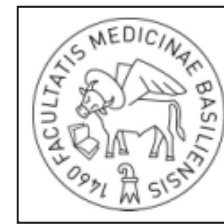
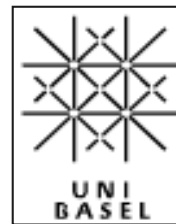


Use of VEPTR for Congenital Spine Deformity



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Orthopaedic Department

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Considerable variability in expert's opinions & decision making

Vitale 2010 CORR

Surgery Yes/No – Type of construct – Where to place – thoracostomy Yes/No

- Hemivertebra resection, Osteotomies
- Early fusion, Hemiepiphysiodesis
- Serial plasters, braces

• Rib based – distraction, rib osteotomies

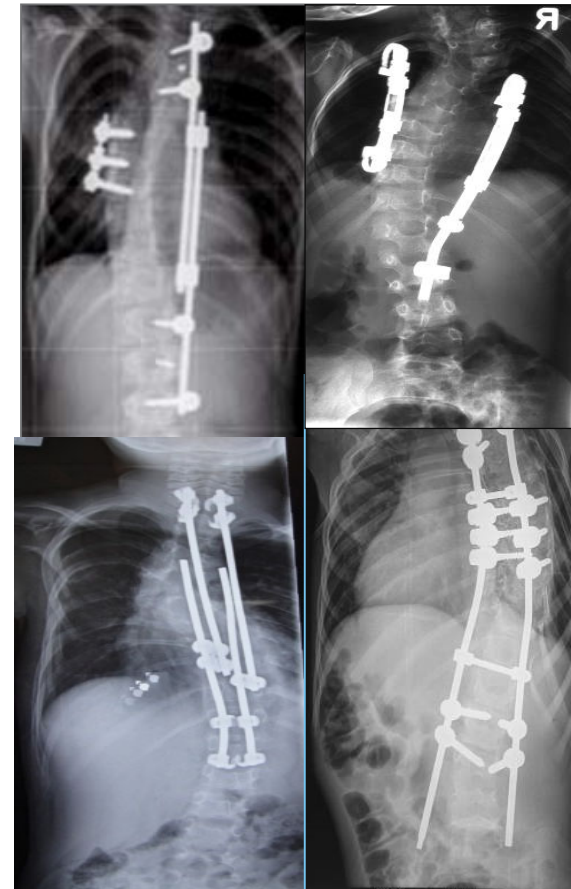
VEPTR, GPS

• Spine based - distraction

Growing rods: uni- / bilateral / motor driven

• Spine based – growth guiding

Shilla, Luque trolley, Stapling, Flexible tethering



VEPTR state of the art for TIS

Vertical *Expandable Prosthetic Titanium Rib*

Thoracic Volume-Depletion Deformities *Campbell JBJS-Am 07*

- I absent ribs
- II fused ribs
- IIIa foreshortened thorax *e.g. Jarcho-Levine*
- IVb transverse constriction *e.g. Jeune Syndrome*

Advantage:

No fixation on the spine, minimized neuro risk

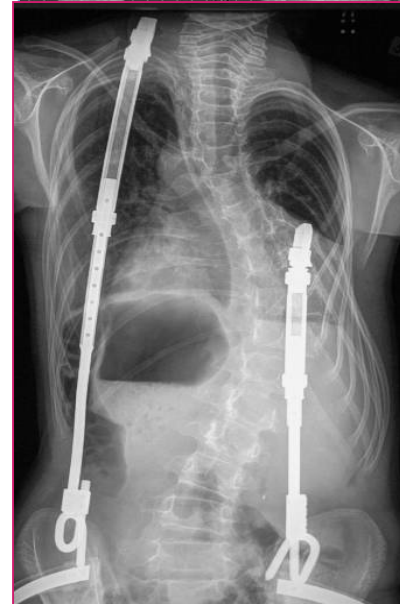
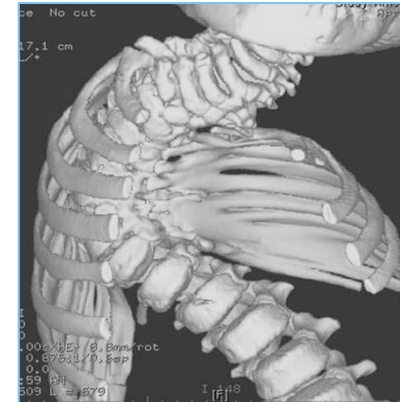
Spine flexibility, No spontaneous fusion

Lung growth, function ?, Thoracic scarring ?

„True correction“ (growth modulation)

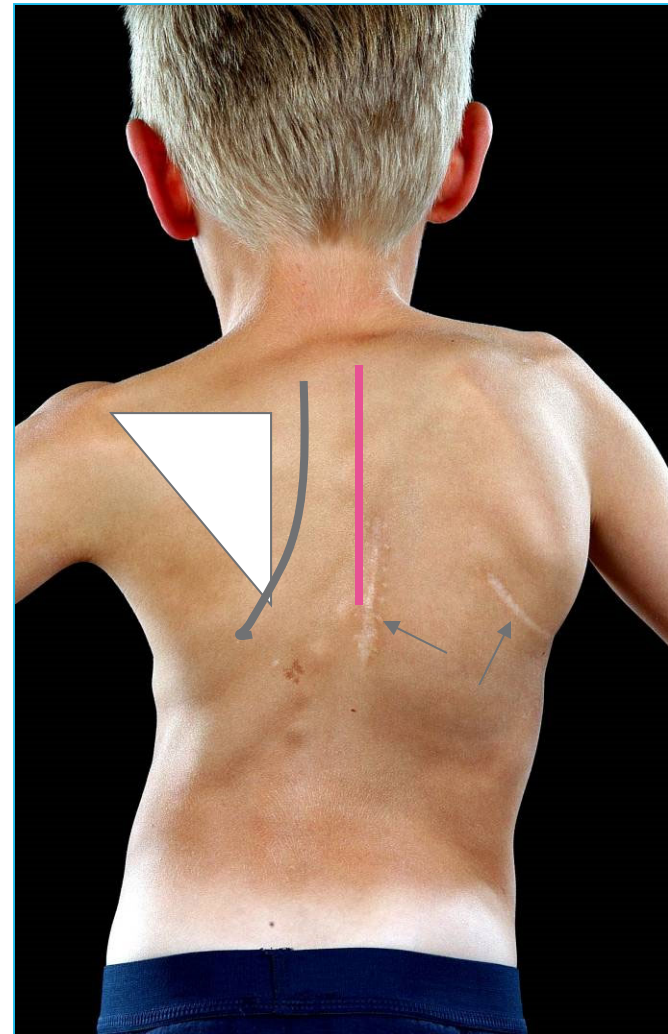
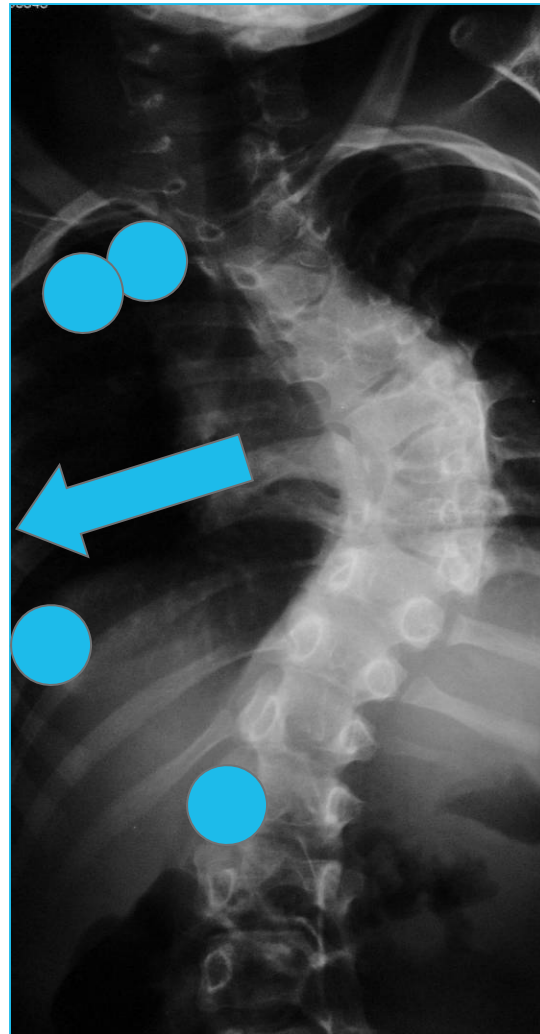
Polyaxial implant, brace free, no restrictions

Anchor points intact for definitive fusion

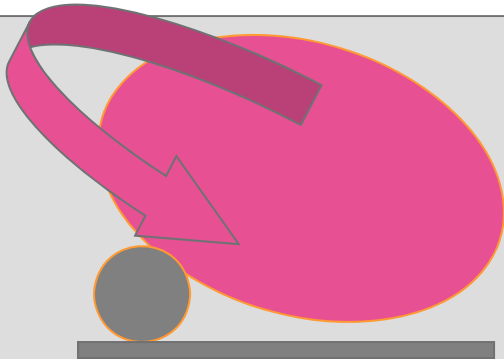


Surgical approach

Rib fixation
Thoracoplasty
Lumbar fixation
Pelvic fixation



Positioning



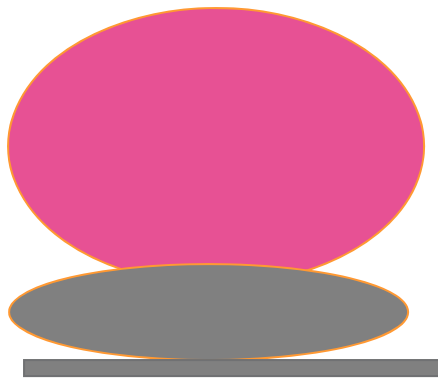
Semiprone

**Elevated @ side
of thoracoplasty**

Pelvis free



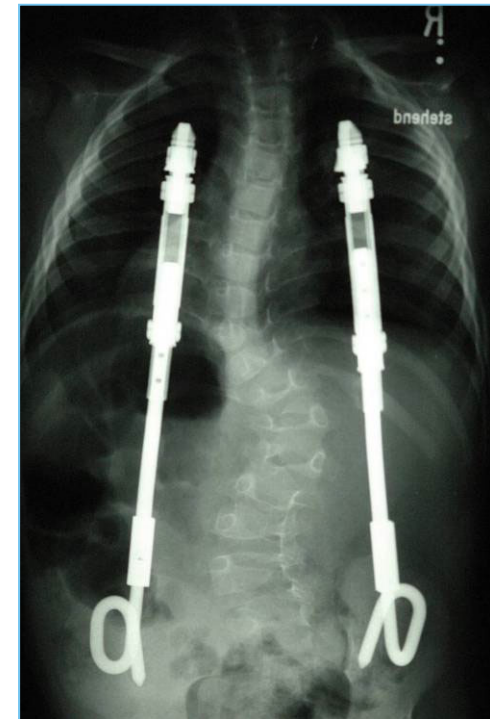
Positioning



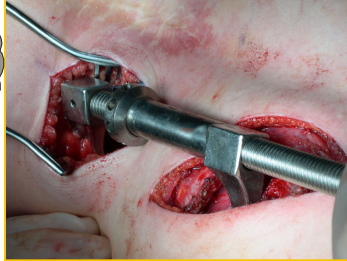
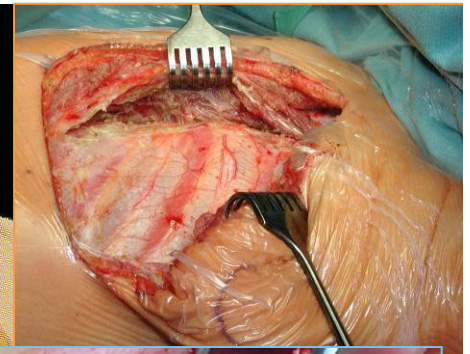
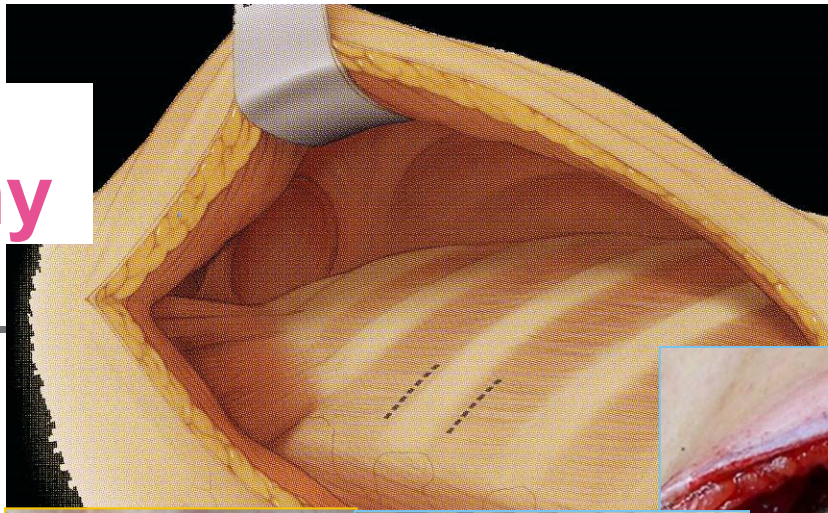
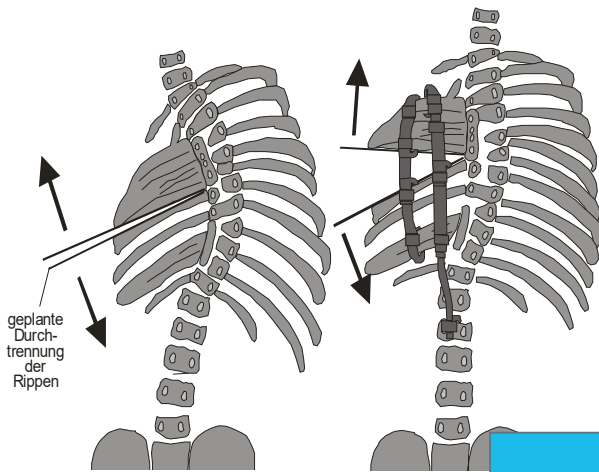
Standard prone

Expansions

**Bilateral primary rib-pelvis constructs
(Eiffel-towers)**



Thoracostomy

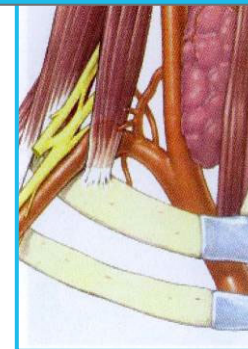
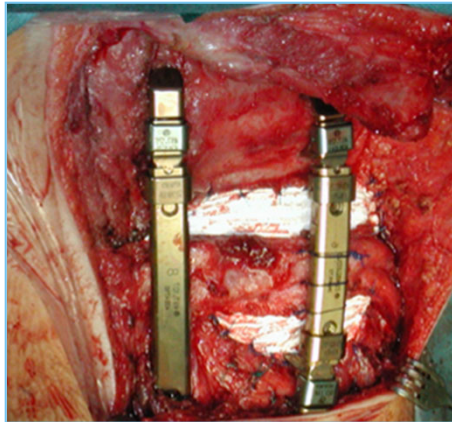


CAVE: Plexus brachialis

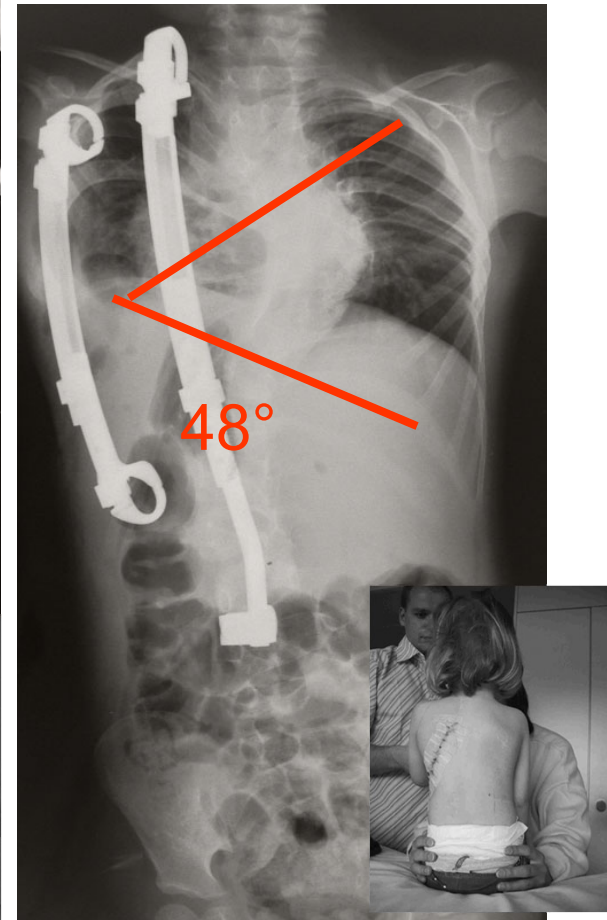
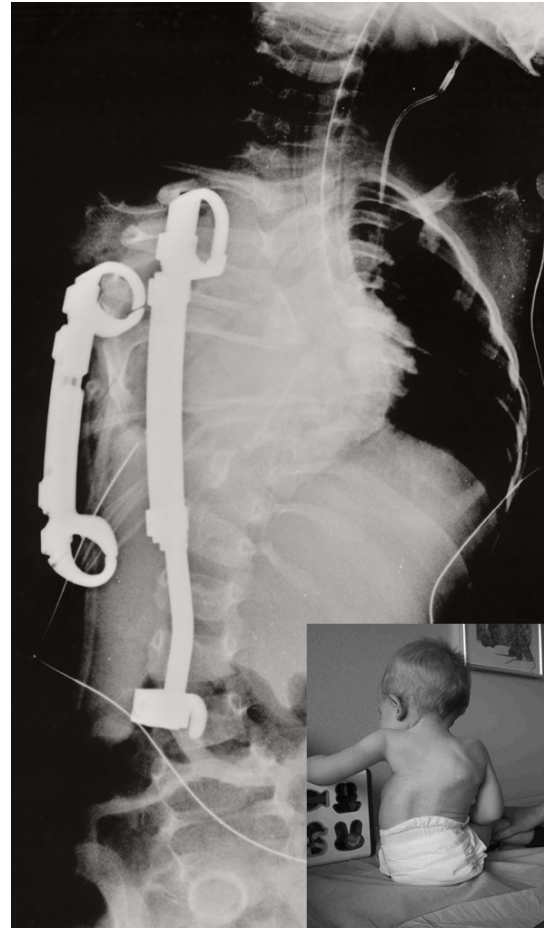
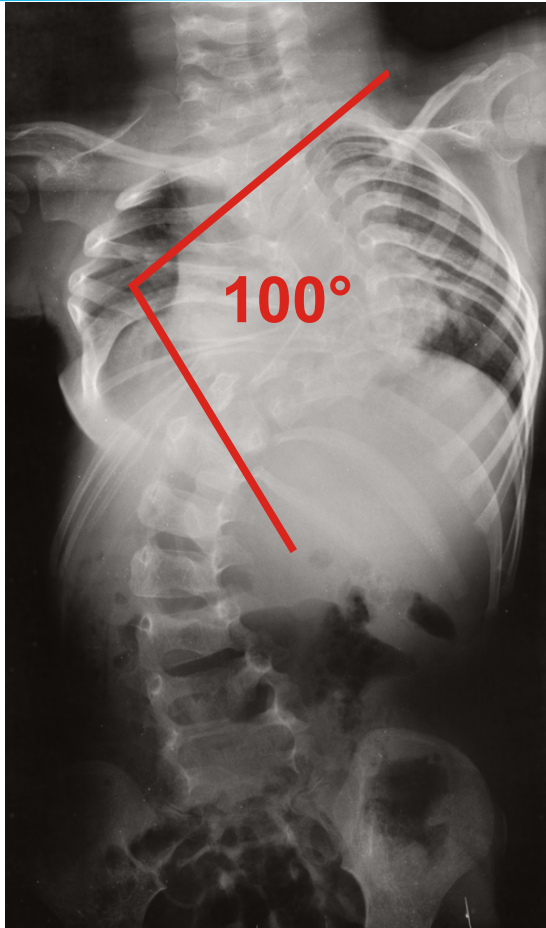
(arm positioning / surgical dissection / Spinal cord monitoring)

Avoid first rib

Avoid going lateral to med. scalenus muscle

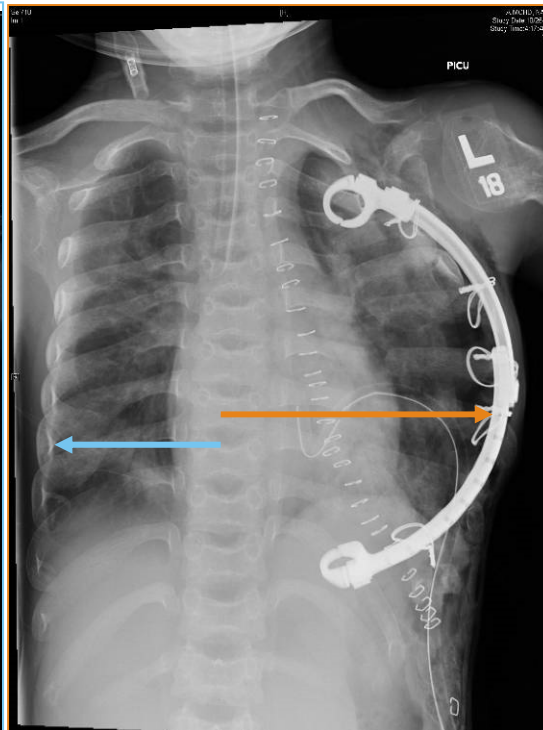


TIS type II Severe congenital scoliosis, unilateral bar, hemivertebra, fused ribs, high insertion of diaphragm



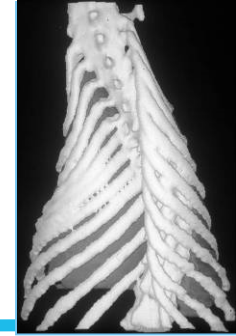
E.G., w. 1+11

TIS type IVb Jeune Syndrome



VEPTR and lung function

thoracic volume, alveolar&lung growth, PFT



No change of volume&PFT - Change of Cobb angle does not correlate w/ PFT change - PFT shows increasing stiffness of the thorax w/ growth despite successful expansion- Rx & clinical expansion of the thorax but no similar improvement of lung volume, decrease of FVC, increase of RV - VEPTR for severe TIS: allows further lung expansion w/o further deterioration of lung fct over time. Lack of historic control

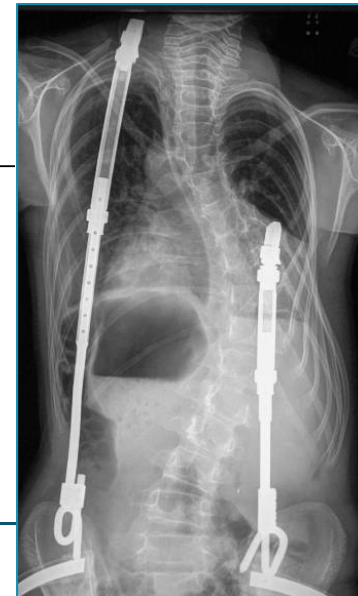
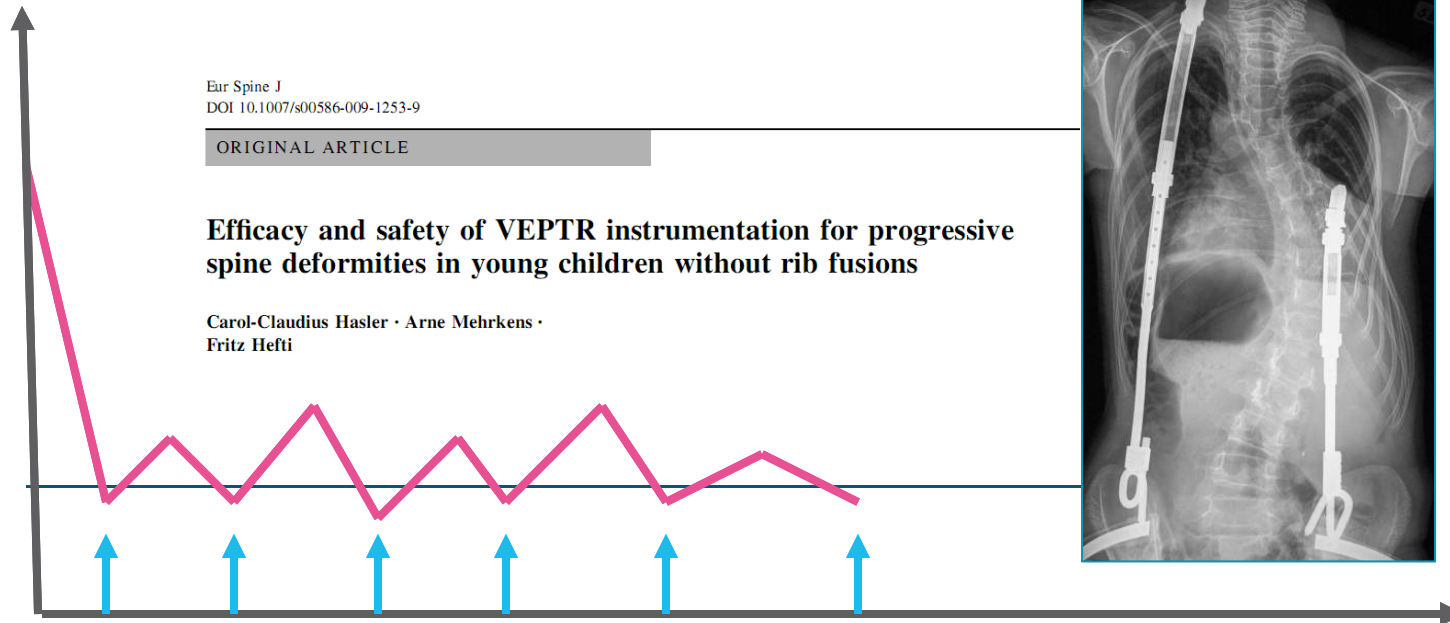
Gadepalli et al. J Pediatr Surg 2011 Redding & Mayer. CORR 2011 Motoyama et al. Paediatr Respir Rev 2009 Mayer & Redding. J Pediatr Orthop 2009 Motoyama. Spine 2006

Reduction of scoliosis, Increase of hemithorax volume, Only small increase of lung volume because of compensatory increase of contralateral lung Expansion thoracoplasty may increase lung fct by increasing alveolar capillaries and preventing emphysematous *in growing rabbits*

Mehta et al. Spine 2010

Law of diminishing returns

Deformity



Heterotopic Ossifications

Basel, Hamburg, Tel Aviv, Oslo N=66 with 4y f/up



27/66 (41%), most around VEPTR implant¹

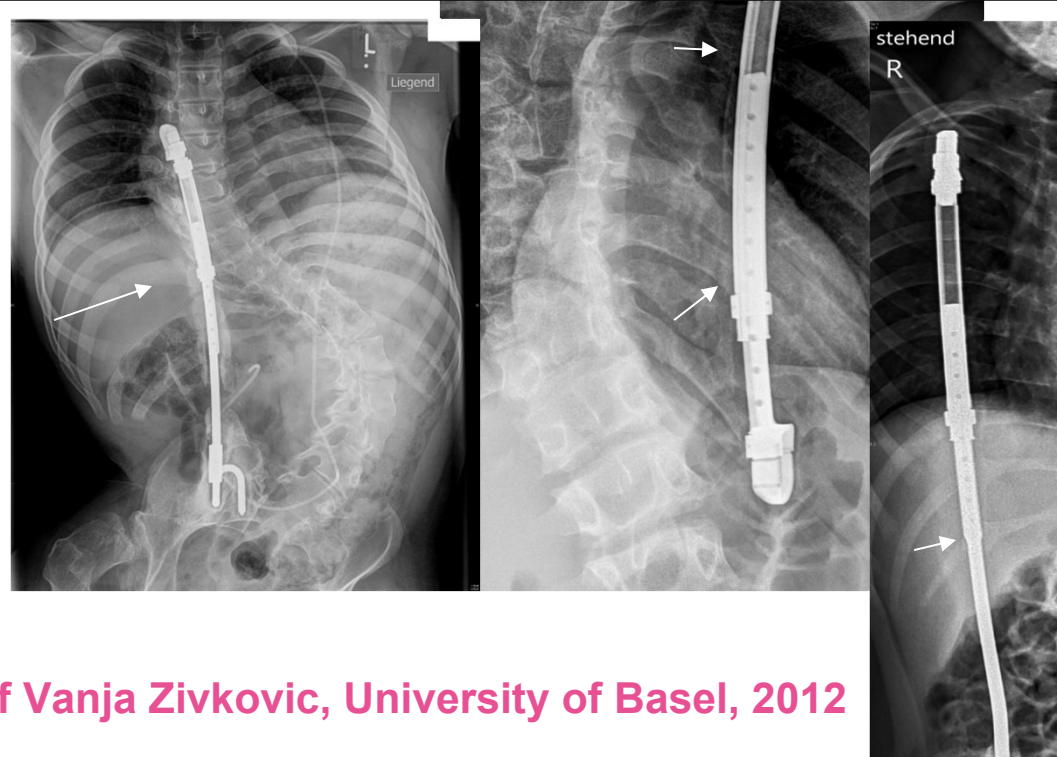
50% of all sheep (6 matched pairs) w/ one or more sites of spontaneous heterotopic bone formation tracking along rods²

Periprosthetic bone

Stiffening, facet degeneration

Scarring

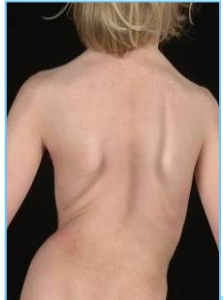
Spontaneous fusions



¹Unpublished data, Dissertation of Vanja Zivkovic, University of Basel, 2012

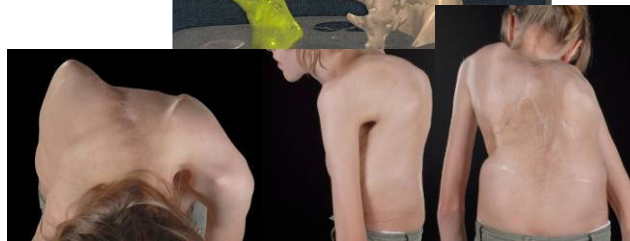
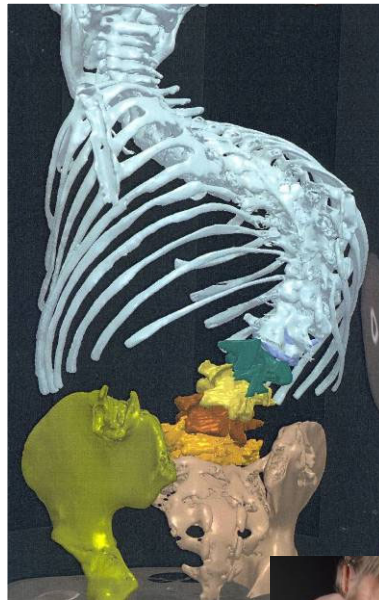
²Quellet J et al. A new gliding spinal ancor for self-growing rods: trolley screw. 47th Annual Meeting of the Scoliosis Research Society, Chicago Sept. 5-8th 2012

Sotos Syndrom cerebral giantism – 13y, f, 6 year VEPTR



2006, 7y, f
pre VEPTR

2008, 9y,
5 expansions



2012 @ the time of final instrumentation

Kyphoscoliosis

**Ossification along the
implant†**

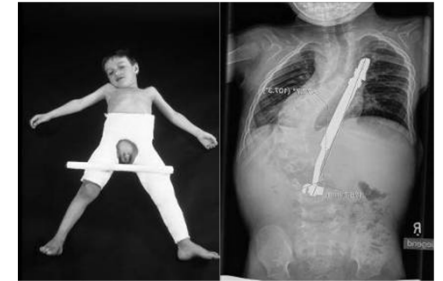
Spontaneous rib fusions

Autofusion T5- L3

**Uncontrolled rotation
Severe osteoporosis**

Treatment of Early Onset Spinal Deformity with VEPTR: a Challenge for the final correction spondylodesis *Lattig F et al J Spinal Disord Tech 2012 Aug 18*

Effects of immobilization



Kahanovitz N et al. CORR 1984. *The effect of internal fixation without arthrodesis on human facet joint cartilage* / **Gardner VO&Armstrong GW 1990** *Long-term lumbar facet joint changes in spinal fracture patients treated w/ Harrington rods* **6-26mths and 6-12y fixation for TL-#'s.: degen.**

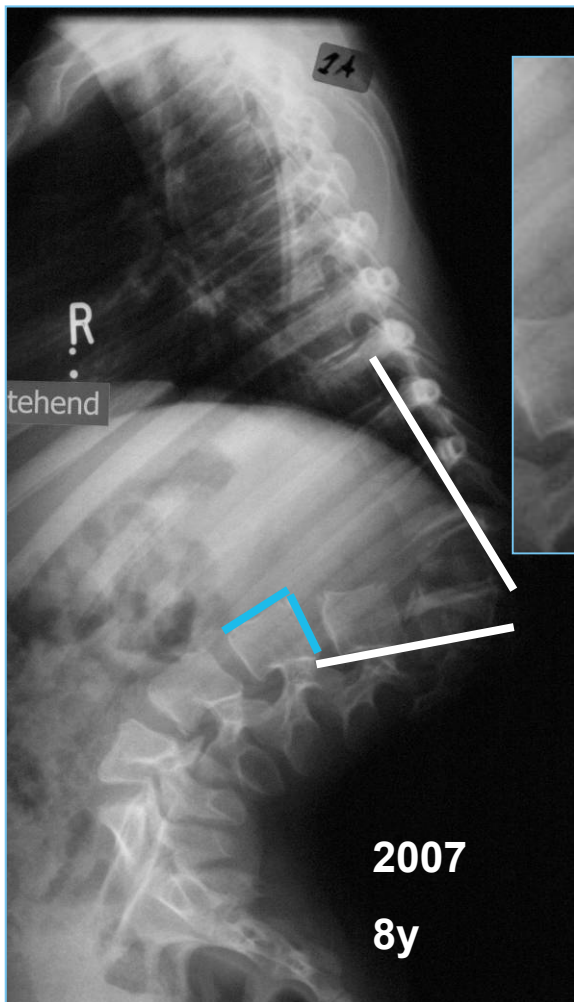
Kahanovitz N et al. Spine 1976. *The effects of internal fixation on the articular cartilage of unfused canine facet joint cartilage* **2-6mths Harrington rods : facet degen., persisting degen. after metal r/o**

MacLean JJ et al. Spine 2003 *Effects of immobilization and dynamic compression on intervertebral disc gene expression in vivo* **Ilizarov on rat tails; 72hrs immobilization vs dynamic compression and coupled effect immobil. followed by compression: Alteration of gene expression (down- & upregulation) in discs**

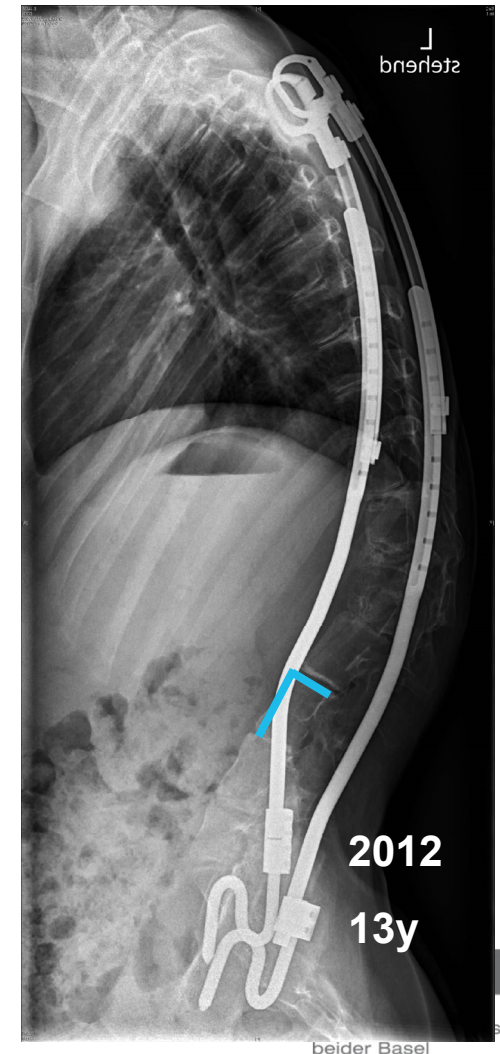
Igbal K et al. Indian J Orthop 2012 *Effects of immobilization on thickness of superficial zone of articular cartilage of patellae in rats* **4/52 POP knee**

Sakamoto J et al. Conncet tissue res 2009 *Immobilization-induced cartilage degeneration* **4/52 POP vs CPM @ ankle**

Congenital Hyperkyphosis *Goldenhar Syndrome, f*

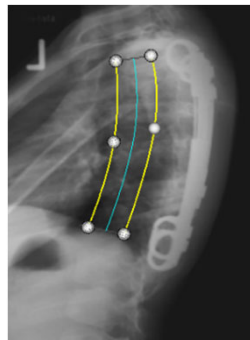
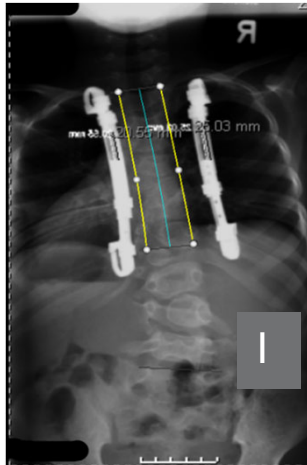


Remodelling, growth stimulation
Vertebral body height-depth ratio
like quadruped animals
Disc narrowing
Fusion

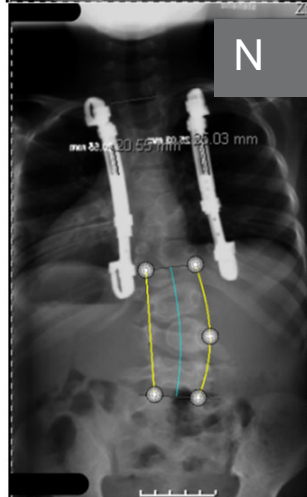
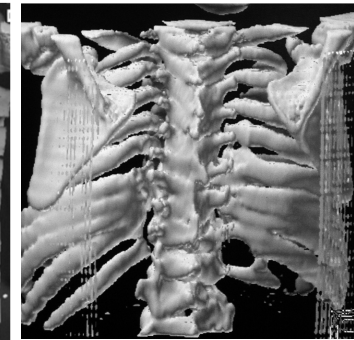
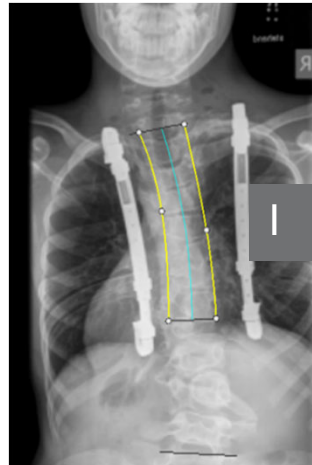


Growth stimulation

@implantation



4y f/up



$$I_1/N_1 = V_1$$

$$I_2/N_2 = V_2$$

N=26

Software for true spine length

Comparison instrumented I vs uninstrumented N

VEPTR stimulates growth even in severely malformed sections of the spine

e.g. Jarcho-Levine

Challenges



poor soft tissues & bone quality

small dimensions sick patients bulky implant

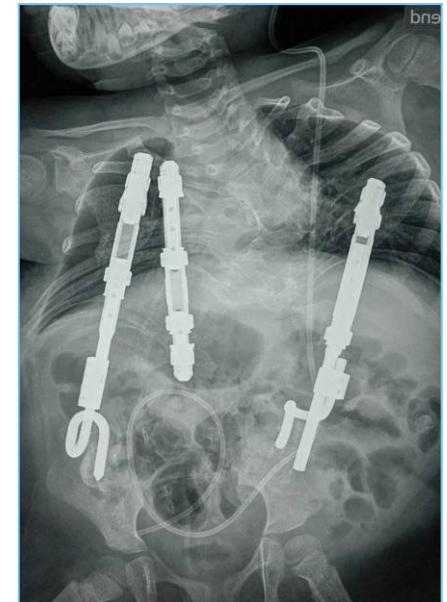
Repeat surgery: increasing risk of colonization and infection *Plaass C, Hasler C, Trampuz A, Studer D*

@AAOS Chicago 2013

Title: Bacterial Colonization Of Growth Retaining Spine Implants In Children With Severe Spinal And Thoracic Deformities

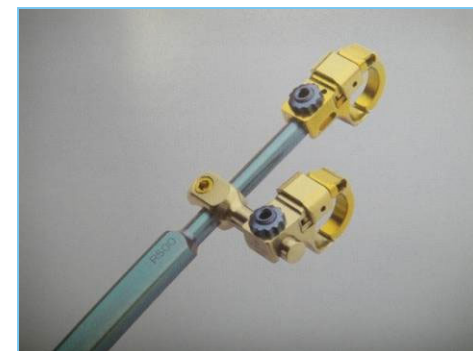
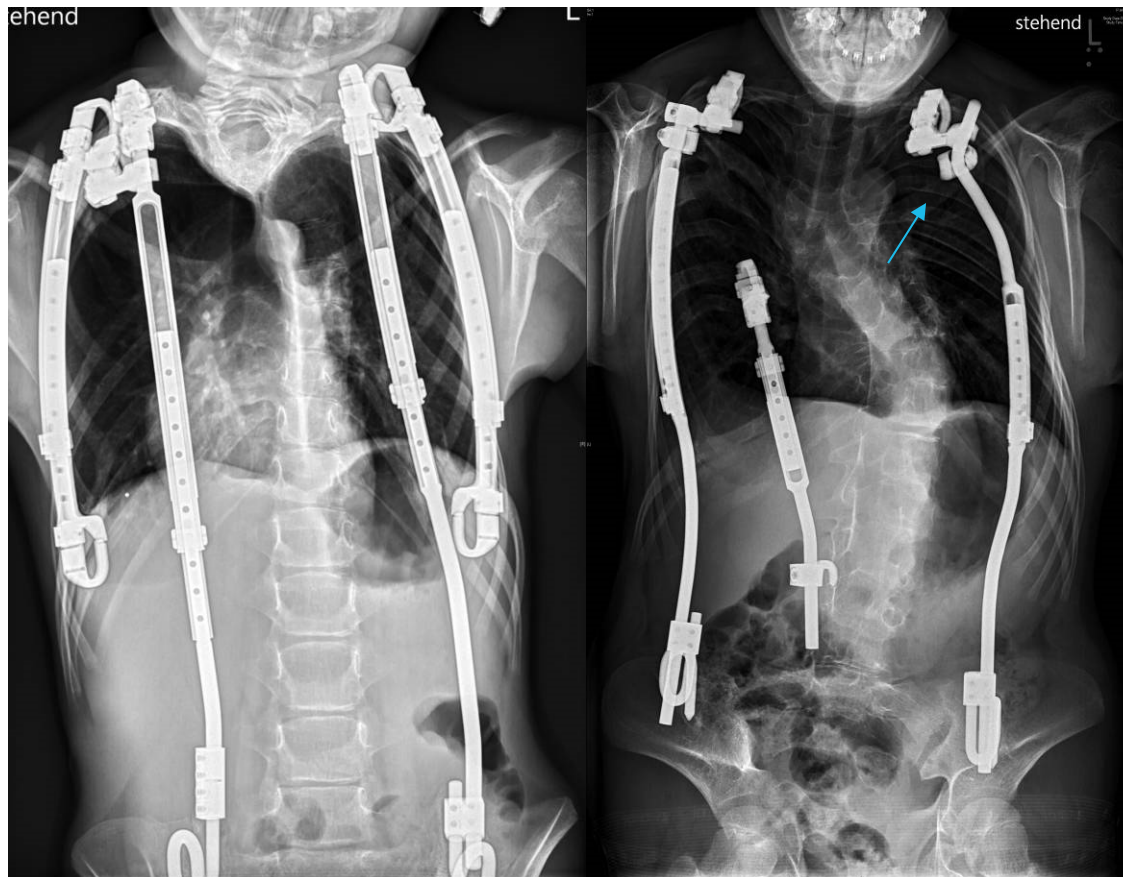
Location: Room McCormick Place, Room S102

Time: Thursday, March 21, 2013



VEPTR II & hybrid constructs

e.g. w/ Universal clamps



Conclusions

TIS: VEPTR = state of the art

Unsolved problems ossifications, stiffening, autofusion:

Rare events esophageal rupture, thoracic outlet syndrome, neurologic compromise, plexus palsy

Related to chest wall pathology fatalities&life threatening events post surgery

Lung growth & function, role of diaphragm, thoracic wall stability
no clear evidence, ongoing research

Risks&burden of repeat surgery: will be overcome by motorized implants

Growth stimulation: proved to happen, but potentially better with „continuous or small increment“ lengthening



Orthopaedic ward, University Children's Hospital Basel www.ukbb.ch