Scoliosis in Children and Adolescents

Faculty Disclosure

John Lonstein, M.D. has disclosed no actual or potential conflict of interest in relation to this educational activity.

During this educational activity Dr. Lonstein will not be discussing the use of any commercial or investigational product not approved for any purpose by the FDA.

Scoliosis in Children and Adolescents

A lecture on etiology, natural history, treatment and management of spinal deformities

Program Objectives

Upon completion of this program, participants should be able to:

- Identify the etiology of spinal deformities
- Make decisions about referred cases
- Understand the natural history of spinal deformities
- Appreciate the treatment methods available

Production by

www.hoffmancommunications.com
www.medcentrus.com

PEDIATRIC GRAND ROUNDS

Scoliosis in Children and Adolescents

Scoliosis in Children and Adolescents

Classification
Screening
Non-operative treatment
Operative treatment

Key Terms
- Scoliosis
- Kyphosis
- Lordosis

Scoliosis
- Lateral curvature of the spine >10°
- Curve apex
  - Convexity determines R/L
  - Site of apex denotes area of spine
- Magnitude measured in degrees
  - Straight spine = 0°
- Lateral curve accompanied by rotation

John Lonstein, M.D., Orthopedic Surgeon,
Twin Cities Spine Center, Minneapolis, MN,
Children's Grand Rounds CME 12-21-2006
Scoliosis

- Scoliosis is not a diagnosis
- Many possible etiologies
  - Idiopathic
  - Congenital
  - Neuromuscular
  - Neurofibromatosis
  - Post-irradiation
  - Metabolic

"Congenital" implies that deformity is present because something went wrong in the basic formation of the spine.

"Neuromuscular" implies that a curve developed as a result of abnormal function in nerves or muscles.

"Degenerative" implies that the aging process played a role.

"Syndromic" suggests that something about the genetic make-up of a child predisposed them to scoliosis.

"Idiopathic" means we really don't know what's going on.

Idiopathic Scoliosis

- Infantile: < age 3
- Juvenile: 3-10
- Adolescent: 10+

Prevalence of AIS

Widely variable reports (0.3 to 15.3%) due to:

- Different detection methods (exams, school screening, chest x-ray)
- Different populations
- Different definitions
Adolescent Idiopathic Scoliosis

<table>
<thead>
<tr>
<th>Prevalence</th>
<th>Curve Magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - 3%</td>
<td>&gt; 10°</td>
</tr>
<tr>
<td>0.3 - 0.5%</td>
<td>&gt; 20°</td>
</tr>
<tr>
<td>0.2 - 0.3%</td>
<td>&gt; 30°</td>
</tr>
</tbody>
</table>

Familial – genetic aspect
Progressive

Idiopathic Scoliosis Progression

<table>
<thead>
<tr>
<th>20-29°</th>
<th>30-39°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunnell (123) 52 % 67 %</td>
<td></td>
</tr>
<tr>
<td>Picault (53) 56 % 63 %</td>
<td></td>
</tr>
<tr>
<td>Gardner (78) 38 % 30 %</td>
<td></td>
</tr>
<tr>
<td>Lonstein (282) 37 % –</td>
<td></td>
</tr>
</tbody>
</table>

Curve Progression
Factors

- Curve Pattern
- Magnitude
- Age
- Maturity - Puberty
  - Risser
  - Menarche
Scoliosis in Children and Adolescents

Congenital Deformities Classification

- Defect of formation
- Defect of segmentation
- Mixed

Congenital anomalies

Pure scoliosis 80%
Kyphoscoliosis 14%
Pure kyphosis 6%

Median Yearly Rate of Progression, Without Treatment, for each Type of Congenital Scoliosis in Each Region of the Spine (McMaster & Ohtsuka)
Associated anomalies

- Up to 60% of patients have one or more associated anomalies

Beals et al Spine 1993

Associated anomalies

- Urogenital
  - 20-33%
- Cardiac
  - 10-15%
- Klippel-Feil
  - 25%
- Nervous System
  - 20-40%

Neuromuscular Scoliosis

- Neurogenic
  - Upper Motor Neurone
    - Cerebral Palsy
    - Traumatic Paraplegia
  - Lower Motor Neurone
    - Poliomyelitis
    - Spinal Muscle Atrophy
    - Spina Bifida
- Myogenic
  - Duchenne Muscular Dystrophy

Cerebral palsy

Linked to severity
  - Hemi < Diplegia < Quadriplegia
  - 15% have curves >30°
  - Often large, stiff, debilitating

Myelomeningocele

Linked to severity (Level)
  - Thoracic > Upper Lumbar > Lower Lumbar > Sacral
Linked to canal cord anomalies
  - ~100% have brainstem malformations
  - ~20-50% have syrinx
  - ~25% have other congenital vertebral anomalies
    - Includes diastematomyelia, etc
  - 100% have scarring of the distal cord

Neuromuscular Deformities

Principles

- Paralysis / muscle imbalance
- Other problems
  - Extremities
  - Spine
  - Kidneys
  - Vision
  - Hearing
  - Intelligence

John Lonstein, M.D., Orthopedic Surgeon,
Twin Cities Spine Center, Minneapolis, MN,
Children's Grand Rounds CME 12-21-2006
Scoliosis in Children and Adolescents

Kyphosis
- Postural
- Scheuermann’s Disease
- Congenital
- Infection
- Tumor
- Fracture
- Osteoporosis

Postural Kyphosis
- Hyperkyphosis
- Non structural
- Flexible
- X-ray normal
- Treatment - time
  - exercise

Structural Hyperkyphosis
- Anterior deficiency - growth
  - bone
- Posterior deficiency - bone
  - ligaments
  - muscle

Scheuermann’s Disease
- Structural hyperkyphosis
- Adolescence
- End plate changes - irregularity
  - Schmorl’s nodules
  - Vertebral wedging
  - Narrow disc space
- Presents - Pain
  - Hyperkyphosis

John Lonstein, M.D., Orthopedic Surgeon,
Twin Cities Spine Center, Minneapolis, MN,
Children's Grand Rounds CME 12-21-2006
Scoliosis in Children and Adolescents

Lordosis
- Postural
- Congenital
- Hip Flexion Contracture
- Idiopathic Scoliosis

Potential Deleterious Effects of Untreated Spinal Deformity
- Cardiopulmonary Dysfunction
- Back Pain
- Neurological Impairment
- Altered appearance
- Socioeconomic

Idiopathic Scoliosis
Cardiorespiratory Complication
- \( \downarrow \) PFT
  - \( \downarrow \) with curves over 80° - 90°
  - If \( \downarrow \) to 50% predicted - declines with age
- Cardiorespiratory failure/death
  - Significant for curves diagnosed under age 5
  - Rare in adolescent I.S.

John Lonstein, M.D., Orthopedic Surgeon,
Twin Cities Spine Center, Minneapolis, MN,
Children's Grand Rounds CME 12-21-2006
**Natural History**

**Back Pain**
Controversial

- High incidence (Sweden)
- No difference (Iowa)
- Fewer in heavy labor
- High rate in normal population

**Socioeconomic**

- Altered appearance
- Self image
- Fewer married
- Higher disability rate

**Early detection**

- Detect small curves
- Early bracing
- Reduce the need for surgery

- Annual screening
  - School
  - Annual physicals: preschool / sports

---

The essence of the treatment of severe scoliosis is never to permit it to become severe.
Scoliosis in Children and Adolescents

Screening
- School or routine examination
- Detect back asymmetry
- Referral for confirmation / evaluation
- Examination to confirm asymmetry
- X-ray to diagnose scoliosis

John Lonstein, M.D., Orthopedic Surgeon,
Twin Cities Spine Center, Minneapolis, MN,
Children's Grand Rounds CME 12-21-2006
Scoliosis in Children and Adolescents

Screening

- SCREENED POSITIVE
  - RESCREENED
    - FOLLOWED BY SCREENER
    - REFERRED

Decision Making

- Patient Evaluated
  - No Treatment
  - Treatment Required
    - Non-Operative
    - Operative
Scoliosis in Children and Adolescents

**No treatment**
- No scoliosis
- Minor curve at the end of growth
  - $< 20^\circ$
  - Risser 4-5

**Non-operative Treatment**
Observation for Progression
Measurement error
- Idiopathic 3-5°
- Congenital 8-10°
- Neuromuscular 10-15°

Active treatment

**Non-operative Treatment**

**Aim of Treatment**
- Control Curve
- Prevent progression
- Prevent need for surgery
- Improve cosmesis

**Treatment Methods**
- Orthosis
  - Milwaukee brace
  - TLSO
- Electrical stimulation
- Exercises
- Biofeedback
- Chiropractic manipulation

John Lonstein, M.D., Orthopedic Surgeon,
Twin Cities Spine Center, Minneapolis, MN,
Children's Grand Rounds CME 12-21-2006
Scoliosis in Children and Adolescents

### Wearing Schedule
- Full time
- Out for - Bathing
  - Swimming
  - Physical education
- Extra time out - Sports
  - Dancing
  - Gymnastics
- i.e., in brace 20-22 hours/day

### Important Treatment Factors
- Compliance
- Education
- Family Support
- Enthusiastic physician/staff

### Boston Brace Results
- **54 Patients**
  - Non compliant (< 12 hrs) 41° ⇒ 56°
  - Part time (12-18 hrs) 37° ⇒ 41°
  - Full time (18-23 hrs) 39° ⇒ 35°

### Boston Brace Results
- **Fusion**
  - Non Compliant 11/15 - 73%
  - Part time 16/17 - 35%
  - Full time 2/22 - 9%

---

John Lonstein, M.D., Orthopedic Surgeon,
Twin Cities Spine Center, Minneapolis, MN,
Children's Grand Rounds CME 12-21-2006
Brace Comparison

- Boston system 16-23 hrs/day (127)
- Charleston brace 8-10 hrs/day (121)
- R 0-1
- 25° - 45°

Katz, DE et al Spine 1997

Brace Comparison

Progression > 5°

- 25° - 35°
- 36° - 45°

Boston 35% 49%
Charleston 47% 92%

Katz, DE et al Spine 1997

Milwaukee Brace

Response

- Initial improvement of 50%
- Gradual loss of improvement
- 15-20% correction at weaning
- Loss to original curve

Milwaukee Brace

Results

- 1020 adolescents
- Av. F/U OOB 6.2 yrs.
- Surgical rate 22%

Lonstein, Winter JBJS 1998
Scoliosis in Children and Adolescents

**Milwaukee Brace Results**

*Failure*

- Number to surgery
- Number progressed initial to follow-up > 5°

**Failures - Risser 0-1**

<table>
<thead>
<tr>
<th></th>
<th>Natural History</th>
<th>Milwaukee Brace</th>
<th>Stimulator</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29°</td>
<td>68%</td>
<td>40%</td>
<td>72%</td>
</tr>
<tr>
<td>30-39°</td>
<td>68%</td>
<td>43%</td>
<td>75%</td>
</tr>
</tbody>
</table>

**Failures - Risser 2+**

<table>
<thead>
<tr>
<th></th>
<th>Natural History</th>
<th>Milwaukee Brace</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29°</td>
<td>23%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>30-39°</td>
<td>43%</td>
<td>22%</td>
<td></td>
</tr>
</tbody>
</table>

**TLSO Results**

- Few studies available
- Low failure rate
  - Surgery
  - Curve increase
- Natural history
  - Fewer curves
  - Less progressive

**SRS Study**

- Natural history
- Electrical stimulation
- Milwaukee brace

**SRS Prospective Study**

- Female
- Idiopathic
- Single curve
- 5+ vertebrae in curve
- Apex T8-L1
- 25-35°
- Skeletal age 10-15
Scoliosis in Children and Adolescents

SRS Prospective Study
- Observation 131
- Stimulator 49
- Brace 115

Results
- Observation and stimulator
  - Results similar - 70% progression
- Brace - 40% progression

Bracing for Kyphosis
- Scheuermann’s disease
- Flexible Kyphosis
- Never for congenital kyphosis
Scoliosis in Children and Adolescents

Surgery

Indications
- Large curve on presentation
- Natural history of definite progression
- Curve not controlled by brace
- Progressive curve under observation

Surgery

Principles
- Prevent progression
- Correct deformity
- Maintain correction
  - Fusion
  - Instrumentation
    - Hooks, screws, wires

Surgery

Approaches
- Posterior
- Anterior
- Combined

John Lonstein, M.D., Orthopedic Surgeon,
Twin Cities Spine Center, Minneapolis, MN,
Children's Grand Rounds CME 12-21-2006
Scoliosis in Children and Adolescents

Scoliosis in Children and Adolescents

Anterior + Posterior fusion

Congenital Kyphosis

Anterior + Posterior fusion

Congenital Kyphosis

Anterior + Posterior fusion

Cerebral Palsy

John Lonstein, M.D., Orthopedic Surgeon,
Twin Cities Spine Center, Minneapolis, MN,
Children's Grand Rounds CME 12-21-2006
What are the long term effects of bracing or surgery on the patient’s life?

Adolescent Idiopathic Scoliosis, Brace and Surgical treated, Av. 22 years after completing treatment.


Series
- 136 Surgically treated (93.7% f/u)
- 111 Brace treated (91% f/u)
- 100 age / sex matched controls

- Average age 40 at follow-up
- Surgery - all Harrington instrumentation
- Bracing - 95% Milwaukee Brace

Curve magnitude
- Surgical 62° ⇒ 33° ⇒ 36°
- Brace 33° ⇒ 30° ⇒ 38°
  - 33 ↑ 11° - 20°
  - 5 ↑ 21° - 25°
  - One had subsequent surgery

Degenerative disease
- Higher in treated groups than controls
- Not related to level of fusion in surgical cases
- Surgical cases had flatter backs than controls or brace patients
Scoliosis in Children and Adolescents

Function

- No differences in
  - Childbearing rate
  - Caesarean section rate
  - Overall back pain
  - Back pain with pregnancy

Differences

- Higher mean age at 1st pregnancy in brace patients
- Increase in subjective back stiffness with correlated increase in limitation of sexual function in treated patients

Summary

- Early detection of deformity by screening
- Prompt and appropriate referral
- Non-operative treatment
  - Observation
  - Bracing
- Reduce the need for surgery
- Appropriate surgery

Question: When you do a spinal fusion, how does it affect growth?

Question: What about releasing the tether? What does that do to scoliosis?
Question: Why does the U.S. Government discourage school screening for scoliosis?

Question: What percentage of kids who have Scheuermann’s go on to require surgery?

Question: Are you suggesting that a clinic do an x-ray whenever they see asymmetry in a young patient?

Question: Do you recommend that the primary care physician do the initial x-ray, or should they just refer the patient to you?

Question about painful scoliosis…

Thanks for viewing this presentation!

To receive CME credit, please click the CME Eval button below and complete the form.