

# Elevated Serum Titanium Levels in Children with Early Onset Scoliosis Treated with Rib-Based Growing Constructs and Magnetically Controlled Growing Rods

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# Disclosures

- Li: see program
- Graham: none
- Robbins: none
- Farley: see program



# Background

- Growth-sparing surgery in EOS aims to control spinal deformity while achieving maximal spine length, spine mobility, thoracic function

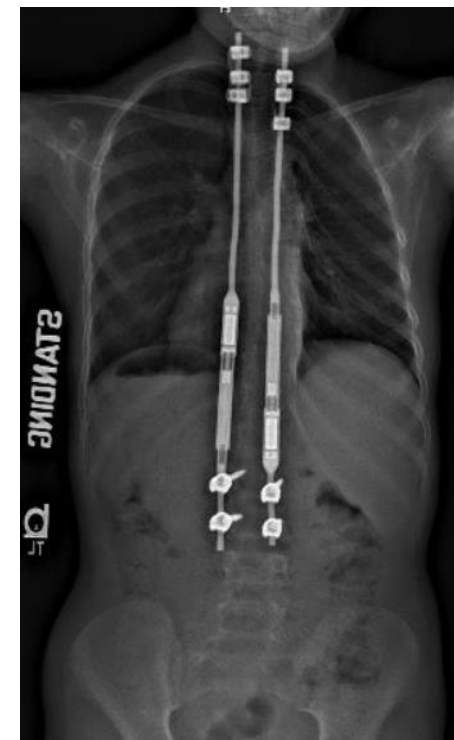
Rib  
Based  
Growing  
Constructs



Traditional  
Growing  
Rods



Magnetically  
Controlled  
Growing  
Rods

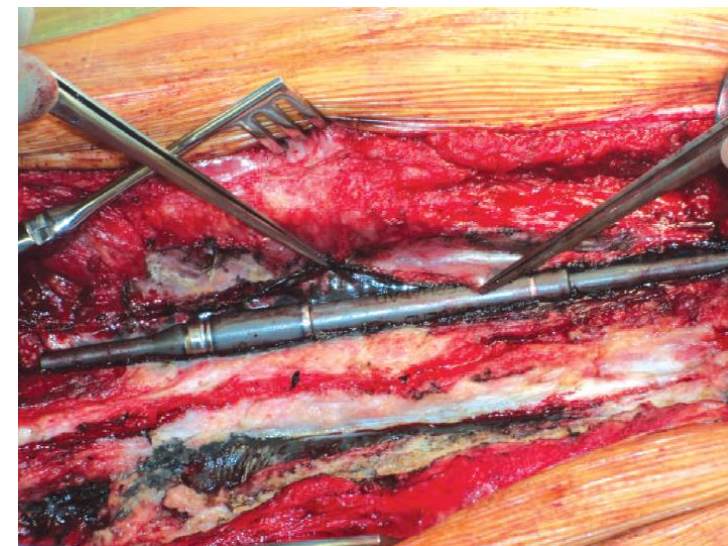


# Background

- Significant metallosis around MCGR has been reported
  - Hosseini, Spine 2016; Jones, Spine J 2016; Teoh, Bone Joint J 2016
- Titanium wear debris inside explanted MCGR
  - Teoh, Bone Joint J 2016; Joyce, Spine 2017



Reproduced from Joyce TJ, et al: Analysis of explanted magnetically controlled growing rods from seven UK spinal centers. *Spine* 2017;43:E16-E22.



Reproduced from Teoh KH, et al: Metallosis following implantation of magnetically controlled growing rods. *Bone Joint J* 2016;98-B:1662-1667.

# Metal Ion Release During Growth-Friendly Instrumentation for Early-Onset Scoliosis: A Preliminary Study

Caglar Yilgor, MD<sup>a</sup>, Ayaz Efendiyev, MD<sup>b</sup>, Filiz Akbiyik, MD<sup>c</sup>, Gokhan Demirkiran, MD<sup>b</sup>, Alpaslan Senkoylu, MD<sup>d</sup>, Ahmet Alanay, MD<sup>a</sup>, Muharrem Yazici, MD<sup>b,\*</sup>

- 15 TGR, 22 MCGR, 15 age-matched controls
- Significantly higher serum titanium (Ti) levels in patients treated with TGR and MCGR compared to controls
- RBGC not assessed

Titanium (µg/L)

Control

Growing rod

MCGR

2.8 ± 1.4

7.3 ± 4.3

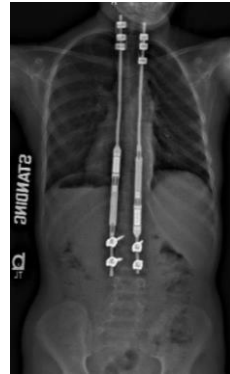
10.2 ± 6.8

Spine Deformity 2018



# Purpose

- Evaluate serum Ti levels in EOS patients treated with RBGC and MCGR
- RBGC: titanium/aluminum/niobium
- MCGR: titanium/aluminum/vanadium



Element	Weight %	
	RBGC (Ti-6Al-7Nb)	MCGR (Ti-6Al-4V)
Aluminum	5.5-6.5	5.5-6.5
Niobium	6.5-7.5	
Vanadium		3.5-4.5
Tantalum	<0.5	
Iron	<0.25	<0.25
Oxygen	<0.2	<0.13
Carbon	<0.08	<0.08
Nitrogen	<0.05	<0.05
Hydrogen	<0.009	<0.012
<b>Titanium</b>	<b>84.911</b>	<b>88.478</b>



# Hypothesis

- EOS patients treated with all types of growth-sparing instrumentation may have elevated serum Ti levels



# Methods

- Prospective cross-sectional case series from single institution
- Serum Ti levels collected at clinic visit or lengthening/exchange procedure from April to September 2018 \*updated data\*
- Normal serum Ti: 0-1 ng/mL (Mayo Clinic Labs)
  - Yilgor et al:  $\mu\text{g/L} = \text{ng/mL}$
- Four independent analyses conducted using Mann-Whitney U test





# Results (updated)

	RBGC (n = 12)	MCGR (n = 5)	P-value
Age (years)	7.7 ± 2.7	10.4 ± 1.3	0.051
<b>Serum Ti (ng/mL)</b>	<b>8.4 ± 3.5</b>	<b>4.6 ± 2.3</b>	<b>0.042</b>
<b>Time from implant insertion to serum Ti measurement (years)</b>	<b>5.5 ± 2.7</b>	<b>1.9 ± 0.9</b>	<b>0.001</b>
Total rods implanted during treatment (n)	5.4 ± 3.6	2.8 ± 1.1	0.064

- All patients had a serum Ti level above normal



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- Similar number of lengthenings (7.5 vs 6.8) and rods currently implanted (1.8 vs 2.0)

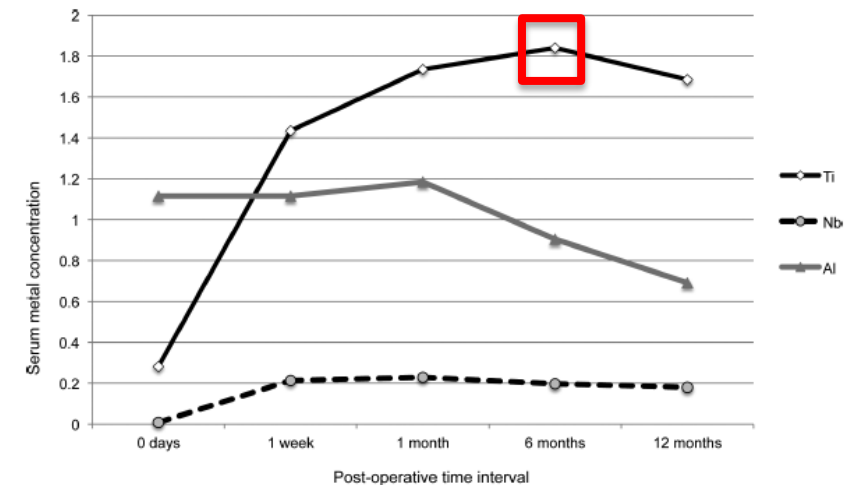


# Serum Titanium, Niobium, and Aluminum Levels After Instrumented Spinal Arthrodesis in Children

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Leanne M. Sutherland, BSc (Hons), PhD,\*† Brian J.C. Freeman, MB, BCh, BAO, DM, FRCS (Tr and Orth), FRACS,†§¶ and Peter J. Cundy, MBBS, FRACS,\*†¶

- 95% had elevated postop serum Ti

	Implant	Serum Ti level	
		Median/mean	Reference range
Cundy et al	PSF/ASF	1.84 (peak)	0.05-0.70 ppb (preop levels)
Yilgor et al	Controls	2.8	<7.7 µg/L (AnkaLab, Ankara, Turkey)
	TGR	7.3	
	MCGR	10.2	
Our study	RBGC	8.4	<1 ng/mL (Mayo Clinic Labs)
	MCGR	4.6	



(1 ppb = 1 µg/L = 1 ng/mL)

Spine 2013



# Discussion

- Long-term effects of local and systemic exposure to elevated Ti levels unknown
- Elevated serum Ti levels considered nontoxic
- Ti debris found to accumulate in organs in human postmortem studies and animal studies
- Children who receive growth-sparing instrumentation exposed to elevated Ti levels at earlier ages and for longer periods of time



# Limitations

- Small sample size
- Cross-sectional study
- No control group
- No standard reference range for serum Ti across different labs



# Conclusion

- Elevated serum Ti levels may be present in EOS patients with all forms of growth-sparing instrumentation
- RBGC may release more Ti than MCGR
- Serum Ti levels may be associated with duration of treatment and total number of rods implanted during treatment



# Conclusion

- Significance of elevated serum Ti in children unclear
- Need additional studies to evaluate serial serum Ti (and possibly tissue Ti) in a larger population of EOS patients with different types of growth-sparing instrumentation

