

Spine

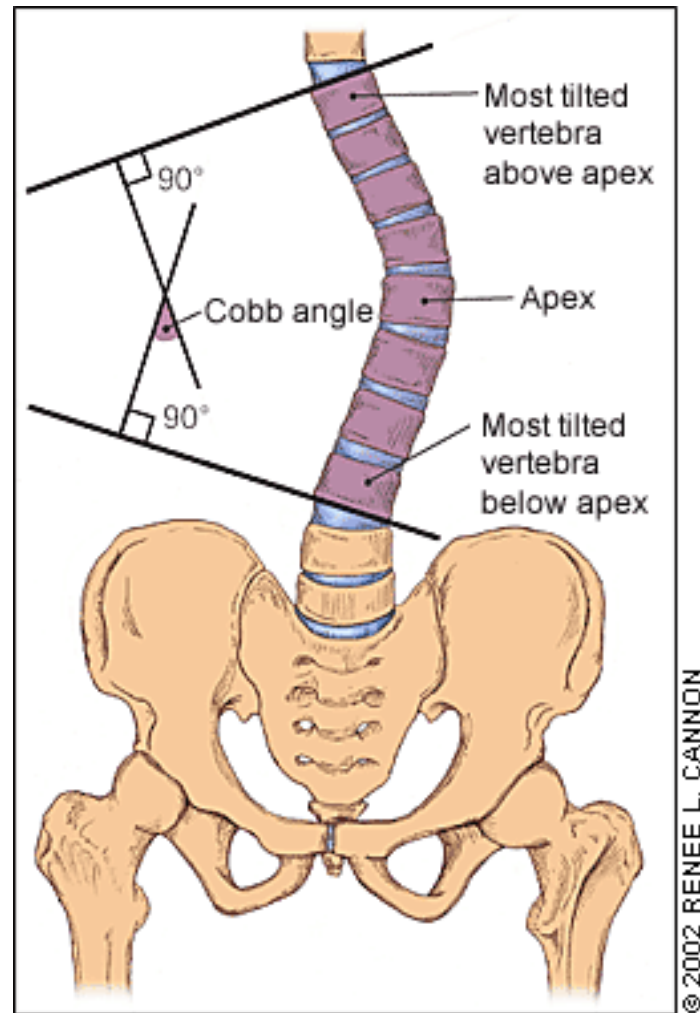
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Adolescent idiopathic scoliosis surgical intervention

- Indication:

1. Thoracic curves $>45^{\circ}$ in the skeletally immature patient, Or $>50^{\circ}$ in the skeletally mature p't
2. Thoracolumbar/lumbar $>40-45^{\circ}$, especially significant rotation or translation because thoracolumbar/lumbar are easy to progress

Cobb angle



Adolescent idiopathic scoliosis surgical intervention

- The goal of surgery:
 1. to prevent curves progression with spinal arthrodesis
 2. To safely improve the three-dimensional deformity

(1542) 關於 Adolescent idiopathic scoliosis 的手術治療

- (A) 對於 skeletally immature 的病患，thoracic curve 大於 45° 考慮手術。
- (B) 對於 skeletally mature 的病患，thoracic curve 大於 50° 考慮手術。
- (C) Thoracolumbar/lumbar curve 大於 $40^{\circ} \sim 45^{\circ}$ 考慮手術。
- (D) 手術的主要目的是防止度數惡化。

(2005, OKU 8, P.777)

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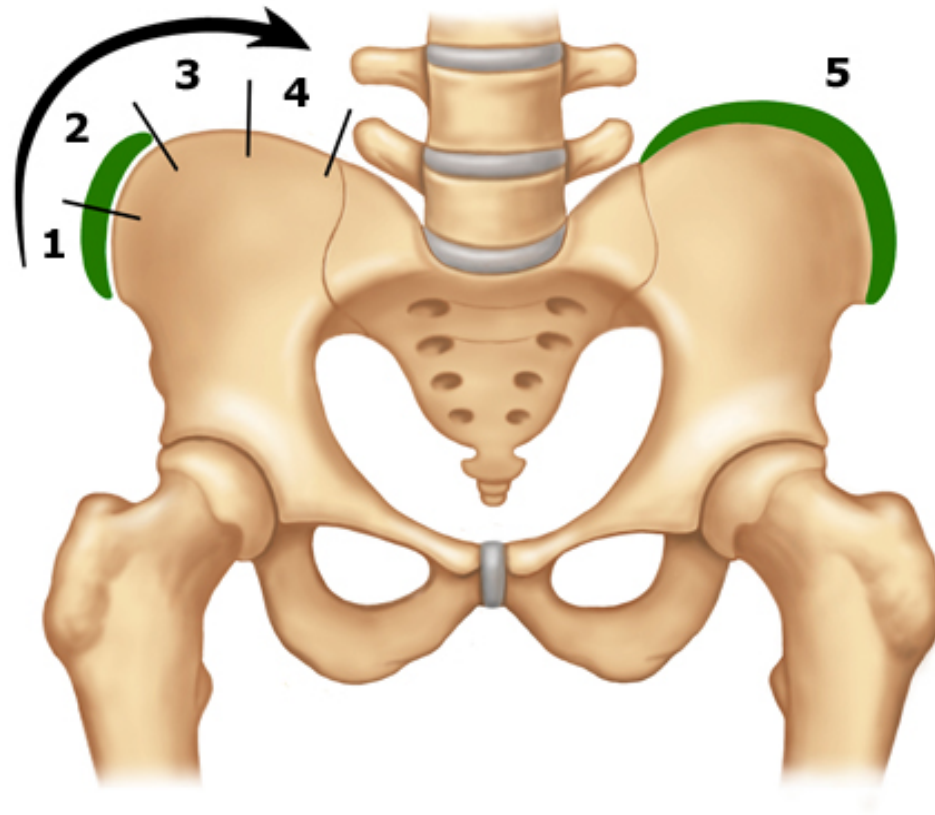
Adolescent idiopathic scoliosis surgical intervention

- **Posterior approach** is standard and traditional for all curve patterns and is best for double or triple curves
- **Anterior approach** : for
 1. **More common for Thracolumbar/lumbar curve** because removal of disk achieving improvement in coronal plane deformity and restoration in lumbar lordosis. Correction in done with **convex compression**
 2. Thoracic curve, especially hypokyphosis

Adolescent idiopathic scoliosis surgical intervention

- For A+P
 1. Skeletally immature(Risser grade 0 with open triadial cartilage)
 2. Large curve $>80^{\circ}$
 3. Stiff curve $>50\%$ flexibility index

Skeletal maturity



Adolescent idiopathic scoliosis surgical intervention

- Neurologic monitoring

Somatosensory-evoked potentials:

A 50% decrease in amplitude or an increase in latency of 10%

➔ neurologic injury



Spinal Cord Monitoring during Spine Surgery at Great River Hospital

Adolescent idiopathic scoliosis surgical intervention

- **SRS-22 scores**: scoliosis research society-22 patient outcome

➔ quality of life questionnaire



1. Improvement in pain, general self-image, function for back condition and level of activity **after surgery**
2. improvement in coronal **Cobb angle correction does not correlate** with improved SRS-22

(1543) 關於 Adolescent idiopathic scoliosis 的 surgical intervention

(A) Anterior approach 通常由 convex side 實行。

(B) 實行 posterior fusion and instrumentation 者，如 skeletally immature(Risser 0)、large curve($>80^{\circ}$)和 stiff($<50\%$ flexibility index)，則考慮增加實行 anterior discectomy 及 fusion。

(C) 使用 somatosensory-evoked potential 時，如 50% decrease in amplitude 和/或 10% increase in latency，可能產生神經損傷。

(D) Cobb angle 矯正的程度和病患生活品質無關。

(2005, OKU 8, P.777、779)

Neurofibromatosis scoliosis

- NF-1:
 1. Peripheral neurofibromatosis
 2. AD, 17q
 3. Schwann cell tumors
 4. abnormalities of the nervous tissue, bones, and skin
 5. Bone deformity:
spinal deformities, such as scoliosis or kyphosis
congenital tibial dysplasia with bowing and pseudarthrosis, of
the tibia, forearm,
other bones, as well as overgrowth phenomenon of an
extremity
 6. 2% of patients who have scoliosis have neuro.bromatosis,

Neurofibromatosis scoliosis

Box 1. Diagnostic criteria for neurofibromatosis type 1

More than six café au lait spots
measuring at least 15 mm in adults
and 5 mm in children

Two or more neurofibromas of any type
or one plexiform neurofibroma

Freckling in the axillary or inguinal
regions

Optic glioma

Two or more Lisch nodules (ie, iris
hamartomas)

A distinctive bony lesion, such as
sphenoid wing dysplasia, or thinning
of the cortex of a long bone with or
without pseudarthrosis

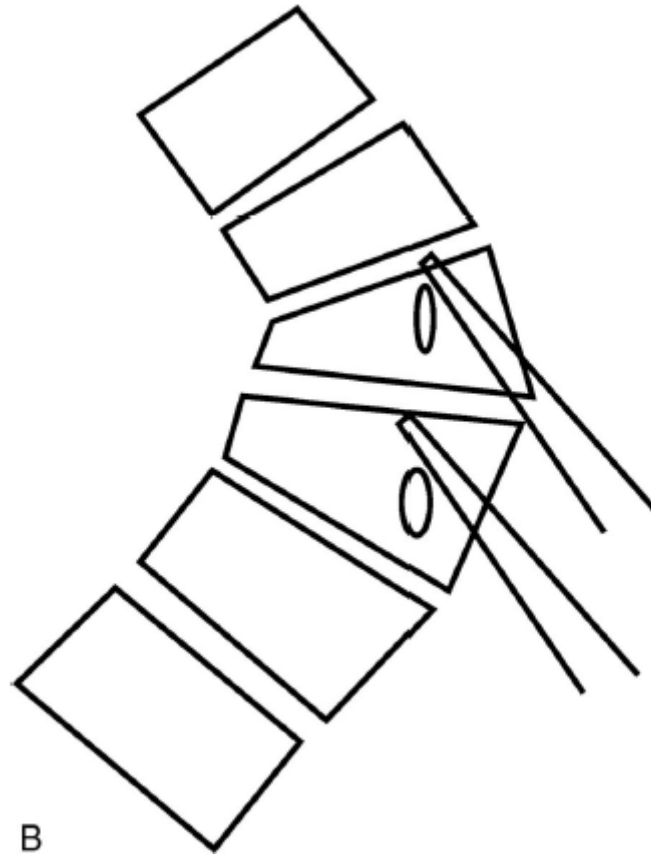
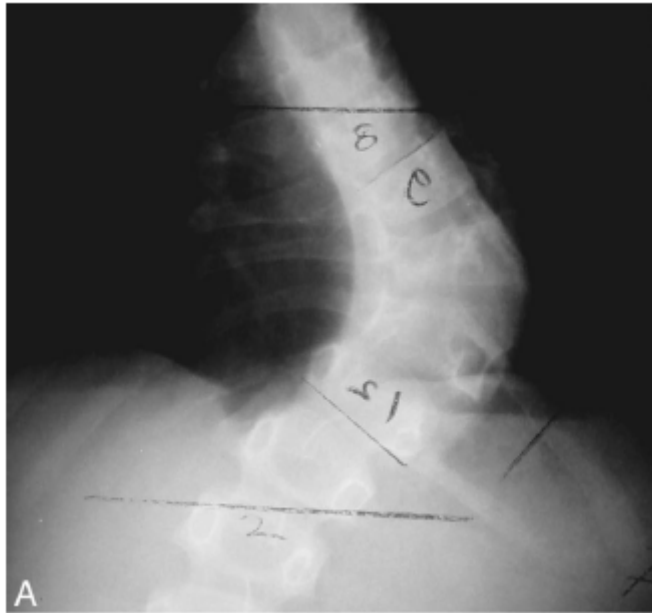
Neurofibromatosis scoliosis

Nine radiographic characteristics of dystrophic deformity as seen in 457 children

Characteristics	% incidence
<u>Rib penciling</u>	62
Vertebral rotation	51
<u>Posterior vertebral scalloping</u>	31
Vertebral wedging	36
Spindling of transverse processes	31
<u>Anterior vertebral scalloping</u>	31
Widened interpediculate distance	29
Enlarged intervertebral foramina	25
Lateral vertebral scalloping	13

From Durrani AA, Crawford AH, Choudry SN, et al. Modulation of spinal deformities in patients with neurofibromatosis type 1. Spine 2000;25:69–75; with permission.

Rib pencilled



Neurofibromatosis scoliosis

- NF-2
 1. Not common: 1/100000 (v.s. NF-1: 1/4000)
 2. AD, Chr22
 3. Bilateral schwannoma of vestibular portion of cranial 8 nerve
 4. Schwannomas of other peripheral nerves, meningiomas, and ependymomas also are common
 5. NF-2 does not seem to have orthopedic manifestations.

Marfan syndrome (MFS)

- a connective tissue disorder
- on multiple organ system involvement, most notably skeletal, ocular, and cardiovascular systems
- The skeletal features:
dolichostenomelia, or disproportionately long limbs, to protrusio acetabuli, dural ectasia, and scoliosis.
- Spinal deformity: scoliosis 63% ($>10^{\circ}$)

Other Causes of Scoliosis

(1544) 關於 Neurofibromatosis scoliosis

(A) Neurofibromatosis 是顯性遺傳疾病 (autosomal dominant)，但也有些是基因突變 (sporadic mutation)。

(B) 通常有一個 short sharp dystrophic curve 和一個 idiopathic compensatory curve。

(C) Scalloping of the posterior body, enlargement of neural foramen 和 defective pedicle 表示 spinal canal 內有 neurofibroma。

(D) 病患身上常見到 café-au-lait spots。

(Lovell & Winter, P.256, 258)

(1545) 關於 Marfan syndrome 和 spinal deformity

(A) Marfan syndrome 因 connective tissue disorder 常有 skeletal, ocular 和 cardiovascular 等變異。

(B) Marfan syndrome 的 skeletal 變異如 long slender digits, long narrow limb 和 spinal deformity。

(C) Spinal deformity 最常見是 scoliosis 其次是 thoracic lordosis with lumbar kyphosis 再其次是 thoracolumbar kyphosis。

(D) 大於 50 度建議手術治療。

(Lovell & Winter, P.179-180, 709)

Adult spinal deformity

- A sequela of untreated adolescent idiopathic scoliosis, failed surgical or nonsurgical treatment, degenerative changes
- Degenerative change by iatrogenic instability after decompressive procedure or by metabolic bone disease such as osteoporosis

Adult scoliosis

- Scoliosis can continue to progress after skeletal maturity
- Large thoracic curve ($>60^{\circ}$): the greatest risk for progression
- Thoracic curves $> 50^{\circ} \rightarrow 1^{\circ} / y$
Thoracolumbar curve $0.5^{\circ} / y$
Lumbar curve $0.24^{\circ} / y$

Adult scoliosis

- Risk factor for curve progression including:

Curvature $>30^{\circ}$

Apical rotation $>33\%$

>6 mm of lateral listhesis

Poor seating of L5/S

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Adult scoliosis

- In contrast to **asymptomatic adolescent** patients with scoliosis, the adult have back pain
- Etiology:
 - 1) **muscle fatigue on the convexity,**
 - 2) **trunk imbalance and facet arthropathy on the concavity**
 - 3) Degenerative disk disease
- Back pain common in lumbar curves or thoracolumbar/lumbar curve $>45^{\circ}$ with apical rotation and coronal imbalance

Adult Spinal Deformity

(1546) 關於 Adult spinal deformity

- (A) 可以是因 adolescent idiopathic scoliosis 沒有治療所造成
- (B) 可以是因脊椎老化或合併骨質疏鬆所造成
- (C) 可以是因脊椎手術後所造成
- (D) 可能引起背痛或坐骨神經痛

(2005, OKU 8, P.565)

(1547) 關於 Adult spinal deformity

- (A) 脊椎側彎即使到了 skeletal maturity 仍可能繼續 progress
- (B) Thoracic scoliosis 若超過 50 度，平均每年 progress 約 1 度
- (C) Throacic scoliosis 若超過 60 度，則 progress 的危險性很大
- (D) Thoracic scoliosis 若小於 30 度，則不易 progress

(2005, OKU 8, P.565)

(1548) 關於 Adult spinal deformity

- (A) Adolescent idiopathic scoliosis 通常沒有症狀，但 Adult scoliosis 經常合併背痛
- (B) 疼痛可能來自於脊椎側彎凸側 (convex side) 的肌肉疲勞 (muscle fatigue)
- (C) 疼痛可能來自於脊椎側彎凹側 (concave side) 的關節面病變 (facet Arthropathy)
- (D) 疼痛較常發生於腰椎側彎

(2005, OKU 8, P.565)

(1549) 關於 Adult lumbar scoliosis

- (A) 可能合併 spondylolisthesis
- (B) 可能合併 Lateral Olisthesis of vertebral bodies
- (C) 可能合併 facet osteoarthritis
- (D) 可能造成 spinal stenosis

(2005, OKU 8, P.566)

Adult scoliosis

- **Surgical indication:**

Thoracic curve $> 50^{\circ}$ to 60°

Chronic pain that is unrelieved by conservative tx

Significant loss of pulmonary disease

Spinal stenosis

(1550) 關於 Adult scoliosis 的 surgical indications

(A) Thoracic scoliosis 大於 50 度

(B) 慢性背痛無法用保守療法得到緩解

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(C) 肺功能明顯受到影響及減低

(D) 脊椎側彎繼續 progress，同時造成 coronal 或 sagittal imbalance

(E) 腰椎側彎合併腰椎狹窄 (spinal stenosis) 的症狀

(2005, OKU 8, P.567)

Adult scoliosis surgical intervention

- A greater risk of surgical complications than adolescents.
- **Major complications** include pseudarthrosis, residual pain, neurologic injury, infection thromboembolism

Adult scoliosis surgical intervention

- Combined procedures are preferable to staged procedures, because of
 1. A lower infection rate,
 2. Stage procedure easily leads to patient malnutrition
 3. To avoid prolonged immobilization

Adult scoliosis surgical intervention

- To avoid complication

1. Normalization of nutritional status <6-12w/ks
2. Hyperalimentation or enteral **nutritional** supplement in stage procedure
3. Foot pumps and physical therapy with assistance to minimize risk of DVT
4. Aggressive respiratory therapy
5. **Redosing of antibiotics every 4 hrs or 1500ml blood loss**

Adult scoliosis surgical intervention

- **Surgical goal:** to achieve coronal and sagittal plane balance

(1551) 關於 Adult spinal deformity 的手術治療

(A) 有較高的 complication rate

(B) 常見的 complications 包括 pseudarthrosis、neurologic injury、Infection 及 thromboembolism

(C) Thoracoplasty 會造成術後肺功能的減低，而且術後二年也不易恢復

(D) 若必須作 anterior 及 posterior surgery，則 one stage operation 優於 2 stage operation

(2005, OKU 8, P.566~567)

(1552) 關於 Adult spinal deformity 的手術治療

(A) 若採取 staged operations，則必須在兩階段手術期間，作足夠的營養補充

(B) 若手術時間太長，則每 4 小時必須再給予抗生素

(C) 若術中出血量超過 1500 cc，則必須再給予抗生素

(D) 手術治療最主要的目的是達到 coronal 及 sagittal balance，其次才是脊椎側彎矯正的程度

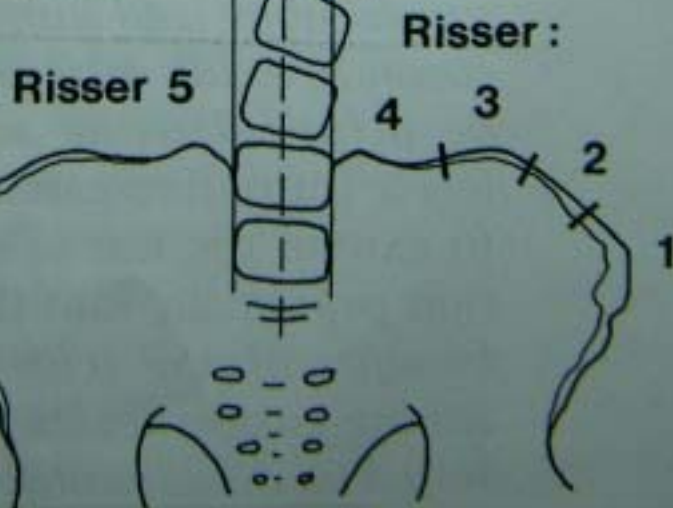
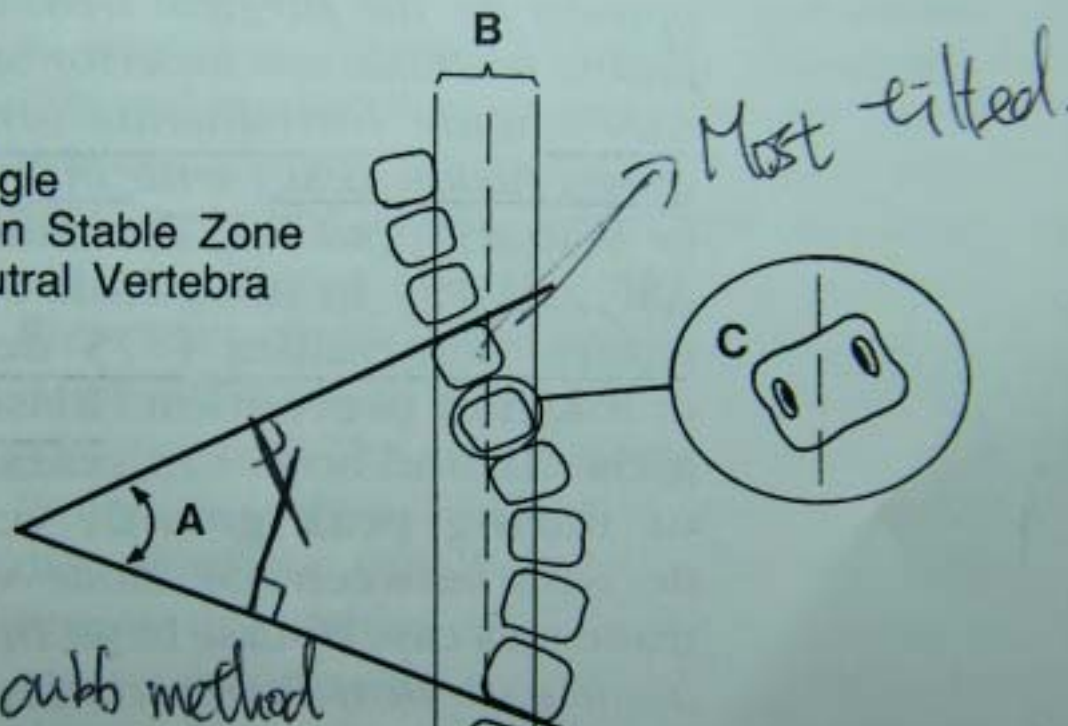
(2005, OKU 8, P.567)

Adult scoliosis surgical intervention

- **Fusion level:**

- 1) The weight bearing PA x-ray and lateral and lateral bending x-ray
- 2) The cranial end in the Harrington stable zone (neutrally rotated)
- 3) The first unfused disk at the caudal end is flexible on lateral bending
- 4) The fusion should not be stopped within the apex of thoracic kyphosis

- A) Cobb Angle
- B) Harrington Stable Zone
- C) Moe Neutral Vertebra



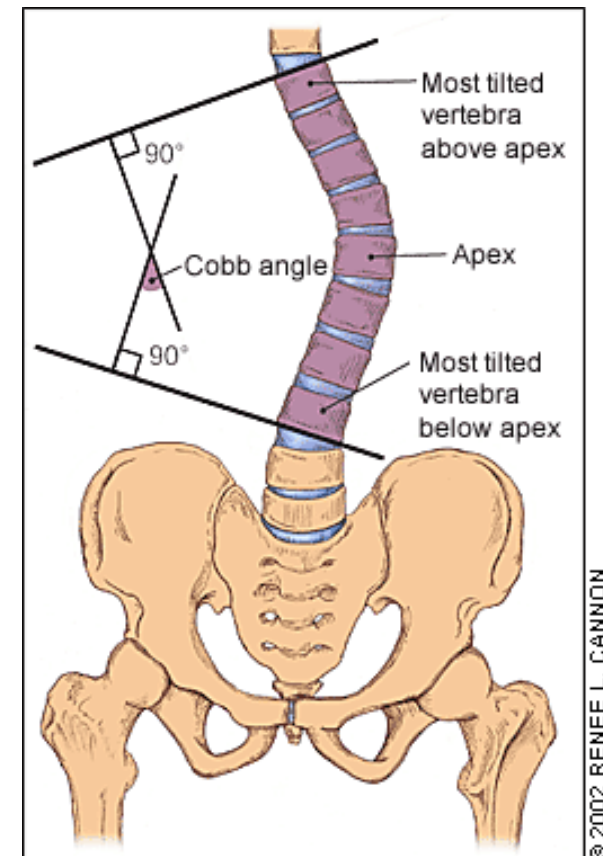
Adam's test

(1553) 關於 Adult spinal deformity 的手術治療

- (A) 若有合併骨質疏鬆，必須作 segmental fixation 以增加穩定度
 - (B) 若脊椎側彎超過 70 度，建議作 combined anterior and posterior surgery
 - (C) Fusion 不能停在 Apex of kyphosis
 - (D) Fusion 尾端第一個 unfused disc，必須是 mobile and flexible on Lateral bending
- (2005, OKU 8, P.568)**

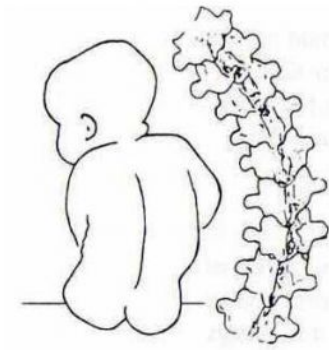
Idiopathic scoliosis

- Lateral curvature of the spine with a Cobb angle of 10° or greater and axial plane rotation
- Infantile (0~3)
- Juvenile (3~10)
- Adolescent (10~18)

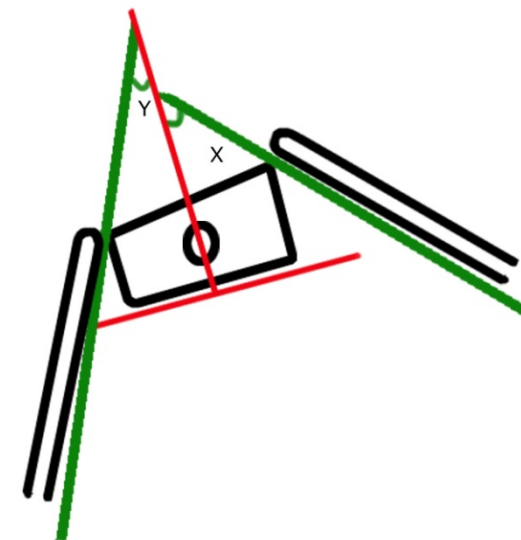
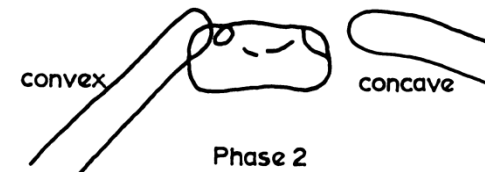
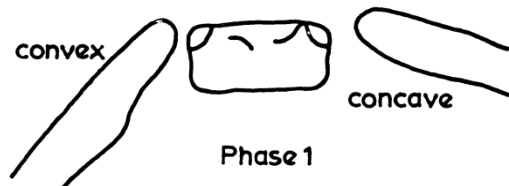


Infantile scoliosis

- Cobb angle $\geq 20^\circ \rightarrow$ 21.7% had neural axis abnormalities, 80% of these patients required neurosurgical intervention
- male to female ratio 1:1
- Left curves are more



- Phase 2 rib: curve is likely to progress
- Phase 1 rib and RVAD (rib-vertebral angle difference) $> 20^\circ$ has a significant risk for curve progression
- $> 30^\circ \Rightarrow$ orthotic device
- Curve $> 50^\circ$: surgical indication
 \Rightarrow Posterior instrumentation



$$RVAD = X - Y$$

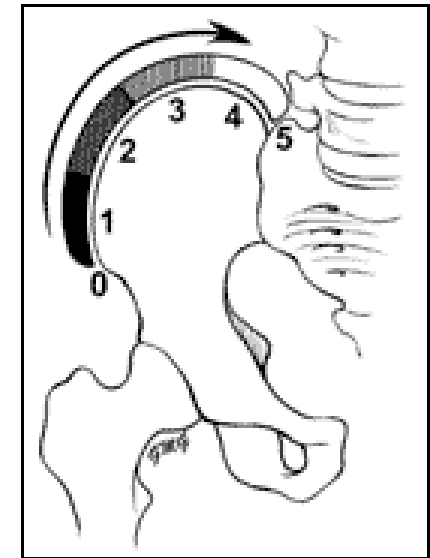
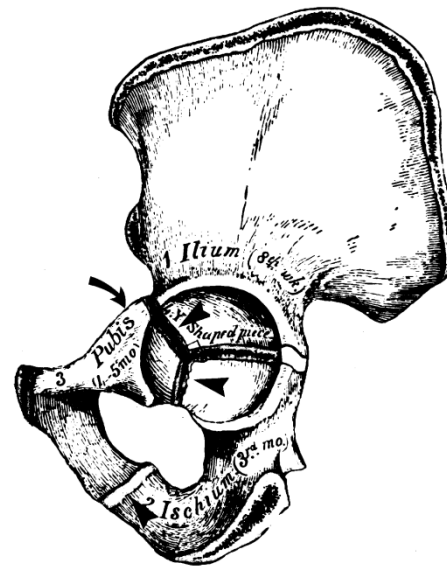
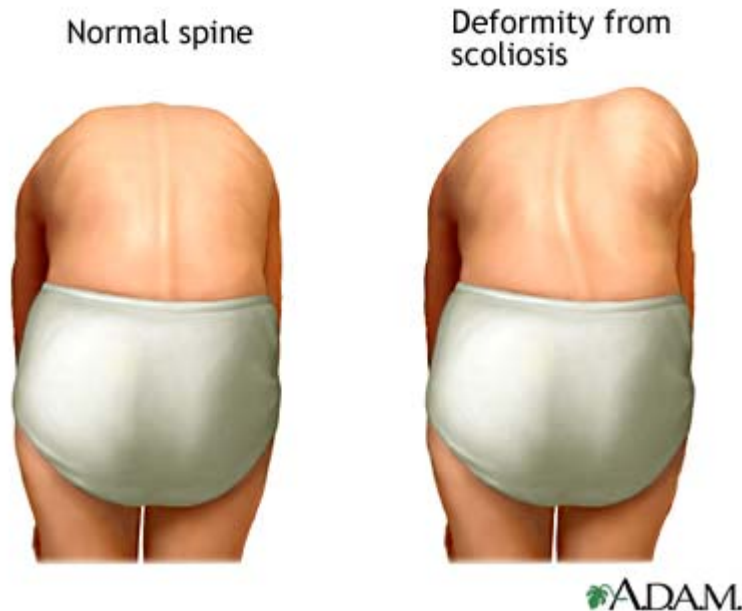
Juvenile idiopathic scoliosis

- Age of 3 to 10 years
- 15% of all patients with idiopathic scoliosis
- Female > male
- 95% have progressive curves
- 20 to 25% neural axis abnormalities
- MRI is recommended
- Curve > 30° or > 20° with 5° of progression
=>bracing

Adolescent idiopathic scoliosis

- Curve between 10° to 20° : 2% to 3%
- Curve $> 30^{\circ}$: 0.3%
- smaller curve, male = female; Curve $> 30^{\circ}$, female to male = 10 : 1
- Curve progress in two scenarios: continued spine growth and large curve magnitude despite completion of spine growth

- Radiographic parameters that indicate skeletal immaturity include open triradiate cartilage and Risser grade 0 to 1



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Adams Forward Bend Test

- Spinal balance: dropping a C7 plumb line and comparing it with the center sacral vertical line
- Nash-Moe: vertebral rotation
- Clavicle angle: shoulder balance



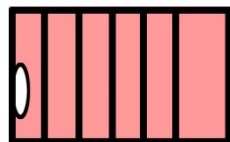
Normal spine



Mid rotation



Moderate rotation



Severe rotation

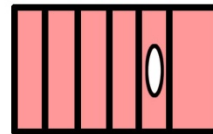
Cobb technique



Normal spine



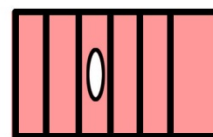
Mid rotation, right pedicle only partly visible



Moderate rotation, right pedicle disappeared



Severe rotation, left pedicle in midline



Marked rotation, left pedicle on right side

Nash-Moe technique



- King-Moe classification
 - 5 type
 - P-A view
- Lenke classification
 - Three components: curve type (1~6), lumbar modifier (A,B,C), thoracic kyphosis (negative, normal, positive)
 - P-A and lateral view, best-effort supine bend film

Congenital scoliosis

- Two basic types: defects of vertebral formation and defects of vertebral segmentation
- The combination of unilateral failure of segmentation and contralateral hemivertebra: the worse prognosis
- Bracing has no benefit on congenital curves, it may help to control long flexible compensatory curves below the congenital components

Congenital kyphosis

- Defect of formation (type 1), defect of segmentation (type 2), or a combination
- failure of segmentation: less common, less deformity
- Type 1: partial or complete deficiency of the vertebral body, but the posterior elements remain present=>anterior impingement on the spinal cord=>surgical intervention should begin immediately

- Type 2: anterior portion of two or more adjacent vertebrae bodies are fused=>less progressive, less deformity, lower risk of paraplegia
- Nonsurgical treatment has no benefit
- Younger than age of 3~5 years, kyphosis < 50°=>simple posterior fusion without instrumentation

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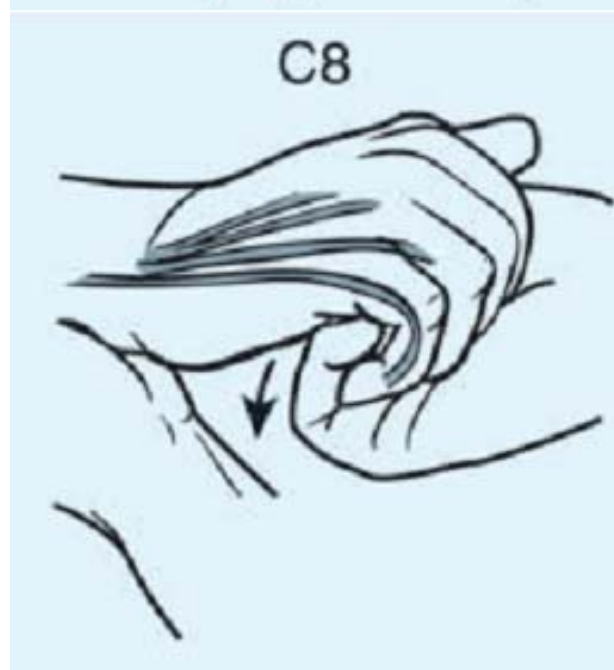
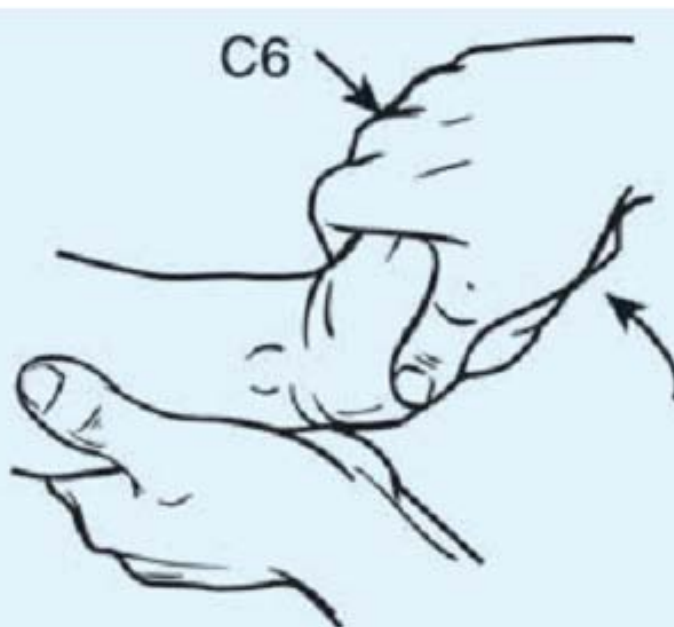
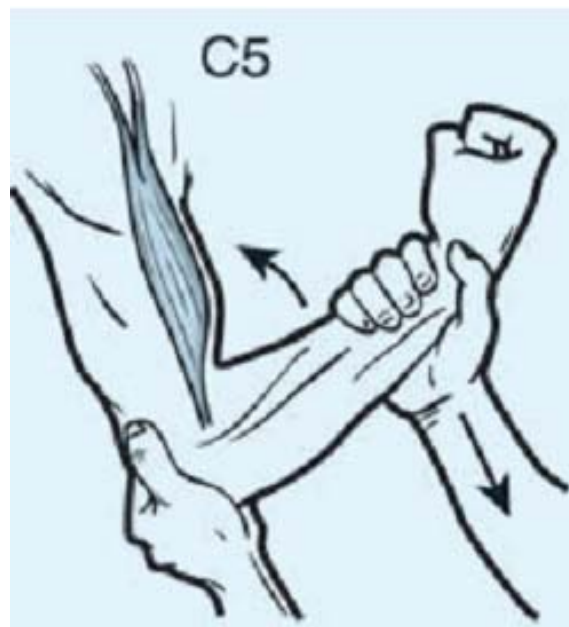
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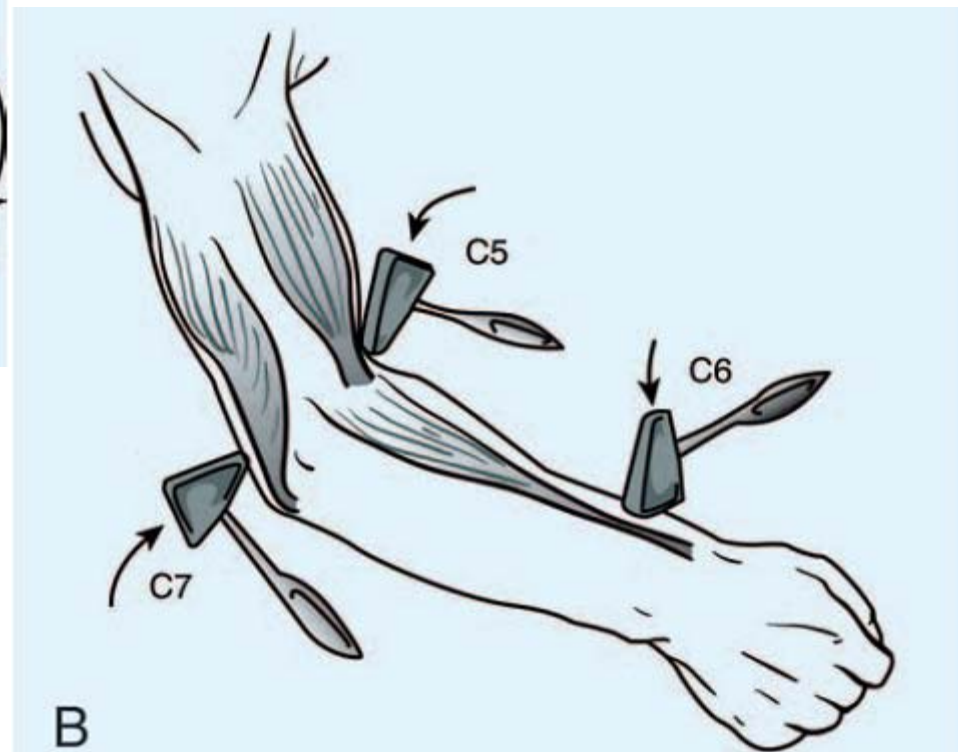
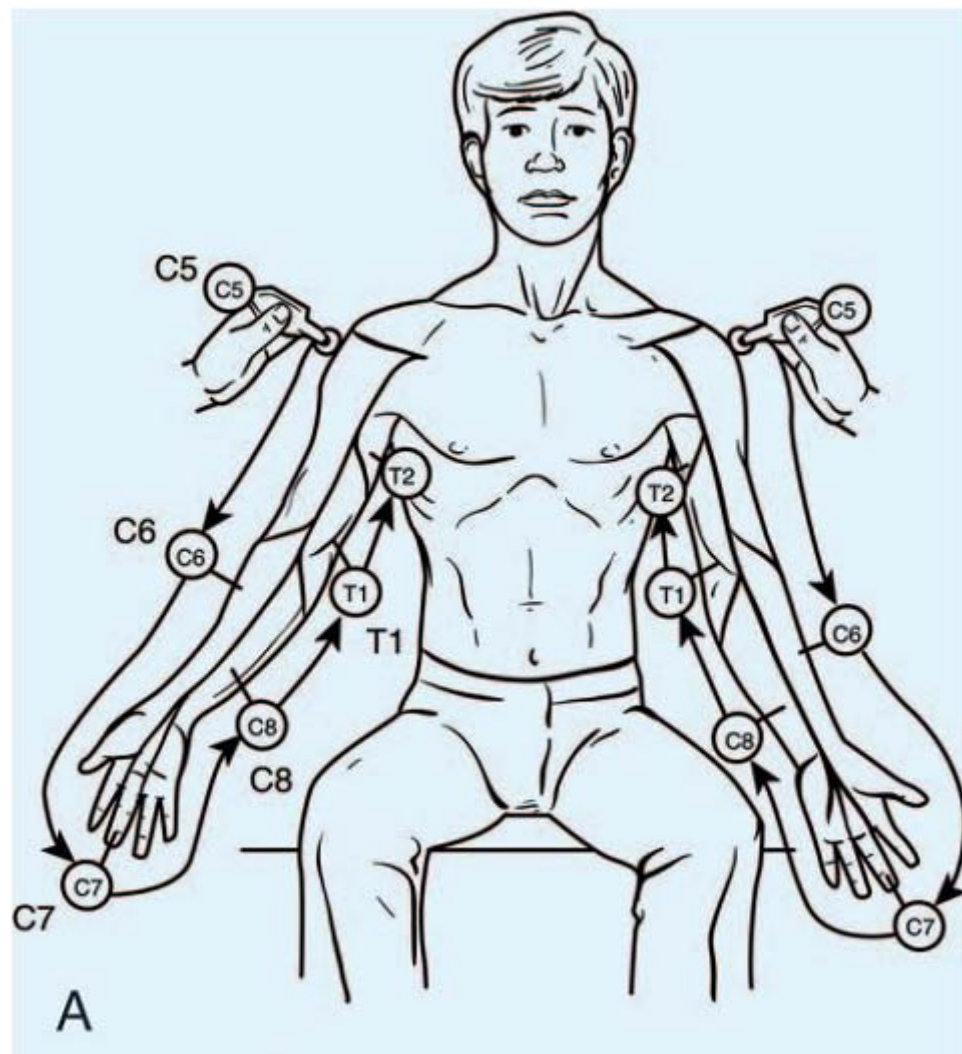
BOOK READING ORTHOPEDIC REVIEW

Cervical disk diseases

- Cervical disk diseases: degenerative process, in aging patient
- No specific trauma
- Microtrauma
- ➔ change in the proteoglycan, and collagen content of the nucleus ➔ loss of water ➔ less support ➔ loss normal lordosis ➔ disk herniation /bulging, load to facet and uncovertebral joint, lig. Flavum redundant

- Radiculopathy
 - Pain, paresthesia, weakness
 - With/without neck pain
 - Hyporeflexia
 - Biceps C5
 - Brachioradialis C6
 - Triceps C7
 - Weakness or atrophy of the innervated muscle group





- C5, c6, c7: most commonly affected by cervical disk disease
- Most flexion and extension in the subaxial spine

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- Myelopathy:
 - Disk bulging, uncovertebral hypertrophy with vertebral end plate osteophytes, ligamentum flavum hypertrophy/redundancy
 - Compression on the anterior spinal arteries → ischemia of the spinal cord

- Myelopathy
 - Clumsiness (loss of fine motor skills)
 - Ataxia
 - Spasticity
 - Dropping of objects, Changes in handwriting, Restlessness in the legs
 - Loss of bowel or bladder control
 - Hyperreflexia below the level of spinal cord compression
 - Hoffman sign
 - Babinski sign
 - Difficulty with tandem gait

- Differential diagnosis:
 - Multiple sclerosis
 - Anterior horn disease
 - Central nervous system tumors

- Cervical spondylosis → may with neck pain
- Myotomal nerve root distribution → pain or discomfort in a referred sclerotomal distribution

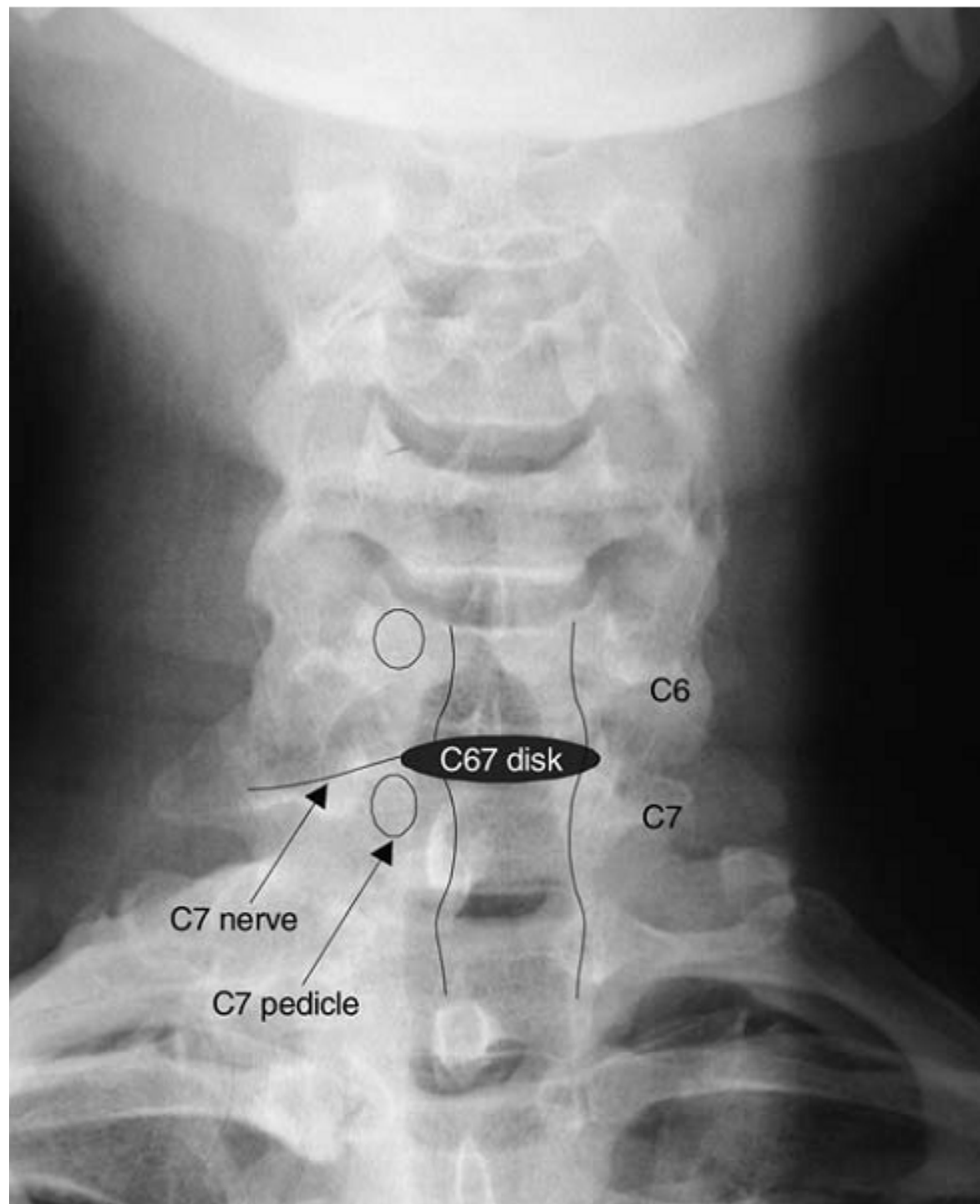
- > 75% patient: symptoms of radiculopathy improve with conservative treatment, including physical therapy, NSAID, activity modification
- Cervical myelopathy: less predictable course, slowly worsening clinical picture

Image

- AP, lateral
- Flexion and extension: instability
- Oblique view: neural foramen and facets
- Swimmer's view: cervicothoracic junction

- MRI:
 - Sagittal: good overview of the levels of cord compression and central disk pathology
 - False impression of cervical kyphosis
 - Parasagittal: lateral disk herniation and foraminal narrowing

- CT + myelography
- Diskography



Nonsurgical care

- Neck pain and cervical radiculopathy → should start with conservative, nonsurgical measures, (physical therapy, traction, activity modification, medications)
- Isometric exercises
- Traction
- NSAID
- Steroid (oral or injection)
- Narcotics: not used in chronic pain
- Nerve root blocks / epidural steroid injection

- signs or symptoms of myelopathy develop → surgical decompression
- Radiographic evidence of spinal cord compression when patients have no correlating symptoms or examinations: is not a surgical indication

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Figure 4 Preoperative sagittal MRI (A) and postoperative lateral radiograph (B) of a patient with persistent C6 radicular symptoms who underwent anterior cervical dis

Surgical indications

- Axial neck pain from degenerative disk disease: rarely an indication for OP, 60-70% success rates for fusion
- Cervical disk replacement, low term??
- Radiculopathy: responds well , > 90% success rates
- Clinically myelopathy: indicated for OP

- Anterior decompression: central disk herniation, uncovertebral spurring, central canal stenosis
- Landmarks:
 - carotid tubercle → lateral process of C6
 - cricoid cartilage → C6 level
 - thyroid cartilage → C4-C5 level

- Diskectomy and decompression ➔ interbody fusion
- Allograft: good fusion rates for sigle level
- Diskectomy without fusion: kyphotic collapse, neck pain, potential recurrent foraminal narrowing

- Plate:
 - Potentially increase union rate
 - Limit hyphotic collapse
 - Minimize the need for external cervical orthoses

- Posterior laminoforaminotomy:
 - purely foraminal stenosis and radiculopathy from a soft disk or hypertrophied facet or uncovertebral joint
 - myelopathy
 - Not good treatment for axial neck pain