



Long-term consequences of rib distraction: Solving one problem and creating another one

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**10th Int. Congress on
Early Onset Scoliosis
Utrecht 2016**

VEPTR 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*



Potential advantages

No fixation on the spine, minimized neuro risk

Polyaxial anchors,

Anchor points intact for definitive fusion

Avoids spontaneous fusion, preserves spine flexibility,

Enlarges/stabilizes chest cage, promotes lung growth&function

True deformity correction by growth modulation



Growth

Spine flexibility

Chest cage

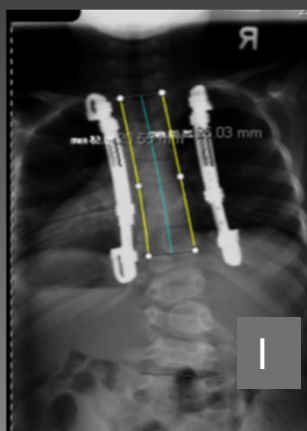
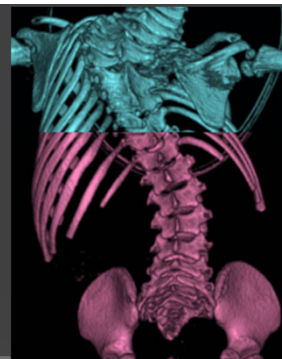
VEPTR promotes growth

Hell-Vocke A. J Bone Jt Surg 85-A 2003

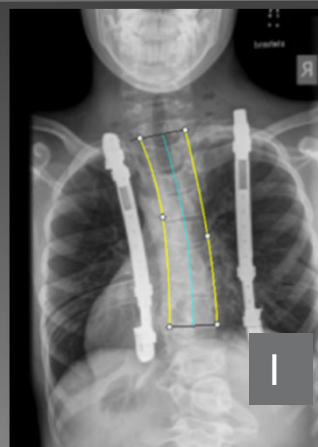
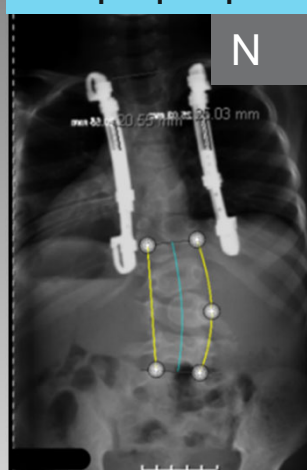
Murphy RS et al. JPO 2016

@implantation

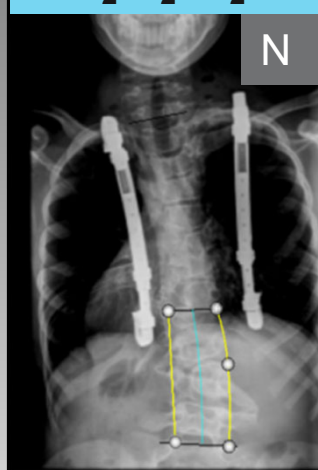
4y f/up



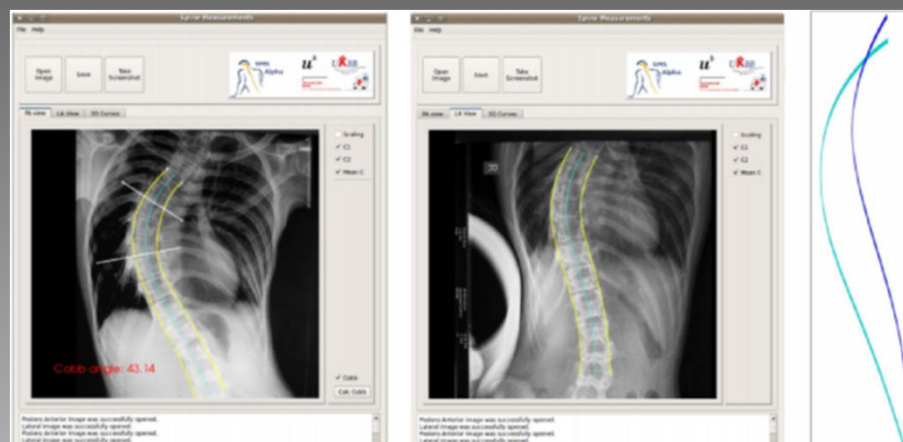
$$I_1/N_1=V_1$$



$$I_2/N_2=V_2$$



Comparison of instrumented I vs uninstrumented section N before (V_1) and 4 years after (V_2) the index procedure



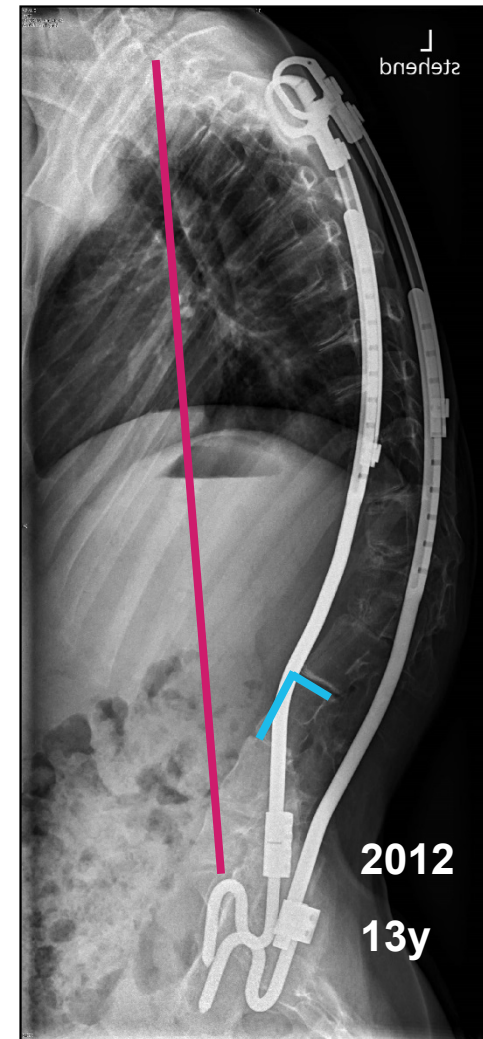
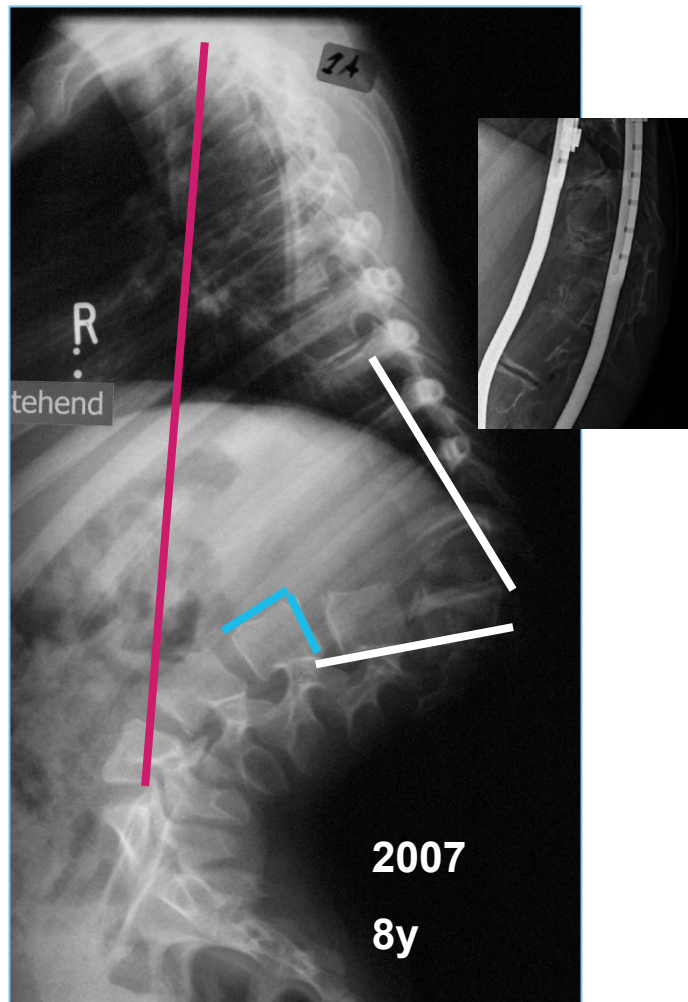
Berger S, Hasler C et al

A software program to measure the three-dimensional length of the spine

Computer Methods and Programs in Biomedicine 2017, 138:57-64

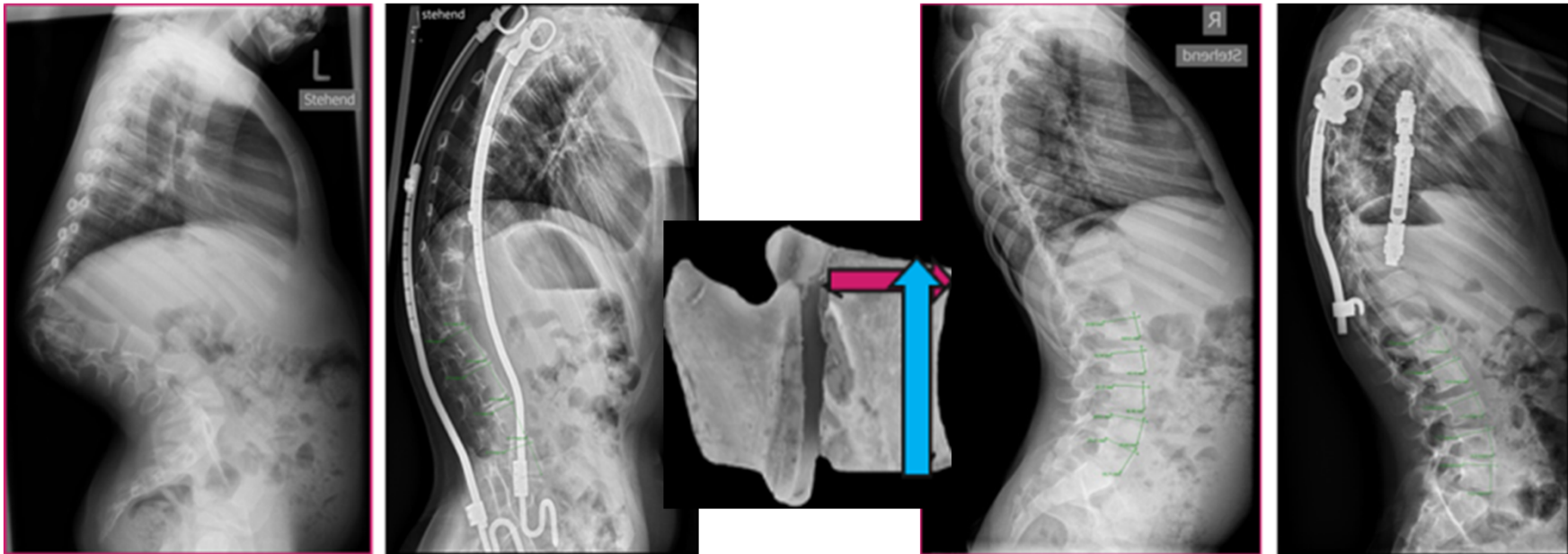
Unpublished data

Vertebral body growth



Hasler C et al J Child Orthop 2015 Aug;9(4):287-93

Metamorphosis of human lumbar vertebrae induced by VEPTR growth modulation and stress shielding

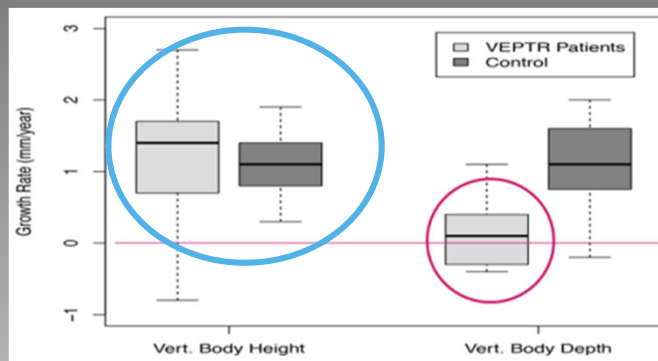
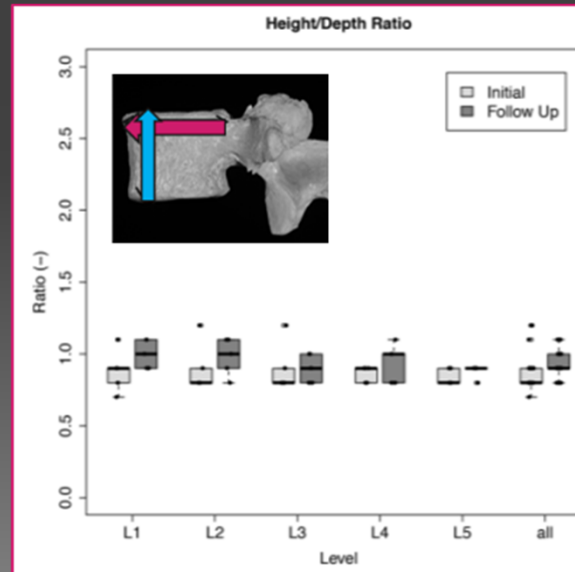
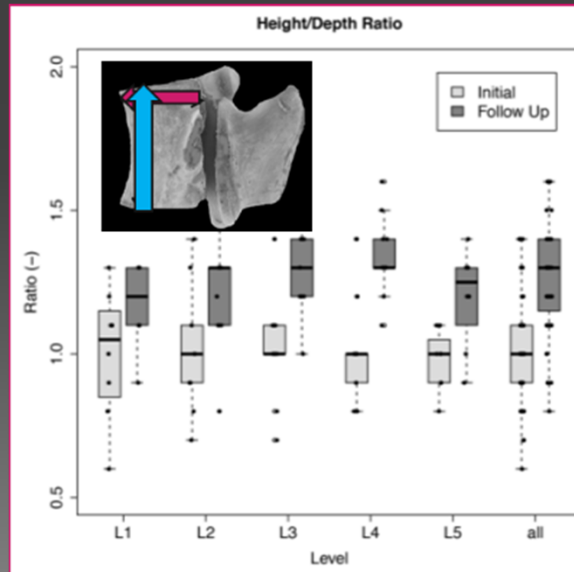


Group 1

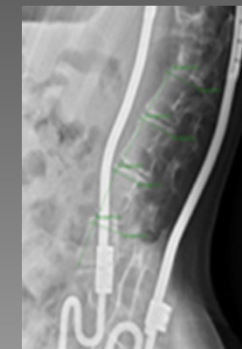
Controls

VEPTR

Controls



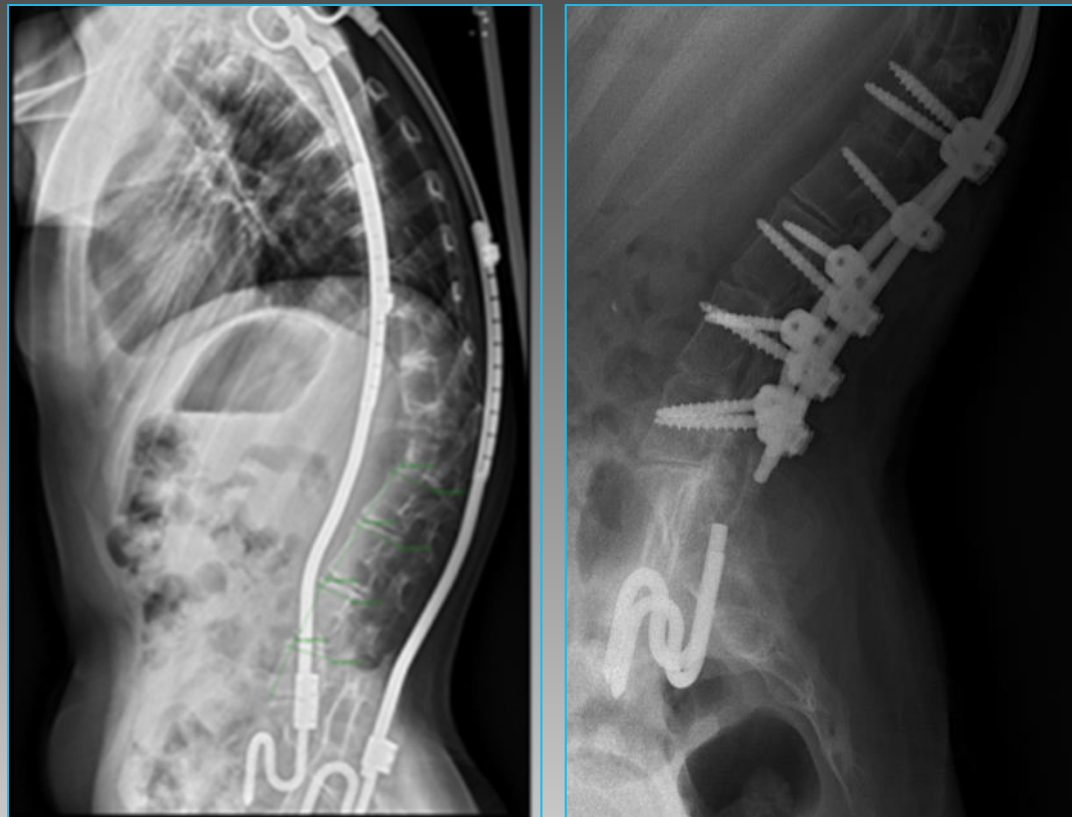
Growth in depth almost stopped during the observation period



Hasler et al 2010 Spine

Distraction & Stress shielding → Vertebral Body Metamorphosis

Soft bone, low vertebral ap diameter \longrightarrow **short bicortical screws**



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

Kyphoscoliosis

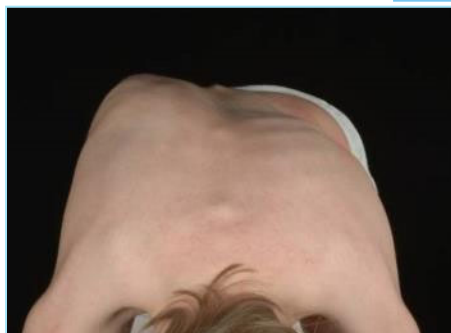
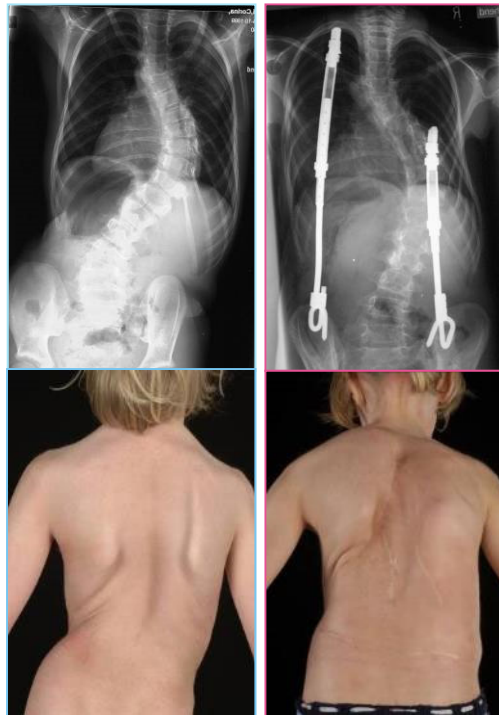
Ossification along the implant

Spontaneous rib fusions

Autofusion T5- L3

Uncontrolled rotation (70°)

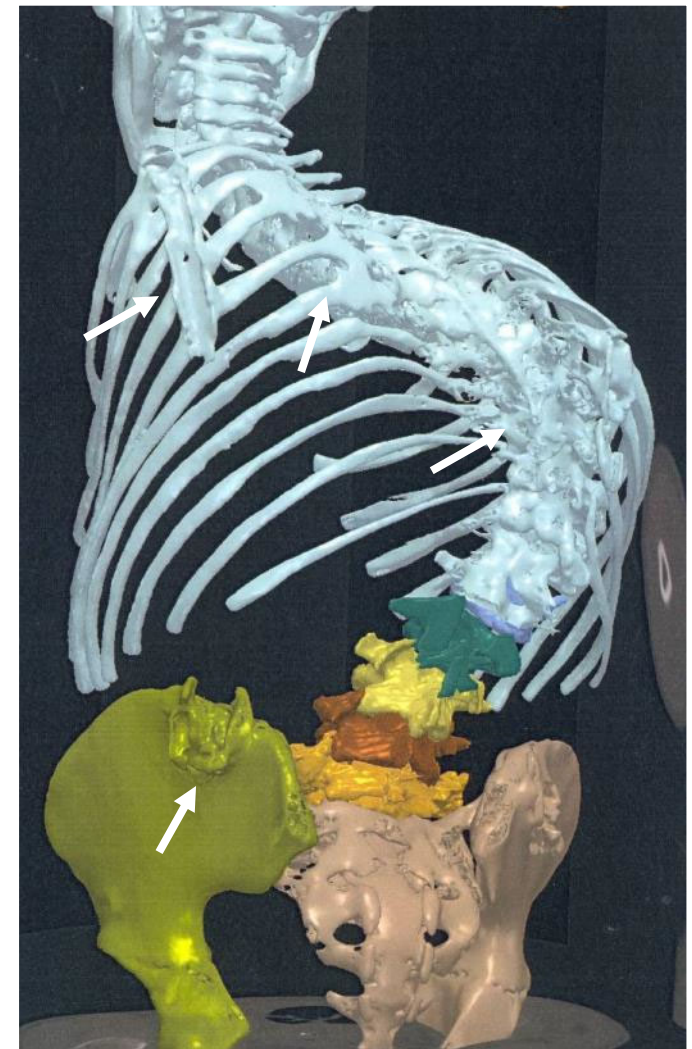
Severe osteoporosis



2006, 7y, f
pre VEPTR



2008, 9y, f post VEPTR
5 expansions



2012 @ the time of final instrumentation

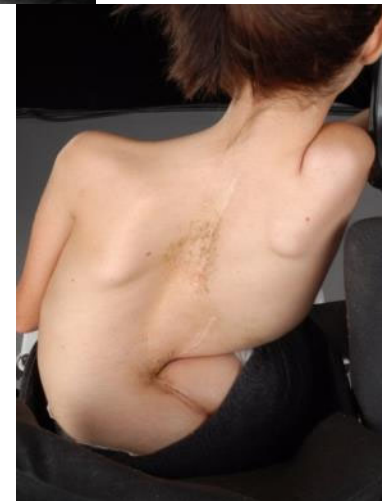
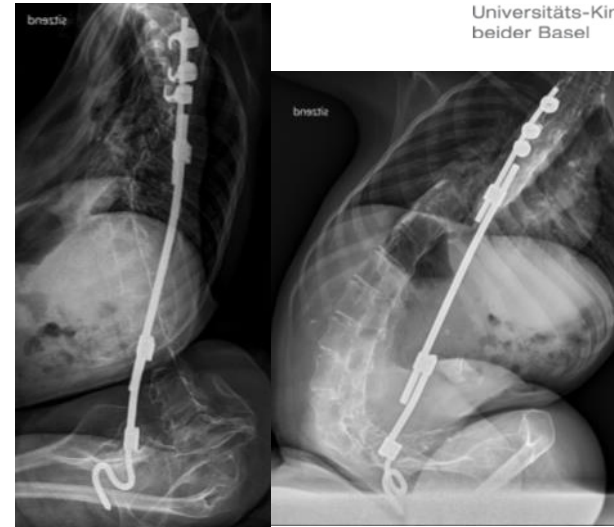
Crankshaft



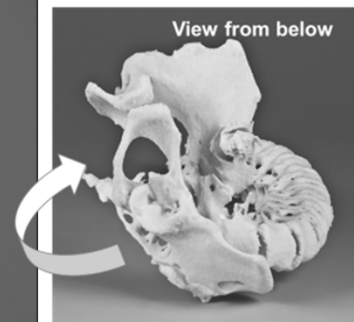
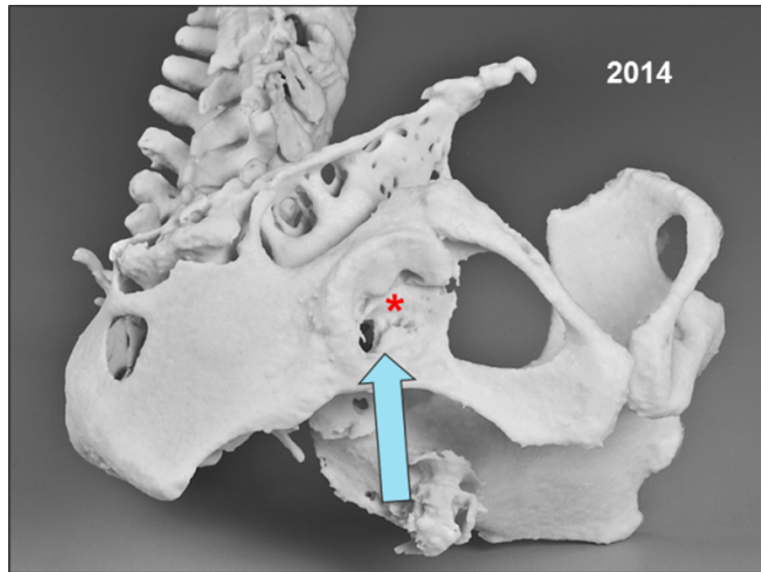
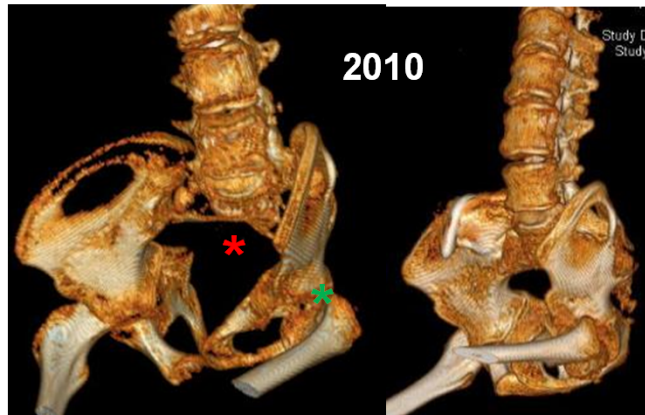
9y, f,
Arthrogryposis



11y



16y





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*
- *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*
- *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. Followe by compr. Alteration of gene expression (down- & upregulation) in discs*

Sawyer JR et al PSF vs observation in patients who have undergone distraction-based treatment for EOS. Spine Deformity 2016 (Nov) **PSF did not provide significant curve correction**

Lattig F et al Treatment of EOS deformity with VEPTR: a challenge for the final spondylodesis. Clin Spine Surg 2016 **Autofusion**



**Experimental lumbar scoliosis in growing
sheep induced by a flexible tether:
*Spontaneous bilateral facet fusions***

Heterotopic Ossifications

¹Multicenter radiographic study Basel, Hamburg, Tel Aviv, Oslo N=66 with 4y f/up

Zivkovic V, Büchler P, Ovadia D, Riise R, Stücker R, Hasler C. Extraspinal ossifications after implantation of VEPTR J Child Orthop 2014

Groenefeld B, Hell AK.

Ossifications after VEPTR rib treatment in children with TIS and scoliosis Spine 2013

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



Periprosthetic bone

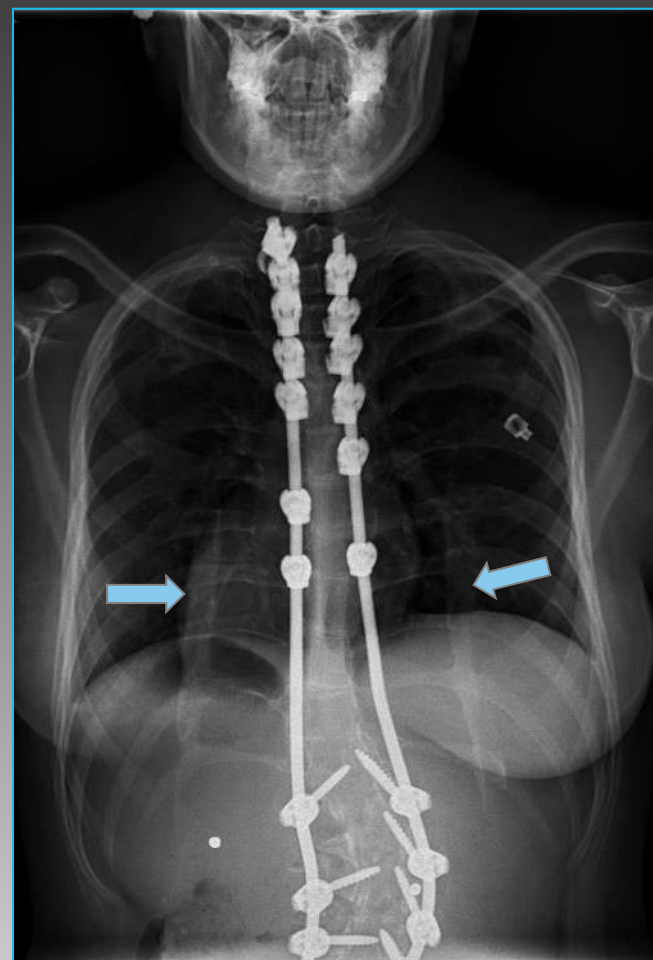
Scarring

Spontaneous fusions

Effect on chest cage compliance and pulmonary fct ?

Dede O. J Bone Joint Surg 2014 N=21 TIS/VEPTR patients 6y f/up

Decrease of predicted FCV and increase of chest wall stiffness



Conclusions

Vertebral morphology
Immobilisation

Periosteal growth ↓ *Enchondral ossification* ↑
Facet & disc degeneration, spontaneous fusion

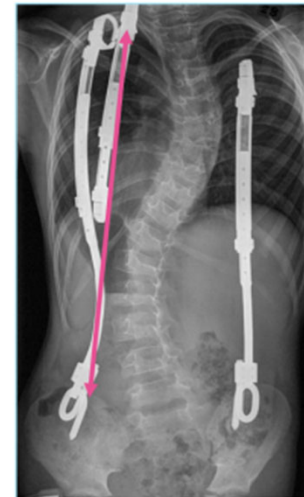
Crankshaft
Ossifications

Impact on the chest wall ?

Multiple malformations
Stiff anyway



Normally segmented spine
Harnessed spine and thorax



VEPTR 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*

