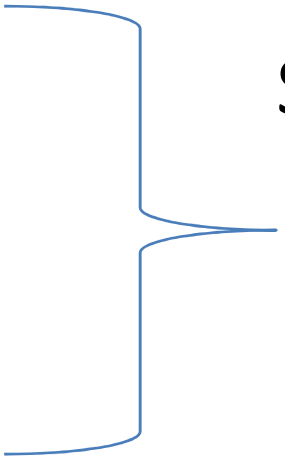
Minimally Invasive & Endoscopic Spine Surgery

Presented by: Amandeep

Why Minimally Invasive Spine Surgery?

- A basic tenet of surgery is to effectively treat pathology with minimal disturbance of normal anatomy: leaving “the smallest footprint.”

- Illumination
- Magnification
- Instrumentation



Small incisions

Less tissue disruptions

Why Minimally Invasive Spine Surgery?

- A basic tenet of surgery is to effectively treat pathology with minimal disturbance of normal anatomy: leaving ***"the smallest footprint."***

  -Minimizes tissue trauma, post-operative pain &hospital stay

  -Better cosmesis

MISS-Advantages:

- Reduced post-operative pain
- Tiny scars
- Shorter recovery time
- Shorter hospital stay

- Surgery → Tissue damage
- Tissue Damage → Pain/Function
- MIS → Less Pain/Better Function

- Kawaguchi et al (Spine;1998): Effect of retraction on back muscles in rats
- Three comparison groups:

    2-hour continuous retraction,

    5-minute retraction release after 1 hour of retraction

    5-minute release at every 40 minutes of retraction.

- Kawaguchi et al(Spine;1998)
- Histochemical examination at 48hrs, 1week, 6weeks
- Serum CPK MM measurement at 48 hrs
- Results: Muscle degeneration max. in group 1

  CPK MM highest in group1

  Regenerated muscle fibres of smallest diameter in group1

- Taylor H et al(Spine;2002): Impact of self retaining retractors on paraspinal muscles
- Twenty patients; Intramuscular pressure measurement 5, 30, 60 min into the surgery
- Muscle biopsies before and after retraction studied using ATP birefringence.
- Results:

    Significant increase in IMP during retraction

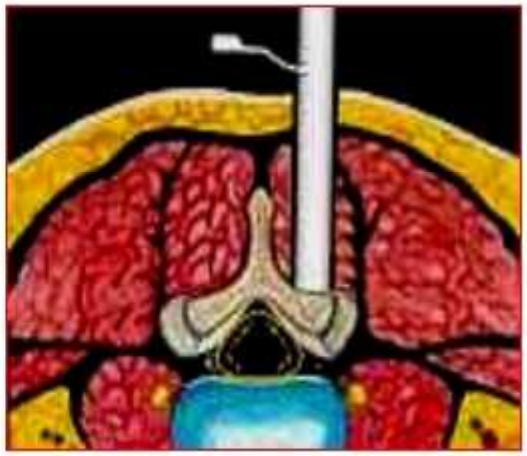
    Reduced function following retraction(decreased ATP)

- Datta G et al(Neursurgery;2004):Back pain & disability after lumbar laminectomy: Is there a relation to muscle retraction?
- Twenty patients; continuous monitoring of IMP &IPP
- VAS, ODI,SF-36 Health survey
- Results:

  Rapid/sustained rise in IMP with retraction;IPP→0

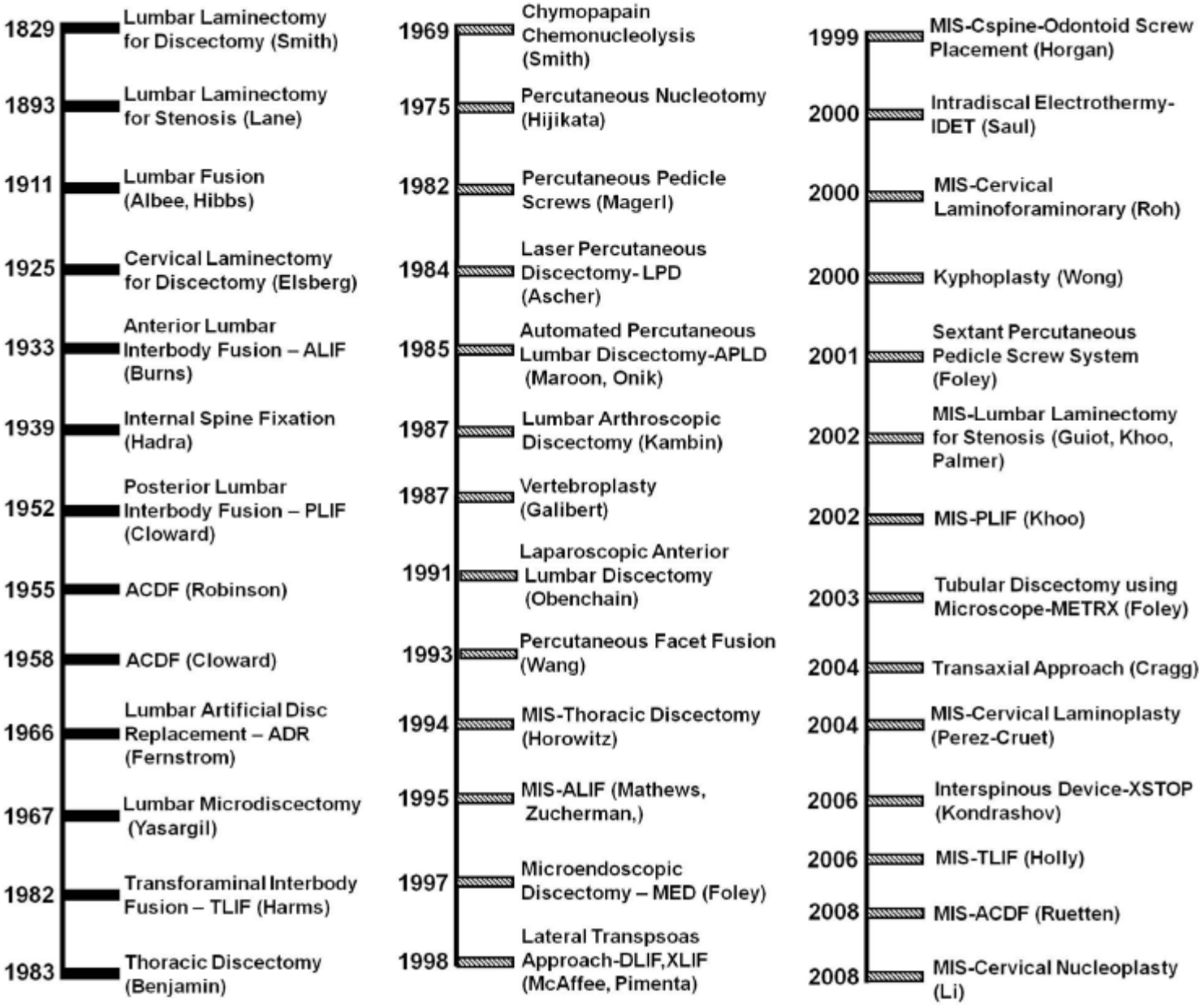
  VAS,ODI,SF-36 at 6 months worse with retraction>60min;no relation to retractor type, IMP/IPP, surgeon, wound length

- MISS circumvents iatrogenic surgical morbidity decreasing tissue injury and blood loss, and thereby reduce length of hospitalization, perioperative pain, analgesic usage, and recovery times.

- In many   decompressive operations into outpatient procedures.

  Thus capturing the interest of surgeons and patients alike.

Milestones in Spine Surgery



Types of Spinal Minimally Invasive Procedures

- Minimally invasive procedures and technologies can be broadly characterized as:
- Traditional open procedures through small incisions(open microdiscectomy),
- Endoscopy (thoracic/lumbar discectomy, deformity management, and trauma management),
- Tubular retractor–muscle dilation (MED, METRx, XLIF, Sextant, Mantis, and Longitude),
- Fine needle procedures (chemonucleolysis, nucleotome procedures, vertebroplasty, and kyphoplasty), and
- Miscellaneous technologies (laser-assisted percutaneous discectomy, X-STOP, and AxiaLIF).

Keys to MISS

- Smaller incisions
- Muscle splitting instead of muscle cutting
  Spine Surgery
- Fluoroscopic and image-guided navigation

MISS-Lumbar Spine Disease

- MI Discectomy
- Anterior Lumbar Interbody Fusion (ALIF)
- Posterior Lumbar Interbody Fusion (PLIF)
- Transforaminal Lumbar Interbody Fusion
- eXtreme Lateral Interbody Fusion
- AxialIF for Degenerative L4-S1 Disc Disease
- Kyphoplasty/Vertebroplasty

Evolution of MISS-Lumbar Disc Disease

- 1857: Virchow-Traumatic Lumbar disc disease
- 1955: Mallis- Intraoperative binocular
- 1963: Smith- Chemonucleolysis
- 1967: Yasargil- Microdiscectomy
- 1975: Hijikata- Percutaneous discectomy
- 1978:Williams-Open lumbar microdiscectomy
- 1984: Ascher- Nd-YAG Laser
- 1987: Maroon- APLD

Evolution of MISS-Lumbar Disc Disease

- 1991: Faubert & Caspart-Tubular retractor for discectomy
- 1997: Foley & Smith-MED
- 2000: Saal & Saal- Intradiscal electrothermy
- 2003:METRx System-Adaptation of microscope to tubular retractors

Endoscopy

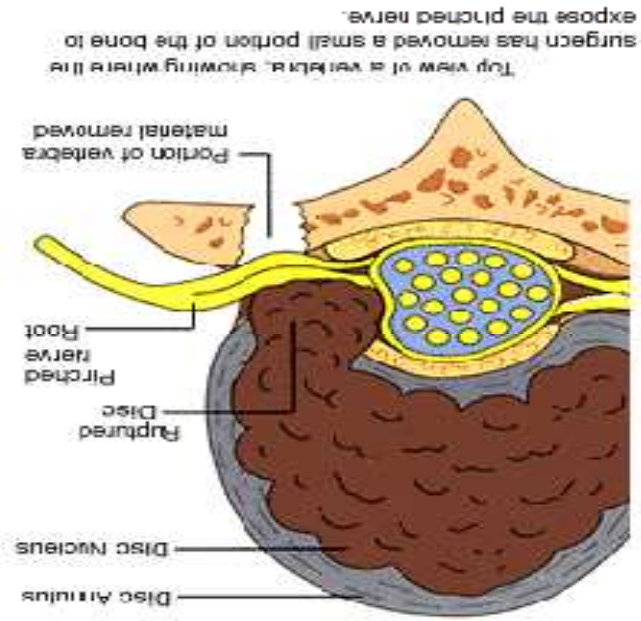
- Posterior cervical lamino-foraminotomy and discectomy .
- Thoracic discectomy, lumbar laminectomy for stenosis
- Farlateral lumbar discectomy , and interbody lumbar
- Fusion

Retractor Systems

- METRx
- MIRA
- AccuVision Minimally Invasive spine System
- NAPA Minimally Invasive Retractor System
- Serengeti Retractor System
- Luxor Minimally Invasive Retractor System

Microlumbar discectomy

- Entry point is through the interlaminar window
- Microscope provides better visualization



Microlumbar discectomy

Indications:

- Single level disc herniation
- Adjacent bisegmental herniation
- Desiccated disc with bony root entrapment/lateral canal stenosis

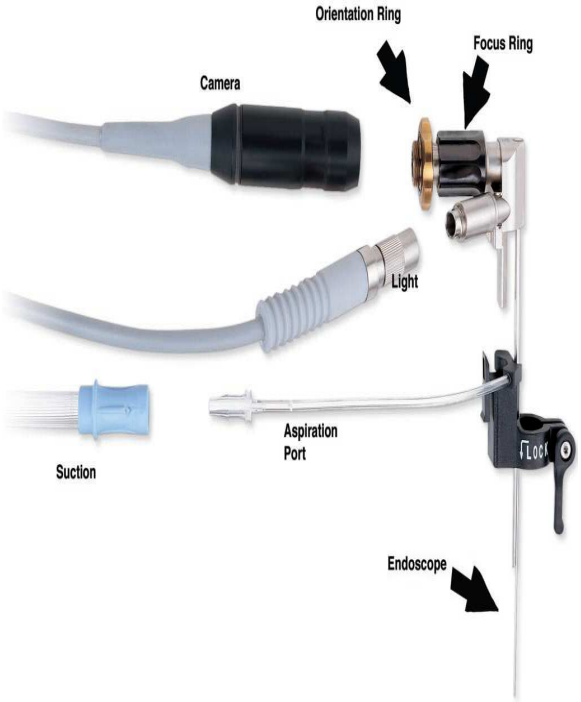
Contraindications:

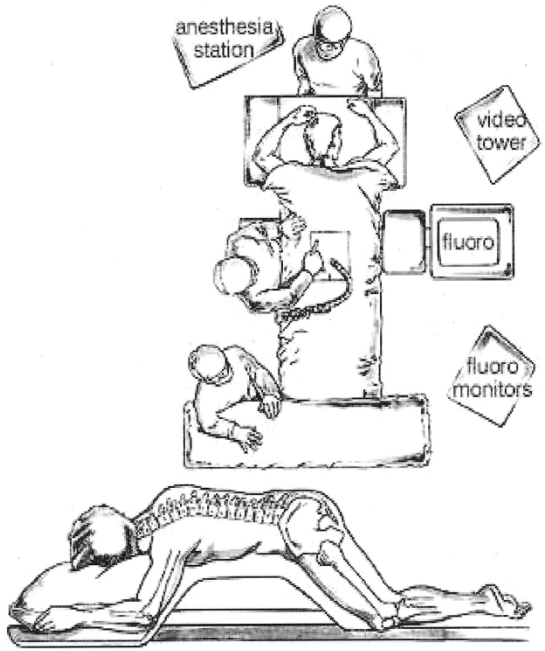
- Spinal canal stenosis
- > 2 level disc
- Bony bridging of interlaminar space

Microendoscopic discectomy

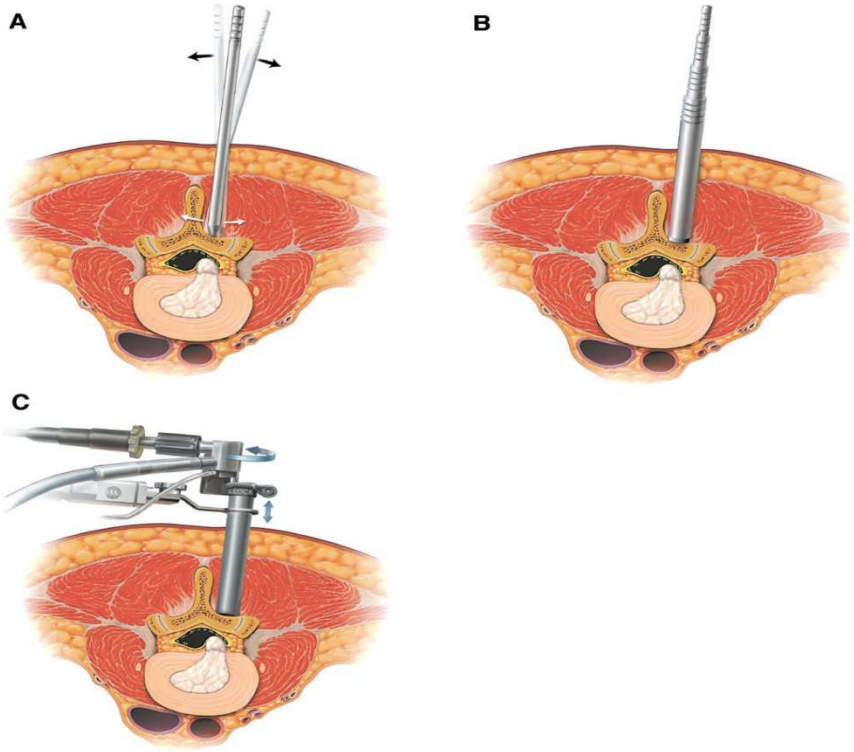
- First developed in 1997
- Muscle splitting approach with serial tubular dilators
- Tubular retractor and special endoscope used to perform discectomy

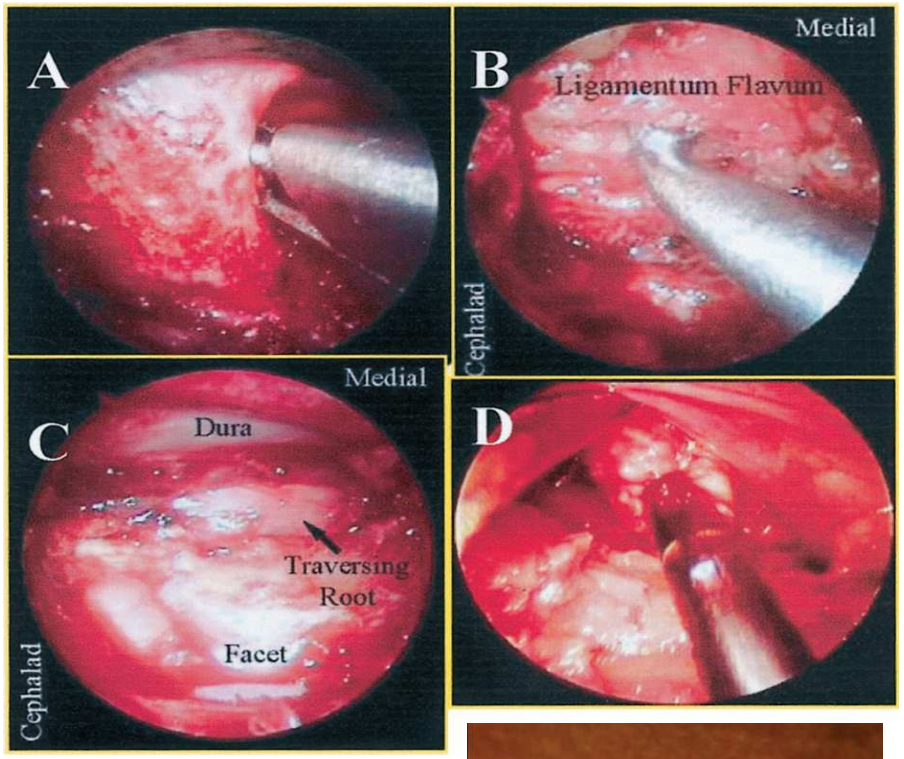
Microendoscopic discectomy

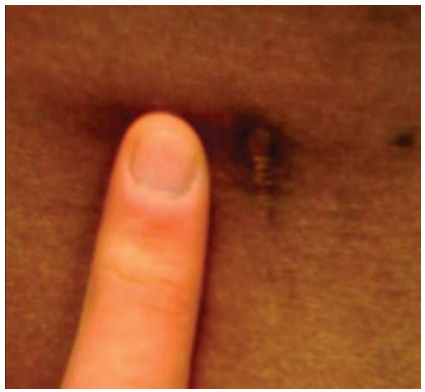




MED


A
B
C


A
B
Medial
Ligamentum Flavum
Cephalad
C
Medial
Dura
Traversing
Root
Facet
Cephalad
D



MED-Advantages

- It reduces tissue trauma, less traumatic than standard microdiscectomy
- Integral visualization and illumination of the operative field through the endoscope
- Allows direct visualization of the nerve root and disc disease, and
- Enables bony decompression.

MED-Limitations

- There is a learning curve to using the system efficiently and safely
- Complications like dural tear, if occur can be difficult to repair
- Delicate instruments with risk of instrument failure

MED vs Open Lumbar discectomy

- Righesso O et al(Neurosurgery;2007)
- Randomized controlled trial
- 40 patients with sciatica/lumbar disc disease;24 months follow-up
- Statistically significant variables amongst many studied:

    Length of incision- Greater in OD

    Length of hospital stay- Greater in OD

    Operative time- Greater in MED

MISS-Degenerative Disease of Spine

- Advances in imaging, instrumentation, bone graft substitutes have allowed development of MISS
- Much of the developmental trends in MISS and in spine surgery in general have been driven by the challenge of achieving arthrodesis in the lumbar spine.

MISS-Degenerative Disease of Spine

- The chronology of open techniques for accessing the disc space

  1933: Burns-ALIF

  1952: Cloward-PLIF

  1966:Fernstrom ADR

  1982: Harms & Rolinger-TLIF

- 1991: Obenchain- Anterior laparoscopic disc removal
- 2002:Khoo- First MIS–PLIF procedure
- 2006,:Holly and Schwender MISTLIFs using tubular retractors.
- 2008:Park & Foley- Percutaneous reduction screws (CD Horizon Sextant, Medtronic, Inc.) along with PEEK interbody spacers to perform MISTLIF procedure in patients with Grades I and II isthmic spondylolisthesis.

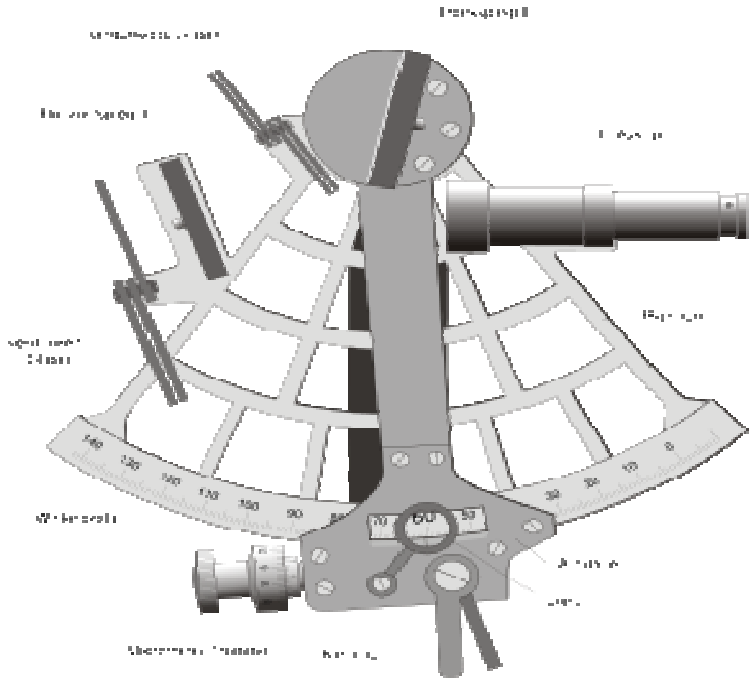
Minimally Invasive Percutaneous Posterior Lumbar Interbody Fusion

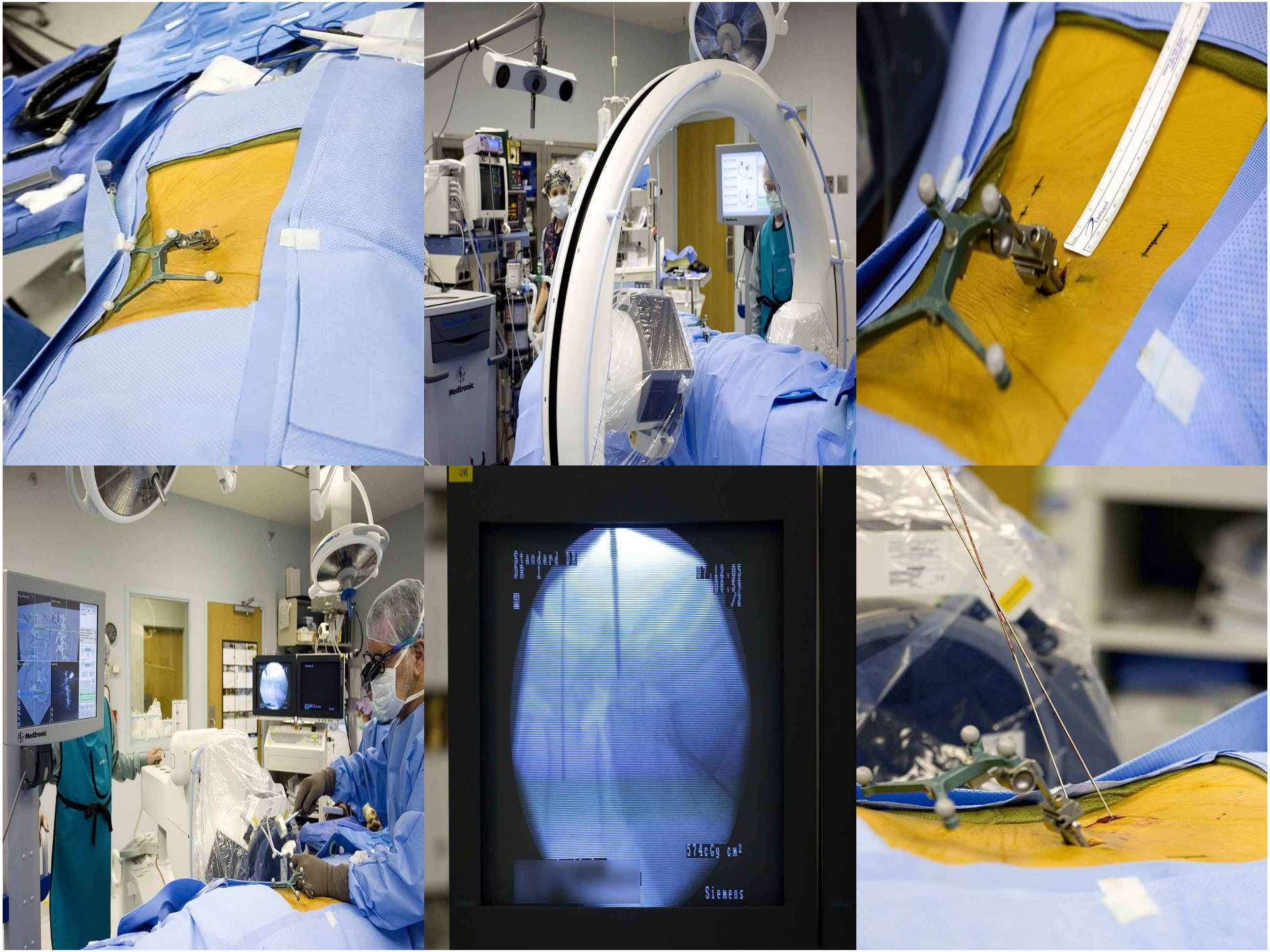
Sextant System

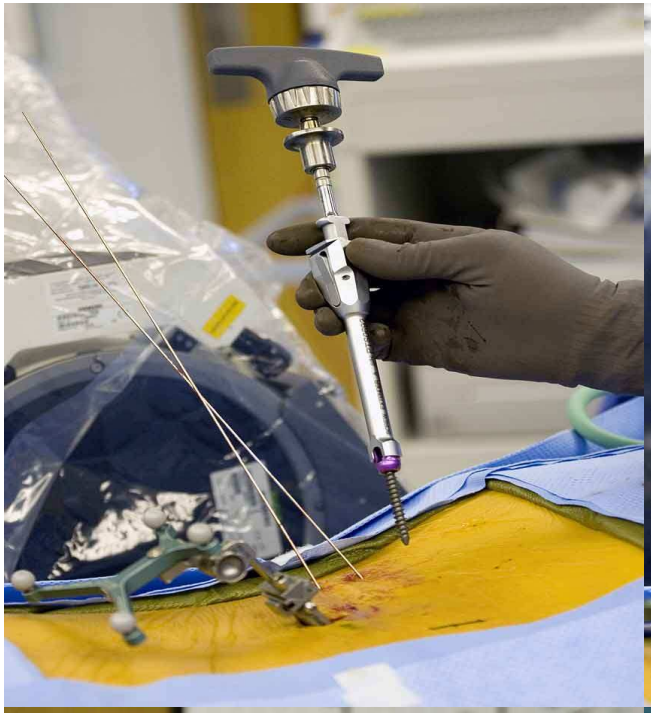
Sextant- An instrument used to measure the altitude of an object above horizon

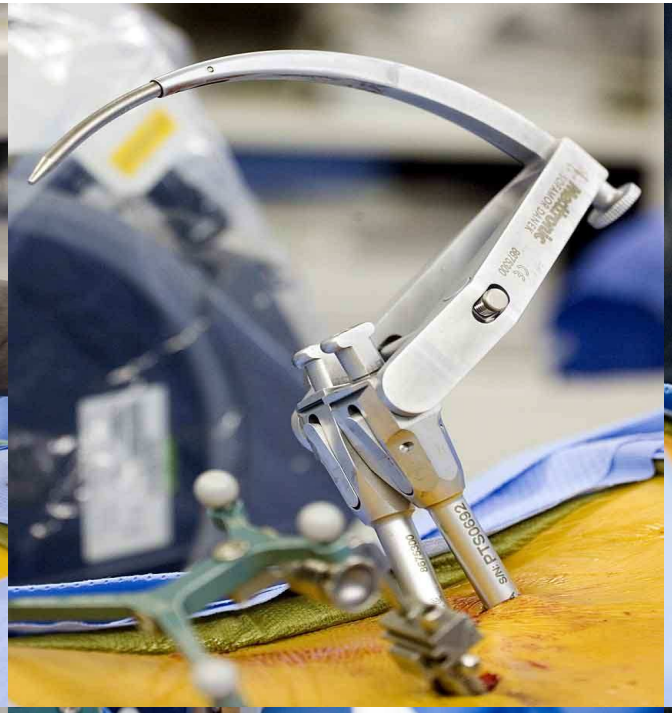
The scale has a length of 1/6 of a full circle

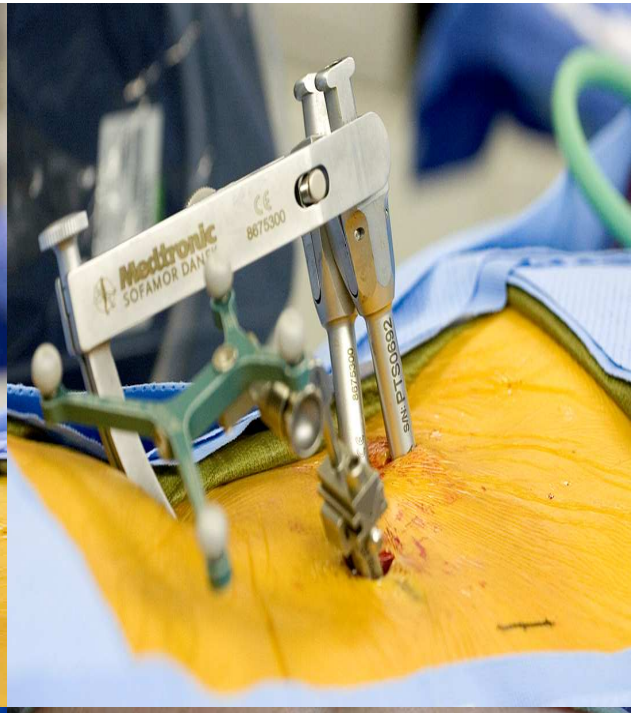
Principle: Any two points in proximity can be considered part of a circle

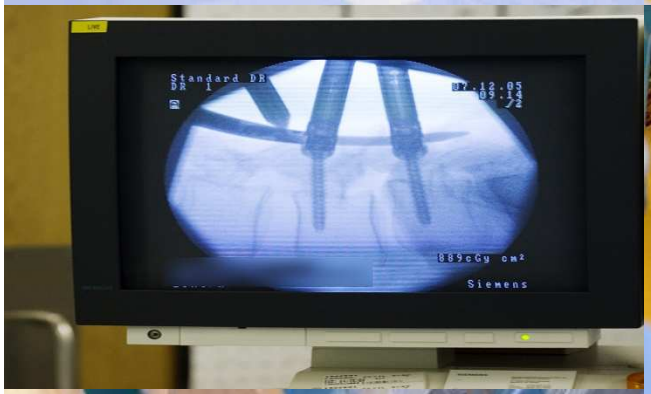


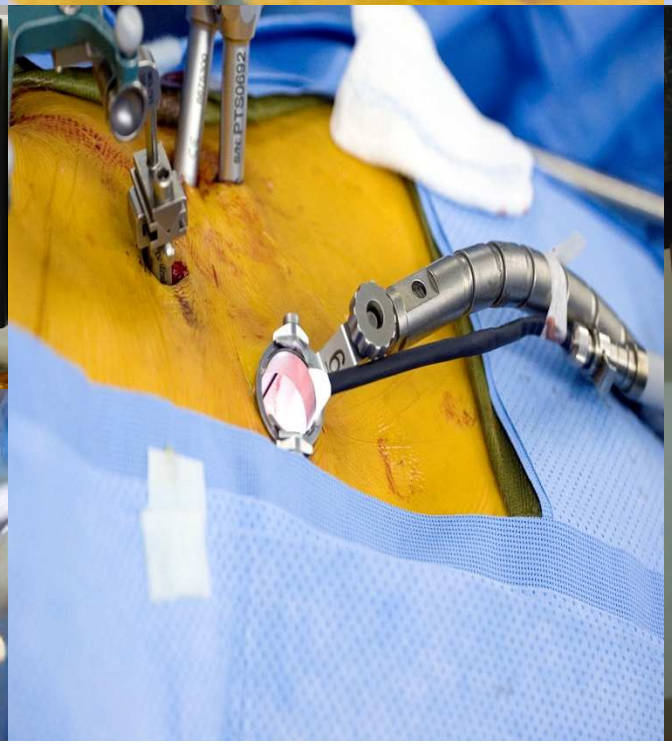

Medtronic
Medtronic
574cGy cm²
Siemens

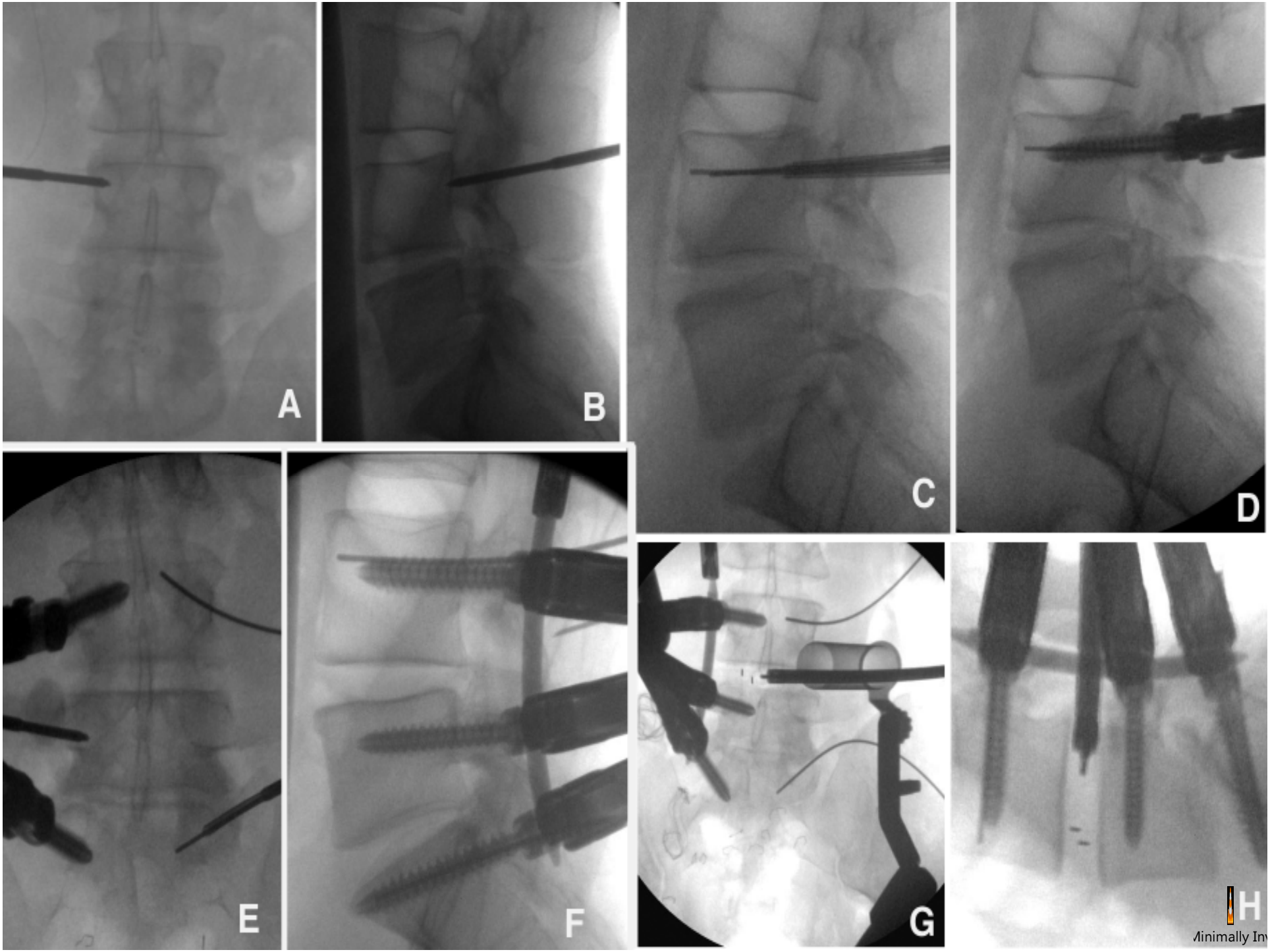



Medtronic
SN:PTS0692


Medtronic
SOFAMOR DANEK
SN:PTS0692


Standard DR
889cGy cm²
Siemens


SN:PTS0692

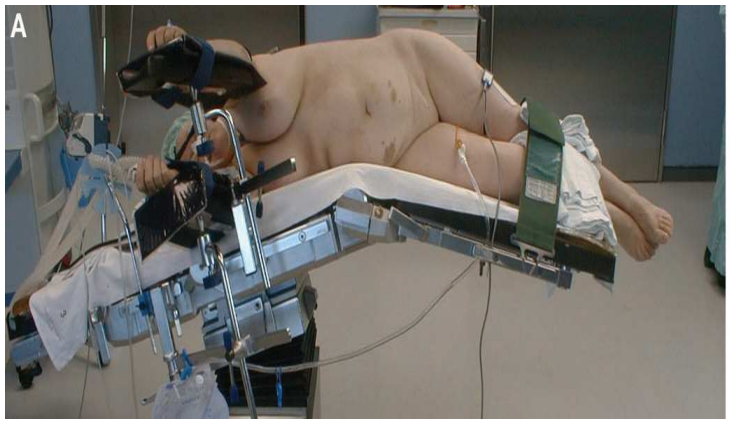

A
B
C
D
E
F
G
H

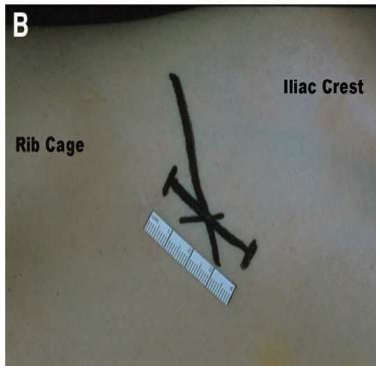
Anterior Lumbar Interbody Fusion

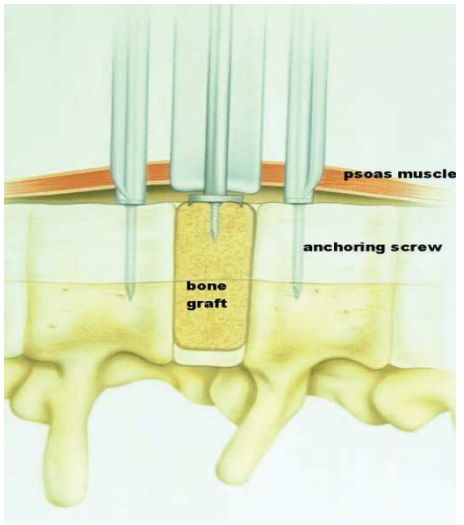
- Iatrogenic trauma- the main contributor to complications and morbidity associated with open anterior approach to the lumbar spine and lumbosacral junction
- The application of microsurgical principles and philosophy could overcome these technique-associated disadvantages.

Anterior Lumbar Interbody Fusion

- Retroperitoneal microsurgical approach (L2-3,L3-4,L4-5)

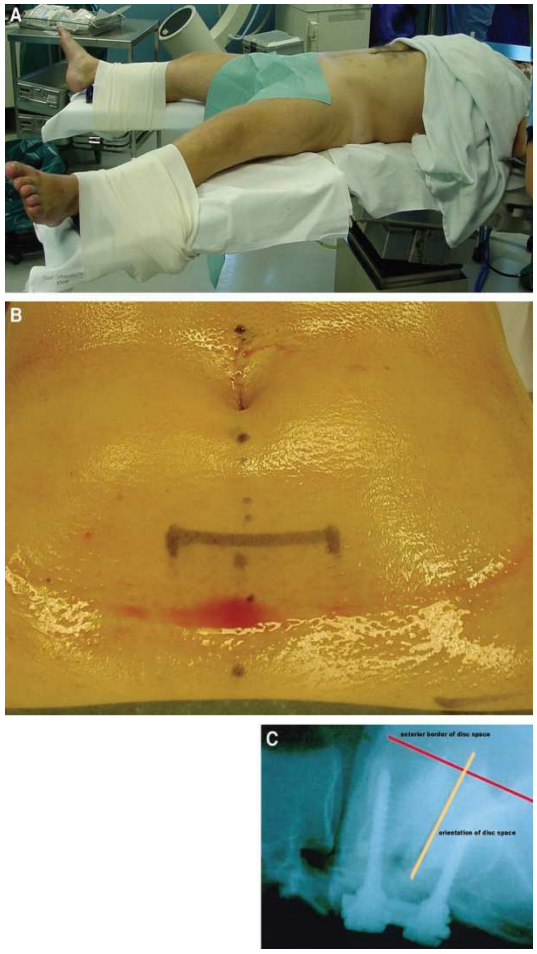






Anterior Lumbar Interbody Fusion

- Midline microsurgical approach to L5-S1



Anterior Lumbar Interbody Fusion

- Voss S et al (1998):

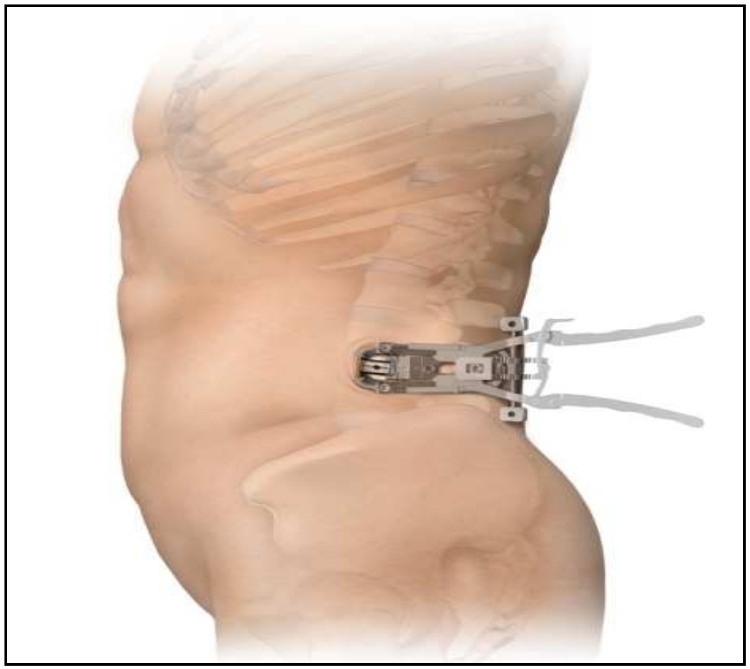
  20% reduction in operative time

  50% reduction in blood loss

  No significant difference in clinical outcome &complication rates

eXtreme Lateral Interbody Fusion-XLIF

- Retroperitoneal approach
- Lateral flank incision
- Microscope/Endoscope



eXtreme Lateral Interbody Fusion-XLIF

- Patient starts walking within few hours
- Discharged after 24 hours
- Rapid return to normal activity, within weeks rather than months

eXtreme Lateral Interbody Fusion-XLIF

- XLIF can be performed for a variety of conditions :
- Degenerative disc disease,
- Recurrent disc herniation,
- Spondylolisthesis,
- Pseudoarthrosis, osteomyelitis/discitis, and post-laminectomy syndrome.
- Anterior and lateral tumors of the thoracolumbar spine
- Debilitating spinal deformity (scoliosis).

eXtreme Lateral Interbody Fusion-XLIF

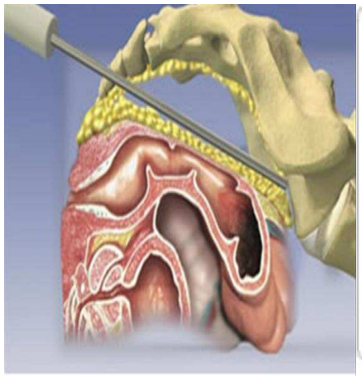
- Patient selection is important –

  Severe canal stenosis secondary to facet hypertrophy &

  Dorsal compressive disease require posterior approach

AxiaLIF

- Developed by Cragg,2004
- Safe, reproducible, pre-sacral approach
- Minimallv invasive access



AxiaLIF

- Soft-tissue sparing
- Annulus remains intact
- Restoration of disc height
- Immediate rigid segmental fixation and stability of L4-S1
- Virgin corridor for a previously operated segment
- Enables fusion of L5-S1 without removing implants from rostral previously implanted segment

IF 2L Animati

AxiaLIF-Complications

- Hemorrhage
- Bowel Perforation
- Infection
- Hardware failure

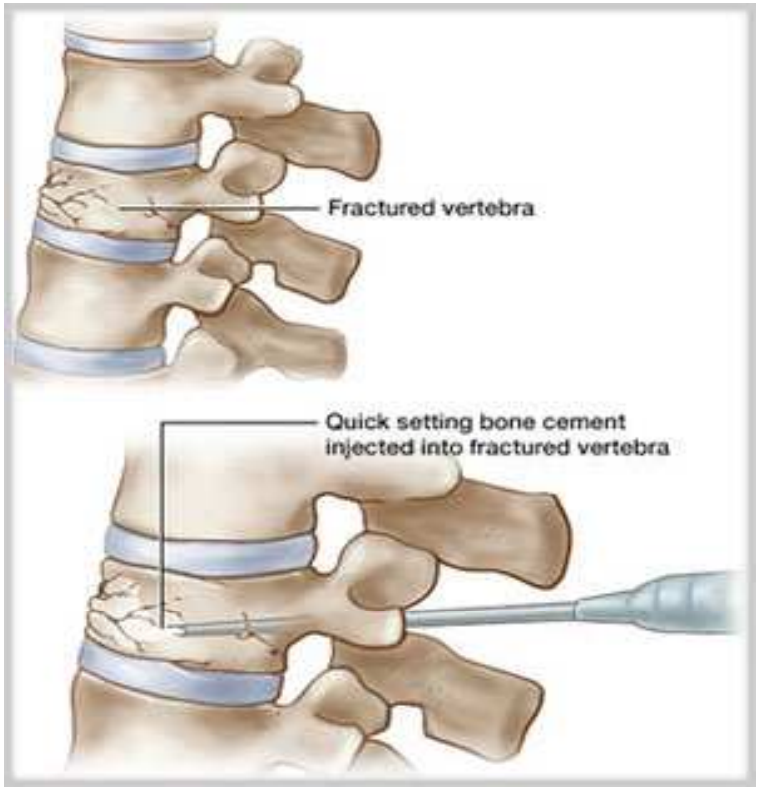
Vertebroplasty/Kyphoplasty

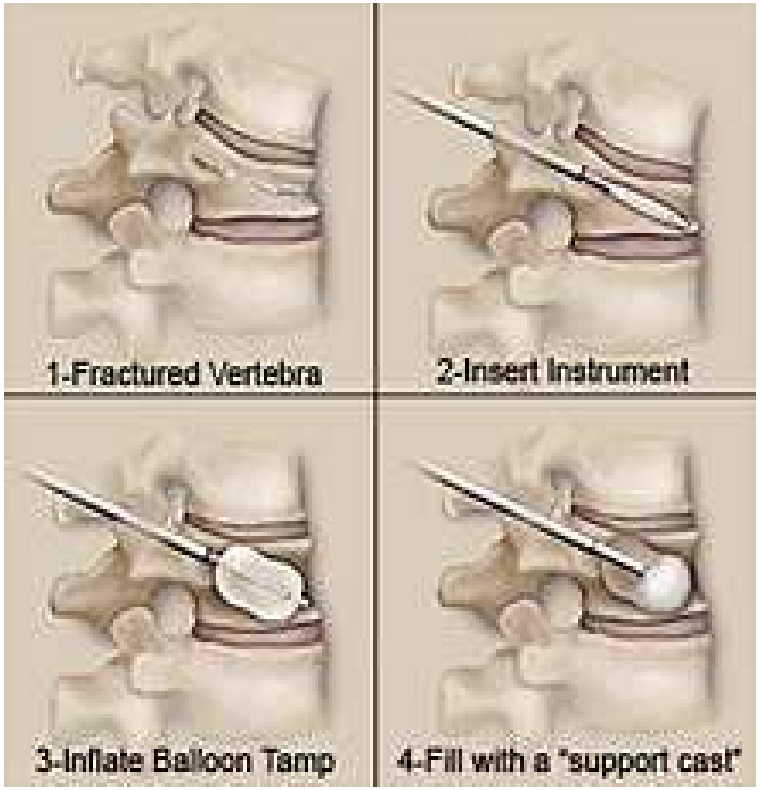
- Percutaneous vertebroplasty –Deramond et al(1987)
- An image-guided, minimally invasive, non-surgical therapy used to strengthen a broken vertebra
- Indications:

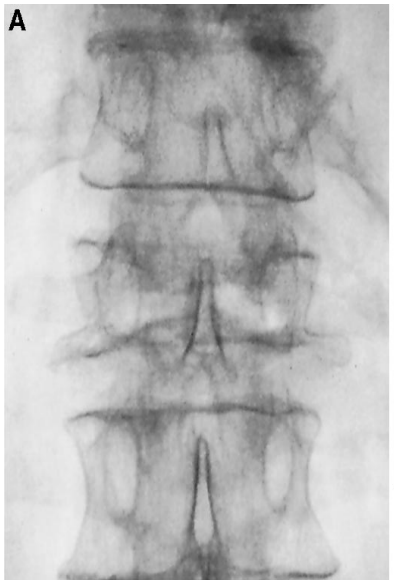
  - Pain caused by osteoporotic compression fractures.
  - Pain caused by fractures due to vascular malformations.
  - Pain caused by fractures due to tumors, which have invaded the vertebral body

Vertebroplasty /Kyphoplasty

- Contraindications:
- Recent systemic/spinal infection
- Uncorrected bleeding diathesis
- Insufficient cardiopulmonary health
- Fracture related canal compromise with myelopathy / radiculopathy


Fractured vertebra
Quick setting bone cement
injected into fractured vertebra


1-Fractured Vertebra
2-Insert Instrument
3-Inflate Balloon Tamp
4-Fill with a "support cast"


A

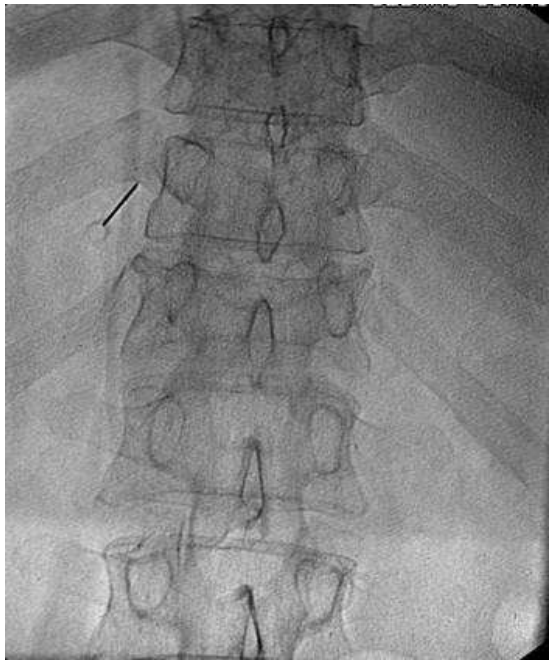

B


A

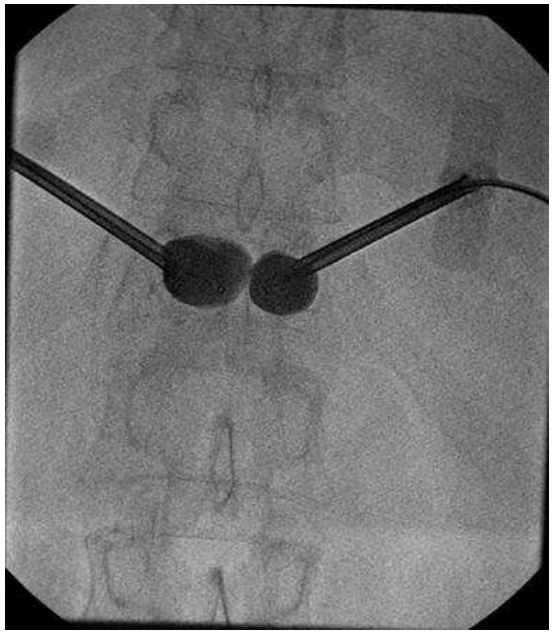

B

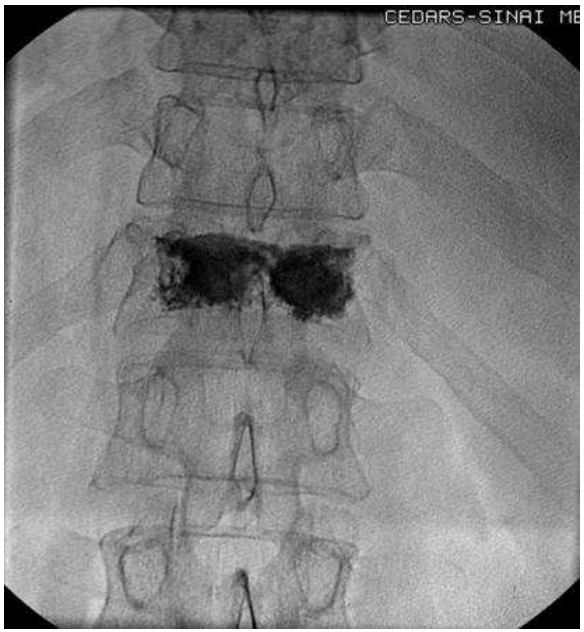

A


B




CEDARS-SINAI MEDI




CEDARS-SINAI ME

Vertebroplasty-Complications

- Incidence :< 10%
  - Increased pain,
  - Radiculopathy,
  - Cord compression,
  - Infection,
  - Rib fracture,
  - Adjacent level vertebral body collapse,
  - Venous embolism
  - Cement migration(radiculopathy-4%;cord compression-0.5%)

Vertebroplasty-Complications

- Cement migration can be prevented by partial filling of VB(<30% by vol of VB)
- Liebschner et al(Spine;2001)-Only 15% volume fraction is needed to restore stiffness to predamaged levels.

Video Assisted Thoracoscopic Surgery

- Indications:
  - -Disc herniation
  - -Sympathectomy
  - -Vertebral biopsy
  - -Vertebrectomy
  - -Bone graft/instrumentation
  - -Anterior release for spinal deformity correction

VATS-Surgical approach

- Side selection:
  - Lateralization of pathology
  - Eccentric placement of aorta
- Anesthesia:
  - Single lung ventilation/bronchial blockers

VATS-Surgical approach

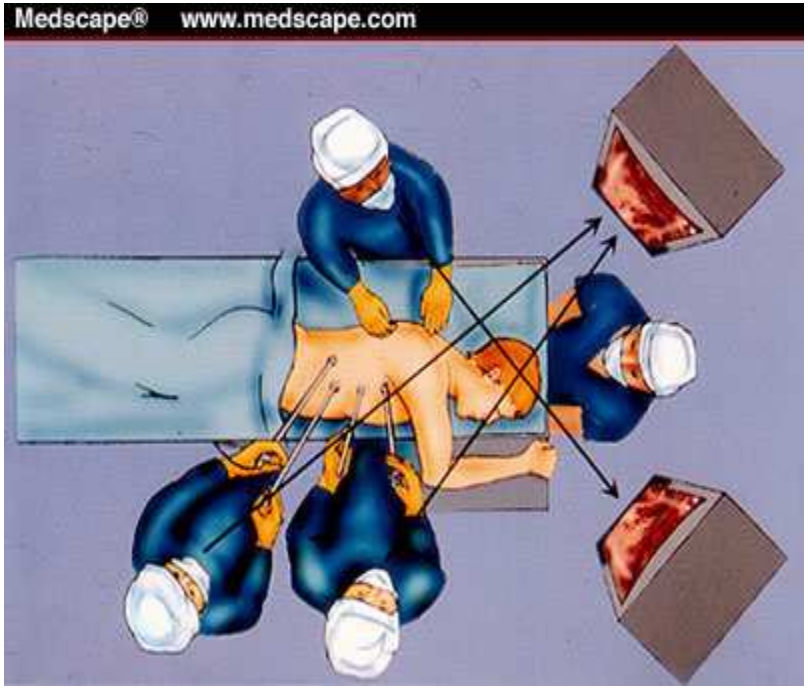
- Position: Lateral decubitus
- Port placement:

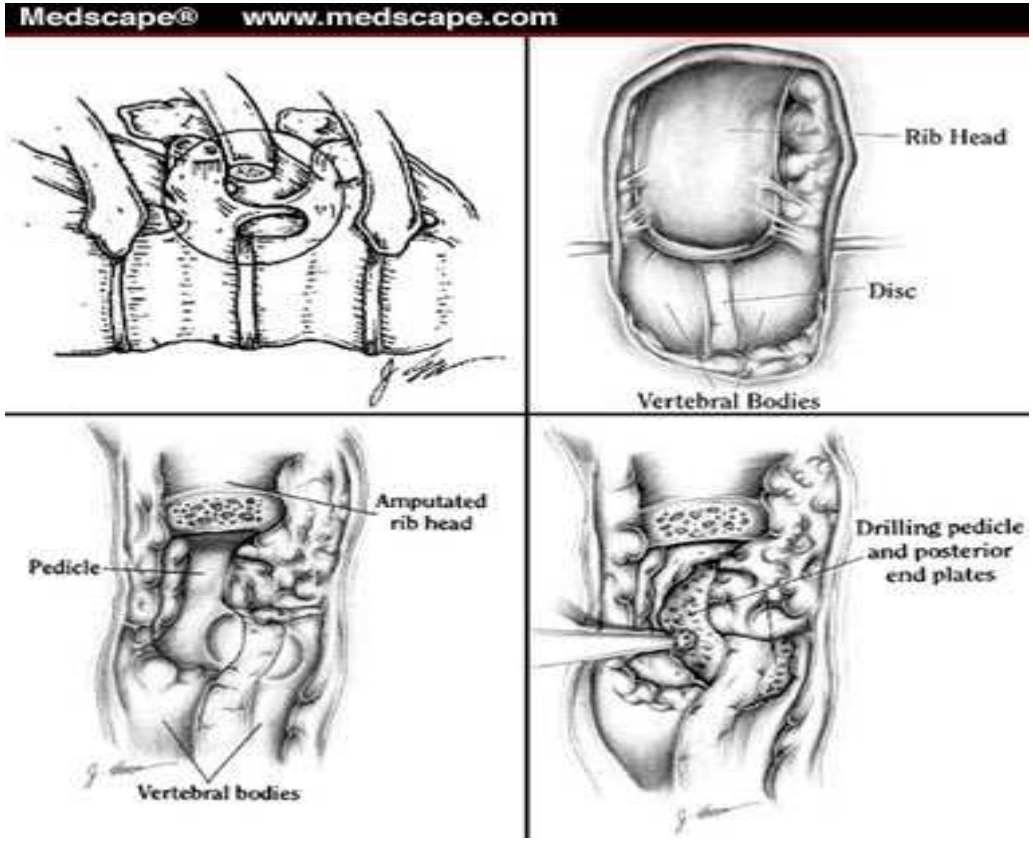
Reverse L pattern

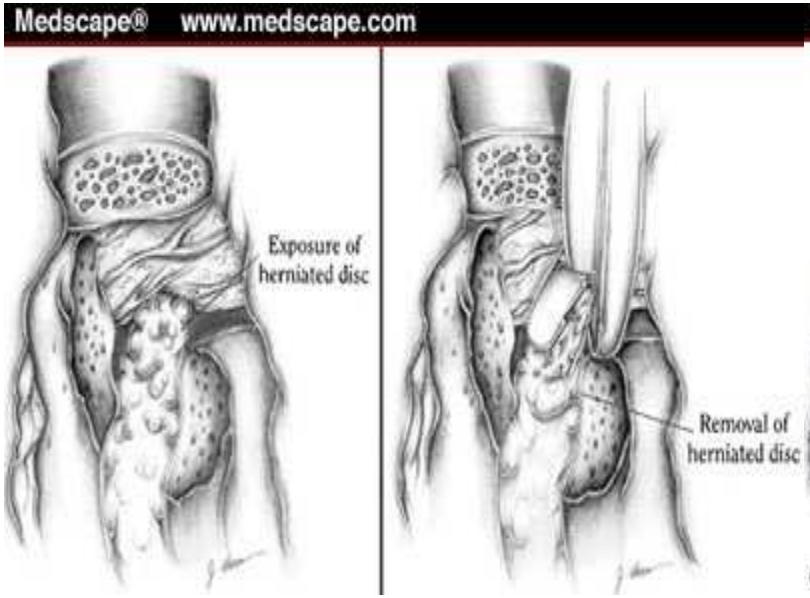
10mm(3-18mm);3-4 portals

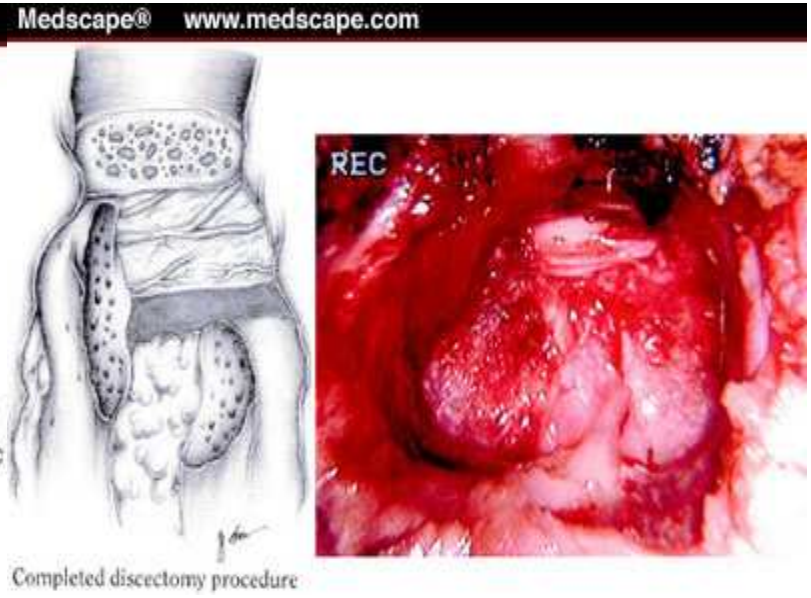
First port-Anterior axillary line 6^{th}/7^{th} ICS.

One port caudal & another rostral central to the area of interest




Medscape® www.medscape.com
Rib Head
Disc
Vertebral Bodies
Amputated rib head
Pedicle
Vertebral bodies
Drilling pedicle and posterior end plates


Medscape® www.medscape.com
Exposure of herniated disc
Removal of herniated disc


Medscape® www.medscape.com
REC
Completed discectomy procedure

VATS-Thoracic Discectomy

- VATS vs Open Thoracotomy

  Lanreneau et al(1993): Less pain, improved pulmonary function & superior shoulder girdle function in VATS group.

  Caputy et al (1995):Successful use of VATS for thoracic discectomy in cadaveric/porcine followed by clinical use.

VATS-Thoracic Discectomy

- Thoracoscopy Vs Costotransversectomy (CT)&Open thoracotomy for thoracic discectomy

Rosenthal & Dickman(1999):

Fresh neurological deficits- None in thoracoscopy & thoracotomy group;7% in CT group

Intercostal neuralgia-Thoracoscopy-16%;CT-20%; Thoracotomy -50%

VATS-Thoracic Discectomy

- One hour reduction in operative time
- 50% reduction in blood loss, narcotic use & hospital length of stay
- Neurological improvement- 27/36(myelopathy);19/19(radiculopathy)
- Neurological stabilization in all

MISS-Disadvantages

- Steep learning curve
- Hand-eye coordination
- Lack of tactile feedback