

When Anterior Tethering is Best



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Disclosures as Listed

- **15 years of Growth Modulation Research**
- **6 years of Clinical Experience**
- **Tether Device Patent**

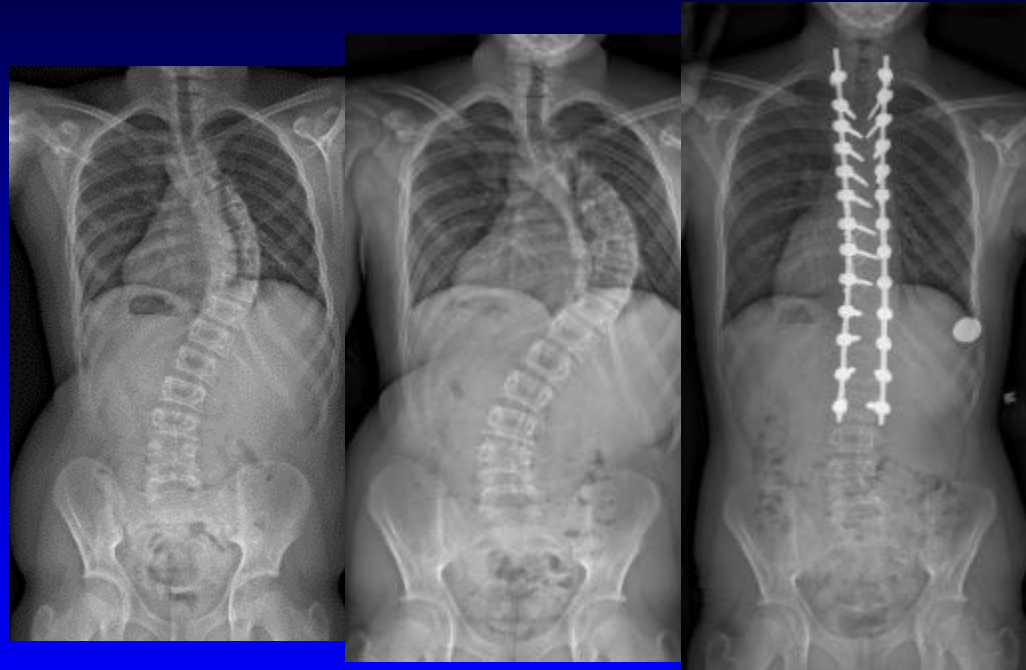
The Problems...

- **Fusion Steals Motion**
- **No FDA approved non-fusion option to reduce the deformity**
- **Posterior Fusion very reliable, hard to beat...**



Posterior Instrumented Fusion

- Stops progression
- Reliable
- Powerful

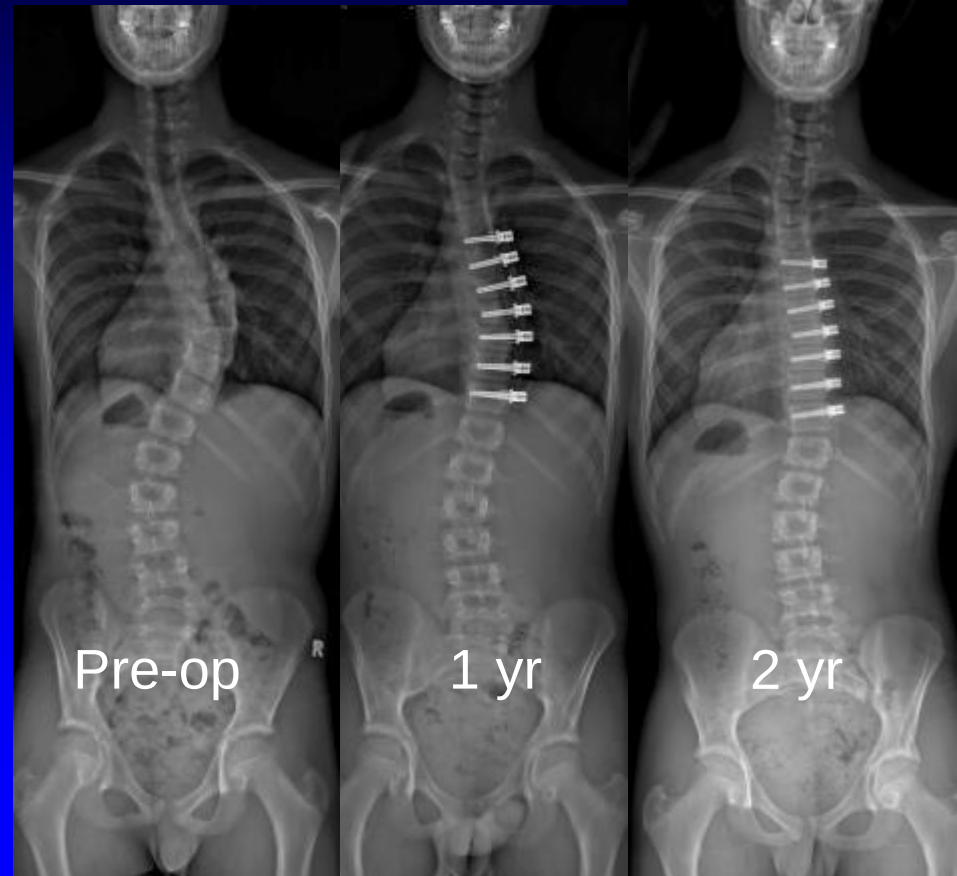


...but we must find better ways!

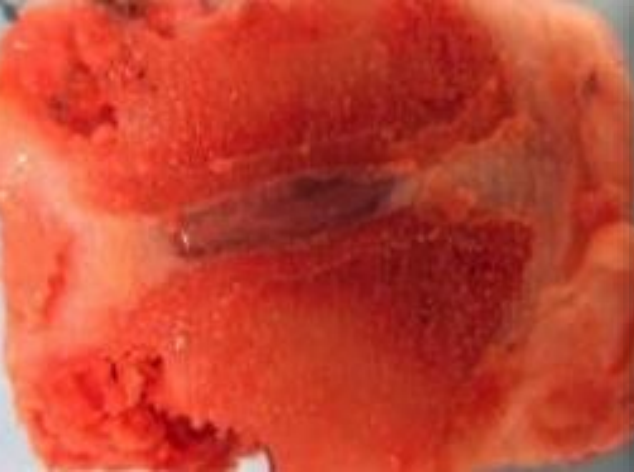
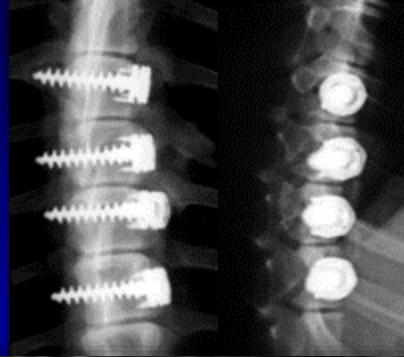
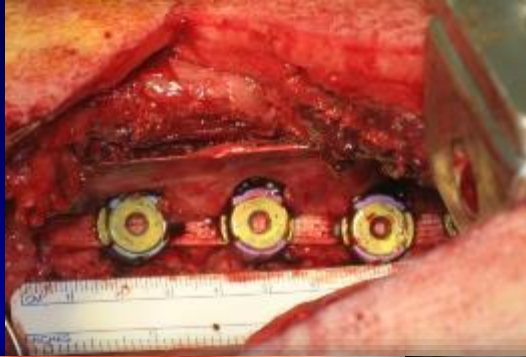


Anterior Spinal Growth Tethering

- **Maintain motion**
- **Modulate growth**
- **Heuter-Volkman**
- **Reshape vertebrae**
- **Requires real growth (2-3 years)**

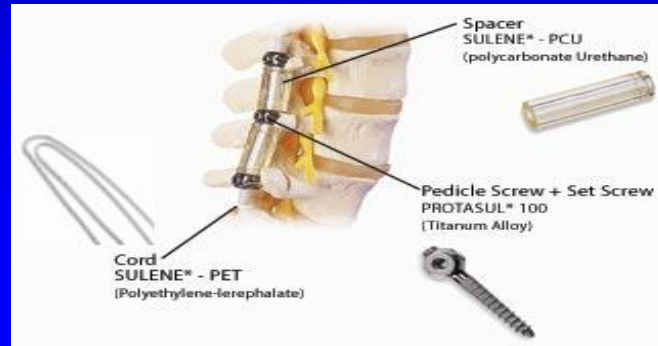


Porcine Models – Disc Preserved, Growth Modulated



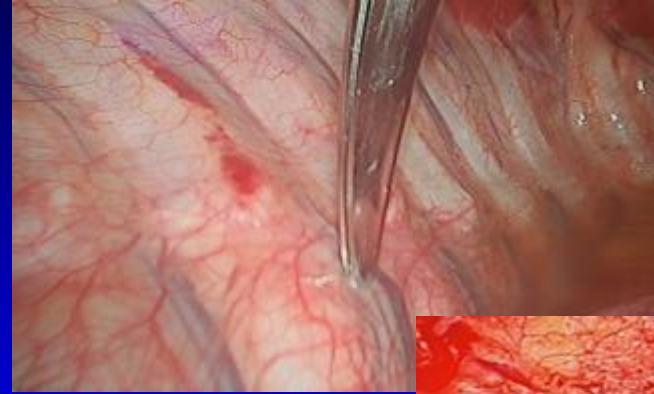
Clinical Anterior Tethering “Physician Directed Use” w/ 510k Cleared Device

- **Posterior Adult Lumbar system**
- **Cord and Screws used anteriorly**

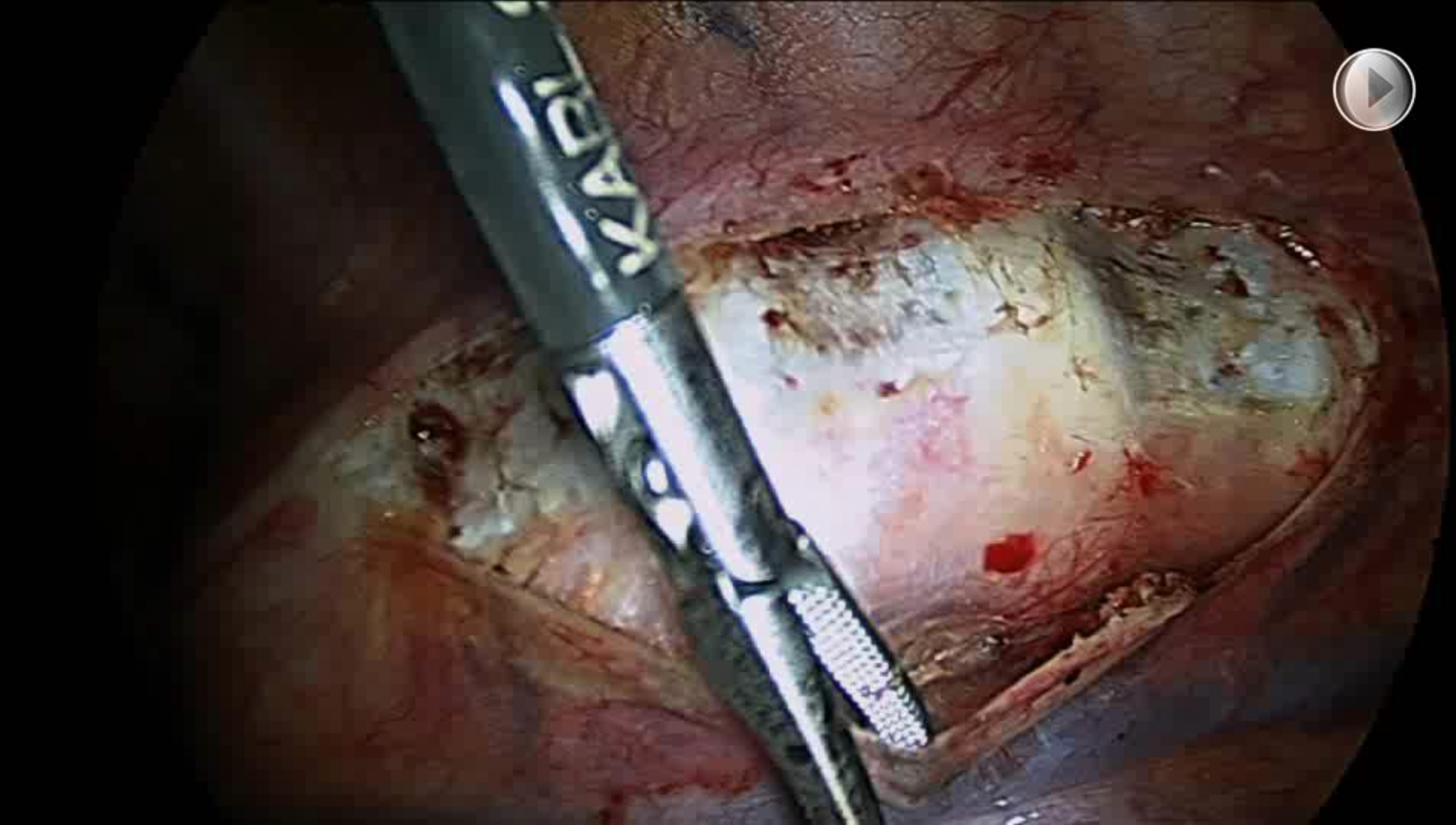


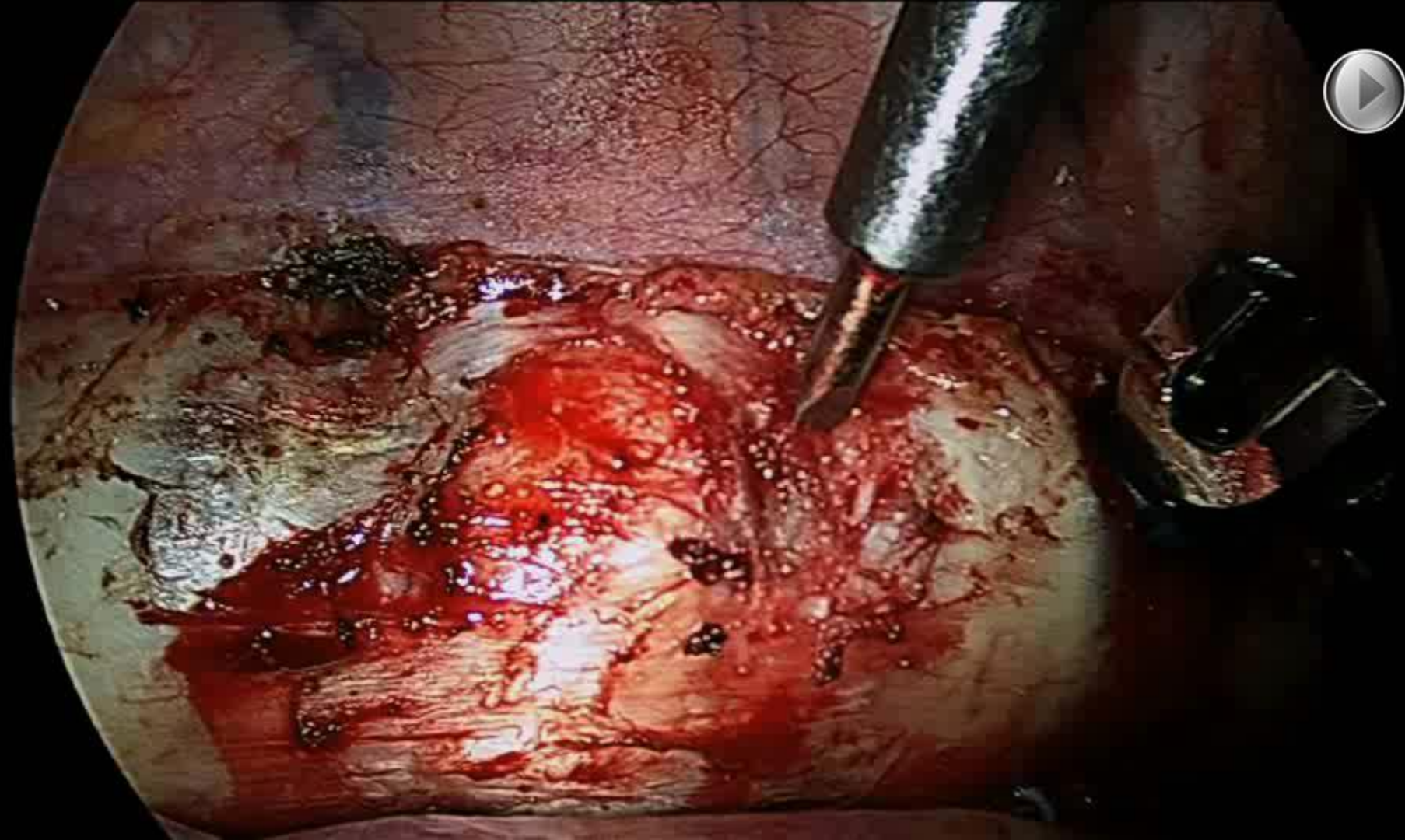
Thoracoscopic Approach

- **Single lung ventilation**
- **4 incisions (15mm)**
- **Divide segmental vessels**
- **Vertebral pronged staple & screw**
- **Tension the tether**



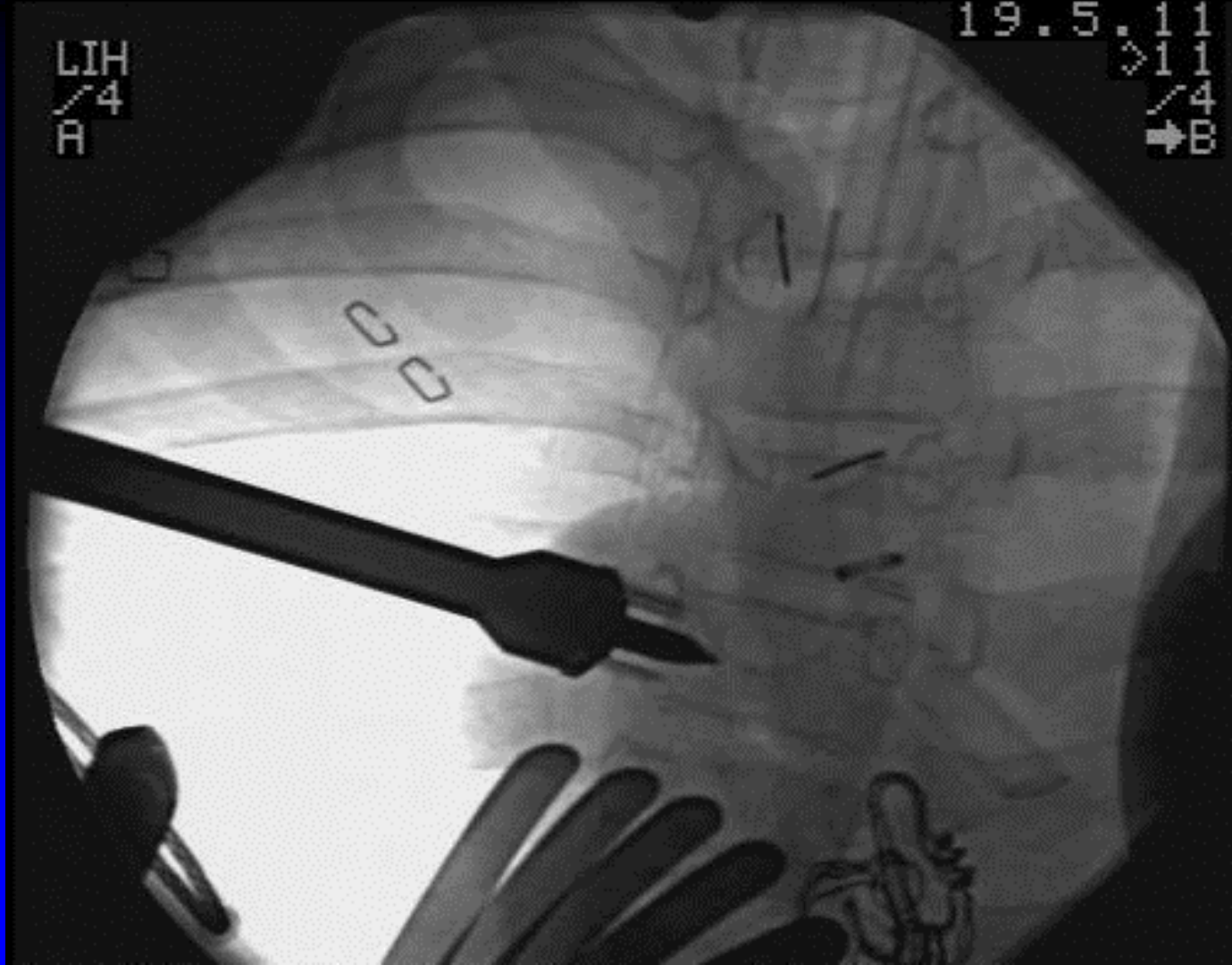


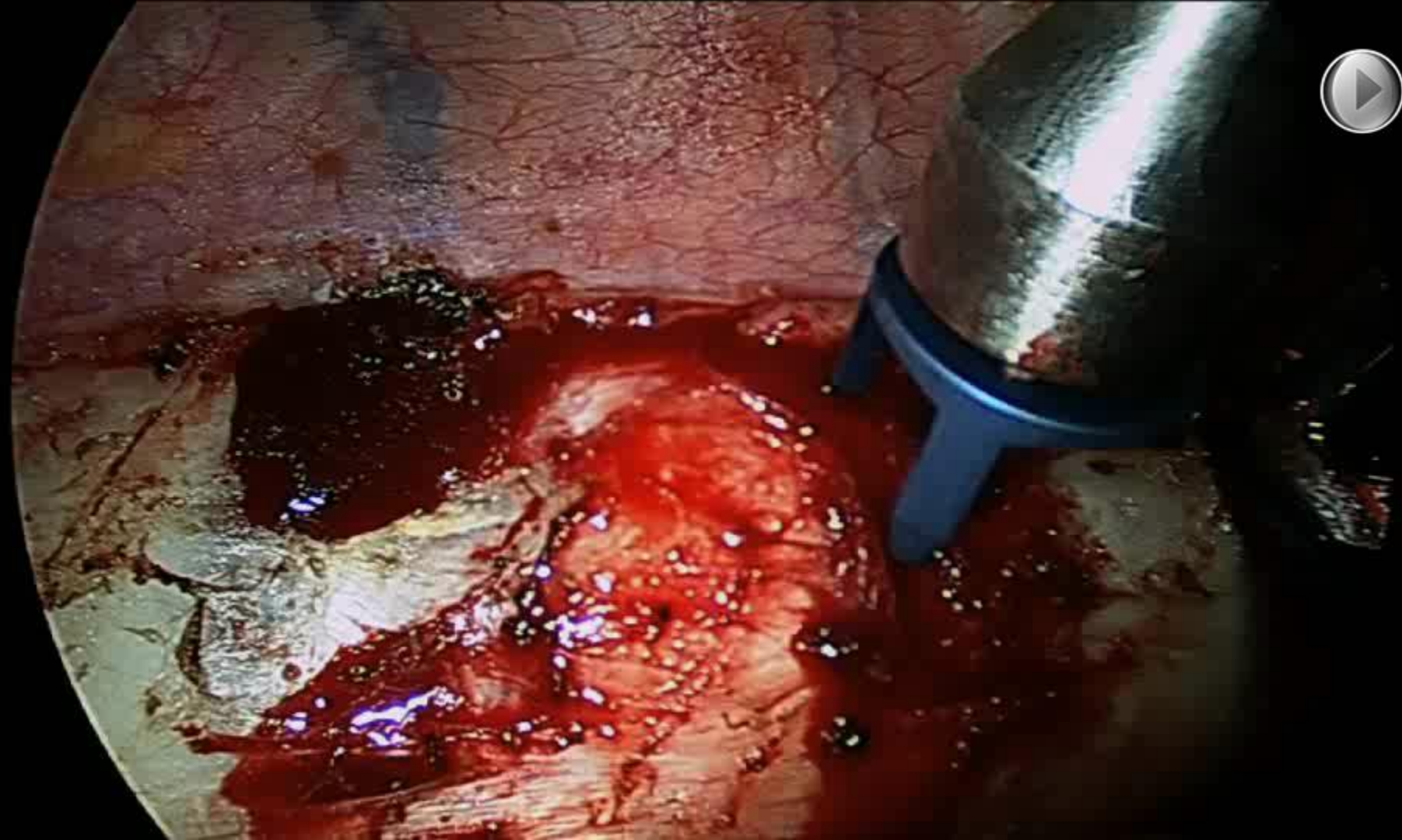




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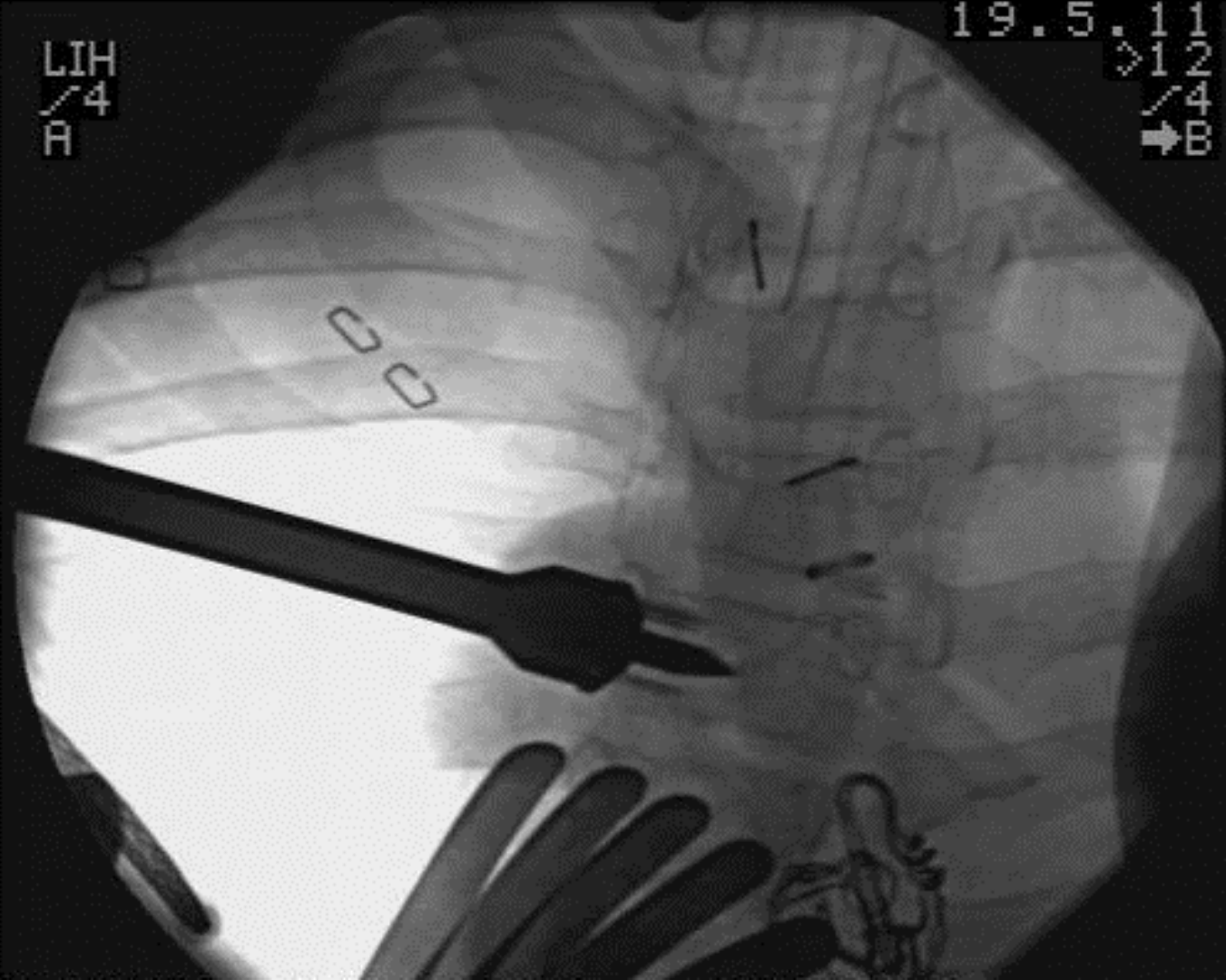
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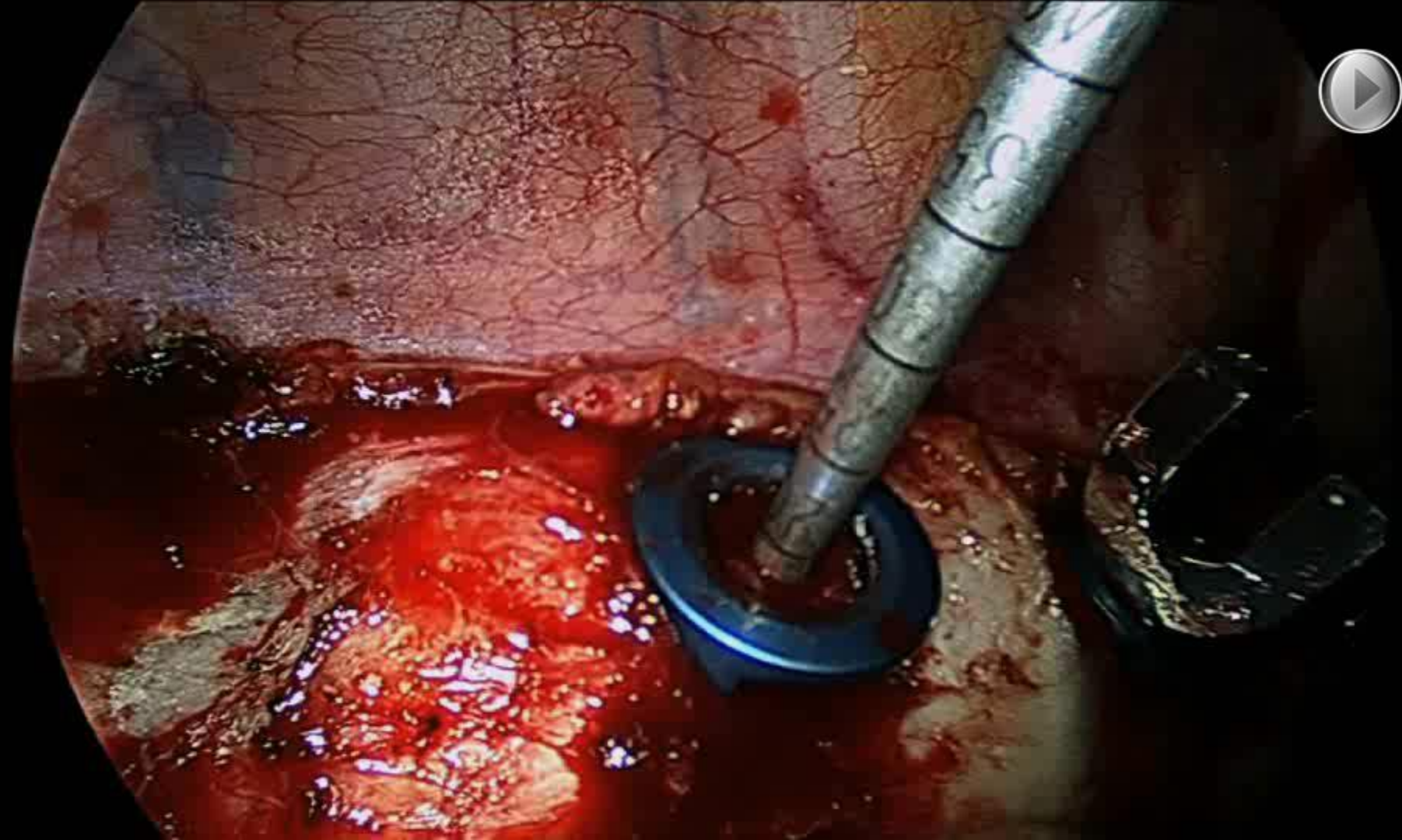




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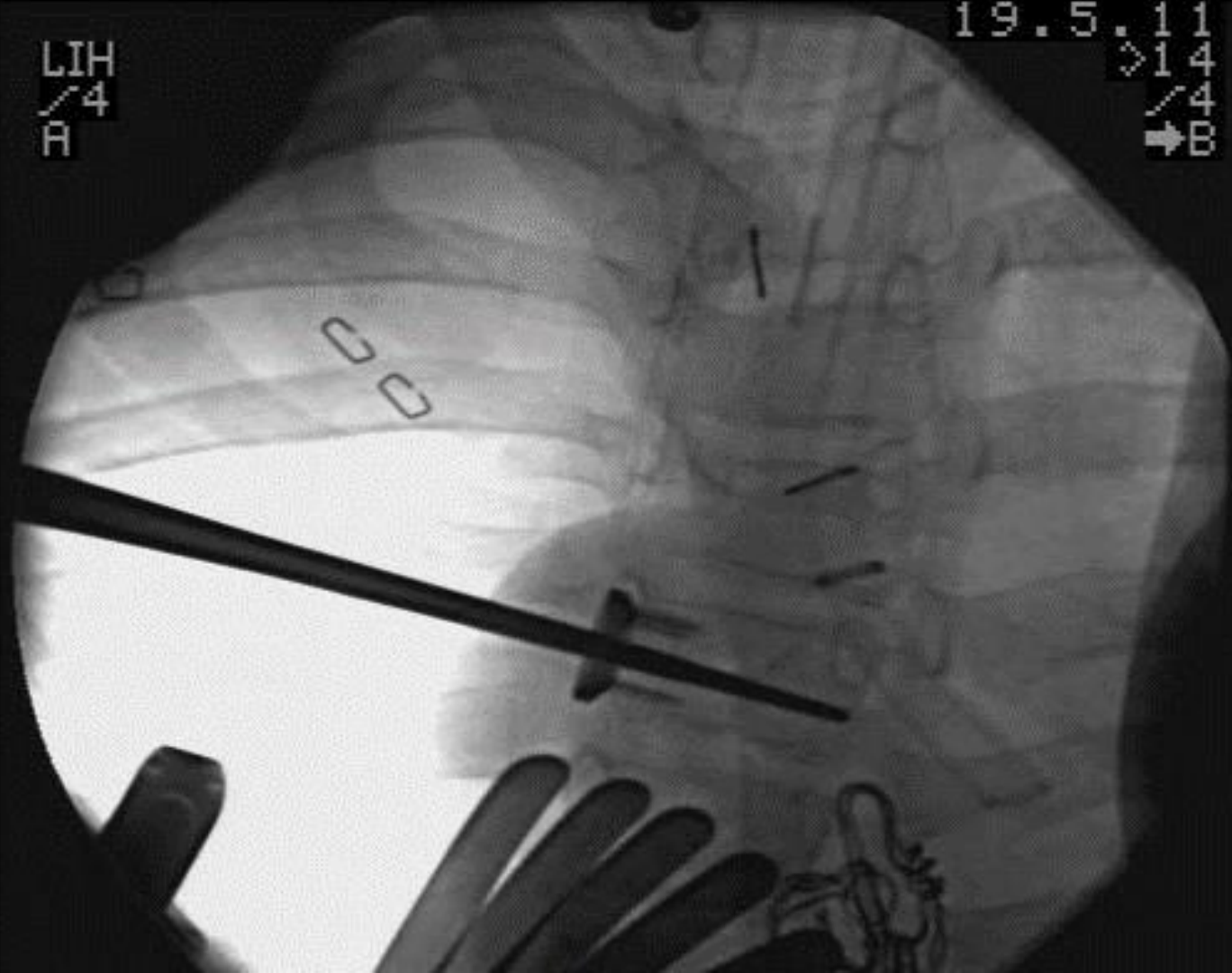
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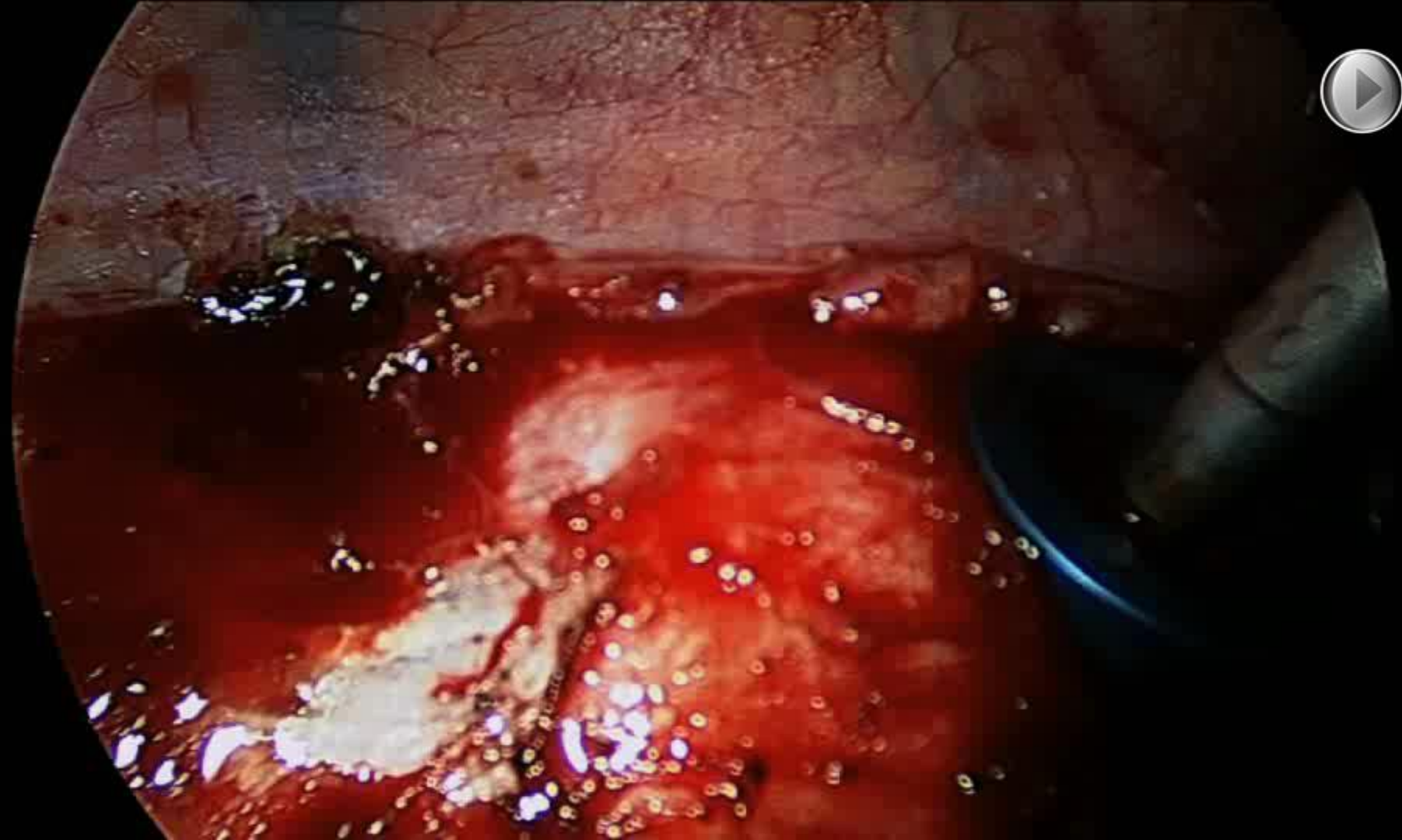




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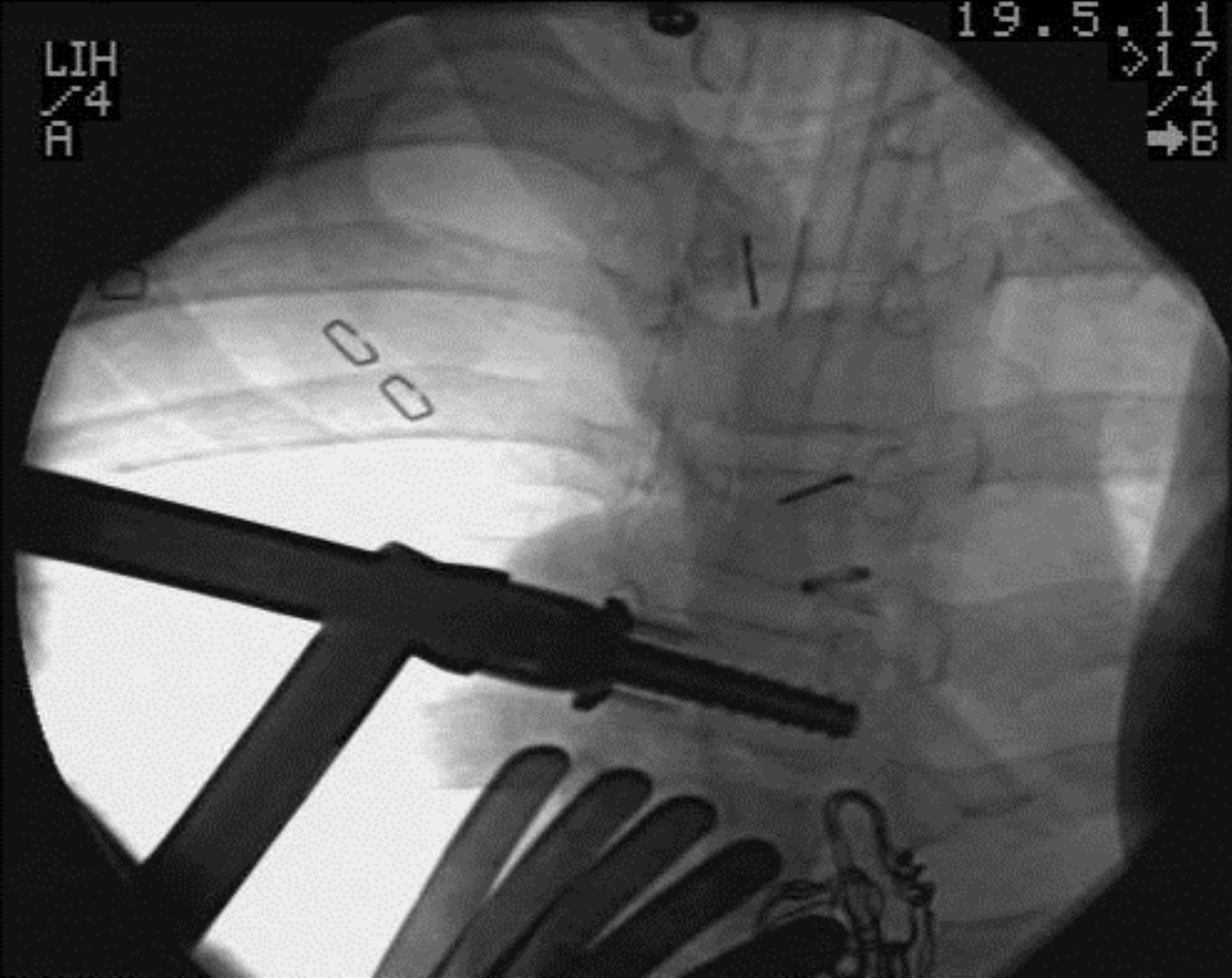
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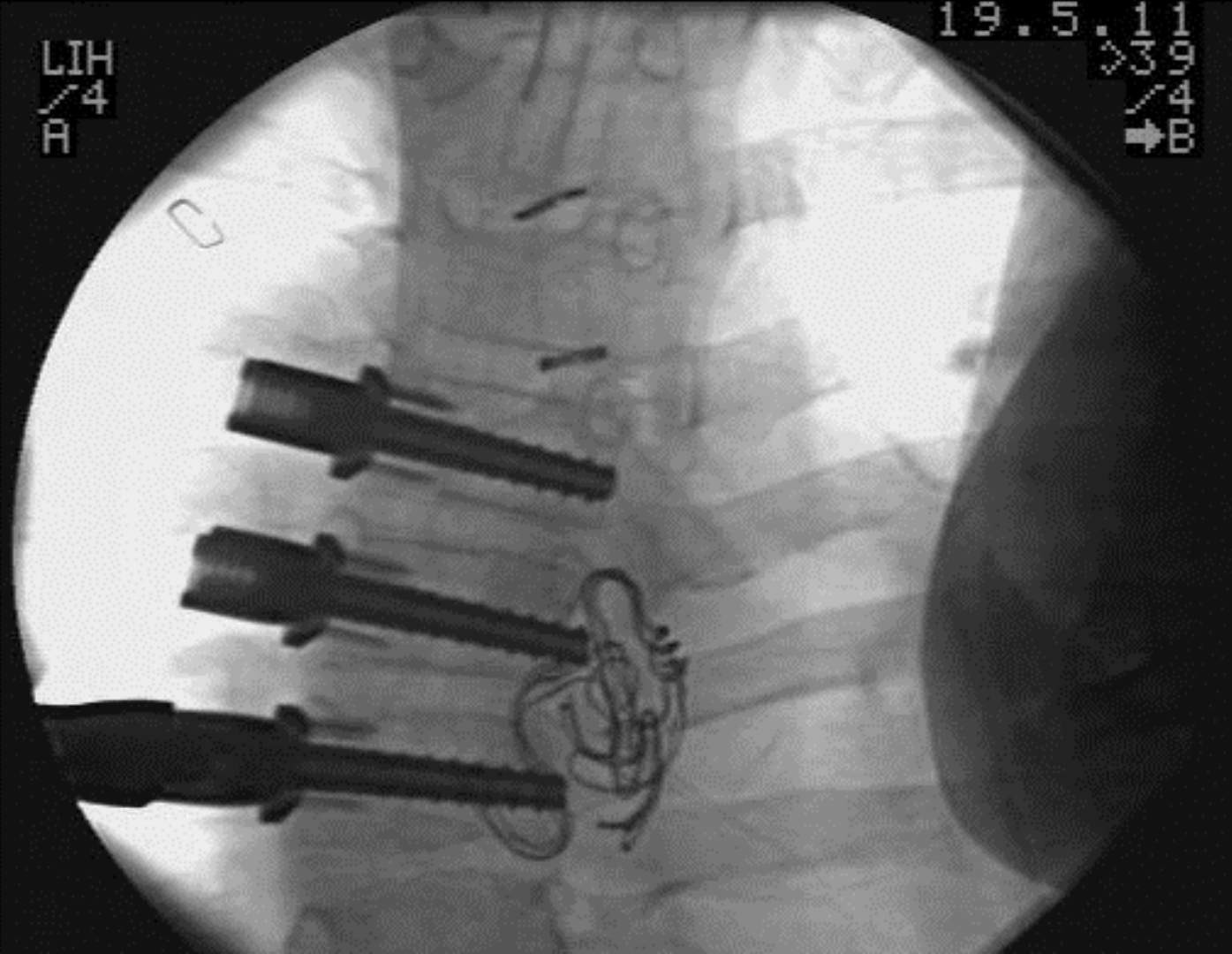
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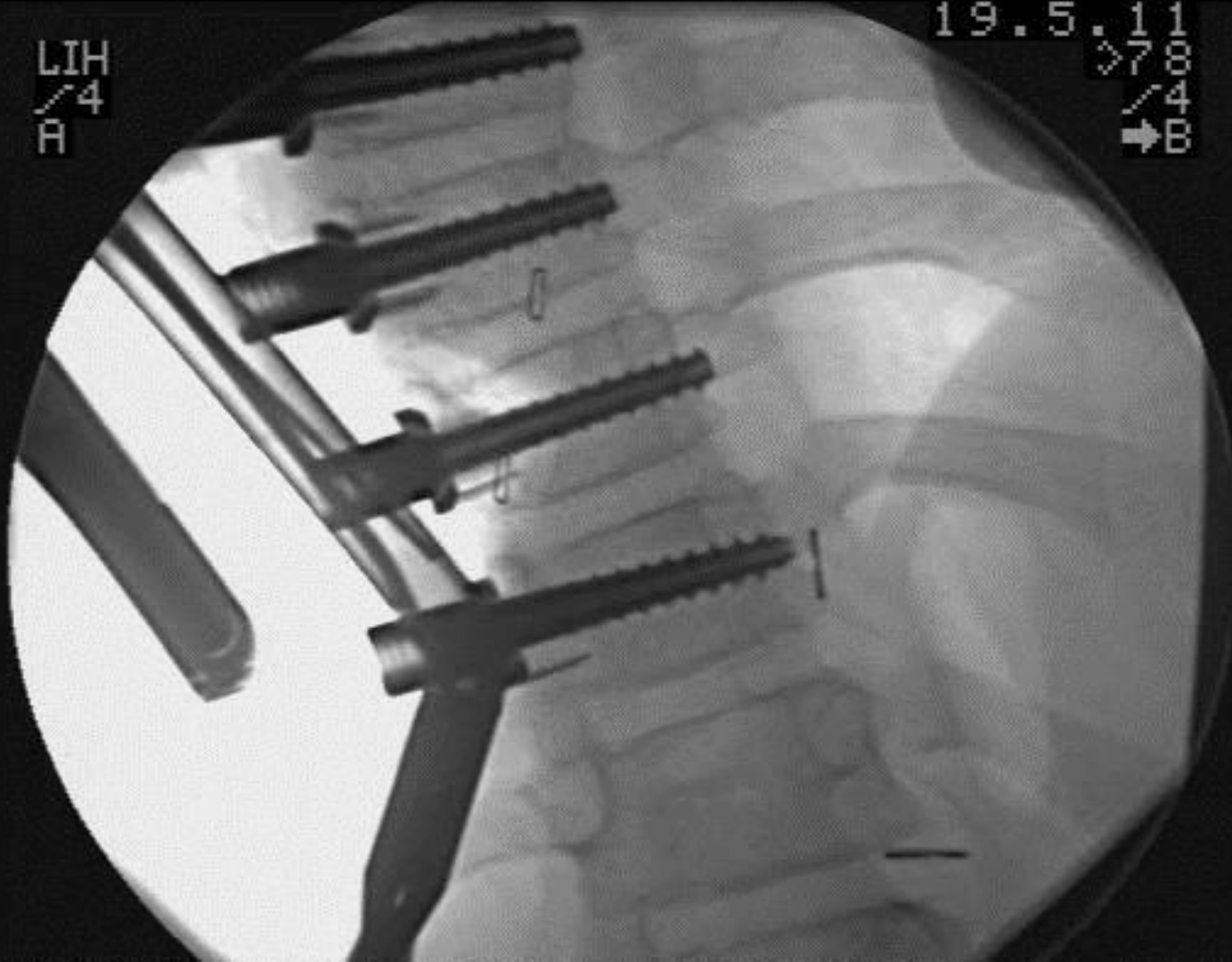
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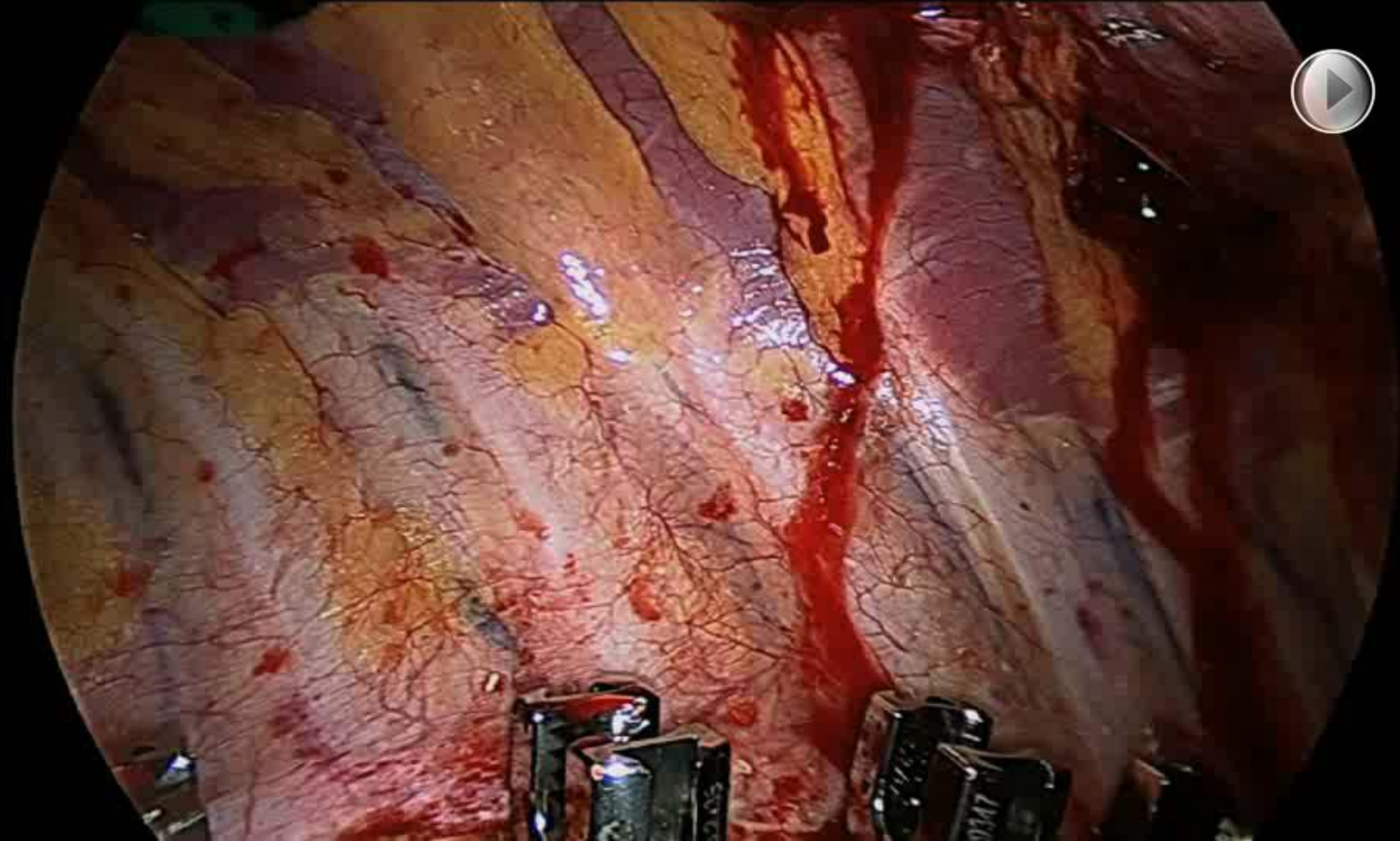
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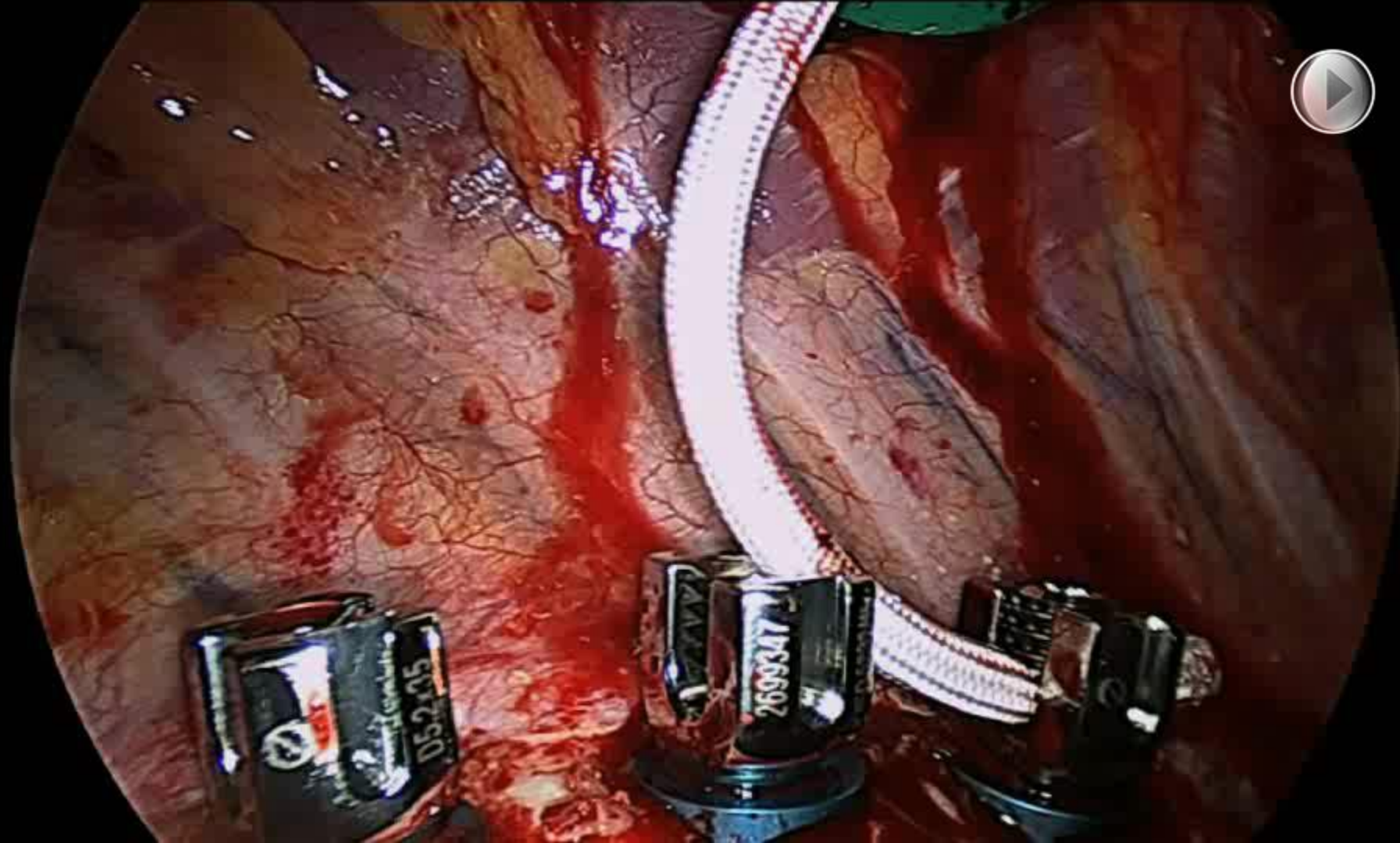


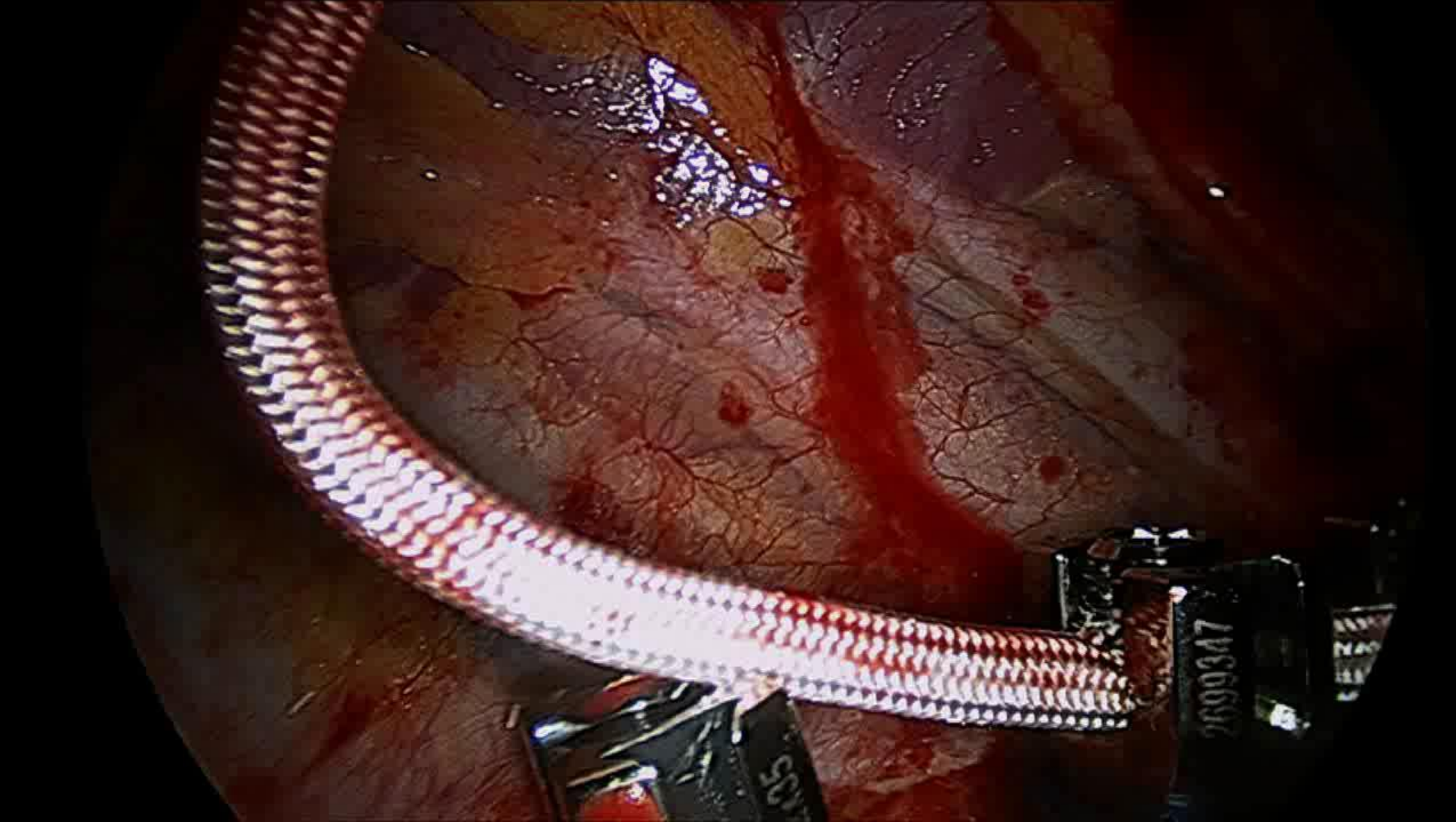
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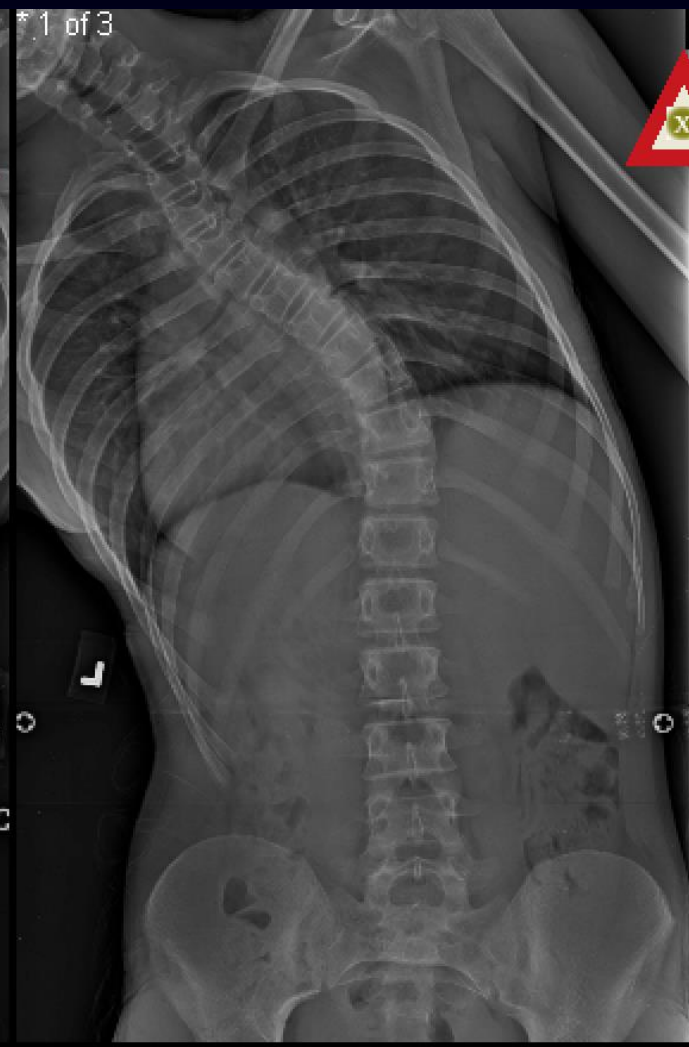
AIS, Risser 0, open TRC



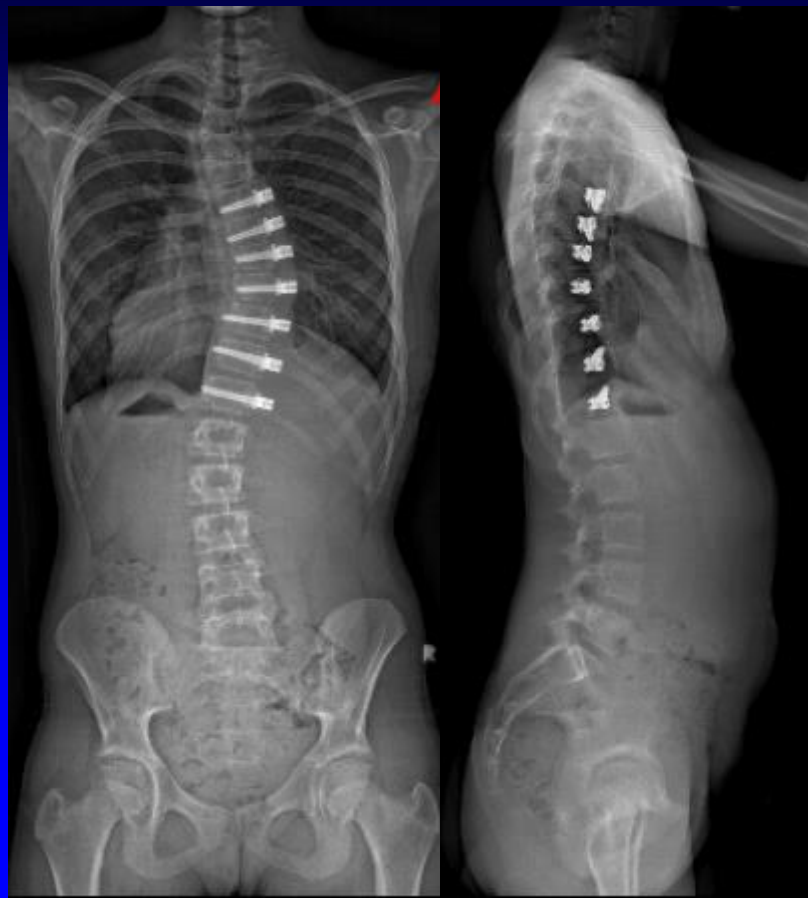
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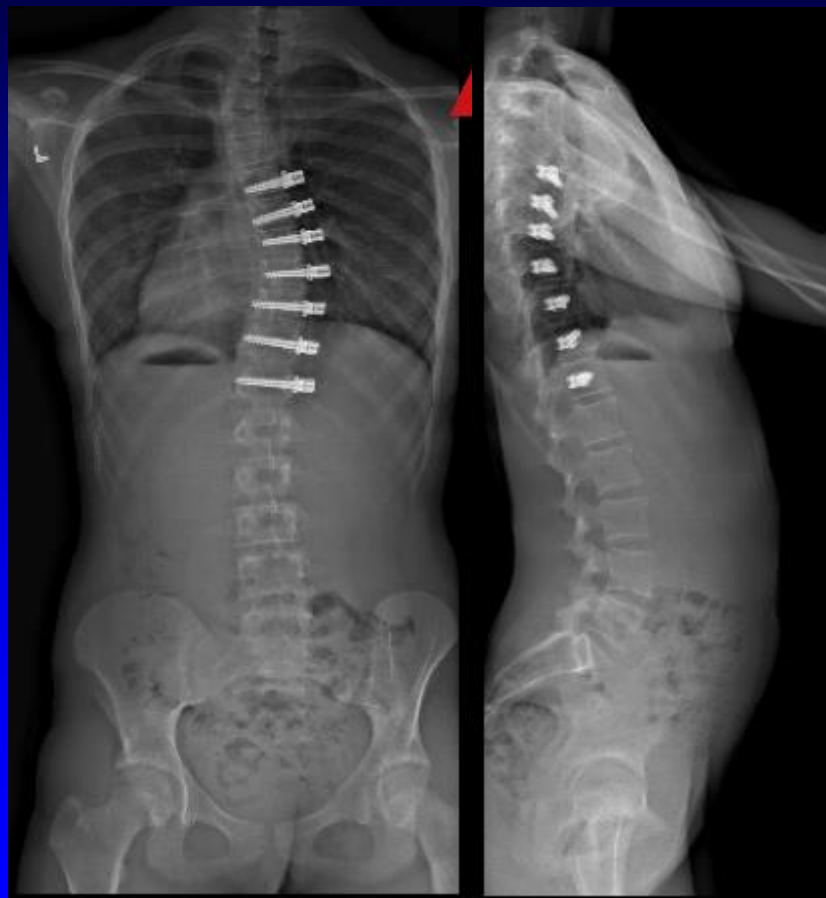
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Post op



1 year post op



2 years postop



6 years postop

- **Mature**
- **Stable**
- **Balanced curves**
- **Tether broken (arrow)**



How does tether compare to PSF?

- Compare > 2 year Outcomes of Tether to PSF
- Single Center
- Patients eligible for either procedure



Methods

- **Surgery dates: 2011-2014**
- **Lenke 1 or 2 curve types**
- **Risser ≤ 1**
- **Age 9-14 yrs**
- **Cobb 40-70**
- **Minimum 2 yr follow-up (range 2-5 yrs)**



Demographics

	ASGT	PSF	P value
Number of patients	17	14	
Age at surgery (y)	11 (9-14)	12 (11-14)	0.04*
Operative time (min)	194 $\pm$ 35	278 $\pm$ 68	0.001*
EBL (ml)	84 (30-100)	939 (300-2000)	<0.001*
Hospital stay (days)	5.5 $\pm$ 1.4	5.5 $\pm$ 1	0.9
Motion Segs fused/tethered	5.8 $\pm$ 0.5	10 $\pm$ 1	<0.001*
Latest Follow-up (y)	2.5 (2-4)	2.8 (2-5)	ns

Similar Curve Characteristics, but Younger

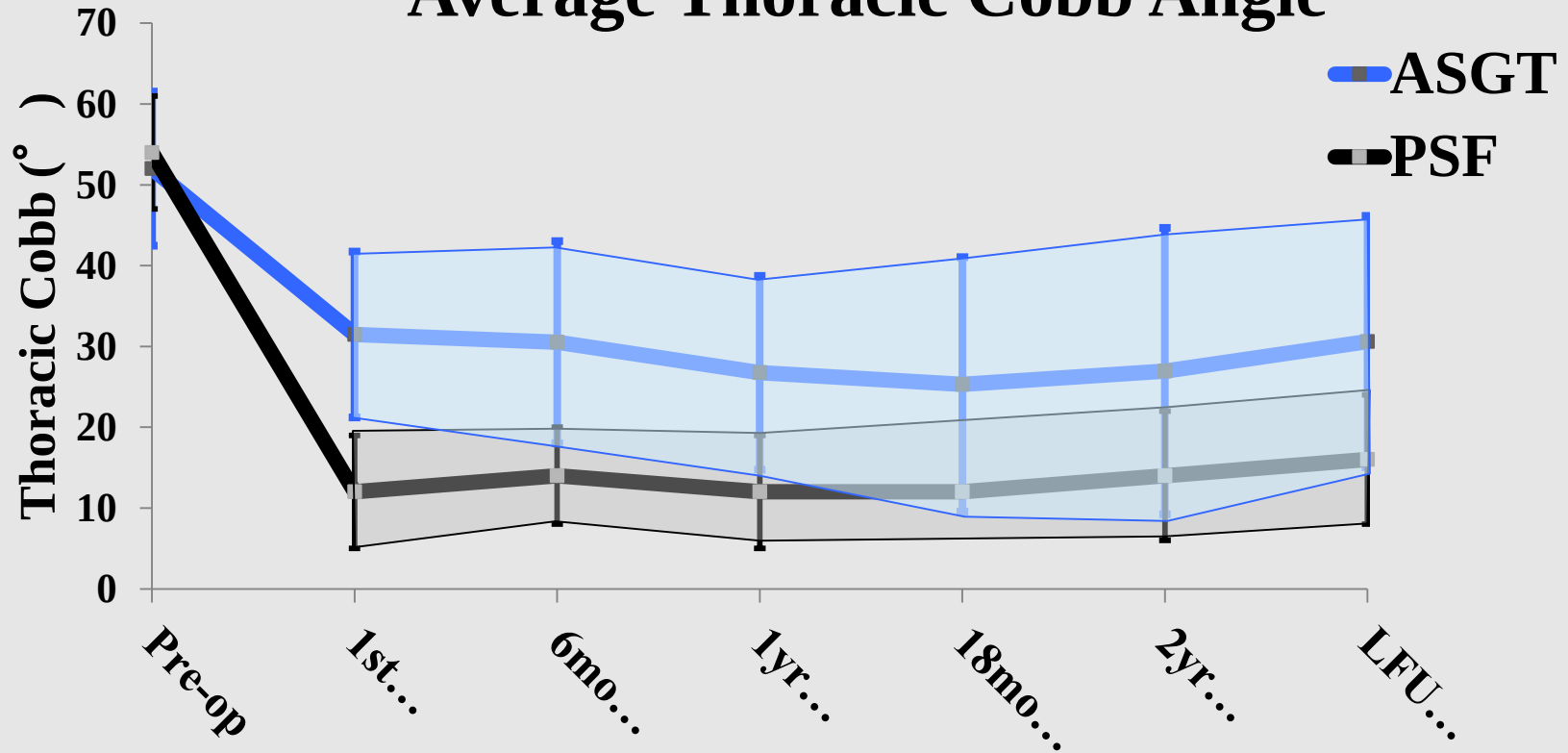
	ASGT	PSF	p
Pre-op Thoracic Cobb (°)	52 ± 10 (40 - 67)	54 ± 7 (40 - 65)	0.6
Pre-op Thoracic curve Flexibility (%)	48 ± 14	34 ± 21	0.04*
Pre-op Lumbar Cobb (°)	33 ± 10	33 ± 8	0.9
Pre-op Risser 0	100%	71%	
Open TRC	94%	36%	
Sanders Maturity Score	2.3 ± 0.8	3.7 ± 1.0	0.001*
% Idiopathic Scoliosis	76%	93%	

Latest Follow-up (many still growing)

	ASGT	PSF	p
Latest post-op Thoracic Cobb (°)	31 ± 16 (-35 - 57)	16 ± 8 (6 – 30)	0.002*
Thoracic correction (%)	56 (5-180)	70 (38-89)	0.24
Latest post-op Lumbar Cobb (°)	28 ± 16	11 ± 9	0.002*
Pre-op T2-T12 Kyphosis (°)	25 ± 13	22 ± 8	0.3
Latest post-op T2-T12 Kyphosis (°)	22 ± 10	29 ± 8	0.05
Latest post-op Risser	2 (0-4)	3.5 (2-5)	0.01*
Height change post-op (cm)	15.2 ± 5.4	8 ± 3.6	<0.001*



Average Thoracic Cobb Angle



Revisions/Complications		n
ASGT		17
Total revision surgeries		7
Tether removal (overcorrection)		4
Lumbar tether added		1
Broken Tether replaced @ OSH		1
Conversion to PSF		1
Revision indicated (PSF)		3
Complications (minor pulmonary)		2
Broken Tether		8
PSF		14
Total revision surgeries		0
Revision indicated		0
Complications (minor medical)		1



25%

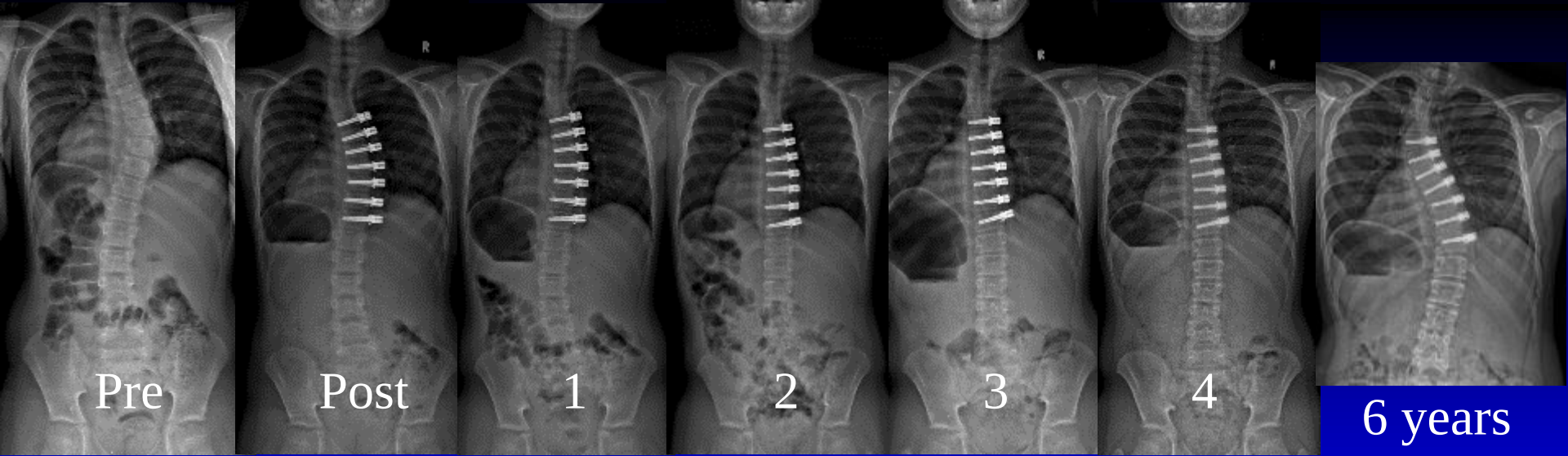
SRS-22 Outcomes

	ASGT	PSF	p
Pre-op SRS-22 Total	4.3 $\pm$ 0.4 (n = 6)	4.1 $\pm$ 0.5 (n = 12)	0.2
Pain	5.0 $\pm$ 0.1	4.3 $\pm$ 0.5	0.001*
Mental Health	4.5 $\pm$ 0.6	4.0 $\pm$ 0.8	0.3
Self Image	3.7 $\pm$ 0.8	3.7 $\pm$ 0.8	0.95
Satisfaction	4.3 $\pm$ 1.0	3.9 $\pm$ 0.8	0.4
General Function	4.4 $\pm$ 0.3	4.5 $\pm$ 0.6	0.7
Latest post-op SRS-22 Total	4.7 $\pm$ 0.2 (n = 5)	4.6 $\pm$ 0.2 (n = 12)	0.27
Pain	4.6 $\pm$ 0.6	4.6 $\pm$ 0.4	0.88
Mental Health	4.8 $\pm$ 0.2	4.4 $\pm$ 0.6	0.08
Self Image	4.9 $\pm$ 0.2	4.7 $\pm$ 0.4	0.25
Satisfaction	4.9 $\pm$ 0.2	4.9 $\pm$ 0.2	0.88
General Function	4.6 $\pm$ 0.4	4.6 $\pm$ 0.3	1

Best Candidates to Tether

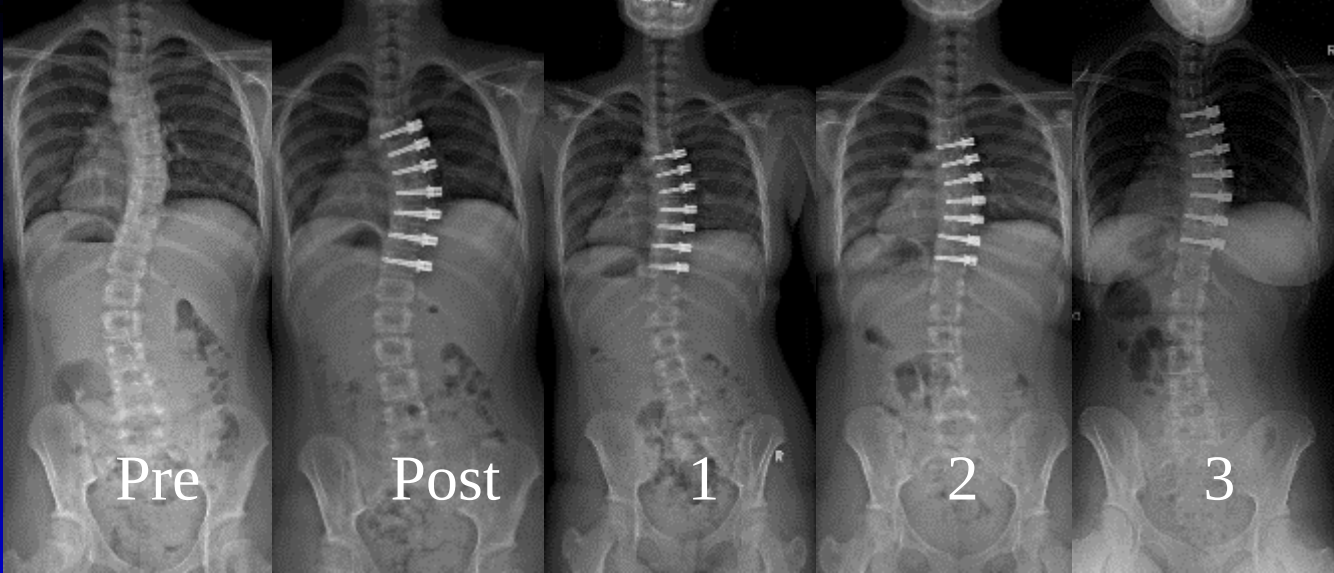
- **Right thoracic: 45-60 degrees**
- **Lenke 1AL, 1B (1C, 2's)**
- **End vertebra: L1 or above**
- **Hypokyphosis**
- **Peak growth remaining, age 11-12**



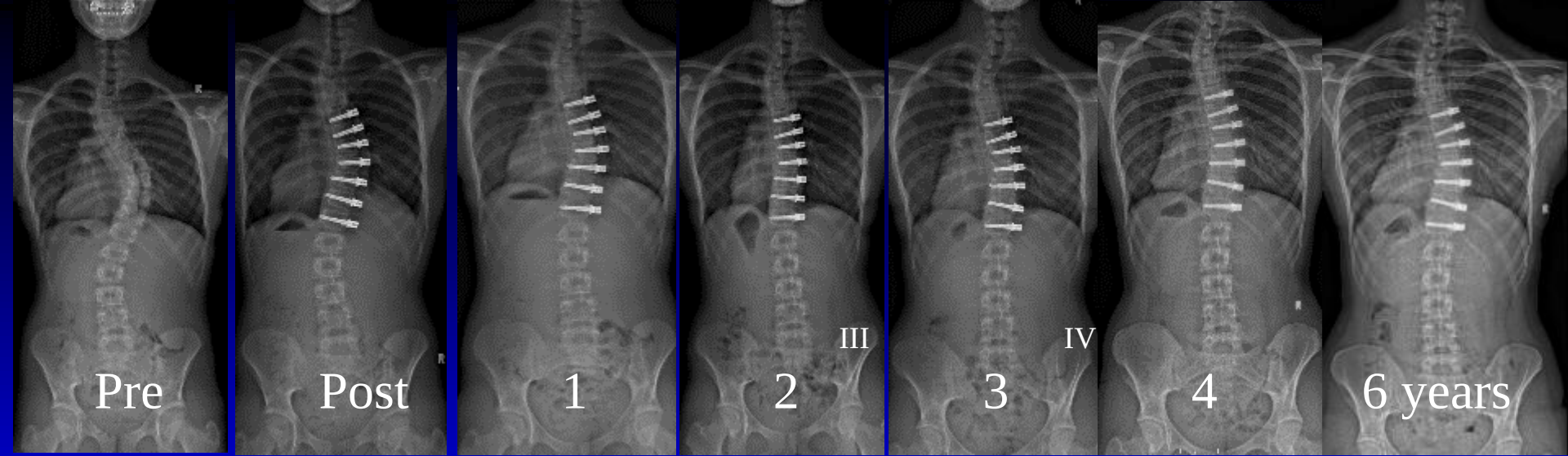


- 10 y/o male, very immature, Small curve
- Proximal overcorrection
- Distal adding on, broken tether (2 levels)

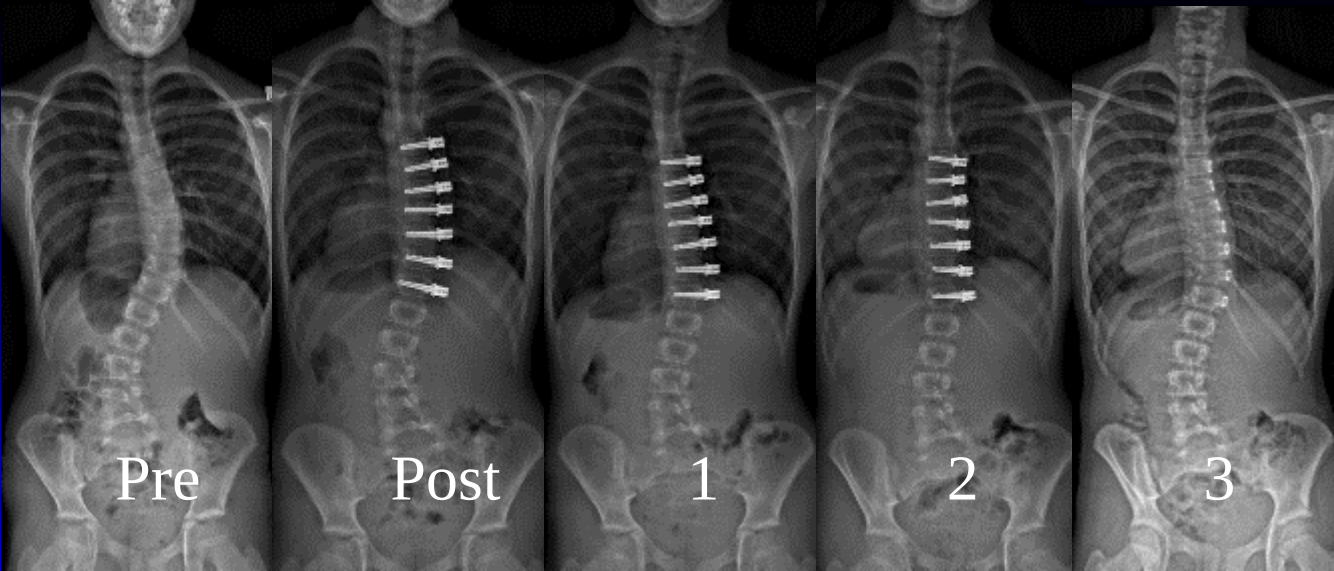




- 10 y/o male, immature, Small curve
- Finished growth 3 years postop
- Modest correction, broken tether (1 level)



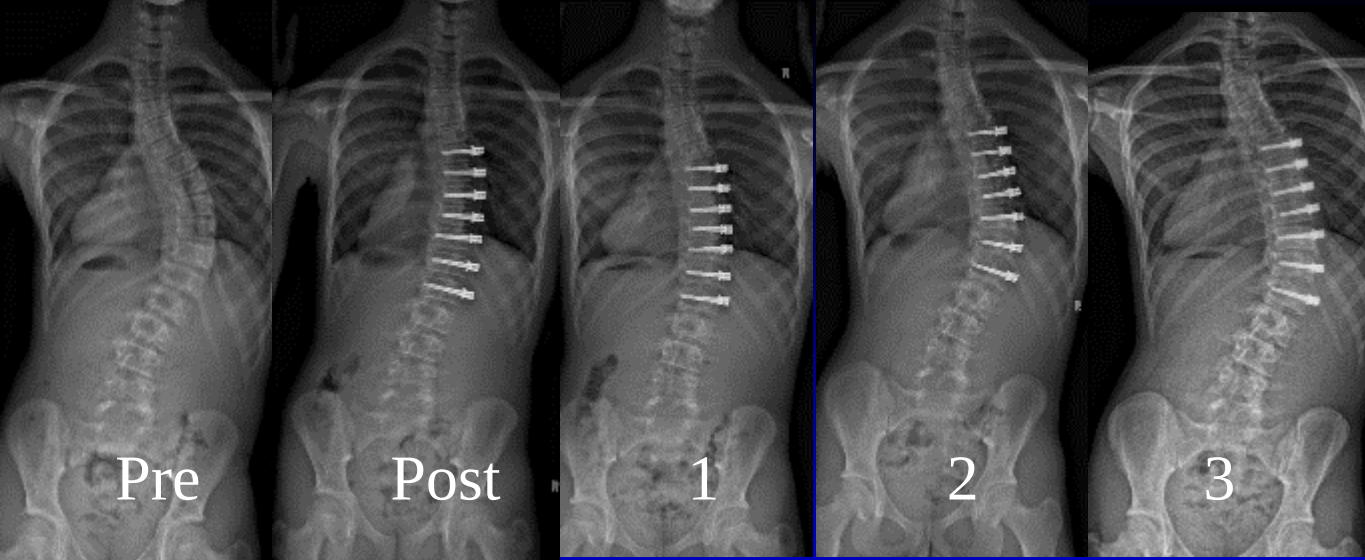
- 12 y/o F, Risser 0, closing TRC, 53° curve
- Modest loss of correction, starting at 2 yrs
- Broken tether near completion of growth



4

6 years

- **9 y/o F, R0, open TRC, Low thoracic apex**
- **Better to include L1 (but loose)**
- **Tether removed too early (broken at apex)**



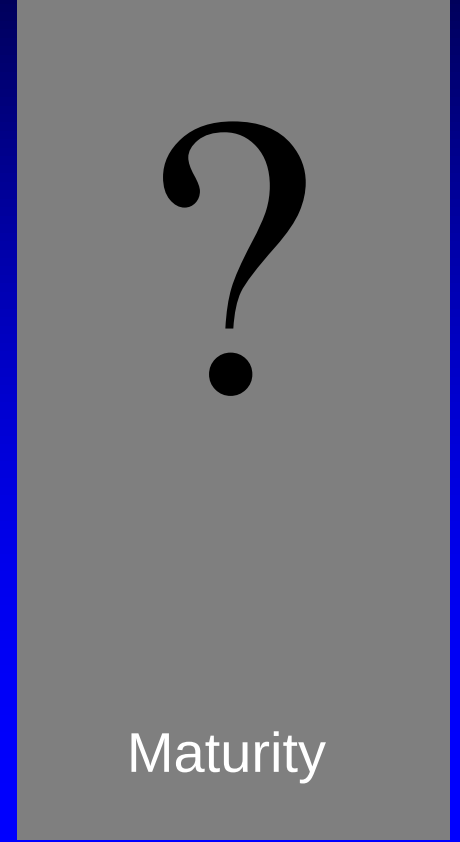
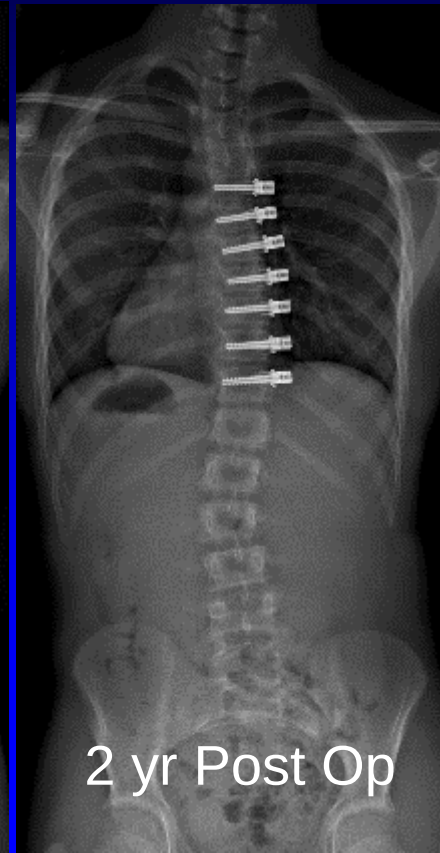
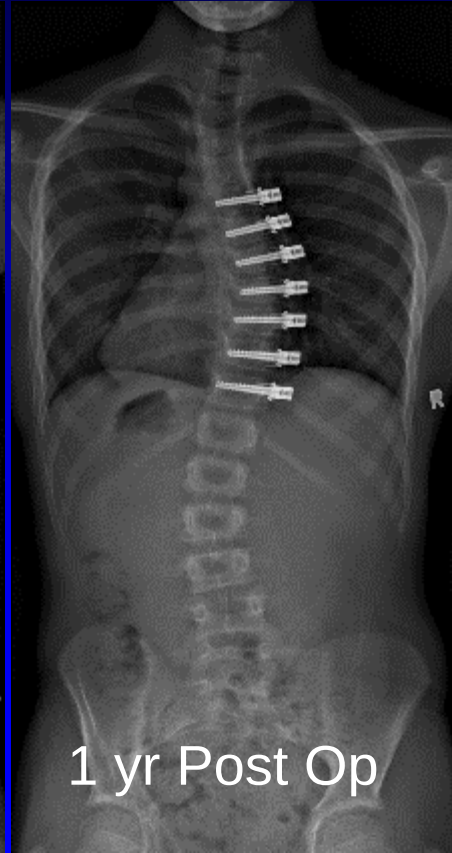
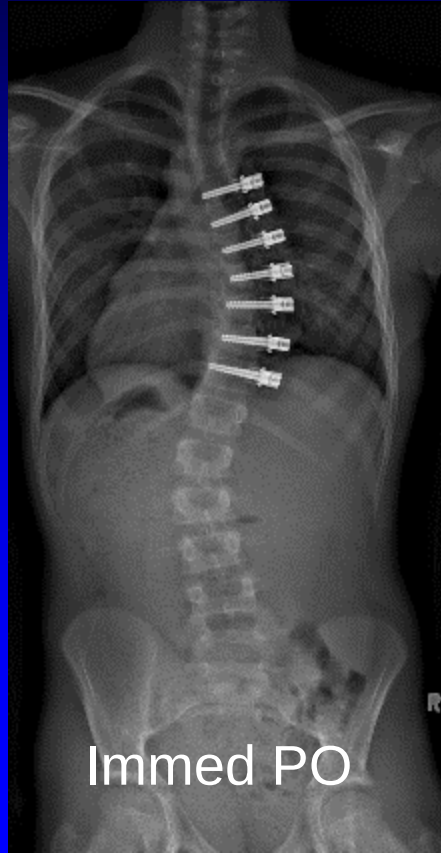
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6 years

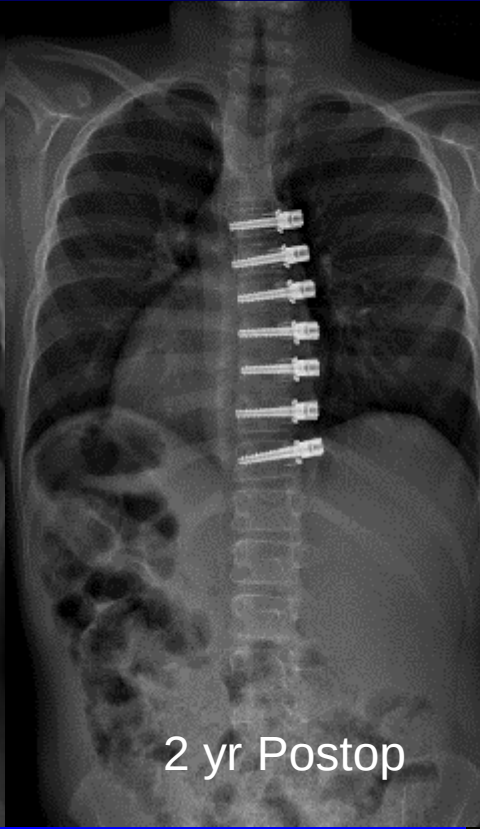
- 13 y/o M, R0, closing TRC, Bigger curve
- Tether began failing at 18 months
- Bottom 3 levels failed



Results at/after Maturity



Tethering remains unpredictable



Do what is right, not what is easy

- Growth is hard to predict
- Without growth no lasting correction
- Patients confused by internet rhetoric

and high degree curves not elsewhere obtained. This is because we have pioneered advanced
on. We really do not have criteria of exclusion from this treatment like many other centers .Each
will recommend options.

Conclusions

- **Shared Decision Making Required (flexibility vs reliability)**
- **Watch out for those serving KoolAid**

