INVITED REVIEW

Analgesic Discography: Can Analgesic Testing Identify a Painful Disc?

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Abstract

As a diagnostic test, provocation discography (PD) remains controversial with many stakeholders at an impasse. Despite its shortcomings, however, PD is the current standard for the diagnosis of painful internal disc disruption. Until recently, the injection of local anesthetic into the disc had not been well-studied, with only a handful of studies published over the last 60 years. To better diagnose and treat discogenic pain, interest has been renewed in various methods of analgesic discography (AD), including the recent introduction of functional analgesic discography (FAD).

In this review, we critically examine the current AD and FAD literature and discuss construct validity, predictive value, technique and test selection. In that few studies have been published, the current evidence for the utility of analgesic discography and functional analgesic discography is limited. The evidence is insufficient to suggest that AD should replace PD in identifying a given disc as the source of patient's pain. However, for patients undergoing provocative discography, AD or FAD may be useful confirmatory procedures. Further research is needed to compare PD to AD, to refine technical performance of the test, to determine if AD or FAD reduces the false-positive rates of PD, and to prove the predictive value of AD/FAD in terms of surgical outcomes.

Introduction

Only 60 years ago, discs were thought to be incapable of producing pain. Since then, much has changed scientifically, financially and politically. Now, as treatment options expand and health care costs spiral, governments, insurers, providers and patients are demanding more definitive diagnostic tests for discogenic pain, or at minimum, tests that clearly lead to improved treatment outcomes. Lacking "gold standard" proof, some are again disputing the existence of discogenic pain.[1-3] In this environment, analgesic discography and other diagnostic methods for painful disc degeneration are being actively pursued.

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Absent pathognomonic findings, discogenic pain is often diagnosed through a "preponderance" of evidence. In some cases, the history and physical examination combined with imaging findings are sufficient. Unfortunately, history and physical examination findings may be unreliable.[4-6] Imaging alone cannot differentiate patients with disc, facet joint or sacroiliac joint mediated low back pain (LBP) from asymptomatic adults.[7-12] Additionally, MRI often reveals multiple potential pain sources.[13-15]

Provocation discography (PD) is used in confirming or refuting a particular disc as a source of a patient's pain. The premise: "If a particular disc is painful, then stressing it should reproduce the patient's pain. If the disc is not the source of a patient's pain, then stressing it either should not be painful or should produce pain that is not the patient's familiar or accustomed pain." (International Spine Intervention Society [ISIS] Guidelines, Chapter 7).

Indeed, recently all the published PD data on asymptomatic subjects undergoing PD show that, in asymptomatic volunteers without confounding factors, the false positive rate is less than 5%. To obtain these results, limit pressure provocation, utilize pressure-controlled manometry, and follow the International Spine Intervention Society (ISIS) and the International Association for the Study of Pain (IASP) standards. Even when volunteers

with significant confounding factors (ie, chronic pain, prior discectomy, etc) were included, the false positive rate averaged less than 10%.[16] However, if one does not adhere to these strict criteria, false positive rates are undoubtedly higher. Additionally, although these guidelines are increasingly accepted, the majority of those performing PD still rely on manual, unrestricted pressurization and provocation of concordant pain.

Thus, although useful as one of many data points in arriving at a diagnosis, provocation discography is not a stand-alone test. It cannot rule out other sources of pain, determine whether the disc is the primary source of pain, or determine the significance of a patient's perceived suffering. PD can only determine if a patient's response is statistically different from an asymptomatic volunteer with similar annular disruption experiencing the same intradiscal distending pressure. As with any subjective test, provocation discography results can also be altered, intentionally or unintentionally, by either the discographer or the patient. An inexperienced or biased operator can produce erroneous results.[1-3] Similarly, poor patient selection can increase the chance of erroneous results. Finally, the reliability of provocation discography cannot be equated with outcome from treatment. Surgical treatment limitations do not necessarily negate the diagnostic value of discography or the diagnosis of painful internal disc disruption.

Analgesic and provocation discography are, in many ways, opposite sides of the same coin. Whereas PD attempts to confirm the disc as a pain source by reproducing a patient's usual symptoms, AD attempts to relieve those symptoms. Analgesic discography can be used alone or in combination with PD. It can also be combined with functional testing, so called "functional analgesic discography." In the following sections we explore our current understanding of the role of analgesic discography.

History

The first reported use of analgesic discography was in 1948 by Hirsch.[17] He described diagnostic disc punctures in 16 patients with chronic low back pain and negative myelograms. If disc puncture or needle movement increased the patient's pain, he injected 0.5cc of 1% Novocaine. "With addition of more volume into the disc, the patients experienced a temporary increase in pain, however, it resolved in 2-3 minutes." At three minutes, the patient's straight leg raise test was markedly reduced, spine mobility normalized, spasms resolved and "the patient considered himself quite free of his lumbago." This effect lasted two to four hours. In contrast, other patients' pain was evoked by injection of normal saline, not by disc puncture or needle movement. Injected patients symptomatically worsened for several hours before returning to their baseline pain level.

Subsequently, injection of local anesthetic into a presumed painful disc following provocation discography has been used sporadically over the decades to help surgeons confirm the diagnosis of discogenic pain.[4,18,19] In the late 1970s, Roth et al[18] asserted that analgesic discography more precisely confirmed both the diagnosis of discogenic pain and the pathologic level as compared to provocation discography. He reported a 93% good or excellent recovery rate in 71 patients over a two-year follow-up period utilizing cervical analgesic discography.

Until recently, descriptions of analgesic discography have largely been "embedded" in the methods sections of various studies based on the preference of the discographer in attempting to select the best surgical candidates. For example, in the study by Coppes et al,[4] local anesthetic was injected post–provocation discography as a confirmatory test. The analgesic discography was considered a confirmatory test for the surgeons. The authors reported that "additional injection of 0.5 to 1.0 mL of bupivacaine into the disc through the same needle relieved the pain for 1 to 4 hours."[4]

Alamin was the first to place epidural catheters in the disc as a part of the process of analgesic discography in 2006.[20,21] This allowed for multi-level anesthetic and placebo testing of the disc, as well as functional testing in the recovery area using typical provocation maneuvers. Alamin codeveloped a balloon tipped catheter (Discyphor™ Kyphon) to allow for anchoring of the device in the disc during functional testing and coined the term "functional analgesic discography" (**Figure 1,** next page).

Construct Validity

The disc was first shown in 1981[22] to contain nociceptors in the outer one third of the posterior annulus and thus to be a potential pain generator. More recently, provocation discography positive discs removed at surgery have shown neo-innervation extending into the nucleus pulposus.[23] Compared to asymptomatic discs, painful disrupted lumbar intervertebral discs have higher concentrations of sensory fibers in both end plates and nucleus.[4,24] This high concentration of sensory fibers combined with increased levels of proinflammatory mediators such as IL-8 and PGE2 are theorized to cause hyperalgesia and pain upon loading.[25-27] In fact, in this hyperalgesic state, even normal mechanical loading, especially lateral shear and torsion, will be painful.

Logically, if discogenic pain is caused by sensitized nociceptors within torn annular fissures or the immediately adjacent end plates or outer annulus of the disc, injection of local anesthetic into that disc should relieve pain to the extent that a sufficient concentration of local anesthetic reaches and blocks the offending nerve endings. However, despite the long-time occasional use of AD and the increasing use of FAD, the construct validity of analgesic discography has only been partially investigated. Questions remain related to the appropriate volume, type and concentration of local anesthetic sufficient to fully anesthetize the disc, as well as the onset and offset times of various anesthetics, particularly in the acidic, avascular environment of the disc. Additionally, although it is assumed that the end plates are anesthetized along with the disc, the implications of this for treatment are unknown.

As with PD, analgesic discography is a procedure-based, subjective test and the validity of the results depend upon a variety

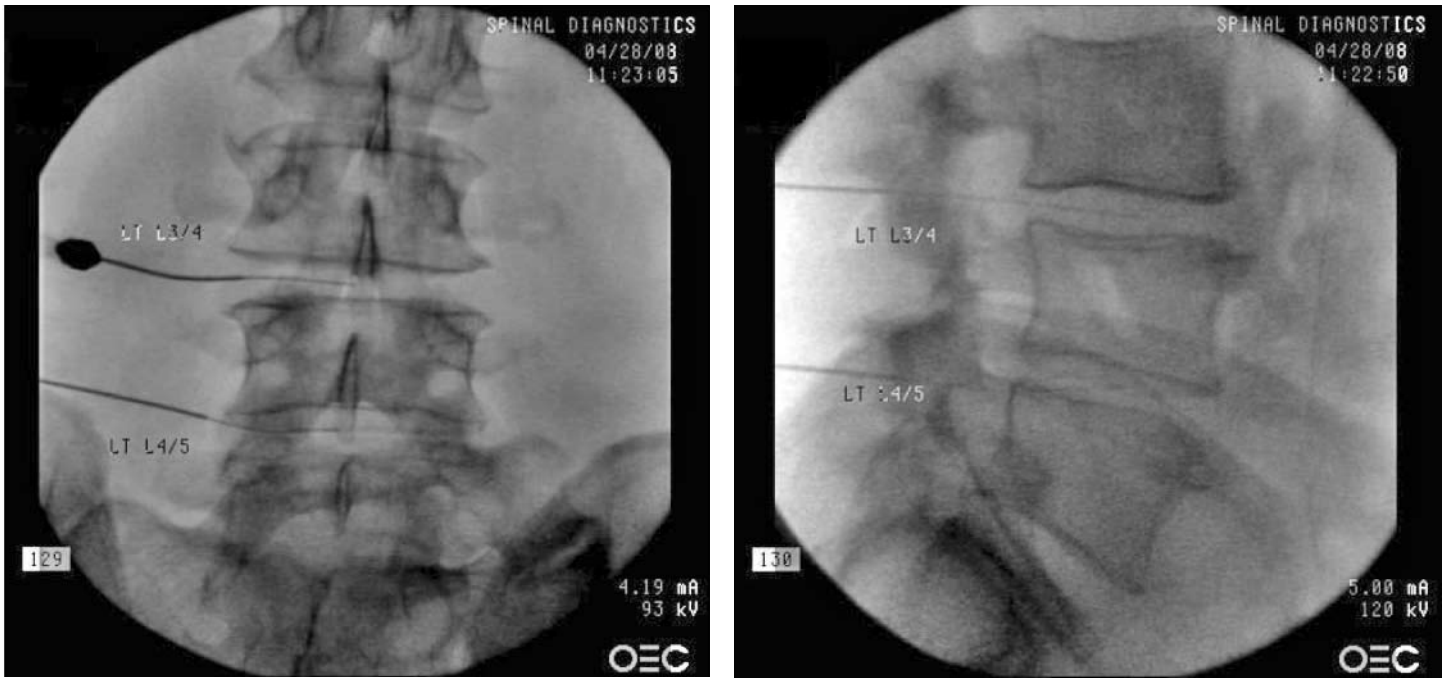


Figure 1. AP (left) and lateral (right) views. Case Study: 46-year-old man with chronic low back pain with prior equivocal positive PD at L5-S1 at high pressure in a partially sacralized L5-S1 segment; L3-4 no pain on PD and L4-5 with 4/10 non-concordant pain. FAD with equivocal relief at L4-5. Subsequent analgesic disc injection performed with of 1.0cc of 0.75cc bupivacaine at L3-4 and L4-5. Overall subjective relief = 98%. (Images courtesy of Richard Derby, MD)

of technical and nontechnical factors. Technically, the placement of the catheter itself can be a source of pain, either through irritation of tissue during insertion, or via a direct irritation of the adjacent nerve by the indwelling catheter. The quantity of local anesthetic injected may also be insufficient to affect an adequate block if pain results from abnormally high stress gradients within the end plates/vertebral bodies or the intact annulus, especially if anesthetic leaks from the disc.

Conversely, leakage of local anesthetic through an outer annular tear could block adjacent structures at the same or adjacent levels, including the sinuvertebral nerve which innervates the disc or the adjacent posterior longitudinal ligament, which is an integral part of the disc. Indeed, Bartynski et al[28] reported pain relief during PD correlated with leak of local anesthetic through outer annular tears. His study, however, was a retrospective review without controls. Patients "were continuously asked" whether their pain subsided after moderate to rapid manual injection contrast followed by 2% xylocaine. The time postinjection was not recorded and thus one might assume the next level was injected within 5 minutes, an insufficient time for xylocaine to diffuse through the outer annulus. Regardless of whether local anesthetic is injected, experience shows that pain often subsides if it was provoked by the opening of an annular tear, or if pressure on the outer annulus/end plates is not maintained because of a leak. Their finding that patients reported complete or partial relief in only 31% of the painful discs with intact outer annulus compared to 89% of leaking discs could also be attributed to false negative responses caused by persisting annular tension activating unblocked pain receptors within the annulus, posterior annular ligament or the end plates/vertebral bodies.

Nontechnical factors can also lead to erroneous AD results. Neurophysiologic phenomenon with convergence of neurons from adjacent receptor fields might lead to false positive results. On the other hand, central sensitization or uninvestigated alternative pain sources (multiple discs, secondary muscle spasms, sacroiliac joint, zygapophysial joint, etc) may contribute to low back pain and lead to a false negative AD response. Even in patients in whom all other known sources of pain have been excluded, pain relief is rarely complete following AD. Although DePalma reported 80% of patients achieving ≥ 50% reduction in VAS,[29] Alamin's[20,21] and Derby's[30] patients reported considerably less pain relief. Indeed, in all of the studies to date of AD, the majority of patients did not obtain pain relief approaching 75% - 100%. What is the source of this unrelieved pain? Does this pain originate outside the disc or does it result from AD's inherent limitations? These questions remain unanswered.

Finally, the problematic impact of psychosocial factors in the management of low back pain is well documented in the literature. Currently, surgeons most often request analgesic testing to confirm provocation findings in those patients in whom they are wary to offer surgical intervention. These patients might not report pain relief following AD as many take significant doses of narcotics, have not experienced relief from other procedures, and often claim that various interventional treatments made them

worse. One could argue that this response adds to AD's appeal. A patient may be counseled that pain relief following a fusion or artificial disc replacement is unlikely to exceed that experienced with AD. Failure to have significant relief is a persuasive way to convince the patient to stop pursuing a surgical treatment.

Comparisons of Analgesic Discography with Provocation Discography

Although the concept of identifying a painful disc using AD makes sense, questions remain. First and foremost, without knowing the sensitivity or specificity or either AD or PD, we cannot know whether disagreement between them is due to false positive or false negative results in one or the other test. These limitations notwithstanding, comparison studies of PD and AD have been published.

Alamin[21,22] compared the ability of FAD and PD to predict favorable surgical outcome in 41 patients. All patients underwent preprocedure functional testing to determine which activities were painful and rated the pain that each activity elicited. Standard provocation discography was then performed on all patients. A balloon-tipped catheter was inserted into patients' PD positive discs before leaving the operating suite. In the recovery room, the catheter(s) were sequentially injected first with normal saline followed by testing with 0.75 mL of local anesthetic (4% xylocaine or 0.75% bupivacaine). The patients then underwent repeat functional testing within 20 minutes in positions that typically provoked their pain. In a 2007 NASS abstract, Alamin[22] reports the following: "7 of the 41 (17%) patients had 2-level findings on provocation discography that were reduced to 1-level findings on the FAD test. 11 patients (27%) had positive provocation discograms that were negative on FAD testing. Two patients (5%) had a negative provocation discogram, and yet pain relief on the FAD. 21 patients (51%) had confirmatory findings on the FAD test. DRAM profile of distressed depressive (DD) or distressed somatic (DS) was a significant predictor of negative findings on the FAD test."

Alamin's reported 44% false positive PD rate per patient (27% of patients with single-level positive PD had a negative FAD, plus 17% with two-level positive PD reduced to one level with FAD) was not substantiated by DePalma (unpublished data, 2008). Using a similar protocol, DePalma performed PD followed by insertion of Discyphor FAD catheters into each positive disc. Data were collected on all patients but, as per ISIS criteria, he excluded patients with more than two positive levels. After a post–PD CT scan, patients graded provoked pain in sitting, lumbar flexion, flexion/axial rotation and supine positions. The disc(s) were then sequentially injected with 0.8 mL of 4% xylocaine. Successful disc anesthetization was confirmed using an intradiscal saline challenge to assure that distension did not produce pain. The patients then underwent postprocedure functional retesting over the following 5- to 10-minute period. He found a strong correlation between PD and AD, with 80% of positive PD discs demonstrating > 50% pain reduction during FAD and an additional 8% demonstrating a 25% - 50% or partial reduction. Patients with confounding psychological factors showed the same correlation, and co-morbid depression or somatization was not a significant predictor of results. The predictive value for surgery outcome was not studied.

Derby et al used a different approach to study the validity of AD (R Derby, JE Lee, Wolfer LR, unpublished data, 2008). Using the ISIS Standard, he evaluated 70 patients with chronic low back pain referred for PD. The control group underwent routine provocation discography (n = 23 patients). The experimental group received 2.5 cc of an equal mixture of local anesthetic (either 4% xylocaine or 0.75% bupivacaine) and nonionic contrast media during PD. Among the control group 18/23 patients (78%) had positive discograms, for a total of 63 positive discs. Among the experimental group, 30/47 patients (70%) had positive discograms for a total of 107 positive discs. Amongst the positive discs, he compared pain relief in patients whose discs were injected with contrast alone versus those discs receiving local anesthetic. He used functional testing, including range of motion (lumbar flexion, extension and side-bending), static loading positions (sitting and standing) and walking. Testing was done prior to PD and at 15 and 45 minutes post–PD. Among control patients, 6% (1/18) reported ≥ 50% subjective relief. Among local anesthetic subjects, 8% (2/25) reported ≥ 50% relief. There was no significant difference between groups. Moreover, neither the type of local anesthetic used nor the time tested made a significant difference, although there appeared to be a trend for greater pain relief at 45 versus 15 minutes. Sitting and forward flexion did reveal significant difference versus other testing positions. However, using Alamin's criteria for a positive response (≥ 2–point decrease in VAS), he found a statistically significant difference between groups. Twenty-nine percent (29%) of the LA group reported a 2/10 or greater decrease in VA scores at 15 minutes and 39% at 45 minutes (in sitting position). In the control group, 8.3% of patients reported relief at 15 minutes and 0% reported relief at 45 minutes. Contrary to Bartynski et al,[29] patients having one or more discs that leaked did not correlate with reported pain relief. Alamin reported 51% of patients with a positive confirmatory FAD after PD, whereas Derby found approximately 30-40% patients reporting relief after LA injection.

Predictive Value Comparisons between PD and AD

Although no studies have directly compared surgical outcomes in PD versus AD positive patients, several studies attest to the ability of each to identify a painful internally disrupted disc. In PD positive patients, Derby et al showed that surgeons achieved good to excellent outcomes following single level interbody fusion supplemented with pedicle screw fixation and posterior lateral fusion in ~62% of patients having a SF-36 mental component summary score (MCS) of greater than 40.[31] Carragee, using much stricter success criteria, reported surgical outcome following single level fusions for IDD with positive discograms

ranging from ~33% for highly effective results to ~75% meeting minimum FDA standards of a ≥ 2/10 decrease VAS score and ≥10 decrease in ODI.[32]

Most recently, Cooper et al[33] showed that discography predicted response to fusion. Discograms were assigned scores based on the ISIS scoring system. Positive discograms (score > 70) and indeterminate discograms (scores > 50) predicted response to fusion surgery. The breakpoint was 50; with an ISIS discogram score of greater than 50, patients who underwent fusion surgery were five times more likely to return to ≥ 25% of normal daily activities, 3.4 times more likely to return to ≥ 50% daily activities and 3.3 times more likely to have less pain compared with patients with a similar ISIS score who elected not to have surgery.

Several studies also document pain relief following interbody fusion surgeries based on pain relief following AD. Alamin et al[22] recently reported outcomes at a mean follow up of six months (range 6 to 24 months) in 16 patients who underwent fusion after a positive FAD. Oswestry and VAS scores at six months post surgery decreased ≥ 50%. The mean Oswestry score decreased from 55 to 25 at follow-up. Mean back pain VAS decreased from 6.9 to 2.6. Ohtori et al,[34] recently published a randomized-controlled trial comparing surgical outcomes of patients with positive PD (1.5 mL contrast) versus "discoblock" (analgesic discography with 0.75 mL 0.5% bupivacaine). Forty-two patients with severe LBP with L4–5 or L5–S1 disc degeneration on MRI underwent either PD or AD. Twelve patients were excluded due to negative PD or AD testing. Surgical outcomes in 15 patients with positive PD versus 15 patients with positive AD were compared following interbody fusion or disc replacement. Improvement in the VAS, Japanese Orthopedic Association Score (JOAS), Oswestry Disability Index (ODI) and patient satisfaction score at three years follow-up were statistically significant in the discoblock group versus PD group ($p < 0.05$). Three patients were dissatisfied with surgical outcome after PD versus one patient with AD.

Technique

Prior to the procedure, the patient typically undergoes standard functional testing wherein the visual or verbal analog score on a 0 to 10 scale is recorded following various provocation maneuvers. Testing at a minimum should include the activities that typically increase a patient's pain.

One can use standard disc access techniques and inject approximately 1.0 ml of 0.75% bupivicaine or 4% xylocaine with antibiotic (eg, 2-6 mg/mL cephalosporin). The patient is then taken to the recovery area and is retested 10 to15 minutes following injection of xylocaine or 20 to 30 minutes following injection of bupivacaine.

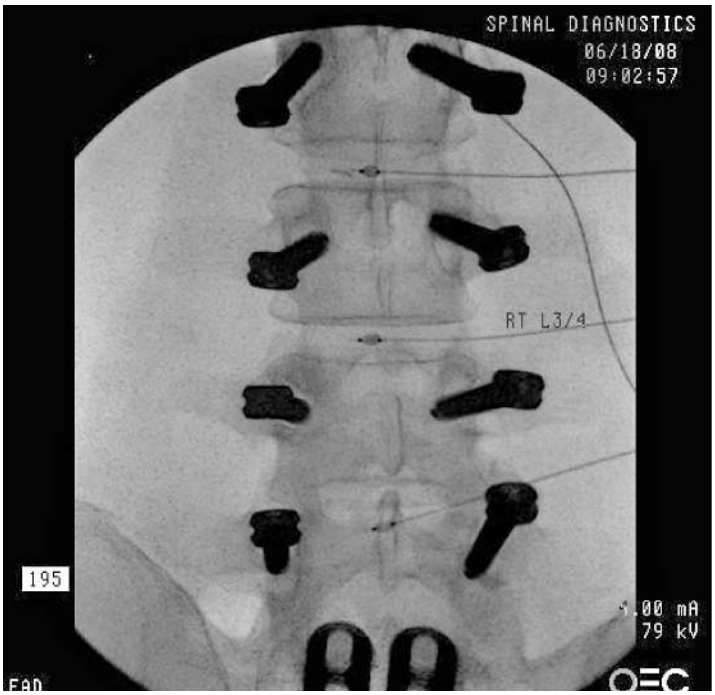
If one chooses the FAD technique, catheter placement is straightforward. Currently, the consensus for FAD is to inject 0.8 – 1.0 mL of 4% xylocaine into the disc. The original design included advancing a catheter over a guide wire. The new generation device does not require a guide wire and uses a smaller gauge needle (20 gauge 7.5" or 8.0") with a bullet point tip to reduce annular disruption. The new catheter is also softer and more flexible to reduce catheter-related pain. The smaller gauge introducer is advanced in a standard fashion toward the dorsolateral disc annulus.

If PD is to be performed, a 25 gauge discography needle is inserted through the introducer and into the mid-nucleus pulposus. Following PD, the 25 gauge needle is removed and the Discyphor catheter is inserted through the introducer and directly into the annulus. If PD is not performed, the catheter is directly inserted through the introducer. The catheter has a port for injection, and a port to inflate a small balloon designed to prevent the catheter from being dislodged during provocation testing. The catheter is then secured at its skin exit point and the patient is taken to the recovery area. Preblock testing or a placebo injection with the FAD technique can be performed after insertion of the catheter or repeated after anesthetization to confirm disc anesthesia. In the setting of sequential disc testing, the patient is tested 15 minutes following the injection of the first disc; the next level is then injected and similarly tested. If a catheter is not used, the patient will need to either return on another day, or be returned to the operating suite and another level investigated.

The percentage or absolute amount of pain reduction required for a test to be deemed positive has not been validated, but Alamin's surgical outcomes provide a starting point. Alamin and Derby defined a positive response with disc analgesia as a decrease in VAS pain scale of ≥ 2/10. DePalma defined a positive response as ≥ 50% reduction in VAS pre- and post-FAD.

Whether to perform AD as a stand-alone test or to perform AD in the same session as PD is likewise undecided. Currently, FAD catheters are more often inserted directly following provocation testing into the positive or indeterminate discs. Alamin's and DePalma's studies both used this protocol. DePalma waited approximately 45-60 minutes following PD, during which time a CT scan was performed. Alternatively, one could inject contrast into all positive disc(s) at the end of AD and then send the patient for CT scanning.

The order of injection is an individual choice and may depend on what information is important. Typically PD is performed from the least to most clinically suspected level to mitigate the effect of lingering provoked pain. In the case of AD, lingering pain is not a concern. When surgery at a particular segment is inevitable because of undisputed indications, the primary question is the status of adjacent segments. Because the presence or absence of pain at a planned surgical level is less important, one might consider injecting the adjacent level first. No pain relief would indicate that this segment (or the disc at this segment) is not a significant source of pain. On the other hand, if used to validate a source of discogenic pain, consideration can be given to injecting the most clinically suspected disc first.



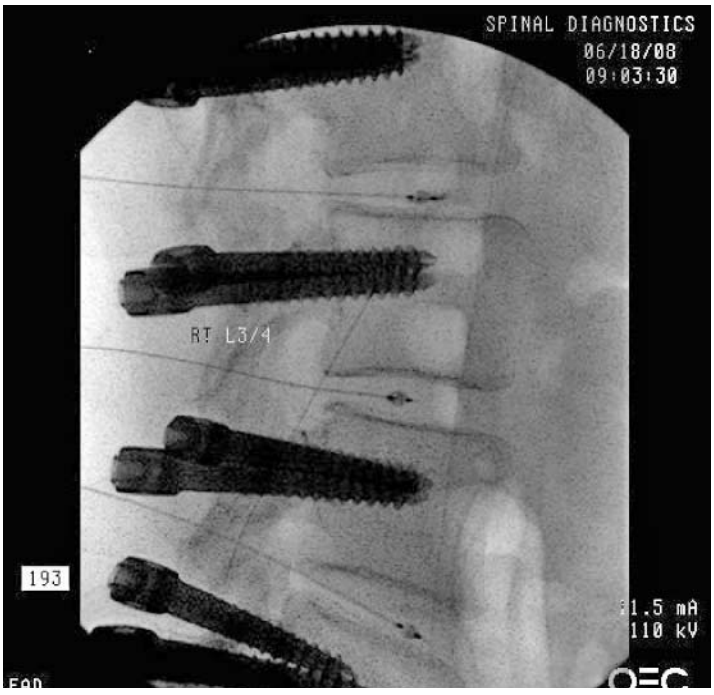


Figure 2. AP (left) and lateral* (right) views. Case Study: 46-year-old male status post L5-S1 anterior fusion. He did well for a few years then developed pain. PD indeterminate from L1-2 to L4-5. Patient then underwent posterior instrumentation with dynamic stabilization to L1. Subsequently, patient complained of low back pain with axial loading. Surgical question was whether adjacent disc levels were a source of pain which could benefit from circumferential fusion. Functional analgesic discogram performed at L2-3, L3-4 and L4-5: L2-3 and L3-4 levels, no relief of pain. At L4-5, with 1.0 cc of 4% lidocaine, overall relief of pain=80%. (Images courtesy of Richard Derby, MD) *Note: At the L5-S1 level, the FAD catheter is slightly anterolateral, but was within the nucleus pulposus.

Test Selection

A variety of options are available including PD only, AD only, PD immediately followed by confirmatory AD, or PD followed by confirmatory AD on another session. (**Figures 1 and 2**). Performing AD as a stand-alone procedure or combining it with PD as a confirmatory test is an individual choice and will often depend on the circumstances, including cost and authorization issues.

The senior author is skeptical about same day PD-AD testing reliability in all but the most obvious cases. This is especially true when the structural pathology is minimal, or when the capacity of the patient to get better or admit to getting better from any procedure is dubious, as the ramifications of the test are magnified. Potentially confounding factors include acute pain sensitization, lingering adjacent level pain and continued radial annular stress caused by injecting one to three mL of contrast into a disc. In addition, there is concern about local anesthetic dilution thus affecting concentration and the effect of an interaction of contrast with local anesthetic. DePalma's, but not necessarily Alamin's, study suggests that this protocol may lead to acceptable results. On the other hand, Derby's data suggest that it may be difficult to evaluate patients after a provocation test, potentially leading to an increase in false negative results. In any case, testing without the potential confounding effects of lingering pain, acute pain sensitization or contrast pressurization from PD should be more reliable.

If one wants to globally rule in or out discogenic pain using AD, one can simply inject every disc with local anesthetic. If only one disc is in question, injection into that single disc is sufficient. Furthermore, if one or more segments will have to be surgically addressed for undisputed structural reasons, one may elect to inject only a questionable adjacent level to make sure pain is not relieved.

Although performing AD by a single injection without a catheter is the most cost efficient method, it is also most probably the least reliable. The FAD technique is appealing and attractive when multiple levels need testing, retesting is necessary, or when placebo testing is warranted. In fact, one could make the case that if improved surgical results can be substantiated by disinterested investigators, FAD or AD could become the criterion standard to one's diagnosis that a particular disc is the source of the patient's pain. (Note that we stated THE source rather than A source of pain).

Summary Recommendations

Given that there is not a definitive test to prove discogenic pain, AD must, by necessity, be compared against the current controversial standard, PD. This circular testing logic means

that disagreement between PD and AD cannot automatically be attributed to false positive or false negative results in one or the other test. The best compromise might be to recommend agreement of both PD and AD tests when internal disc disruption is the primary indication for operation. For example, confirmation by AD may be considered when one is planning surgical treatment for disc pain where the only structural abnormalities are one or more grade 3 annular tears.

For AD testing, the authors recommend that a positive response be classified as a minimum 2–point decrease in VAS. However, 50% or more pain relief would be much more convincing. An indeterminate response would be defined as 25% – 49% and a negative response as < 25% pain relief. Stricter criteria could be used if one wants to increase specificity. Recommendations on criteria for a positive response should be updated based on further research.

Conclusion

Conceptually, AD/FAD are appealing. Similar to most of our diagnostic spinal interventions, these tests rely on relief of pain, rather than its provocation. Provocative tests have inherent liabilities. If further research indicates that the false-negative rate for AD/FAD is acceptable, it could potentially replace PD as the standard. Further research is also needed to compare PD to AD, to refine technical performance of the test, to determine if AD or FAD reduces the false-positive rates of PD, and to prove the predictive value of AD/FAD in terms of surgical outcomes. Currently, AD/FAD could be used as a stand-alone test or as a confirmatory test to PD in indeterminate cases, pending further research on analgesic discography.

Irrespective of FAD's ultimate fate, the search for more definitive diagnostic tests for the various sources of low back pain deserves substantial resources. Ideally, these tests should be independent of a patient's subjective need to respond to either pain provocation or pain relief. The diagnosis of painful disc degeneration can then be truly separated from the outcome of treatment. In the mean time, given that no other diagnostic spinal procedure's predictive value has been plagued by controversy such as PD, a better understanding of the role of disc analgesia is warranted.

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