Pain Physician. 2006; 199-206, ISSN 1533-3159

A Technique Report

Fluoroscopic Axial Imaging in Percutaneous Lumbosacral Procedures: An Underutilized Technique

Michael B. Furman, MD, Ryan S. Reeves, MD, Thomas S. Lee, MD, and Ninad D. Sthalekar, MD

Background: The L4-5 and L5-S1 intervertebral disc spaces are the most frequent sites of discal spinal pathology, hence, diagnostic and therapeutic interventions are commonly performed at these levels.

While performing fluoroscopically guided spinal procedures such as discography or intradiscal electrothermal anuloplasty (IDEA), antero-posterior (AP), lateral, and oblique views are utilized. However axial projection is not typically possible without three-dimensional imaging such as computerized tomography (CT). Intra-procedural CT is not commonly available. Instead, post-discography CT axial views are used to grade the degree of disruption. However, post-procedural CT is not always immediately available, and it increases costs and may increase patient discomfort, inconvenience, and radiation exposure.

Intra-procedure fluoroscopic axial (F-axial) views offer the benefit of dynamic information by helping confirm needle, introducer, or intradiscal catheter position.

Objective: To describe an alternative approach to axial imaging of the L5-S1 intradiscal space.

Setting: Spine Speciality Center

Technique: We describe a simple technique for visualizing L5-S1 axial images intra-procedurally using F-axial views. Taking advantage of the patient's lordosis, the C-arm image intensifier is rotated cadally so F-axial images are obtained.

We also demonstrate other uses of intra-procedural F-axials, including confirmation of discography needle placement and IDEA introducer and catheter positioning.

Conclusion: The L4-5 and L5-S1 intervertebral disc spaces are frequent sites of discal spinal pathology. Multiple diagnostic and therapeutic procedures are performed at these levels. This report describes an adjunctive technique for visualizing the L5-S1 axial images intra-procedurally using a fluoroscopic axial (F-axial) view.

Key Words: Fluoroscopic Axial Images, Post-discography CT scan, Discography, Percutaneous Intradiscal Treatment, Internal Disc Disruption

One of the diagnostic methodologies often utilized in the evaluation of chronic refractory low back pain is disc stimulation or provocation discography (1-3). This is frequently followed by post-discography CT, which has the advantage of providing axial views of the intervertebral discs (IVDs) to evaluate the presence and extent of concentric and/or radial fissures within the anulus fibrosis. In his 1990 publication, Thomas Bernard described a study of 250 patients in which computed tomography (CT) scanning after discography was not only able to define the herniation and disc architecture, but also could help rationalize false-positive levels in the setting of non-nuclear (annular) injections (4). Conventional AP and lateral views provided by fluoroscopy are not able to provide this perspective.

Despite the advantages noted above, post-discography CT has its shortcomings when compared to standard fluoroscopy. CT generated imaging requires higher radiation doses than that of standard fluoroscopy and has its associated additional expenses (5). Also, it is rarely possible to perform simultaneous CT during discography. Indeed, CT is typically not available on site for immediate post-procedural imaging

Standard Imaging

The L5-S1 disc access is more challenging than the other lumbar discs. This is due to the fact that the iliac crests are often directly in the trajectory of disc access; as a result, a more cephalad image intensifier tilt is often necessary (Figs. 1 and 2).

Due to lordosis, the L5-S1 interspace lies in a different axial plane then the other discs, making it more difficult to image with standard AP projection (Fig. 3). Instead, an intra-procedural Ferguson view is typically obtained by tilting the fluoroscope's image intensifier cranially to obtain a more true AP of the L5-S1 disc level (Fig. 4a, b, c) (6).

To address the lack of intra-procedural axial imaging and challenging L5-S1 disc access concerns, we present an expansion upon the classic bi-planar AP and lateral views by including an intra-procedural fluoroscopic L5-S1 axial (F-axial) projection. This intra-procedural F-axial view allows immediate visualization of needle placement or contrast patterns within the L5-S1 disc, aiding needle tip position confirmation as well as visualization of anatomy. The F-axial view additionally helps

From: Orthopedic and Spine Specialists, York, PA, Spine Team Texas, PA, and Southlake, TX
Address Correspondence: Michael B. Furman, MD, Orthopedic and Spine Specialists, 1855 Powder Mill Rd, York, PA 17402
Email: MBFurman@hotmail.com
Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of Interest: None.
Manuscript received on: 04/28/2006
Revision submitted on: 06/12/2006
Accepted for publication on: 06/14/2006

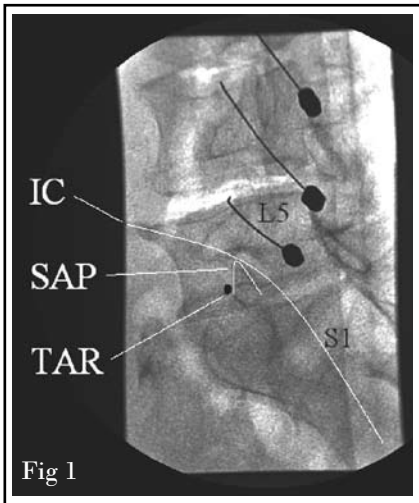


Fig 1

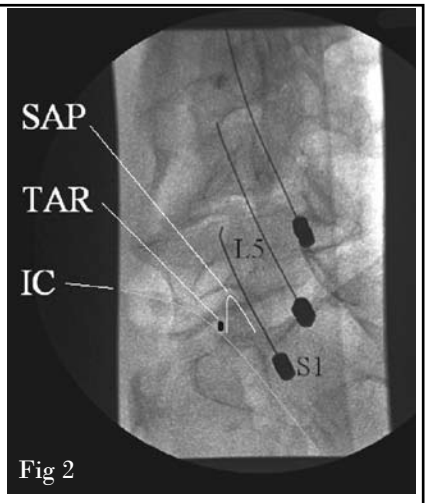


Fig 2

Fig. 1 and Fig. 2 *demonstrate the position of the iliac crest (IC) in relation to the L5-S1 disc space and S1 superior articular process (SAP). The black dot at the end of the line, "TAR" marks the target for needle placement lateral to the SAP. Notice that in Fig. 2 with a cephalic tilt of the C-arm the L5-S1 disc is accessible just lateral to the S1 SAP and is no longer obscured by the IC.*

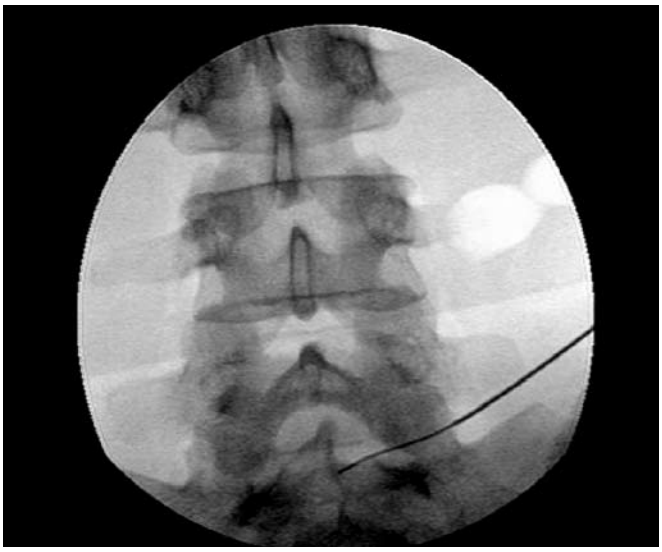


Fig. 3: *Demonstrates a standard AP view of the lumbar spine. Although the needle tip is in the geometric center of the L5-S1 disc it does not appear that way in this image.*

with placement of intradiscal catheters (e.g. IDEA) or other minimally invasive treatment devices (e.g. percutaneous disc decompression) (Fig. 5).

This paper describes a simple approach to axial imaging of the L5-S1 disc. Although this technique has been alluded to in other texts, we are not aware of any detailed description of its application (7).

Anatomy

There is significant lumbar lordosis at the lumbosacral junction, especially manifests itself at the L5-S1 level. The extent of the lordosis at this level can be best appreciated when viewing a lateral roentographic view of the lumbar spine (Fig. 6).

Since a standard lumbar AP (Fig. 3) does not accurately obtain the L5- S1 disc, proceduralists often utilize Ferguson's view to visualize a true fluoroscopic AP of the L5-S1 interspace. Ferguson's view is obtained intraprocedurally by "lining up" the inferior L5 and superior S1 end plates. The fluoroscope's image intensifier is dynamically tilted cranially until the end plates change from an ellipse into a line (Fig. 4a, 4b and 4c)

Description of Technique

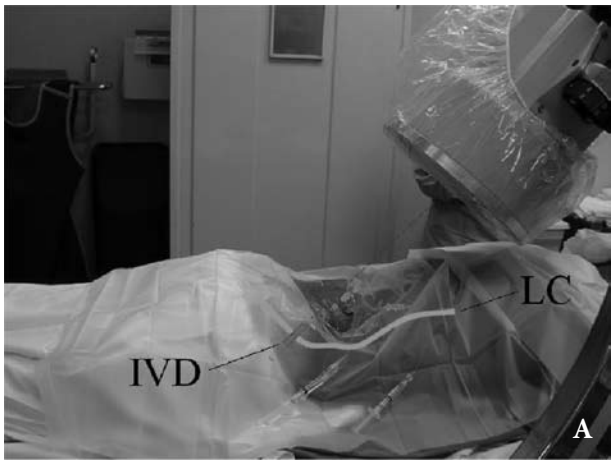
After appropriate preparation, intradiscal procedures were performed with the standard approaches for disc access and confirmation. Once satisfied with the needle or therapeutic catheter position, fluoroscopic lateral, AP, and Ferguson AP images were obtained (Fig. 7a, b, c).

Intra-procedural L5-S1 F-axial views were then obtained in patients undergoing provocation discography and intradiscal electrothermal anuloplasy (IDEA). Taking advantage of the patients' lordosis, the angle used for Ferguson view was obtained. This involved tilting the C-arm's image intensifier cephalad, getting a true AP of the L5-S1 IVD by projecting the roentograph beam parallel to the disc's end plates (Fig. 4a). This was typically 25-40 degrees off of the standard AP (Fig. 4b). The image intensifier was then tilted caudally, almost perpendicular to the Ferguson AP trajectory, to obtain an F-axial L5-S1 image (Fig. 8a and 8b).

Discussion

We describe this technique of fluoroscopic visualization of axial imaging during discography and intradiscal electrothermal anuloplasy procedures. We compare fluoroscopic axial views at the L5-S1 level with CT axial images following discography. Also presented are several cases where this technique changed intra-procedural decision making.

By tilting the fluoroscope intensifier caudally, an F-axial image of



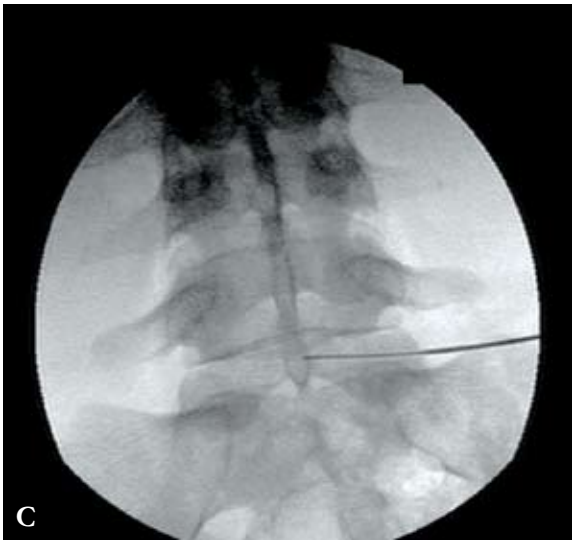


Fig. 4a and 4b: *Demonstrate the position of the C-arm in relation to the patient to obtain a Ferguson view. Fig. 4a demonstrates the curvature of the patient's spine including lumbosacral lordosis – lordotic curve (lc). Note that the fluoroscope is tilted into the same plane as the intervertebral disc (IVD). Fig. 4b demonstrates that approximately a 35 degree C-arm tilt is used for this particular patient. (Patient's head is to the right and feet are to the left in this photograph)*
Fig. 4c: *Demonstrates the corresponding fluoroscopic image with the Ferguson view positioning of the C-arm from 4a and 4b. Notice the sharp appearance of the L5-S1 interspace. The only change from Fig. 3 is the fluoroscope position.*

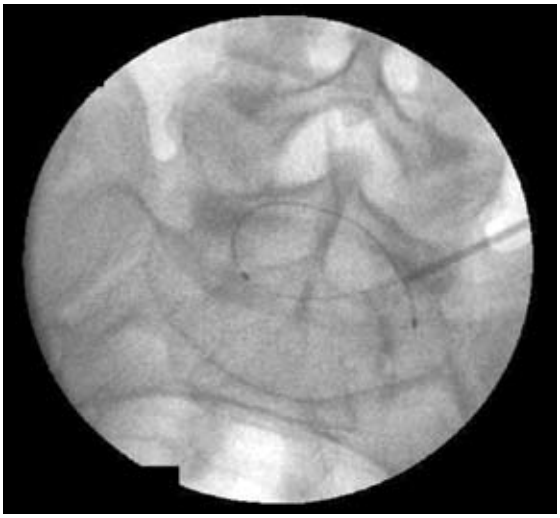


Fig. 5. *Demonstrates the F-axial view of the heating element during an IDEA procedure of the L5-S1 disc.*

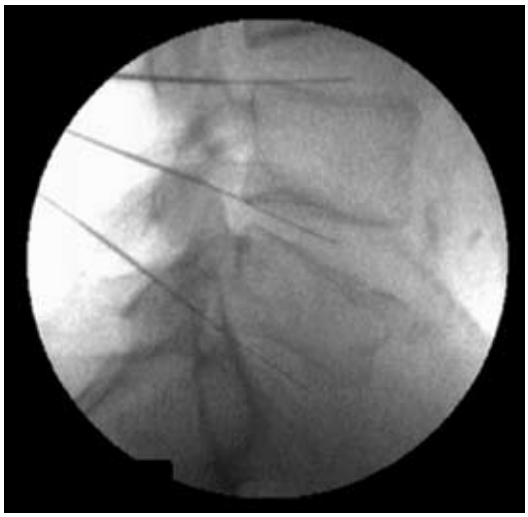


Fig. 6. *Demonstrates the lordotic curve of the lumbar spine. Notice the different trajectories of the spinal needles when entering each respective disc during a discogram procedure*

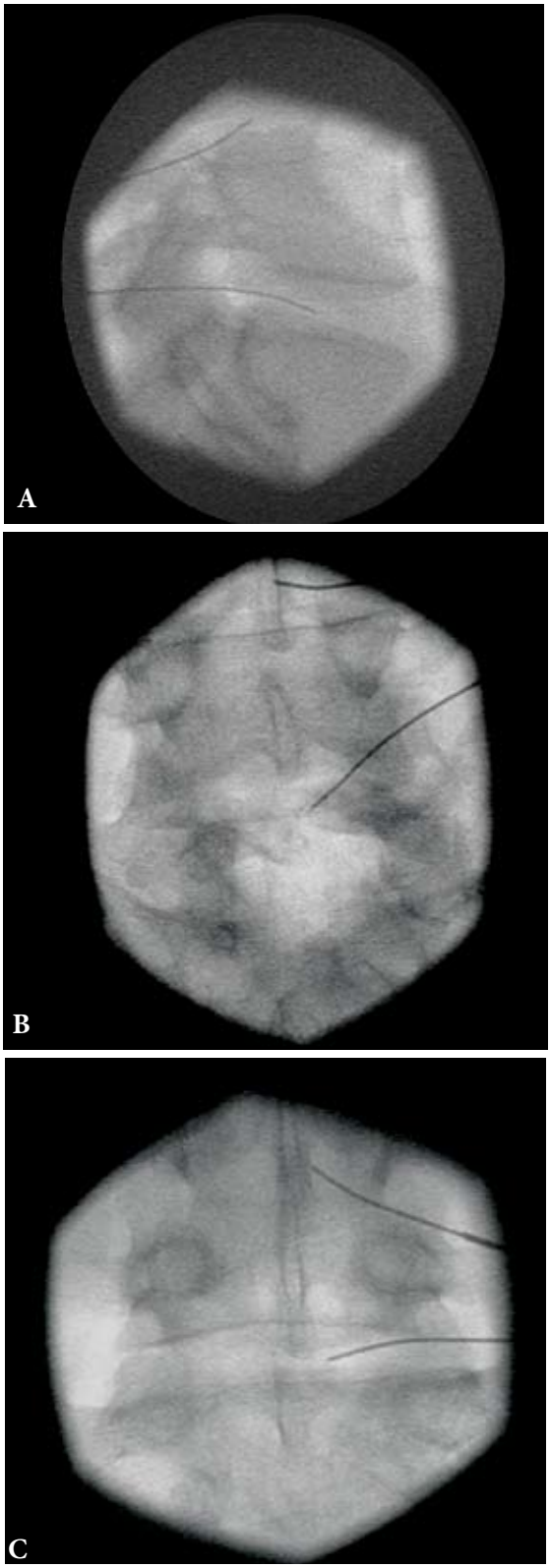


Fig. 7a, b, c. *Demonstrate the standard lateral (7a), AP (7b), and Ferguson (7c) views used to determine final needle positioning prior to contrast injection in the L4-5 and L5-S1 discs during provocation discography.*

the L5-S1 IVD was dynamically obtained. In many cases, needle or catheter position changes were made based on the F-axial view. Sample images from intradiscal procedures were qualitatively correlated with post-discography CT imaging. In patients undergoing anuloplasy, the F-axial projections aid in confirmation of proper localization prior to thermal treatment. Specifically, this confirmed that the catheter was optimally placed in the disc (Figs 11 and 12). Figures 9 a, b, and c demonstrate a qualitative comparison of intraprocedural F-axial and post-discography CT imaging.

Case 1: Discography

This case demonstrates an instance where an L5-S1 disc injection was initially annular. The initial lateral and Ferguson AP views were inconclusive (Fig. 10a and 10b). Once F-axial imaging was performed (Fig. 10c), an annular injection was confirmed. The needle was therefore repositioned (Fig. 10d).

Had an intra-procedural axial image not been obtained, an annular injection may have been missed. A post-procedural CT scan may have demonstrated the non-nuclear injection. In such an instance, a repeat discogram may have been necessary. The potential repeat discography was obviated by intra-procedural F-axial which identified the annular injection intra-procedurally.

Case 2: Demonstration of F-axial imaging during IDEA

Successful anuloplasty relies on precise catheter placement symmetrically within the posterior anulus. This can be accomplished by navigating the catheter into the posterior portion of the disc (11, 12). Typically, AP and lateral is all that is available (Fig.11a and 11b). With the addition of the F- axial view, the heating portion of the catheter can be better visualized (Fig.11c).

Case 3: Intradiscal Catheter Placement

Traditionally the F-axial view is most useful for the L5-S1 level, however it can also be used to visualize catheter place-

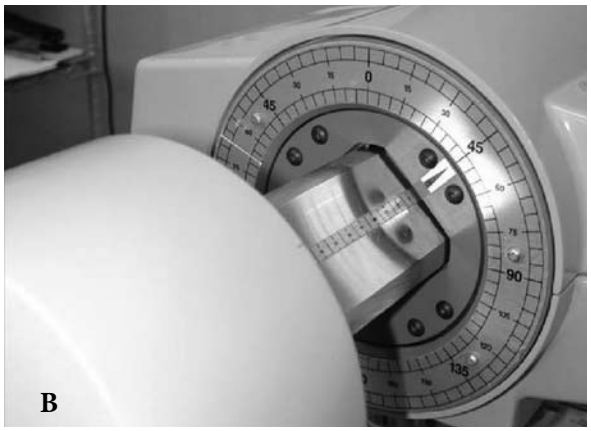
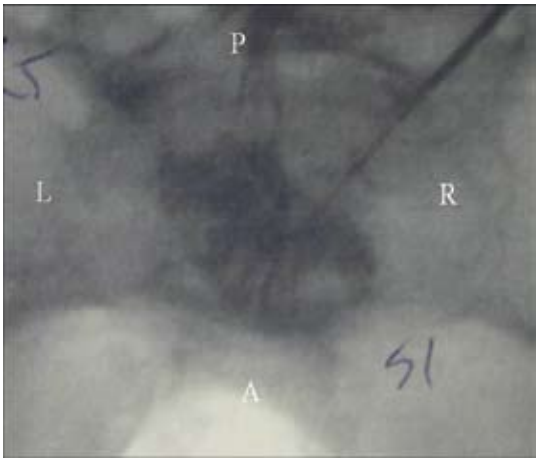
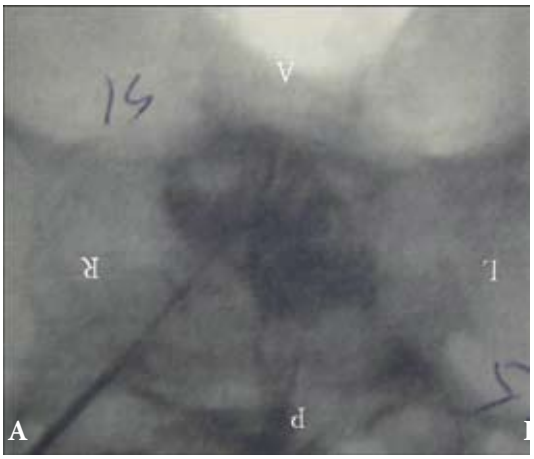


Fig. 8a, b. *Demonstrates the positioning of the C-arm in order to obtain the F-axial view. Typically, a complete 90 degree of tilt from Ferguson's true AP could not be obtained. A large image intensifier and/or patient's body habitus may prohibit further caudal tilt (Fig. 8c). (Patient's head is to the right and feet are to the left in this photograph)*

Fig. 8c. *Demonstrates how the size of the image intensifier and/or body habitus may prohibit further caudal tilt therefore limiting the F-axial view angle. (Patients head is to the right of this photograph and feet are to the left)*





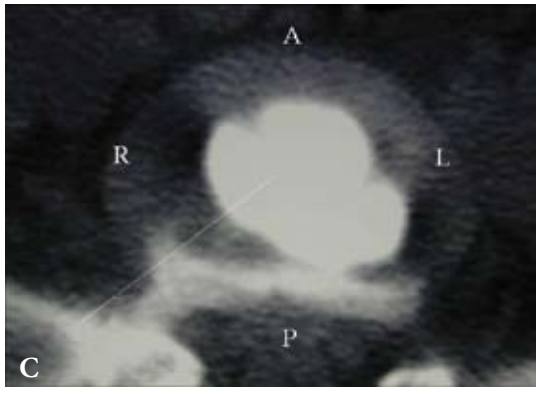


Fig. 9a, b,c. *Demonstrate the F-axial fluoroscopic image (9a) with the corresponding post-discography CT-scan (9c). 9a is the F-axial image seen intra-procedurally. 9a is the same Fig. as 9b, but 9b has been rotated to standard radiographic convention for comparison to 9c. The spinal needle is visualized entering the nucleus of the disc in Fig. 9b. The white line in Fig. 9c marks the trajectory of the spinal needle. Notice how both fluoroscopic and CT images show similar morphology.*

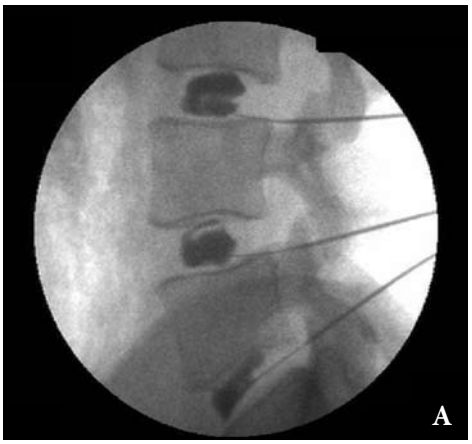


Fig. 10a and 10b. *Demonstrate the corresponding lateral and AP images which do not reveal definitive evidence of the annular injection. Fig. 10d demonstrates an F-axial view with needle repositioned into the nucleus of the L5-S1 disc in a different position from the original annular injection.*

Fig. 10c and 10d. *Demonstrate an F-Axial image with annular injection at the L5-S1 disc (L5-S1 needle is labeled).*

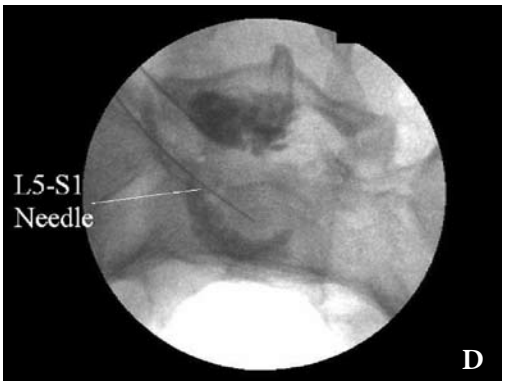
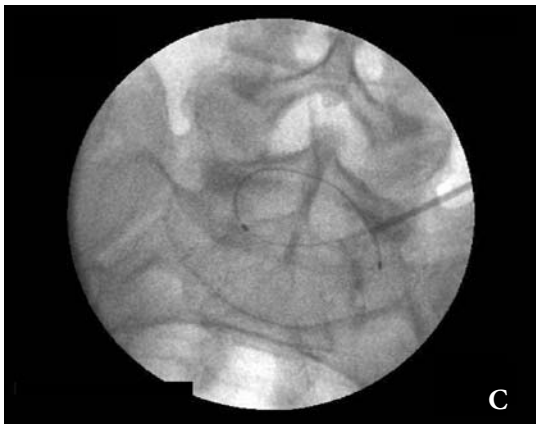
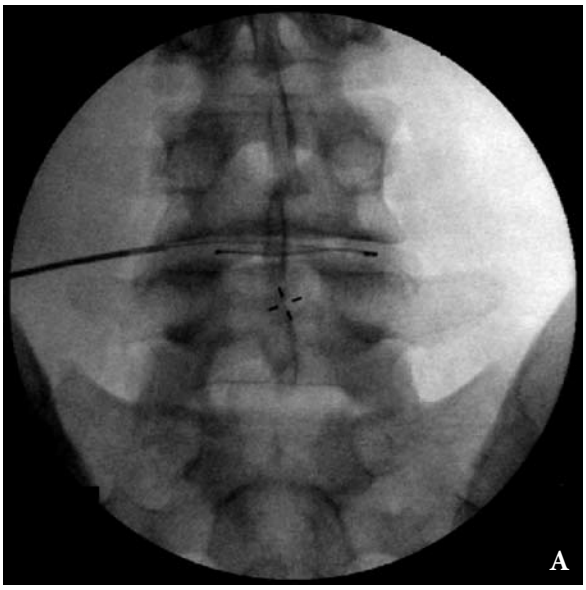


Fig. 11a and 11b. *Demonstrate AP and lateral views of the L5-S1 disc during placement of the heating element during an IDEA procedure.*

Fig. 11c. *Demonstrates the corresponding F-axial view of the heating element in the L5-S1 disc.*





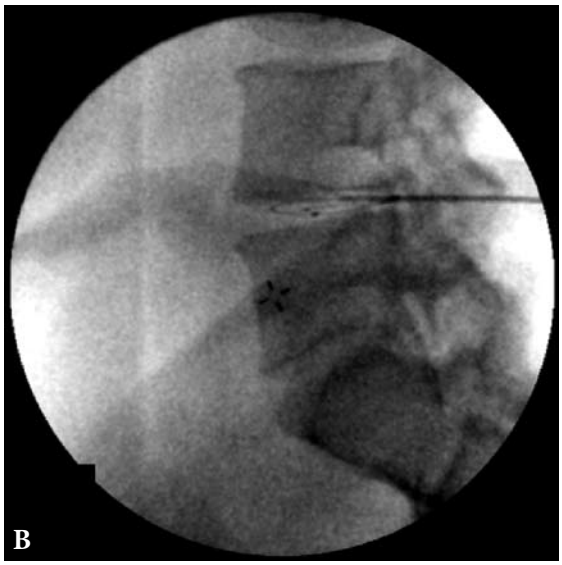


Fig. 12a and 12b *Demonstrate AP and lateral views of the L4-5 disc during placement of the heating element during an IDEA procedure.*

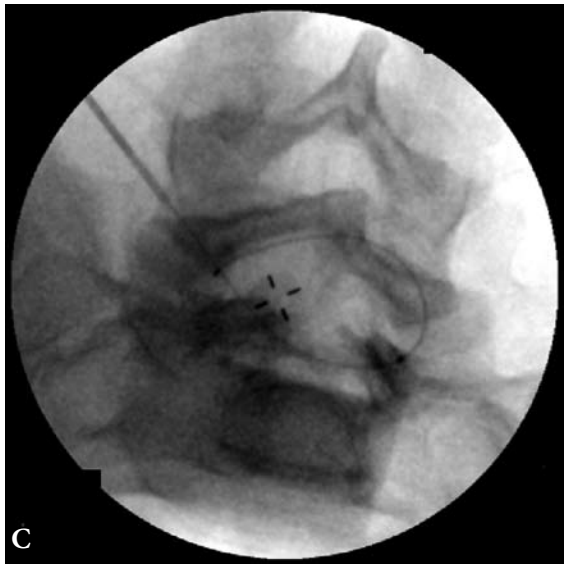


Fig. 12c *Demonstrates the corresponding F-axial view of the heating element in the L4-5 disc. Although catheter placement shown here is slightly eccentric to the right, this view allows additional visualization of the catheter in the anulus.*

ment at the L4-5 level, as illustrated in Fig. 12a, 12b and 12c.

Spinal pain often involves the L4-5 or L5-S1 intervertebral disc space. Intradiscal procedures are becoming more common for evaluation and treatment of spinal pathology (10). As a result of the variability of lumbar lordosis and/or high iliac crests, placement of needles or catheters into the L5-S1 interspace may be demanding. Standard AP and lateral projections may fail to reveal suboptimal needle or catheter placement, often leading to an annular injection or inadvertent annular or intradiscal treatment. This report describes the use of F-axial imaging to aid in the diagnosis and treatment of discogenic low back pain by providing adjunctive intra-procedural views to redirect needle or catheter placement. This may decrease the incidence of L5-S1 annular injections or suboptimal catheter placements

Conclusions

A simple technique for visualizing L5-S1 axial images intra-procedurally using F-axial views is described. In addition to the traditional AP, Ferguson AP, lateral and oblique views, intra-procedural fluoroscopic axial (F-axial) projection offers the additional benefit of providing dynamic information and thereby potentially helping to confirm and/or improve needle, introducer, or intradiscal catheter placement. This technique can prospectively avoid post procedural or repeat testing. Despite the above benefits, it should be noted that this is not a perfect axial view and is typically only useful for the L5-S1 level although it may be attempted for L4-5 view as well.

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Author Affiliation:

Michael B. Furman, MD
Clinical Assistant Professor
Temple University
Department of Physical Medicine and Rehabilitation
Philadelphia, PA
Special Consultant
Sinai Hospital of Baltimore
Deparment of Physical Medicine and Rehabilitation
Baltimore, MD
Orthopaedic and Spine Specialists
1855 Powder Mill Rd
York, PA 17402
Email: MBFurman@hotmail.com or MFurman@Orthospinesp.com

Ryan S. Reeves, MD
Spine Team Texas, PA
1545 E. Southlake Blvd., Suite 100
Southlake, TX 76092
Email: ryan@spineteamtexas.com

Thomas S. Lee, MD
Attending Physiatrist
Physical Medicine and Pain Management Associates, LLC
2002 Medical Parkway, Suite 430
Annapolis, MD 21401
thomas-s-lee@excite.com

Ninad D. Sthalekar, MD
Attending Physiatrist
Pain Relief Centers
Pinellas Park, FL
6640 78th Ave. North, Suite A
Pinellas Park, FL 22781
ninad101@hotmail.com