Spondylolithesis

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Definitions

- Spondylos - Vertebra
- Lysis - Loosening, coming apart
- Olisthein - To slip or to slide

Definitions

spondylolysis

Non-united fracture or defect of the arch of a vertebra usually the pars interarticularis

spondylolisthesis

Anterior displacement of one vertebra upon the neighbouring vertebra

Prevalence

- General Population 2% - 6%
- White males 6.4% 3.8%
- Black males 2.8% 3.5%
- White females 2.3% 5.7%
- Black females 1.1% 2.6%
- Roche and Rowe JBJS 1952
- Eisenstein JBJS 1978

Prevalence

- General Population 2% - 6%
- American School Children 6.0%

  Fredrickson JBJS 1984
- Adolescent Japanese 5.5%

  Hasbe 1913
- Eskimo tribe members 52%

  Stewart JBJS 1953

Incidence in Athletes

• Female Gymnasts	11%	Jackson 76
• Female Gymnasts	19%	Sward 90
• American Football	24%	Ferguson 78
• Weight Lifters	44%	Dangles 87
• Wrestlers	12%	Granhed 88
• Japanese Males	21%	Hoshina 78
• Tennis Players	10%	Sward 1990

Incidence in Cricketers

- Fast Bowlers
- Young Elite 11% Foster 1989
- Young Elite 45% Elliott 1992
- Retired Elite 45% Payne 1987
- Team during 50% Annear 1993

5 year period

- Young Elite 55% Hardcastle 1992

Familial Association

- Incidence in family members
- Spondylolysis 19%
- Dysplastic 33% (1%)*
- Isthmic 15% (5%)*

* Predicted incidence in general population

Wynne-Davies JBJS 1979

Classification

- radiographic
- pathogenic

classification

- radiographic

translation (Meyerding 1932)

- Grade I 0 - 25%
- Grade II 25 - 50%
- Grade III 50 - 75%
- Grade IV 75 - 100%
- Grade V > 100% (spondyloptosis)

classification

- pathogenic

- dysplastic (type 1, congenital)
- isthmic (type 2, spondylolitic)
- degenerative
- traumatic
- pathological
- iatrogenic

Pathogenesis - congenital

- 15-20% of children
- Always L5
- Dysplastic arch
- Elongated pars

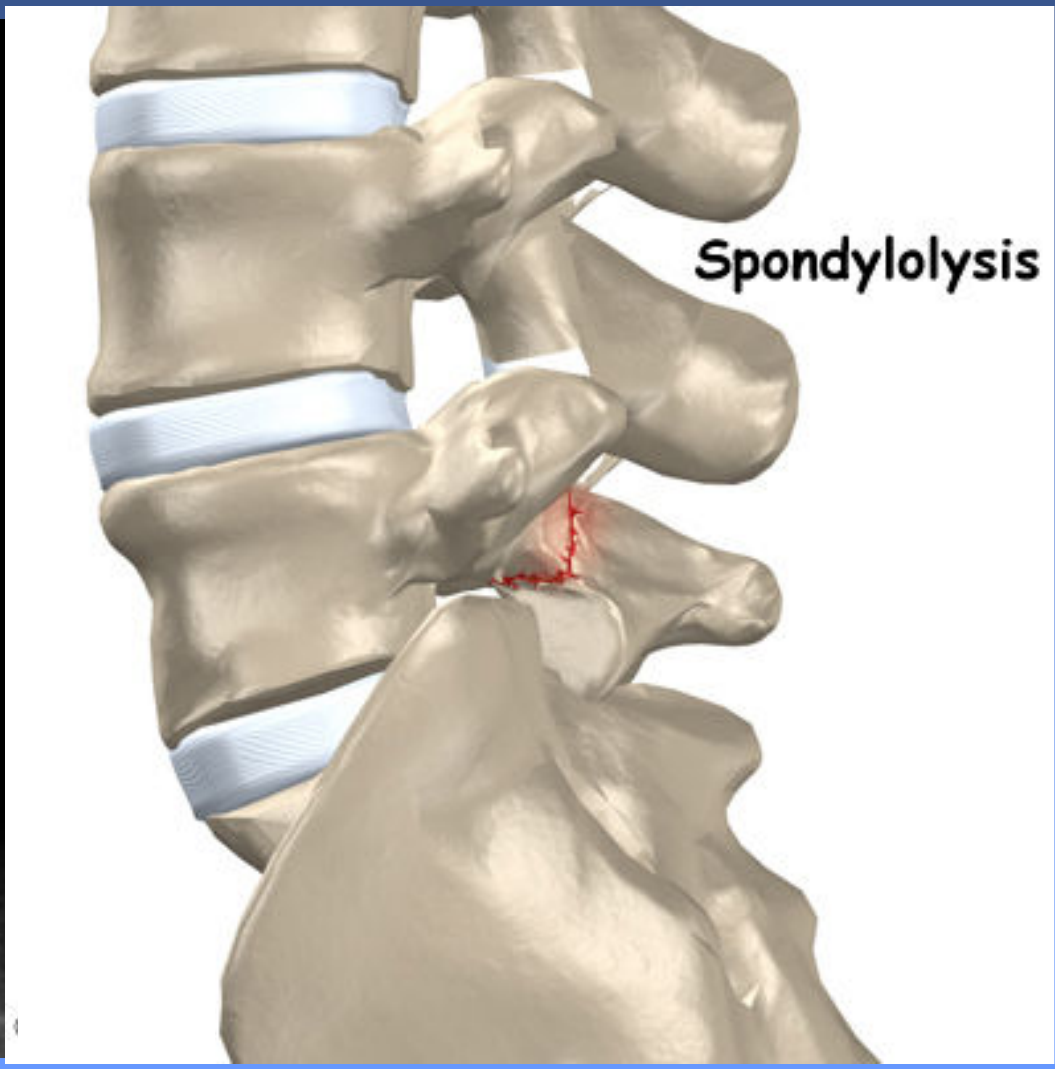
Pathogenesis - congenital

- Spondylolithesis can become severe
- Dome of sacrum rounded
- Can cause CES
- Often traps L5 nerve root

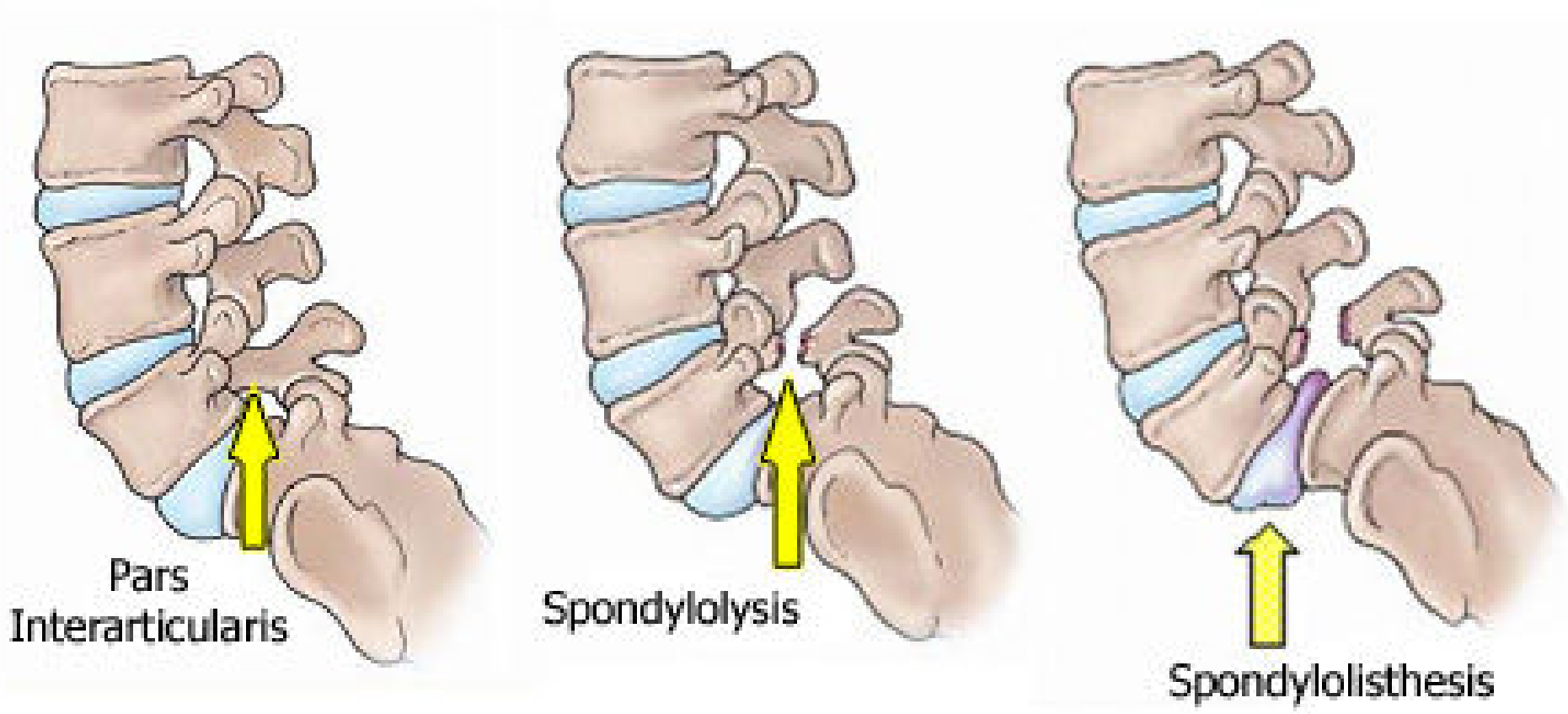
Aetiology: Congenital

- Theories
- Failure of fusion of ossification centers Rambaud 1864
- Anomalous ossification and secondary trauma Willis 1931
- Dissolution of continuity of the bone due to a congenital weakness at this point Wiltse 1957

Pathogenesis - spondylolytic



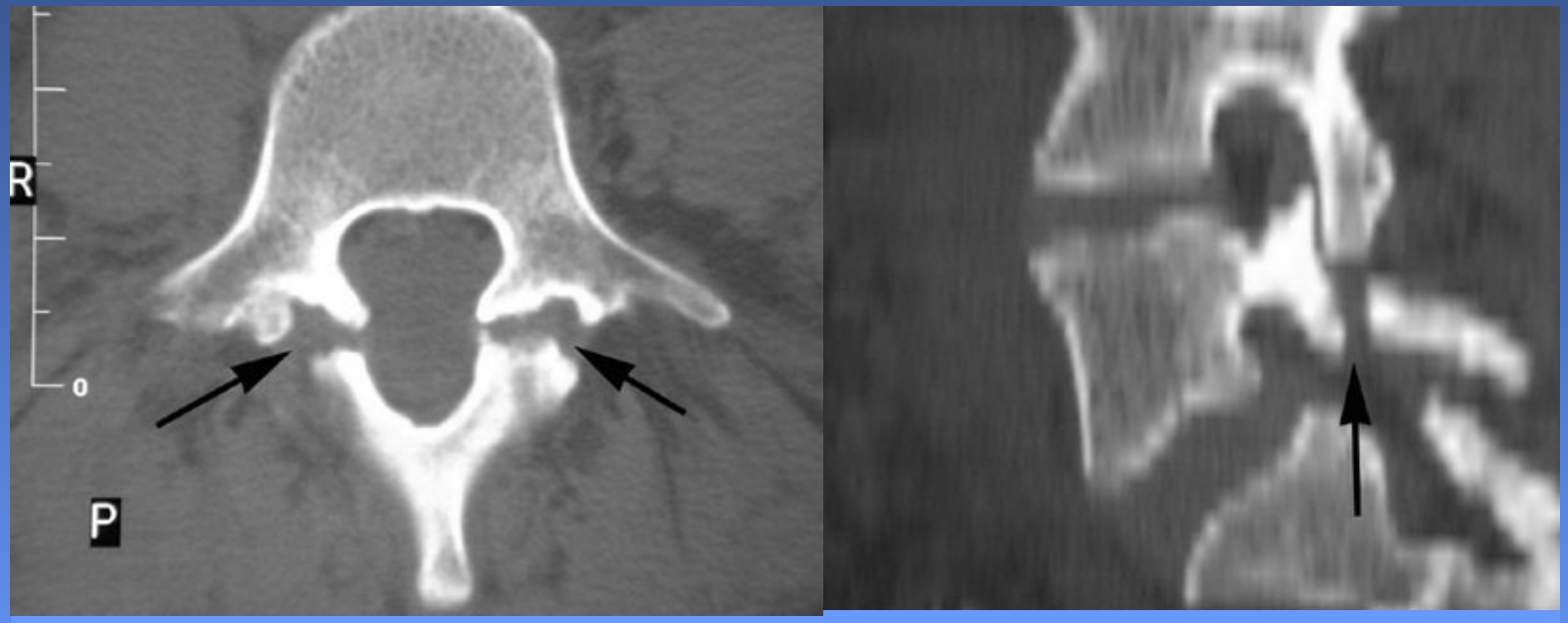
Pathogenesis - spondylolytic



Pathogenesis - spondylolytic

- May be related to large superior facet

Pathogenesis - spondylolytic



Aetiology: Acquired

- Trauma repetitive
- Stress or fatigue fracture of pars intra-articularis Wiltse 1975
- Trauma acute
- Posture
- Increased stresses in lordosis

Aetiology: Acquired

- Acute Fracture
- Single episode associated with the onset of symptoms
- Males 50%
- Females 25%
- Hensinger Spine 1976

Aetiology: Acquired

- Stress Fracture
- Repetitive motions causing stress concentration at pars
- Implicated motions
- Extension,
- Forward and lateral flexion
- Thoracolumbar rotation

Aetiology: Acquired

- Biology of immature spine
- Bone - plastic in adolescents greater bending (higher stress concentration)
- Pars - ossification incomplete in adolescents (less able to withstand applied forces)

Aetiology: Acquired

- Biology of immature spine
- Disc - highly resistant to shear forces in adolescent (force transmitted to pars)
- Soft Tissues - plastic, greater flexibility, greater bending, (higher forces at areas of stress)

Aetiology: Acquired

- Mechanics of immature spine
- Shear stress concentrated in pars
- Lordosis - increased compressive load on facets leads to increased tensile force on pars

Cryon and Hutton JBJS 1978

Aetiology: Acquired

- Biomechanics of immature spine
- Scheuermann's Kyphosis - increased incidence of spondylolysis (50%)

Ogilvie and Sherman Spine 1987

- Compensatory increase in lumbar lordosis

Associated conditions

- Spina bifida
- Scoliosis

Spina bifida occulta

- Spondylolysis
- Dysplastic 94%
- Isthmic 32%
- Unaffected relatives 7%

Wynne-Davies JBJS 1979

Scoliosis

- Incidence of scoliosis
- Symptomatic spondylolysthesis 48%
- Dysplastic - 59%
- Isthmic - 42%
- Symptomatic spondylolysis 13%

Scoliosis

- Patterns of scoliosis
- Sciatic - lumbar curve due to muscle spasm (resolves)
- Olisthetic - torsional curve beginning at defect (2/3 resolve)
- Idiopathic - structural (will not resolve)

Scoliosis

- Incidence of spondylolysis in idiopathic scoliosis 6.2%
- Treat as separate problems
- Early arthrodesis (lumbo-sacral) in symptomatic patient

  Seitsalo et al Spine 1988

Presentation spondylolysis +/- spondylolithesis

- Commonest teenager/young adult
- Congenitals present early
- Many present later in life - second peak of presentation 40-50 years
- Majority asymptomatic

Presentation spondylolysis +/- spondylolisthesis

- Pain
- Deformity (kyphus/scoliosis)
- Neurology unusual except in congenitals
- Tight hamstrings
- Local tenderness and spasm

Imaging

- To make a diagnosis
- To ascertain acute or chronic pars lesion and therefore chances of healing
- To look for other pathologies and pain sources e.g. disc degeneration

Imaging

- Plain films
- Oblique x-rays – Historical high radiation dose and probably no longer justified
- CT
- Bone scan/Spec
- MRI – STIR sequences very useful

Sairyo JBJS(Br)2009;91-B:206-9

- 23 children treated conservatively
- Rest and soft brace
- Early, progressive and terminal defects
- 87% early defects healed
- 32% progressive defects healed
- 0% terminal healed
- 77% high signal defects healed 0% no high signal defects healed

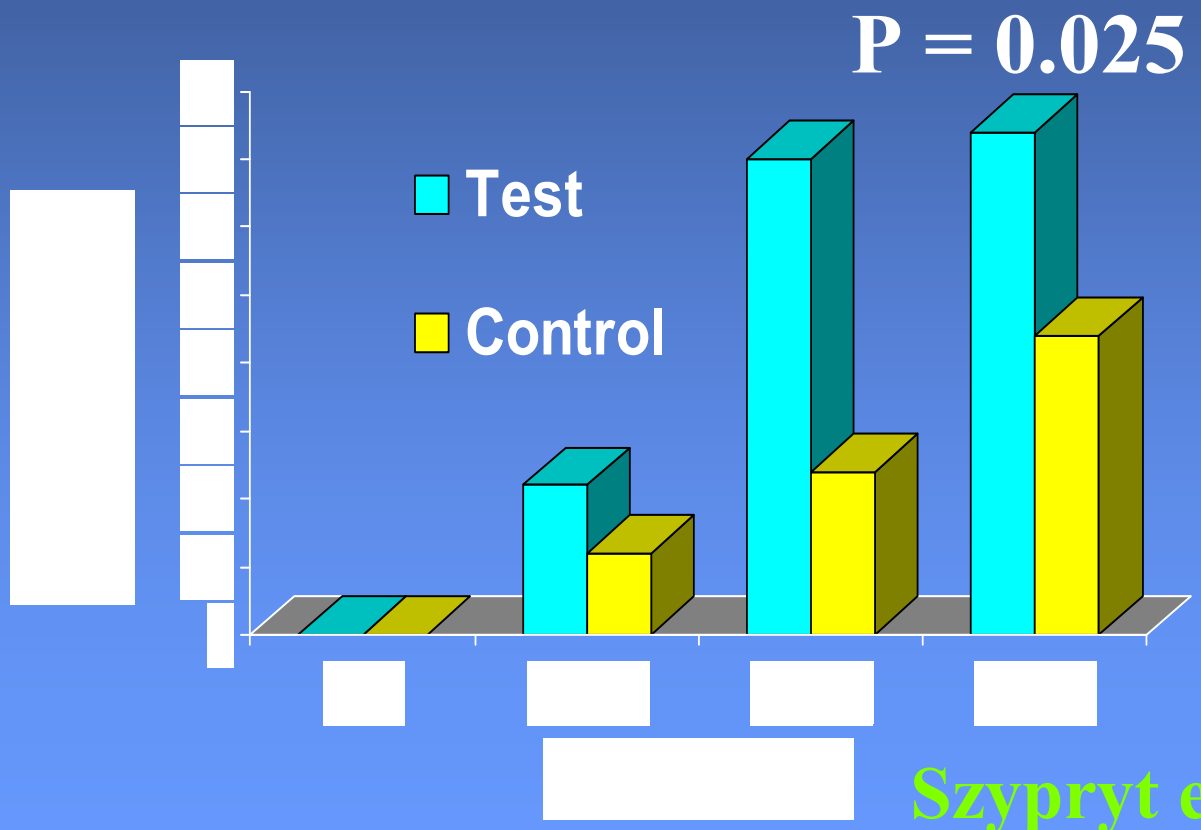
Management of spondylolysis

- Conservative treatment first line and usually successful
- Acute pars defects- Limitation of activities ? Bracing then rehab
- Chronic pars defects – physio, injections and surgery

Disc degeneration

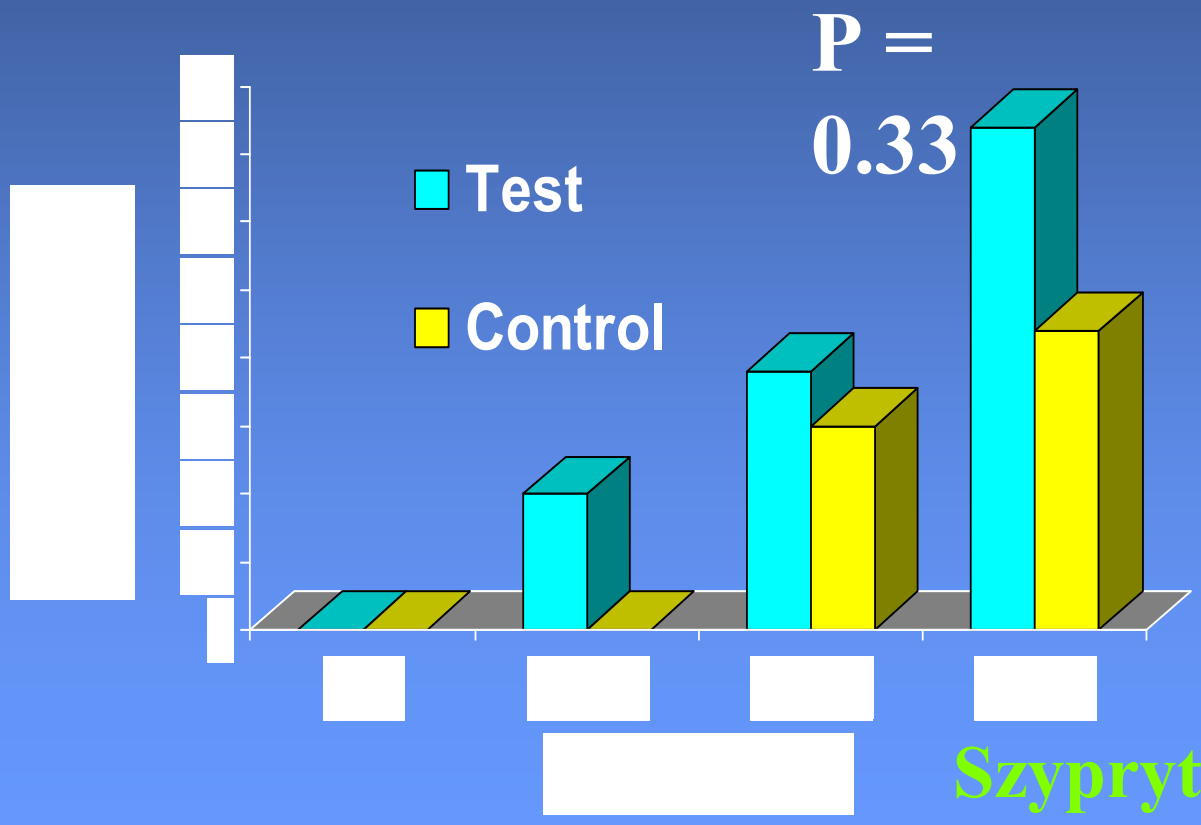
- “A neural arch defect is associated with an increased prevalence of disc degeneration, which is greater than is seen in a normal aging population”
- Szypryt et al spine 1989

Disc degeneration below level of the spondylolysis



Szypryt et al Spine 1989

Disc degeneration above level of the spondylolysis



Szypryt et al Spine 1989

Management of spondylolisthesis

- Nonoperative
- Significant relief of pain in 2/3 of patients

Pizzutillo JPO 1989

Physiotherapy core stability and flexion exercises

Activity restriction

Indications for surgery

- Failed conservative treatment
- Progressive slip
- Neurology
- Deformity

Diagnosis of pain source

- Establish source of pain injections can be useful
- Lysis
- Disc
- Facet
- Other (musculoligamentous)

Surgery-Direct Repair

- Indications
- Positive relief with lysis block
- Normal disc on MRI and/or discography
- Patient younger than 30
- High performance athlete

Direct Repair

- Advantages
- More physiological
- Restoration of normal anatomy
- No loss of motion segments
- Disadvantages
- Technically more difficult
- Can’t use in Slips > Grade II

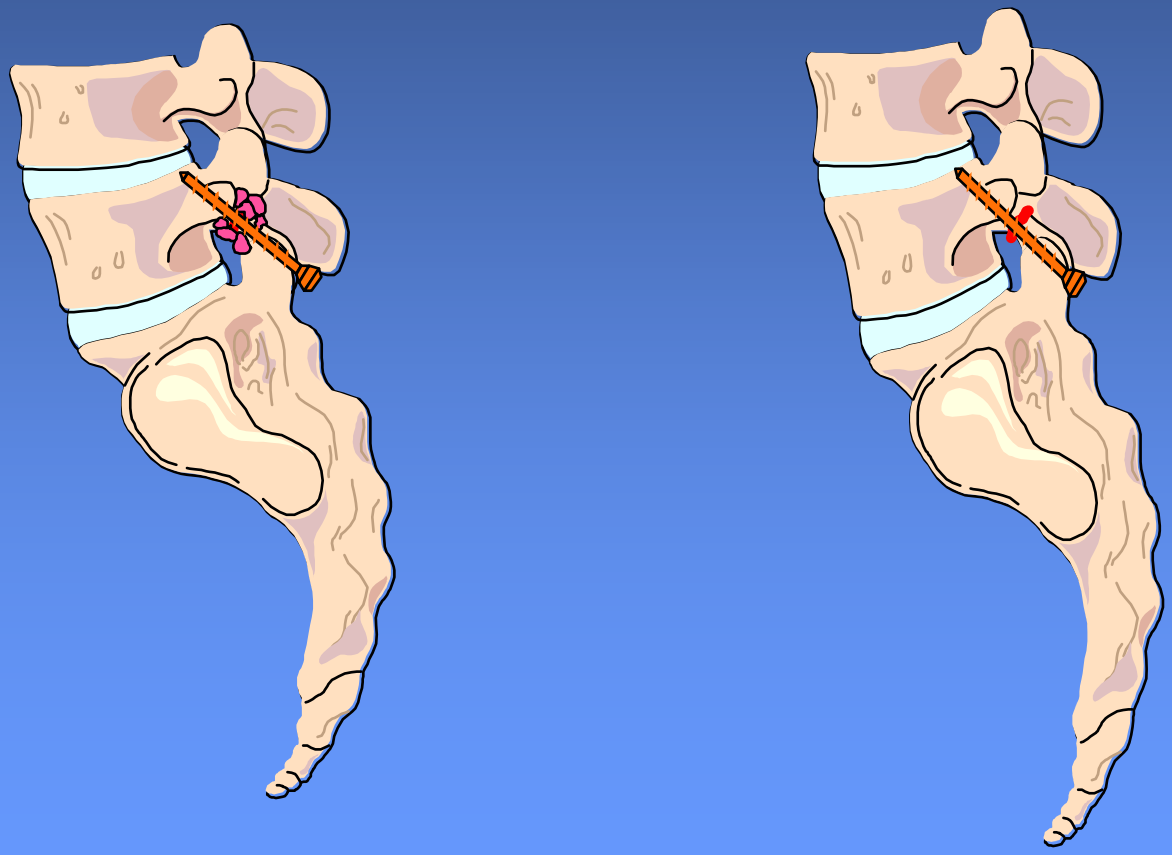
Direct Repair

- Methods
- Bucks repair
- Scott Wiring
- Modified Scott Wiring
- Morscher Hook screw

Direct repair

- Buck's method
- Pars defect debrided to bleeding bone
- 4.5 cortical (over drilled) or malleolar screw placed from lamina across defect into base of pedicle
- Cancellous bone graft into defect

Direct repair-Bucks



Direct Repair

- Buck's Method
- Advantages
- Limited surgical exposure
- All exposure medial to facet joints
- High success rate (83% - 94% healing)
- Disadvantage
- Technically difficult

Direct Repair

- Scott Repair
- Pars defect debrided to bleeding bone
- 18 gauge tension band wire placed around base of transverse process and looped around spinous process on both left and right sides
- Cancellous graft placed in defect
- Wires tightened

Direct Repair

- Modified Scott Repair
- Pars defect debrided to bleeding bone
- Pedicle screws placed
- 18 gauge wire looped around spinous process and screw
- Cancellous graft placed in defect
- Wires tightened

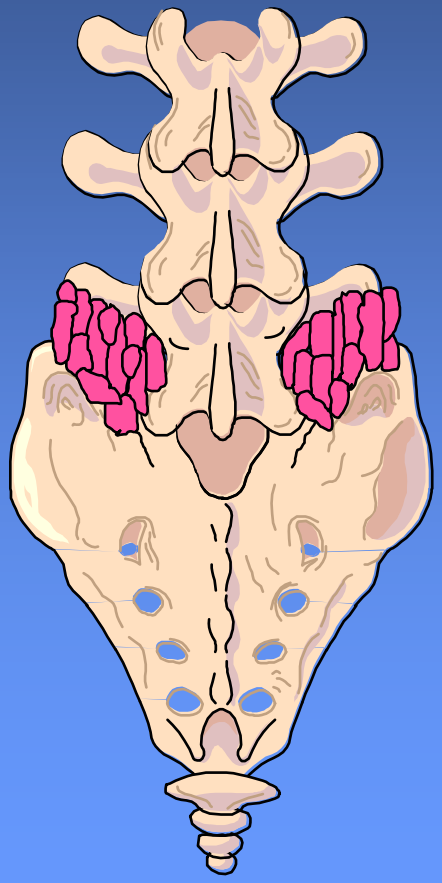
Fusion

- Advantages
- Will also treat other pain sources e.g. facets and degenerate discs
- Disadvantage
- Loss of motion segment(s)

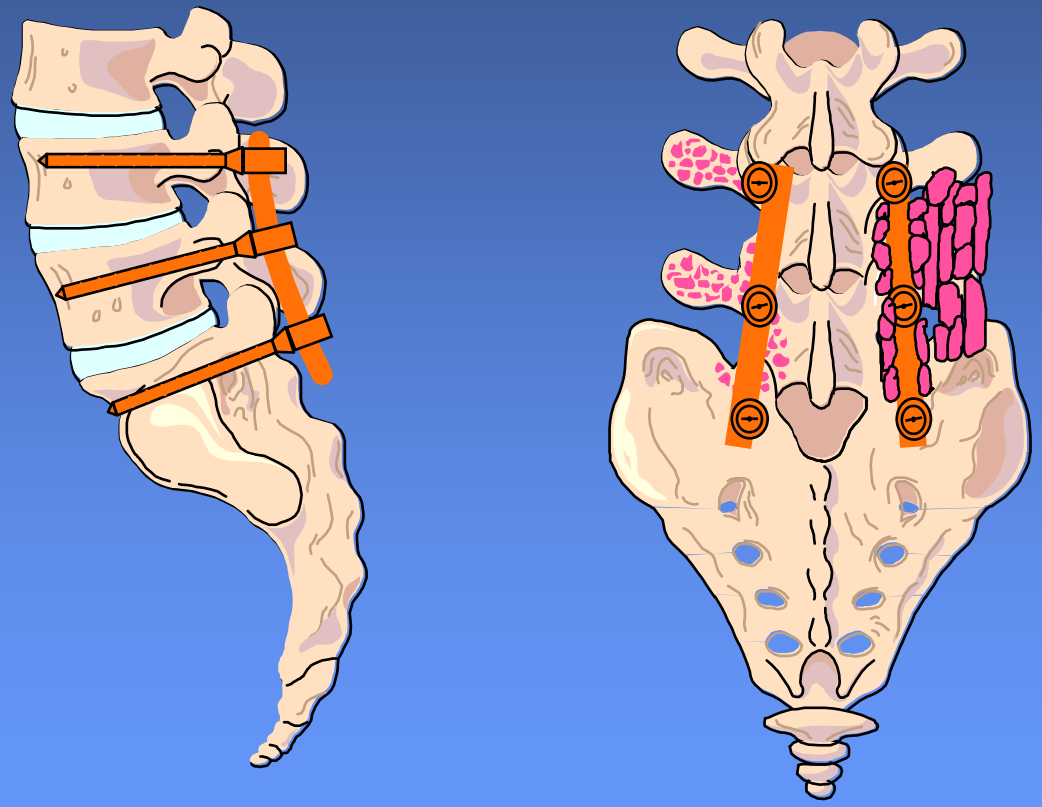
Fusion

- Indications
- Degenerative disc(s)
- Facet involvement
- Slippage grade II or higher
- Age greater than 30

Uninstrumented fusion

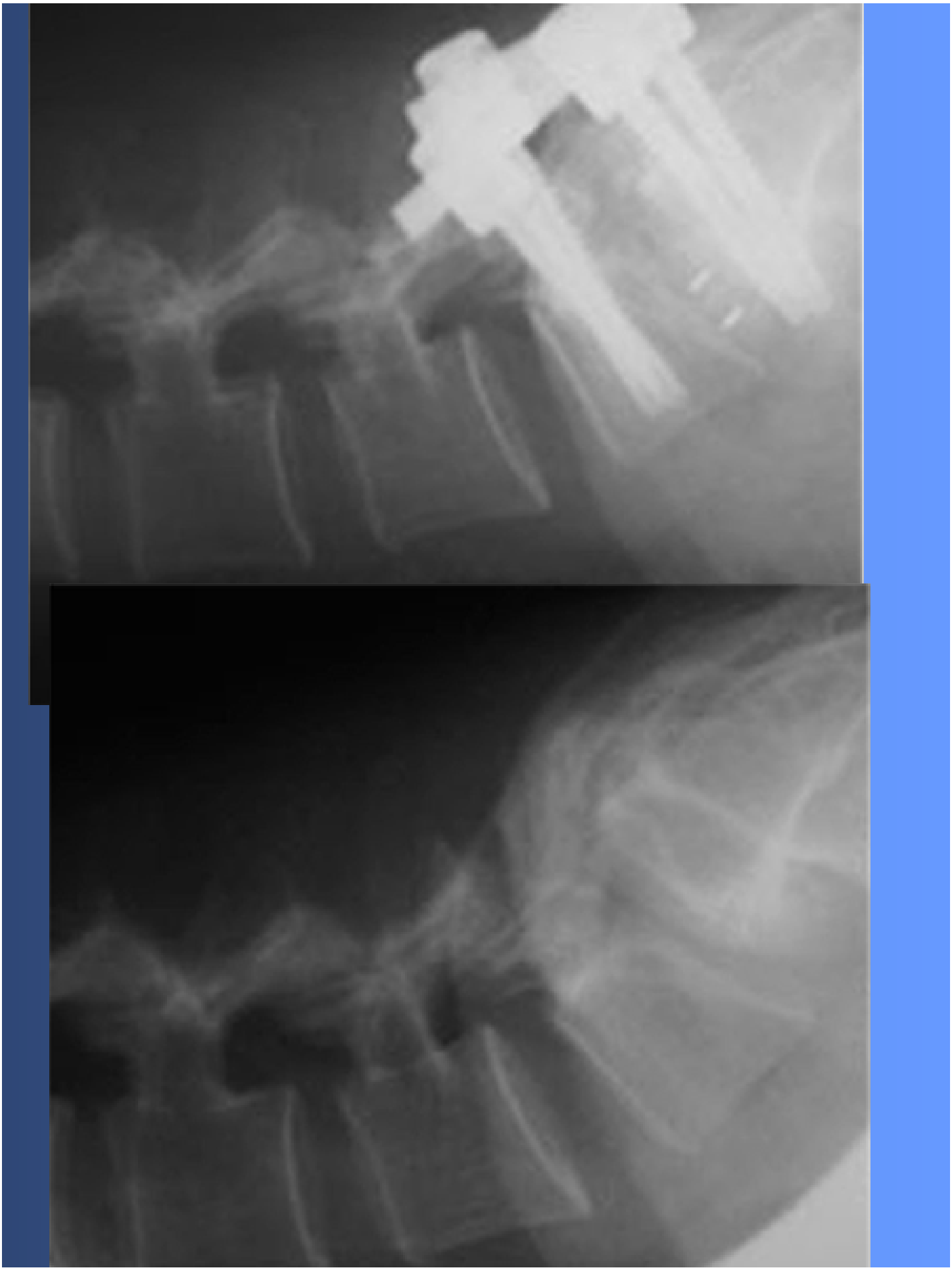


Instrumented fusion



Results

- Generally good with much better outcomes than fusion for DDD
- 80% and greater successful outcomes reported
- Low complication rates



Management of severe grade spondylolytic spondylolithesis

Options

- In-situ fusion - with and without instrumentation
- Reduction and fusion

In-situ fusion - *published results*

B. L. FREEMAN, III, AND N. L. DONATI

JOURNAL OF BONE AND JOINT SURGERY VOL 71A NO 4 APRIL 1989

- ★ 14 teenagers with G III+ slip
- ★ treated with in-situ fusion
- ★ followed for av. 11.9 yrs
- ★ no severe pain or restriction of activity
- ★ all had solid fusion
- ★ no progression of slip
- ★ no intraop or postop complications
- ★ only 2 dissatisfied with cosmetic result

S. SIETSALO, K. OSTERMAN, H. HYVARINEN,
D. SCHLEZENKA, M. POUSSA

JOURNAL OF BONE AND JOINT SURGERY VOL 72B NO 2 MARCH 1990

- 84 teenagers with G III+ followed 13.8 yrs
  - fusion post. in 30, post-lat. in 54, ant. in 3
- 82% good or excellent results
  - worse if only 1 level fused
- non-union in 13%
- 22% had progression of slip > 10%
- complications in 9%
  - 3 had transient EHL palsy

J. R. JOHNSON, AND E. O'G. KIRWAN

JOURNAL OF BONE AND JOINT SURGERY VOL 65B NO 1 JAN 1983

- 17 teenagers with G III+ followed 14 yrs
- Non instrumented fusion
- 16 rated result excellent
  - only occasional pain, no time off work
- only 2 conscious of cosmetic deformity
  - 9 felt appearance improved
- all had solid fusion
- average 9% further slip
  - all occurred within 1st 2 yrs
- no major complications

Boos 1993

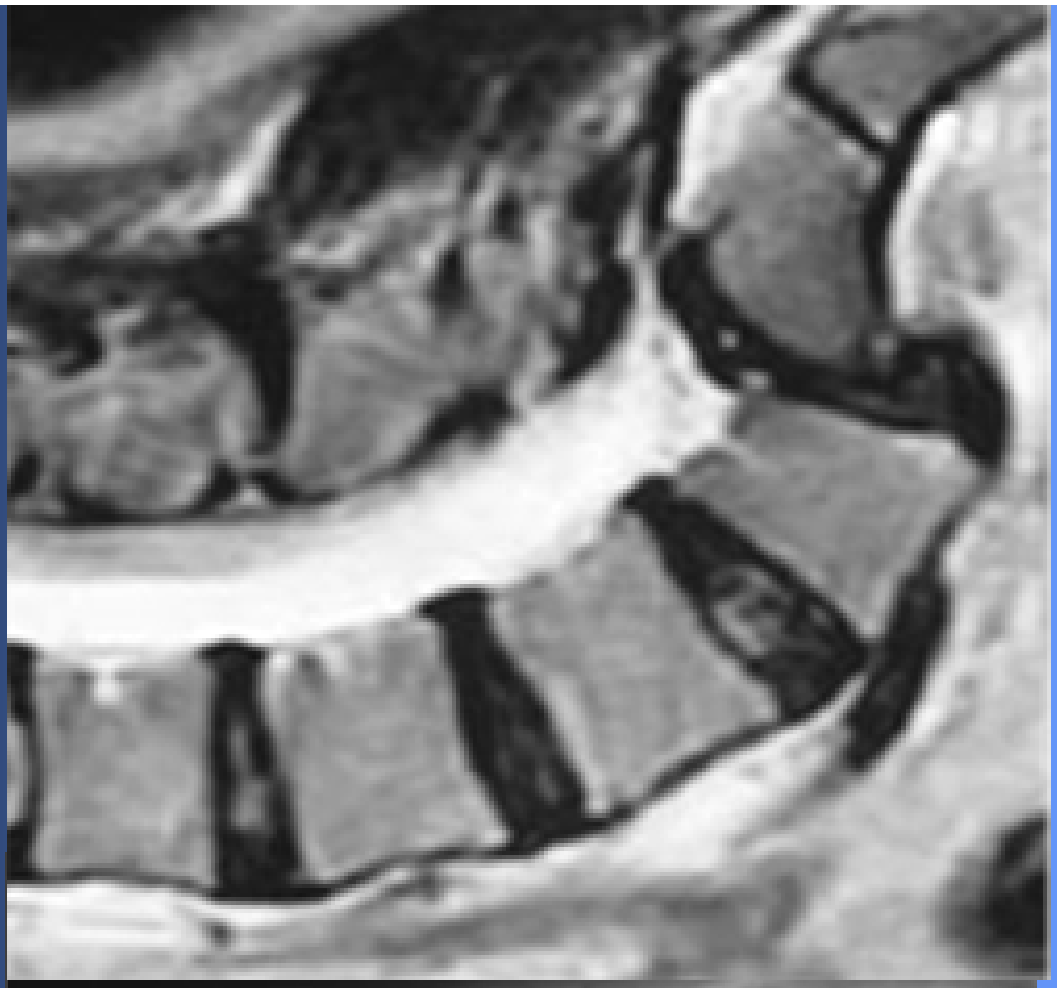
- Compared posterior instrumented with PLIF and instrumentation
- 10 patients
- 6 grade III, 4 grade IV
- 5/6 postero-lateral fusions failed
- Recommended PLIF and posterior instrumentation

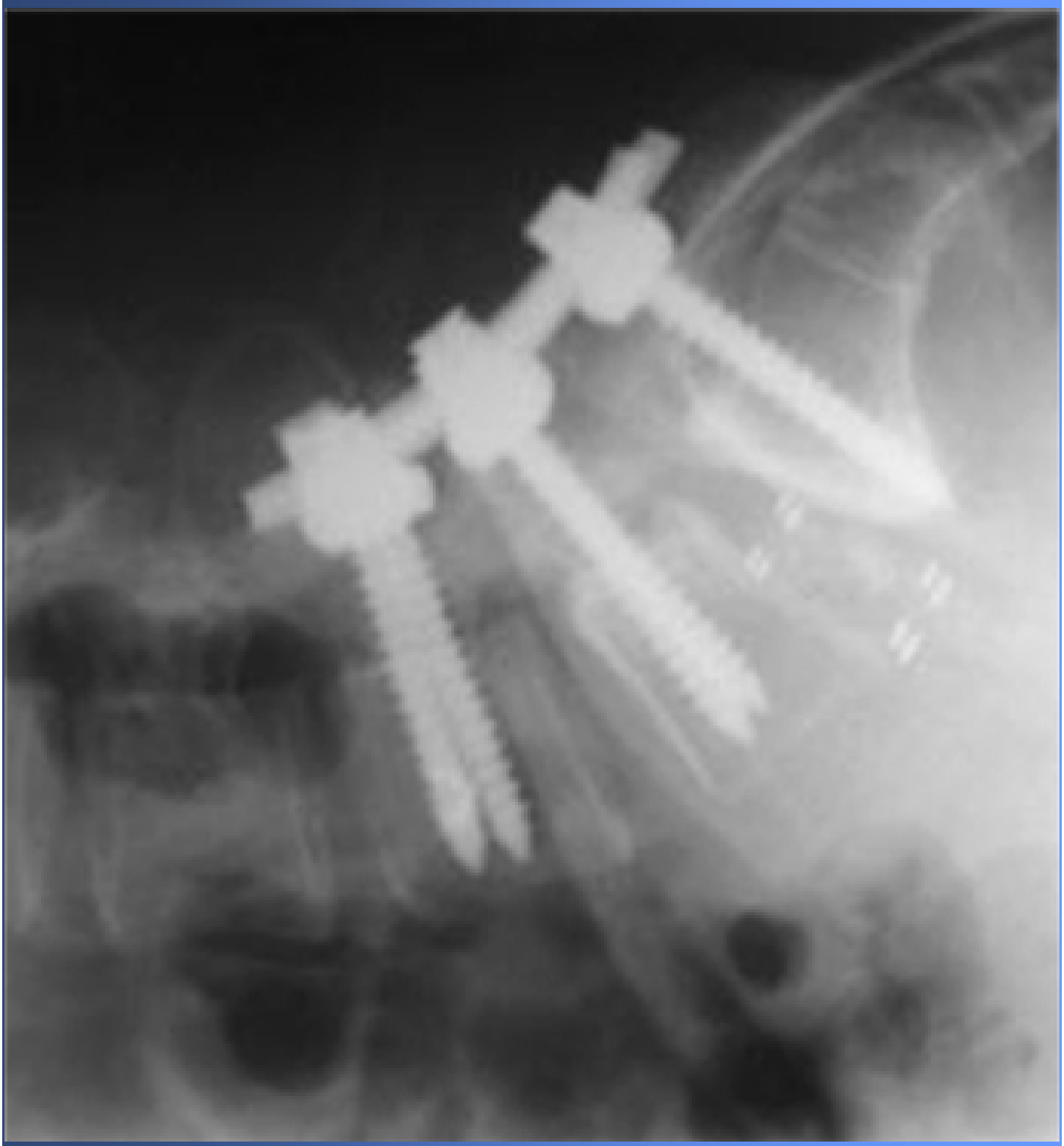
Spine, 1993, 15, 1655-1661

Lehmer 1994

- Staged L5 resection with L4 to S1 fusion
- Grade 5
- 3.9 years
- 16 patients
- ? fused
- 0 progressed
- 12 early neurological deficits, 7 permanent (7 preop also)

Spine, 1994, 19, 1916-1925





Reduce or in-situ

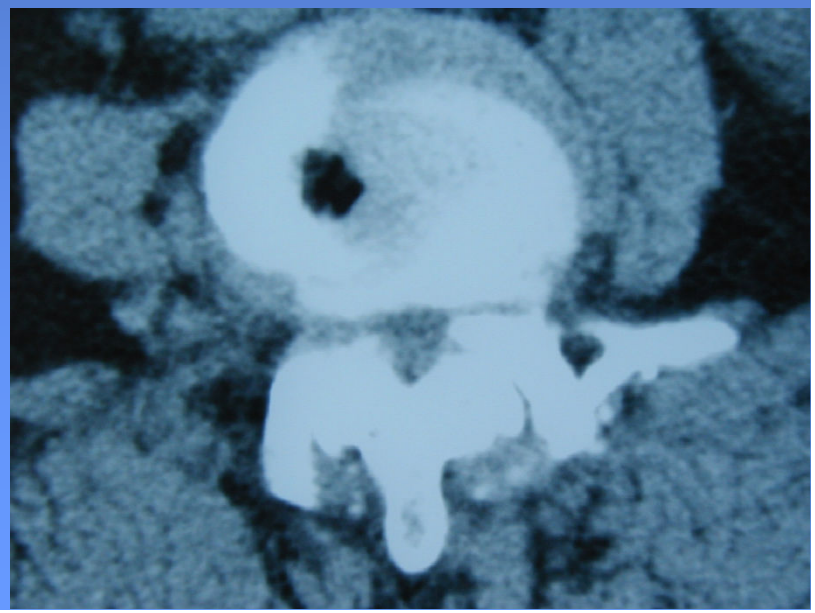
- Difficult to justify large procedures with high complication rates when the results of in-situ fusion so good in most patients
- Only advantage reduction of deformity but rarely effects clinical outcome
- Need front and back surgery to have realistic chances of fusion

Degenerative spondylolithesis

- Due to ageing changes
- Failure of the motion segment
- Facet joint pathology key
- May be associated with sagittal joints

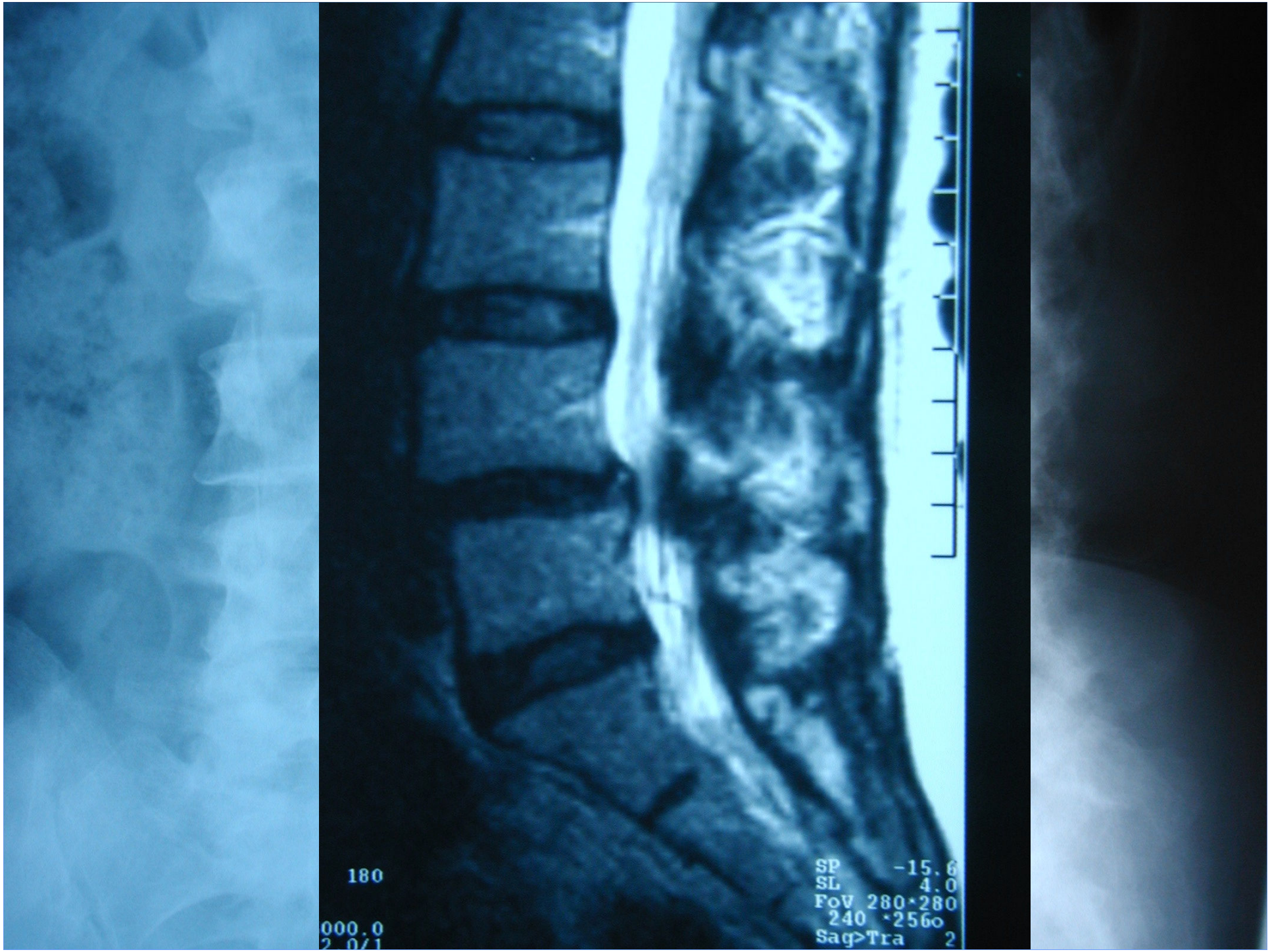
Pathology

- Chronic disc degeneration
- Facet degeneration
- Rotational instability
- Spondylolisthesis



Pathology

- Commonest at L4/L5
- Rarely more than 25-30%
- Leg pain usually worse than back pain
- Usually over the age of 60


180
000.0
SP -15.6
SL 4.0
FoV 280*280
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Sag>Tra 2

Clinical

- Clinical examination commonly unremarkable
- 50% loose ankle jerks
- 20% have PVD
- L5 nerve root most commonly affected
- Flexion-extension Xrays rarely demonstrate instability

Non-operative treatment

- Education
- Controlled activity
- Anti-inflammatories
- Lumbar support - 10%
- Epidural - 10%
- Calcitonin injections - 25%

Fusion advocated with decompression

- 4 published trials
- Small
- Wide age range
- Decompression not described

Fusion advocated for decompression

- 100% follow up
- 50 consecutive patients
- Sequential randomisation
- Non-blinded

–Herkowitz H, Kurtz L. Degenerative spondylolisthesis with spinal stenosis. A prospective study comparing decompression with decompression and intertransverse process arthrodesis. J Bone Jt Surg [Am] 1991;73-A:802-808

Fusion advocated for decompression

- Age 52-84 (mean 63.5)
- 3 year follow up
- 36% pseudarthrosis

Herkowitz H, Kurtz L.
Degenerative spondylolisthesis with spinal stenosis.
A prospective study comparing decompression with decompression and intertransverse process arthrodesis.
J Bone Jt Surg [Am] 1991;73-A:802-808

Fusion advocated for decompression

	Fusion	No fusion
• **Excellent**	11	2
• **Good**	13	9
• **Fair**	1	12
• **Poor**	0	2

–Herkowitz H, Kurtz L. Degenerative spondylolisthesis with spinal stenosis. A prospective study comparing decompression with decompression and intertransverse process arthrodesis. J Bone Jt Surg [Am] 1991;73-A:802-808

Fusion advocated for decompression

- **24/25 (96%) of those without fusion developed progressive olithesis**
- **7/25 (28%) of those with fusion developed progressive olithesis**
- **This suggests that "fusion" stabilises the spine and this may explain differences**
- **9/29 (36%) developed non-union (7/9 had a unilateral fusion)**

–Herkowitz H, Kurtz L. Degenerative spondylolisthesis with spinal stenosis. A prospective study comparing decompression with decompression and intertransverse process arthrodesis. J Bone Jt Surg [Am] 1991;73-A:802-808

Randomised trial-+/- instrumentation

- 76 patients
- 8/76 lost to follow-up
- Fusion + Steffee plate vs. non-instrumented fusion
- Follow-up 2.4 years

Fischgrund J, Mackay M, Herkowitz H, et al. Degenerative lumbar spondylolisthesis with spinal stenosis: a prospective randomized study comparing decompressive laminectomy and arthrodesis with or without spinal instrumentation. Spine 1997;22:2807-12

Outcomes

- Back pain
- Leg pain
- Surgeon rating fusion
- Spondylolithesis progression

Fischgrund J, Mackay M, Herkowitz H, et al.
Degenerative lumbar spondylolisthesis with spinal stenosis:
a prospective randomized study comparing decompressive laminectomy and arthrodesis with or without spinal instrumentation.
Spine 1997;22:2807-12

Outcomes

- Excellent or good
  - 76% with instrumentation
  - 85% without instrumentation
- Solid fusion
  - 82% with instrumentation
  - 45% without instrumentation

Fischgrund J, Mackay M, Herkowitz H, et al. Degenerative lumbar spondylolisthesis with spinal stenosis: a prospective randomized study comparing decompressive laminectomy and arthrodesis with or without spinal instrumentation. Spine 1997;22:2807-12

Outcomes

- Pedicle screws rendered the spine more stable
- Successful fusion was not a predictor of good outcome

Fischgrund J, Mackay M, Herkowitz H, et al. Degenerative lumbar spondylolisthesis with spinal stenosis: a prospective randomized study comparing decompressive laminectomy and arthrodesis with or without spinal instrumentation. Spine 1997;22:2807-12

Successful fusion did not correlate with outcome

Fischgrund J, Mackay M, Herkowitz H, et al. Degenerative lumbar spondylolisthesis with spinal stenosis: a prospective randomized study comparing decompressive laminectomy and arthrodesis with or without spinal instrumentation. Spine 1997;22:2807-12

The effect of fusion on results

- **94/130 degenerative spondylolithesis**
- **Comparison of instrumented and non-instrumented fusion**
- **97% follow-up**
- **Dallas pain questionnaire**

Thomsen K. Christensen F.B. Eiskjaer S.P. et al. The effect of pedicle screw instrumentation on the functional outcome and fusion rates in posterolateral lumbar spinal fusion.A prospective randomised study. Spine 22, 2813-2822,1997.

The effect of implants on surgery

- **80% increase in operation time**
- **42% increase in blood loss (500mls)**
- **10% increase hospital stay (N.S.)**
- **2.6% vs. 0% infection rate**
- **4.8% misplaced screws, with nerve root symptoms**
- **2 long term neurological symptoms**
- **17% hardware failure (1 a problem)**
- **Reoperation rate 19% vs. 6% ($p<0.01$)**

Thomsen K. Christensen F.B. Eiskjaer S.P. et al. The effect of pedicle screw instrumentation on the functional outcome and fusion rates in posterolateral lumbar spinal fusion.A prospective randomise study. Spine 22, 2813-2822,1997.

The effect of implants on surgery

- **Satisfactory 82% instrumented vs 74% non-instrumented (N.S.)**
- **No significant difference in fusion rates between the two groups**
- **No difference in long term stability**
- **Significant difference in ability to carry out daily activities**

Thomsen K. Christensen F.B. Eiskjaer S.P. et al. The effect of pedicle screw instrumentation on the functional outcome and fusion rates in posterolateral lumbar spinal fusion.A prospective randomise study. Spine 22, 2813-2822,1997.

The effect of implants on surgery

- **Perhaps we cannot identify those who will benefit from instrumented fusion**

Thomsen K. Christensen F.B. Eiskjaer S.P. et al. The effect of pedicle screw instrumentation on the functional outcome and fusion rates in posterolateral lumbar spinal fusion.A prospective randomise study. Spine 22, 2813-2822,1997.

Conclusions

- **No evidence that implants improve the outcome**
- **Implants are associated with increased complication rates**
- **Implants increase the costs of procedures**

Thomsen K. Christensen F.B. Eiskjaer S.P. et al. The effect of pedicle screw instrumentation on the functional outcome and fusion rates in posterolateral lumbar spinal fusion.A prospective randomise study. Spine 22, 2813-2822,1997.

Long term results

- **11-13 year follow-up**
- **Randomised fusion +/- instrumentation**
- **Good results maintained**
- **No difference between groups**

The positive effect of posterolateral lumbar spinal fusion is preserved at long-term follow-up: a RCT with 11-13 year follow-up. Anderson et al., Eur Spine J. 2008 Feb;17(2):272-80

Conclusions

- Solid bony fusion itself does not appear to be important for clinical outcome
- Instrumentation does not confer any benefit except in scoliosis
- Instrumentation has significant disadvantages in most patients


Thankyou!