Nocturnal Bending Brace

NIGHTTIME MANAGEMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS

Hanger
FABRICATION NETWORK

THE NOCTURNAL BENDING BRACE CERTIFICATION COURSE
AN ORTHOTIST'S GUIDE TO SCOLIOSIS MANAGEMENT-Revised 2018

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BACKGROUND AND PRINCIPLES

The Nocturnal Bending Brace™ (NBB) has been the Benchmark for non-surgical, nighttime, scoliosis management for more than 35 years. The first NBB was fabricated in 1978 in Nocturnal, SC. A clinical and technical investigational team formed in 1984 and full-time manufacturing began in 1987 at National Labs. National Labs-Orlando has remained the exclusive manufacturer for more than 30 years.

More than 25 research papers have been published on Nocturnal Bending Brace (NBB); References can be found in the appendices of this certification manual.

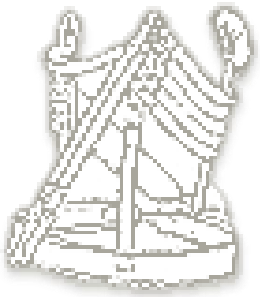


Fig. 1

Non-operative treatment of scoliosis has a long and diverse history. The method of sidebending as an orthotic treatment, while having such a lengthy past, has been a durable technique that remains in use today.

The Kalibis splint, also called the "spiral bandage", was one of the earliest reported orthosis for scoliosis treatment found in the medical literature. Several braces designed in the nineteenth century by German orthotists Heine, Hessing, and Hoffa bear remarkable similarities to later designs by Barr-Buschenfeldt. Probably the most successful and widely accepted sidebending device was the Risser turnbuckle cast, reported in the United States in 1931 by Hibbs, Risser and Ferguson. During the 1970s Lawrence Brown, M.D., of Greenville, South Carolina, utilized a bending brace in a full-time wear program. (*Fig. 1*)

GUIDING PRINCIPLES & GOALS

Nocturnal Bending Brace™ practices three guiding principles:

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.

In Brace Correction (overcorrection)
The amount of in brace correction is a predictor of long-term outcome of treatment.
NBB principles overcorrect a spinal curve in accordance with the spine flexibility and maintain the patient's scoliotic curvatures at, or near, pre-brace values throughout the growth period and on to skeletal maturity.

Patient Compliance (comfort)
Patient comfort and compliance is promoted through nocturnal wear.
Compliance is measured by a compliance monitor embedded into the device.

The GOALS of the Nocturnal Bending Brace:

1. **Maintain the patient's scoliotic curvature** at, or near, pre-brace values throughout the growth period and on to skeletal maturity.
2. Promote better brace **wear compliance** through the nocturnal wear.
3. Promote positive self-image **& reduce burden of treatment**

GROWTH MODULATION THEORY
IN BRACE CORRECTION CORRELATION

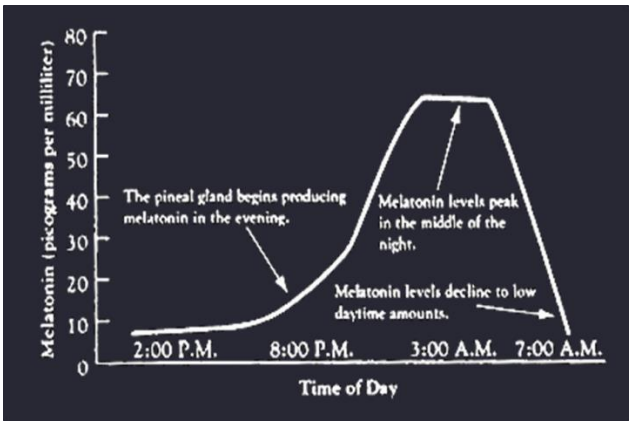
In-brace correction correlates to biomechanical effectiveness of brace treatment in AIS.

Hueter-Volkmann principle: in brace correction predicts long-term outcome of the treatment and provides insights in the understanding of brace biomechanics.
Clin J, Aubin CÉ, Sangole A, Labelle H, Parent S Spine 2010 ;35(18):1706-13.

EVIDENCE-Spinal growth modulation by compression

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

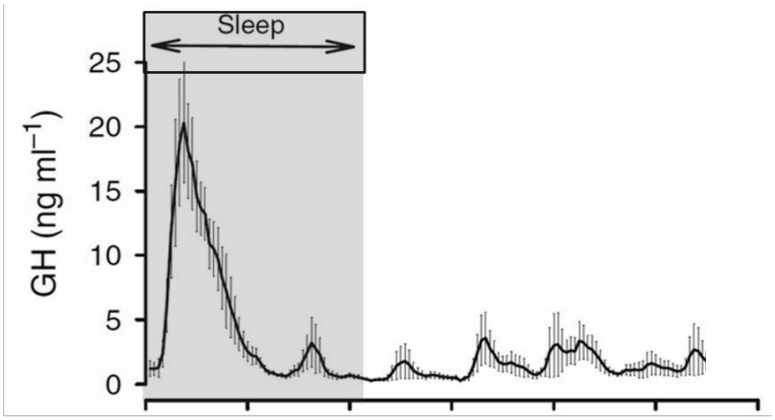
MELATONIN THEORY



- Levels are high **at night** - minimal levels during the day.
- Levels are low in patients with progressive AIS.
- IF scoliosis is a disorder of GRAVITY, then daytime support is necessary.
- IF scoliosis is a disorder of GROWTH then nighttime bracing may be all that's required.

Fig. 2

GROWTH HORMONE IS ONLY PRESENT AND ACTIVE AT NIGHT



- "…at least 90% of bone elongation occurs during recumbency and almost no growth occurs during standing or locomotion. The authors hypothesize that growth may also occur in children during rest or sleep."

Noonan KJ, et al. JPO 2004; 24(6):726-31

Brandenberger G, "The 24-h growth hormone rhythm", J Sleep Res. 2004 Sep;13(3):251-5.

Fig. 3

SCOLIOSIS OVERVIEW

Scoliosis definition

Scoliosis is a multifactorial, 3D deformity of the trunk and the spine which appears and can progress during any rapid periods of growth in otherwise healthy children.
Rigo M, Grivas T. Rehabilitation schools for scoliosis: Describing the methods and results. Scoliosis 2010 Dec 24;5:27

Scoliosis Types

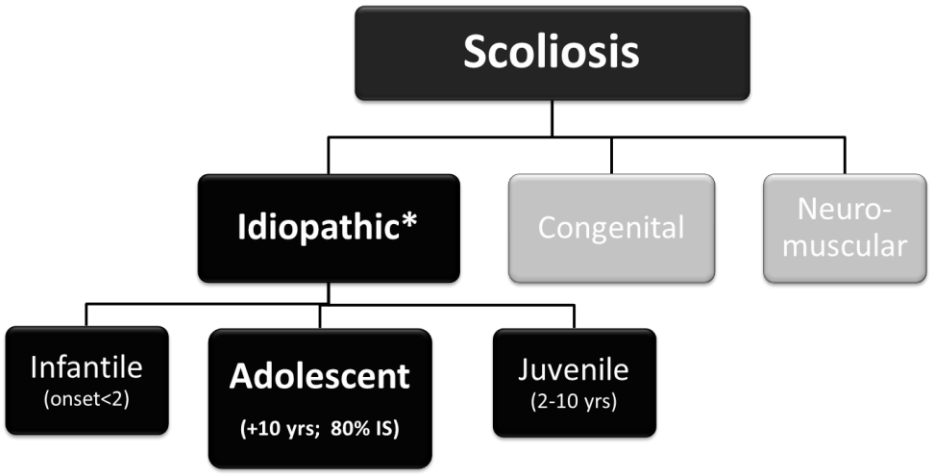


Fig. 4

*Categorized by both age at which the curve is detected and by the type and location of the curve.

RISK FACTORS

Factors influencing prognosis include:
1. Curve type: Where is the curve?
2. Skeletal maturity / Peak height velocity: How old is the patient?
3. Curve magnitude: How big is the curvature?

Prognosis by Curve Type

Curve Type	Untreated Risk of Progression
Double Major	65%
Thoracic	60%
Thoraco-lumbar	55%
Lumbar	35%

Fig. 5

Risk Summary

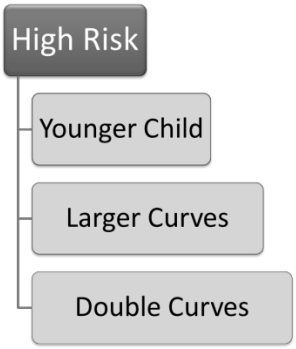
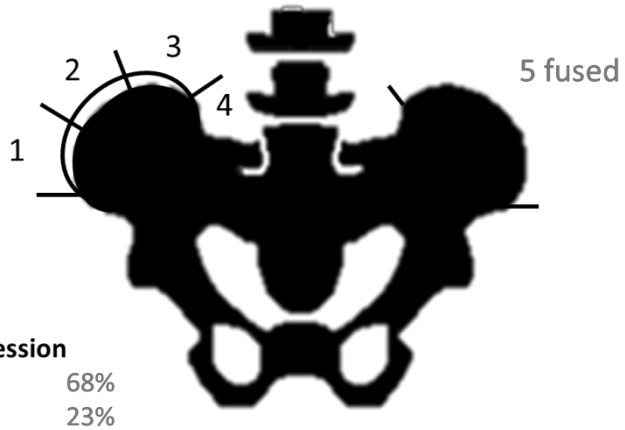


Fig. 6

SKELETAL MATURITY



Risk of Progression

Risser 0-1	68%
Risser 2-3	23%
Risser 4-5	< 5%

Fig. 6

Bracing Indications for Curves <45°

RISSER	Cobb Angle
0	20°
1-2	25°
3	30°
4-5	Aged out / contraindication

Fig. 7

PEAK HEIGHT VELOCITY

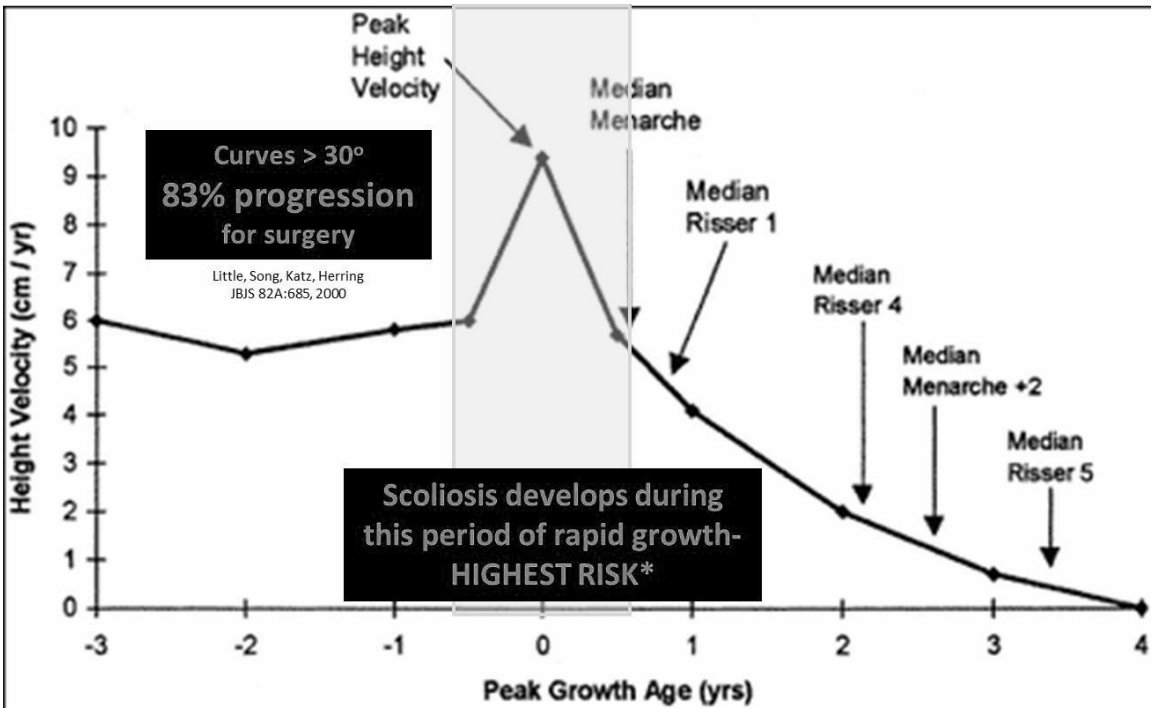
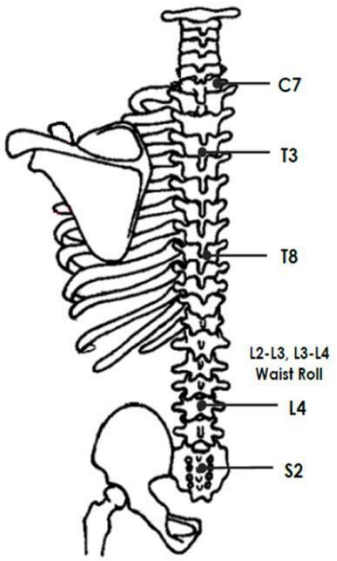


Fig. 8

SPINE ANATOMY OVERVIEW



C7-Rib 1

T3-Scapula Spine

T8-Inferior scapula

T12- Rib 12

L2-3, L3-4 Waist Roll

L5-S1 Sacralization

Fig. 9

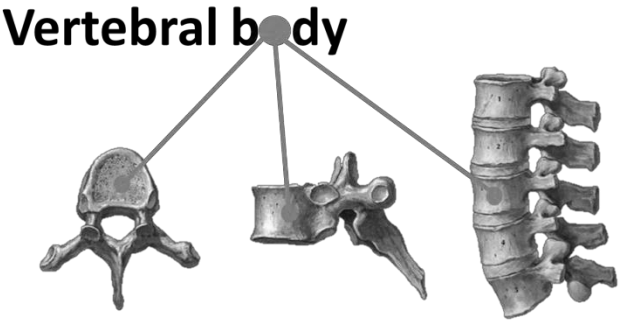


Fig. 10

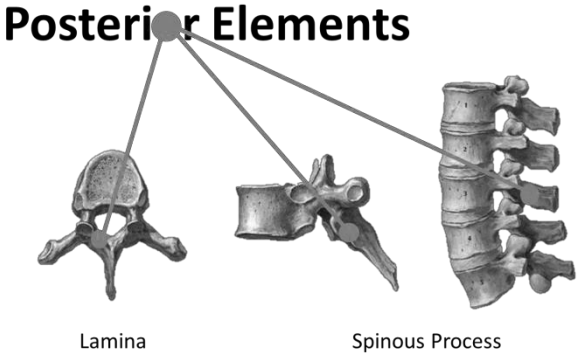


Fig. 11

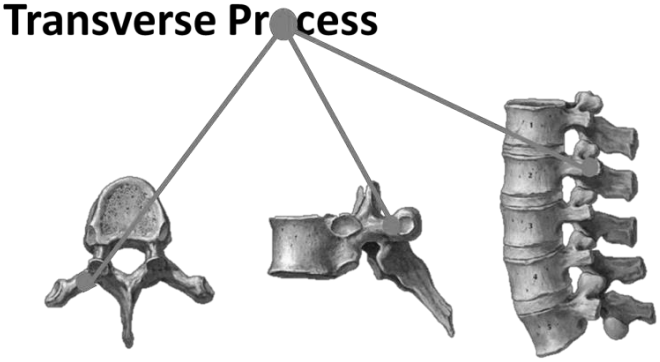


Fig. 12

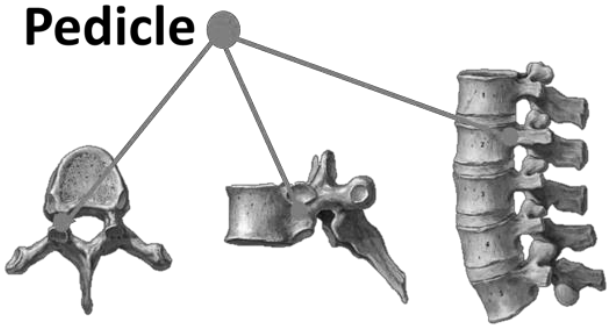
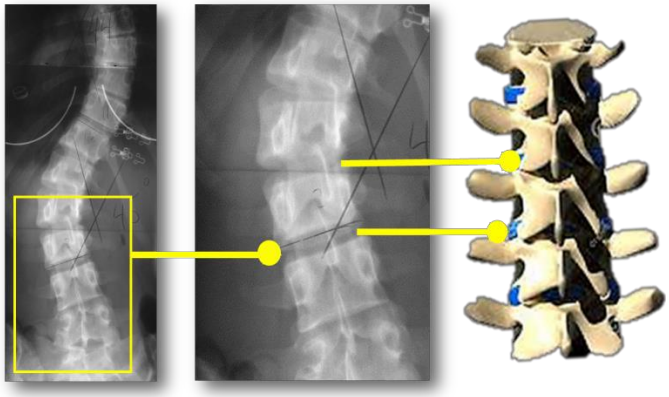
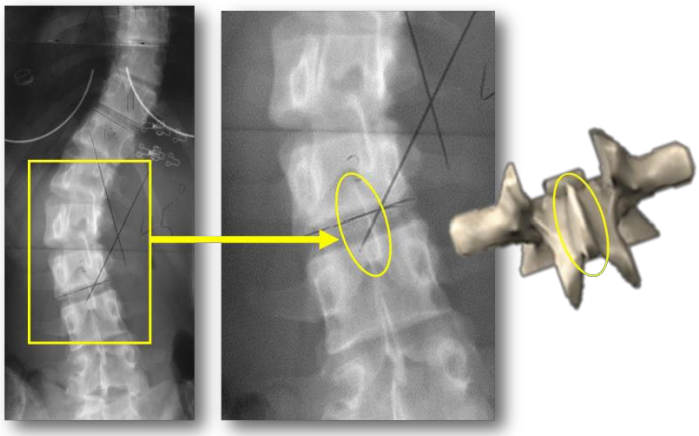


Fig. 13



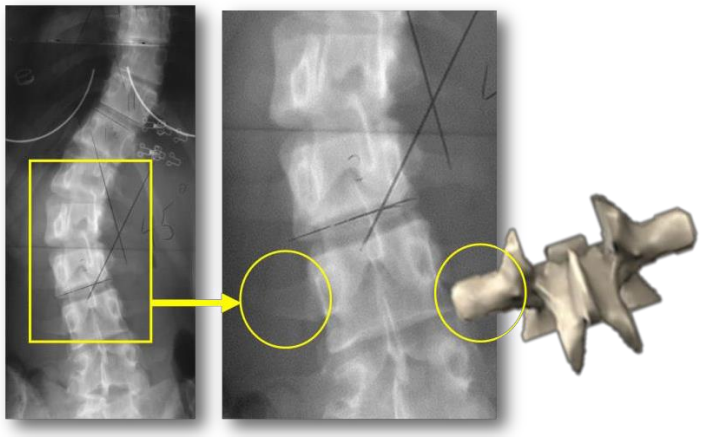
INTERVERTEBRAL DISCS

Fig. 14



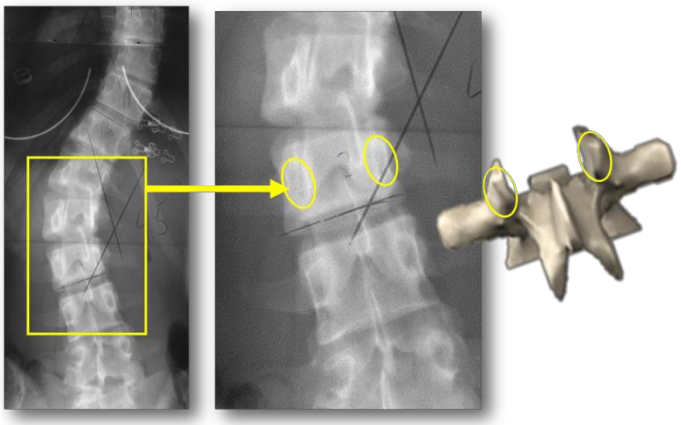
SPINOUS PROCESS

Fig. 15



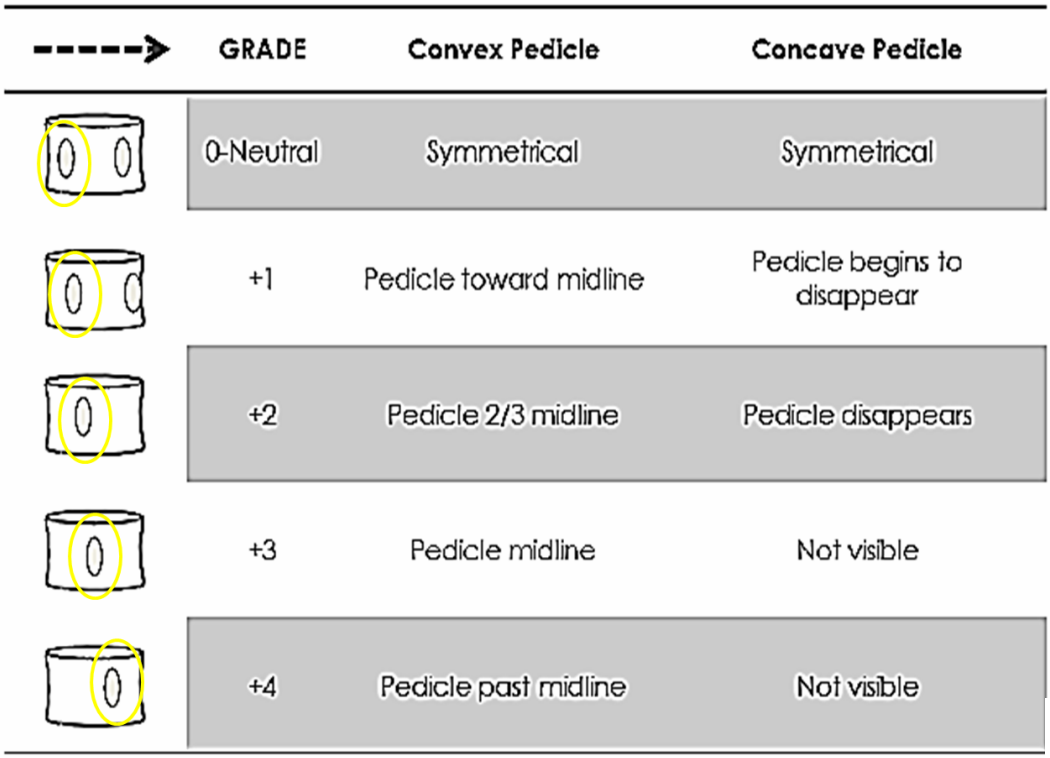
TRANSVERSE PROCESS

Fig. 16



PEDICLES

Fig. 17



---->	GRADE	Convex Pedicle	Concave Pedicle
	0-Neutral	Symmetrical	Symmetrical
	+1	Pedicle toward midline	Pedicle begins to disappear
	+2	Pedicle 2/3 midline	Pedicle disappears
	+3	Pedicle midline	Not visible
	+4	Pedicle past midline	Not visible

Fig. 18

PATIENT EVALUATION BASICS

A clinical examination is always conducted by the orthotist prior to the measuring session. Patient flexibility can be assessed and a reasonable prediction of in-brace results may be determined from the clinical exam. This is also a good time to gauge the patient's tolerance level and take appropriate action to alleviate fears and anxieties in order to help the procedure go smoothly.

FORWARD BENDING: VERTEBRAL ROTATION

Fig. 19

Forward Bending – Have the patient stand facing away from you with weight equally distributed on both feet. With arms extended and palms together, bend the patient forward to 90 degrees and stop. Ask the patient to try and touch the floor to evaluate hamstring tightness. Observe and note trunk rotation limitations.

FLEXIBILITY: TRUNK ROTATION

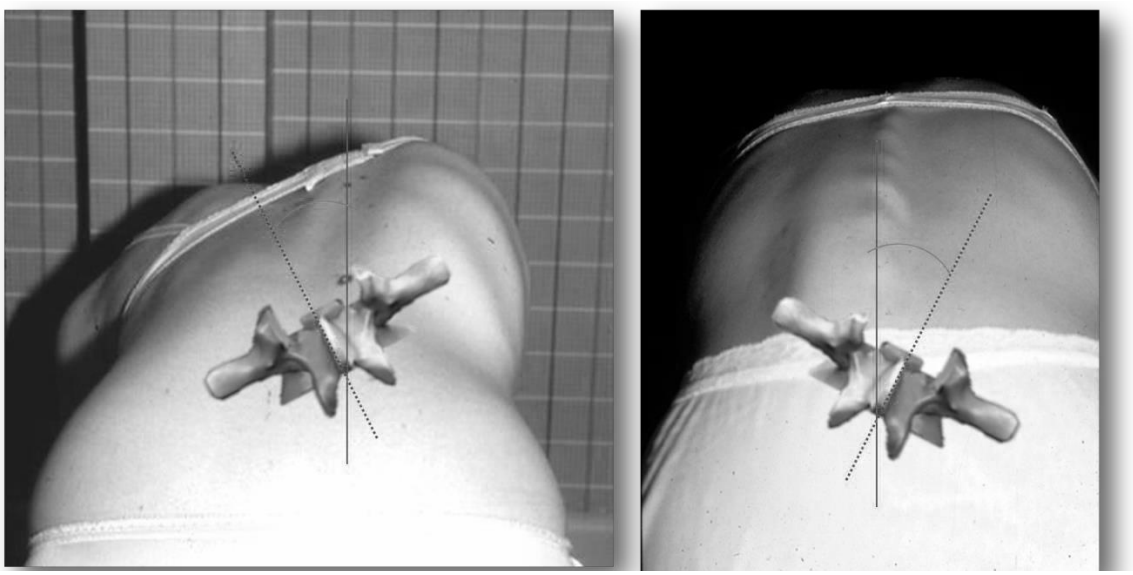
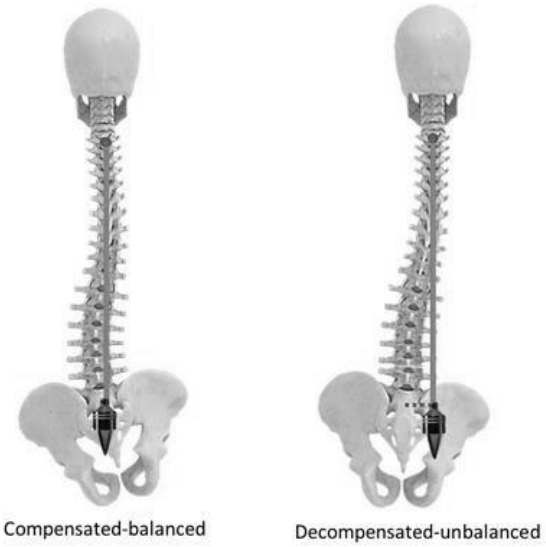


Fig. 20

Flexibility or stiffness – Have the patient stand upright and then bend laterally at the waist. Note how much range the patient has. Next, place your hand at the apex of the curvature and apply a resistive force. Ask the patient to bend laterally over your hand. Note how much range the patient has.

COMPENSATION & DECOMPENSATION



- C7 plumb line to center of buttocks
- Distance in cm

Fig. 21

Radiography

Full-length standing PA X-rays are necessary for the patient evaluation and brace planning. Films should include the full spine and the iliac crests. X-rays should be carefully marked "left" or "right", by the technician. All in-brace x-rays should be taken in the supine position. If indicated, it should be explained to parents that modern X-ray techniques limit exposure through advanced equipment, special grids and high-speed film**. Digital X-Rays are preferred.**

"BLUEPRINTING"

The "blueprint" is an essential resource for the orthotist during the NBB molding and fabrication processes. This process determines where the optimal corrective forces should be applied both during the molding and at brace application.

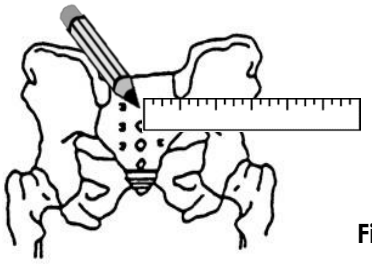


Fig. 22

Center Line—the center line is a vertical drawn on the X-ray indicating where the patient's spine would be if it were straight and free from scoliosis. (Fig 22)

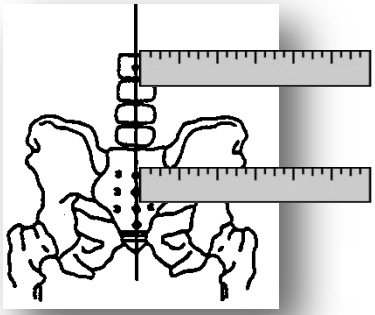


Fig. 23

Sacrum visible Locate and mark a spot at the center of S-2.

With a straight edge, measure the distance from the mark to the edge of the X-ray. (Fig. 23)

At a point several inches above S-2, make a second mark that same distance from the edge of the X-ray as the first mark. Draw a vertical line through the marks. This line is the center line.

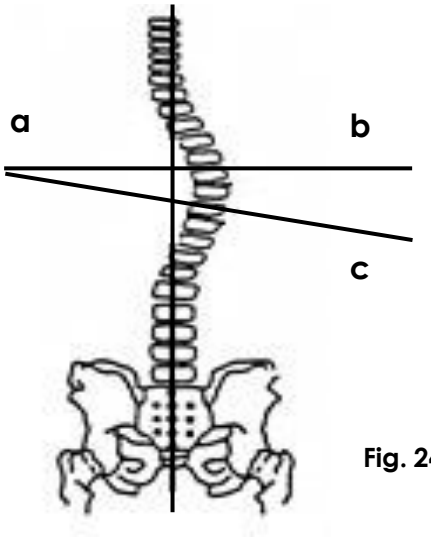


Fig. 24

Vertebral Tilt Angle—The vertebral tilt angle *(Fig. 24a)* is formed by the intersection of a line perpendicular to the center line *(Fig. 24b)* and a line drawn across the inferior endplate of a selected vertebral body. *(Fig. 24c)* The vertebral tilt angle is useful in determining the limits of each scoliotic curve and to properly measure the Cobb Angle.

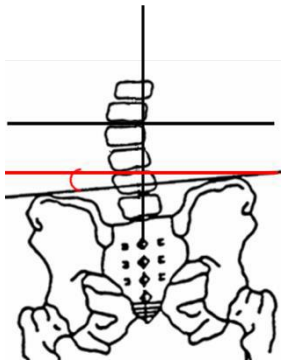


Fig. 25

Vertebral Tilt Angle—The angle formed by the intersection of the line drawn perpendicular to the center line and the line across the superior edge of the iliac crests.

The line perpendicular to the center line may be "lowered" until an angle is formed. (Fig. 25)

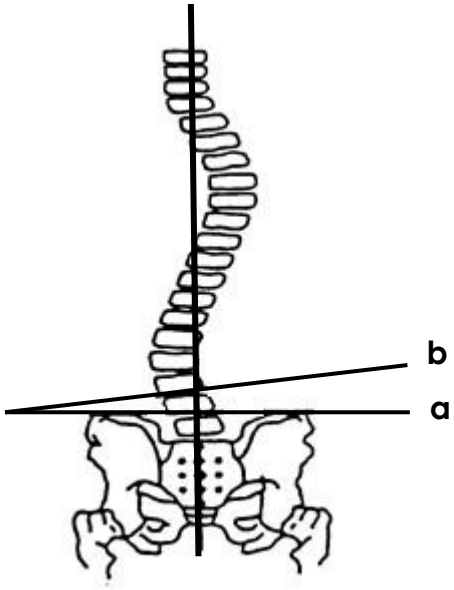


Fig. 26

Lumbar/Pelvic Relationship Angle *(LPR)*—The LPR is the angle formed by the intersection of the pelvic tilt line *(Fig. 26a)* and the vertebral tilt line of L-3, L-4, or L-5 individually *(Fig. 26b)*.

Curve Limits

1. Locate and draw a center line on the X-ray *(Fig. 27a)*.
2. Draw a vertebral tilt line for each vertebra *(Fig. 27b)*.
3. Find the null point by locating a vertebral tilt line, which is perpendicular to the center line. If no vertebral tilt lines are perpendicular to the center line, draw a line perpendicular to the center line, which lies equidistant between the two most nearly perpendicular lines. This line will represent the null point *(Fig. 27c)*

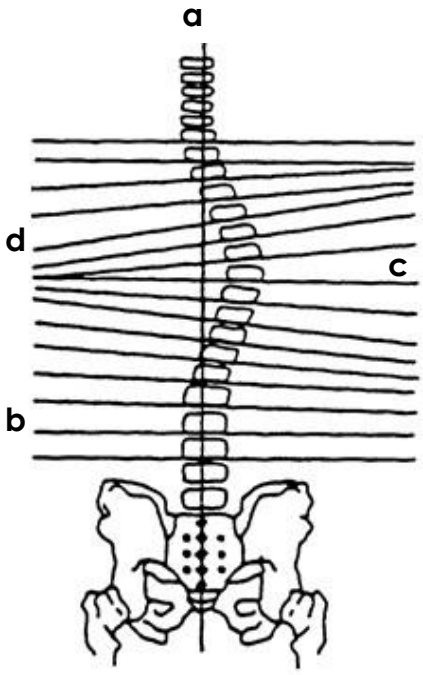


Fig. 27

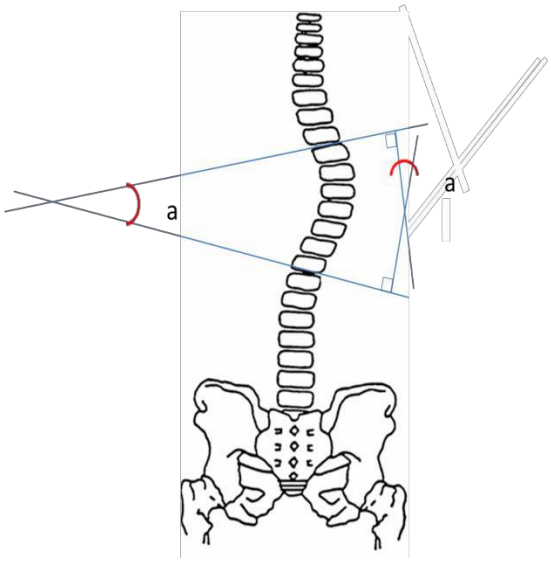


Fig. 28

4. Begin at the null point and measure the vertebral tilt angles of each successive superior vertebra. As long as the angle increases, the vertebral body is included in the curve. The first vertebra with a lesser tilt angle is not included in the curve. To locate the most inferior vertebra in the curve, follow the same procedure and travel in the inferior mode.

5. After locating the superior and inferior vertebral bodies in the curve, draw a line across the superior endplate of the superior vertebra and another line across the inferior endplate of the most inferior vertebra. *(Fig.28)*

DEFINITIONS OF TERMS

1. Lateral Shift Force: Laterally directed force with 10-15 degrees of angulations from the perpendicular applied to the apex of the primary curve. Lateral shift force must be sufficient to move the spine beyond the center line to a point which is equidistant to, and opposite, the original position and to maintain this position during unbending. This force is the **single most important force in the curve correction process and should never be compromised**. *(Fig. 29)*

2. Stabilizing Force: Force applied **opposite to the lateral shift force at the trochanter or the apex of a lumbar curve**. The intensity of the stabilizing force is dictated by the strength of the lateral shift force. *(Fig. 29)*

3. Unbending Force: The unbending force is the **final force applied and is the main curve reducing** force. Pressure is applied at the axillary region opposite the curve's apex. *(Fig 291)* apex of a lumbar curve, shift force is added at the apex of the thoracic curve, and unbending force is exerted at the axilla opposite the apex of the thoracic curve. The secondary unbend is made at the trochanteric region opposite the stabilizing force as an additional corrective measure. *(Fig. 29)*

4. Secondary Unbending Force: An advanced technique in which stabilizing force is applied at the apex of the thoracic curve, and bending force is exerted at the axilla opposite of the apex of the thoracic curve. The secondary bend is made at the throcanteric region opposite the stabilizing force as an additional correction measure.

***Properly distributed forces are essential to successful curve reduction.** When applying stabilizing, shifting and/or unbending forces to the spinal column, it is paramount that the forces be balanced to prevent gross decompensation, with little or no curve correction. Unbending forces should not be applied until the lumbar column has reached the midline.

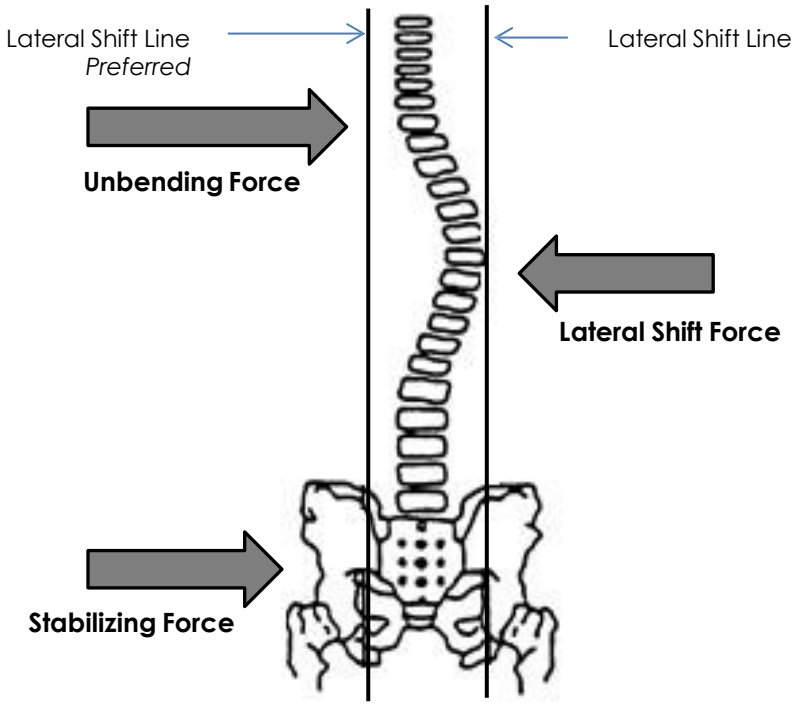


Fig. 29

CLASSIFICATION TREATMENT

Standard nomenclature for curve identification
Five categories of scoliotic curvatures each with a distinct appearance and form

Curve Patterns		
Type I	Lumbar Primary Curve	S-shaped curve in which both thoracic and lumbar curves cross midline. Lumbar curve is larger than the thoracic curve on standing film.
Type II	Thoracic Primary Curve	S-shaped curve in which thoracic and lumbar curve cross midline. Thoracic curve is larger than lumbar curve.
Type III	Single Thoracic Curve	Thoracic curve in which the lumbar curve does not cross midline (also called overhang).
Type IV	Single Thoracolumbar / Lumbar Curve	Long thoracic curve in which L5 is centered over sacrum but L$ fits into long thoracic curve.
Type V	Double Thoracic	Double thoracic curve with T1 tilted into convexity of upper curve. Upper curve structural on side-bending.

Fig. 30

Type I –*Lumbar Primary*-curvatures are "S"- shaped curves. Both the thoracic and lumbar components cross the horizontal midline. On standing X-ray, the **lumbar curve is larger than the thoracic curve**. Even though the lumbar curve is greater in magnitude, the thoracic curve is more flexible. These double curves are treated as lumbar curves. *(Fig. 31)*

Lumbar Primary Curve
'S' Shaped L+T cross Midline

Fig. 31

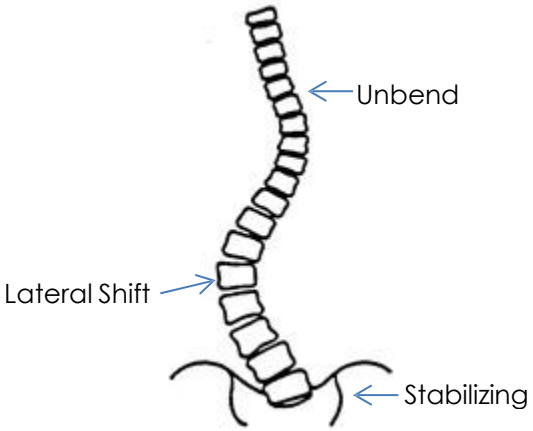


Fig. 32

Applied Forces: Measure the Lumbar/Pelvic Relationship Angle of L-3, L-4, and L-5. If any of these individually are greater than 15 degrees, elevate the pelvis on the concave side of the lumbar curve, this will align the lumbar column properly. *(Fig. 32)* Apply stabilizing force to the trochanter opposite the apex of the lumbar curve.

Correct Positioning: Add lateral shift force to the apex of the lumbar curve with sufficient force to move the spine beyond the midline to a point equidistant to, but opposite, the point of origin. Apply the unbending force to the axillaries region opposite the apex of the lumbar curve. Do not overcorrect the unbending force as this can compromise the lateral shift force. At brace fitting, trim the brace to the apex of the thoracic compensatory curve or to a point slightly above it this will minimize the effect of the thoracic curve. *(Fig. 33)*

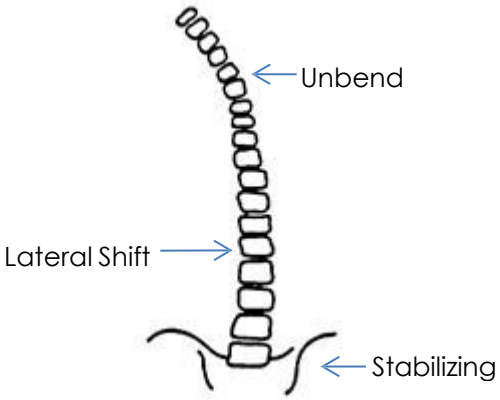
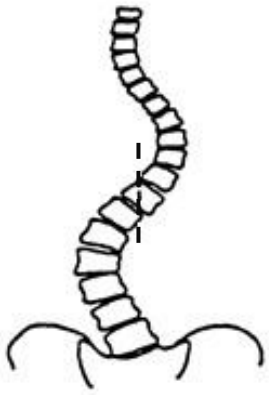


Fig. 33

Type II -***Thoracic Primary***-curvatures are also "S"-shaped. Again, both the thoracic and lumbar components cross the horizontal midline. The thoracic segment measures greater than or equal to the lumbar portion but the thoracic curve is more flexible. Stabilizing the lumbar curve and unbending the thoracic segment best treat these curves. *(Fig. 34)*



Thoracic Primary Curve
'S' Shaped L+T cross Midline

Fig. 34

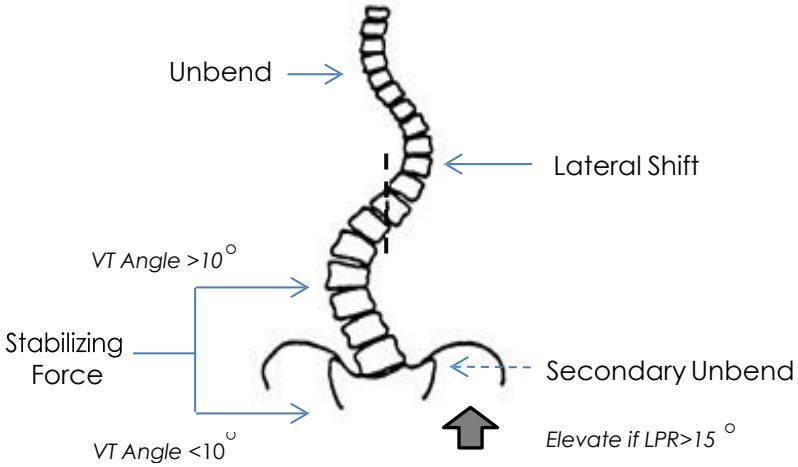


Fig. 35

Applied Forces: Measure the vertebral tilt angle of L-3, L-4, and L-5. If the VTA of any of these three, individually, is greater than 10 degrees, then apply the stabilizing force at the apex of the Lumbar curve. If the VTA of any of these vertebra measures less than 10 degrees, apply the stabilizing force at the trochanter.

Measure the lumbar pelvic relationship (LPR) angle of L-3, L-4, and L-5. If any of these angles individually measures greater than 15 degrees, elevate the pelvis on the concave side of the Lumbar Curve.

Apply a lateral shift force at the apex of the Thoracic curve and shift beyond the midline as much as possible (applying substantial pressure).

Corrected Position: Apply an unbending force in the axilla region but be careful not to compromise or overpower the lateral shift force.

If the LPR angle of L-3, L-4, or L-5 is greater than 10 degrees, then apply a secondary unbending force at the trochanter opposite the stabilizing force. This secondary unbending force is the last force applied and is a laterally directed force. *(Fig. 36)*

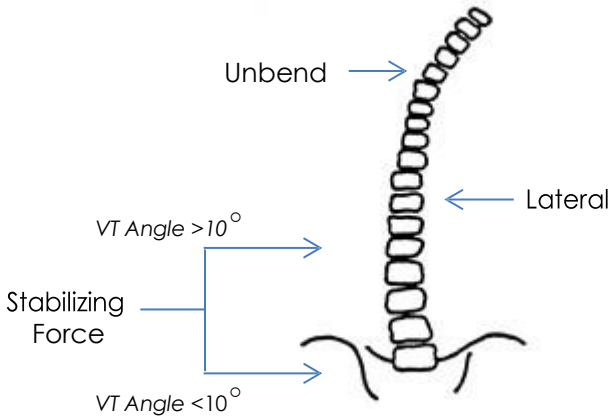


Fig. 36

SECONDARY UNBENDING FORCE: (Advanced technique)

Applied Force: in which a stabilizing force is applied at the apex of the thoracic curve, and bending force is exerted at the axilla opposite of the apex of the thoracic curve. The **secondary unbend is made at the trocanteric region opposite the stabilizing force** as an additional correction measure. (Fig. 37)

Location of Applied Forces II

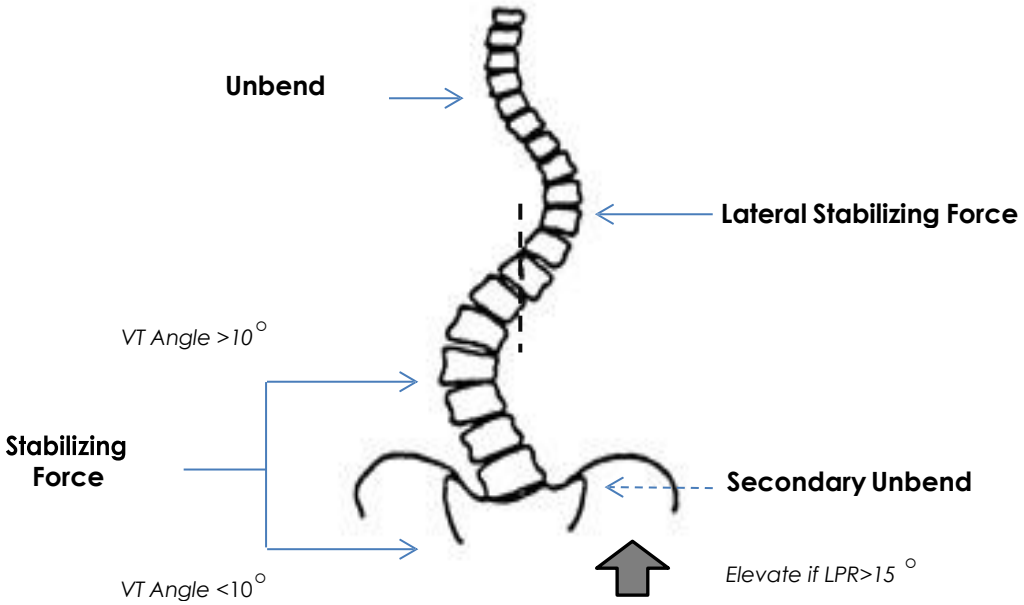


Fig. 37

The **in-brace thoracic curve should be corrected to 100% and the lumbar curve to 50%** in-brace x-ray.

If the thoracic and lumbar curves are at 20 degrees or **less** and within 5 degrees of each other, treating a King Type I-Lumbar Primary as a King Type II-Thoracic Primary is appropriate.

If the thoracic is 27 degrees or greater trim the unbend to the thoracic apex; under 27 degrees, leave the unbend high for maximum correction of the lumbar. If progression occurs, then trim to the thoracic apex.

A lumbar curve of 35 degrees or greater should always be treated as a King I curve to control the lumbar curve. Always consider Risser age, curve degrees, menses, and family history in deciding treatment.

Type III- ***Single Thoracic*- curvatures** are essentially thoracic curves. The lumbar segment does not cross the midline in Type III. This pattern presents the so-called "Overhang" appearance. Type III curves generally present little difficulty in treatment. *(Fig. 38)*

Single Thoracic Overhang

Fig. 38

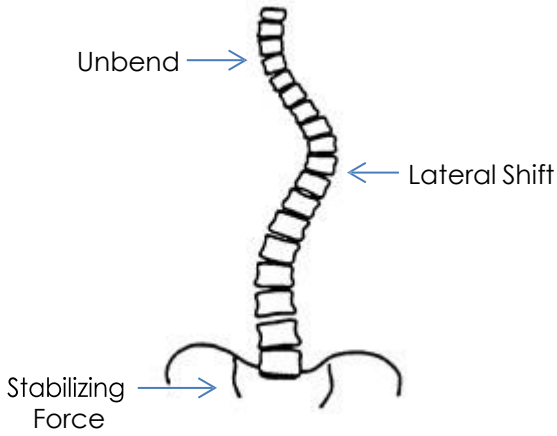


Fig. 39

Applied Force: The correction method for Type III is less difficult than Type II because by definition the Lumbar vertebra will not cross the midline or tilt in the opposite direction of the curve or it will be a Type II curve.

However, we still measure the LPR angle and the VT angle to confirm our diagnosis. In some instances the LPR angle may be greater than 15 degrees if the pelvic tilt angle is unusually large.

Corrected Position: The location of forces applied is to apply the stabilizing force at the trochanter and then the lateral shift force at the apex of the thoracic curve, shifting beyond the midline as far as possible.

Last apply the unbending force in the axilla region opposite the L.S. force being careful not to compromise or overpower the L.S. force. (Fig. 40)

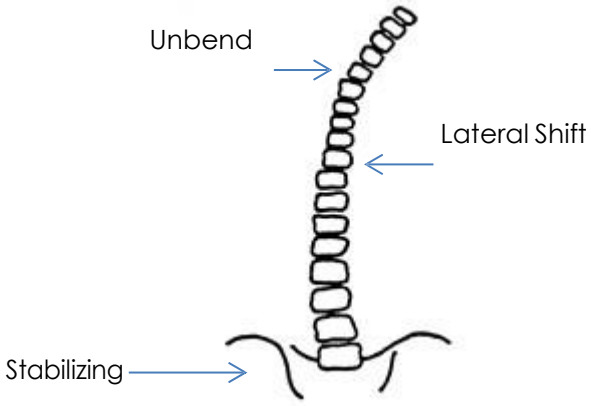


Fig. 40

Type IV-*Single Thoracolumbar / Lumbar*- scoliosis is characterized by long thoracic (thoracic /thoracolumbar) curves in which the body of L-5 is centered over the sacrum but the body of L-4 is tilted into the curved segment.

These curves are best treated as thoracolumbar curves, but emphasis should be placed on shifting the spine to the midline prior to unbending. *(Fig.41)*

Single Thoracolumbar / Lumbar
L-5 Over Sacrum, L-4 Tilted

Fig. 41

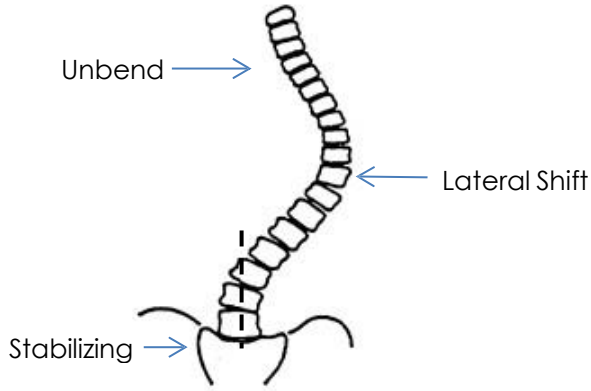


Fig. 42

Applied Force: In a Type IV curve there is no need to measure or consider the LPR angle or the VT angle because, by definition of curve types, they will not be a factor. This type curve is a single curve withL-4 tilted into the curve.

Corrected Position: The location of forces for a Type IV curve is to apply the stabilizing force at the trochanter opposite the apex of the thoracolumbar curve, apply the lateral shift force at the apex of the curve and shift laterally beyond the midline as great a distance as possible.

Apply the unbending force in the axilla and unbend, being careful not to compromise or overpower the lateral shift force. *(Fig. 43)*

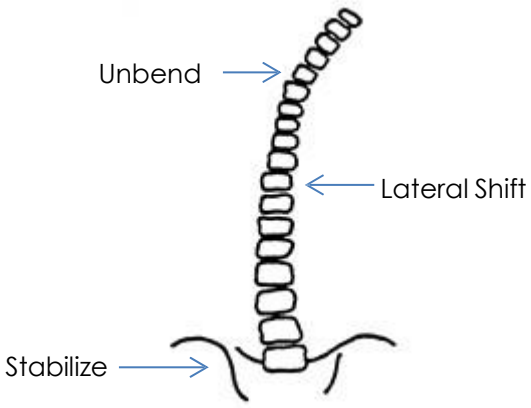
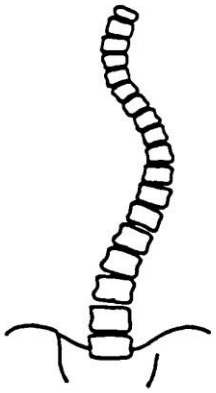


Fig. 43

Type V- *Double Thoracic*- curvatures are double thoracic curves with the body of T-1tilted into the concavity of the upper curve. The thoracic segment appears to be structural on X-ray. Type V curvatures are treated as thoracic curves. *(Fig. 44)*



Double Thoracic
T1 Tilted into Upper Curve
Thoracic Curve is structural

Fig. 44

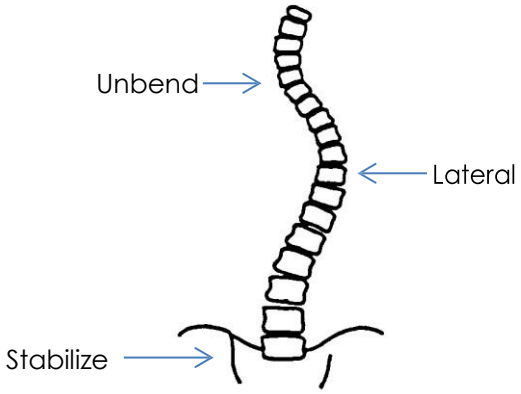


Fig. 45

Applied Force: Apply a stabilizing force at the trochanter opposite the apex of the thoracic curve.

Then add lateral shift force to the apex of the thoracic curve, using sufficient force to move the spine beyond the midline to a point equidistant to, but opposite, the original starting position.

Finally, add unbending force to the axilla opposite the apex of the thoracic curve.

Corrected Position: The curve correction technique is identical to that used in Type IV curvatures. *(Fig. 46)*

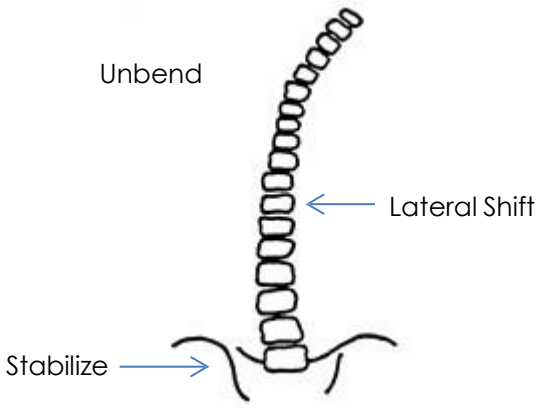
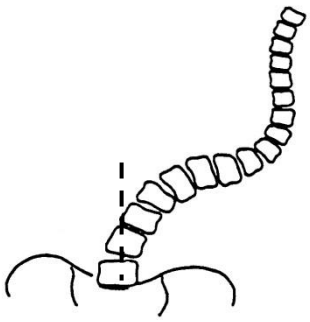


Fig. 46

UNDERSTANDING BALANCED FORCES:

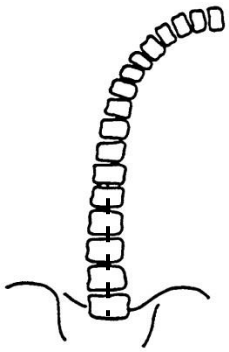
When applying stabilizing, shifting and unbending forces to the spinal column, it is paramount that the forces be balanced so to **prevent gross decompensation,** with little or no curve correction.

Properly distributed forces are essential to successful curve reduction. Unbending forces should not be applied until the lumbar column has reached the midline. *(Fig. 47a and 47b)*



Incorrect

Fig. 47a



Correct

Fig. 47b

BEST PRACTICES / REQUIREMENTS

The quality of the measurements determine the quality of the device outcomes

MEASUREMENTS

- Use the NBB order form:
  http://www.hangerfabrication.com/forms.html
- Measure-Standing up
- Supine is recommended for heavier kids
- Mark anatomical landmarks on stockinet
- Provide ALL measurements, AP, ML lengths and circumferences
- Use a ML Gauge
- **Digital x-ray (Preferred) can be emailed directly to**:
  HFN_Orlando@hanger.com
  Subject: NBB

CURVE TYPE REQUIREMENTS

- Primary major curve
- Include which way to bend

TRIM / FINISH

Trim the brace to the apex of the thoracic compensatory curve or to a point slightly above it this will minimize the effect of the thoracic curve.

***NOTE:**

NBB are not trimmed to finished lengths unless SPECIFICALLY asked for - as radiographs are rarely provided in full length radiograph.

BRACE FITTING AND CHECK-OUT

Trim and fit requirements are the responsibility of the attending orthotists.

1. Place the NBB on the patient in standing. Straps remain unfastened.
2. Have the lay down supine.
3. Position the waist roll of the brace between the patient's ribs and iliac crests.
4. Fasten the Velcro straps and evaluate the axillary trim. ***Trim for maximum axillary pressure.**
5. The patient should be able to lower the arm completely without discomfort. NOTE: The plastic flare above the lateral shift force is expected to be higher than the apex.
6. On the concave side of the brace, the proximal edge of the brace should lie at the apex of the curve. If the trim is too high, the patient will be allowed to bend over the apex of the curvature and the amount of curve correction will be compromised.
7. Trim the antero-proximal edge of the brace for breast relief.
8. The antero-distal trim line should be at or slightly proximal to the gluteal fold. If the trim is too high, the patient will experience discomfort.
9. The postero-distal trim line should be at or slightly proximal to the gluteal fold. If the trim is too high, the patient will experience discomfort.
10. The postero-proximal trim line should describe a smooth diagonal line transitioning form the high, convex side of the brace to the lower concave side.

WEAR AND CARE

Always

- Wear a clean T-shirt under the brace, it should be wrinkle free and long enough to extend below the bottom of the brace
- Thin shorts/boxers may be worn underneath the brace with a shorter shirt if that is more comfortable
- Tighten the brace to the line drawn on the strap by your Orthotist.

Break in

- The break in period normally takes between 7-10 days
- Wear the brace loose for the first few days ; gradually tightening the straps each night

Example break-in schedule:

- 1st Night: Wear the brace to bed and try to go to sleep. If an hour has passed and you don't fall asleep, take off the brace and sleep the rest of the night without it.
- 2nd - 4th Nights: Wear the brace to bed and try to fall asleep (this should be a little easier these nights). If you find that you wake up in the middle of the night, remove the brace and sleep the rest of the night without it.
- 4th-10 Nights: Gradually increase wearing time until you can wear it all through the night.

INITIAL IN-BRACE X-RAY CAVEATS

The measurement of the scoliotic curvature in-brace is a means of comparing the visible effects of treatment with the state of the anatomy before treatment. The measurement itself is a relative comparison with the original condition but is not an active component of the treatment itself.

The Cobb measurement has been the generally accepted standard of scoliosis measuring techniques. After application of the Nocturnal Bending Brace, the Cobb Measurement may be "O" degrees, though technically this is not a true Cobb reference. The endplates used, as reference points may arguably be invalid, after the shape of the curve has been completely changed.

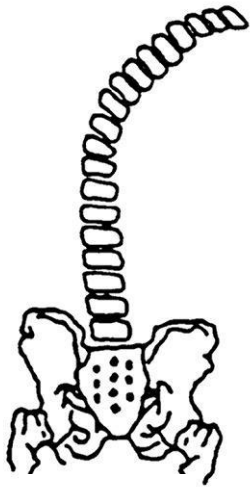


Fig. 49

After NBB application, it is evident that the corrected spine has assumed an\ unorthodox appearance. Several points should be revisited to mitigate this. The patient is supine in-brace, negating concerns about load bearing on the spinal column and compensation versus decompensation as a desirable or undesirable position. For immediate comparative purposes, the Cobb measure alone suffices, but ultimately a subjective visual evaluation by the orthopedist and the orthotic practitioner will probably be more valuable in determining the acceptability of the finished orthosis. *(Fig. 49)*

Just as the theory of sidebending scoliosis correction is not completely understood, yet successful treatment outcomes are reported. A departure from the traditional measuring system by subjective visual evaluation does not controvert the spine's improved appearance, nor does it negate any positive results.

EXERCISE PROGRAM

The use of a regimented exercise program as an adjunct to scoliosis brace treatment is a concept having many adherents, as well as detractors. Both camps have advocated either explicit programs producing measurable results, or "free play" exercise without regimentation.

The Nocturnal Bending Brace system is designed to obtain direct, as well as subtle, benefits from the practice of an exercise program supervised by a Registered Physical Therapist. The therapist is able to recognize the strengths and deficits of each individual patient make recommendations, set up programs, and document results. The therapist may also serve as a patient's and family's motivator by altering the program at intervals to freshen the routine.

The Physical Therapist is able to conduct an individual needs assessment, measure the patient's strength and flexibility, and evaluate such aspects as body control, dexterity and proprioception. Special programs may be incorporated, including aerobic and recreational dance or other exercise routines, which are often in conjunction with organized sports.

The goals of supervised exercise programs are to:

1. Maintain or increase muscle strength and tone
2. Maintain or increase flexibility
3. Promote correct postural alignment
4. Increase awareness of body position

Components of the program may include:

1. Pelvic tilt-supine or upright
2. Abdominal, gluteal and shoulder girdle strengthening
3. Hamstring, hip flexor and pectoral strengthening
4. Diaphragmatic or other deep breathing exercises

CLINICAL EVIDENCE / REFERENCES

'No unified comprehensive mathematical equation has been formulated to accurately describe and predict scoliosis'.

Schultz: A biomechanical view of scoliosis, Spine, 1976

Bracing in Adolescent Idiopathic Scoliosis Treatment (BRAIST)
Weinstein, et al. New Engl Med September 2013

- Significant benefit of bracing in both the randomized and the treated populations
- Bracing significantly decreased the progression of high-risk curves to the threshold for surgery
- The benefit increased with longer hours of brace wear
- The amount of in brace correction is a predictor of long-term outcome of treatment
- Compliance critical

In Defense of Adolescents: They really do use braces for the hours prescribed, if good help is provided. Results from a prospective everyday clinic cohort using thermobrace, Donzelli et al. Scoliosis 2012, 7:12

- Compliance is a key element of brace treatment
- First study to use a TB (thermobrace) monitor
- Higher compliance to bracing than what was previously reported
- Monitor offers valuable insights and does not undermine the relationship with the patients
- Benchmark study for feasibility (monitor validity)

Effect of Compliance Counseling on Brace Use and Success in Patients with Adolescent Idiopathic Scoliosis Lori A. Karol, MD, et al., Bone Joint Surg Am January 6, 2016 98:1-2; doi:10.2106/JBJS.O.01029

- Compliance monitoring positively impacts clinical outcomes

Nighttime Bracing Versus Observation for Early Adolescent Idiopathic Scoliosis; Wiemann, Shah, MD, Price; Pediatr Orthop Volume 34, Number 6, September 2014

- **Early intervention treatment with the NBB may reduce progression to full-time bracing threshold**.
- This study focused specifically on curve magnitudes between 15-25 degrees in skeletally immature, pre-menarchal female
- 100% of patients in the control group (observation) resulted in curves progressing to standard criteria for full-time bracing
- 29% of patients randomized to night time wear were maintained without curve progression. (Statistically significant)

COMPLIANCE MONITORS ARE AVAILABLE ON REQUEST

- Seamlessly integrated during fabrication
- User-friendly interface and
- Calculates compliance to the prescribed protocol including:
- % daily compliance
- % average compliance
- % compliance between selected treatment periods
- One-touch Data is transferred from the brace to the software
- Simple, exportable, printable, reports between appointments.

NBB References:

A Biomechanical Study of the Nocturnal Bending Brace for the Treatment of Scoliosis. Clin J, Aubin CE, Parent S, Labelle H; Spine 2010, 35(19):E940-7.

Nighttime Bracing Versus Observation for Early Adolescent Idiopathic Scoliosis. Wiemann J M, Shah, SA, MD, Price, CT; J Pediatr Orthop 2014

Nighttime Bracing for Adolescent Idiopathic Scoliosis with the Nocturnal Bending Brace®: Long-Term Follow-Up. Price CT, Scott DS, Reed FR Jr, Sproul JT, Riddick MF; J Pediatr Orthop. 1997 Nov-Dec;17(6):703-7.

Long-term Follow-up of Patients with AdolescentIdiopathic Scoliosis Treated Conservatively: An Analysis ofthe Clinical Value of Progression. Montgomery F, Willner S,Appelgren G. J; Pediatr Orthop. 1990 Jan-Feb;10(1):48-52.

Nighttime Bracing for Adolescent Idiopathic Scoliosis with the Nocturnal Bending Brace. Preliminary Report. Price CT, Scott DS, Reed FE Jr, Riddick MF. Spine (Phila Pa 1976). 1990 Dec;15(12):1294-9.

A Comparison Between the Boston Brace and the Nocturnal Bending Brace in Adolescent Idiopathic Scoliosis. Katz DE, Richards BS, Browne RH, Herring JA. Spine (Phila Pa 1976). 1997 Jun 15;22(12):1302-12.

Effectiveness of the Nocturnal [Night-Time] Bending Brace in the Treatment of Adolescent Idiopathic Scoliosis. Lee CS, Hwang CJ, Kim DJ, Kim JH, Kim YT, Lee MY, Yoon SJ, Lee DH; J Pediatr Orthop. 2012 Jun;32(4):368-72.

*NOTE: NBB was sold under the name Charlseton Bending Brace until May 2018. Charleston Bending Brace is a registered trademark of Original Bending Brace, LLC.

Ordering Process:

Hanger FABRICATION NETWORK

Nocturnal Bending Brace

Ph 407.852.6170 | Fx 407.852.6171
HFN_Orlando@Hanger.com

Workorder #: (Lab Use Only)

Bill To:
Address:

☐ Same as Bill to

Ship To:
Address:

Email:
Phone #:

Patient Name:
Order Date:

Height:
Weight:
Age:

☐ Pt is a previous NBB wearer
☐ Other Brace Type:

☐ Male ☐ Female

Compliance Monitor ☐ YES ☐ NO

In-Office Request Date: ☐ am ☐ pm

☐ NBB-Standard
☐ NBB II-dynamic lumbar pad
☐ NBB Lite-early intervention

OPS invoice / NG encounter:

STANDARD COLORS
(Choose One)
☐ Natural
☐ Light Pink
☐ Light Blue
☐ Transfer (extra charge)
Number:
Description:

IMPORTANT INSTRUCTIONS

- All measurements must be taken and completed on this order form
- Email digital x-ray to: HFN_Orlando@hanger.com
  Subject Line: Bending Brace for "Patient Identifier"
- *Incomplete information may compromise outcomes & delay turn around ability*

SELECT TYPE OF TREATMENT OR **PROVIDE MAJOR CURVE**

☐ NBB-1
☐ NBB-2
☐ NBB-3
☐ NBB-4
☐ NBB-5

☐ LT
☐ RT
☐ Double
☐ Lumbar
☐ Thoracic
☐ Thorocolumbar

BRACE BEND TO

☐ Right
☐ Left

COBB ANGLES: (limits & magnitudes)
Thoracic ____ Apex ____
Lumbar ____ Apex ____

LORDOSIS
Supine mx:
In brace: ☐ 10° ☐ 20° ☐ Other: ____°
(In brace 0° if not otherwise specified)

MEASUREMENTS IN INCHES ONLY

Measurements taken	Standing Circ.	Supine M/L *	Supine A/P *
Axilla			
Xyphoid			
2" above waist			
Waist			
ASIS			
Gluteal Fold/ Trochanter			

* M/L & A/P measurements taken with a M/L mx stick (not a tape measure)

Linear mx:	Supine	Standing
Axilla		Thoracic Height
Xyphoid		
Waist		
Gluteal Fold (Finished Length)		

(All length measurements will be used to determine finished trims)

Manual: ☐ English ☐ Spanish

SPECIAL INSTRUCTIONS:

Practitioner (print name):

Signature:
(Must be signed by a BB Certificate holder only)

BB Certification Number:

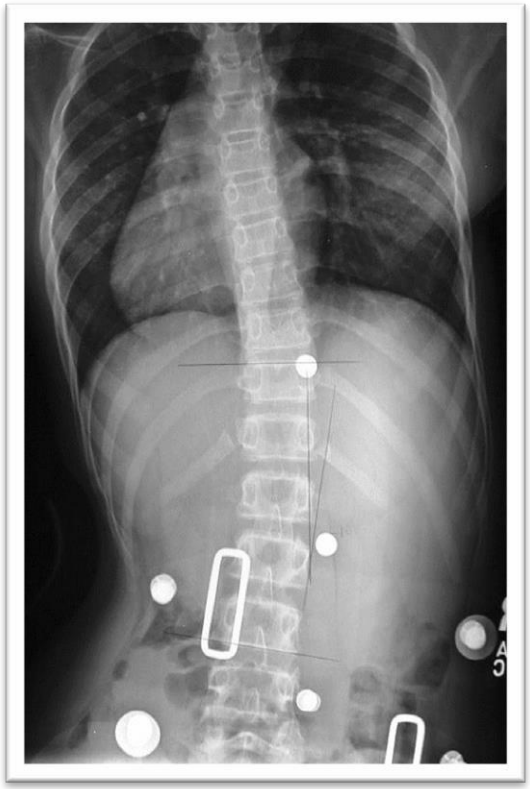
CASE STUDIES

REVIEW: NBB Goals

1. **Maintain the patient's scoliotic curvature** at, or near, pre-brace values throughout the growth period and on to skeletal maturity.
2. Promote better brace **wear compliance** through the nocturnal wear.
3. Promote positive self-image & **reduce burden of treatment**

CASE STUDIES-Module 1

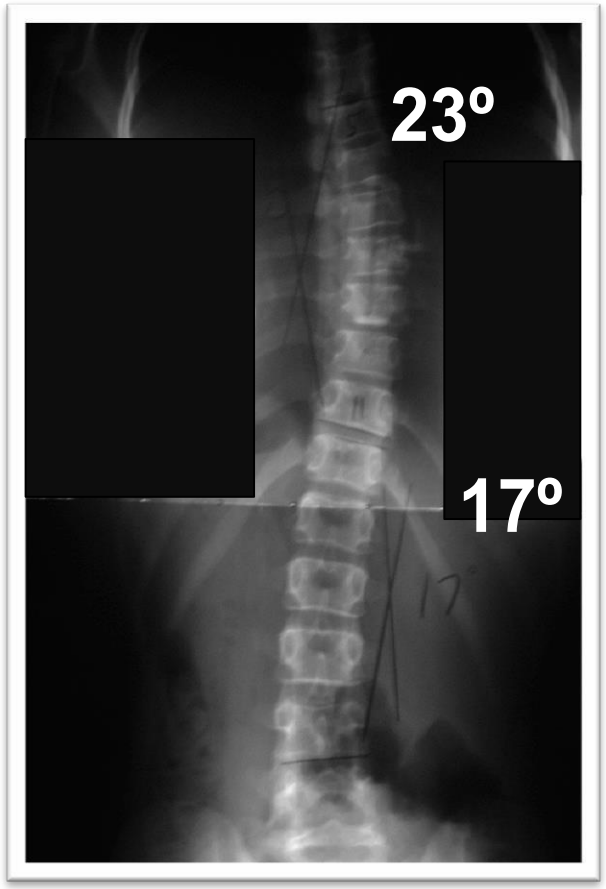
PA-no brace



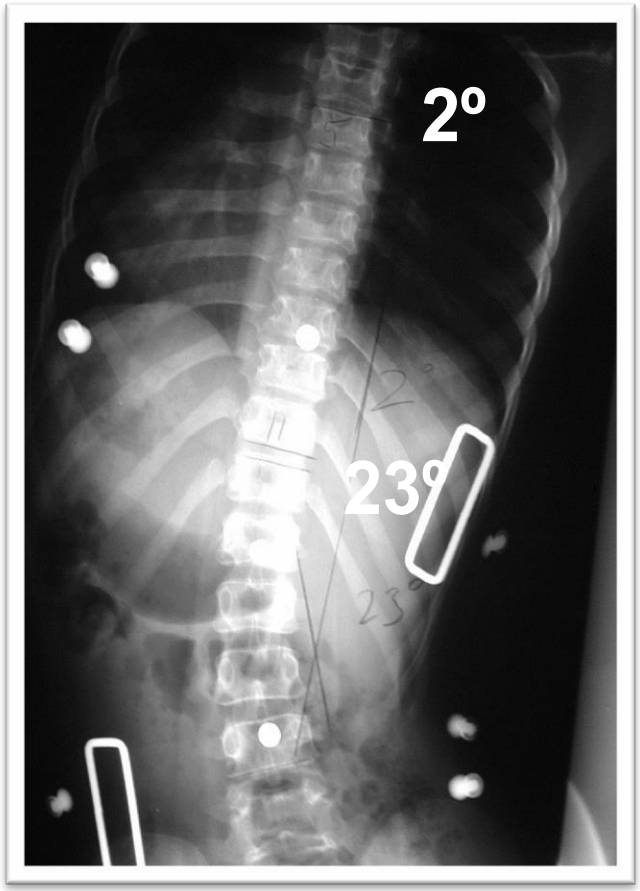
PA- brace

1 year post

notes



PA-no brace

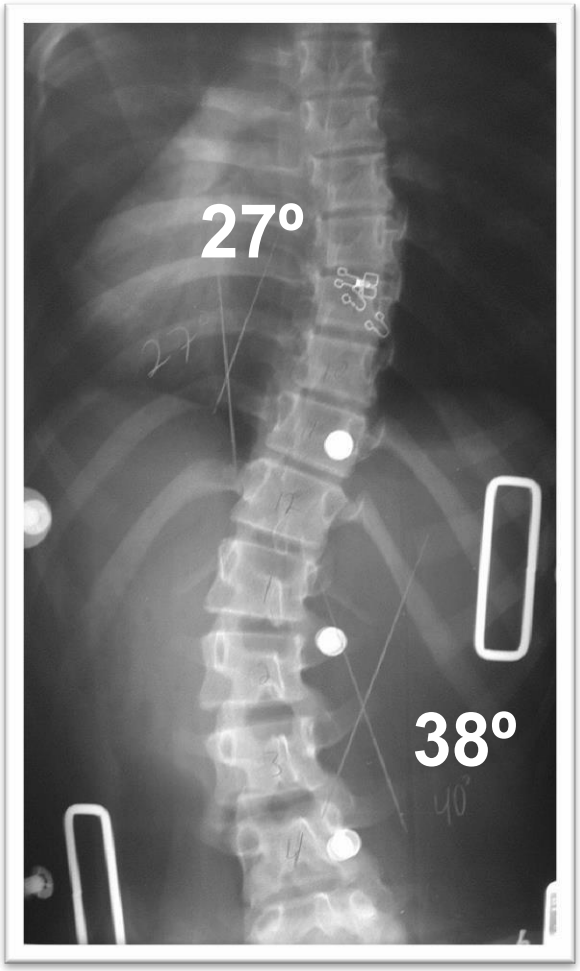


PA- brace

1 year post

notes

PA-no brace



PA- brace

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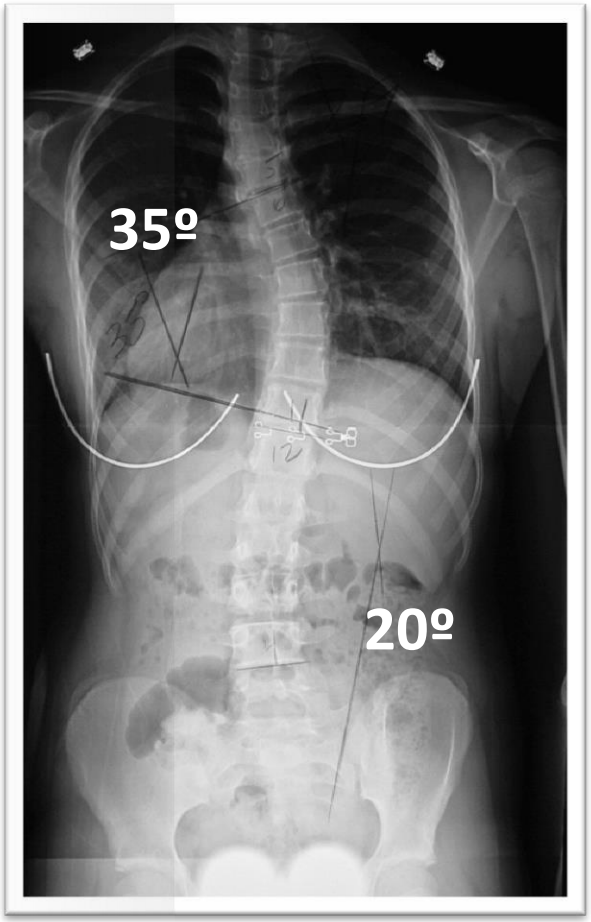

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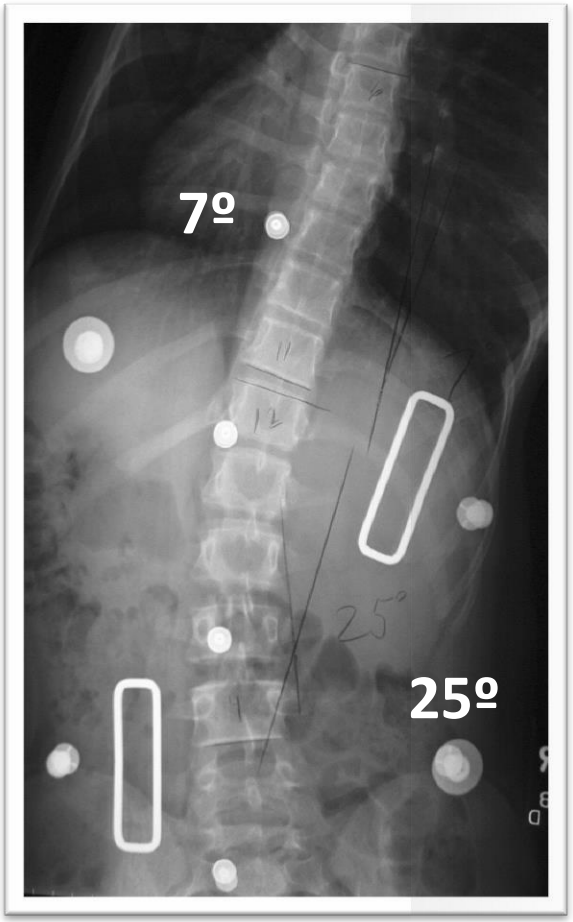
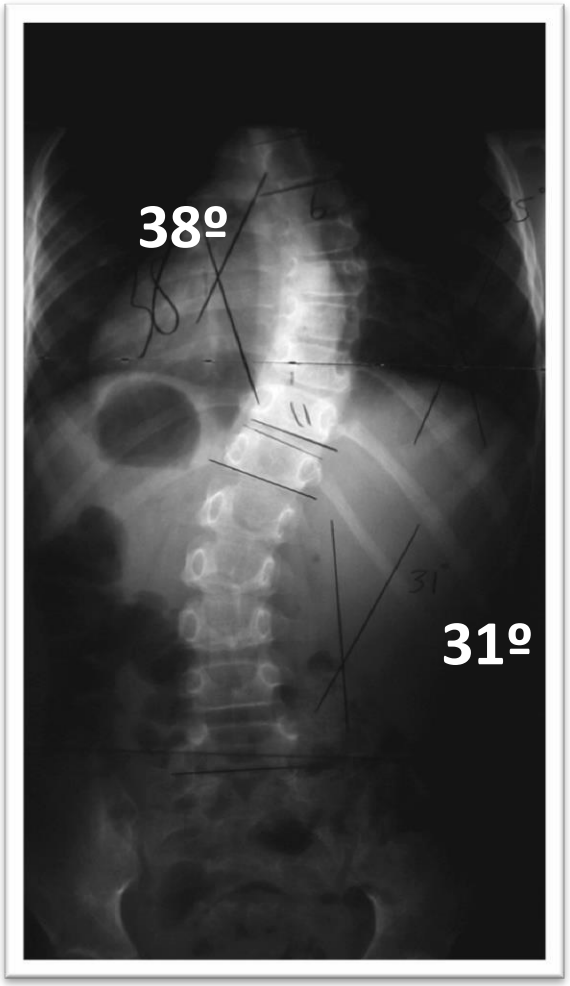


PA- brace

1 year post

notes



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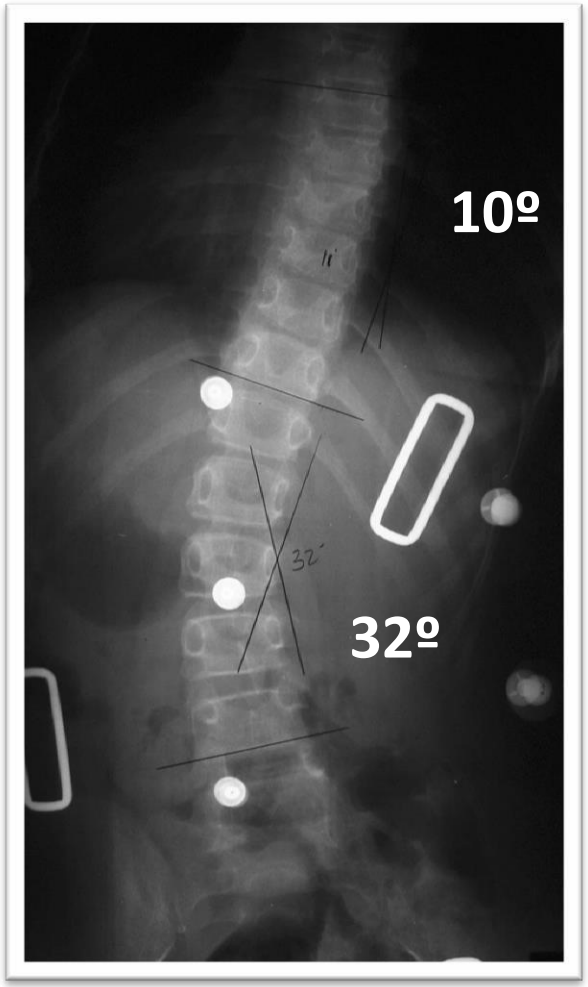
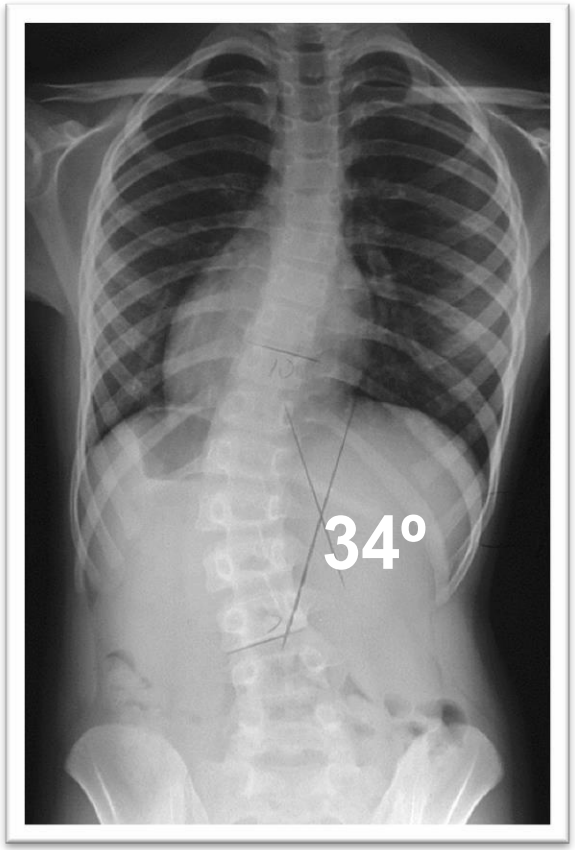
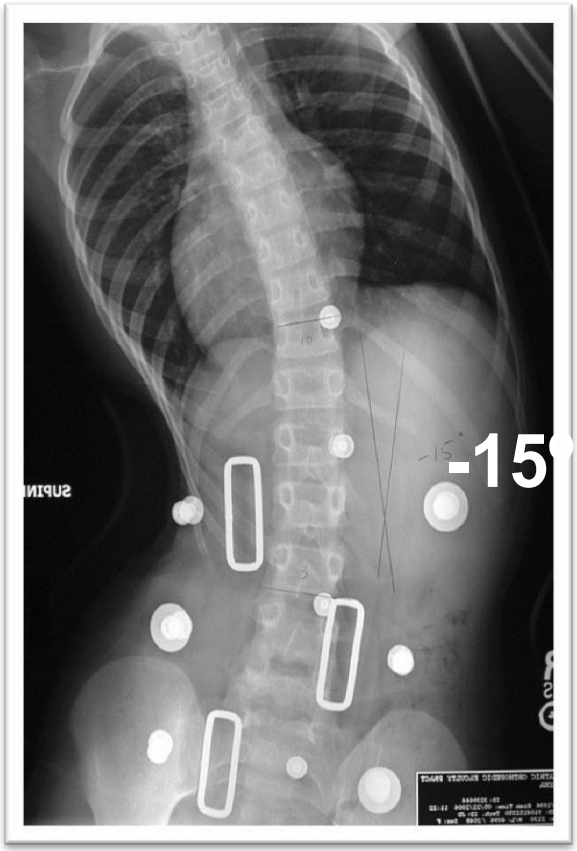


PA- brace

1 year post

notes

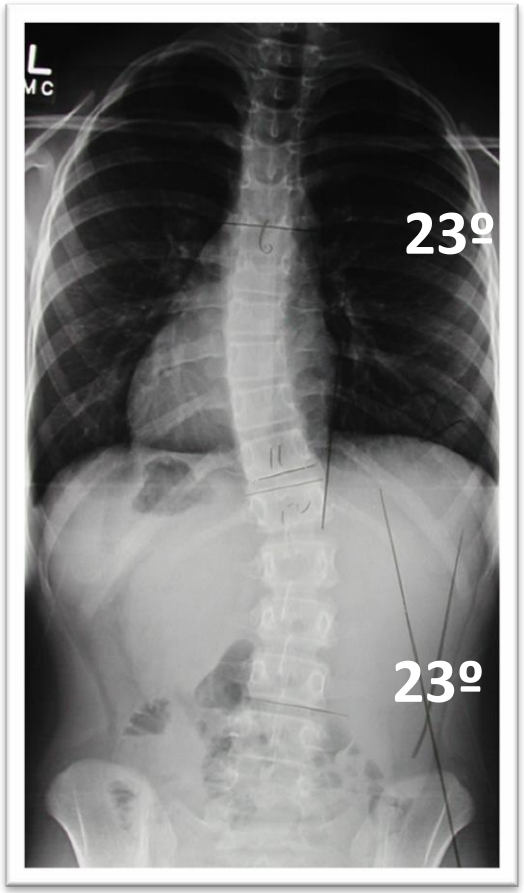




PA-no brace

PA- brace

1 year post



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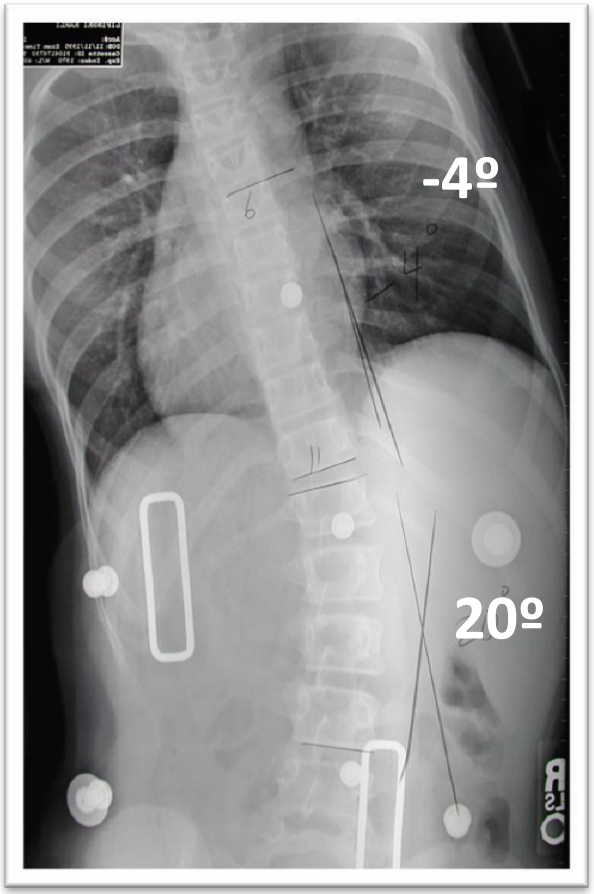
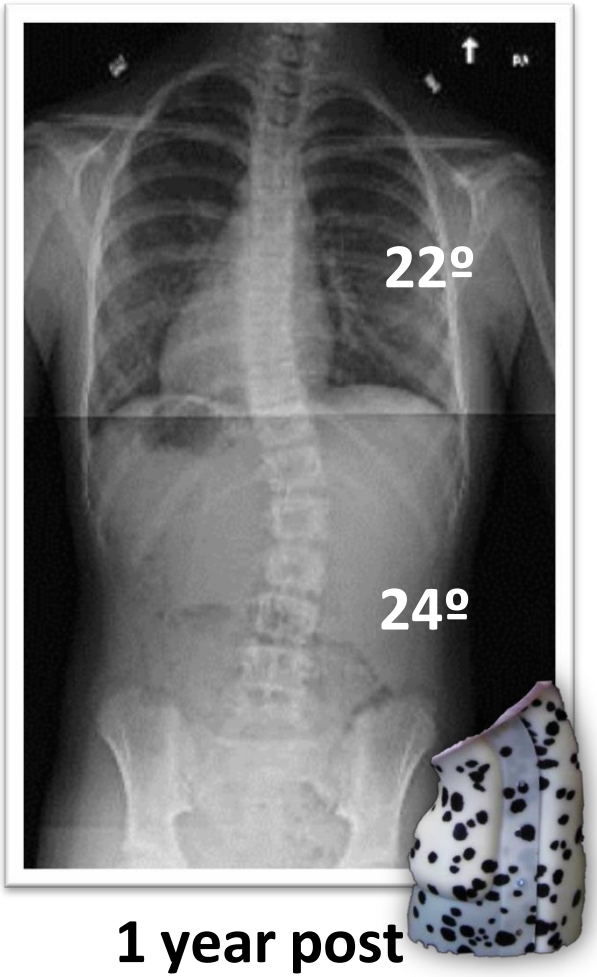
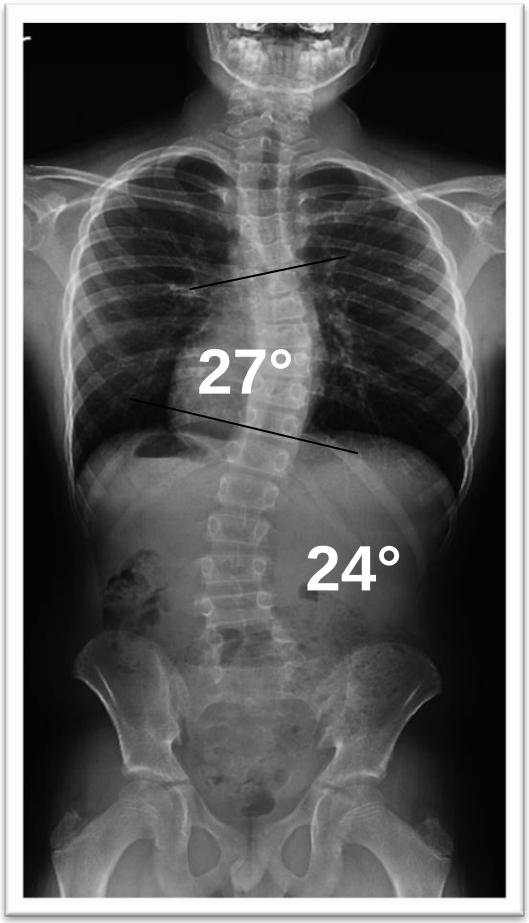


PA- brace

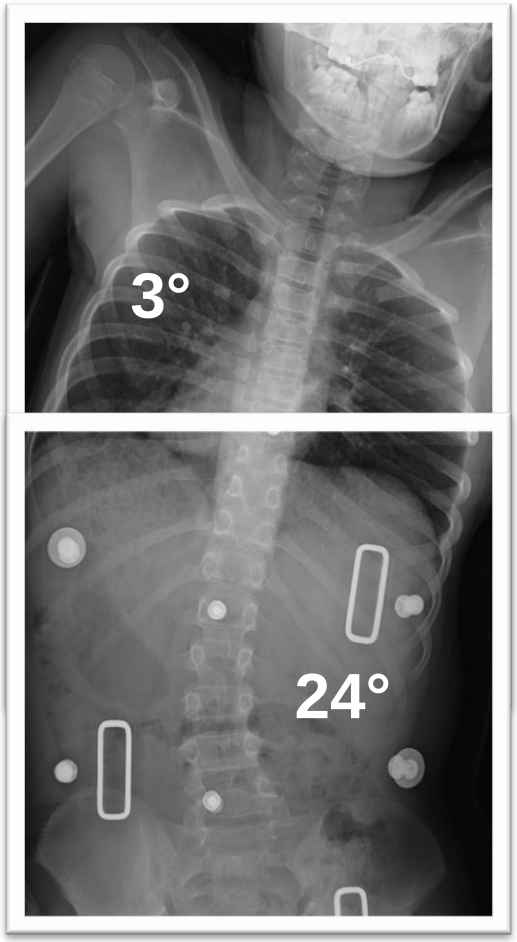


1 year post

notes



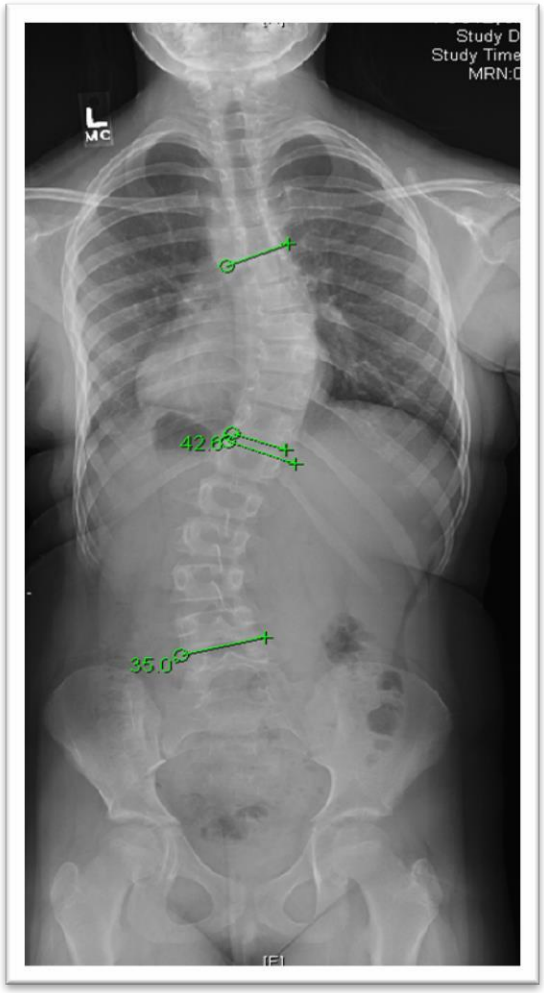
PA-no brace



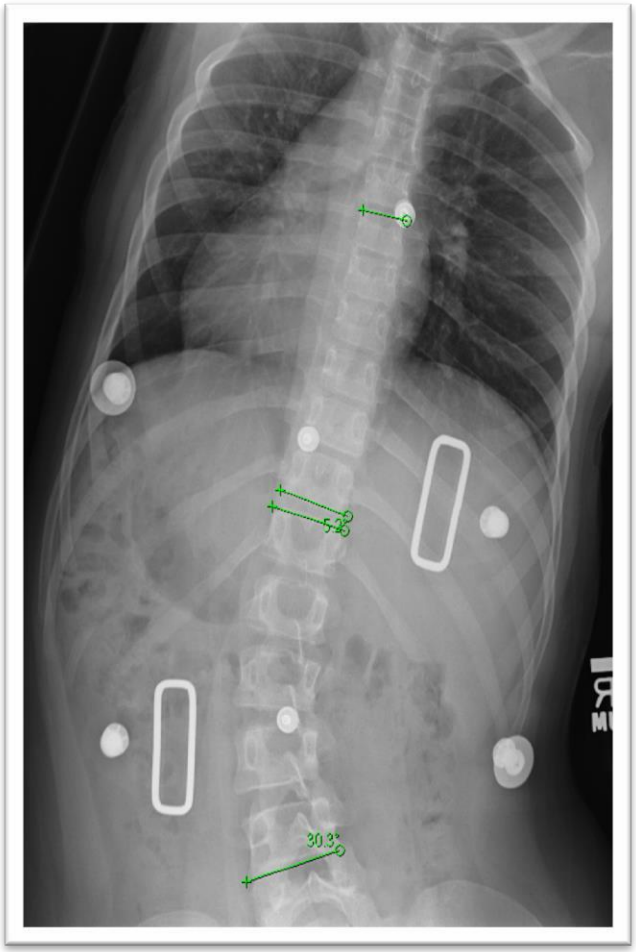
PA- brace

NBB

notes



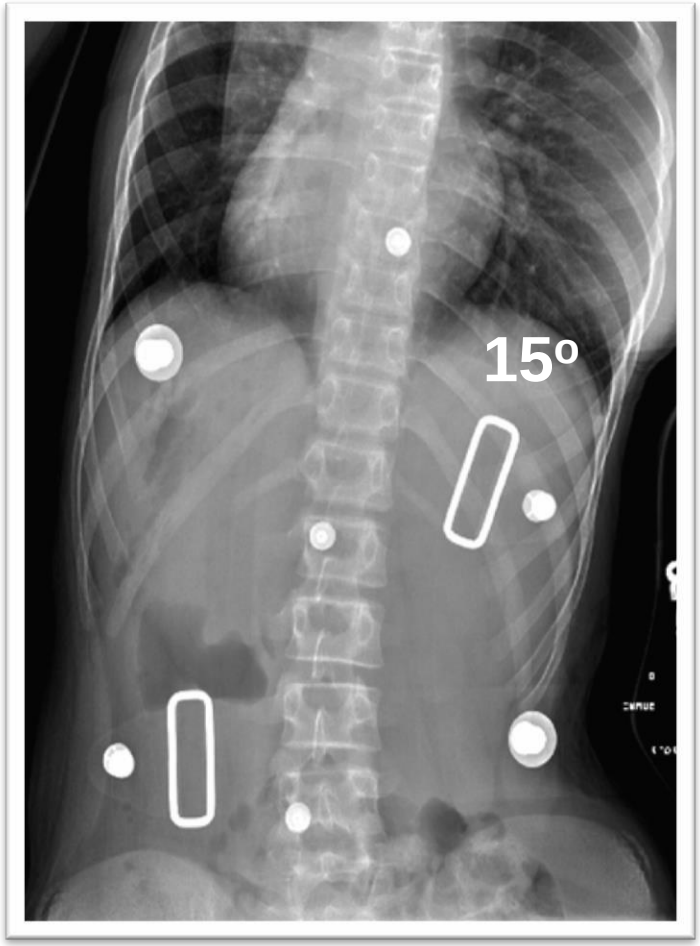
PA-no brace

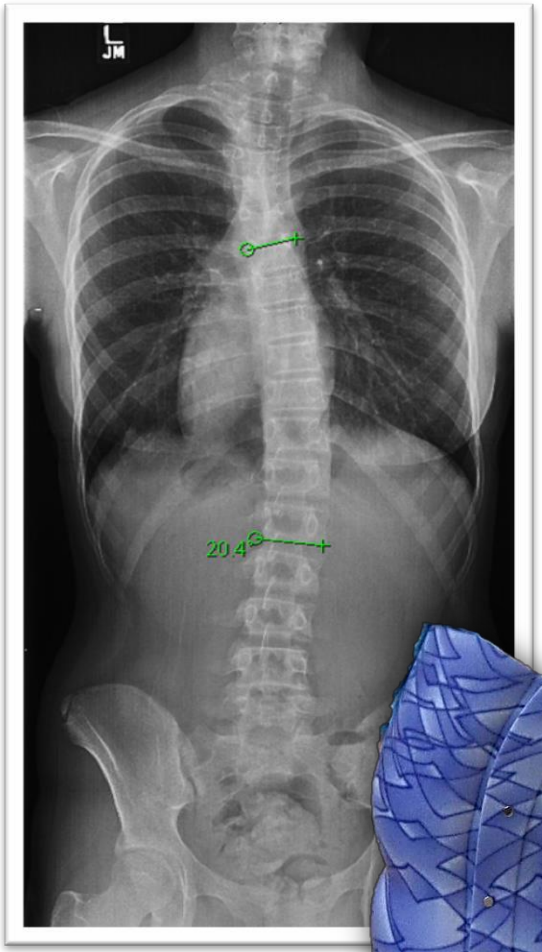


PA- brace

NBB

notes

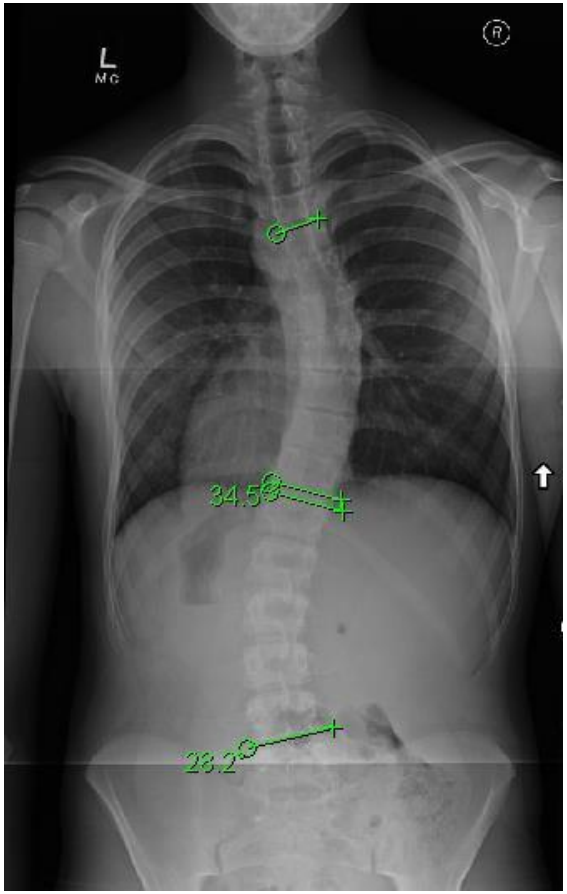


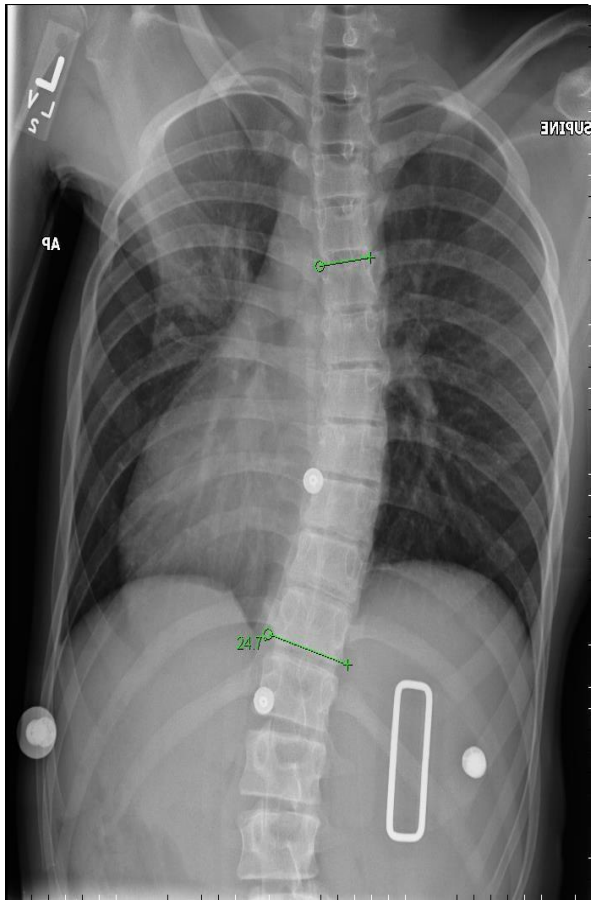


PA-no brace **PA- brace** **1 year post**

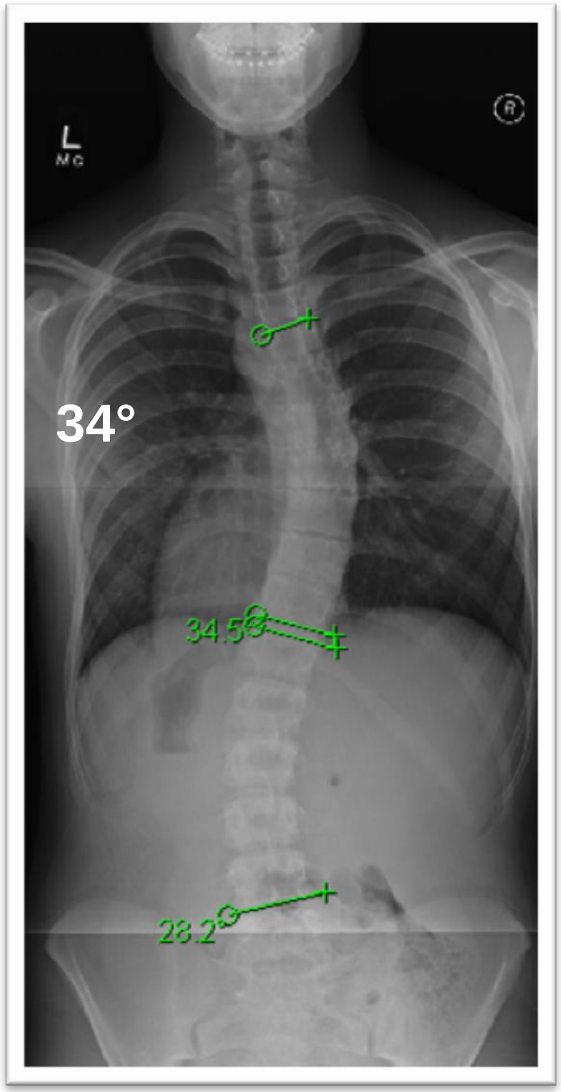
notes

Poor compliance

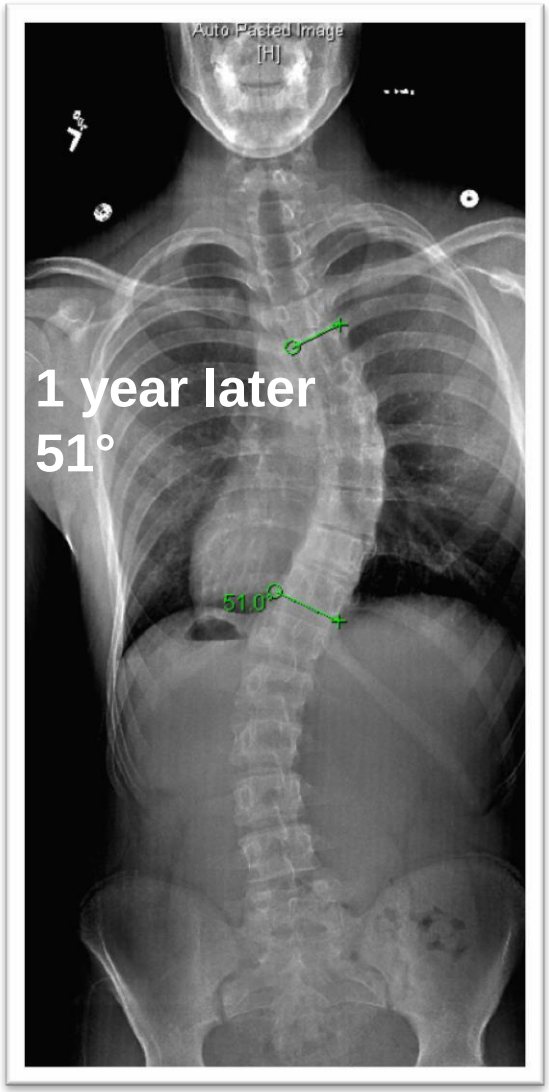




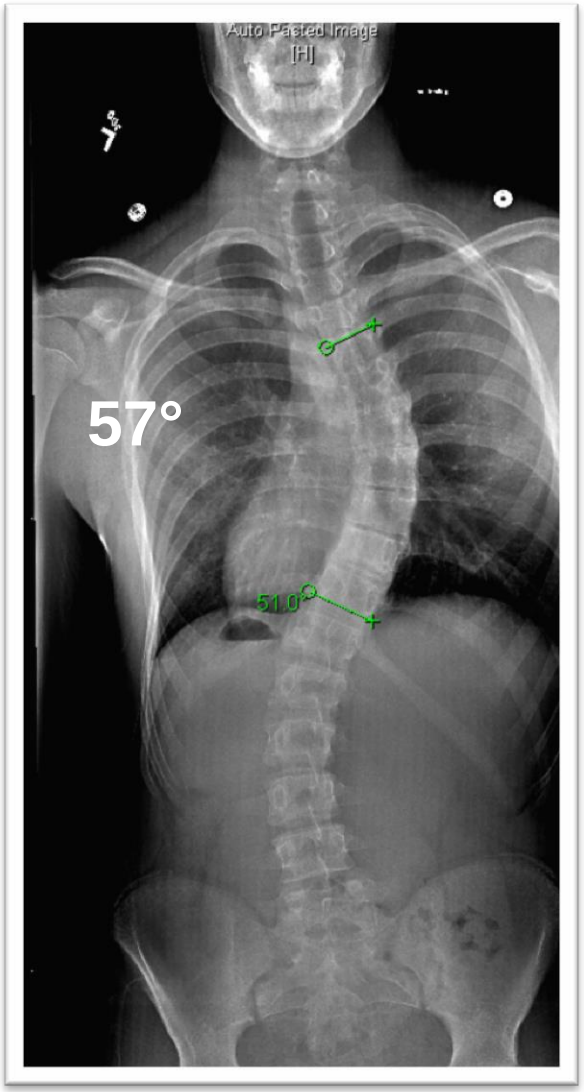
notes


34°
34.5
28.2


Auto Pasted Image
[H]
6 months later
44°
44.5


Auto Pasted Image
[H]
1 year later
51°
51.0

notes

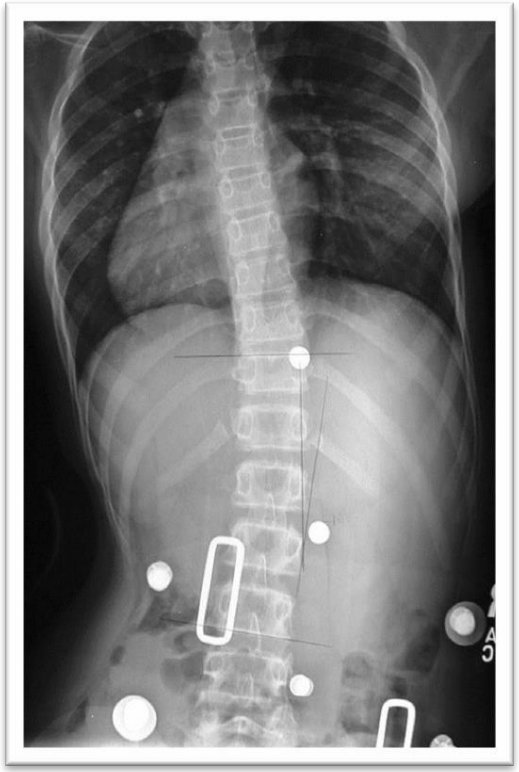

Auto Pasted Image
[H]
57°
51.0

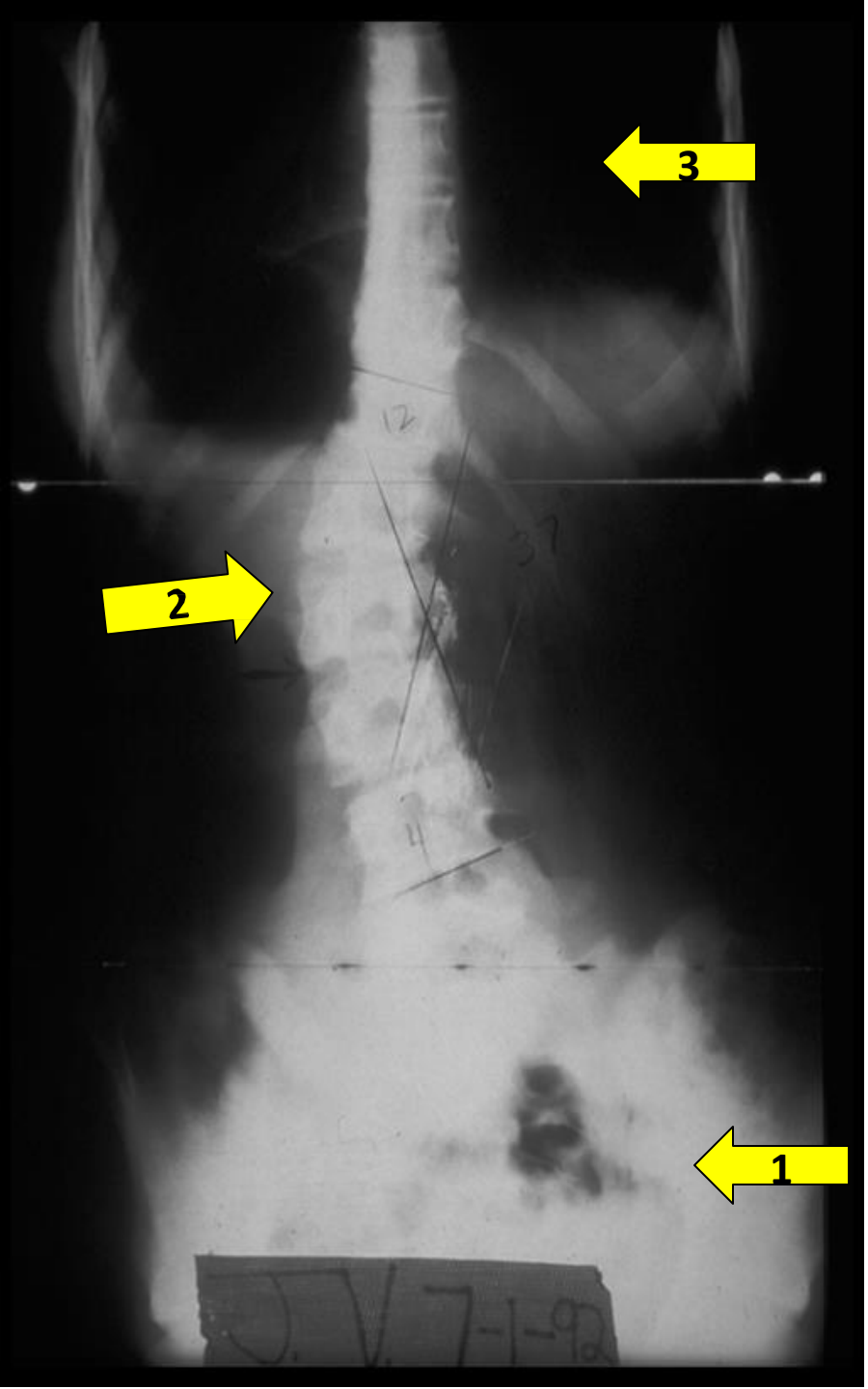

Auto Pasted Image
[H]
Post
Instrumentation


Auto Pasted Image
[F]

notes

CASE STUDIES-Module 2





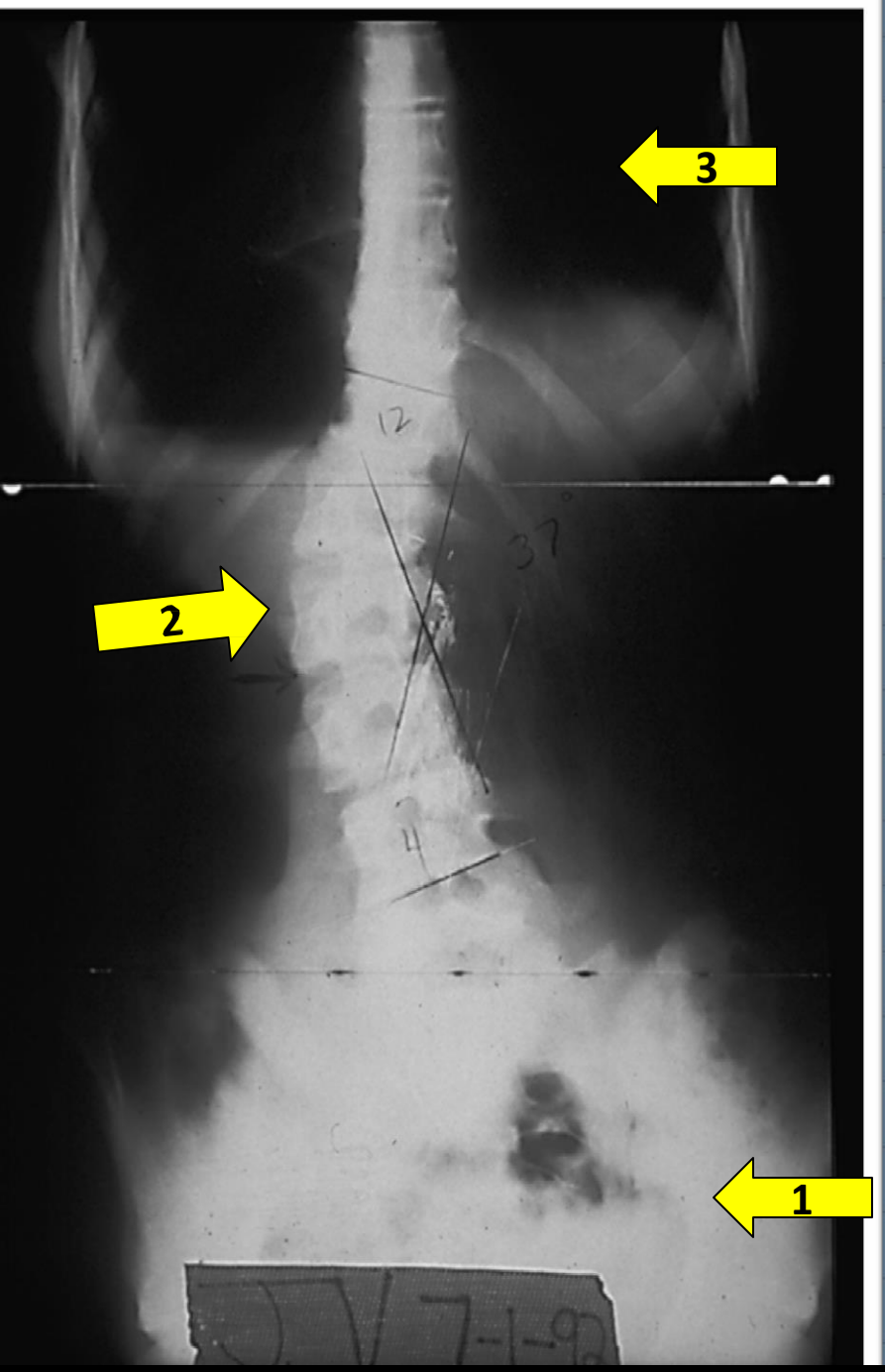
TYPE I

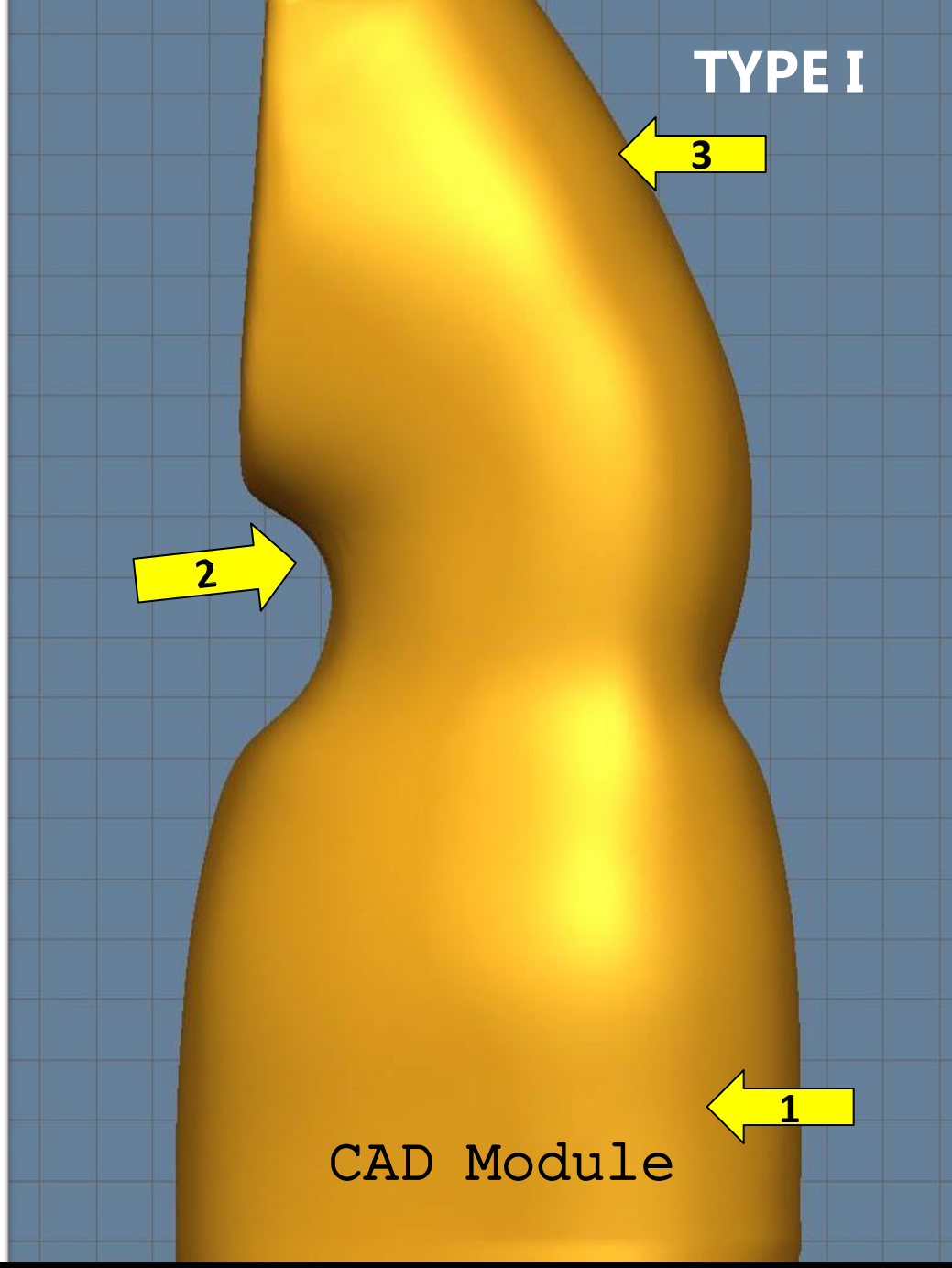
1. APPLY A STATIC STABILIZING FORCE AT THE THROCHANTER

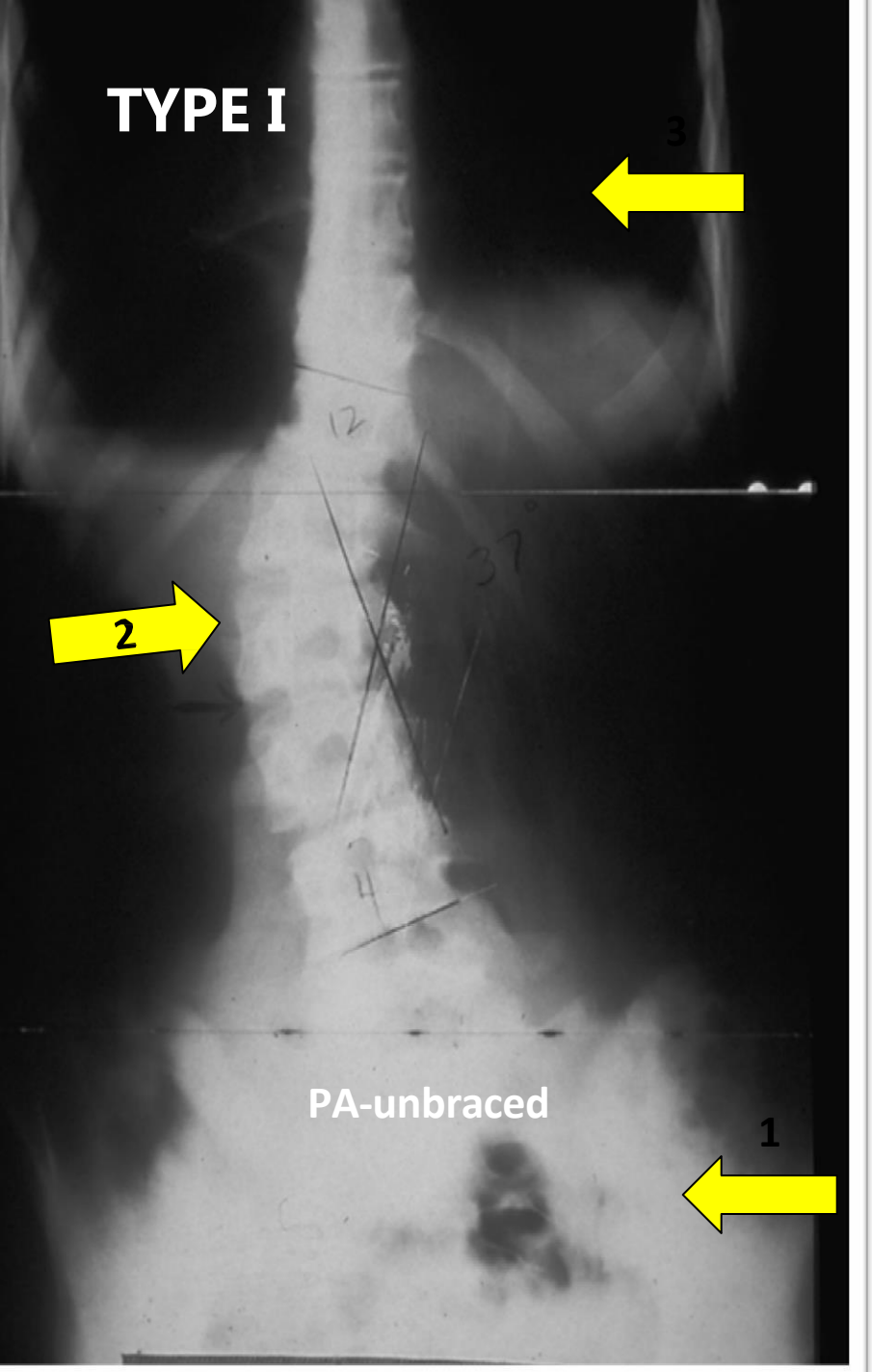
2. APPLY A DYNAMIC SHIFTING FORCE AT THE APEX OF THE CURVE

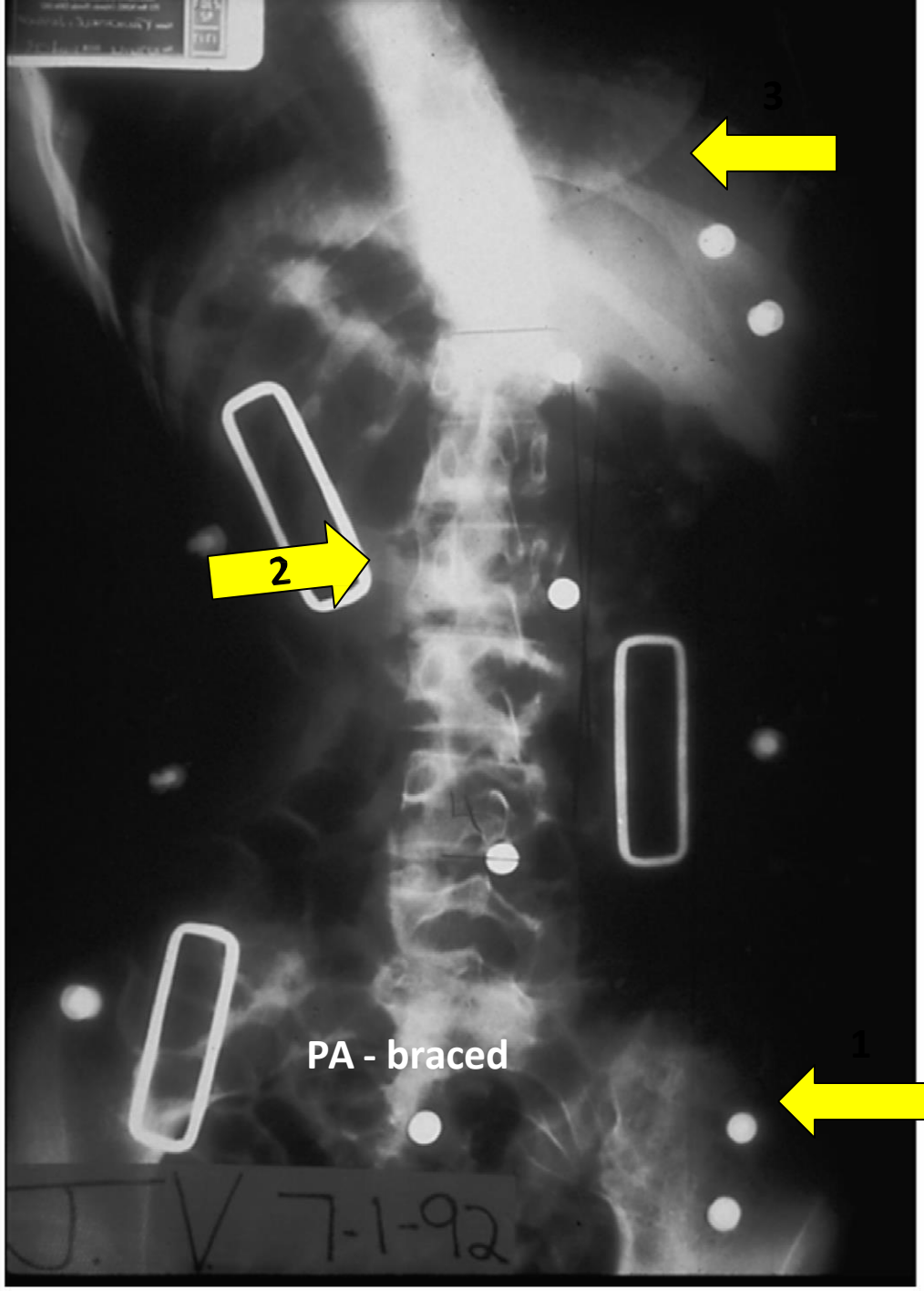
3. APPLY AN UNBENDING PRESSURE AT THE AXILLA

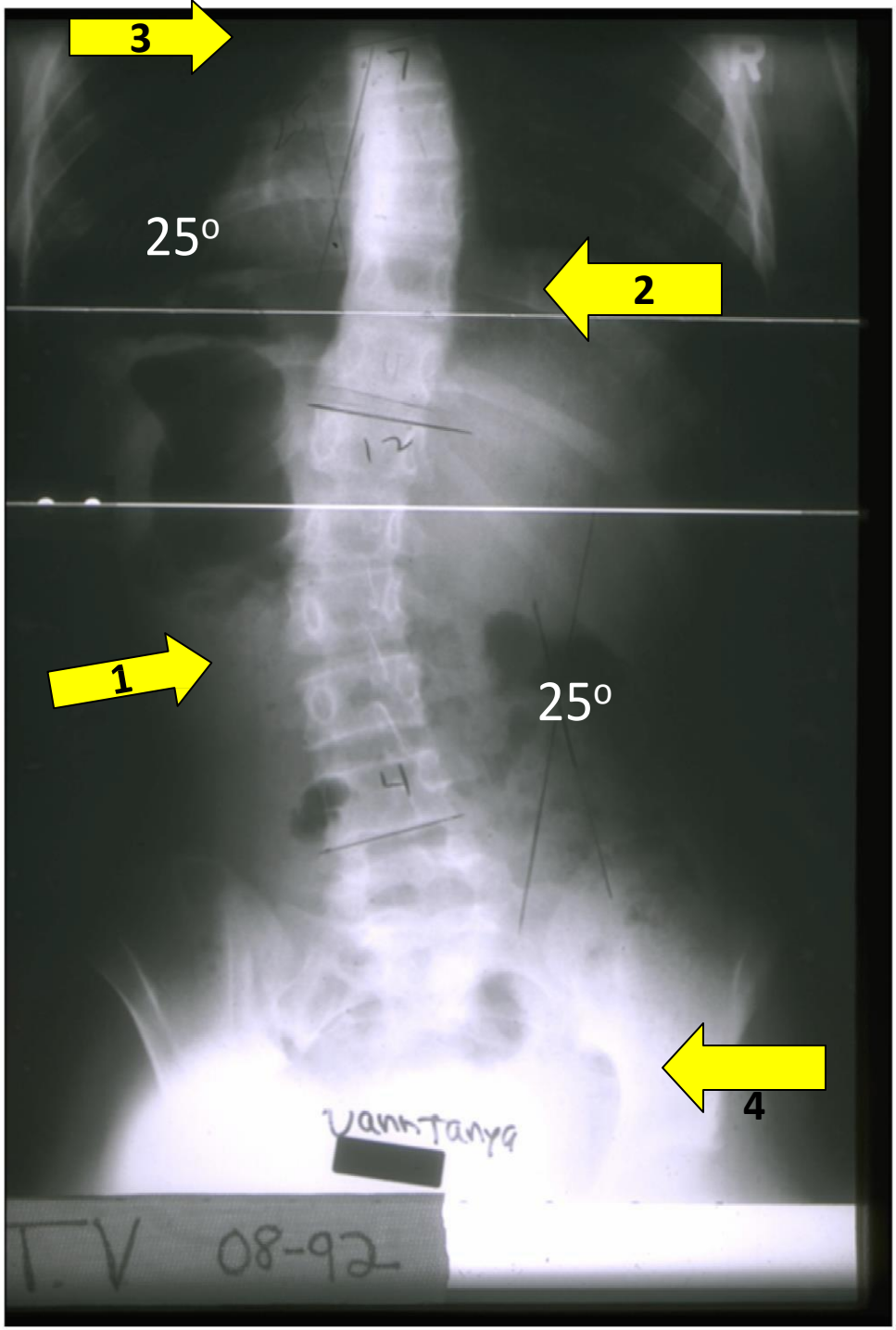
notes


3
2
1


TYPE I
3
2
1
CAD Module


TYPE I
3
2
1
PA-unbraced


3
2
1
PA - braced
J.V. 7-1-92



TYPE II

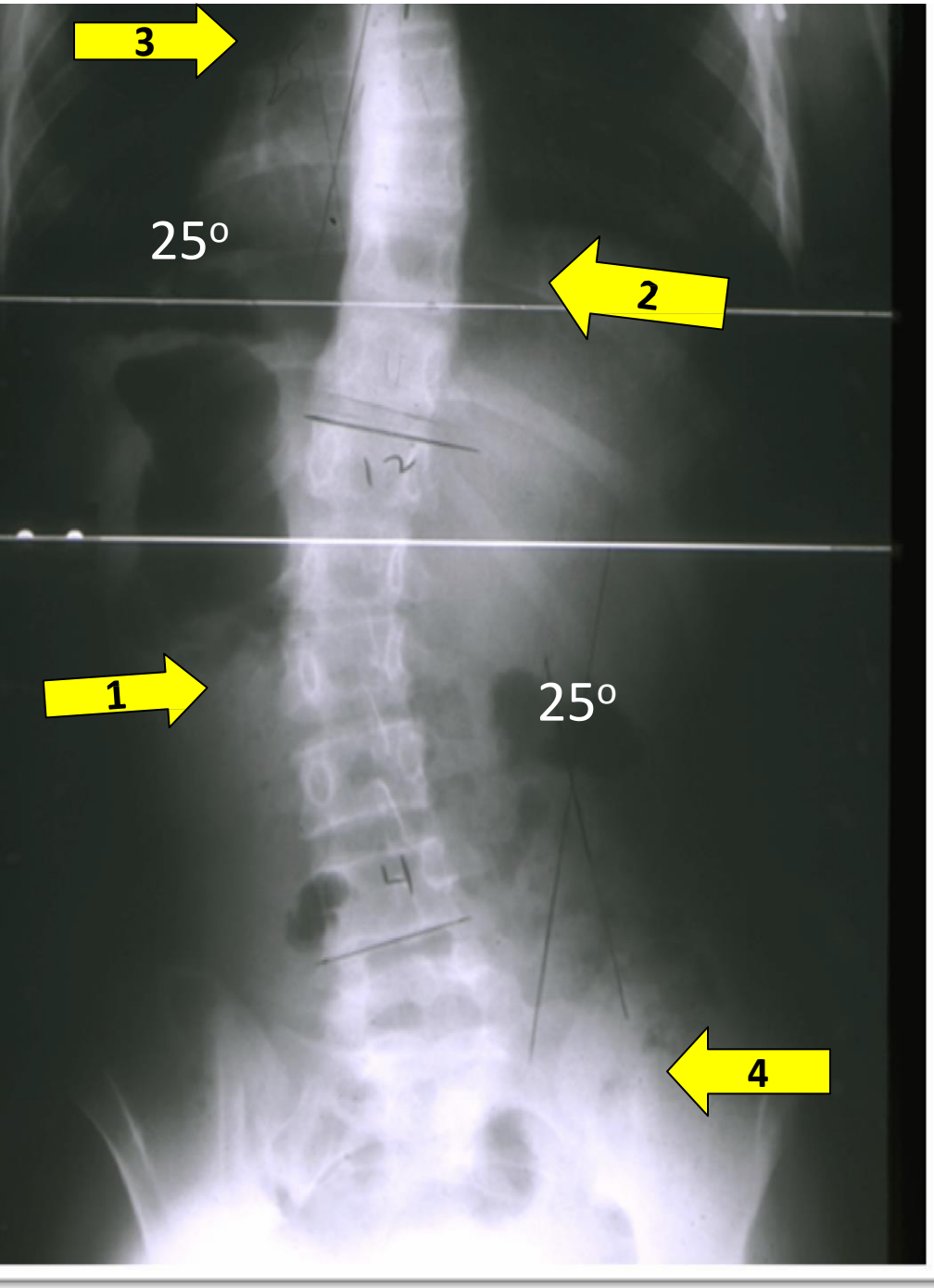
1. STATIC STABILIZING PRESSURE

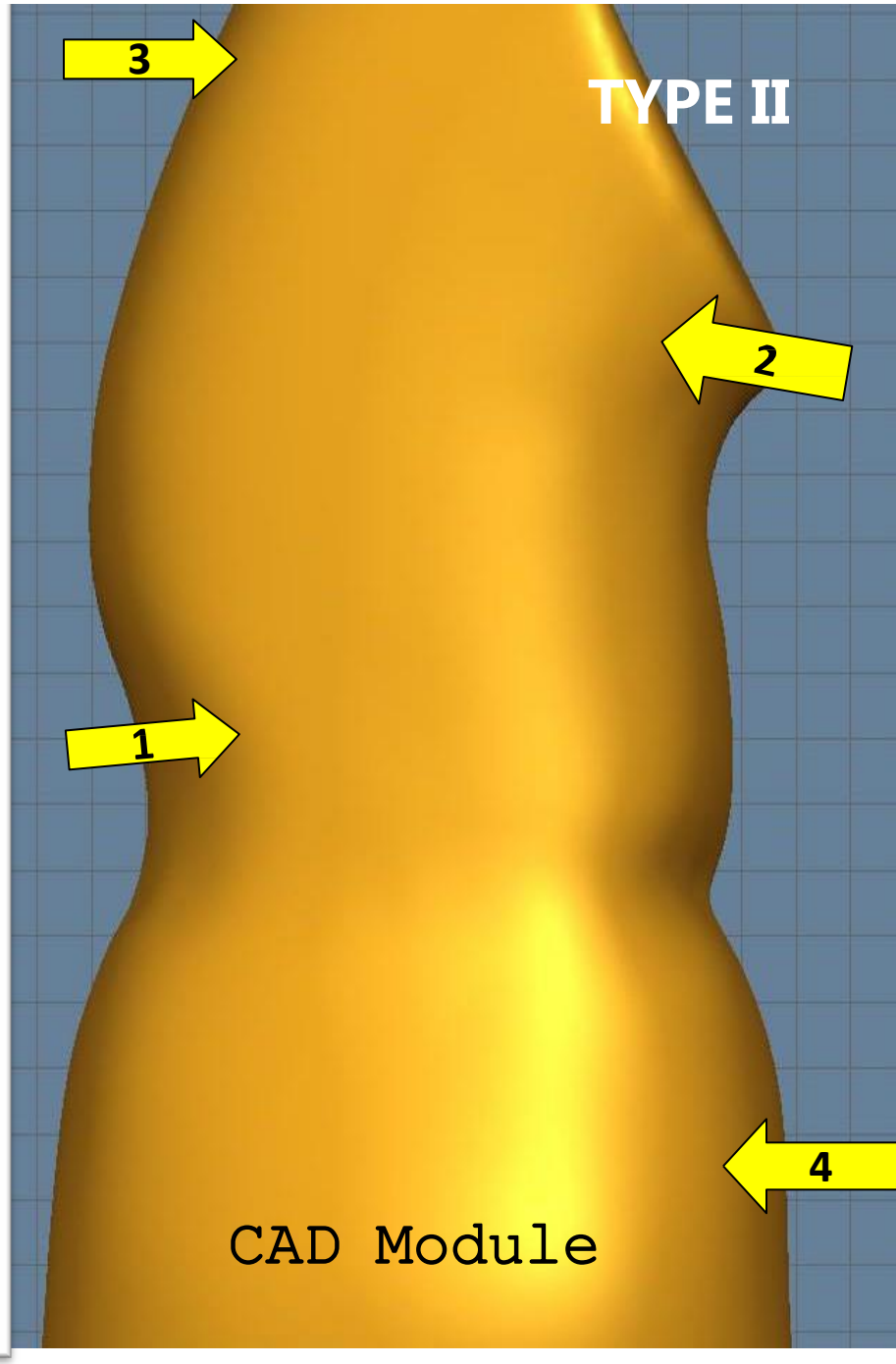
2. DYNAMIC / STATIC LATERAL SHIFT PRESSURE

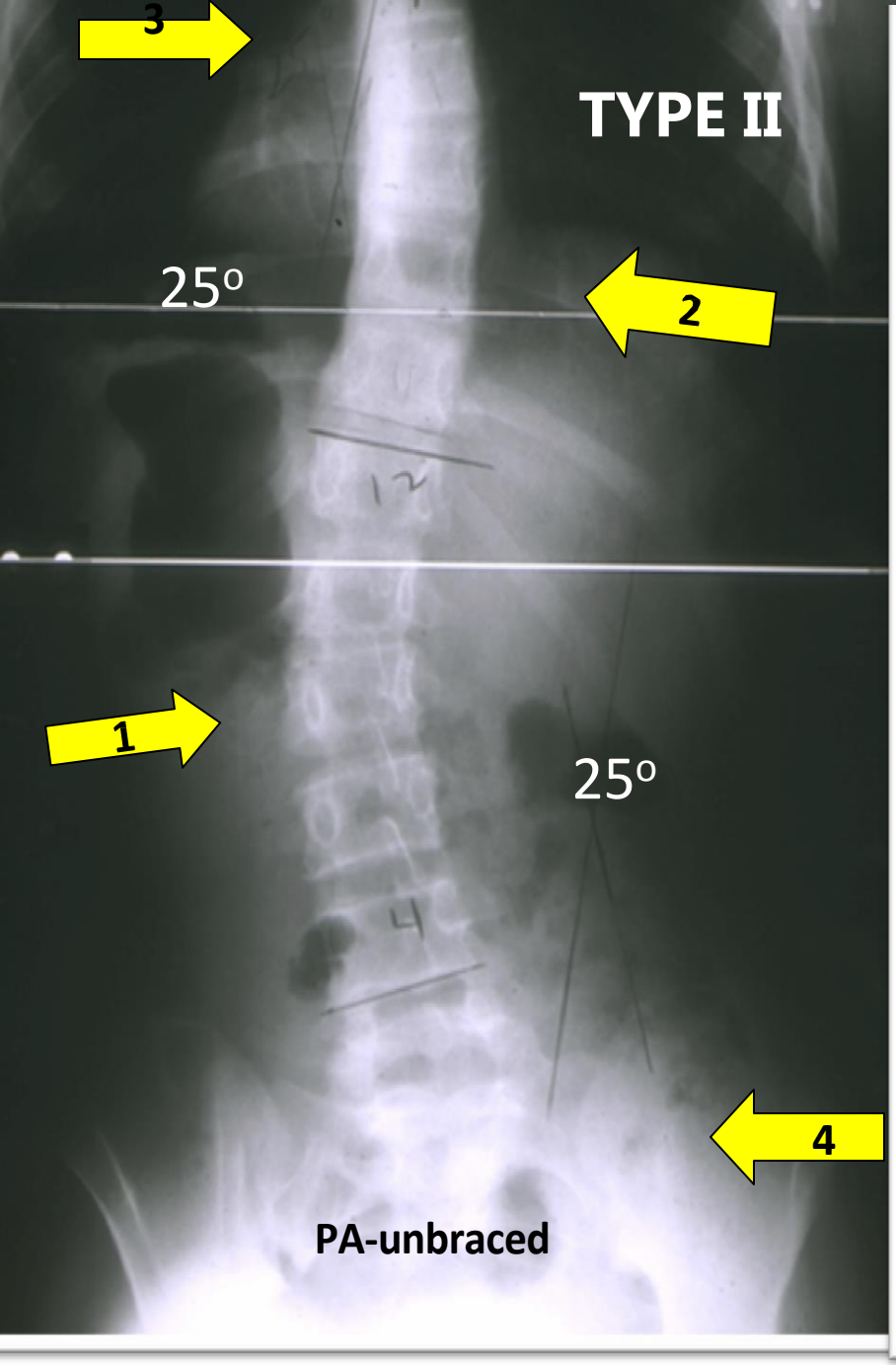
3. DYNAMIC UNBENDING PRESSURE

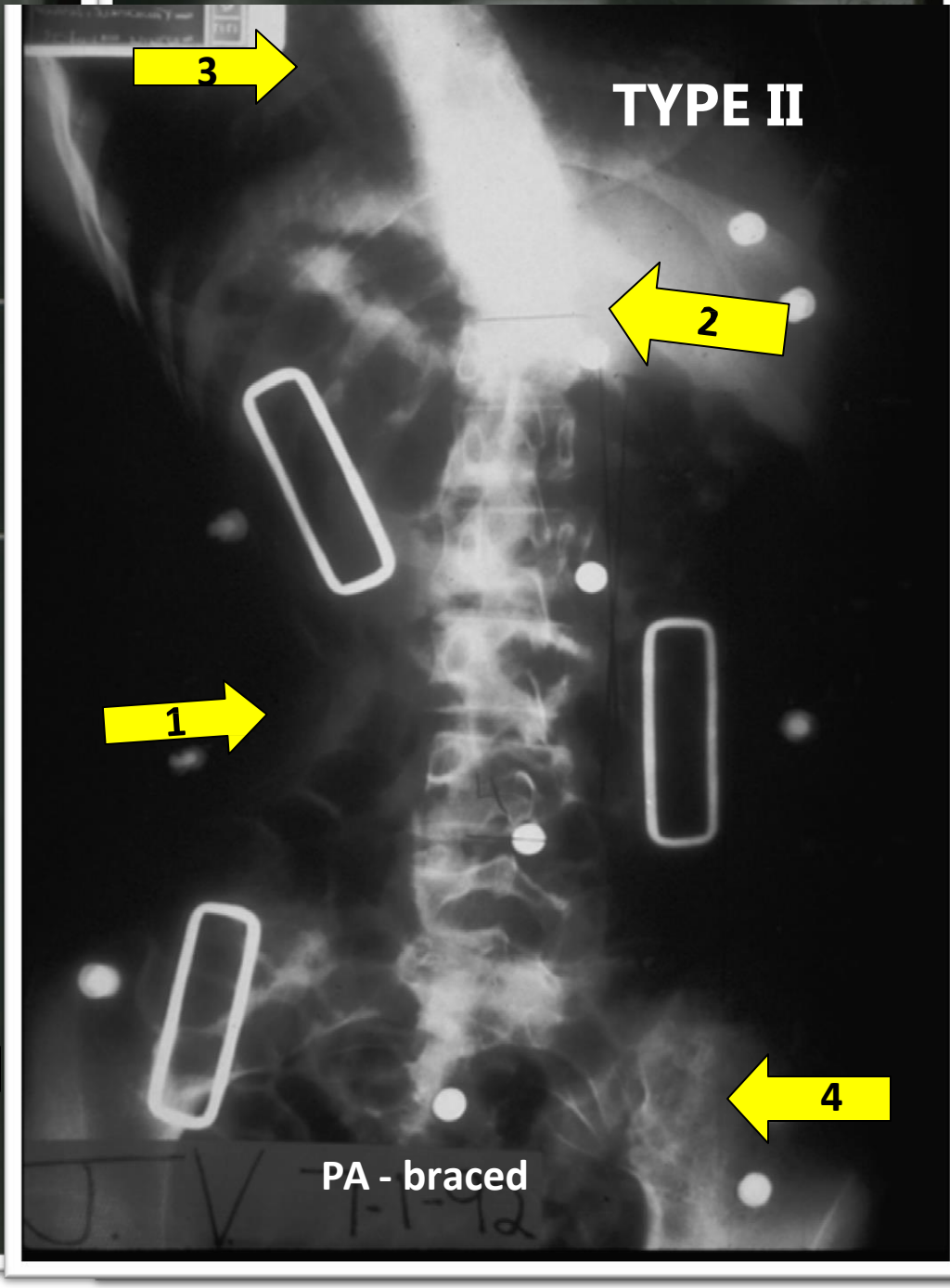
4. DYNAMIC UNBENDING PRESSURE

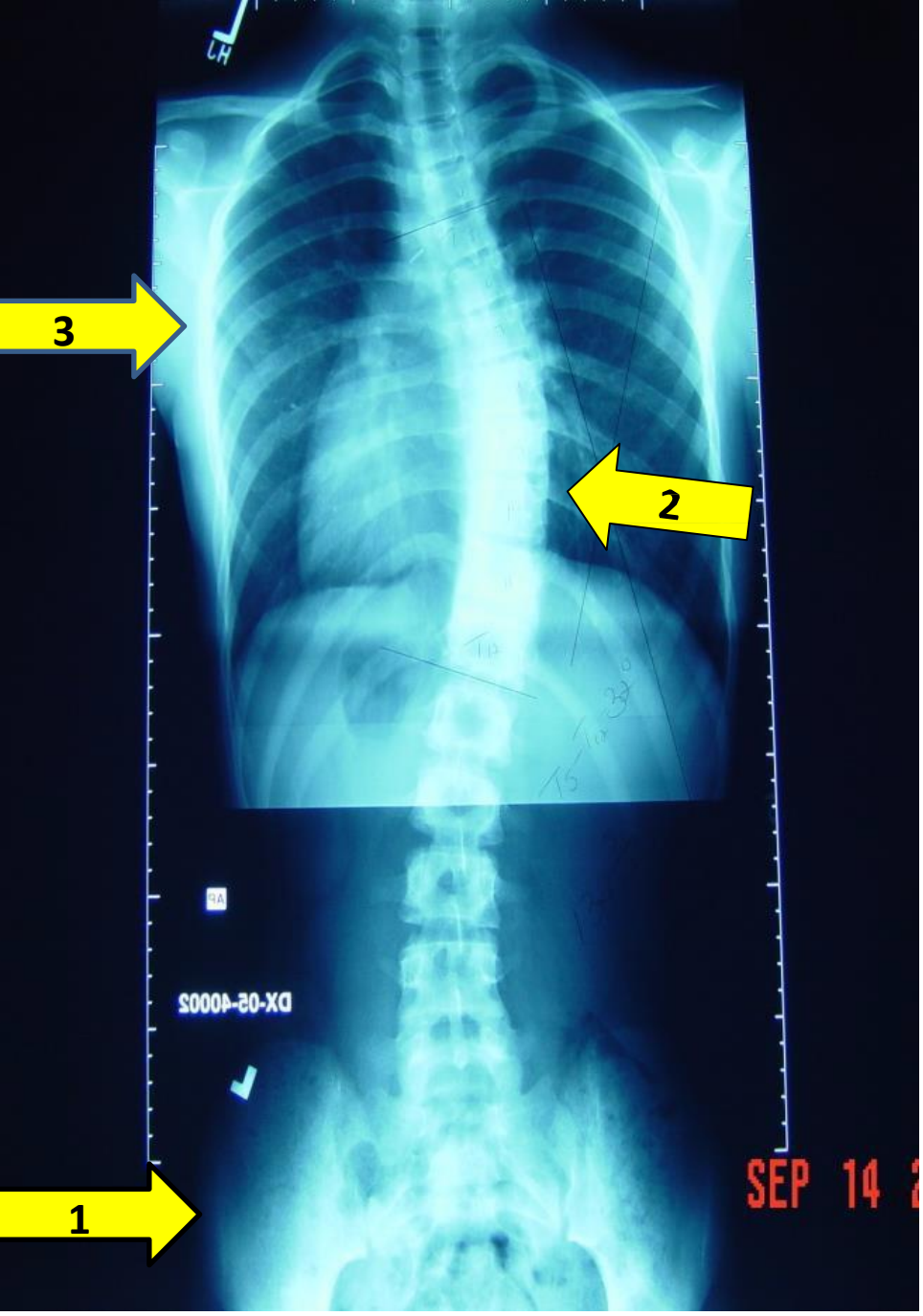
notes


3
25°
2
1
25°
4


3
TYPE II
2
1
4
CAD Module


3
TYPE II
25°
2
1
25°
4
PA-unbraced


3
TYPE II
2
1
4
PA - braced



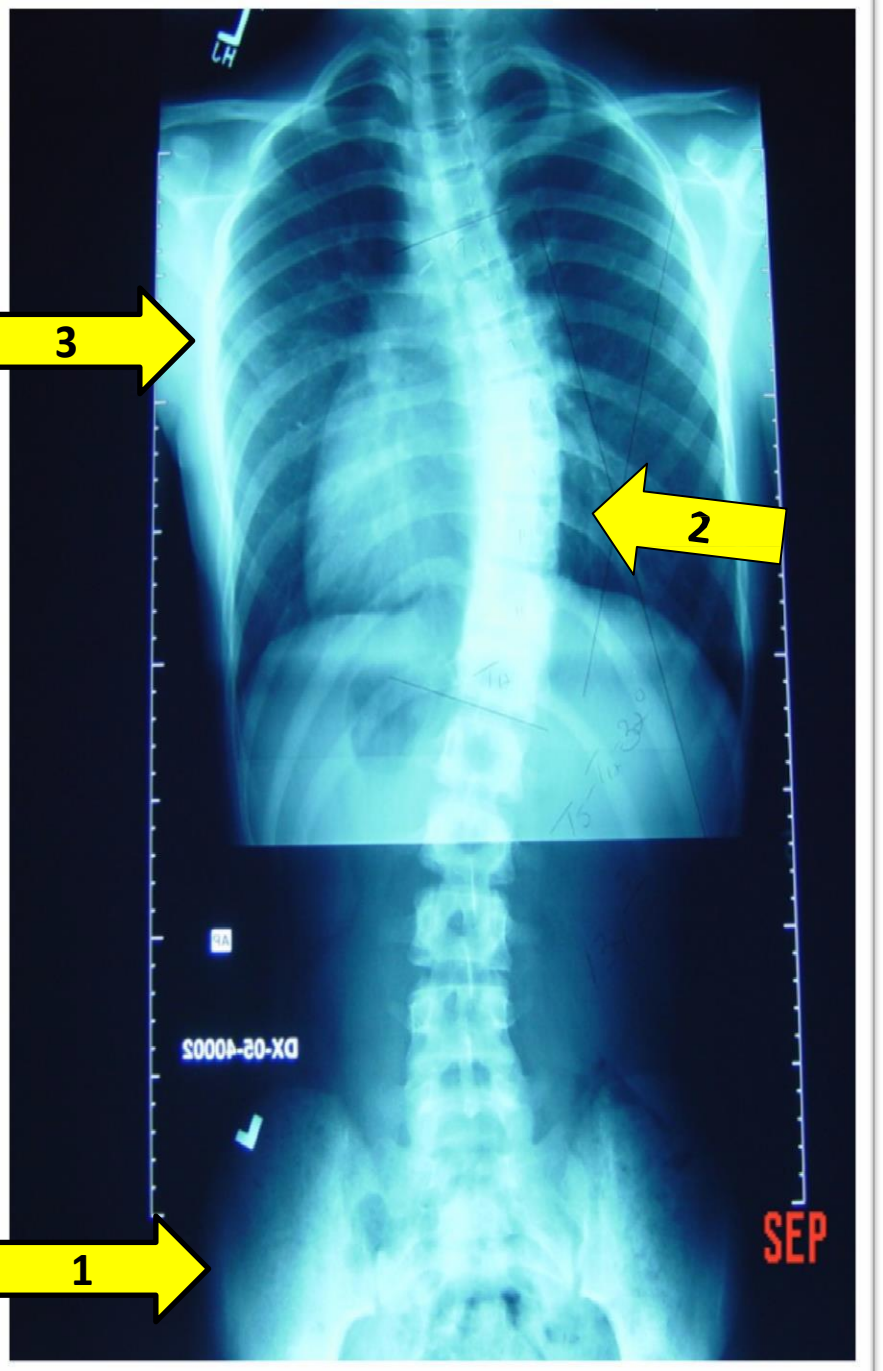
TYPE III

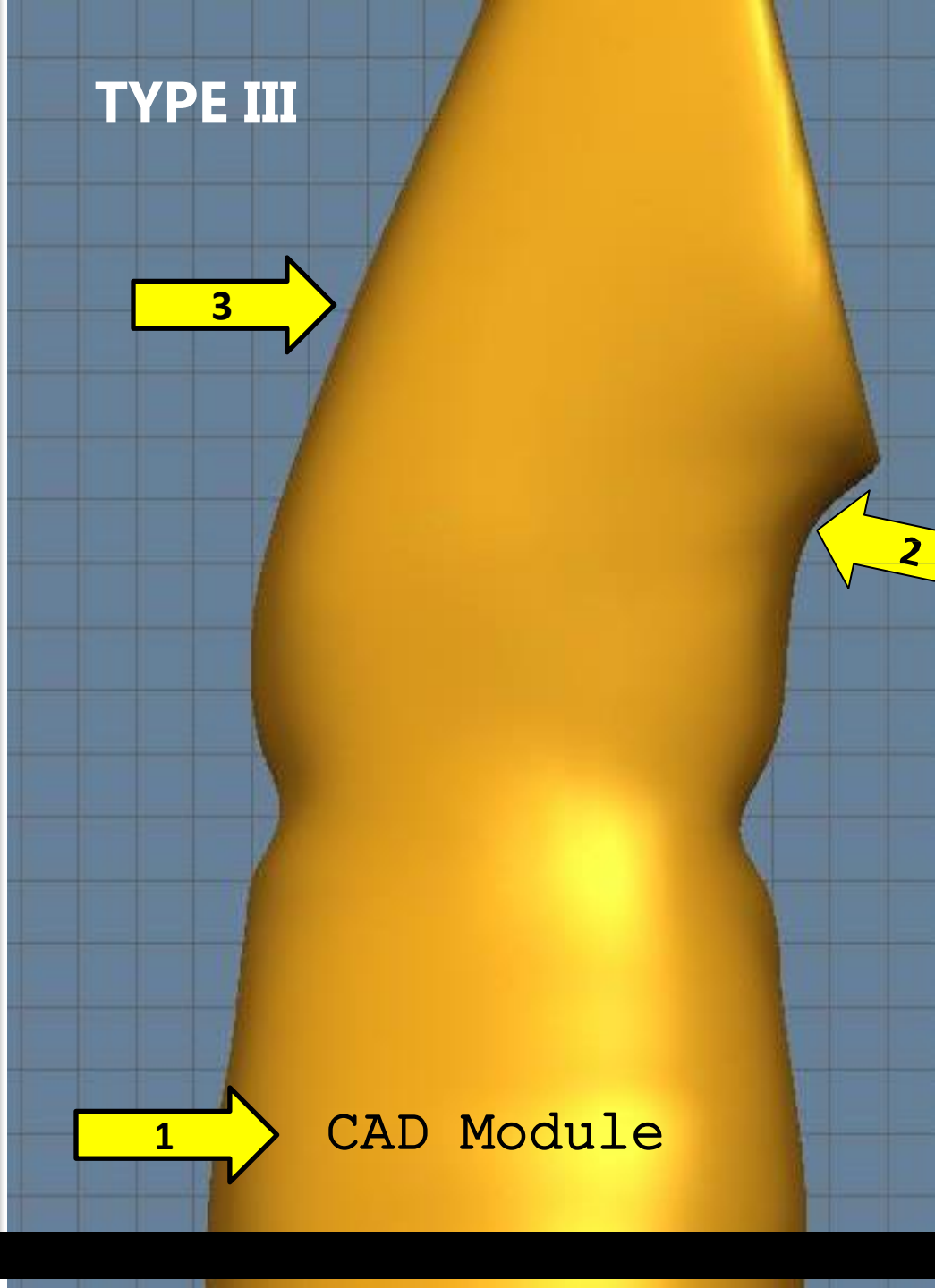
1. APPLY A STATIC STABILIZING FORCE AT THE THROCHANTER

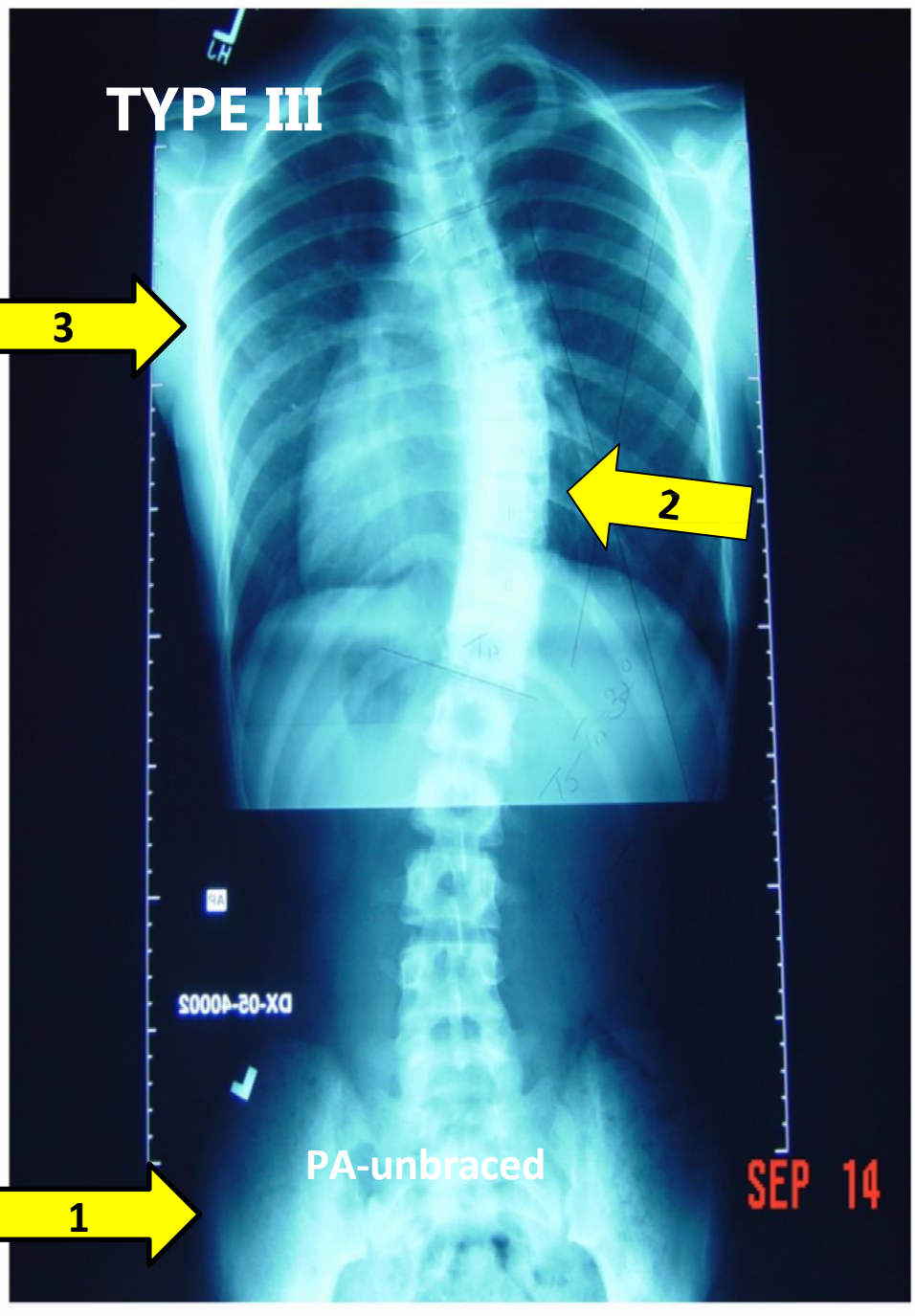
2. APPLY A DYNAMIC SHIFTING FORCE AT THE APEX OF THE CURVE

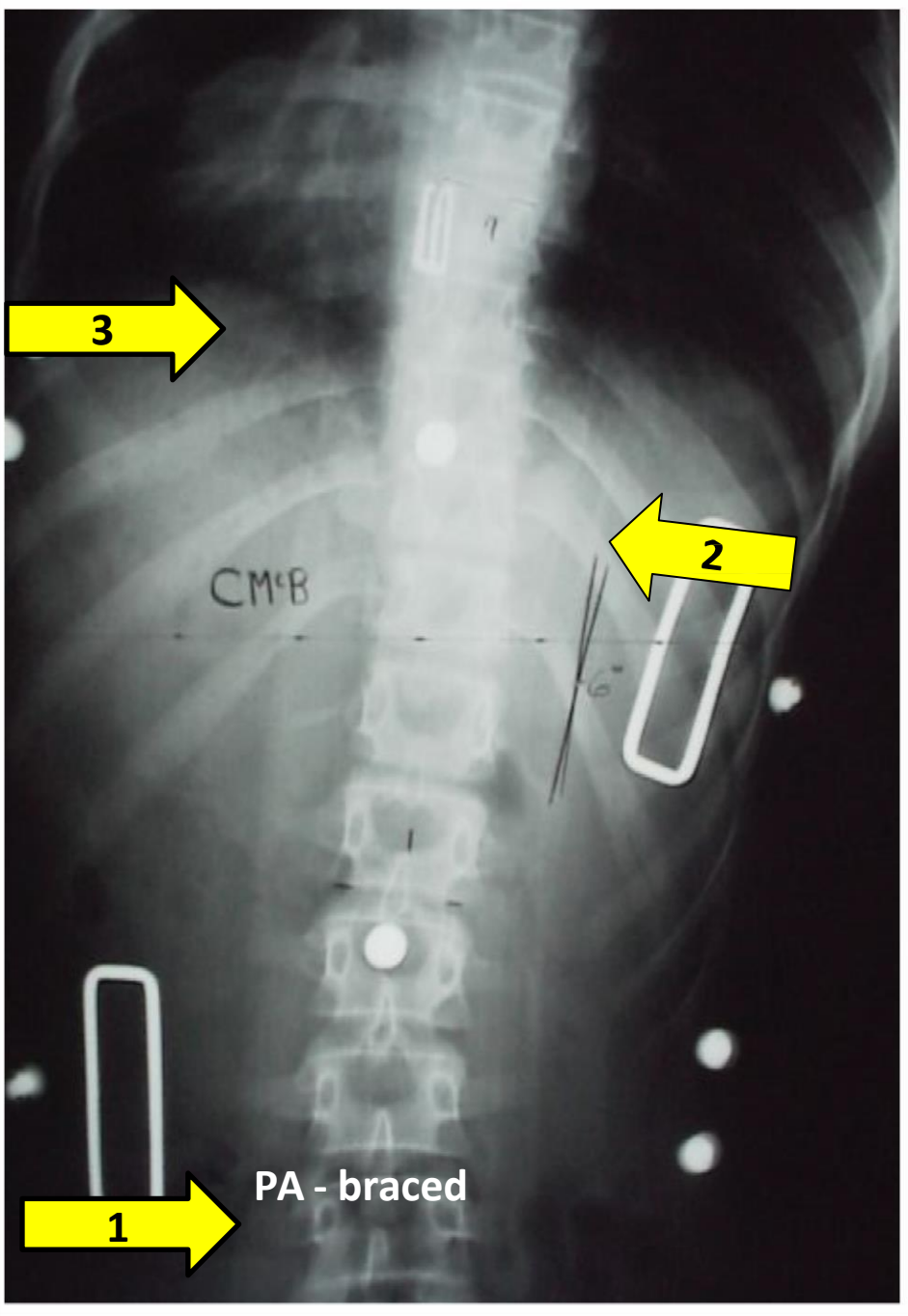
3. APPLY AN UNBENDING PRESSURE AT THE AXILLA

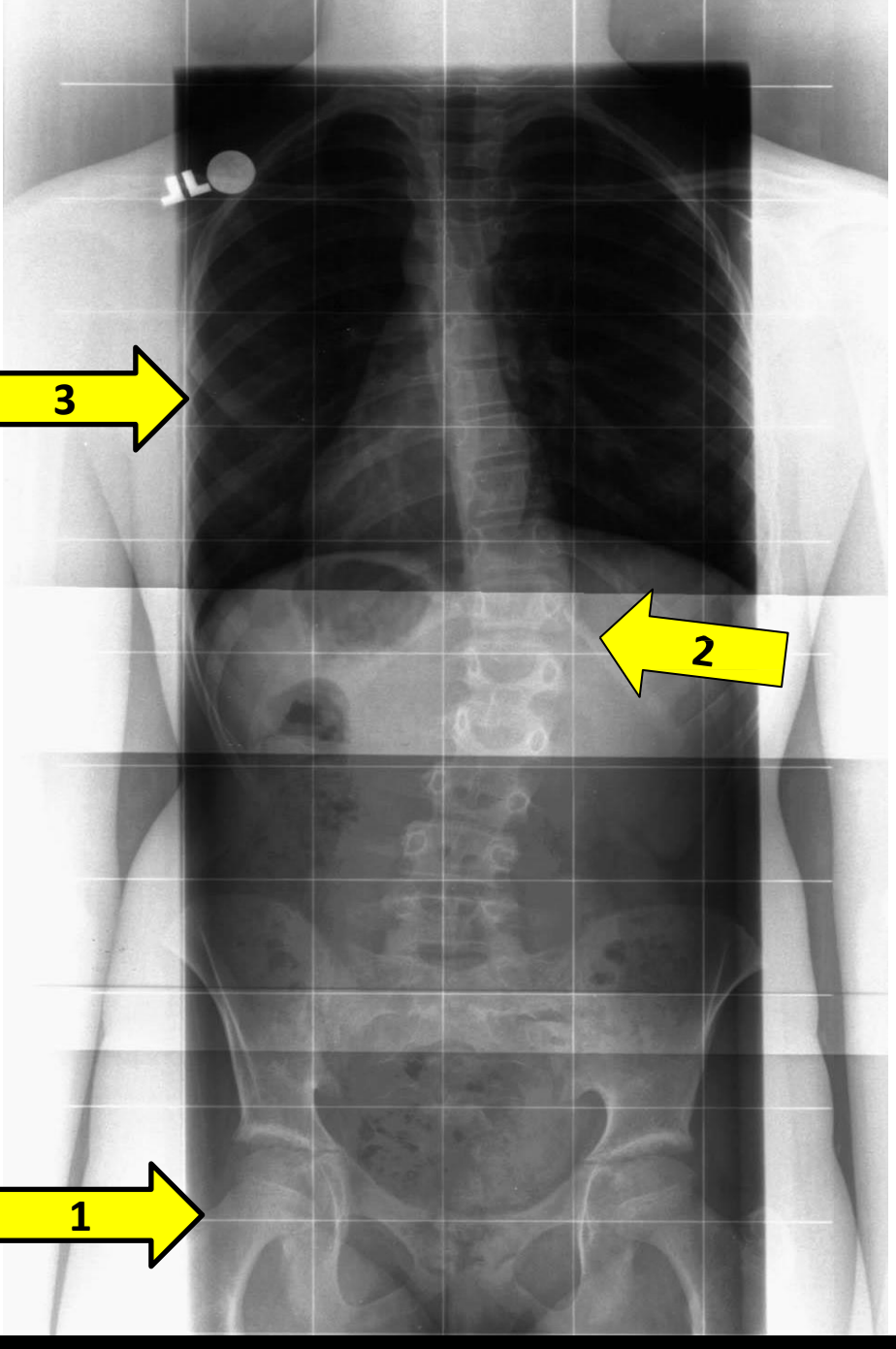
notes


3
2
1
SEP


TYPE III
3
2
1
CAD Module


TYPE III
3
2
1
PA-unbraced
SEP 14


3
2
1
PA - braced



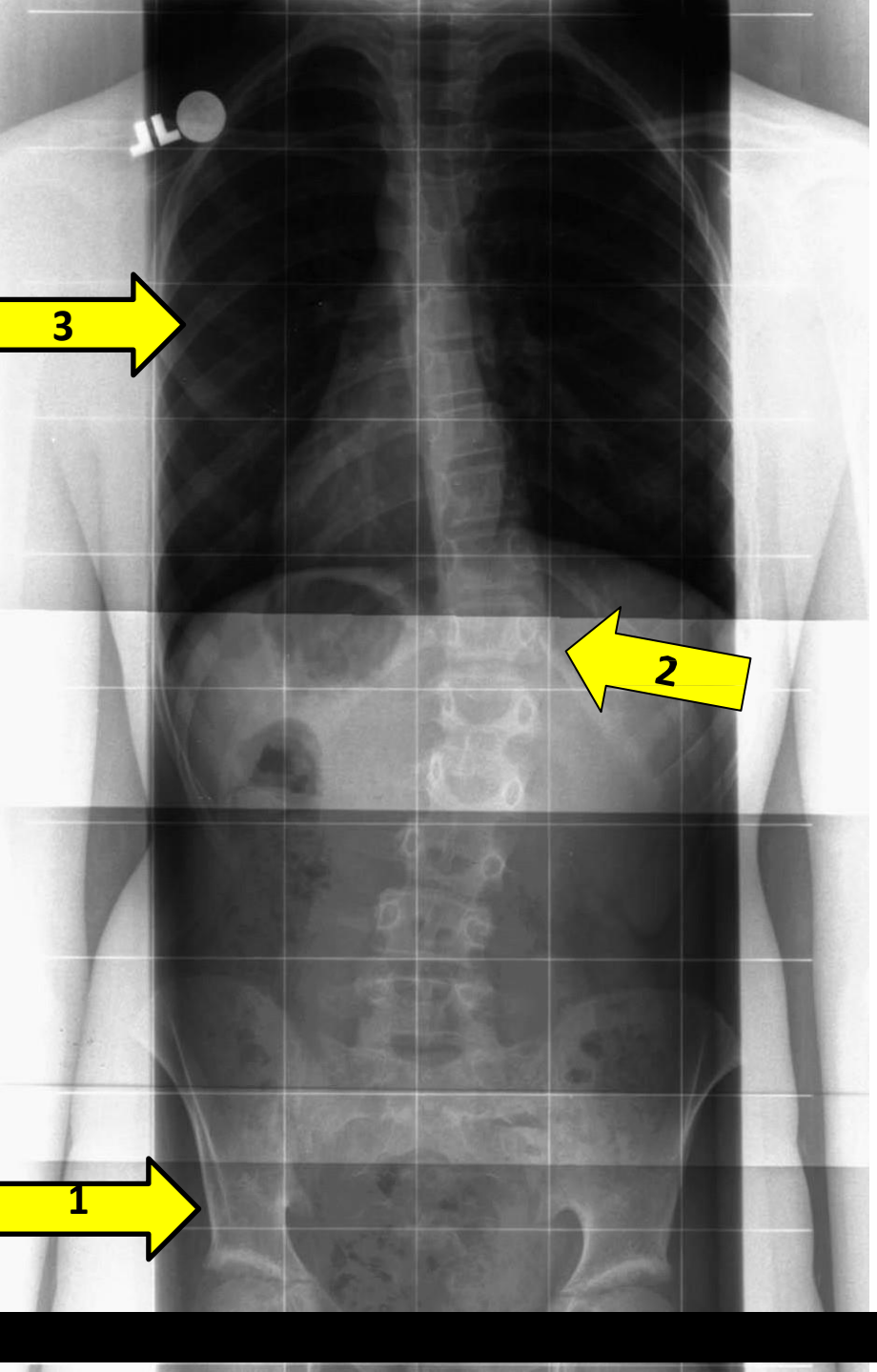
TYPE IV

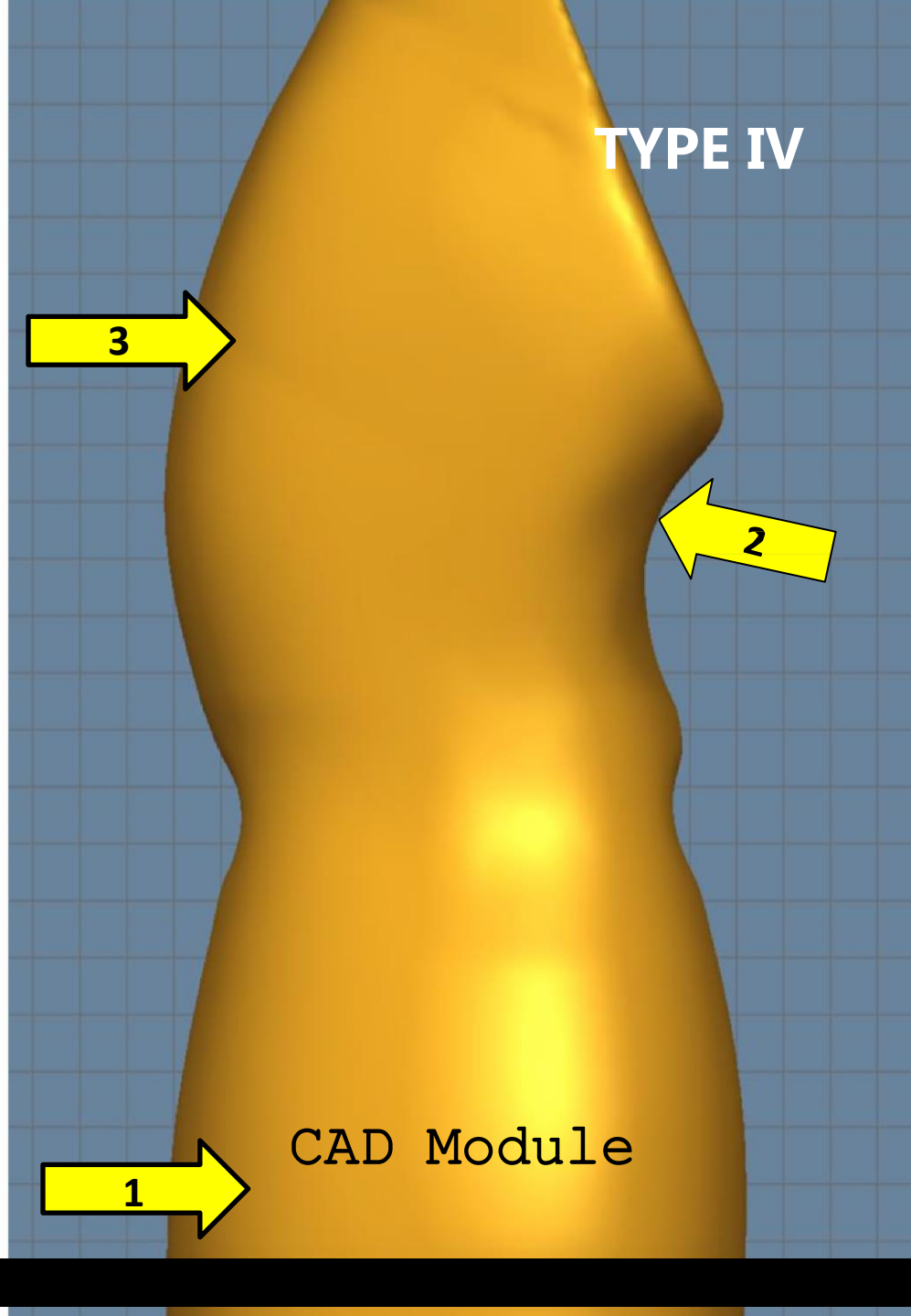
1. APPLY A STATIC STABILIZING FORCE AT THE THROCHANTER

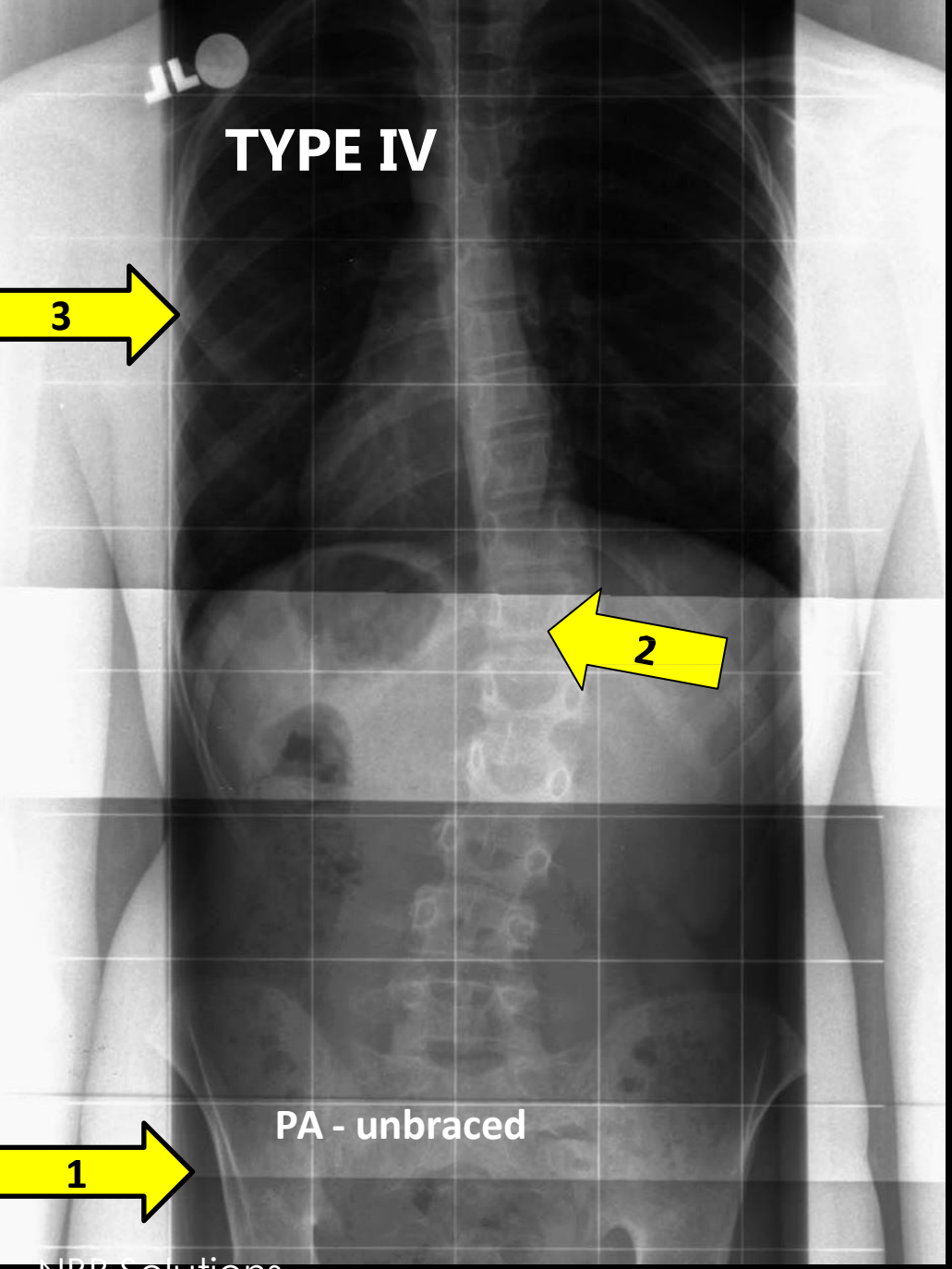
2. APPLY A DYNAMIC SHIFTING FORCE AT THE APEX OF THE CURVE

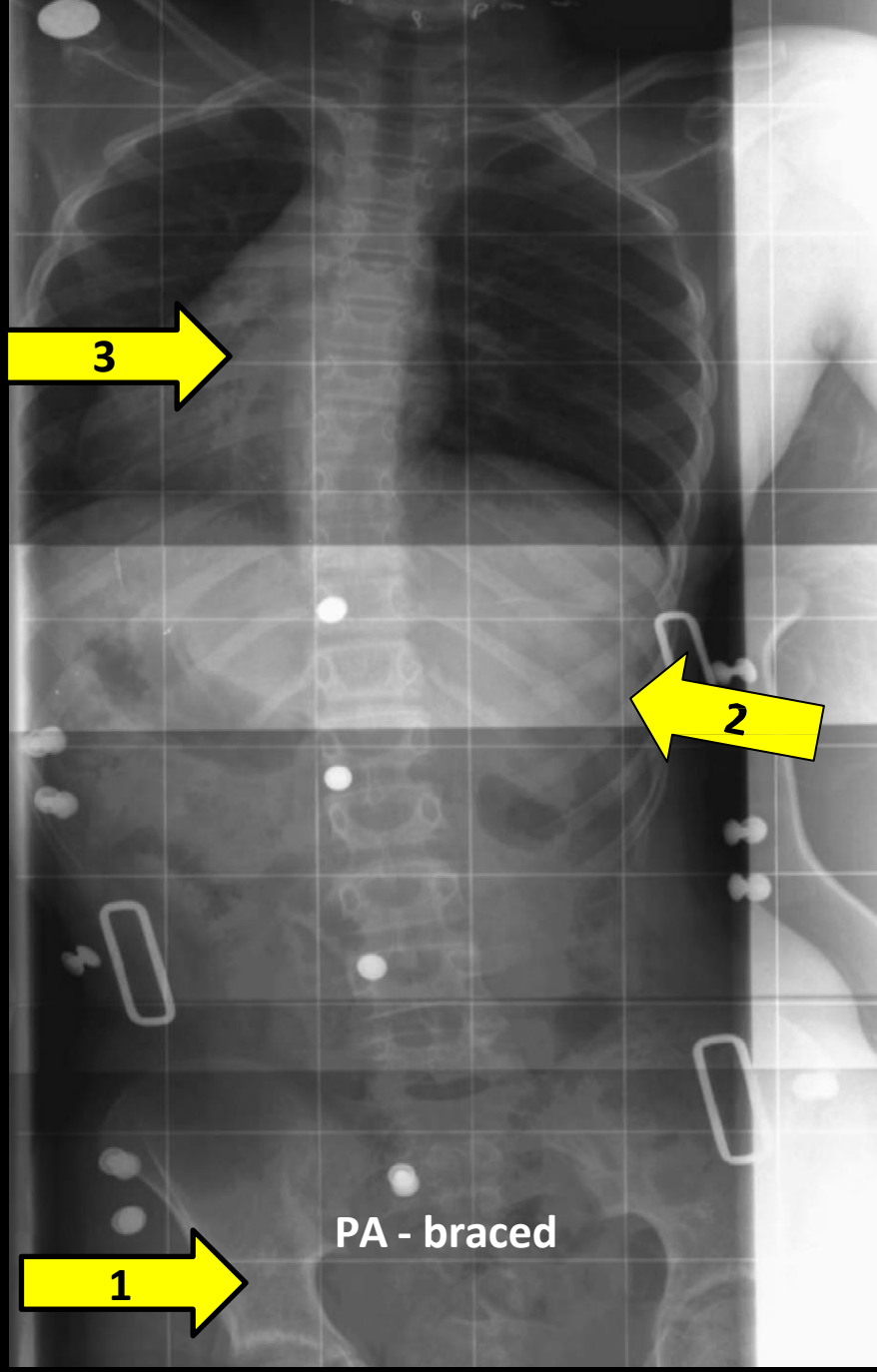
3. APPLY AN UNBENDING PRESSURE AT THE AXILLA

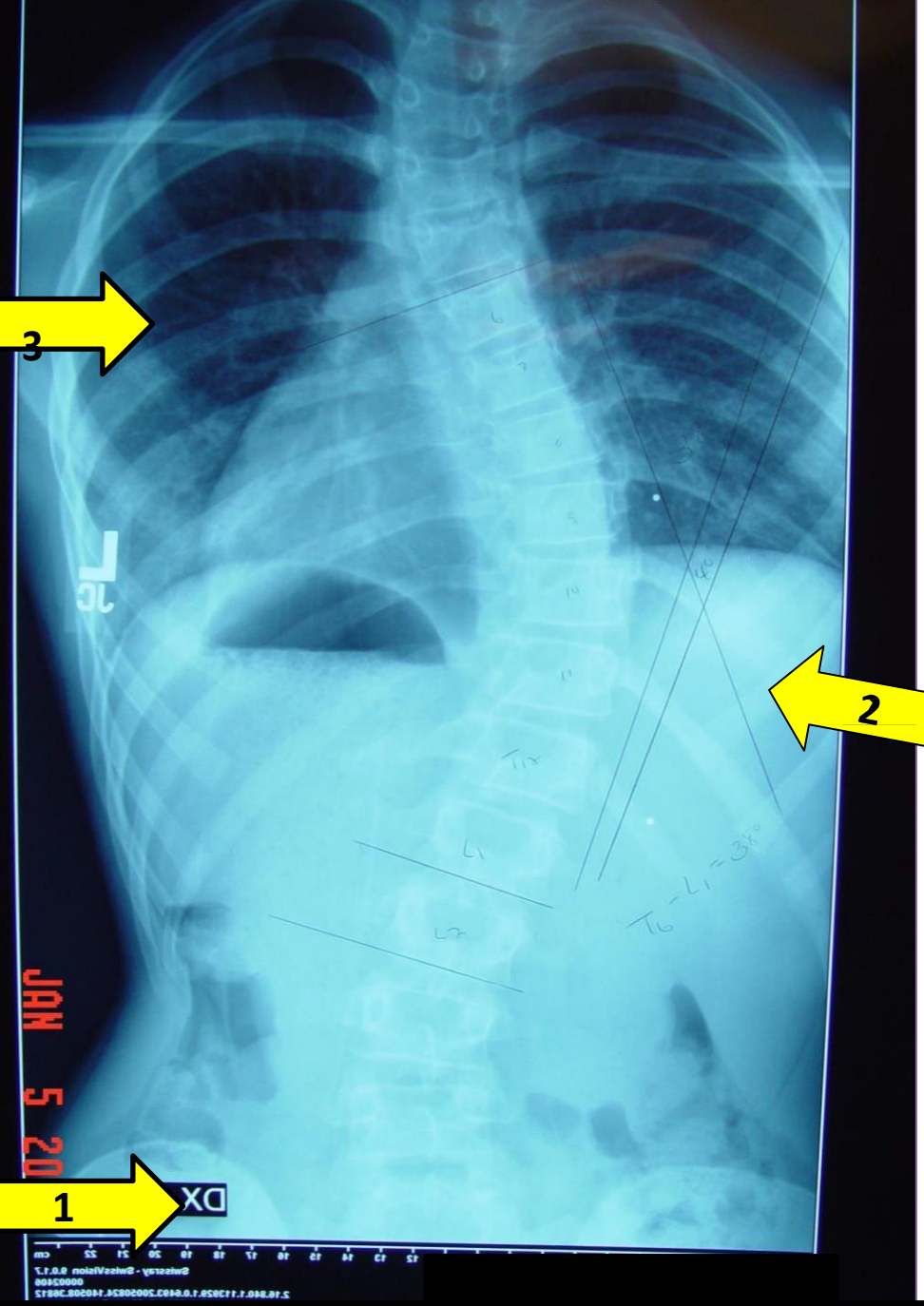
notes


3
2
1


TYPE IV
3
2
1
CAD Module


TYPE IV
3
2
1
PA - unbraced


3
2
1
PA - braced



Type V

1. APPLY A STATIC STABILIZING FORCE AT THE THROCHANTER

2. APPLY A DYNAMIC SHIFTING FORCE AT THE APEX OF THE CURVE

3. APPLY AN UNBENDING PRESSURE AT THE AXILLA

notes