

10

The Percutaneous Laser Disc Decompression Procedure

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The major component of percutaneous laser disc decompression is needle placement. Needle placement is guided by biplane fluoroscopy. When I initially performed PLDD at St. Luke's-Roosevelt Hospital in New York City, I used a fixed table in a radiographic suite equipped with a GE C-arm fluoroscope. The device weighed perhaps 1 to 2 tons and had an electric motor. This meant that to move the C-arm I had to press a button to activate the motor. Because of the inertia of the C-arm, the fluoroscope did not move immediately, nor did it stop immediately. The images obtained were therefore suboptimal. The success rate of the PLDD procedure using this equipment was approximately 75%.

When I moved the procedure to the Laser Spine Center, a stand-alone outpatient laser surgical suite, I installed a new invention, a radiolucent table on casters, which could be moved by hand (Fig. 10.1). This table made it possible to move the patient as well as the C-arm, so that precise views of the needle position could be obtained, millimeter by millimeter. It was also much faster than the cumbersome motor-driven C-arm. I believe I am the only one in the world with this equipment. Very soon, the success rate went from 75 to 89%. It was not a matter of mastering a learning curve, since I had already performed 200 procedures at St. Luke's-Roosevelt. I attribute the increased success rate to the improved imaging provided by the movable radiolucent table. I urge those who are about to embark on PLDD to obtain or build such a table. When I had one made in 1992 in New York it cost



Figure 10.1. Radiolucent table on casters allows maximal movement of the patient and permits millimeter-by-millimeter adjustment in relation to the x-ray tube for optimal imaging.

\$2000. Probably prices in or after 2003 will be slightly higher, but the convenience of being able to move the patient by hand so that the imaging is optimal cannot be overestimated.

The incidence of disc herniation in my experience is lumbar, 90%; cervical, 8%; and thoracic, 2%.

The step-by-step instructions for the PLDD procedure in lumbar discs are followed by briefer remarks on PLDD for thoracic and cervical discs.

Lumbar Discs

1. The patient is placed in the lateral recumbent position, with the head either to the right or the left (Fig. 10.2). The side chosen does not matter, since the reduction in pressure occurs throughout the disc.
2. The patient is told that he or she can follow the action on one of the radiologic screens.

10 The Percutaneous Laser Disc Decompression Procedure 139



Figure 10.2. The patient is placed in the lateral recumbent position. The head may be to the right or the left, since pressure reduction occurs throughout the disc.

3. The outline of the pelvic crest is drawn with an indelible ink pen, and the needle must not enter south of this line (Fig. 10.3).
4. The middle of the spine (using the spinous processes as landmarks) is outlined with the same pen (Fig. 10.3).
5. A line parallel to and 10 cm above the midline is drawn (Fig. 10.3). A quick way to do this is to measure the combined width of four fingers of your nondominant hand. In my case it is 8 cm; then placing the hand on the patient's back, I can estimate the extra 2 cm. The entry point of the needle will be somewhere on this line.
6. The C-arm is turned on.
7. The appropriate disc is imaged.
8. A long radiopaque needle is placed on the trunk of the patient to overlie the target disc (Fig. 10.4).
9. A line is drawn along the needle (Fig. 10.4).
10. The point of needle entry is the intersection of the line drawn along the needle with the 10 cm horizontal line.
11. The surgeon dons sterile gloves.
12. The patient is prepped with soap, alcohol, and Betadine, being careful to wipe from center to periphery, and never to return to the center.
13. The patient is draped with a large drape, with the opening over the point of entry (Fig. 10.5).
14. The C-arm is sterile draped (Fig. 10.6).
15. The delivery kit (Percudisc, New York) (Fig. 10.7) is opened.



Figure 10.3. The iliac crest is outlined with a felt-tipped pen. Similarly, the midline is outlined by connecting the points over the spinous processes. A line parallel to and 10 cm above the midline is drawn. The needle entry point will be somewhere on this line.



Figure 10.4. A radiopaque needle is placed on the trunk of the patient to overlie the target disc. A line is drawn along this needle. The intersection of this line with the horizontal line is the point of needle entry.

10 The Percutaneous Laser Disc Decompression Procedure 141

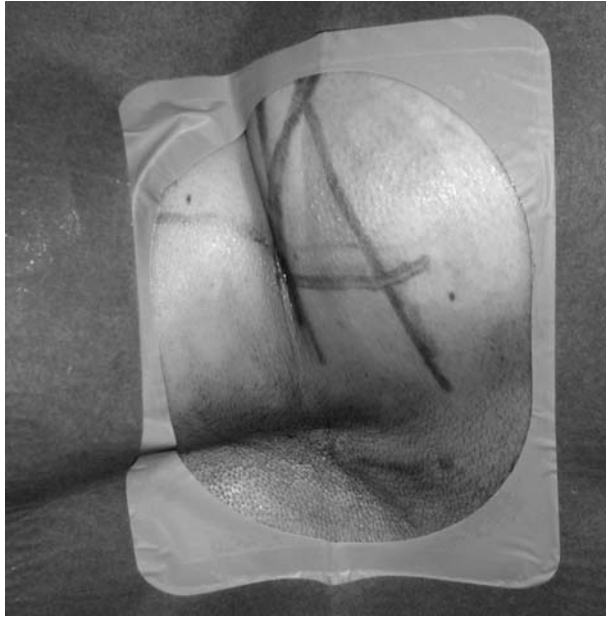


Figure 10.5. The patient is covered with a sterile drape.

16. The trochars are inserted into the two 18-gauge, 9-inch-long needles (Fig. 10.7).
17. The 5-inch-long spinal tap needle is prepared by withdrawing the trochar (Fig. 10.8).
18. The two long needles, the spinal tap needle, and the 24-gauge needle and the 10 mL syringe are brought to the operating



Figure 10.6. A sterile drape is placed over the C-arm.



Figure 10.7. The Percudisc delivery kit is opened. Trochars are inserted into the two 18-gauge, 9-inch-long needles.

area and placed on a sterile part of the patient drape (Fig. 10.9).

19. One or two 10 mL syringes are filled with 1% lidocaine (Xylocaine) (Fig. 10.10).
20. The skin over the entry site (Fig. 10.11) is infiltrated with the anesthetic, using one of the syringes and the 24-gauge needle.
21. The anesthetized skin is then entered with the spinal tap needle, which is connected to the syringe bearing the Xylocaine



Figure 10.8. The trochar is withdrawn from the 5-inch-long spinal tap needle.

10 The Percutaneous Laser Disc Decompression Procedure 143



Figure 10.9. The 9-inch needles, the 27-gauge needle, and the 10 mL syringe, are brought to the operating area and placed on a sterile part of the patient drape.



Figure 10.10. One or two 10 mL syringes are filled with 1% Xylocaine.



Figure 10.11. The skin over the entry site is infiltrated with Xylocaine.

and inserted at a 45-degree angle to the horizontal in the direction of the needle line drawn in step 9 (Fig. 10.12).

22. Xylocaine is injected, and the needle advanced 2 seconds later; more Xylocaine is injected, and the needle is further advanced until the needle tip is 2 to 3 cm from the spine (Fig. 10.13).
23. No Xylocaine is injected beyond this point, since one does not want to anesthetize the nerve root. This is to be left "live" so that the patient can feel sciatic pain if the needle touches the nerve root. If sciatic pain occurs, the needle is withdrawn and aimed at the "safe triangle" (Fig. 10.14), that is, caudad and posterior, to avoid the nerve root. In over 2000 procedures the author has observed these steps scrupulously, and no nerve root damage has occurred.
24. The 9-inch-long, 18-gauge needle with trochar is then inserted into the patient at a 45-degree angle in the direction of the line drawn in step 9 (Fig. 10.15). The patient is asked to report leg pain. If there is no leg pain, the needle is inserted until the tip appears to abut the edge of the spine (Fig. 10.16). An anteroposterior (AP) view is then obtained. If the tip appears to be some distance from the edge of the spine (Fig. 10.17), the needle is too far anterior, and must be redirected medially. The needle must be withdrawn at least

10 The Percutaneous Laser Disc Decompression Procedure 145



Figure 10.12. The syringe with Xylocaine is connected to the 5-inch spinal tap needle, which is inserted at a 45-degree angle to the horizontal in the direction of the needle shown in Figure 10.4.

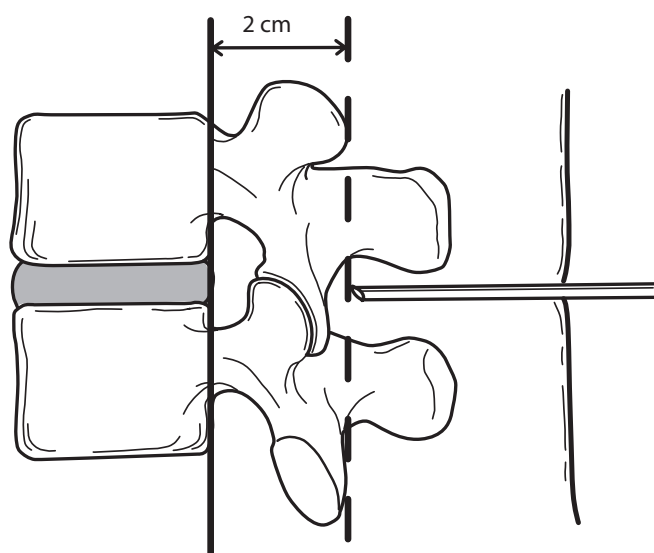


Figure 10.13. Xylocaine is injected as the needle is advanced until the tip is 2 to 3 cm from the spine.

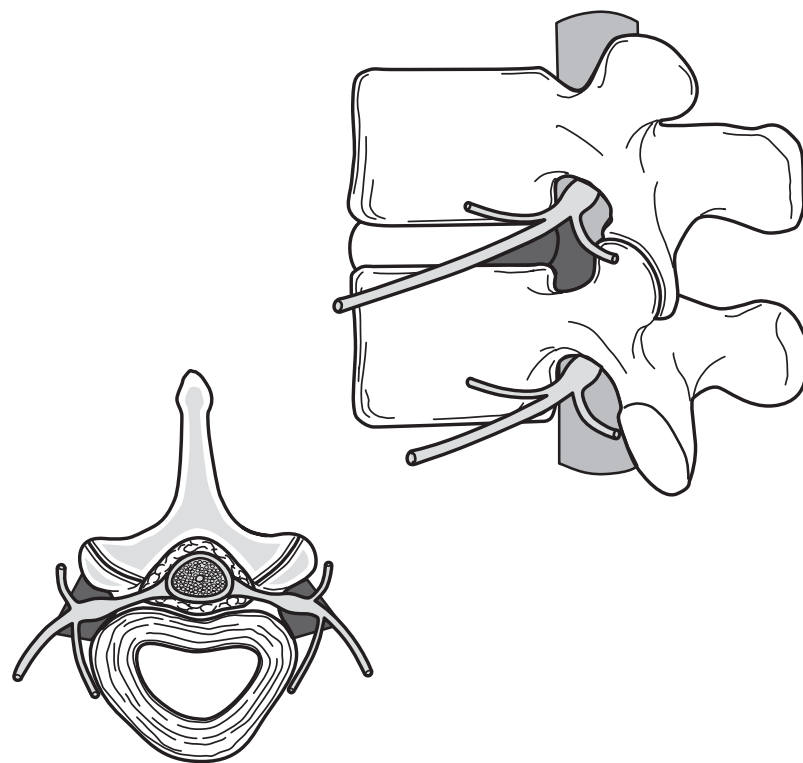


Figure 10.14. The *safe triangle* that avoids the nerve root: aim toward the apex caudally and inferiorly.

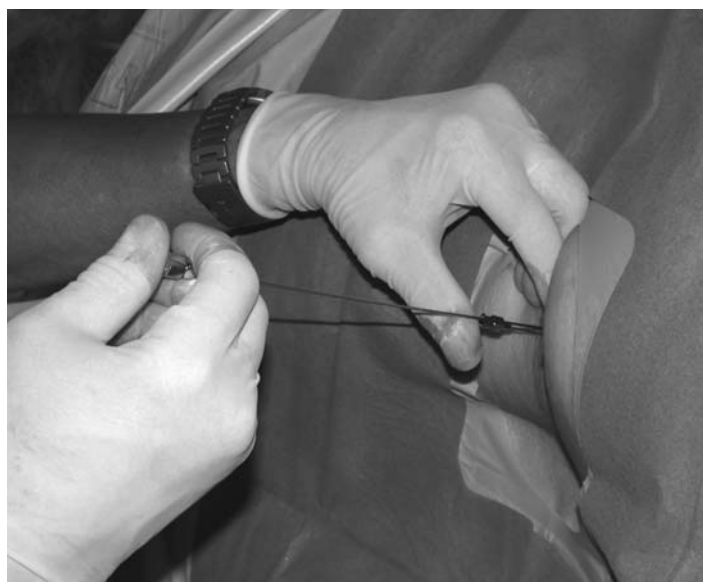


Figure 10.15. The 9-inch, 18-gauge needle is then inserted using the infiltration needle as a guide.

10 The Percutaneous Laser Disc Decompression Procedure 147

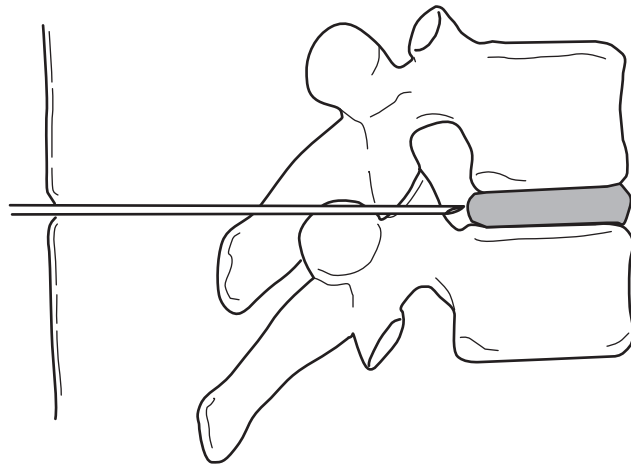


Figure 10.16. The needle tip now abuts the edge of the spine.

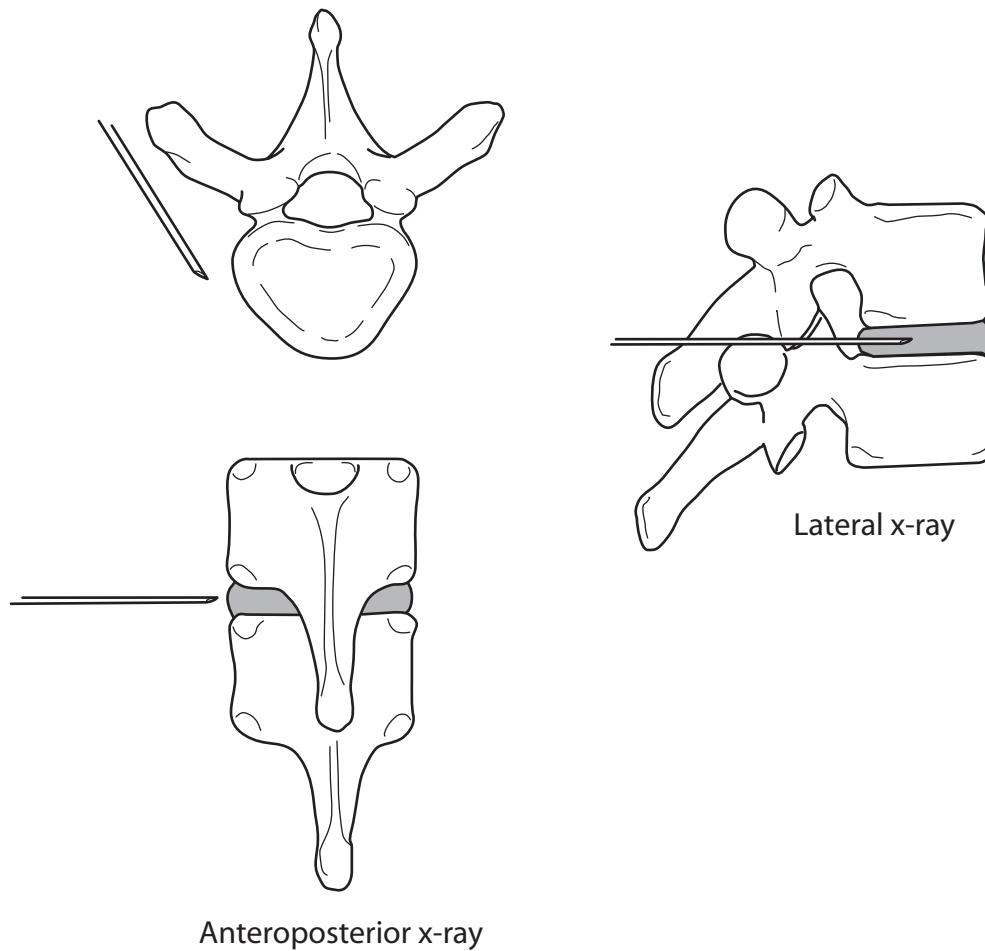


Figure 10.17. This needle tip is too far anterior and must be directed medially.

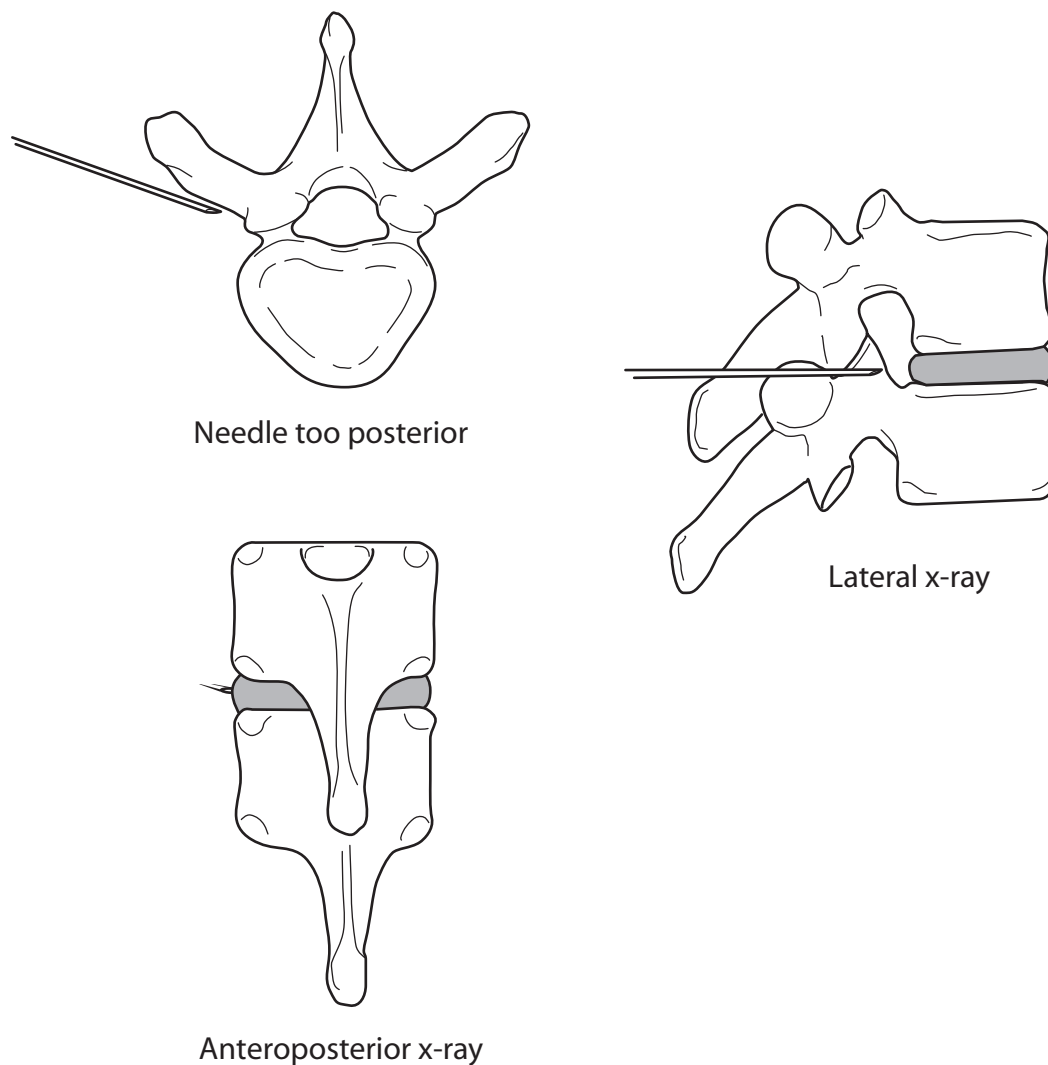


Figure 10.18. This needle tip is too medial and must be redirected anteriorly.

3 to 4 cm before it can be redirected. Now on reinsertion, if the tip is too medial to the edge of the spine in the AP view (Fig. 10.18), the needle must be redirected so that in both AP and lateral views, the tip just abuts the edge of the spine (Fig. 10.19). This, then, is the correct position of the needle, and it may be advanced past the annulus. Before this is done, the patient is told to expect a brief (half-second) moment of pain. On entry past the annulus, the pain will subside because only the surface layers of the annulus have pain fibers. At this point the needle tip is just past the annulus and should be left in place. Spot films are taken in both AP and lateral projections. The needle should also be parallel and midway be-

10 The Percutaneous Laser Disc Decompression Procedure 149

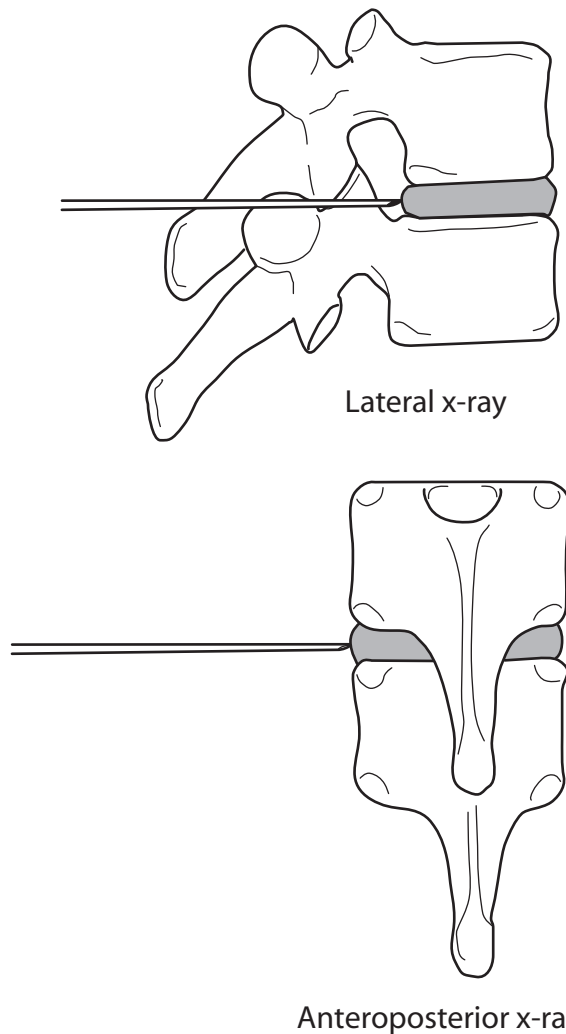


Figure 10.19. The anteroposterior and lateral views of correct needle tip position. In both views, the tip just abuts the edge of the spine.

tween the endplates (Fig. 10.20). With correct needle position, the laser can cause no damage because the tip is just past the annulus and is directed away from the endplates. The laser tract is elliptical and olive shaped, is 2.0 cm long and 5 to 6 mm in diameter, and will be confined to the nucleus pulposus. There will be no damage to any adjacent structures such as the opposite annulus, the intestines beyond, the nerve roots, or the spinal cord or nerves, depending on whether the level is above or below L-1.

Incorrect needle placement is illustrated in Figure 10.21: The needle has been inserted too far into the disc; there will be danger of the laser burning through the opposite annulus



A



B

Figure 10.20. The needle is parallel and midway between the endplates.

10 The Percutaneous Laser Disc Decompression Procedure 151

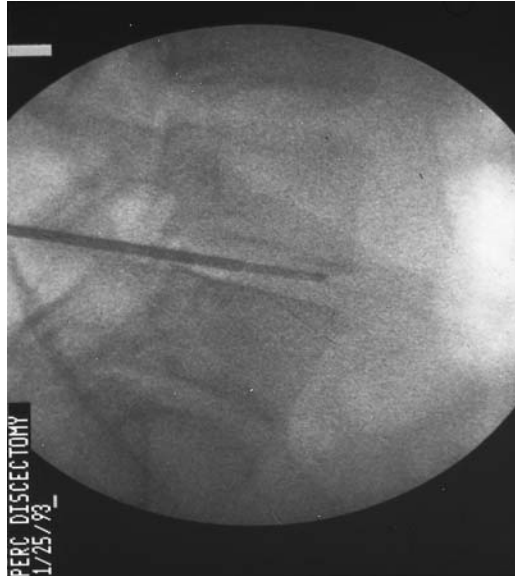


Figure 10.21. The needle has been inserted too far into the disc.

and perforating bowel (there are a few reports of this complication). The needle in Figure 10.22 also is angled incorrectly, being aimed at the endplate. The laser will inflict thermal injury on the endplate and the vertebral bone behind it.

When the needle is incorrectly placed, or if bony obstruction occurs, the needle should be partially withdrawn im-

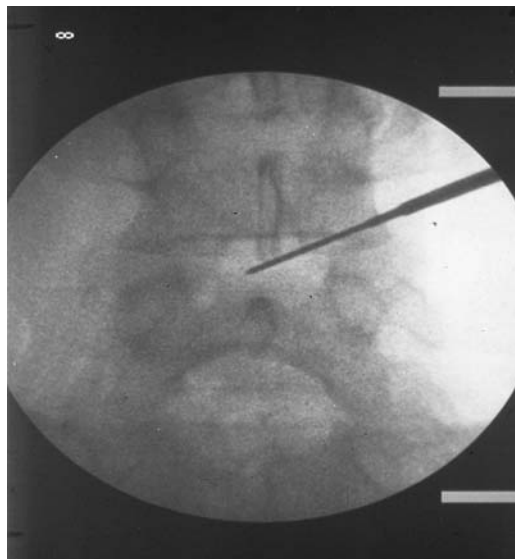


Figure 10.22. The needle is incorrectly placed, being aimed at the endplate.

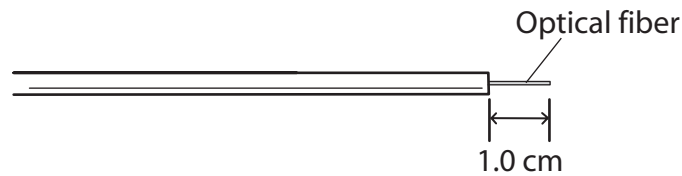


Figure 10.23. The laser fiber correctly protrudes 1.0 cm from the needle tip.

mediately and redirected. If in spite of the new direction, bony obstruction is again encountered, the laser surgeon should not waste time with repeated and fruitless attempts at reinsertion. The needle should be completely withdrawn, and a new entry point tried. This new point may be more medial or more lateral to the 10 cm horizontal line. One must experiment.

25. The optical fiber is carefully removed from the delivery kit and attached to the Neodymium:YAG (Nd:YAG) laser.
26. The laser is turned on and the fiber calibrated, with the fiber turned toward the floor and never toward the face of anyone in the room. (It is not necessary to provide patient or personnel with protective glasses, since the laser will be turned on only when the fiber is in the patient.)
27. The laser fiber is inserted into one of the 9-inch 18-gauge needles and observed to protrude 1.0 cm from the tip of the needle (Fig. 10.23).
28. Laser dosage is at 20 w with shots of 1.0-second duration separated by 5-second pauses. This equals 20 joules per firing. The patient is told to expect pressure and/or warmth. Low-grade pain may occur; if this exceeds 4 on a scale of 1 to 10, the pauses are lengthened appropriately to reduce pain to a more tolerable level. The cause of pain is inadequate heat dissipation, since the disc is poorly vascularized. Slowing down the laser applications will allow for better heat dissipation.
29. In extreme cases I allow the patient to control the firings. I will turn on the laser only when the pain is gone. This adds to patient confidence.
30. If the fiber lights up (turns incandescent), I withdraw the fiber to inspect it for "burnback," which means that the heat of the laser has burned the fiber so that the tip is now less than 1.0 cm from the needle tip. If this happens, a second fiber is obtained from another delivery kit. Because of the cost of the kits, it is helpful that this does not happen very often.
31. In most cases, the full dose of laser energy can be delivered with no problems. The total laser dose varies according to the height of the patient and the volume of the disc. If there



Figure 10.24. A sharp, round laser spot indicating good focus. (See color insert)

is no loss of disc height, the usual dose is 1000 joules (Nd:YAG) for a patient 152 to 165 cm tall, and 1500 joules for one 165 to 183 cm tall or taller. If the disc height is half of that of the other discs, the disc volume will be halved, and I will reduce the number of joules by 25%.

32. At 500 joules I routinely pull the fiber to inspect the tip. Usually the tip has been somewhat degraded; I then refresh the tip by breaking off a tiny portion with thumb and forefinger. This usually results in a sharper round laser spot (Fig. 10.24, see color plate). The laser must then be recalibrated, and the fiber measured against a spare 18-gauge needle to ensure protrusion of the fiber tip to be at least 1 cm beyond the needle tip. At the same time I will smell the proximal end of the needle to try to detect the characteristic odor of burning protein. One must use all one's senses to ascertain that laser vaporization is taking place. If there is no characteristic smell, one should check the laser to see that it is producing full power. If it is not, a backup laser is introduced online. At any rate, a backup laser is good insurance, since a laser that fails when a patient is on the table, draped, with a needle inserted, is a situation to avoid.
33. During the lasing it is important to engage the patient in (one-way) conversation, since it is very reassuring, and much useful information can be imparted. I tell the patient to expect back pain from the needling for about 5 days. If this does not

occur, and it often does not, the patient feels he or she is “ahead of the game.” Also, the patient is informed that on day 3 or 4, 10% of patients experience muscle spasm on either the right or the left side, and if that happens, there is nothing to worry about, since it usually subsides in about 3 days. Treatment for this is discussed in Chapter 11, on complications of PLDD.

34. The patient is also informed that although the chance of developing infectious discitis is only 0.4%, to the patient who does experience this complication, it is 100%. I point out that fever, together with severe midline pain, may be due to infectious discitis. If these symptoms occur, the patient is to call me and the family doctor immediately. Blood tests will be done, usually a repeat magnetic resonance imaging (MRI), and needle aspiration for bacteriologic studies. All fever is not necessarily infectious discitis: I had one patient whose post-PLDD fever turned out to be due to a viral pneumonia, one who had bronchitis, and one who had a fever of unknown origin (F.U.O.). If, however, infectious discitis is found, intravenous (IV) access will be provided, together with appropriate IV antibiotics for a minimum of 6 weeks. The patient is also informed that such rare infections are not due to a fault in aseptic technique—if so, the incidence would be considerably higher. More likely there has been an unsuspected focus of infection, such as a skin, urologic, or dental infection that seeded such as the disc, a vulnerable, relatively avascular target.
35. Now the procedure is completed; the needle is withdrawn, and a dry sterile dressing is applied.
36. The drapes are removed, and the patient is positioned on his or her back.
37. The patient is asked if the pain in the back and leg is gone, or if reduced, by how much.
38. A repeat neurologic examination is performed and recorded.
39. The patient is now assisted to a sitting position.
40. The radial pulse is checked for adequate systolic pressure, and the face and temple are observed for good cerebral perfusion.
41. If both these observations are normal, the patient is allowed to get off the table and walk to the recovery room.
42. An Acubelt (Camp International, MI) is fitted on the patient (Fig. 10.25) and the patient is instructed to wear it during waking hours for 7 days.
43. The patient is sent home or to a nearby hotel and put to bed rest for 24 hours.
44. A methylprednisolone (Medrol) dose pack (4 mg) is prescribed, as well as Percocet (acetaminophen in combination with oxycodone), 5 mg four times a day, as needed, for pain.



Figure 10.25. An Acubelt is a belt based on acupressure principles. There are eight buttons that press on acupuncture points in the back.

45. The patient is seen in follow-up the next day.
46. If the patient is in the 89% success group, he or she is encouraged to walk one mile in half-mile increments that day.
47. On day 3, the patient can walk more, up to pain limitations.
48. On day 5, the patient who is a white collar worker can return to work for a half-day.
49. If that is well tolerated, on day 6, the patient can resume a full work schedule.
50. The patient is not to drive a car for 7 days.
51. Patients whose work demands lifting or pulling heavy loads are encouraged to become supervisors or teachers or to seek other employment.

Thoracic Discs

Needle entry in the thoracic disc situation is much like that described for lumbar discs. However, the chief danger here is inadvertent creation of pneumothorax. If the needle is placed too laterally (Fig. 10.26), the tip may enter the thorax and puncture lung tissue. I therefore draw the horizontal line 8 cm from the midline instead of the 10 cm as for the lumbar discs. Since the intercostal vessels and nerves are adjacent to the inferior rib surface (Fig. 10.27), every effort is made to enter the disc with the needle over the superior border of the rib.

At the end of the procedure, the trachea should be examined to ensure that it is not deviated; auscultation of the lungs should be performed to ensure the presence of good breath sounds; and

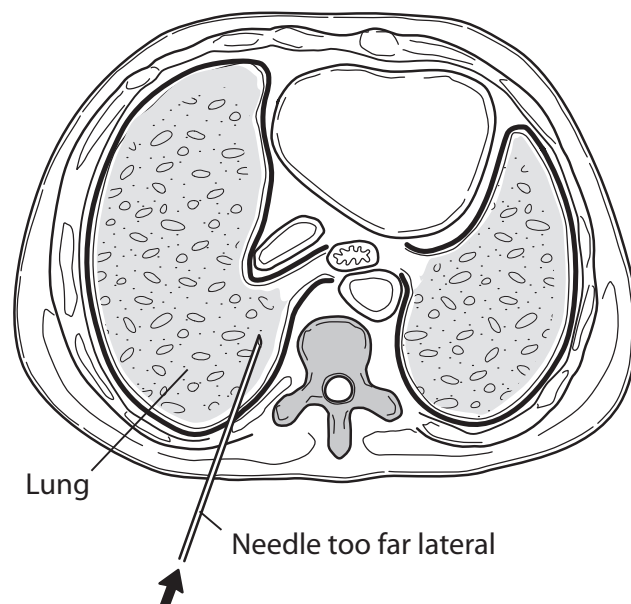


Figure 10.26. A needle placed too far laterally may enter the thoracic cavity and puncture lung tissue, causing pneumothorax.

the pulse is checked for tachycardia. If these signs are all normal, there is no pneumothorax.

When I first began performing PLDD on thoracic discs I had a nearby emergency room standing by with a chest surgeon ready with a chest tube, and a car outside my surgical suite with engine running. I have been lucky; there have been no cases of pneumothorax.

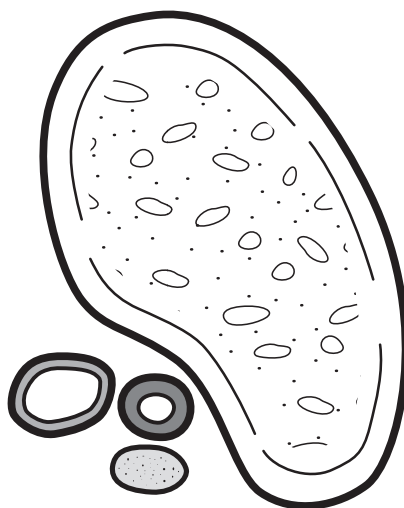


Figure 10.27. Cross-sectional view of a rib showing the position of intercostal artery, vein, and nerve just inferior to the rib.

10 The Percutaneous Laser Disc Decompression Procedure 157

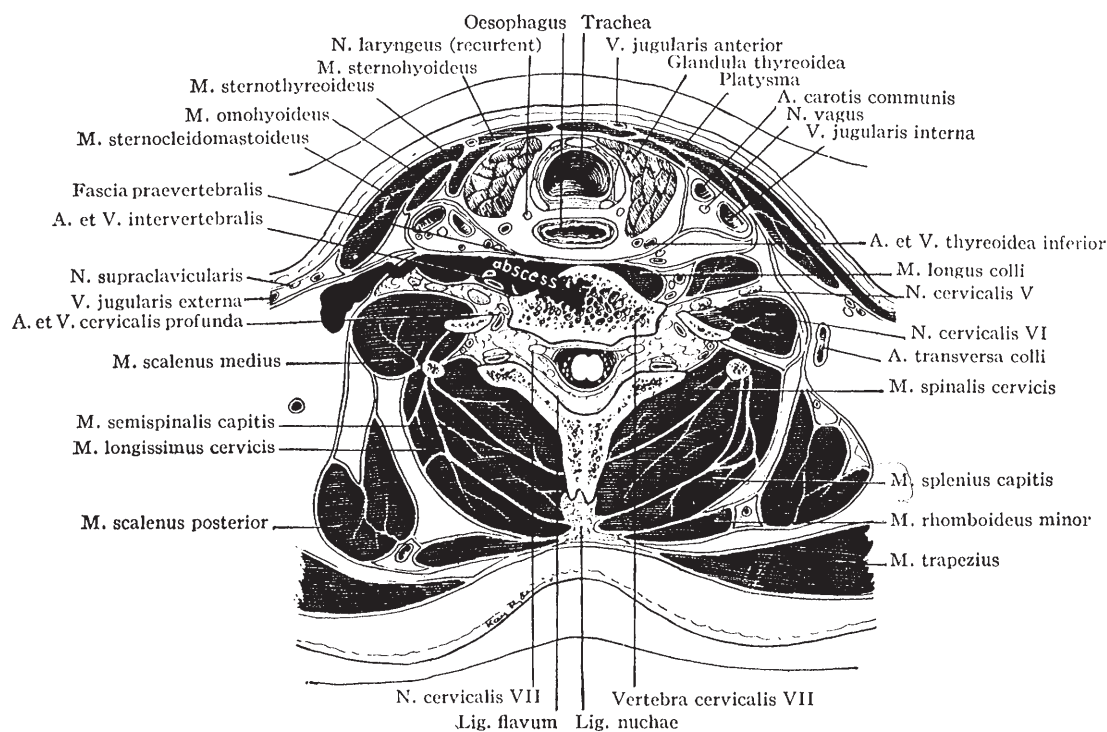


Figure 10.28. Cross-sectional view of the cervical area showing the many vital structures nearby: carotid sheath, vertebral arteries, esophagus, trachea, nerve roots, and spinal cord.

Cervical Discs

A brief outline of the procedure for cervical discs is included for completeness; it is not intended as detailed instructions for the novice laser surgeon. I wish to emphasize that because of the many vital nearby structures (Fig. 10.28) (carotid sheath, vertebral arteries, esophagus, trachea, nerve roots, spinal cord), and the much smaller size of cervical discs, and their angles, it is best not to attempt PLDD of these discs without a one-on-one intensive tutorial from an experienced user of this procedure. The risks are just too high and potentially too serious for the novice laser surgeon to attempt percutaneous decompression of a cervical disc without expert advice.

1. The patient is placed in the supine position.
2. For the C6-7 disc, the patient has been fluoroscoped or has had a single lateral radiograph taken to ensure that the disc can be seen (i.e., is not obscured by a short neck or high shoulders).
3. With thumb pressure to push the trachea and esophagus medially, a line is drawn along the anterior border of the sternocleidomastoid muscle (Fig. 10.29).



Figure 10.29. A line is drawn along the anterior border of the sternocleidomastoid muscle.

4. With the C-arm placed for a lateral view, a 20-gauge needle is lined up laterally so that it overlies the disc to be treated.
5. A line is drawn alongside this needle. Where it intersects the first line is the point of insertion.
6. A wheal is raised in the skin at this point with 1% Xylocaine.
7. Again, with pressure against the esophagus and trachea, a 21-gauge needle with syringe is used to anesthetize a tract at a 45-degree angle directly onto the disc under continuous fluoroscopic control. When the needle tip just touches the annulus, there is a distinct feel of a slight increase of resistance not unlike piercing a stiff sponge. There is no *give* if the needle hits bone. Anesthetic (1 mL) is injected into the outer surface of the annulus.

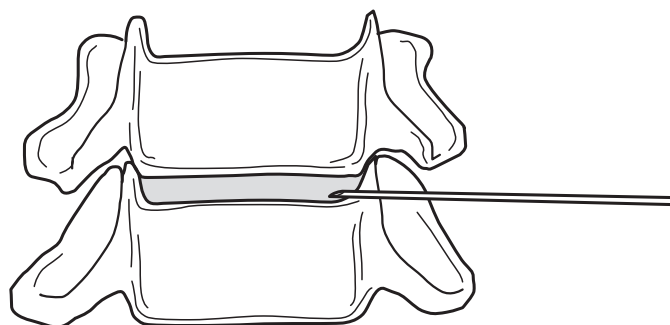


Figure 10.30. Correct needle position in the anteroposterior view.

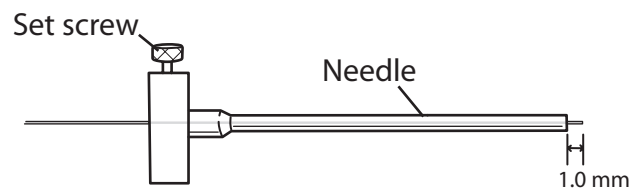


Figure 10.31. The fiber tip protrudes exactly 1.0 mm from the needle tip, and the fiber has been secured proximally by a plastic screw-on stopper.

8. The needle is withdrawn and an 18-gauge Seldinger needle inserted along the anesthetized tract, advanced until it touches the annulus and inserted 5 to 6 mm past the annulus. Anteroposterior and lateral views are obtained to verify correct needle position (Fig. 10.30). Spot films are taken. It is vital not to insert the needle too far.
9. The trochar is withdrawn and the optical fiber, previously measured against another Seldinger needle so that the tip protrudes exactly 1 mm from the needle tip and fitted proximally with a plastic screw-on stopper to maintain this geometry (Fig. 10.31), is inserted into the needle as far as the stopper will allow.
10. The fiber is connected to the laser.
11. The laser, previously calibrated to fire at 1 second \times 10 watts, is now turned on with 2- to 3-second pauses until 300 joules has been delivered.
12. The fiber is withdrawn, then the needle.
13. A pressure dressing is applied.
14. In the first 24 hours the patient wears a soft cervical collar. Other than this, there are no restrictions. All my patients returned to work on the first postoperative day.

The Problem of the L5-S1 Disc

In the anterior-posterior view, the L5-S1 disc sits at the bottom of a valley flanked by the two hills of the iliac crest. It is difficult to draw a straight line from the apex of each hill to the disc and expect it to run into the disc such that it is midway between the two endplates and also be parallel to the disc axis.

In the past, this anatomic relationship made it impossible, 25% of the time, for spine surgeons to enter the L5-S1 disc. This was especially true in male patients because of the android shape of the pelvis, with its high crest.

Kambin introduced the curved needle (Fig. 10.32), but even Kambin had difficulty directing it some of the time. In less experienced hands this task is even more difficult.

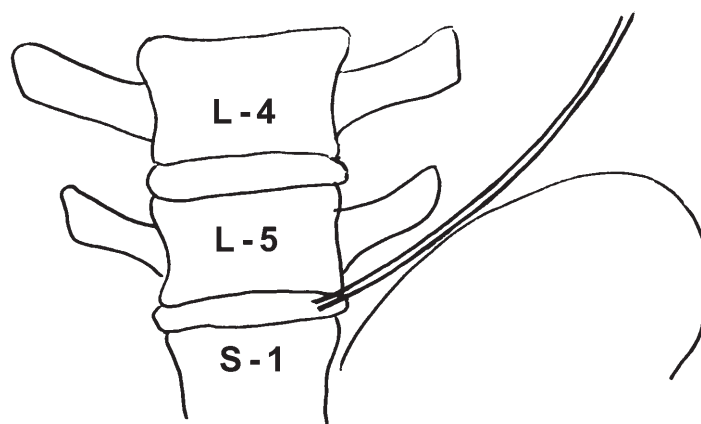


Figure 10.32. The Kambin curved needle.

In the 41 PLDDs of the L5-S1 disc performed by our group until October 1993, the disc was entered with either a straight or curved needle using a dorsolateral approach. Both approaches failed in case 42, so a direct, transthecal midline posterior insertion was used. This approach was used in 20 subsequent cases. *Spinal tap headache* occurred in only seven patients (33%). The design of the needle tip, with a rounded, conical point without a cutting beveled edge, permitted the nerve fibers of the cauda equina to be pushed apart without damage, with minimal radicular pain. There were no neurologic sequelae.

In case 63 (1993) we encountered a low-lying spinous process making the transthecal approach impossible, since the needle would have been pointed at the cephalad endplate. Therefore, entry was attempted 10 degrees away from the midline to bypass the spinous process and still maintain the position midway between the endplates and parallel to the disc axis. Thereafter we began to use this extrathecal route whenever the 45-degree dorsolateral approach was not possible; there have been no complications.

The entry point is determined by fluoroscopy. An AP view, with the radiographic beam directed in a gun barrel fashion so that the disc is viewed without parallax, is obtained. Where this line crosses the midline is marked. The entry point is 10 degrees on either side of the X. For a transthecal entry, the X is the point of entry.

The anatomic relationships are seen in Figure 10.33. The thecal sac is seen in a myelographic study (Fig. 10.34) to terminate between S1 and S2. The X is the entry point of the needle.

In practice, the midline is marked by palpation of the spinous processes of L3 through L5. The needle entry is monitored by lat-

10 The Percutaneous Laser Disc Decompression Procedure 161

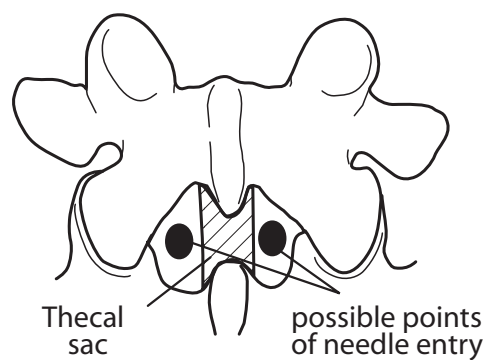


Figure 10.33. The anatomic relationships of the arch formed by the pedicles, cauda equina, and thecal sac.



Figure 10.34. Myelographic study showing the termination of the thecal sac between S1 and S2.



Figure 10.35. Axial view of a computed tomographic scan showing the needle lateral to the thecal sac.

eral fluoroscopy to ensure that the needle is parallel to the disc axis and midway between the two endplates. If the L5-S1 nerve root is touched, the needle is withdrawn and repositioned. I try to aim for the edge of the arch formed by the inferior margin of the L5 vertebral body. When the needle point touches bone, it is *walked* medially until it enters at point O. Further insertion permits entry into the disc while avoiding the thecal sac. In an axial cut of a computed tomography (CT) scan (Fig. 10.35), the needle can be seen to be lateral to the thecal sac. A lateral view is then obtained to ensure that the needle has not been advanced beyond the annulus. This is an extremely important point, since the needle is now aimed at the anterior border of the disc, and excessively deep penetration risks perforation of the anterior annulus and damage to pelvic organs.

In the author's experience over the past 17 years, the extrathecal or the transthecal route was employed between 5 and 10% of the time. I must emphasize that if repeated attempts at entry into the L5-S1 disc with the standard dorsolateral route fail, rather than cause further soft tissue damage, it is best to immediately switch to, first, the extrathecal route, and if this fails, to the transthecal route.

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