



Radiographic Comparison of Patient-Specific and Conventional Rods in Adolescent Idiopathic Scoliosis Surgery

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Introduction

- ▶ 3D perspective on surgical correction of adolescent idiopathic scoliosis (AIS)
- ▶ Posterior segmental spinal instrumentation
 - ▶ Three-column fixation of spine via pedicle screws
 - ▶ Rod contouring by surgeons : key element of final spinal alignment
- ▶ Spinal sagittal alignment: substantially correlated with health-related quality of life outcome scores in adults
- ▶ Significant variation of rod-contouring exists between scoliosis surgeons

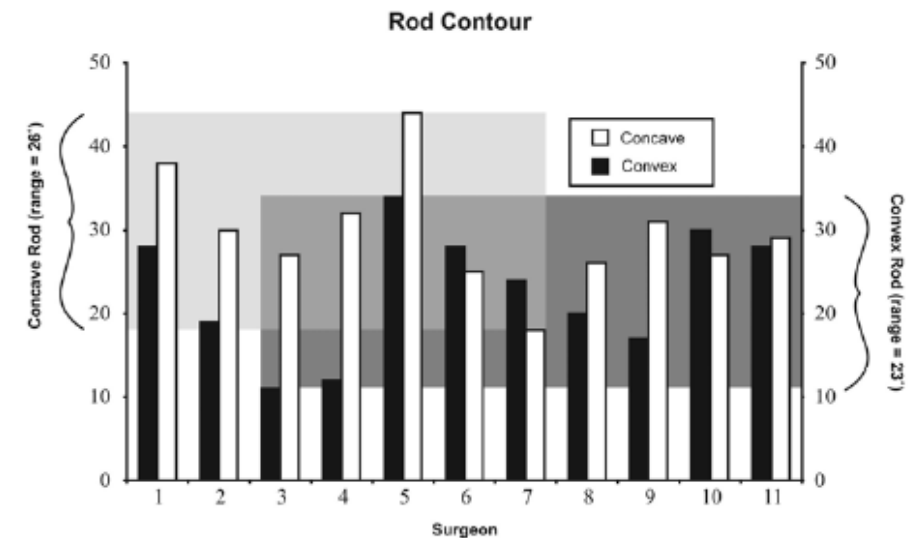
Rod Contouring Variations

- IMAST 2007
- 11 Senior Scoliosis Surgeons
- PA/Lat X-rays for right thoracic AIS
- Given 1 SS and 1 Ti rod
“Bend the rods for this patient”
- Range: 18-44° of thoracic kyphosis.

Poster #7

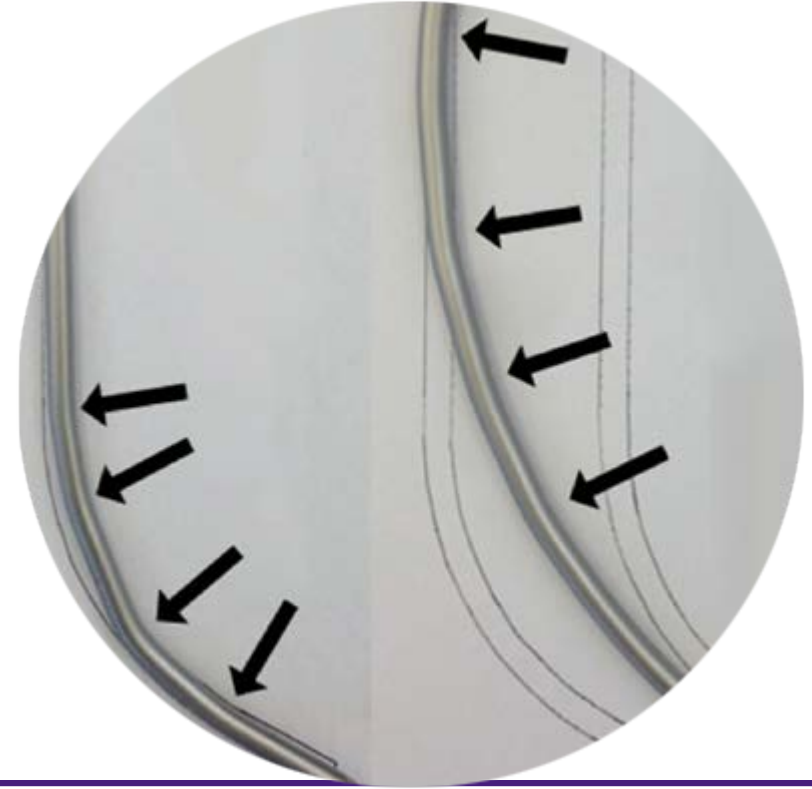
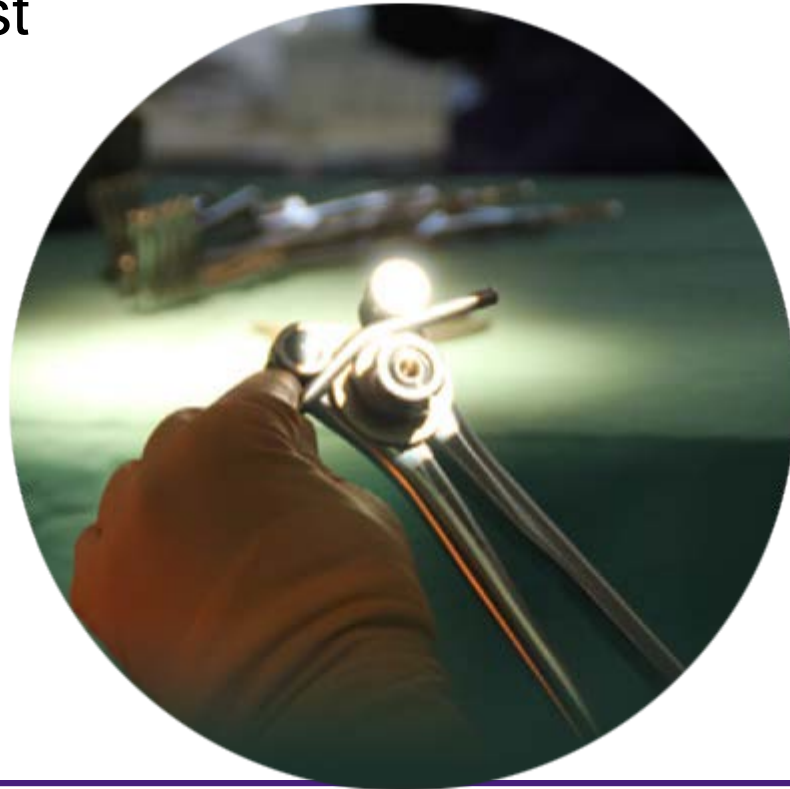
The Variation in How Surgeons Contour Rods for Scoliosis Correction is Substantial

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Alternative: Prefabricated Patient-Specific Rods

- Based on patient's spinal alignment parameters
 - Pros: no subjective planning or suboptimal manual contouring
 - Cons: cost





Methods

- Retrospective study on AIS patients – single surgeon
- 56 consecutive cases with 1 year follow-up
 - Group C (28 pts 12/2012-12/2014): manually contoured **C**onventional rods
 - Correction Technique: Cotrel-Dubousset Single Rod Technique
 - Group PS (28 pts, 12/2014-12/2015): **P**atient-**S**pecific prefabricated rods
 - Correction Technique: Simultaneous Translation on Two Rods
- Pre-, intra- and postoperative care was similar between the groups.

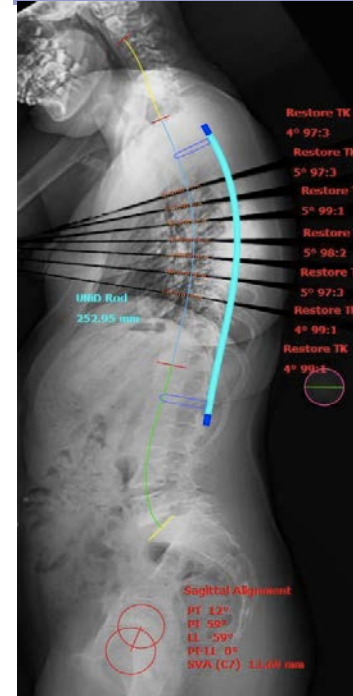
Patient-Specific Rods

- Calibrated digital radiographs
- Preoperative planning with digital analysis software
 - Surgimap Spine Software (Nemaris, New York, NY)
- Pre-fabricated planned rods inserted during surgery
 - Medicrea, Lyon, France

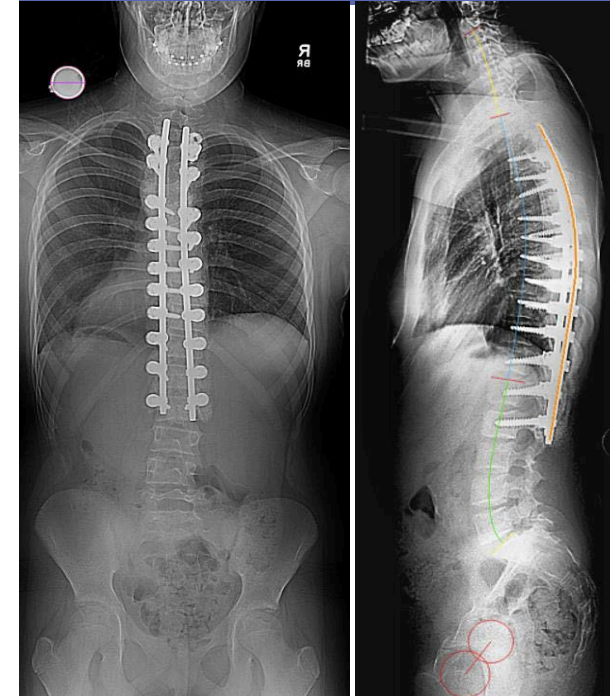
Preoperative



Plan



Postoperative





Methods

- Comparative radiographic analysis of spinal alignment and rod contour at immediate, 1-3 months and 1 year follow up after surgery.
- **Hypothesis**
PS rods are associated with more physiologic sagittal alignment and less rod contour change compared to C rods.
 - **Primary outcomes:** sagittal parameters (LL, TK, TL)
 - **Secondary outcomes:** coronal alignment, rod contour parameters

Results – Preoperative Parameters

*	Patient - Specific Group N=28	Conventional Group N=28
Age (yr)	15.0	14.8
Gender (♀ : ♂ %)	76	85
Body Mass Index (kg/m ²)	21.7	21.4
Cobb angle (°)	57.1	54.8
Pelvic Incidence (°)	49.5	50.0
Thoracic Kyphosis (T5-T12, °)	30.5	27.5
Lumbar Lordosis (L1-S1, °)	57.6	61.0

* All p values > 0.05

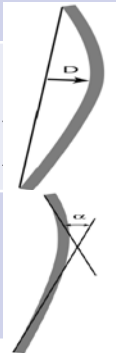
Results – Operative Parameters

*	Patient - Specific Group N=28	Conventional Group N=28
# of Fused Levels	10.2	9.4
Rod Material (Ti Alloy Rods, %)	81	65
Rod Diameter (mm)	6.0	5.8
Surgical Duration (min)	201	206
Complications	1 (wound dehiscence)	0

* All p values > 0.05

Results – Postoperative Parameters

*	Patient - Specific Group N=28	Conventional Group N=28
Thoracic Kyphosis (T5-T12, °)	28.1	24.4
Lumbar Lordosis (L1-S1, °)	55.8	57.6
Cobb angle (°)	10.2	9.4
Maximal Rod Deflection Distance (Δ: 1 year postop – immediate postop, mm)	1.1	1.4
Angle of Tangents to Rod Endpoints (Δ: 1 year postop – immediate postop, °)	1.8	3.1



* All p values > 0.05

Results – Subgroup Analysis (TL Fusion)

*	Patient - Specific Group N=14	Conventional Group N=13
Age (yr)	14.9	14.3
Gender (♀ : ♂ %)	71	77
Body Mass Index (kg/m ²)	21.7	20.4
Cobb angle (°)	56.0	62.4
Pelvic Incidence (°)	48.8	54.5
Thoracic Kyphosis (T5-T12, °)	36.5	31.5
Thoracolumbar Angle (T10-L2, °)	0.9	3.2
Lumbar Lordosis (L1-S1, °)	59.3	65.3
# of Fused Levels	11.5	11.1
Surgical Duration (min)	213	222

* All p values > 0.05

Results – Subgroup Analysis (TL Fusion - Postop)

Postop Alignment	Patient - Specific Group N=14	Conventional Group N=13
Thoracic Kyphosis (T5-T12, °) *	32.8	26.1
Thoracolumbar Angle (T10-L2, °) (Normal Range : -5 to +5°)	-0.3	-7.3
Lumbar Lordosis (L1-S1, °) *	62.9	57.6

P = 0.001

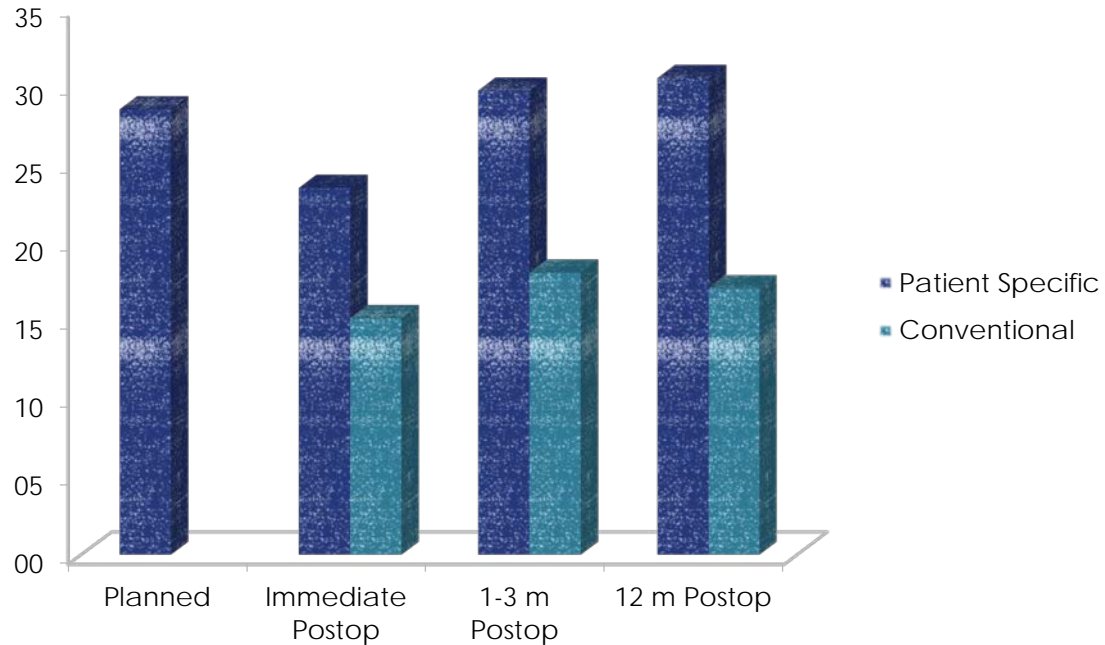
* p values > 0.05

Rod Contour Analysis

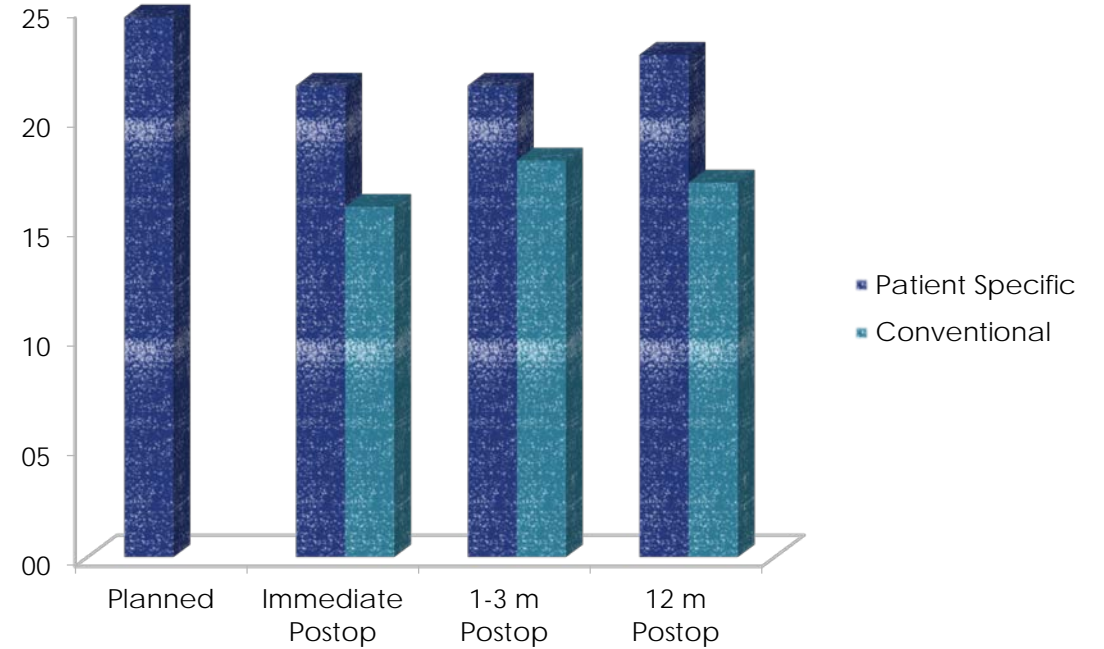


	Group	Maximal Rod Deflection Distance	Angle of Tangents to Rod Endpoints
Planned	UNiD	24.6	28.5
	Control	NA	NA
Immediate	UNiD	21.5	23.5
	Control	16.0	15.2
1-3mo	UNiD	21.5	29.7
	Control	17.1	18.1
1y	UNiD	22.9	30.5
	Control	17.1	17.1

Rod Contour Analysis



Angle of Tangents to Rod End Points



Maximum Deflection Distance





Discussion

- ▶ First clinical study on application of patient-specific rod technology in AIS patients.
- ▶ Patient- Specific rod technology was safe.
 - ▶ No implant-related complications during follow-up
- ▶ Patient-Specific rods resulted in comparable radiographic outcomes compared to Conventional Rods.
 - ▶ The power of this study needs to improve in order to show an alignment advantage for Patient-Specific rods



Discussion

- ▶ Patient-Specific rod technology can help decrease errors in manual rod contouring
 - ▶ Surgeon-dependent
 - ▶ In our study: suboptimal positioning of thoracolumbar deflection in C rods
- ▶ No significant changes of rod contour were observed in PS and C rods.
 - ▶ Rod flattening occurs after AIS surgery (rod memory) *Cidambi et al, Spine 2012*
 - ▶ Rod material can affect rod memory and resistance



Limitations

- ▶ Retrospective study
- ▶ Single surgeon (↓ external validity)
- ▶ Observer-dependent measurements
- ▶ Limited follow-up (1 yr)
- ▶ Measurement accuracy
 - ▶ Influence of radiographic projection
- ▶ Learning curve with PS rods

Considerations

- ▶ No selection criteria / consecutive cases
- ▶ Consistency in method of care
- ▶ 2 independent observers
- ▶ Adequate for purpose of this study (radiographic outcomes, rod contouring)



Conclusions

- ▶ Patient- Specific rod technology was safe and resulted in at least comparable radiographic outcomes compared to Conventional rods
 - ▶ Can decrease errors in rod contouring (this study: TL junction angle)
 - ▶ No complications
 - ▶ No rod contour change
- ▶ Non-inferiority of Patient- Specific rod technology compared to Conventional rod
- ▶ Study to continue with further follow-up and patient recruitment.