PHYSICAL THERAPY CONSIDERATIONS FOR THE PEDIATRIC SPINE

Karen Turner-Bare, MPT
Department of Therapeutic Services
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SCOLIOSIS
DEFINITION: a lateral curvature of the spine; the curve in the coronal plane must be greater than 10° with a vertebral rotation component on the radiograph.
Scoliosis is a three dimensional deformity.

5 TYPES OF SCOLIOSIS TO CONSIDER
Adolescent Idiopathic Scoliosis (AIS)
Juvenile Idiopathic Scoliosis
Infantile Scoliosis
Congenital Scoliosis
Neuromuscular Scoliosis

ADOLESCENT IDIOPATHIC SCOLIOSIS
- Occurs at or around the onset of puberty
- Curve Progression
  - Females 19.3%
  - Males 1.2%
- Familial Tendency
  - siblings of patients with AIS are 7x more often diagnosed
  - children of patients with AIS are 3x more often diagnosed

JUVENILE IDIOPATHIC SCOLIOSIS
- Identified between 3 years and 9 years of age
- Most common is a Right Thoracic curve
- Has a high rate of progression with a resultant severe deformity if left untreated
- Equal prevalence male to female
- Prevalence: 2-4% of children aged 10 to skeletal maturity
- Overall male-to-female ratio 1:3.6

INFANTILE SCOLIOSIS
- Onset is less than 3 years old
- 80-90% spontaneously resolve
- Remaining 10-20% will progress through childhood to severe deformity if left untreated
- More frequent in Males
- Most curves are Left Thoracic
- Is NOT associated with vertebral anomalies
CONGENITAL SCOLIOSIS

- Scoliosis that develops as the result of vertebral anomalies
- Male-to-Female ratio 1:1.4
- Abnormalities in other organ systems have been associated in as many as 61% of these cases:
  - Cardiac associated with congenital deformities of the Thoracic Spine
  - Kidney associated with congenital deformities of the Lumbar Spine

NEUROMUSCULAR SCOLIOSIS

- Scoliosis associated with systemic or chronic disease
- Decreased functional ability
- Diminished hand function (due to need for UE support to compensate for diminished balance)
- Respiratory compromise
- Usually has rapid progression
- Presents with more disabling outcomes

SCREENING FOR AIS

- Annual exam with PCP/Pediatrician
- Sports physical
- School screenings
- Scoliometer
  - Developed by Dr. Wm Bunnell in 1975
  - Like a level
  - Studies have shown high intra and inter-rater reliability coefficients
  - Cobb angle and scoliometer values are correlated w/ statistical significance.
  - 7 degree ATR on scoliometer is about 20 degree Cobb angle
  - Adams Forward Bend test in conjunction with Scoliometer provides best value of assessment in screenings

Screenings and US Govt

- 1996 United States Preventive Services Task Force (USPSTF) concluded that there was insufficient evidence for or against screening for AIS.
- 2004 USPSTF changed their position and recommended against the routine screening of asymptomatic AIS.
- This change in position was not based on any significant change in the available literature.

Screenings for AIS supported by:

- AAP: American Academy of Pediatrics
- POSNA: Pediatric Orthopedic Society of North America
- AAOS: American Academy of Orthopedic Surgeons
- SRS: Scoliosis Research Society

  - All 4 associations have collaborated to put forward a statement to support screenings for AIS to provide early treatment for this deformity.
  - Potential benefits of Screening for AIS include:
    - bracing intervention that may avoid the need for surgery;
    - identify the most optimal time for surgical correction is indicated;
    - identify patients who may otherwise be underserved by medicine;
    - avoid the inappropriate use of x-ray/exposure to radiation when child is referred to physician.

NEMOURS SCOLIOSIS SCREENING IN THE SCHOOLS PROGRAM

- Coordinated screening process between the Delaware Department of Education, Health Services Division and Nemours/ADHC Physical Therapists
  - Sponsored by the Nemours Orthopaedic Department
  - Phase I
    - School Nurse screens 5th – 9th grades
  - Phase II
    - Therapist determines
      - No follow-up needed
      - Phase II follow-up for next school year
      - Prompt referral to a physician for further assessment of orthopaedic concerns
NEMOURS SCOLI SCREENING PROGRAM's 2010 "STATS"

- # 5th – 9th graders in Phase I: 41,890
- # students screened Phase II: 1,967
- # students that do not require follow-up: 1,113
- # of students that PTs indicate for follow-up in Phase II the following school year: 746
- # of students identified by PTs for prompt referral to physician for evaluation: 108

Orthopedic concerns other than scoliosis identified through screenings:
- Scheuermann’s Kyphosis
- Pectus Excavatum
- Blount’s Disease

CLINICAL INTERVENTION for the child with
IDIOPATHIC or CONGENITAL SCOLIOSIS

Treatment decisions are made by physician assessment of:
- Skeletal maturity (Risser sign)
- Digital Skeletal Age (hand x-ray)
- Growth potential of the child
- Curve magnitude

TREATMENT CONSIDERATIONS for the child with
IDIOPATHIC or CONGENITAL SCOLIOSIS

NON-SURGICAL
- Clinical exam by orthopaedist
- Brace fabrication
- Exercise

SURGICAL
- Braces fabrication
- Exercise

ORTHOTICS/BRACING prescribed by orthopaedic surgeon for child with
IDIOPATHIC or CONGENITAL SCOLIOSIS

- Wilmington Jacket
  - (custom molded, full contact)
- Charleston Brace
  - (night time only; maximum sidebend)
- Boston Brace
  - (prefabricated with custom inserts)
- SpineCor®
  - (dynamic with elastic bands)

PT’S AND ORTHOTIC WEAR

- Encourage compliance with prescribed wear of “back brace”
- Check fit, pressure points and “comfort” for compliance
- Refer to orthotist or orthopaedist when brace is not fitting properly
- Goal of the “scoliosis jacket”:
  - to stabilize a curve in an effort to avoid surgery or delay need for surgery
  - Assist patient to discover comfortable positions in brace to increase compliance with wear

EXERCISE WITH YOUR FAVORITE PHYSICAL THERAPIST

Exercise is generally indicated for low magnitude curves; less than 40 degrees.

- Spinal stabilization
- Balance activities
- Core strengthening
- Postural correction & lateral shifts
- Flexibility
- Respiratory activities

To address the findings/theories in the literature that suggest that (idiopathic) scoliosis may be the result of:
- Mechanical vertebral column failure
- Decompensation of the spine
- Postural regulation system dysfunction
EXERCISE PROTOCOLS IN THE LITERATURE

SEAS – Scientific Exercises Approach to Scoliosis

Specific exercise to promote:
- Spinal stability
- Balance reactions
- Retain physiologic sagittal spinal curves

In 2011: Romano and Negrini, et al. of the Italian Spine Institute, Italy
In 2006: Negrini et al.: 1 year prospective controlled study of 48 patients
28.9% had improvement in SEAS exercise group as compared to 5% in controls.

In 2008: Negrini et al.: 74 patients, 34 to SEAS exercise group, 39 in "usual physiotherapy group".
6.1% of SEAS group went on to needing bracing
25% of control group required bracing
Cobb angle: improved 23.5% in SEAS group
worsened in 11.8% in SEAS group
Cobb angle: improved 11.1% in usual physiotherapy group;
worsened in 13.8% in physiotherapy group

EXERCISE PROTOCOLS IN THE LITERATURE

SCHROTH METHOD

Intensive inpatient rehab exercise program 6-8 hours/day for 4-6 weeks
Goals:
- Decrease curve progression
- Reduce pain
- Increase vital capacity
- Improve posture and appearance

1992 Weiss et al.: 107 patients were evaluated for the efficacy of Scoliosis Intensive Inpatient Rehab/Schroth Method over 4-6 weeks:
44% improved and 3% worsened (Cobb angle)

1997 Weiss et al.: 181 adolescents; same 4-6 week intensive inpatient Schroth Method treatment followed by daily 30 minute HEP for total of 33 months:
found that at end of treatment 29-25% worsened; 18% improved.

2003 Weiss et al.: matched subgroups for sex and age tracked over 33 months.
Schroth group had 53% - 70% improvement of Cobb angle vs control (no exercise group)
with 29% - 44% improvement. (10 y/o group vs. 13 y/o group)

2005 Otman et al.: modified to 6 week intensive outpatient Schroth method
5 days/wk for 4 hours/day and additional 90 min/day HEP for 1 year;
50 adolescents all had improvement of average Cobb angle of 26.1° down to 17.8° (about 8.5 degrees)

INTEGRATED SCOLIOSIS REHAB

Integrated Scoliosis Rehabilitation/SR Scoliologic™

Goals:
- Facilitate correction of asymmetric posture
- Maintain correction during ADLs

2006 Weiss & Klein: prospective controlled study of patient pairs - matched by sex, age, Cobb angle, curve pattern and brace wear.
18 patients in each group.
All patients had 4 week intensive inpatient rehab.
The experimental group had added “physiologic exercises” and asymmetric 3D exercises for 90 min/day in the 3rd-4th weeks.
Postures then practiced during all ADLs.
Use of a surface topographic analysis found that lateral deviation improved 2.3 mm and surface rotation 1.2° in the experimental group vs. 0.3 mm and 0.6° in the control group.
**EXERCISE PROTOCOLS IN THE LITERATURE**

**DoboMed**

*Active three-dimensional self-correction*

**Goal:**
- Active stabilization of the corrected position performed as postural habit in closed kinematic chains

**DOBOMED**

Introduced by Professor Dobosiewicz in Poland in 1979.

2003 Durmala et al.

Followed 138 AIS patients with an exercise program of asymmetric trunk mobilization for one hour daily in and out of brace over 12 month time period.

Reported a 31-39% decrease in Cobb angle.

**EXERCISE PROTOCOLS IN THE LITERATURE**

**Side shift exercise and hitch exercise**

- Lateral trunk shifts toward the concavity of the primary curve (sitting or standing)
- Heel lift to “hitch” pelvis on convex side of primary curve
- Combined with part time brace wear

**SIDE SHIFT AND HITCH**

1999 den Boer et al.: compared 44 patients in a “sideshift and hitch” exercise group with 120 adolescents in brace only.

After 2.2 years of exercise and 3 years of bracing, the exercise group’s Cobb angle was found to progress an average of 2.6° vs -0.5° in the brace group.

2002 Maruyama et al.: followed 69 skeletally mature (Risser grade IV or V) patients who exercised with side shift and hitch 30 reps/day.

After average follow up of 4.2 years, authors observed that 22% curves progressed and 14% improved.

**Comments on the Exercise Protocols in the Literature**

- Fusco et al.
  - Published a systemic review in the Jan 2011 Journal of Physiotherapy Theory and Practice – UK
  - 5 different exercise protocols, 4 in Europe and 1 in Japan
- All support use of early conservative treatment of AIS with therapeutic exercise
- Support exercise as an adjunct to brace wear
- Some assert to slow or stop the progression of AIS
- Others assert to be slow and does not stop the progression of AIS

- Very little published in US
  - In 1999, Univ of California graduate PT student, Nancy Byl and San Francisco School of Medicine med student John Gray reported decreased performance of adolescents with AIS in complex balance activities, especially those activities when vision and proprioception were simultaneously challenged, particularly those with severe curves. (Use of force plate in Gait Lab and San Fran’s Shriners Hosp)

- Great opportunity to consider US based studies on exercise interventions for scoliosis w/ or w/o brace wear prior to surgical interventions

**SURGICAL OPTIONS for IDIOPATHIC or CONGENITAL SCOLIOSIS**

Surgical correction or stabilization via:

- Posterior Spinal Fusion (PSF)
  - Rigid Spinal Fixation
  - Growth Rod (Expandable) Instrumentation
- Anterior Spinal Release and Fusion (ASF)
- Anterior/Posterior Spinal Fusion (ASF/PSF)
- Vertical Expandable Prosthetic Titanium Rib (VEPTR)
THE PHYSICAL THERAPIST’S ROLE IN REHABILITATION OF THE ACUTE POST-SURGICAL PEDIATRIC SPINE at NEMOURS (with correction of IDIOPATHIC or CONGENITAL SCOLIOSIS)

- BID PT Mon –Fri; daily Sat and Sun
- Post op precautions:
  - Log roll only (no trunk torsion)
  - Caution with trunk flexion
- Out of bed on POD#1
- Start ambulation training and progress endurance as tolerates, including stairs
- Progress sitting OOB to 4x/day
- Average discharge POD#4 or 5
- Educate patient and caregiver on therapeutic exercise (HEP)
  - Cervical lateral side-bend stretch
  - Mirror as feedback for postural alignment and retraining visual horizon
  - Pelvic tilts and gluteal sets and lumbar stabilization as tolerates
- Team approach w/ staff nursing, orthopaedics and pain control team, patient and caregiver

PT’s POST-OP SPINAL FUSION GOALS for mild IDIOPATHIC or CONGENITAL SCOLIOSIS corrections

Patient and caregiver will be independent with:
1. Bed mobility and transfers.
2. Sitting OOB for 2 hours 2x/day.
3. Ambulation x 200’ or more on level surfaces.
4. Ascend/Descend x 9 steps.
5. Verbalizing and demonstrating post op precautions and HEP.

ONGOING GUIDELINES after the SURGICAL CORRECTION of IDIOPATHIC or CONGENITAL SCOLIOSIS

- Recheck with surgeon within 3 weeks from discharge
- Return to school within one month
- No lifting greater than 10 lbs until cleared by surgeon
- No contact sports until cleared by surgeon
- Continue HEP until cleared by surgeon

SPORTS AND RECREATION AFTER SPINAL FUSION

Non-contact sports that are generally allowed 6-12 months after spinal fusion
- Basketball
- Soccer
- Running
- Tennis
- Baseball
- Cross-country skiing
- Swimming

Contact sports that are generally advised against after spinal fusion:
- Football
- Ice Hockey
- Gymnastics
- Wrestling
- Competition/Recreational Horseback Riding

NEUROMUSCULAR SCOLIOSIS

MYOPATHIC
- Muscular Dystrophies (DMD, CMD, BMD, CMT)
- Mitochondrial Disorders
- Syndromes

NEUROPATHIC (UPPER or LOWER MOTOR NEURON)
- Cerebral Palsy
- Spinal Muscular Atrophy
- Myelomeningocele
- SCI of infant or young child

COMPARING NM SCOLIOSIS AND AIS

NM Scoliosis
- Earlier onset of age
- Associated with systemic or chronic diseases
- Rapid progression
- Greater risk for respiratory compromise
- C-curve deformity most common
- Increased prevalence of pelvic obliquity
- Chronic consumer of physical therapy and other medical services

AIS
- Age of onset: adolescence
- ‘Idiopathic’
- May have a familial trend
- Progression usually associated with pubescent growth spurs
- S-curve most common deformity
- Unusual in USA to have pre-op PT for scoliosis
- Usually very active
### TREATMENT CONSIDERATIONS for NEUROMUSCULAR SCOLIOSIS

#### NONSURGICAL
- Clinical examination with orthopaedic surgeon every 4-6 months with orthopaedist
- Orthotic/bracing
- Custom seating system

#### SURGICAL

### ORTHOTICS and NM SCOLIOSIS
- Often the custom-molded TLSO type
  - Often made with more pliable materials
- Worn during all upright activities
- Usually off at night

### GOALS of Scoli Jacket for the patient w/ NM scoliosis:
- To postpone surgery during growing years
- To provide postural support during functional activities

### SEATING
- Custom seating system
  - to provide optimal external support
  - mobility on a stroller, manual or power wheelchair base

### SEATING

### SURGICAL INTERVENTION FOR NM SCOLIOSIS
- Surgical correction or stabilization via:
  - Posterior Spinal Fusion (PSF)
    - Rigid Spinal Fixation
    - Growth Rod (Expandable) Instrumentation
  - Anterior Spinal Release and Fusion (ASF)
  - Anterior/Posterior Spinal Fusion (ASF/PSF)
  - Halo Traction followed by Surgical Correction of the Spine

### PT's ROLE s/p FUSION of NM SCOLIOSIS at NEMOURS
- BID PT Mon-Fri; daily Sat and Sun
- Post op precautions:
  - Log roll only (no trunk torsion)
  - Caution with trunk flexion (do not force past 90 degrees)
  - Out of bed (OOB) on POD#1 or as soon as extubated
  - Sit OOB for 30 min as tolerates twice daily and progress endurance each day
- Perform personal seating system modifications as needed to accommodate corrected posture
- Educate patient and caregiver on therapeutic exercise (HEP)
  - BUE & BLE PROM
  - Frequent skin checks for "new" weight bearing surfaces on buttocks and back
- Average discharge POD#8-10
- Team approach w/ staff nursing, orthopaedics and anesthesiology (pain control team), wheelchair engineer, patient and caregiver

### PT's POST-OP SPINAL FUSION GOALS for most NM SCOLIOSIS corrections
- Caregiver will be independent with:
  1. Providing safe bed mobility and transfers.
  2. Verbalizing and demonstrating post op precautions and HEP.
  3. Patient will tolerate sitting OOB for 2 hours 2-3x/day as demonstrated by stable vital signs.
  4. PT/Wheelchair engineering team will perform personal wheelchair modifications for optimal fit and comfort.
### POST-OP DIFFERENCES for PT consideration in NM SCOLIOSIS vs. AIS

**NM Scoliosis**
- Usually fused from upper Thoracic spine into pelvis
- May have concurrent neurosurgery
- Longer post-op stay
- Frequent post-op ICU admission
- Often with blood volume and BP issues post-op
- Often has Respiratory support needs post-op
- Increased risk post-op for pancreatitis
- Often non-ambulator and/or non-verbal

**AIS**
- Generally fusion is Thoracic into Lumbar region
- Mobilize and discharge efficiently (3-5 days)
- Independent ambulation is primary goal
- Very verbal

### ONGOING GUIDELINES after the SURGICAL CORRECTION of NM SCOLIOSIS

- Recheck with surgeon within 3 weeks from discharge
- Return to school when able to tolerate sitting greater than 2 hours at a time/cleared by surgeon
- Continue HEP until cleared by surgeon
- Resume therapies (PT, OT, Aquatics, Therapeutic Riding) once cleared by surgeon
- Resume recreational activities once cleared by surgeon

### GROWING RODS AND VEPTRs

**GROWing RODs**
- Log roll only
- Caution with hip flexion past 90
- Supportive custom seating system
- Use of custom scoli jacket if prescribed by surgeon
- Difference is return for short stay (1 overnight) to have Growing Rod or VEPTR lengthened about every 4-6 months; occasionally longer inpatient stay if growing rod needs exchanged for longer one
- Benefit of VEPTR:
  - Limits scar tissue (bony and soft tissue) build up along spine for future final PSF surgery
  - Provides direct treatment to thoracic/rib cage deformity

**VEPTR**
- Vertical Expandable Prosthetic Titanium Rib

### HALO TRACTION

**THE NEMOURS APPROACH TO TREATMENT OF SEVERE SCOLIOSIS AND/OR KYPHOSCOLIOSIS**
- For severe scoliosis or kyphoscoliosis
- Often in early onset forms of spinal deformity: infantile or juvenile
- Can also be applied to patients with NM scoliosis

**HALO TRACTION**

- Halo applied in OR under anesthesia by orthopaedic surgeon, with or without additional spinal surgical release or osteotomies
- Halo traction set up for bed, wheelchair and when applicable use of a modified specialty walker
- Initial gravity traction of 6-10 lbs in bed (depends on size and age of child)
- Incremental increases of traction weights as prescribed daily by orthopaedic surgeon: in bed, in wheelchair and up in walker
- Floating:
  - Goal of weights in wheelchair: for patient to be barely seated on seat cushion
  - Goal of weights in walker: for patient to be skimming floor with their feet
- Remain in hospital in Halo Traction for 4-8 weeks
- Stage 2 of surgical correction as scheduled by orthopaedic surgeon

**OPTIONS:** Spinal Growing Rods, VEPTR, PSF, ASF/PSF
Halo Traction and necessities

Daily goals in Halo Traction

- OOB as frequently and as long as comfortable throughout day
- Maintain traction during all transitions
- Perform neuro checks after each weight increase including Cranial Nerve screens
- Pin care – daily, NSS and sterile q-tips
- Empower parents to be as independent as possible
- Involve Child Life Therapist

HALO TRACTION WALKER

- Kaye Posture Walker w/ suspension conversion kit modified by adding pulley system and traction weights in an anti-sway tube
- Modifications performed in collaboration between Nemours/AIDHC PTs and Nemours Research Engineers
- Permission and legal parameters for modifying equipment were obtained from Kaye Products Inc, by Nemours/AIDHC PT

FAMOUS PEOPLE WHO HAVE SCOLIOSIS

- Jessica Andrews | Singer
- Linda Blair | Actress
- Kurt Cobain | Singer
- Laura Dern | Actress
- Rachel McAdams | Actress/Musician
- Jamie Everson | Swimmer
- Emmy Rossum | Actress
- Bunny New | Golf Player
- Jennifer Lee | Politician
- Robert Lewandowski | Football Player
- Yuriko | Actress
- Lisa Marie | Actress/Singer
- John Owen | Swimmer
- Catherine Swanson | Actress/Musician
- Sarah Polley | Actress
- Isabelle Roselli-Wiedemann | Model (the daughter of Isabella Rossellini)

Thank you to each patient, family care-giver and medical team member that share their experiences and expertise for the ongoing pursuit of clinical excellence in the medical treatment of children.