

Spinal Cord Injury and the Growing Spine

ICEOS November 19, 2011

Amer F. Samdani, MD

Director Pediatric Spine

Shriners Hospitals for Children

Philadelphia, PA

Outline

- Epidemiology of spine deformity following SCI in the growing child
- Bracing: Pros and Cons
- Surgical considerations
 - Timing of surgery
 - Sagittal profile

Pediatric SCI: Epidemiology

- Incidence (10-11,000/yr total)
 - < 18 year = 1,500-2,000/year
 - < 10 years = 500/year
 - 1.99/100,000 children
- Etiology
 - 56% MVA (younger)
 - 14% Falls (younger)
 - 9% Gun violence (older)
 - 8.8% Sports (older)



ASIA Scale

A = Complete: No motor or sensory function is preserved in the sacral segments S4-S5.

Vogel L, Samdani A, et al Spinal Cord 2009

B = Incomplete: Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5.

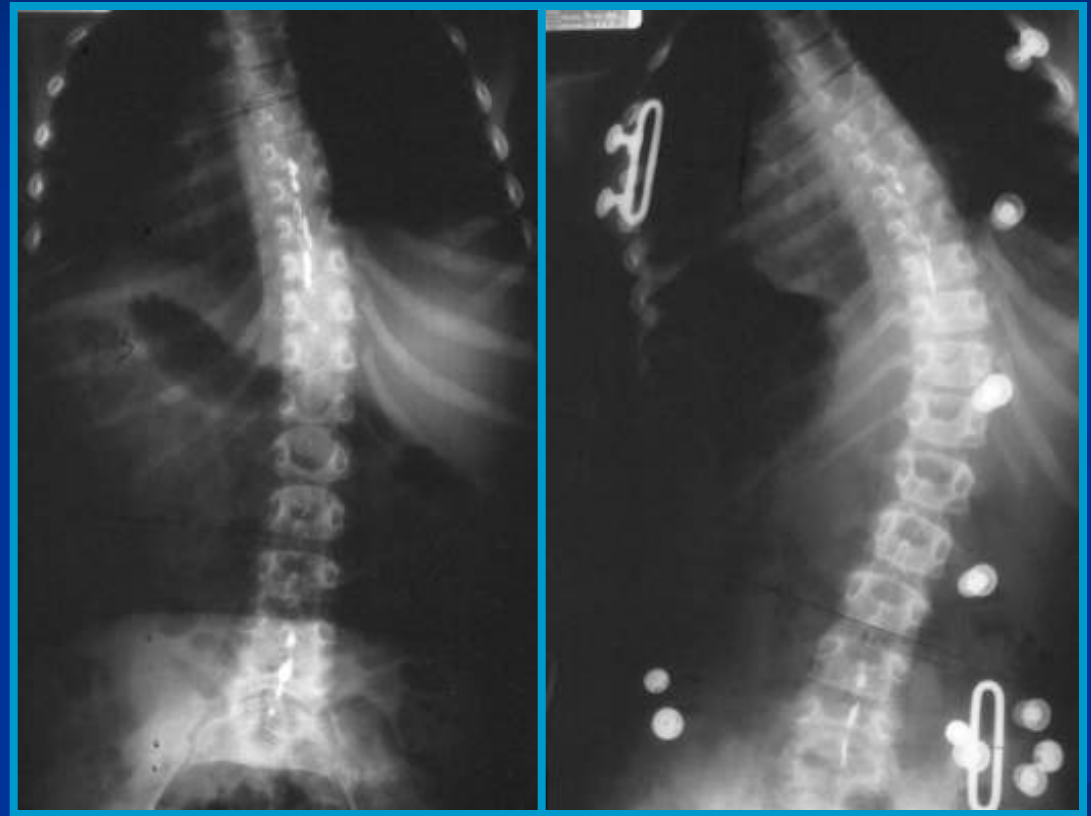
C = Incomplete: Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3.

D = Incomplete: Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more.

E = Normal: Motor and sensory function

Incidence of Scoliosis

- Prevalence > 90%
- Influence of age on prevalence (Lancourt *et al*)
 - 0-10 years 100%
 - 11-16 years 19%
 - > 16 years 12%
- Risk of surgery when injury is prior to maturity: 67% (Dearolf, Betz *et al*)



6 months

Spine deformity: Etiology



- Muscle weakness / imbalance
- Spinal column residual deformity following fracture
- Iatrogenic: laminectomy

Problems with Spine Deformity

- Pelvic obliquity
- Poor sitting ability causing reduced UE function
- Pressure sores
- Pain
- Poor LE orthotic fitting and use
- Gastrointestinal dysfunction
- Cardiopulmonary dysfunction



The Effect of Bracing on Paralytic Scoliosis Secondary to Spinal Cord Injury

J Spinal Cord Med 27(Suppl 1):S88-92, 2004

Samir Mehta, MD
Randal R Betz, MD
MJ Mulcahey, MS
Craig McDonald, MD
Lawrence C Vogel, MD
Caroline Anderson, PhD



Funding from Shriners Hospitals for Children Grant #9155

Specific Aim

- To evaluate the impact of bracing versus no bracing
 - Ability to prevent curve progression
 - Ability to delay surgical fusion
- Hypothesis:
 - Earlier bracing leads to decreased prevalence or delay of surgical fusion

Most orthopedic surgeons wait till the curve is >25 degrees to begin bracing

Results

Group	Braced patients requiring surgery	Patients with no brace requiring surgery
I (< 10°) N = 42	13 / 29 (45%)	10 / 13 (77%)
II (11 to 20°) N = 25	9 / 18 (50%)	6 / 7 (86%)
III (21 to 40°) N = 27	12 / 20 (60%)	6 / 7 (86%)

p=0.03

p=0.04

p=0.08

Results

	Time to surgery from presentation (years)		
Group	Braced	Not braced	
I (N = 42)	8.5	4.2	p=0.002
II (N = 25)	6.8	3.7	p=0.008
III (N = 27)	4.2	3.2	p=0.38

Group IV and V no difference in time to surgery

Conclusions

- Bracing may **prevent** surgery in approximately 50% of patients with curves $< 20^\circ$
- Bracing significantly **delays** time to surgical correction in curves $< 20^\circ$

The Effect of Thoracic Lumbar Sacral Orthoses on Reachable Workspace Volumes in Children with Spinal Cord Injury *Sison-Williamson et al, 2007*

- The reachable workspace of children with SCI is impacted and **lessened by 28%** with the use of a TLSO.
- This may be an important factor negatively impacting brace compliance in children with SCI in that the TLSO interferes with their ability to reach and, therefore, children may prefer not to wear the orthosis

Slide 13

SA12

other potential problems- breathing, eating, need cutouts

Samdani, Amer, 8/19/2011

Other Options for Prevention of Scoliosis Progression

- Wheelchair modifications
 - Higher back
 - Firmer back
 - Lateral trunk supports
 - Custom mold
- They do not prevent curve progression but help with sitting balance and allow free use of the arms



Indications for Surgery

- Function problems or pain in mature patient
- Decreasing pulmonary function
- Progressing curves $> 40^\circ$ in a growing child



Larger Curve Magnitude Is Associated with Markedly Increased Perioperative Complications After Scoliosis Surgery in Patients with SCI

Samdani et al; IMAST 2011

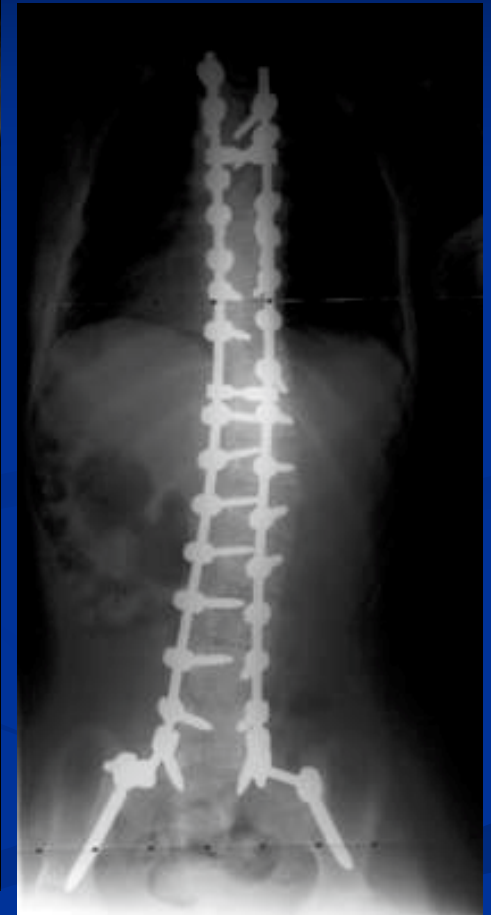
- 45 patients with diagnosis of SCI and scoliosis who underwent a posterior spinal fusion between 1998-2010
- Patients were divided into two groups:
 - Smaller curves (SC) $<70^\circ$, N=19
 - Larger curves (LC) $>70^\circ$, N=26

Results

	Small Curves <70°	Large Curves >70°	P Value
Mean age (years)	12.5 ± 2	14.7 ± 2	0.001
Major curve	54 ± 12°	85 ± 11°	0.000
Operative time (minutes)	463 ± 87	536 ± 122	0.016
Blood loss (cc)	2673 ± 1437	3524 ± 2199	0.075
Mean hospital stay (days)	10.9 ± 4	14.9 ± 9	0.048
Major perioperative complication	21%	36%	

Complications: Smaller Curves

- 21% (4/19)
- Dural tear
- Pneumonia
- Prolonged intubation
- Wound infection



Complications: Larger Curves

- 36% (9/26)
- Wound infections (3)
- Aspiration (2)
- Prolonged intubation (2)
- Dural tear
- Unplanned staged surgery (excessive blood loss)
- Sepsis
- ARDS
- Vision loss



The Effect of Correction of Paralytic Spine Deformity on Compensation Strategies

Implications

- Most significant for patients with tetraplegia
 - Loss of compensatory mouth-to-hand
- Loss of ability for perianal care (paraplegia)



Patient with C5 SCI

Paralytic Scoliosis and Kyphosis

- Pulmonary function compromised
- Compensatory mouth-to-hand provides ability to feed self



- Correction of paralytic spine deformity
- Improved pulmonary function
- Loss of compensatory mouth-to-hand function



Normal vs. SCI



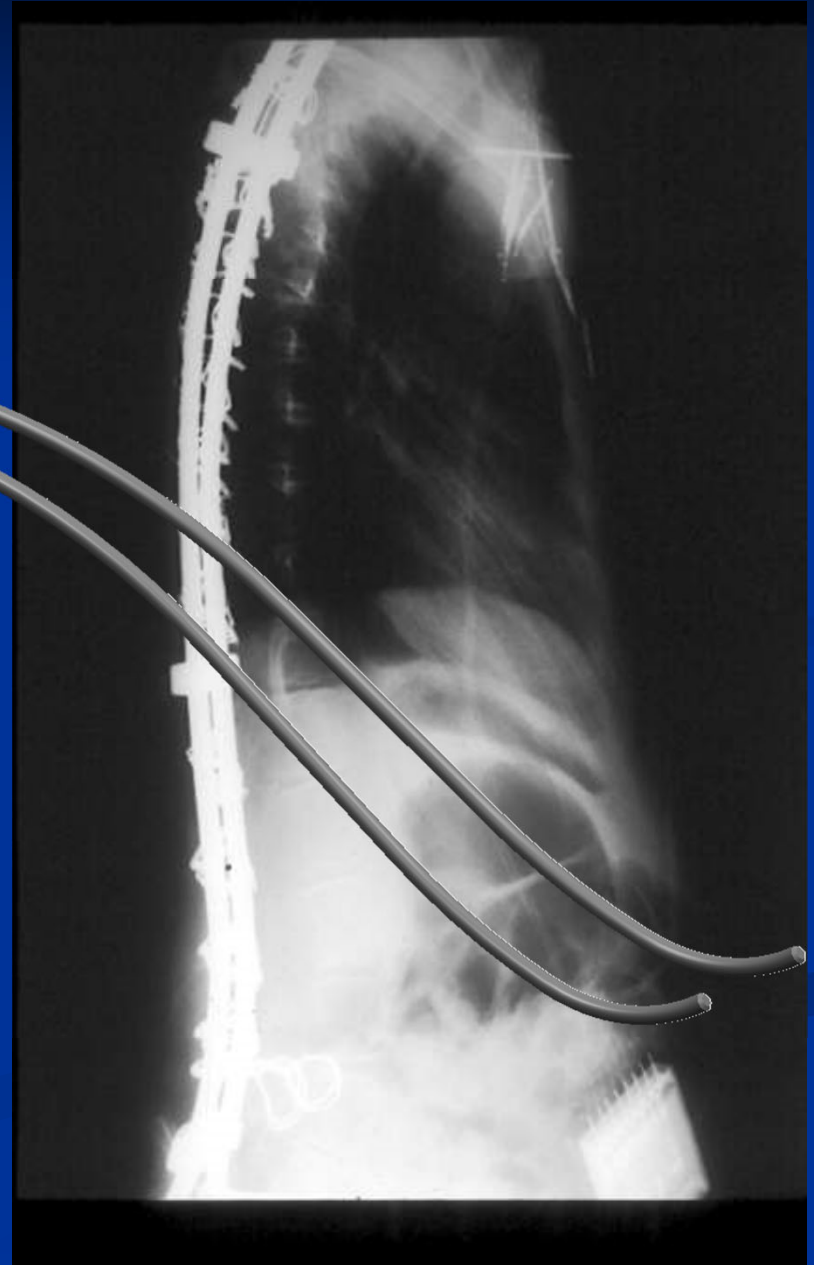
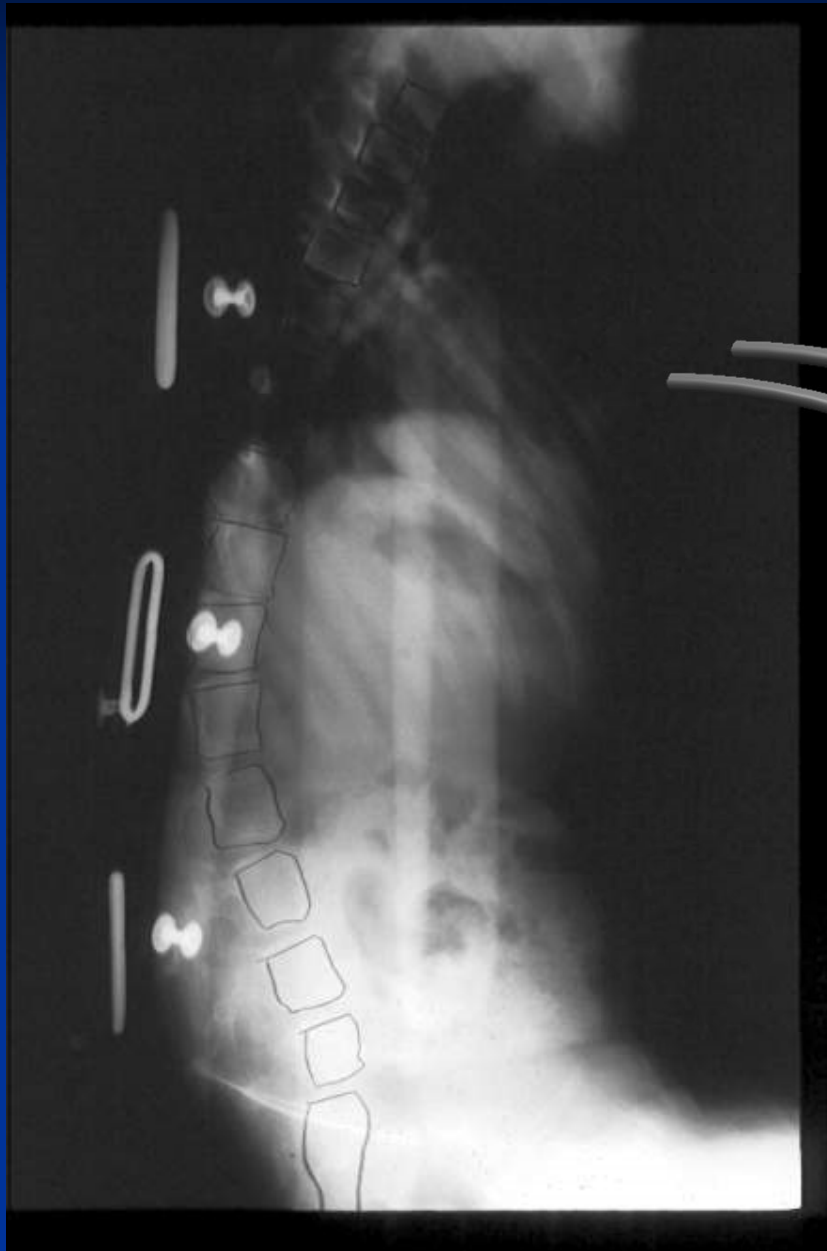
Mean Values and Standard Deviation for Cobb Measurements of Sagittal Profile

	Normal Spine	SCI
Thoracic kyphosis	38.5 (\pm 8.1)	40.2 (\pm 9)
Thoracolumbar region	5 (\pm 10)	19.1 (\pm 8)
Lumbar lordosis	-56.6 (\pm 9.1)	-8 (\pm 12)

Check position in a brace pre-op



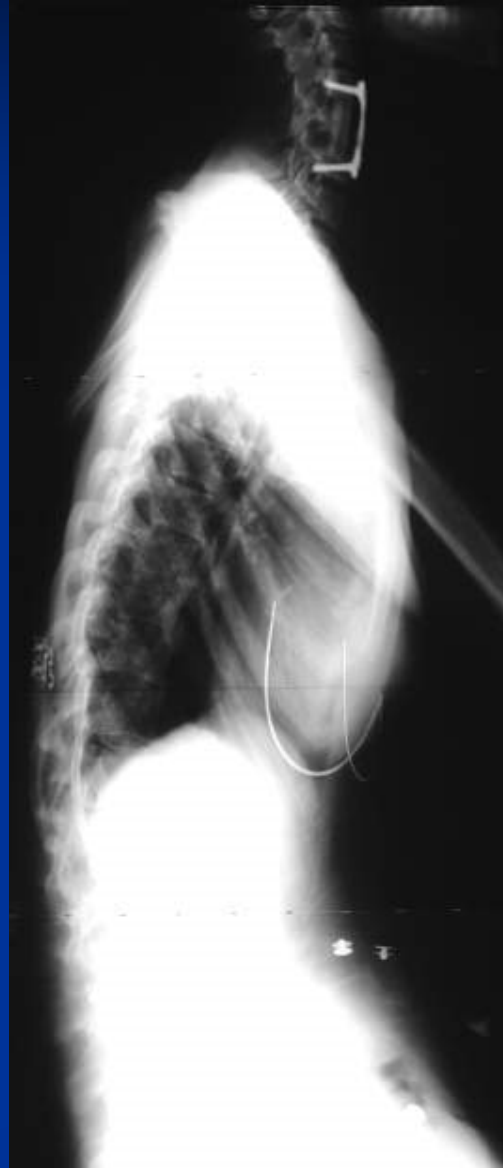
Contour rods to the in brace x-ray of the spine



Post # 1



Pre



Post #2



Summary

- Children with SCI are likely to develop a rapidly progressive scoliosis
- Bracing may delay surgical intervention
- Early surgical intervention may influence number and type of complications
- Maintenance of preoperative sagittal profile

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