Modulating the asymmetrical stress on the scoliotic vertebrae is the key to success in the management of scoliosis in growing children

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Background

Currently, several nonfusion surgical techniques (Growing rods； VEPTR ; Luque-Trolley； Shilla ; Staple;Tether) are used in the clinic.

They do not effectively stop progression of scoliosis p-op in growing children because they have no modulating efficiency , and need repeated instrument-lengthening op , Spinal fusion will be required.

The rapid progression of scoliosis after operation is thought to be still existed asymmetric growth resulting from asymmetric stress on the both sides of the scoliotic spine.

Ideally, a new device which has modulating function should be able to modify the stress acting on the spinal column 。

For this purpose Plate Rod System for Scoliosis (PRSS) was developed in PUMC Hospital in 1998

PRSS (plate-Rod system for scoliosis)

- **Screw-Hooks are fixed on the lamina, a plate-rod is placed on convex side by way of lateral sidewise push to produce asymmetrical stress on the both sides of the scoliotic spine**

- Bony fusion is not required, spinal movement was preseved

  Essentially normal spine can be obtained after removing the implants when the skeletal growth terminated.

Therapeutic Mechanism of PRSS in the Treatment of Scoliosis in Growing Children

When PRSS is placed in place , the tensile stress is produced on concave side and compression stress on the convex side by way of the lateral sidewise push over the convex side 。

During operation, the middle and bottom parts of the PRSS is not static fixed, which allow PRSS rods migration upward to keep up with children growth，thus avoiding the tether fixation on concave side of the scoliosis p-op, and obviating repeated instrument-lengthening

Several experiments has confirmed that PRSS possesses the function of modulating asymmetric growth of the scoliotic spinal segments .

- The components of the PRSS system were tested under the MTS machine .When PRSS is put in place, asymmetrical stress is created by way of the lateral sidewise push and can be calculated according to the Hooke's law).
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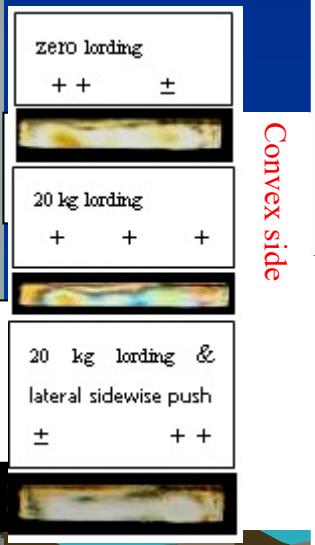
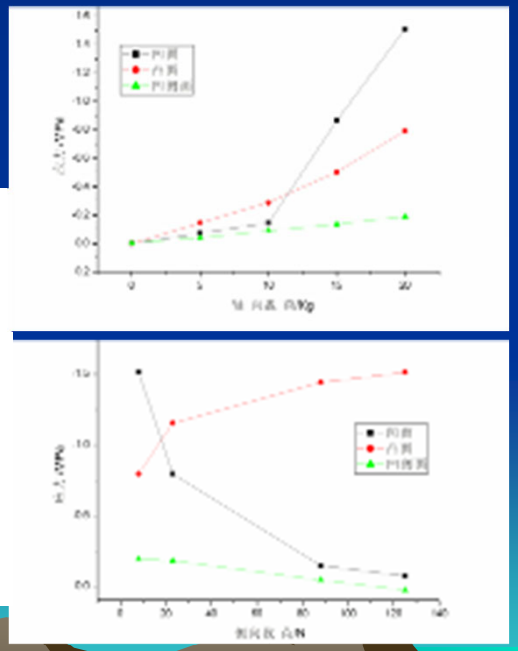
The components of the PRSS system were tested at the laboratory of the University of Hong Kong

Photoelastic test was performed to study the mechanical properties of PRSS

The results indicated that PRSS has a significant power to alter the asymmetric mechanical loadings on both sides of the scoliotic spine.



Convex side



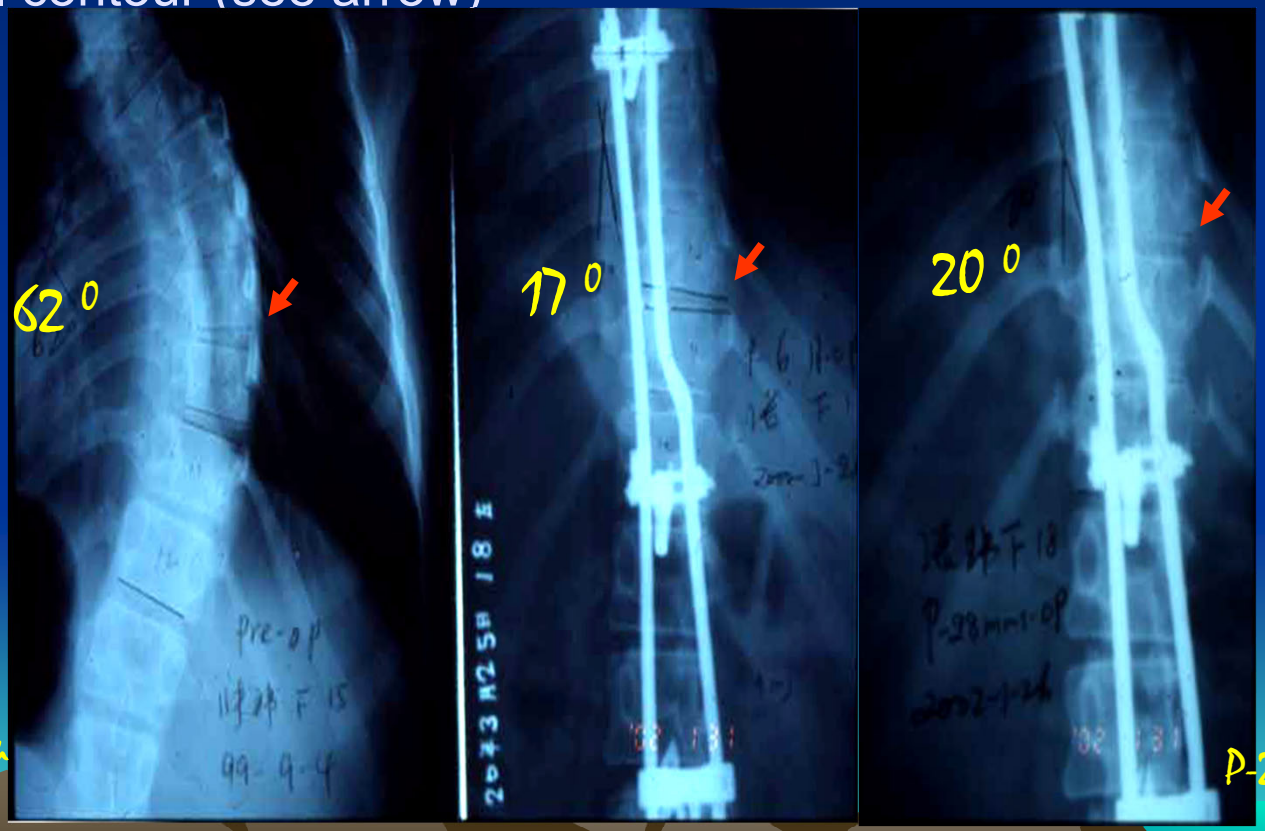
Photoelastic test was performed at Beijing university of technology

The asymmetrical stress data in convex side and on concave side were expressed in a linear formulation of green line as change of compressive stress on concave side;rad one on covex side

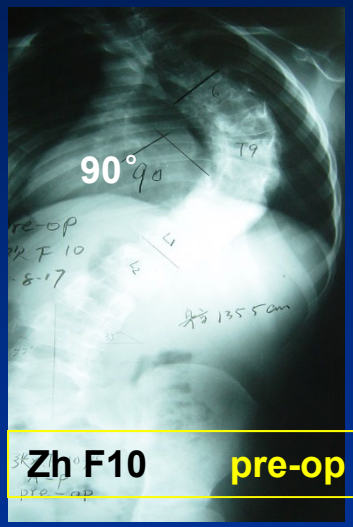
Clinical X-ray **analysis** When PRSS is placed in place

asymmetrical stress produce on the both sides of the scoliotic spine, This is expressed in the change of width of disc space， and wedging vertebrae 。

Asymmetrical stress would affect the growth of both sides at the vertebral cartilage end-plate, wedging vertebrae was then gradually remodeled to normal contour (see arrow)

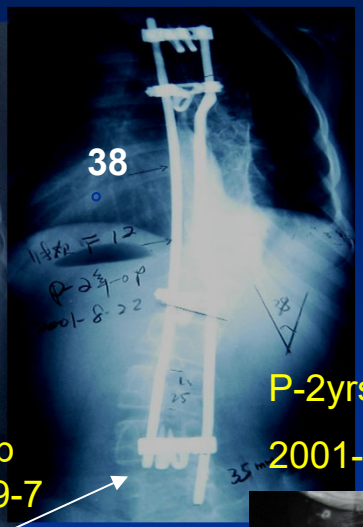


More longitudinal growth on concave side in the lateral growing years is another X-ray evidence of the modulating efficiency of PRSS



Zh F10 pre-op

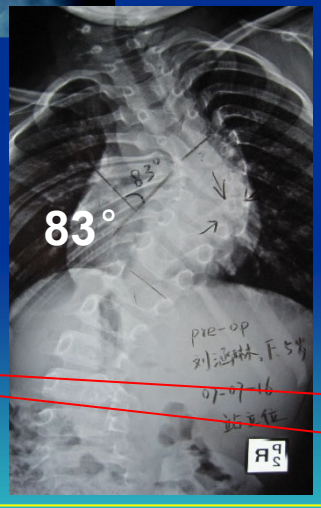
P-op
99-9-7

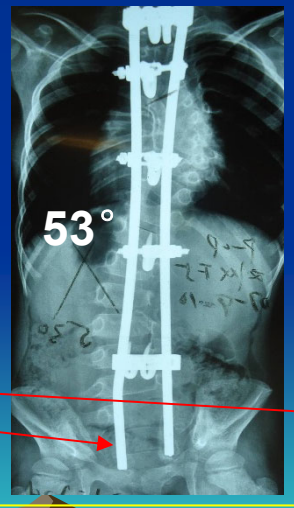


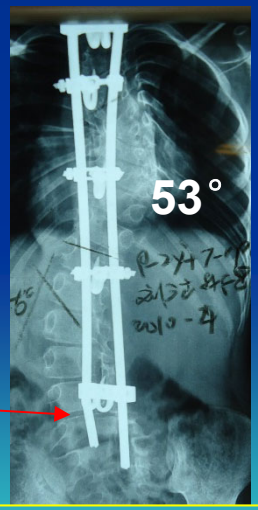
P-2yrs+7-op

2001-7-21

More longitudinal growth on concave sides



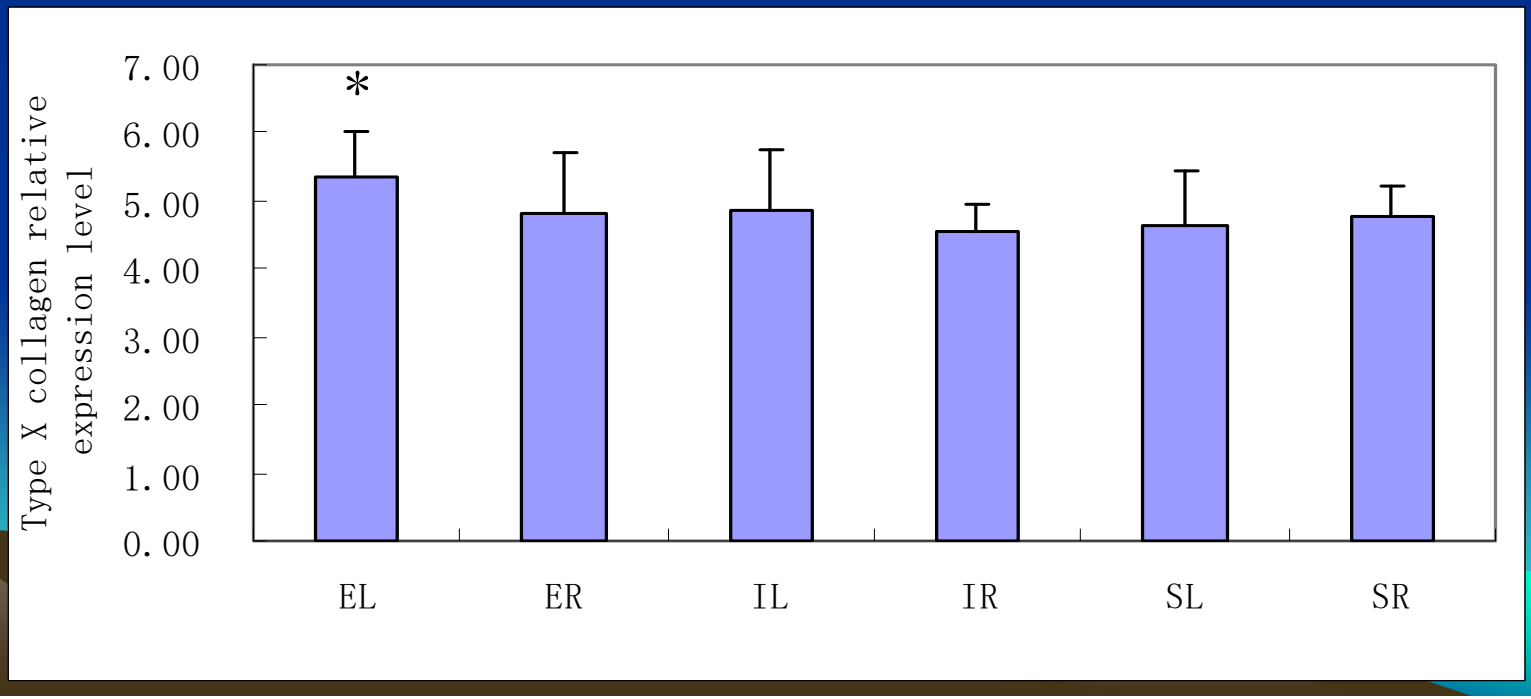




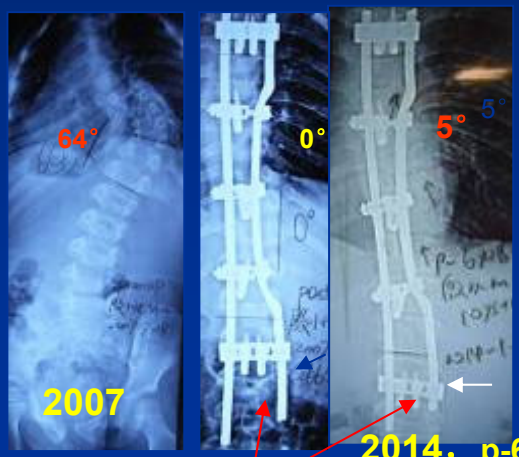
Lu，F5,Pre-op p-op,07-9-11 P-2yrs+8-op

Type x collagen.has also been studied

More type X collagen expressed on the convex side than on the concave side in the PRSS-instrumented animal spine, which suggested that compressive stress accelerates chondrogenesis, subchondral bone formation and cartilage degeneration, so as to retard the growth of vertebral cartilage end-plate over convex side.



The outcome of a series of 23 juvenile scolios treated with PRSS showed that PRSS has a modulating efficiency to low/prevent the risk of scoliotic curve progression P-op



The growth of instrumented spinal column has gained **4.5 cm** at the last follow-up period。

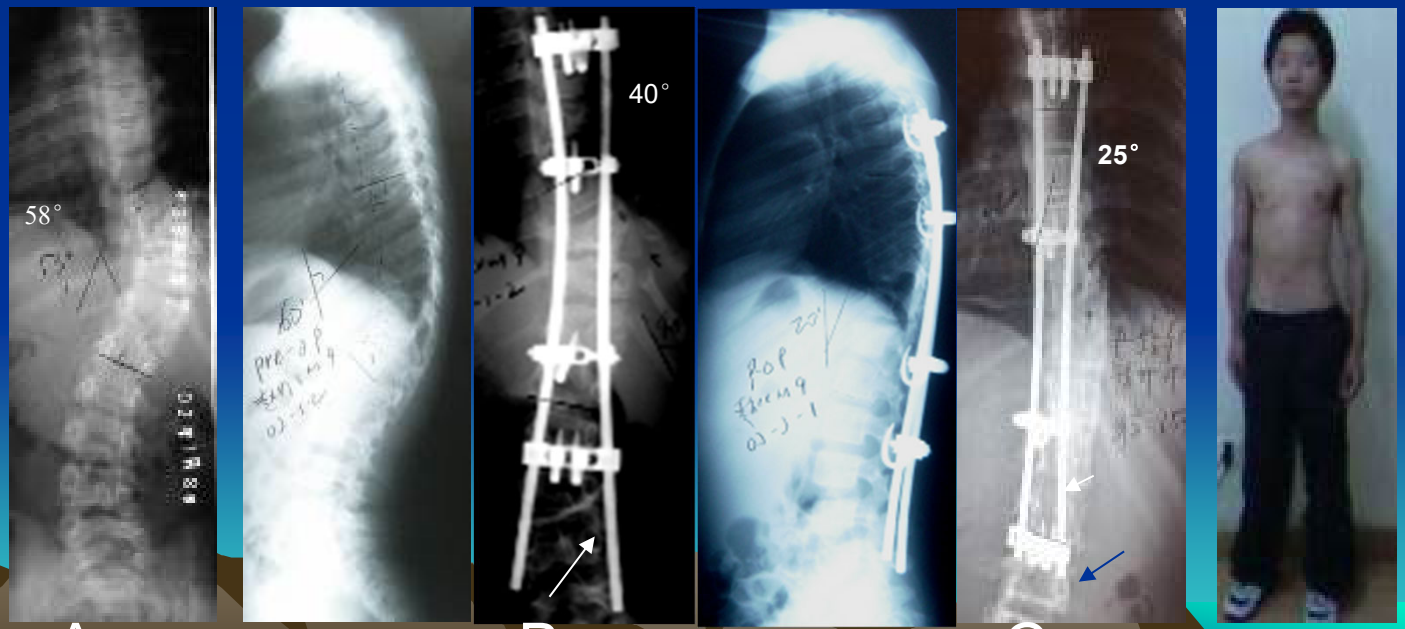
Between June 2000 and July,2008, 23 juvenile scolios were treated using PRSS, ave. age at surgery was 7.98+2.28yrs，
Avg. follow-up period was 2.8+1.4 Yrs, 8 cases ＞ 5 Yrs。

Curve correction: 80.7º ⟹
30.9º(62.2%) p-op ⟹
34.7◦±15.6◦ in the latest follow-up ($P > 0.05$). The data showed **no significant loss of correction** 。

Growth of instrumented spine was average13.34mm，

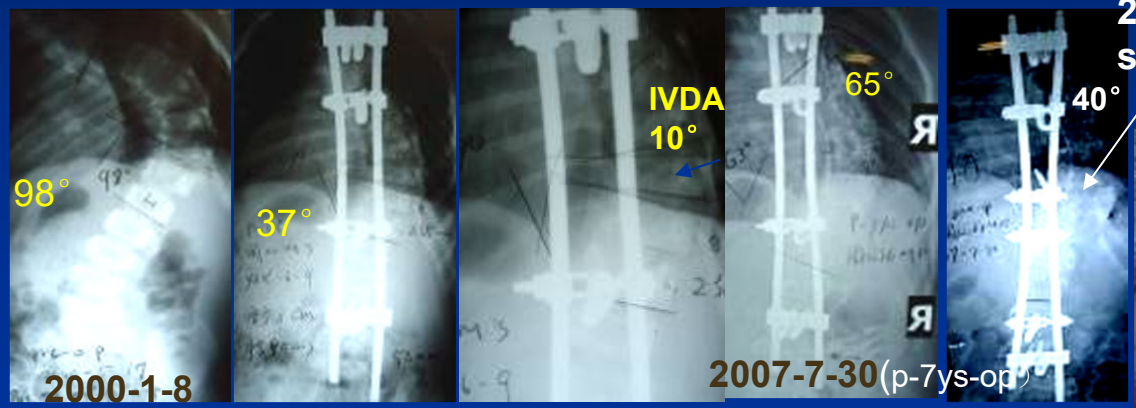
Curve correction continue improving itself P-op, which is another evidence of the modulating efficiency of PRSS

Zhao xx a 10 years old boy with T9 Hamivertebae scoliosis of 58° (A), posterior operation was performed to remove the hamivertebae using transpdicular approach and fixed with PRSS. Scoliotic curve correction has continued improvement from initial 58° to 40 ° p-op (.B) ,and to 25° (C) in the latest followed –up 4 years p-op, instrumented segments growth 5.5 cm (see B and C arrow)

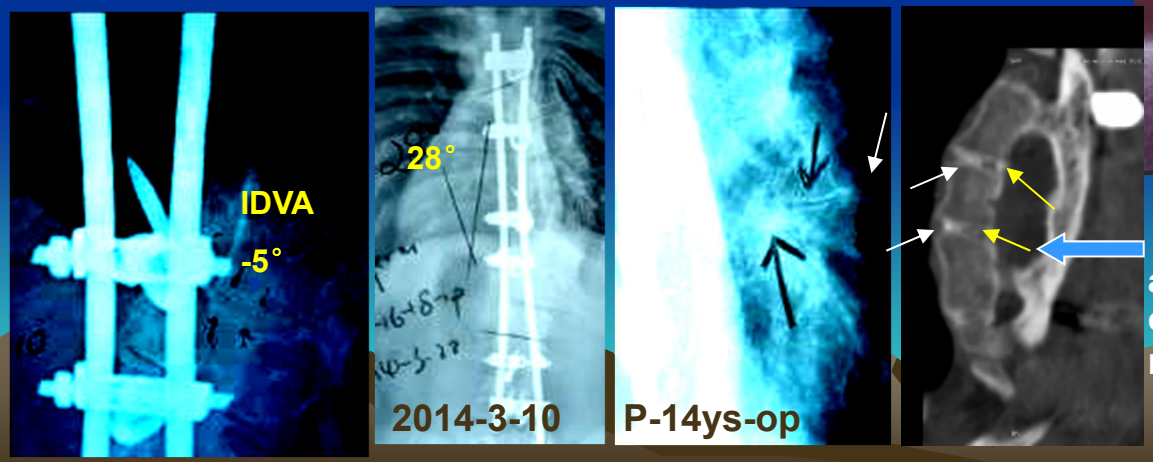


Progression of scoliotic curve after operation could be gradually corrected again by reversing the Hueter-Volkmann effect with PRSS

IVDA=wedge disc angle



2 screws-hook were added on convex side over the apical area

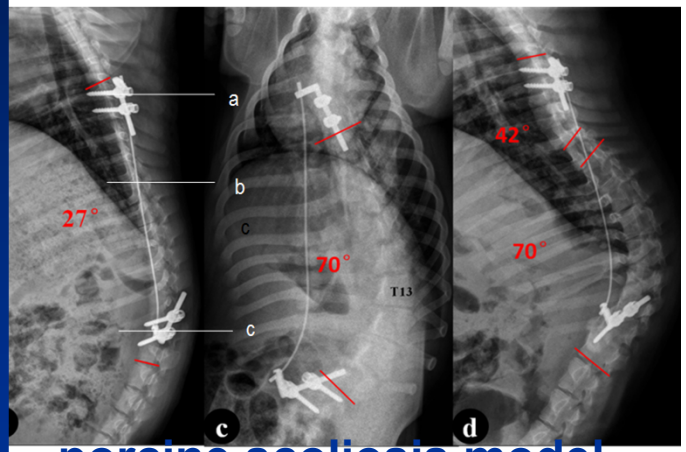


X-ray & 3-D CT showed bony fusion appears on convex side,while on concave side disc space is still intact – residual growth

New idea for the treatment of children scoliosis

One might aim to eliminate the fluency of pedicle screw-tether on concave side after op .

Almost in all pedicle screw methods for scoliosis , both ends of the scolioitic curvature on concave side were tethered after op, which will create compression loading on this side， thus resulting in asymmetric loads on the immature scoliotic vertebrae, which in turn causes worsening of the scoliosis. These process are similar to do a **porcine scoliosis model.**

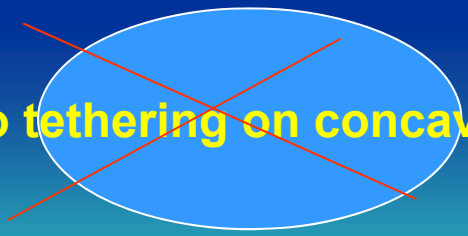


porcine scoliosis model

Our studies suggest that:

Correction mechanism for growing scoliosis should be changed from distraction on concave side to the lateral sidewise push on convex side and from Static lording to dynamic lording

A new device should be



no tethering on concave side

Braun / Akyuz at al indicated that one side of spinal column tie-down will create Idiopathic-Type scoliostic model of the Spine

Nowadays, clinical studies on the fluency of pedicle screw-tether on concave side after operation are still few in number.

Braun JT, Ogilvie JW, Akyuz E,et aL Experimental Scoliosis in an Immature Goat Model: A Method That Creates Idiopathic-Type Deformity with Minimal Violation of the Spinal Elements Along the Curve. Spine (Phila Pa 1976),2003, 28(19):2198-203.

Akyuz E, Braun JT, Brown NA, et al. Static versus dynamic loading in the mechanical modulation of vertebral growth. Spine,2006,31: E952-8.

Conclusion

The PRSS which has significant modulating efficiency is an effective instrumentation for correcting growing scoliosis, especially for EOS , However, our studies are of one instrumentation—PRSS, multicenter study is need to evaluate real merits of this technique .


Thank you!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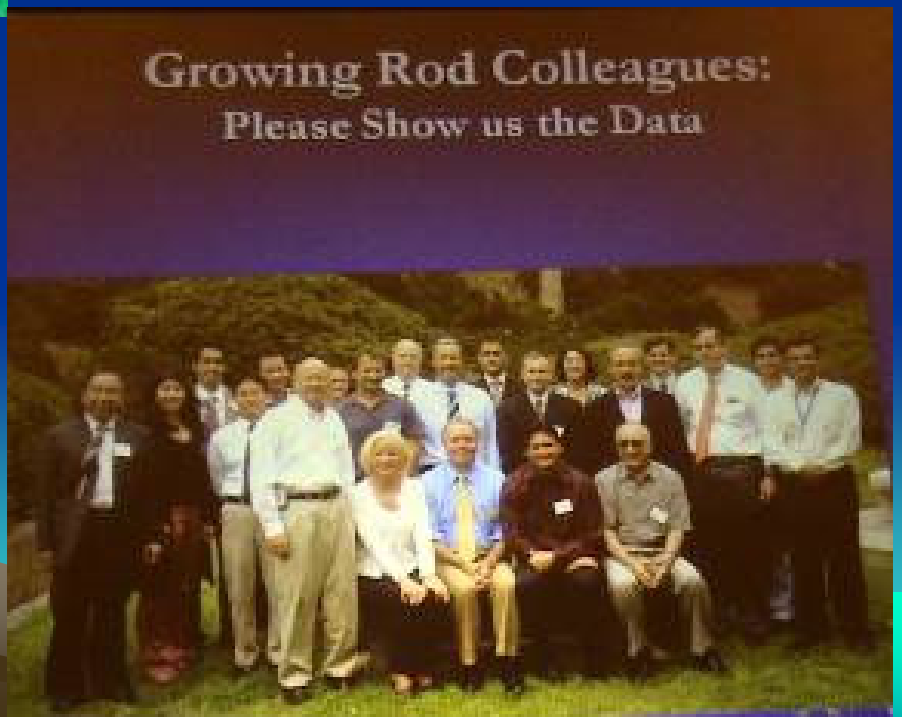
Growing Rod Colleagues:
Please Show us the Data