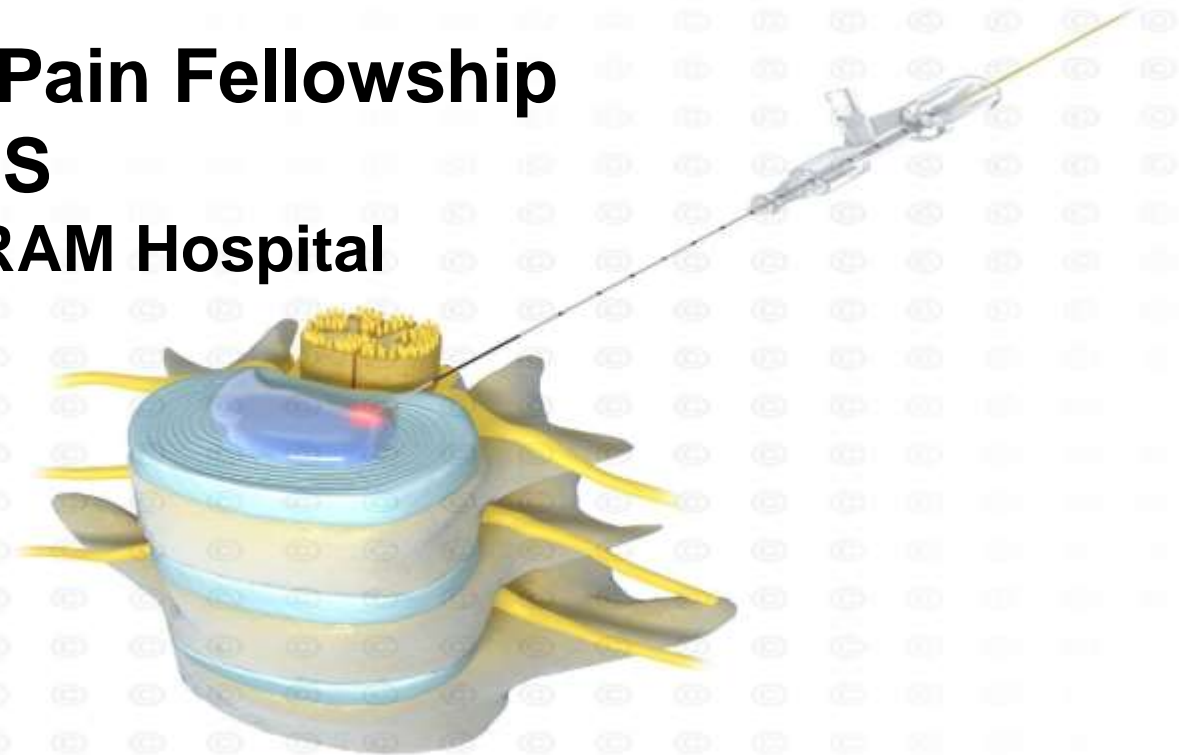


Percutaneous Laser Disc Decompression (PLDD)

**SR Entezary MD, Pain Fellowship
IUMS
RASOOL E AKRAM Hospital**



Disc Anatomy

- The largest avascular structure, anaerobic metabolism, nutrients by diffusion through endplates & periannular.
- Annulus: 15-25 collagen fiber layers of crisscross bundles
- Endplate: flat hyaline cartilage, disc nutrition
- Segmental vessels: capillary bed surrounding the annulus.
- Ant annulus nerve supply: rami communicans; post annulus: sinovertebral. (only outer half)
- ALL & PLL richly supplied by ventral neural plexus.
- Nucleus Pulposus: 14% leakage posterolaterally

Risk Factors

- Genetic: collagen type XI substitutions, overall incidence is 1.7%, but 43% in first-order relatives.
- Atherosclerosis
- Smoking: increases intradiscal lactate, lower PH, degrades hyaluronic acid.
- Vibration: 10-35 Hz
- Sports: wrestling, gymnastics, water-ski
- Disc herniation less than 1 month 12.5%; more than 6 months 82% neovascularization.

Mechanisms of Pain Generation

- Calcitonin Gene-related peptide (CGRP), VIP & substance P.
- Disc protrusion can causes 400 mmHg pressure on nerve roots.
- Acute compression: numbness, paresthesia, weakness, BUT not PAIN.
- Impairment of blood flow, increased vessels permeability, edema, increased tissue pressure & altered impulse conduction.
- Proposed irritants: low PH, proteoglycans, autoimmune reaction to exposed disc, phospholipase A2.

Diagnosis

- MRI
- CT scan
- Dynamic X-Ray
- Thin-needle discography followed by thin-section CT of the injected disc (CT-D) is the most specific test prior to intradiscal therapy, (differentiation between contained or noncontained).
- CT-D should be performed only to confirm containment.
- EMG-NCV?

Table 1.1 Interventional Treatments for Herniated Disc Disease

History of open surgical methods

- 1934 Laminectomy and discectomy, Massachusetts General Hospital, Boston, followed by microdiscectomy in the 1980s

History of percutaneous methods

- 1975 Hijikata, percutaneous discectomy
1983 Kambin, trephine, rongeur, suction
1984 Onik, nucleotome
1986 Choy/Ascher, percutaneous laser disc decompression
2000 Saal, IDET (intradiscal electrothermal annuloplasty)
-

Invasive Procedures

- Laminectomy; 1934; Massachusetts General Hospital
- Discectomy; 1934
- Microdiscectomy; 1980
- Fusion (Adjacent level syndrome)
- Percutaneous Nucleotomy; 1984

Less invasive

- Chemopapain Chemonucleolysis: leakage & NEUROLOGIC complications, Myelitis, Allergic & Anaphylactic reactions.
- IDET anuloplasty (RF), 2000; heats up & destroys pain fibers without retracting the disc herniation.

- Nucleus Pulposus water content: 50-89%, diurnal variations & decreasing with age; 65% proteoglycan & 20% collagen.
- Annulus: 20% proteoglycan & 60% collagen.
- Injection of 1 ml N/S to NP: 2340 mmHg pressure increase.
- Choy: Nd:YAG 1064 nm
- Diod 980 nm is safer
- FDA 1991

External Energy Source
flashlamp, electricity.

Optical cavity

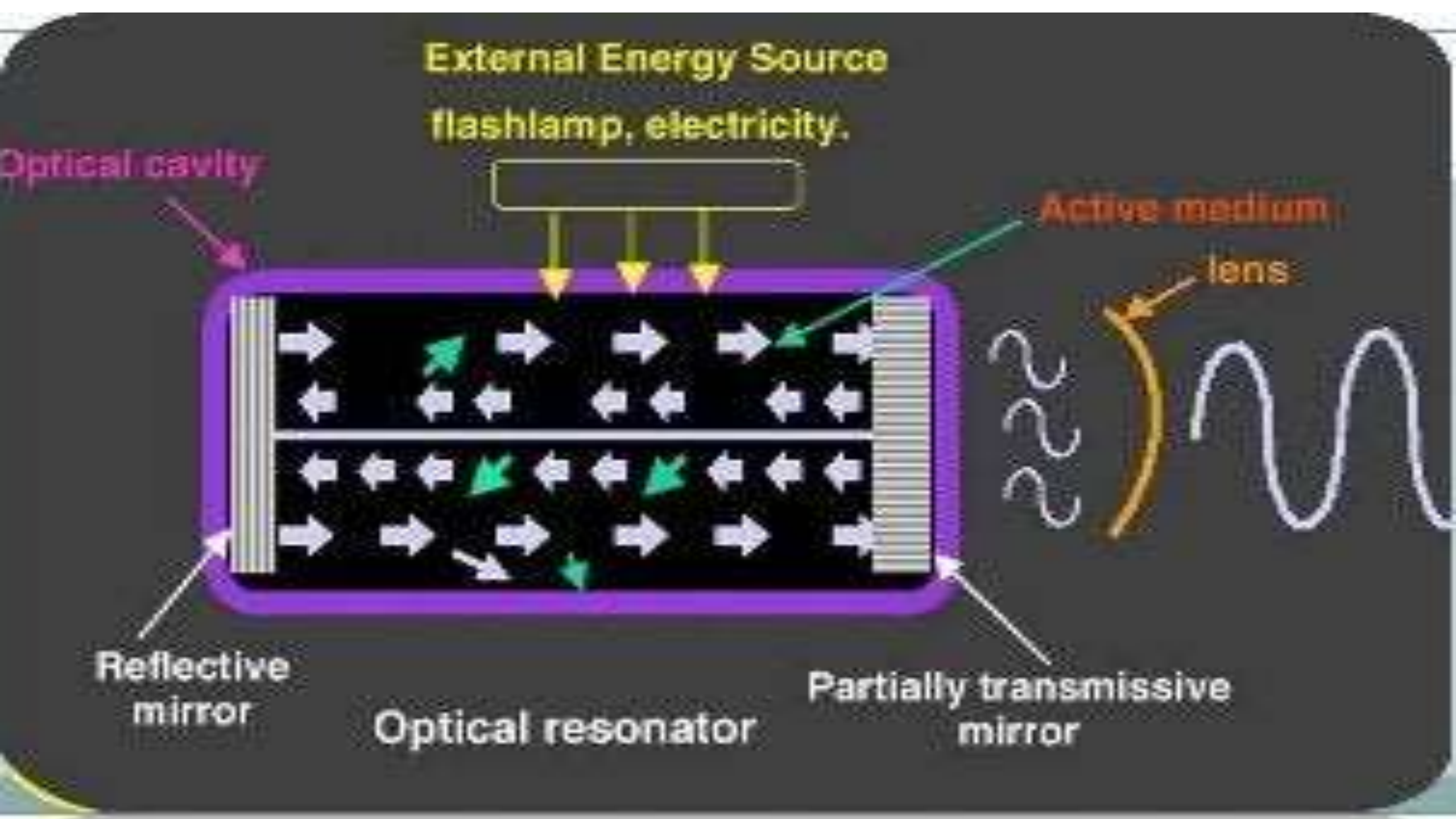
Active medium

lens

Reflective mirror

Optical resonator

Partially transmissive mirror



Some problems with Open Microdiscectomy

Complication like **secondary bleeding, infection**, etc. in 1%

Recurrence rate of more than 8-15%

Peridural **scar tissue** formation in 6-10%

Dural sac tear in 3%, in revision surgery nearly 20%

Iatrogenic **microinstability**

Operating room with specific equipment

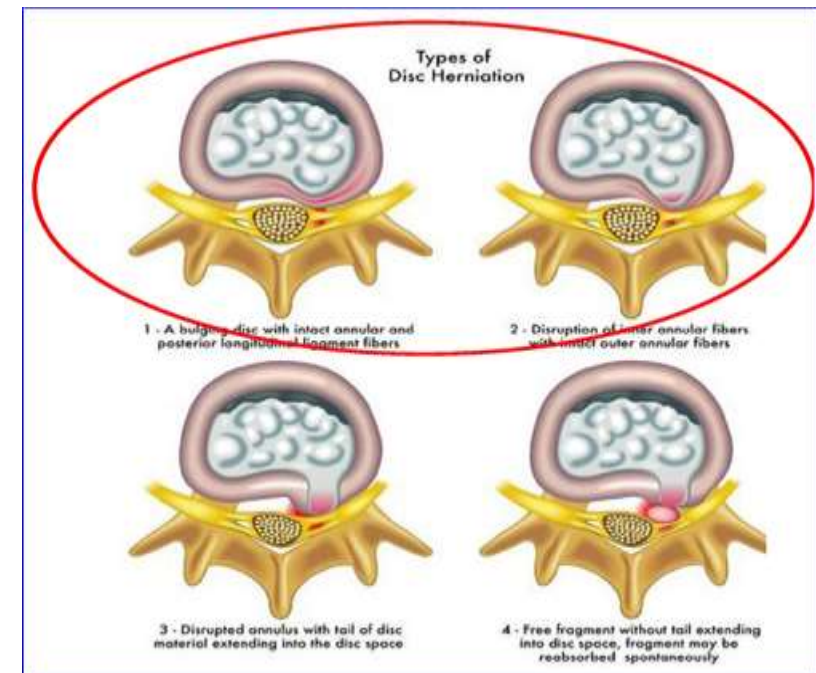
FBSS in 5% (in most cases wrong indication), up to 40%

Percutaneous Disc Decompression for Lumbar Radicular Pain: A Review Article

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**Department of Anaesthesiology, Intensive Care and Pain Medicine, Tan Tock Seng Hospital, Singapore City; [†]Specialist Pain International Clinic, Singapore City, Singapore; [‡]Department of Anesthesiology, Pain and Palliative Medicine, Radboud University Medical Centre, Nijmegen, The Netherlands*

- In patients with small contained herniations, the results after open discectomy are poor, with recurrence of sciatica of 37.5% and reherniation rate of 12.5% (Carragee EJ et al. JBJS 2003)
- Even with newer techniques like microdiscectomy (gold standard), outcomes after surgery for contained herniations are worse compared to sequestered herniations. (Dewing CB et al., Spine 2008)



So searching for ...

- Effective alternative intervertebral surgery for contained disc herniation
- Minimal invasive
- No complications
- Easy to perform
- High success rate
- Quick effect
- No need of long term rehabilitation
- Repeatability if necessary



Percutaneous Laser Disc Decompression

- In recent years, hyperthermal minimally invasive treatment has become increasingly popular (Laser, IDET, etc.)

PLDD is an effective minimally invasive treatment for lumbar disc herniation which:

Reduces intradiscal pressure, leading to reduction of nerve root compression.

Achieves **thermal destruction of intradiscal nociceptors**, which may affect the pathophysiology of discogenic pain. (Schroeder M. et al 2013)

History



P. Ascher (AUT)



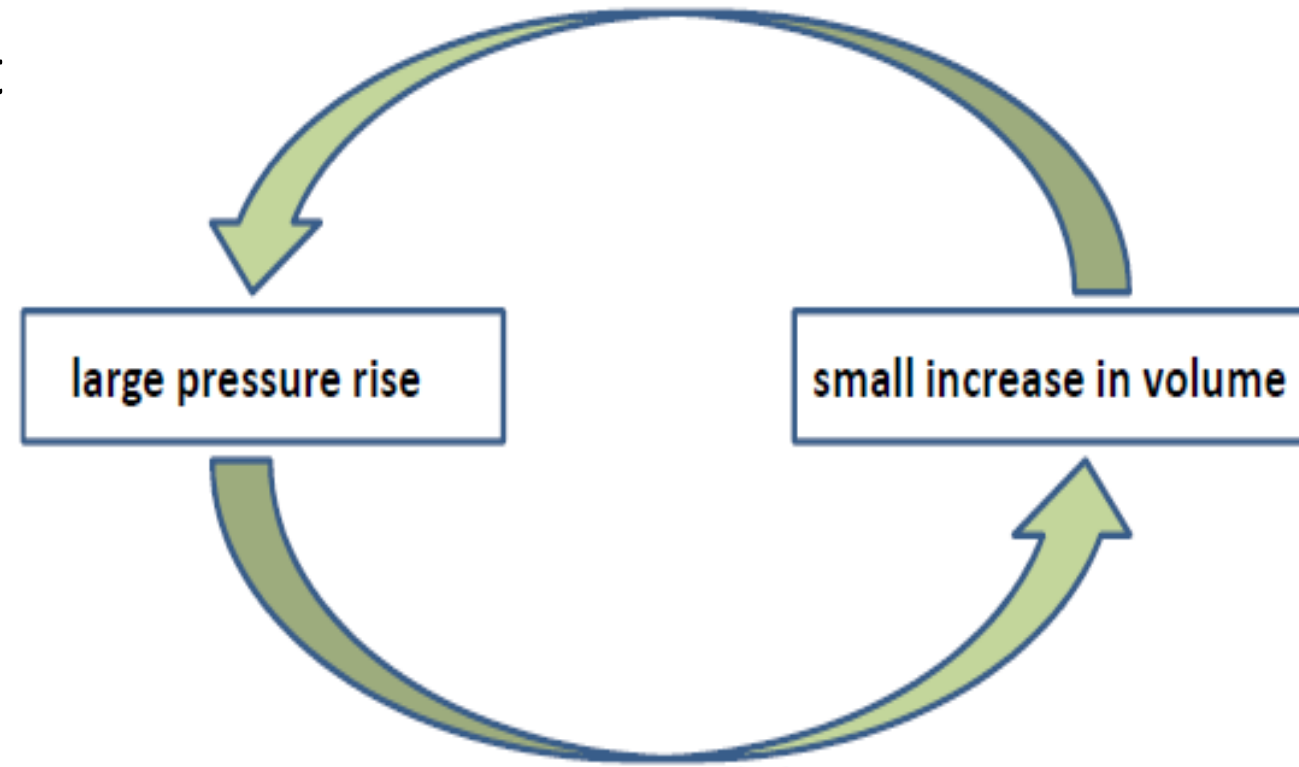
D. Choy (USA)

In mid-February 1986, Peter Ascher and Daniel Choy performed the first percutaneous laser disc decompression (PLDD) procedure at the Neurosurgical Department, University of Graz, Austria. It was planned to deliver 1000 J of energy with an Nd:YAG laser to a herniated L4-L5 disc causing sciatica. At 600 J the procedure was terminated because the pain was gone. [Choy, [Photomed Laser Surg.](#) 2009]

Pressure-Volume Relationship

(Choy DS et al 1995)

- The discus has the properties of a tight hydraulic space:
- Nucleus pulposus is surrounded by the relatively inelastic annulus fibrosus and the solid vertebral end-plates.
- A large pressure rise will regularly result from a small increase in volume and inversely.

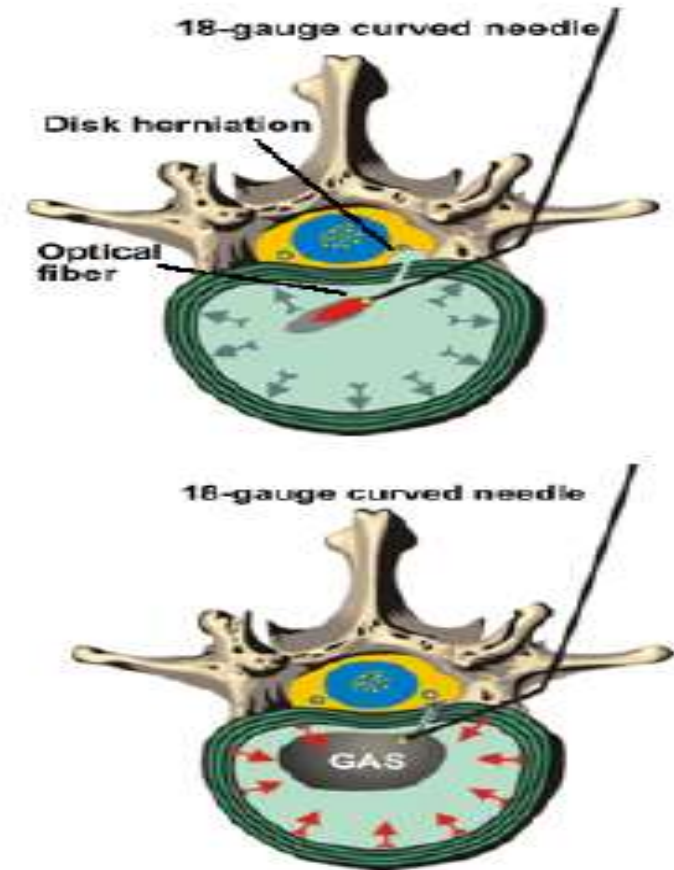


Principles

- Vaporisation of a small volume in a closed hydraulic space (NP) implicates a reduction of intradiscal pressure, thermic “Shrinking Effect” [Hellinger 1998]

→ Reduce volume & pressure of the pathological disk, thus inducing reduction of disk herniation

→ Reducing nerve root compression

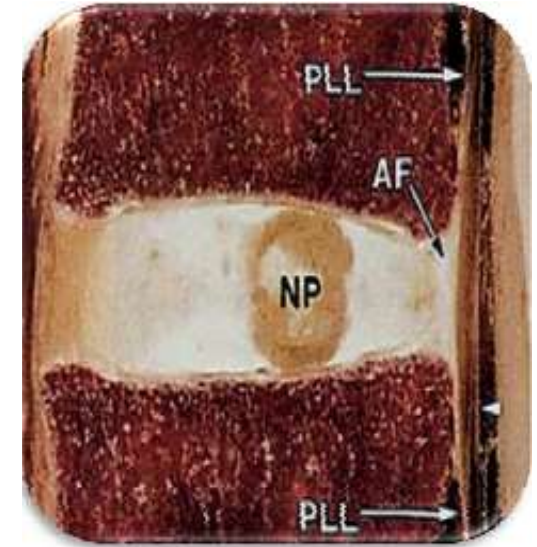


Advantages of PLDD

- 75-92% success rates (MacNab criteria)
- No significant soft tissue injury
- No risk of fibrosis or scarring
- No extensive hospitalization, outpatient basis
- No general anesthesia, mild sedation
- Minimal recovery time
- Lower cost (25-30 % of the surgical treatment cost)

Indications

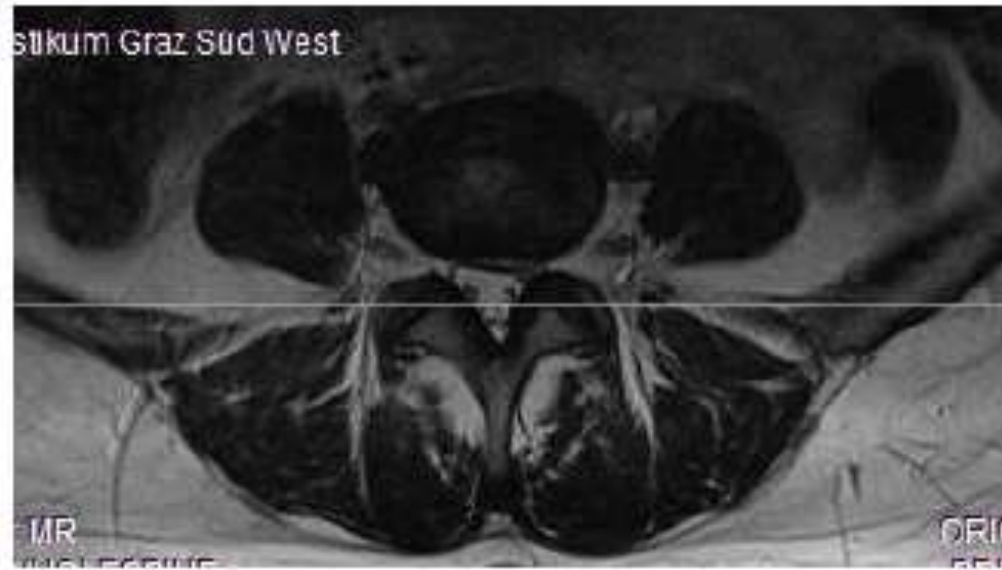
- **Patient selection** is crucial for treatment effectiveness
- **Contained disc** herniations with consecutive foraminal stenosis
- MRI and matching clinical symptoms
- Positive and consistent neurologic findings
 - Leg pain of greater intensity than back pain,
 - **Positive SLR test**,
 - Decreased sensation, normal motor response and tendon reflex
 - Failure of 6 weeks of conservative therapy
- Discogenic spinal stenosis (relative)



Indications

- Radicular LBP
- If neurologic deficits?
- Grade I lysthesis, mild scoliosis, low grade OA (Acceptable)
- Extruded? (Acceptable)

Discogenic Pain Syndrom



High Intensity Zone L4/5

Rupture of the
anulus fibrosus
and ingrowing
nerves into the
nucleus pulposus



Contraindications

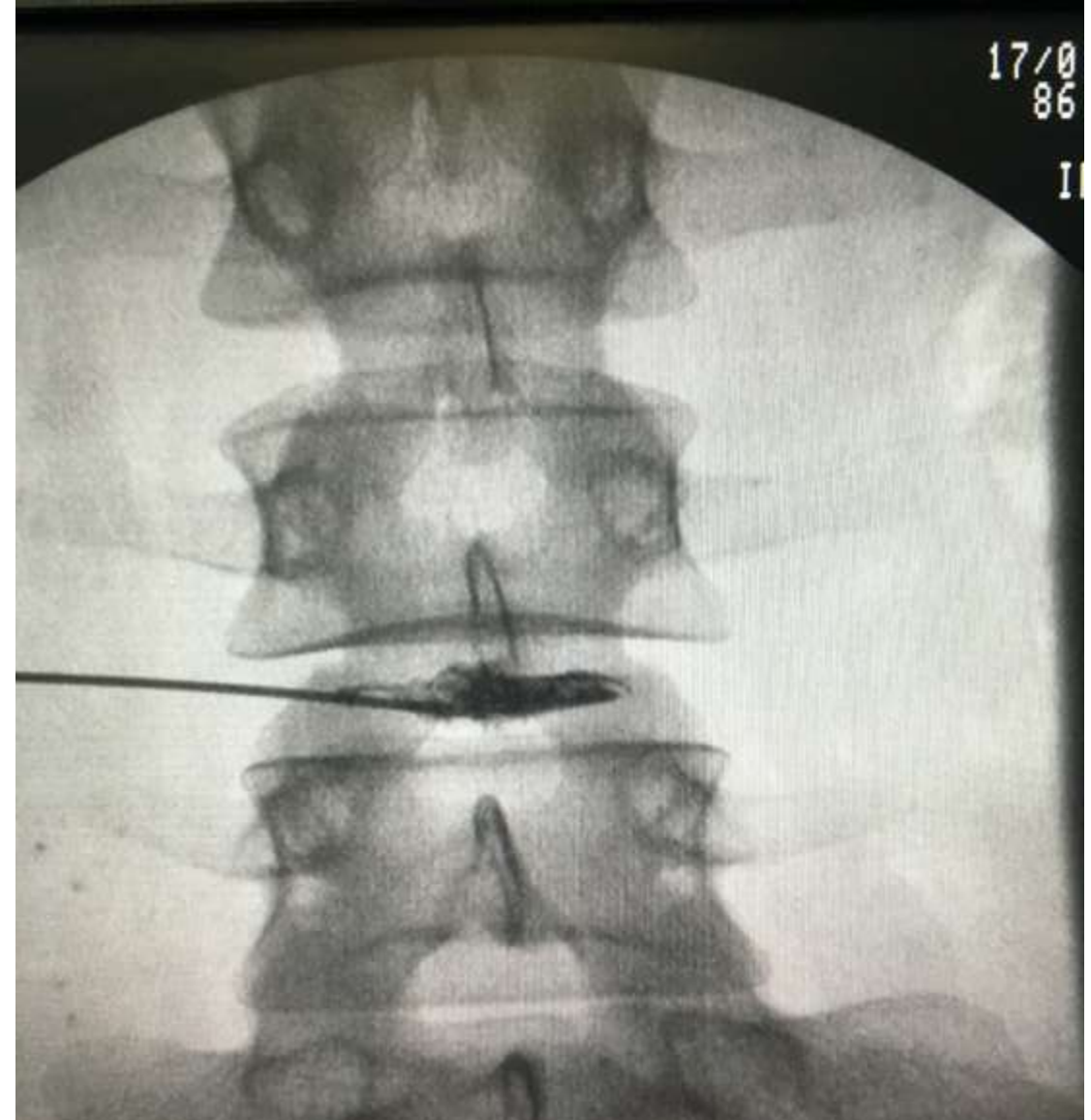
- Nerve paralysis with indication for open surgery
- Systemic or locale infections, malignant tumors
- Anticoagulation
- Spondylolisthesis/Instability (relative)
- Sequestered disc or complete rupture of the AF (epidural float in discography)
- Osseous absolute spinal stenosis or foraminal stenosis
- Significant psychological disorders
- Significant narrowing of disk space

Contraindications

- Without conservative treatment for 3 months
- Severe lysthesis, Severe scoliosis, Metastatic cancer, Compress fracture
- Bone spur on nerve root, Free fragment
- Vacuum phenomenon
- Male over 80
- Hemorrhagic diathesis, Hemangioma adjacent to disc
- MS, Demylinating disease,
- Systemic infections
- Life expectancy less than 1 year.
- Multilevel, facet arthropathy, severe bony spinal stenosis (relative).

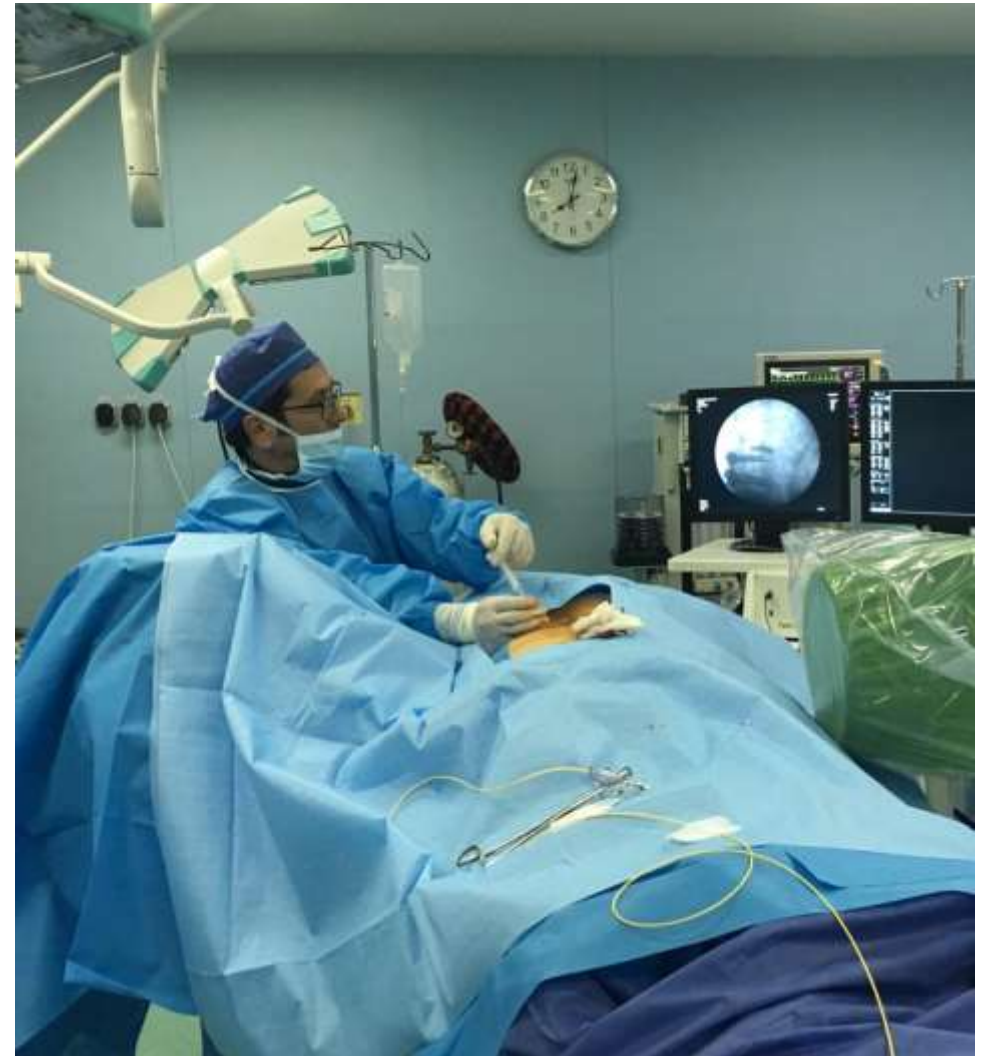
Preoperative diagnostic

- Detailed history
- Orthopedic and neurological investigation
- X-ray, bending x-ray
- MRT (if not possible CT)
- Discography with contrast medium / Memory pain

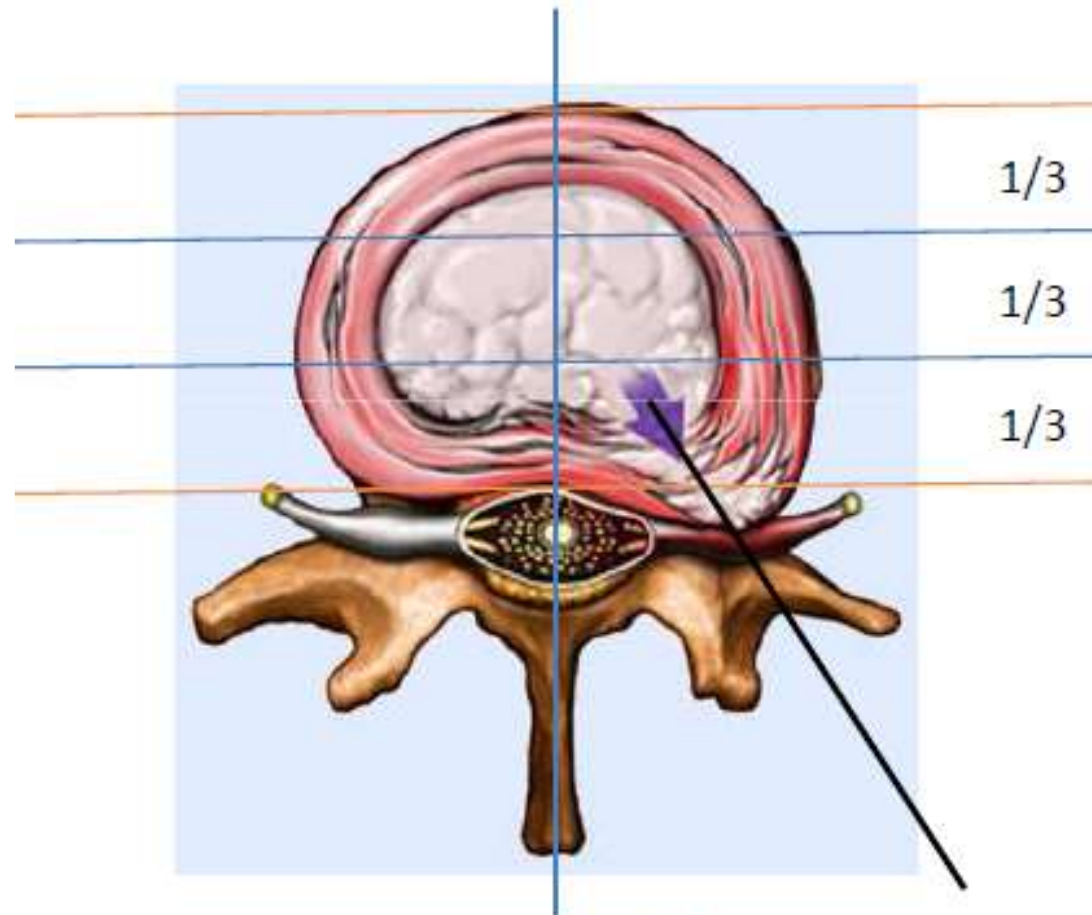


Materials

- C-arm or CT unit with steril OR
- Laser
- Optical fiber with Laser needle (21 G)
- Material for deep local anesthesia
- Contrast medium



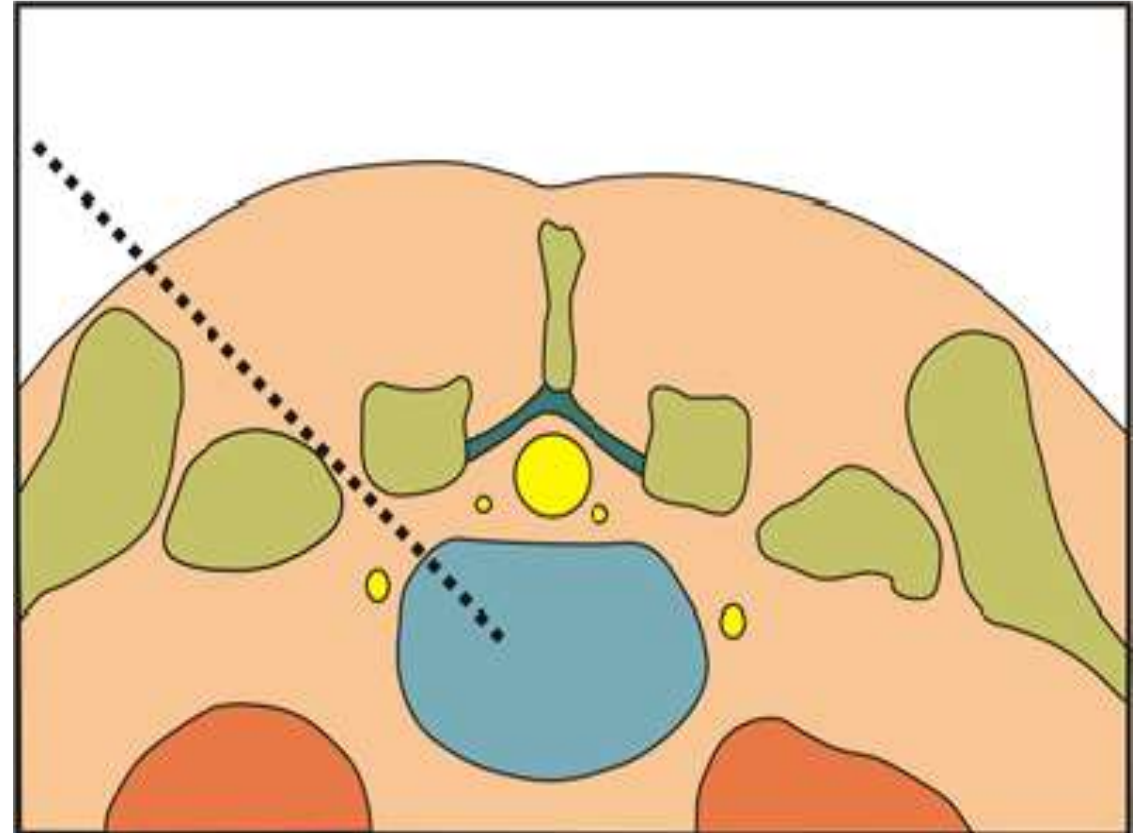
Correct needle placement



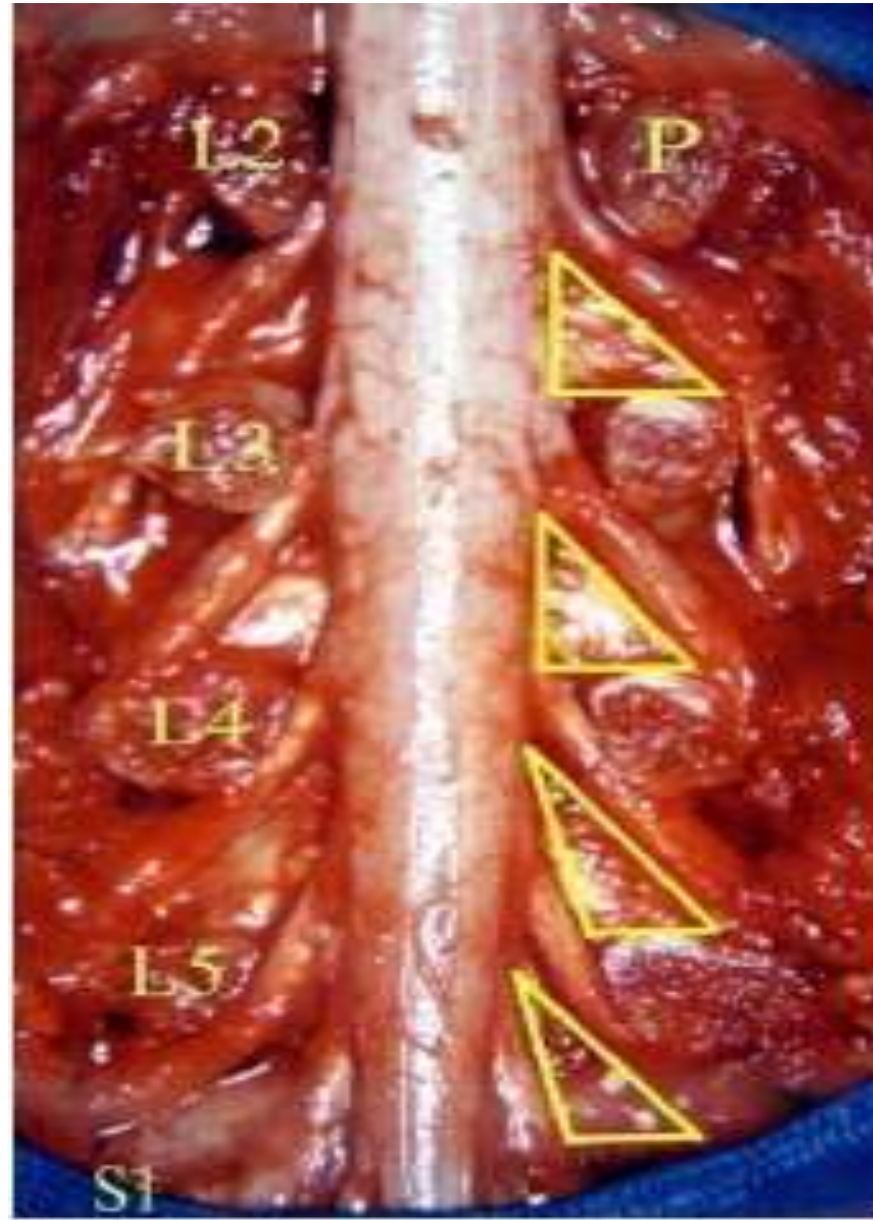
Peripheral position (dorsal 1/3 of the discus, 4 or 8 o'clock)

Procedure

- Patient in prone or lateral decubitus position, pillow under the abdomen to reduce lumbar lordosis and opened posterior disc space
- Local anesthesia with lidocain 1%, dorsolateral approach
- Mild analgosedation, verbal communication important (!)
- Monitoring (BP, ECG, O2 Sat)

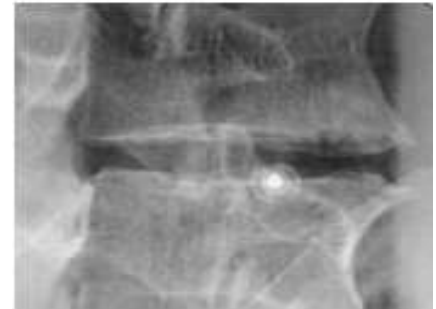
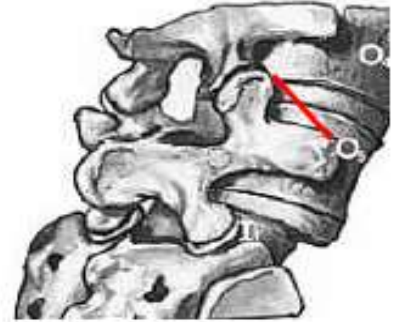


The safe triangle ...



Needle placement lumbar spine

- Setting for C-arm: “Scotty Dog”
- Doubled end plates, 40-45 degree oblique.
- Safe triangle (SAP./Trans proc)
- Nucleotomy in tunnel view
- Parallel alignment of the needle between the vertebral bodies
- Controlling position with x-ray in AP and lateral view

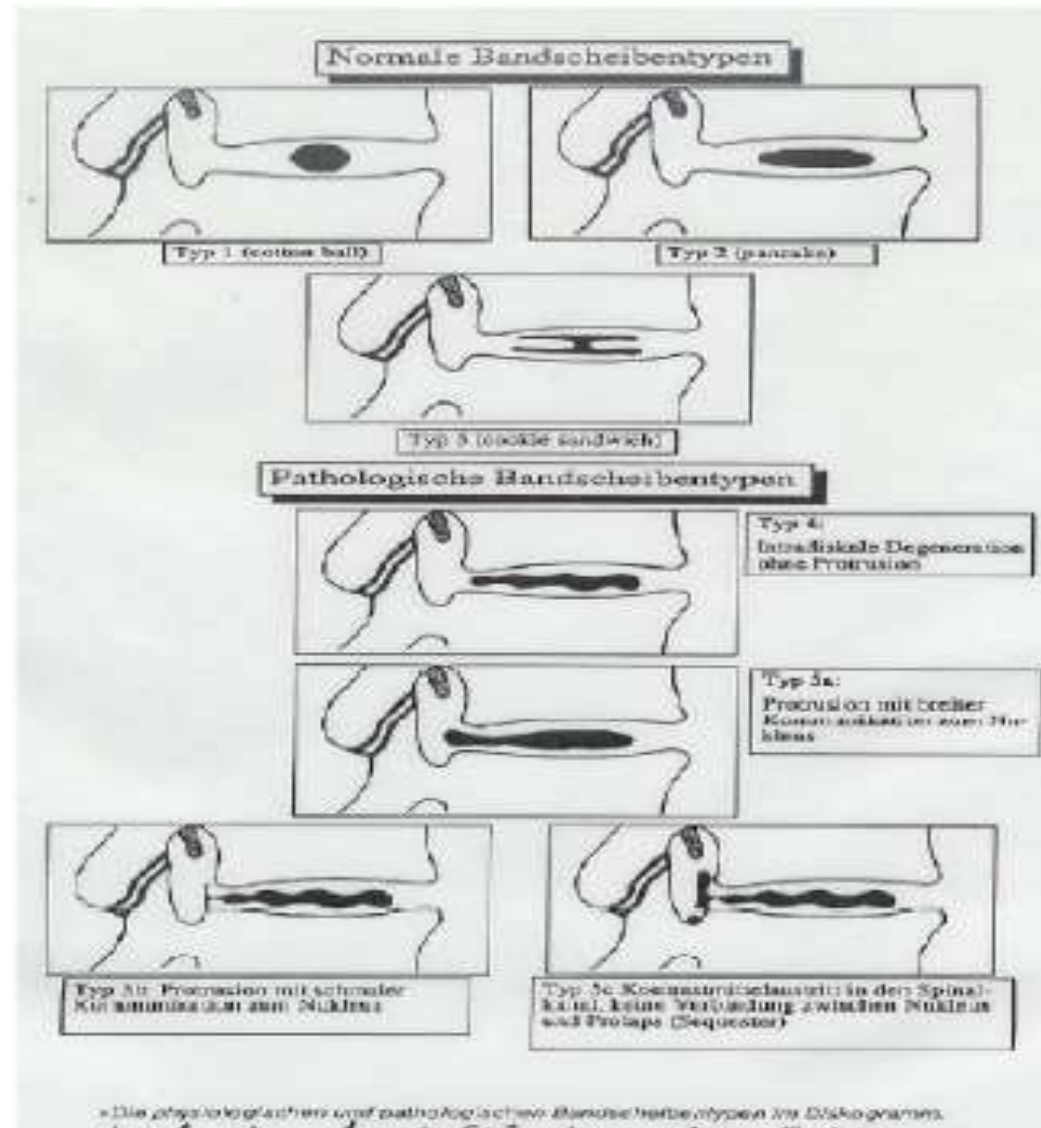


Discography

- Discography with contrast medium
- Memory pain test (provocative test)
- Inserting the fiber through the needle (fiber overlaps the tip of the needle 2mm){for Nd-YAG: 10 cm}
- Start the Laser in pulsed mode
- Flushing the discus with NaCl



Best indication for PLDD Type 5a and 5b



Discography – Memory pain

- Dallas pain classification 1-4:
 - 1. No or insignificant pain reproduction
 - 2. Pain different from the usual painful symptoms
(discordant)
 - 3. Pain similar to some of the usual painful symptoms
(partially concordant)
 - 4. Pain identical to the usual painful symptoms
(concordant)

Needle placement, cervical spine

- The patient is placed in supine position, slightly hyperextension
- Protect trachea/esophagus and carotid art. with the fingers
- LA of the skin
- 20 G needle is inserted anterolaterally
- During the insertion, trachea & esophagus should be pushed to remove them from the pathway



Complications of PLDD are rare

- About 10% of cases: paraspinal muscle spasm on the 3rd or 4th day.
- Treatment: warm compress, Reassurance, Diazepam.
- SIJ pain in 2% (unlocking mechanism), treatment: NSAID, Injection.

- Septic discitis 0,4% (Choy et al. 2004); S.aureus,S.viridanans; 3-5 days after PLDD. All incidences resolved with antibiotics; hence obligatory preoperative antibiotic single shot. Fever, severe pain on the disc, WBC & ESR. Contrast MRI, bone scan, thin needle aspiration; IV Vancomycin.

Complications of PLDD are rare

- No GA! verbal communication is important for safety!
- Thermal aseptic discitis, Modic sign`s from 0% to 1,2% (Singh et al. 2009)
- Thermal Endplate Necrosis.
- Nerve Root Damage, Cauda Equina Syndrome.
- Perforation of Viscus.
- Recurrence of disk herniation.
- Insufficient treatment, wrong indication.

After treatment

- First 24 hrs lying down; then sitting or walking up to 20 min
- Sitting still in one position, is discouraged.
- Protection for 3-4 weeks
- Lumbar soft brace for 2-3 w;
- No long sitting, standing, avoiding hard work.
- Return to work 3 or 10 days
- NSAID`s and analgesic therapy on demand
- Physiotherapy after 5-6 weeks, multimodal setting advisable



only 1 RCT's
PLDD versus
conventional microdiscectomy in sciatica: a
randomized controlled trial (A. Brouwer et al. 2015)

- NON-INFERIORITY TRIAL: THE AIM IS TO SHOW THAT AN EXPERIMENTAL TREATMENT IS NOT (MUCH) WORSE THAN A STANDARD TREATMENT
- They concluded that a strategy of PLDD, followed by surgery if necessary, resulted in non-inferior outcomes compared with open surgery.

PLDD

- Systematic review (Singh et al. 2009):
 - good observational studies, positive result with pain reduction 84% after > 12 month
 - based on good observational studies, PLDD has been shown to be efficacious in treating lumbar radicular pain with low incidence of complications!
- Systematic Review (Vijay S. et al 2009) Level II-2 evidence (evidence obtained from well-designed cohort or case-control analytic studies)

Literature

- Xu-Li Zhao, 2012: T-PLDD can significant decrease pain and improve function of the patients with extruded but nonsequestered herniation (success rate 92% after 12 month)
- Manchetti P., 2007: significant difference in the effectiveness of PLDD vs IDET in non contained disc herniation group; success rate 89% for PLDD vs. 60% for IDET (also more painful); valid alternative respect to open microdiscectomy but lower complication rate.

Literature

- Ren L. 2013: positive efficacy on the treatment of lumbar spinal stenosis, which was more significant on soft discogenic compression than by bony posterior compression
- Ren L. 2013: PLDD did not obviously lower the height of the intervertebral space (on the contrary to Ozon-Chemonucleolysis), instead, it could effectively promote the reduction of disc herniation
- Yakub M. 2011: n=4622, 47 FBSS, 75% good response, 13% fair response, 12% poor response; all cases of FBSS showed a good and fair response, no complications!

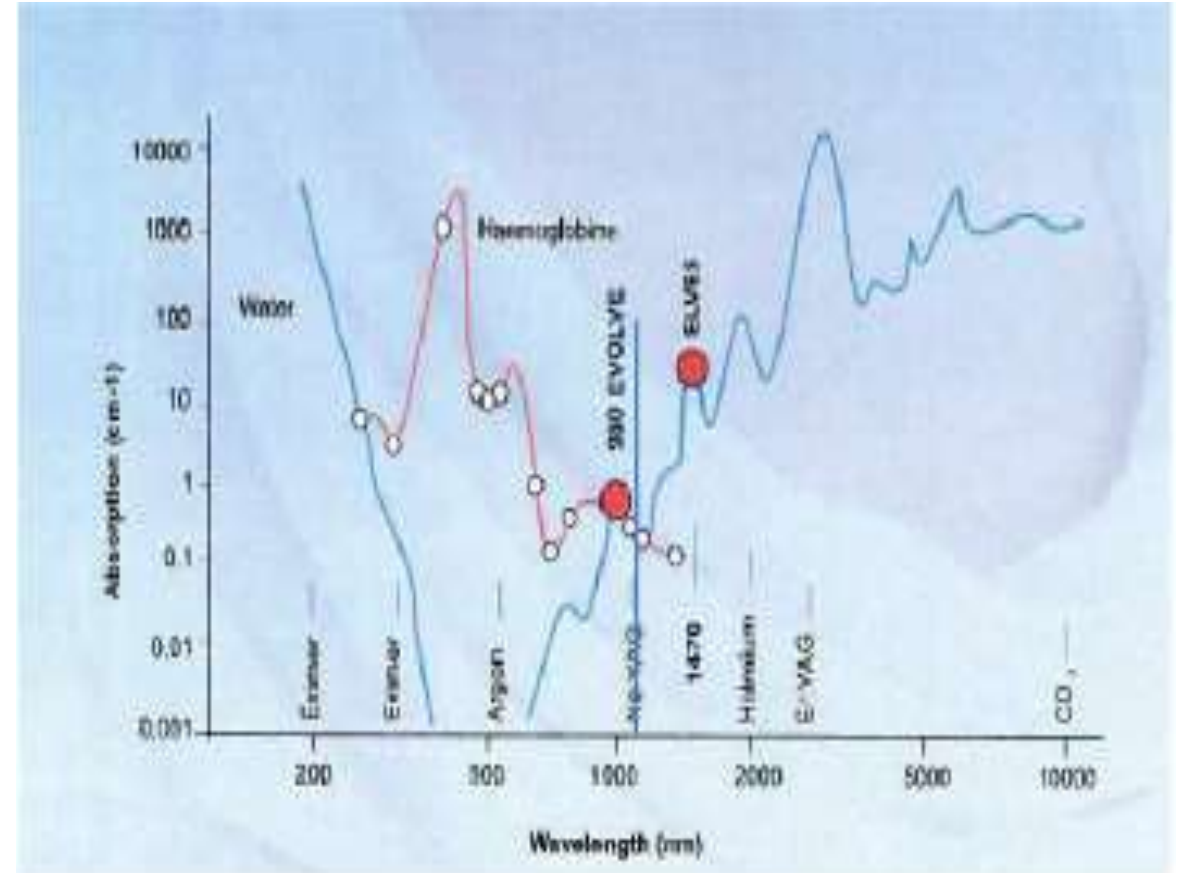
Literature

Menchetti P., 2007: multicentric study; n=1350; success rate at mean follow up of 48 month was 87%; 96 cases after an unsuccessful microsurgical treatment

- Menchetti 2011: multicentric retrospective study with a mean follow-up of 6 years, n = 900 , success rate at a mean follow-up of 5 was about 70% with a very low complication rate.
- 205 Patients, prospective study, 3 years, 76% patient rated PLDD as fair to good (Duarte et al. 2012), no complications

Laser adjustment

- Power in watt
- Energy in joules
- Diode laser with 980nm wave length seems to be the best for PLDD because:
 - absorption by the water (major component of NP) is 5 times higher than 1064nm(Nd:YAG) and 10 times higher than one of 820nm



Adjustment Biolitec Laser 980nm

(by Dr. Kienbacher)

- PLDD lumbar spine:

12 watt / pulse duration 0,6 sec. / pulse break 1,3-1,5 sec. /

in total 800 – 1500 Joule per discus

- PLDD cervical and thoracic spine:

10 watt / pulse duration 0,6 sec. / pulse break 1,5-1,8 sec. /

in total 800 Joule je Segment

