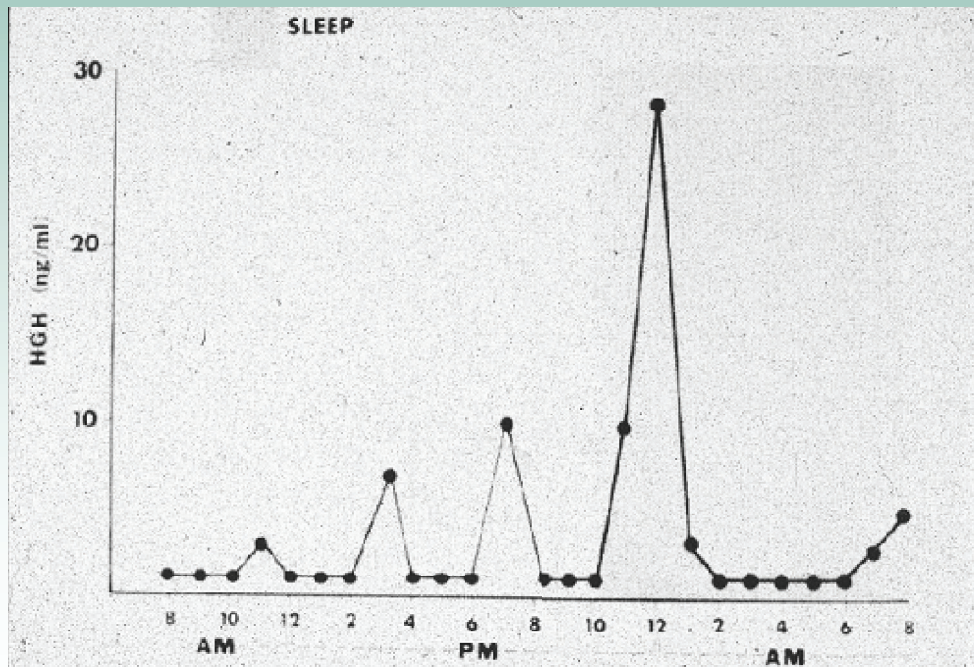
Cochran T, Nachemson A: Long-term anatomic and functional changes in patients with adolescent idiopathic scoliosis treated with the Milwaukee brace. *Spine* 1985

Ugwonali OF, Lomas G, Choe JC, Hyman JE, Lee FY, Vitale MG, Royce DP Jr. Effect of bracing on the quality of life of adolescents with idiopathic scoliosis. *The Spine Journal* 2004

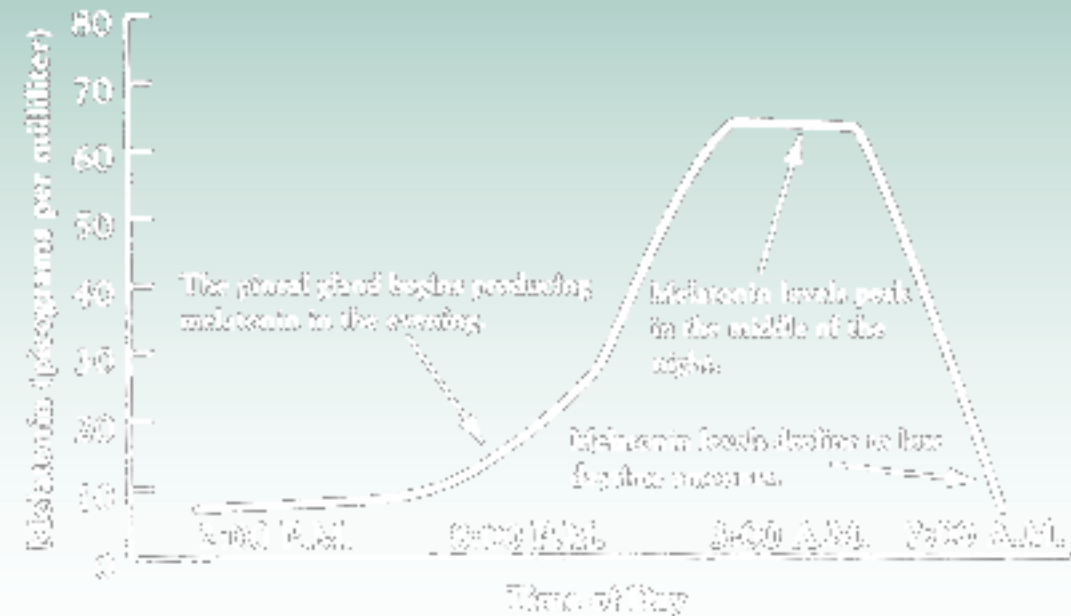
Aulisa AG, Guzzanti V, Perisano C, Marzetti E, Specchia A, Giordano M, Aulisa L: Determination of quality of life in adolescents with idiopathic scoliosis subjected to conservative treatment. *Scoliosis* 2010

# Scoliosis is a disorder of growth

Growth Hormone and Melatonin have high levels at night and minimal levels during the day



**Growth Hormone**

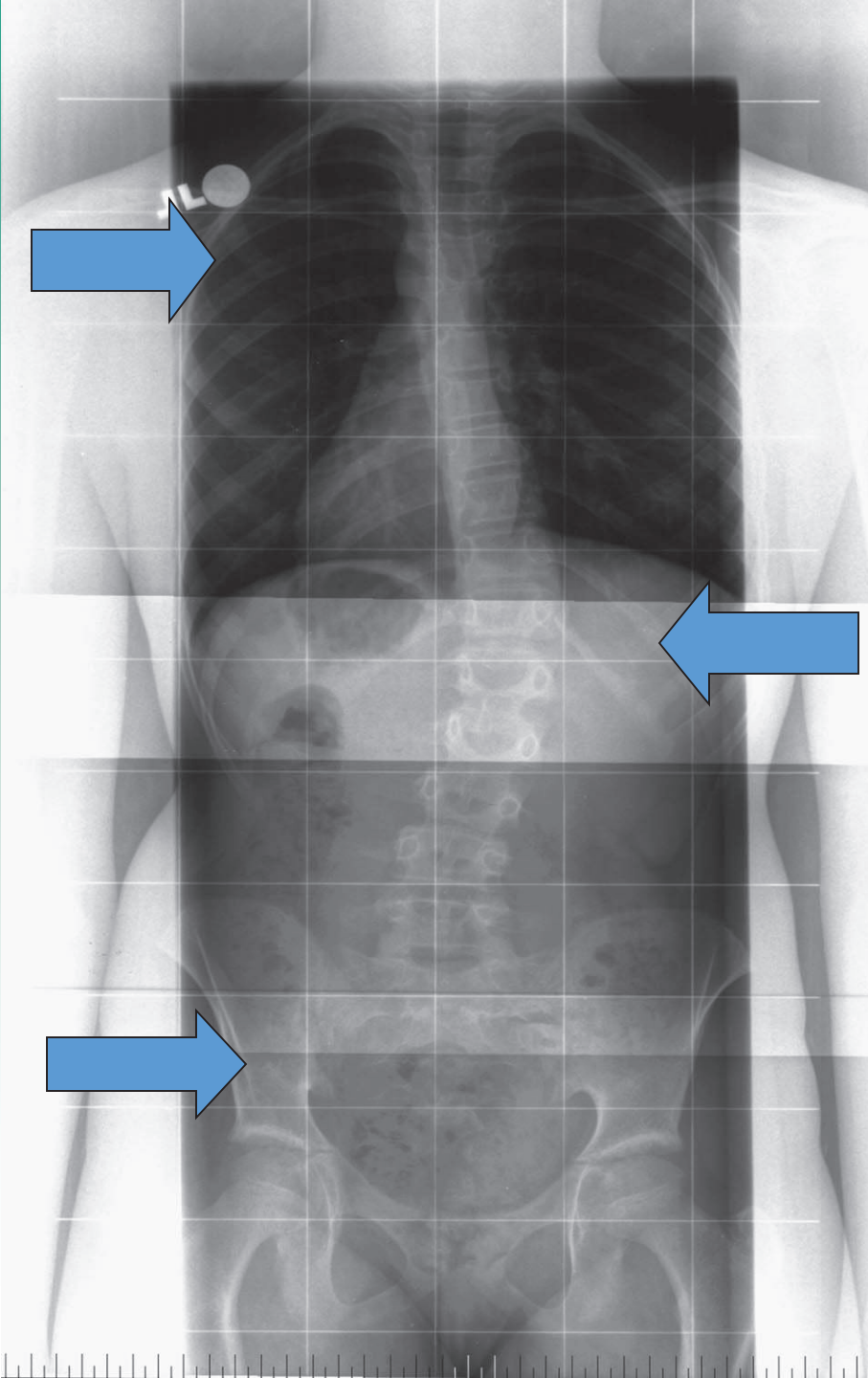


**Melatonin**



# Spinal growth can be modulated by compression!

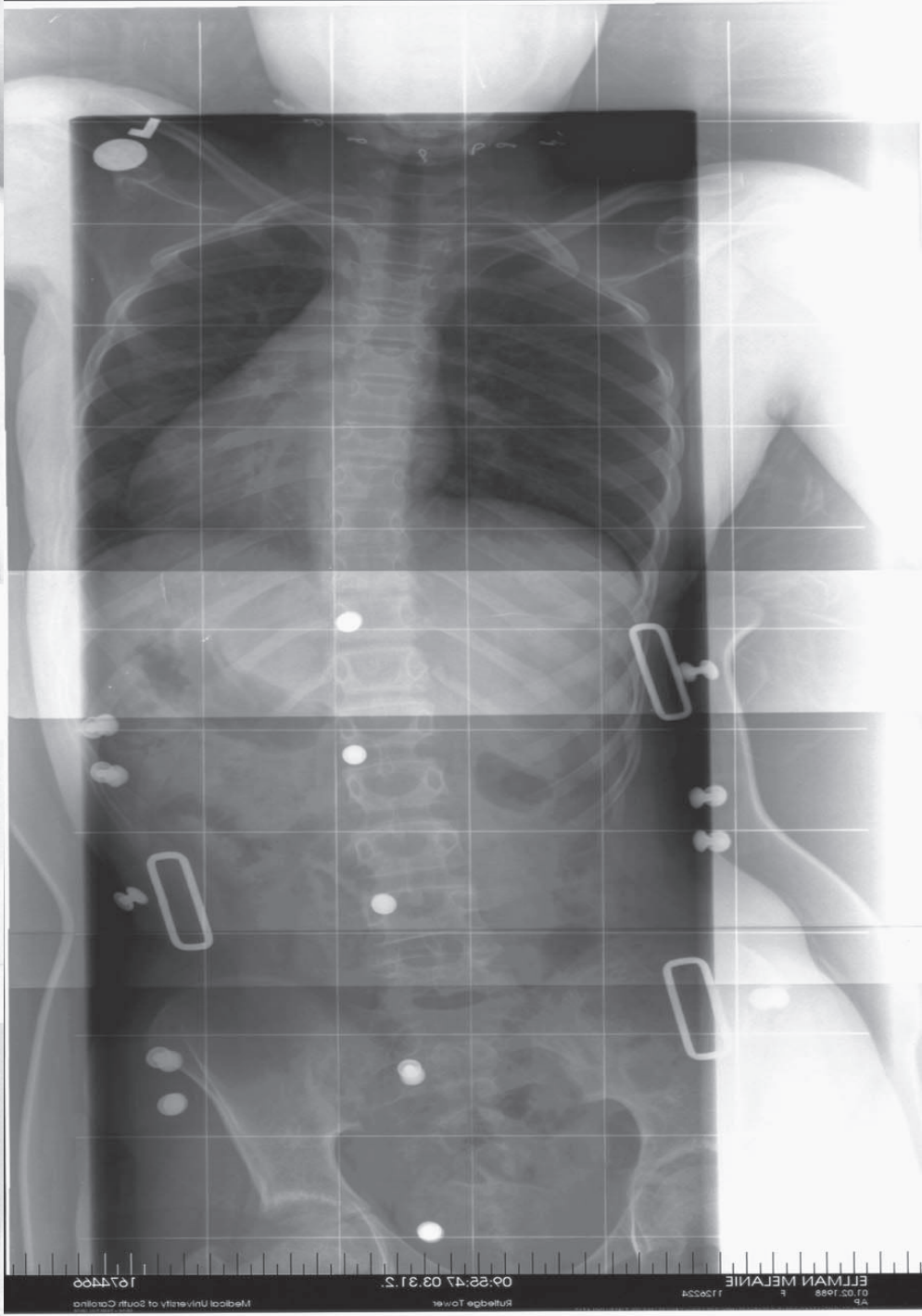
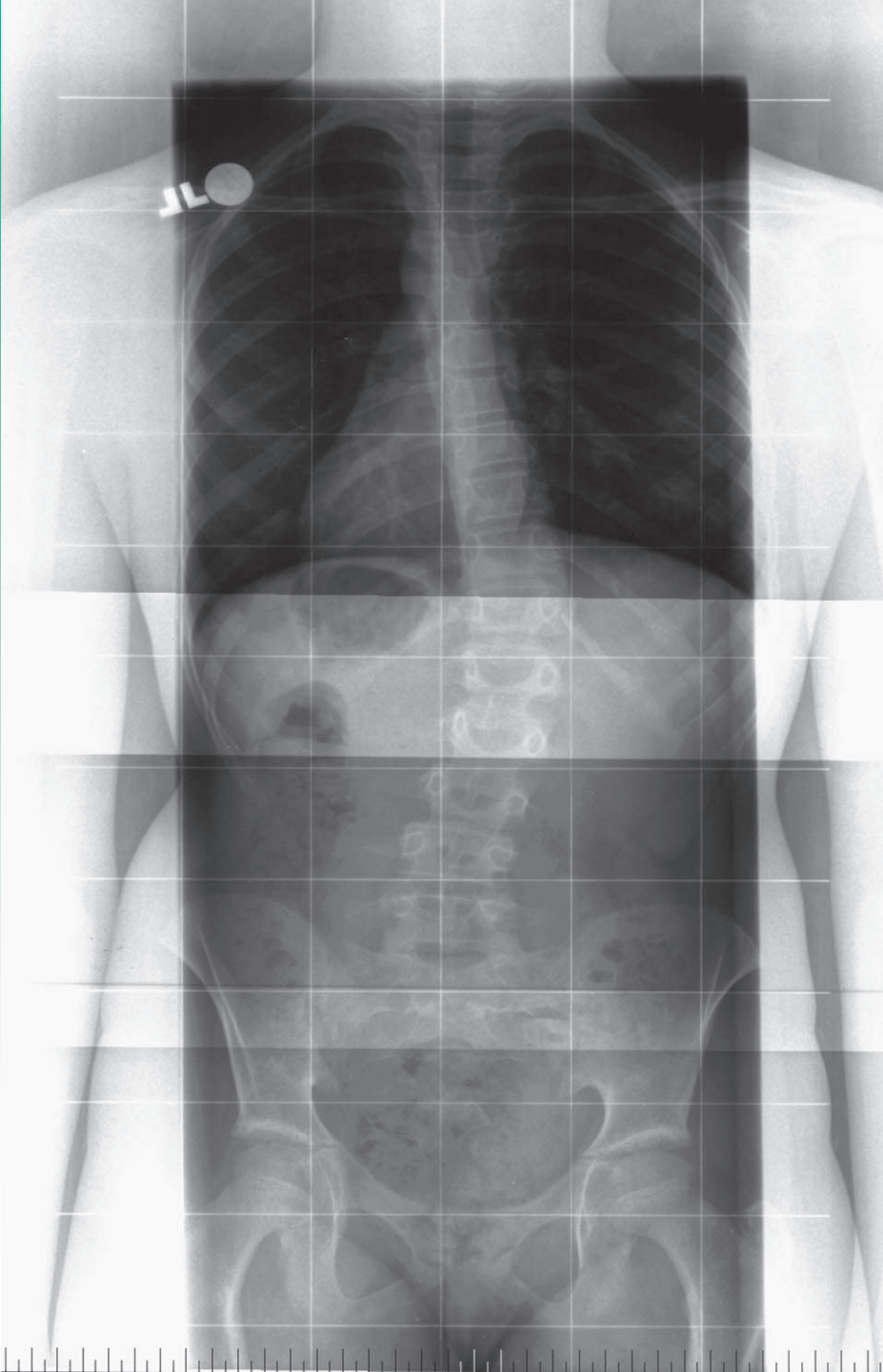
- Villemure I. Aubin CE. Dansereau J. Labelle H. *European Spine Journal*. 13:83, 2004
- Newton PO, et.al. *Spine*. 30:2608, 2005
- Stokes IA, Aronsson DD, et.al. *Journal of Orthopaedic Research*. 24:1327, 2006



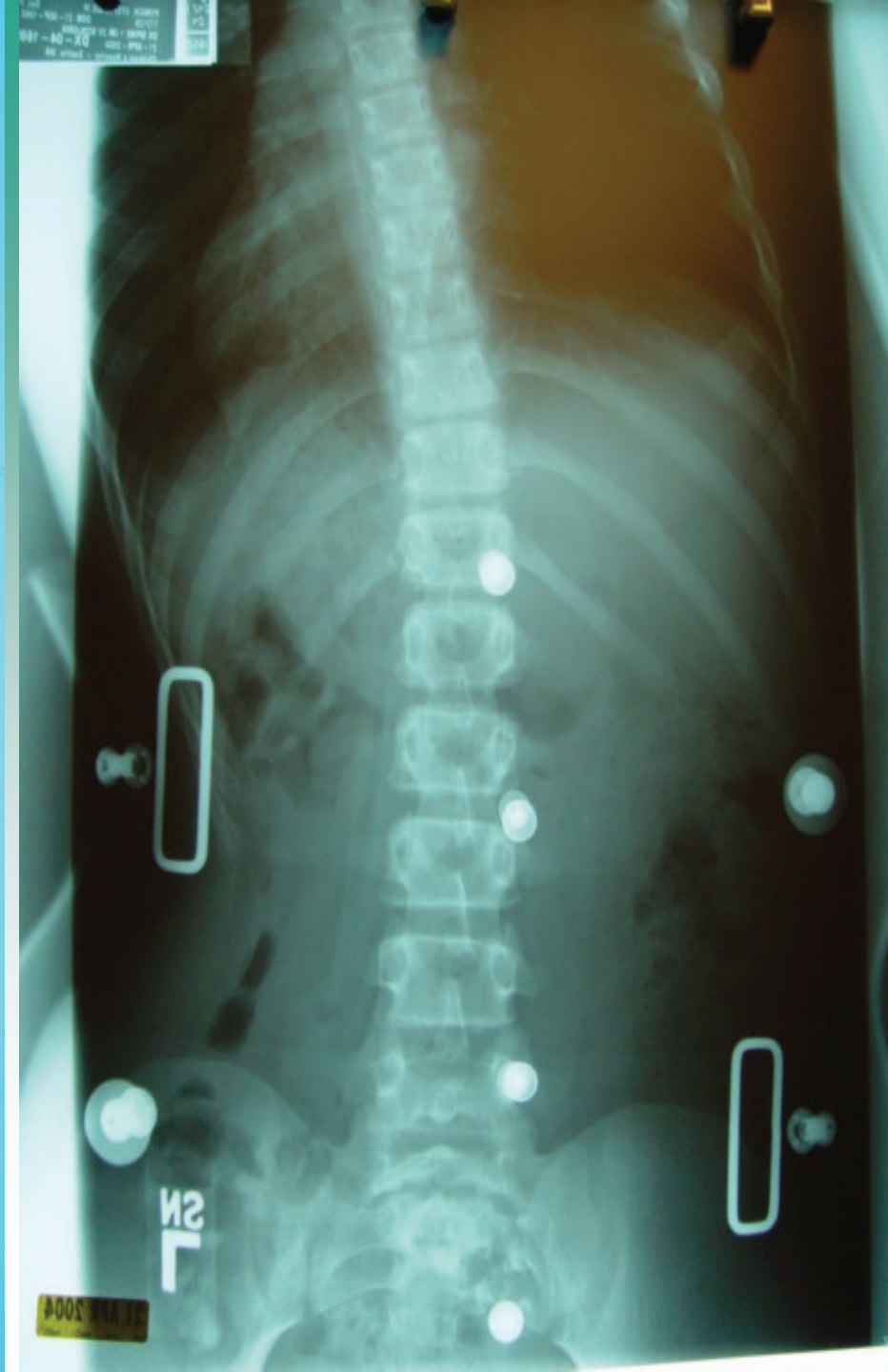
DYNAMIC UNBENDING  
PRESSURE

DYNAMIC / STATIC LATERAL  
SHIFT PRESSURE

STATIC STABILIZATION  
PRESSURE





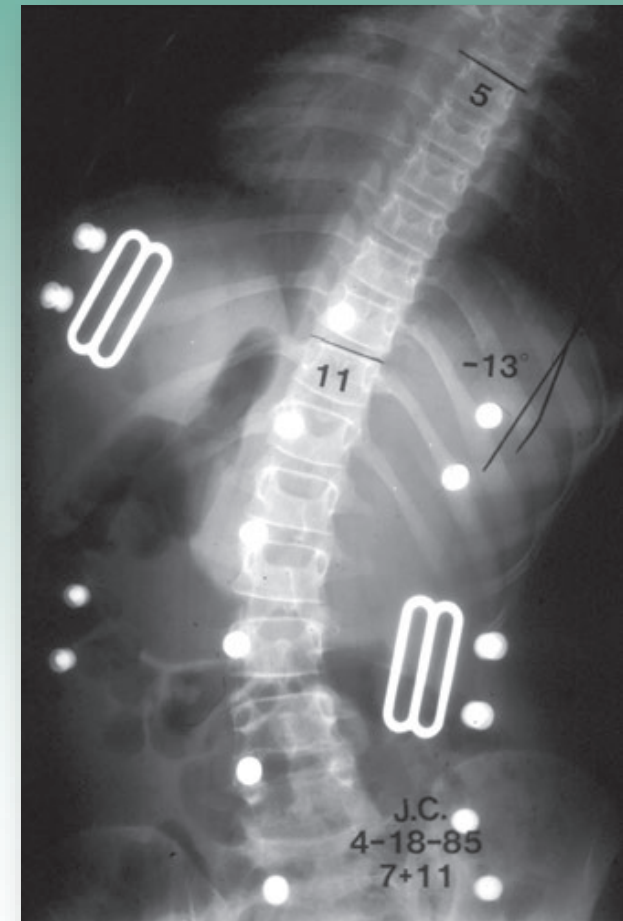




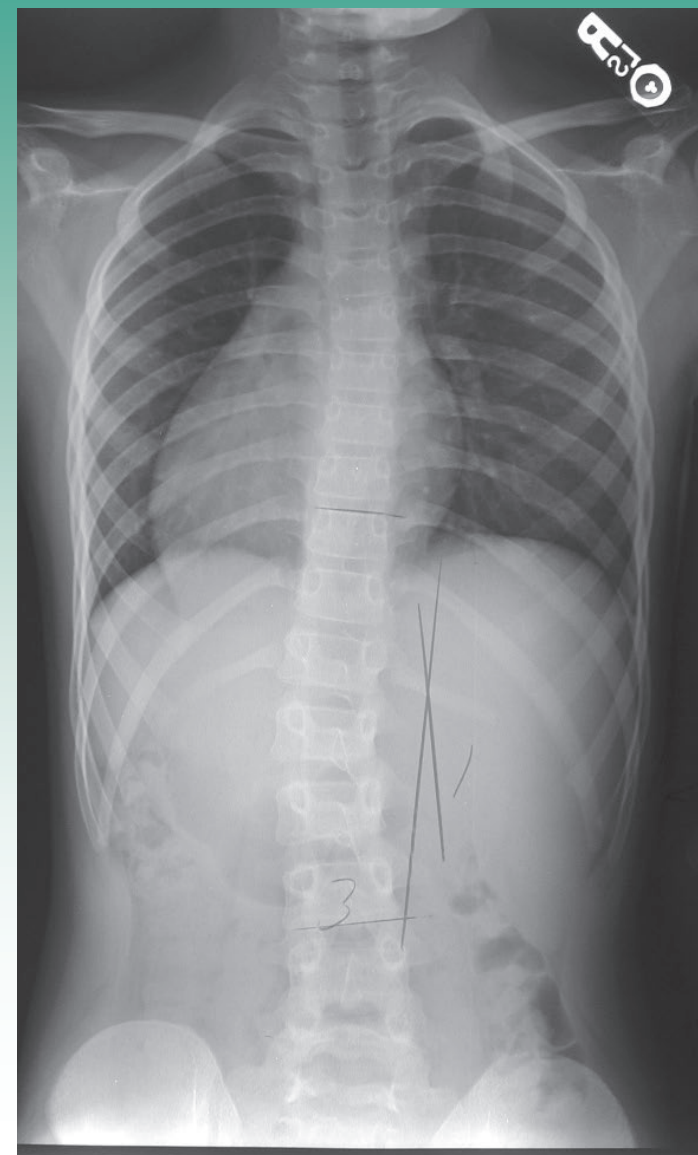
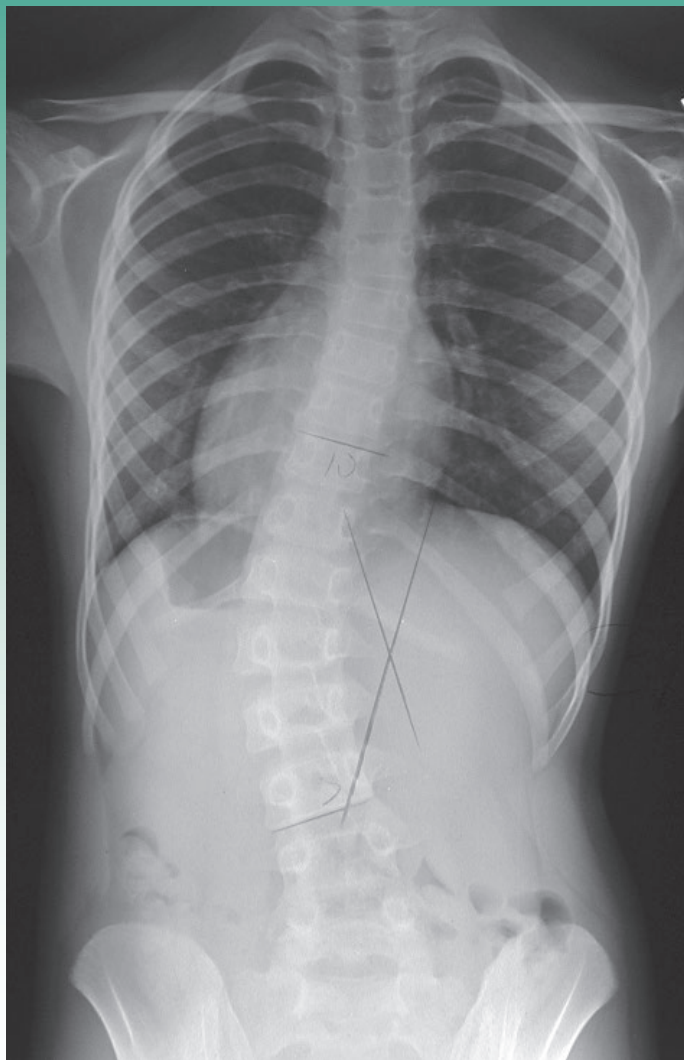
# Greater in Brace Correction Correlates with Correction at Follow-up

Emans, et al.  
Noonan, et al.  
Katz, et al.

Spine 1986  
JBJS 1996  
Spine 1997



End of treatment



## **Boston vs. Charleston Bending Brace**

Both orthoses were comparably effective in treating single thoracolumbar and single lumbar curves.

- Equally effective to 35 degrees
- Boston Brace more effective for larger curves

**Katz, et al.**

**Spine 22:1302, 1997**

# **Charleston Bending Brace**

## **(Risser 0,1 Curves 25°-40°)**

- Charleston Bending Brace is effective in preventing progression of single curves

**Trivedi and Thomson  
Conn. Children's Med. Center  
JPO 21:277, 2001**



# Charleston Bending Brace

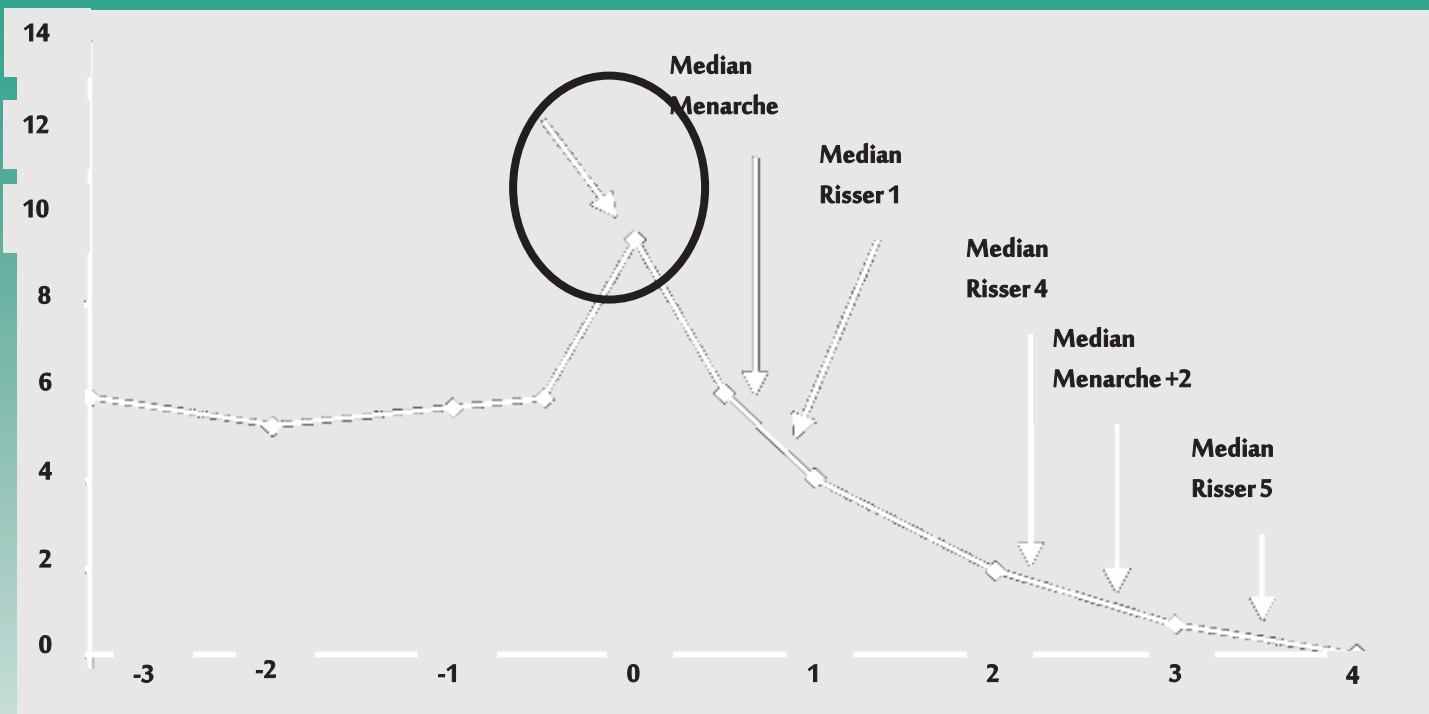
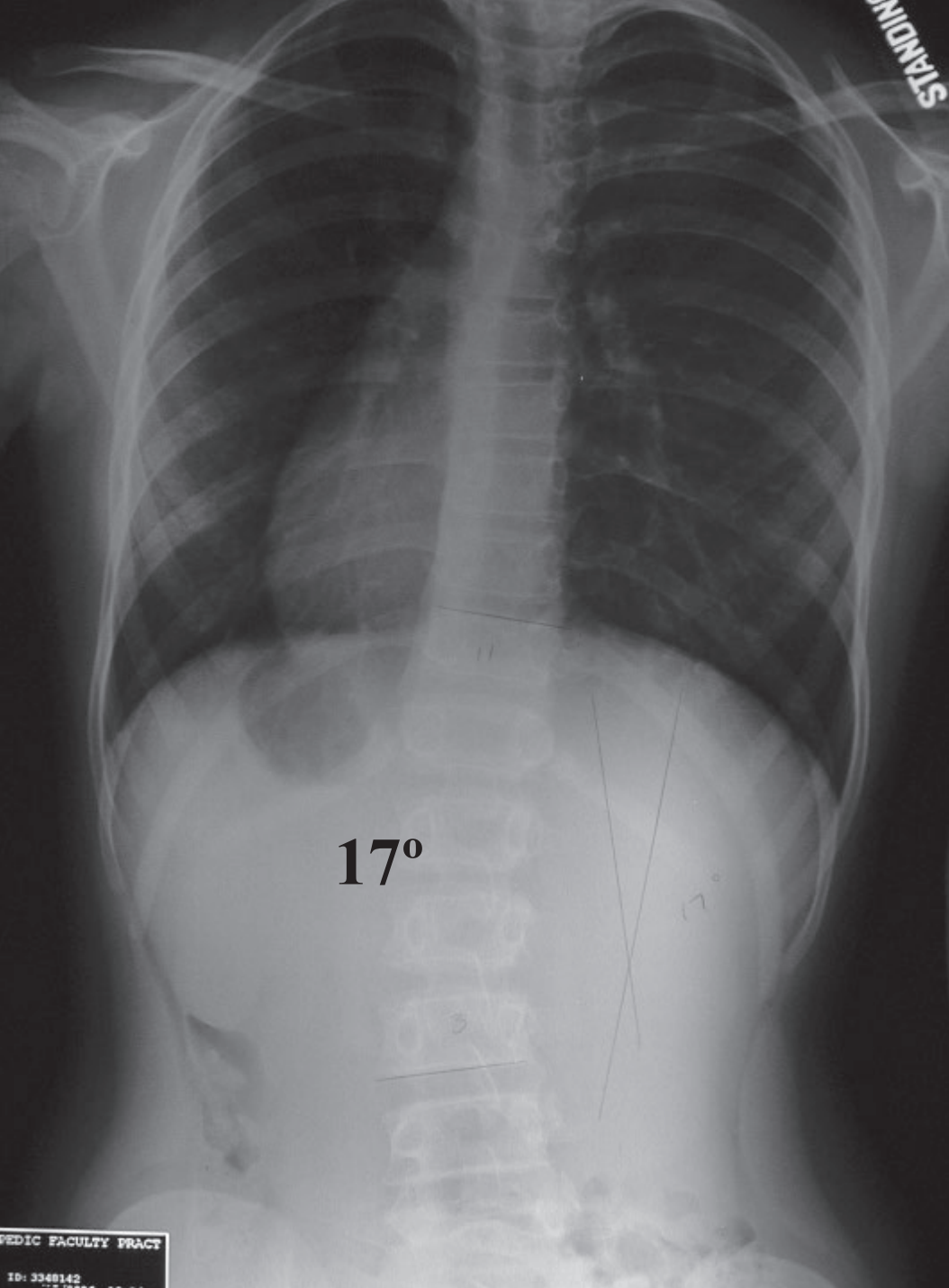
- 85 CBB patients
- 27 TLSO patients
- “No significant differences in success rate was found between the two groups”

**Gepstein, et.al.  
JPO 22:84, 2002**

## **Charleston Bending Brace**

- 30 patients compared to TLSO results
- “Nighttime bending brace was considered as effective as the Wilmington brace in controlling adolescent idiopathic scoliosis”

**Bowen, et.al.  
Orthopedics 24:967, 2001**



**Before peak growth age**

**Curve < 30°**

D.G. Little, K.M. Song, Don Katz and J.A. Herring

Early treatment with a nocturnal  
Charleston Bending Brace  
may reduce progression  
to full-time bracing threshold.

John M. Wiemann, MD,\* Suken A. Shah, MD,w and  
Charles T. Price, MDz  
J Pediatric Orthopaedics 2014



## Results of six year study

- Comparison of night time bracing and observation in adolescent girls
- Curves between 15° and 25°
- Premenarchal girls
- Risser 0
- Lots of growth remaining

John M. Wiemann, MD,\* Suken A. Shah, MD,w and Charles T. Price, MDz  
J Pediatric Orthopaedics 2014

# **Premenarchal Girls**

## **Scoliosis 15°-25°**

- Delaware
  - Observation for all patients until curve progresses past 25 degrees or more than 5 degrees
- Orlando
  - Night time bracing with a Charleston Bending Brace for all patients at time of initial presentation.

# Premenarchal Girls

## Scoliosis 15°-25°

- Delaware
  - All patients progressed in this age group with just observation
  - Bracing 16-23 hours was recommended
- Orlando
  - 30% did not progress and only used night time bracing (highly statistically significant difference)

# What is Calmodulin???

- Calmodulin is a naturally occurring intracellular protein with 147 amino acids.
- The specific function of calmodulin is that of a calcium binding protein
- The binding of calcium to calmodulin enables calmodulin to bind various target proteins in the cell in order to alter their activity.

# **CAN WE PREDICT CURVE PROGRESSION ?**

Elevated levels of calmodulin have been correlated with progression of scoliosis curves

Kindsfater, Lowe, et.al; J Bone Joint Surgery 1994



## WHAT WE KNOW!

- Melatonin has been linked to having therapeutic value in animal studies with regard to a decreasing severity of scoliosis

Machida, Dubouset, et.al; Spine 1996

- Melatonin has also been shown to have an antagonistic interaction with calmodulin

Huerto-Delgadillo, Ant'ón, et.al.; J Pineal Research, 1994

Dr. Price and his colleagues suspect that calmodulin levels are variable in patients with scoliosis. “If calmodulin levels correlate with curve progression and are variable, are the levels then elevated during periods of progression?” Furthermore, do the levels decline following skeletal maturity?

**“And can we anticipate increased rates of progression based on calmodulin level?”**

# Summary

- All braces seem to have some effect on scoliosis
- For double curves more than 35 degrees, the Charleston Bending Brace combined with TLSO daytime wear, may be the best choice to prevent surgery
- Most patients don't wear their braces full time
- The Charleston Bending Brace is effective and easy to use for single curves.
- The Charleston Bending Brace can be used for double curves if designed properly.

# THE CHARLESTON BENDING BRACE™ OBJECTIVES

- Maintain the patient's scoliotic curvatures at, or near, pre-brace values throughout the growth period and on to skeletal maturity.
- Promote better brace wear compliance through the nocturnal wear aspect

# **CBB CLINICAL OUTCOMES ARE GUIDED BY THREE PRINCIPLES:**

- 1. Growth Modulation (unbending).** The rate of the epiphyseal growth plate is affected by pressure applied to its axes. An area of increased pressure inhibits growth and an area of decreased pressure accelerates growth.
- 2. In Brace Correction:** The amount of in brace correction is a predictor of long-term outcome of the treatment. CBB principles overcorrect a spinal curve in accordance with the spine flexibility.
- 3. Patient Compliance:** Patient comfort and compliance is promoted through nocturnal wear.



## Recommendation

- Start with night time bracing for premenarchal girls with small curves
- If night time bracing fails, then switch to night time bracing in conjunction with daytime bracing.
- If combination bracing fails switch to daytime bracing.

# **ADVANTAGES OF THE CBB PROGRAM**

1. Allows full, unrestricted musculoskeletal development.
2. Allows opportunity for athletic participation.
3. Causes fewer and less severe complications.
4. Complications are minimized due to the brace being worn a fewer number of hours over a 24-hour period.
5. Results can be assessed more quickly verses the customary long term follow up.
6. Decision-making regarding success or failure of the program can be made earlier.