Guidelines for the use of discography for the diagnosis of painful degenerative lumbar disc disease

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Object. Discography has been used as a diagnostic test in the evaluation of patients with recalcitrant low-back pain. Recently, its usefulness has been questioned because of the occurrence of false-positive results as well as the influence of psychological factors on test results. The purpose of this review is to establish the literature support for and against the use of discography.

A search of the English-language literature published between 1966 and 2001 was performed. Papers were selected based on inclusion criteria described in the text, and the quality of information was graded using previously described methods.

Conclusions. The authors propose a set of practice parameters based on the literature. Although the data were not judged adequate for the determination of a treatment standard, parameters for the use of discography are provided at a guideline and option level.

KEY WORDS • discography • degenerative disc disease • magnetic resonance imaging • spinal fusion

Low-back pain is an extremely prevalent complaint of individuals living in industrialized society. Although the vast majority of patients improve spontaneously or with nonoperative treatment, there remains a substantial number of patients with medically intractable low-back pain. In some cases, unequivocal lesions of the spine may be identified. Patients with neurological deficits, deformity, gross spinal instability, fractures, and tumors, however, account for the minority of those with low-back pain. In many patients normal plain radiography demonstrates relatively normal anatomy, whereas MR imaging studies reveal degenerative changes of varying severity. These non-specific findings coupled with the influences of Workers' compensation issues, psychological disorder, and other secondary gain issues affecting both the patient and the surgeon make the treatment in these cases very difficult. Discography has been proposed as a potential solution to the diagnostic dilemma concerning which patients to treat surgically and at what segmental level. Discography is very sensitive for the identification of disc degeneration.

Abbreviations used in this paper: ALIF = anterior lumbar interbody fusion; CT = computerized tomography; HIZ = high intensity zone; MR = magnetic resonance; NPV = negative predictive value; PPV = positive predictive value.

The provocation of concordant pain once saline or contrast is injected into the disc space has been interpreted as evidence that a particular disc is the source of the patient's pain and that targeted therapy directed at that disc is warranted. The purpose of this review is to discuss the published evidence that supports or refutes the hypothesis that discography is an accurate and reliable test for the determination of the source of pain in patients with low-back pain.

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Literature Review

The database of the National Library of Medicine was searched using an electronic search engine (PubMed) for articles published between 1966 and May 2002. Use of the search terms "discography or discogram" and the limits of "human and English language" resulted in 274 matches. The titles and abstracts of these 274 articles were reviewed, and duplicates, technical notes, reviews, and other papers that did not concern the use of discography for the diagnosis and management of low-back pain were discarded. The reference lists of the remaining articles were inspected, and several more relevant papers were identified.

fied. Primary references consisting of clinical series in which patients underwent discography were identified and are briefly summarized in Table 1. A number of other references served as background information and are included in the reference list.

Scientific Foundation

Lumbar discography for the diagnosis of abnormalities involving the intervertebral discs was first described by Lindblom in the 1940s and has been used extensively as a diagnostic tool in the evaluation of low-back pain since the 1950s.^{17,33} Proponents of discography maintain that it is more sensitive for the diagnosis of anatomical abnormalities of the intervertebral disc than plain radiography, myelography, or MR imaging.^{7,22,2737,43,54,64} Furthermore, discography remains the only diagnostic test for low-back pain in which there is a physiological endpoint directly relevant to the patient's complaint (that is, the reproduction of concordant low-back pain).^{46,61} Critics of discography claim that the test is oversensitive in that morphological features do not correlate with clinical complaints and that provocation of concordant pain is possible in patients with back pain known to be caused by nonspinal disease.¹⁴ Additionally, several authors have discussed the fact that severe back pain may be elicited by discography in patients without prior complaints of such pain.^{11,13,24} The advent of MR imaging has further confused the issue, because significant controversy exists as to whether discography contributes any diagnostic information to that ascertained using the noninvasive and certainly less painful MR imaging.^{3,6,9,16,20,21,25,26,34,35,42,44,45,47,49–51,58}

The sensitivity, specificity, NPV, and PPV of MR imaging compared with the morphological findings of discography have been described by several authors. Sensitivity refers to the test's ability to detect the disease. Specificity is the probability that a negative test result excludes the disease. The NPV refers to the proportion of patients with negative tests who do not have the disease, and PPV to the proportion of patients with positive tests who do have the disease. Bernard² published the results of a large series in which patients underwent MR imaging and discography. He found that the positive PPV of an MR imaging–documented abnormal result for a discography–demonstrated morphologically abnormal result was 92%. The NPV of a normal-appearing MR image study in the same series was 88%. Schneiderman and colleagues⁵¹ studied 101 disc levels by performing T₂-weighted MR imaging and discography and found that the former was 99% accurate in predicting abnormal morphological findings on discography. Millette, et al.,³⁸ found complete agreement between abnormal MR imaging–detected findings and Stage 2 or Stage 3 disc disruption demonstrated on discography with postdiscogram CT scanning (Dallas classification).⁴⁶ Longergan, et al.,³⁵ as well as Gibson, et al.,²⁰ each described small series in which MR imaging and discography were studied and noted an approximate 90% concordance rate between the two. Although discography may, on occasion, identify abnormalities in patients in whom MR imaging demonstrates normal anatomy, the significance of these findings is unclear. Therefore, it appears that MR imaging is a very good substitute for discography to determine abnormal morphological features of the disc. The use of MR imaging avoids the expense and discomfort of discogra-

phy, as well its rare but potentially serious complications.^{19,30,52} The use of MR imaging is therefore recommended as the morphological imaging study of choice in patients with low-back pain.

Although the morphological normality/abnormality of most intervertebral disc spaces can be established using MR imaging, the significance of a morphologically abnormal disc may be questioned. It is now recognized that both MR imaging and discography (especially with CT scanning) are exquisitely sensitive for the identification of disc abnormalities. The frequency of discography-detected abnormal discs in the low-back pain population is quite high; for example, Grub, et al.,²² found that in 78% of their patients with low-back pain, discography demonstrated findings positive for abnormality at one or more levels despite the fact that plain radiography and myelography demonstrated no such disease. Brodsky and Binder⁸ also found that in many patients with normal-appearing myelograms discography revealed abnormalities. Schwarzer and colleagues⁵³ reported positive discography findings in 39% of their series of 92 patients with low-back pain. Park, et al.,⁴³ also contended that discography indicated the presence of disease whereas the radiographic workup was otherwise unremarkable. The frequency of morphological abnormalities revealed on discography in the back pain population is high, and it increases with age.^{59,60}

Unfortunately, abnormal morphological findings demonstrated on discography and CT discography have also been described in several series of asymptomatic patients.^{13,24,61} Walsh, et al.,⁶¹ found that 17% of discograms obtained in healthy volunteers demonstrated morphological abnormality. Holt²⁴ reported a false-positive rate of up to 37% in his series of asymptomatic prisoners, and Caragee, et al.,¹³ recently described a 40% false-positive rate in a group of asymptomatic individuals. The increasing frequency of morphological abnormalities observed on discography associated with aging appears to be primarily due to painless degenerative changes.⁶⁰ There does not appear to be a correlation between the location of the annular tear and the location of pain.⁵⁶ Finally, discrepancies between morphological appearance and pain provocation have also been described.³⁶

For this reason, discography-related provocation of pain has become the gold standard by which other tests are judged. The standard nomenclature refers to a “concordant discogram.” The description offered by Walsh, et al.,⁶¹ of a “positive” discogram has been adopted by most authors to indicate a concordant discogram. Walsh, et al., required morphological abnormalities to be present along with the provocation of pain that was identical or very similar to the patient's back pain. In general, severity as judged by a visual analog scale as well as by patient behavior must be severe (a score of 3 of 5, or 6 of 10 on the visual analog scale).^{14,61} Several studies have been performed in which discography-detected morphological features and concordant pain provocation are compared. It is clear from these studies that a mismatch often exists between the radiographic findings and a patient's perception of pain. For example, Antti-Poika, et al.,¹ reported only a 53% PPV of morphological changes predicting a concordant pain response. In addition, more than 13% of patients with normal disc anatomy in this same series, concordant pain was elicited with injection. Millette and Melanson³⁹

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TABLE 1

*Summary of studies involving patients with back disorders in whom discography was performed**

Authors & Year	Class	Description	Conclusion
Antti-Poike, et al., 1990	II (discography morphology vs. pain provocation)	abnormal morphology on discography associated w/ pain provocation in 52.8%; normal morphology associated w/ pain provocation 13.2%; postdiscography CT did not add to diagnostic accuracy; morphology PPV 53% & NPV 87%	normal morphology has NPV of 87% for pain provocation & abnormal morphology has a PPV of 53% for pain provocation
Bernard, 1990	III (utility of discography); II (MR vs. discography)	250 patients w/ CT discography; discography added useful information 93% of the time (according to radiologist author); PPV of MR compared w/ discography 92% & NPV 84%	MR correlated w/ CT discography 89% of the time
Block, et al., 1996	III	patients w/ LBP underwent discography & MMPI; those w/ pain had significantly higher hypochondriasis & hysteria scores on the MMPI	psychological factors contribute heavily to discography results
Blumenthal, et al., 1988	III	34 patients w/ positive discography underwent ALIF; of those w/ fusion, 73% had a good clinical result	successful fusion of discogram-positive discs w/ ALIF results in good outcome 73% of the time
Braithwaite, et al., 1998	II (MR vs. discography)	discography at 152 levels including 23 w/ Modic changes; PPV for Modic changes predicting concordant pain 91.3% & NPV 46.5%	modic changes on MR relatively specific but not sensitive for concordance of pain on discography
Brightbill, et al., 1994	III	7 patients w/ abnormal discography despite normal MR	normal MR does not exclude abnormal discography
Brodsky & Binder, 1979	III	discography used to select patients for op; many w/ negative myelogram had positive discography	discography may be positive despite normal myelography
Buirski & Silberstein, 1993	III	abnormal discs on MR characterized in symptomatic & asymptomatic patients; no differences between groups in terms of frequency or severity of imaging changes; all imaging-documented abnormal discs subjected to discography were found to be painful	MR unreliable for identification of painful discs
Carragee, et al., 2000	II	26 w/out back pain followed for 1 year postdiscography; no patient w/out somatization disorder developed back pain as a result of discography	discography does not cause chronic LBP in patients w/out somatization disorders
Carragee, et al., 1999	II (for discography as test for presence of painful disc disease)	24 discs in 8 selected patients w/ nonspinal LBP injected; concordant pain elicited in 8 discs & 4 patients had severe pain in 1 disc & no pain in others (met criteria for op)	lumbar discography cannot reliably differentiate source of LBP because of a high false-positive rate (50%)
Carragee, et al., 2000	Class I (for postdiscectomy population); II (for discography as test for presence of painful disc disease)	2 selected groups postdiscectomy w/ or w/out back pain; discography positive in 40% of asymptomatic & 63% in symptomatic group	lumbar discography has high false-positive rate in patients w/out back pain (40%)
Carragee, et al., 2000	II	selected populations of LBP & non-LBP studied w/ MR & discography; LBP patients had significantly higher rate of HIZ, but 24% of asymptomatic patients also had HIZ	HIZ more common in LBP patients but still present in significant percentage of asymptomatic patients, making presence too non-specific for clinical use
Carragee, et al., 2000	II (for discography as diagnostic test for presence of painful disc disease)	false-positive rate of discography in noncompensated patient low (10%); much higher in compensated patients & those w/ somatization disorders	positive discography rates correlated closely w/ disability claims, somatization, & annular disruption
Colhoun, et al., 1988	III (no patients w/ normal discography treated; selection criteria unclear; definition of success unclear)	195 patients w/ discography; fusion in 182; of those w/ abnormal & painful discs (137), 89% benefited from fusion; of those w/ abnormal but nonpainful discs (25), 52% had good outcomes	treatment of discs w/ pain provocation & abnormal disc morphology results in successful outcome 89% of the time; treatment of abnormal but not painful discs results in success 52% of the time
Derby, et al., 1999	III	retrospective comparison of patients w/ positive discography who underwent different fusion procedures	patients w/ "chemically sensitive" discs do better w/ an interbody fusion compared w/ posterolateral fusion
Gibson, et al., 1986	III (MR vs. discography morphology)	50 discs studied w/ MR & discography; concordant morphometric findings noted in 44; in 6 discs errors were made by observers	MR is as good as or superior to discography for identification of disc degeneration
Gill & Blumenthal, 1992	II	53 patients underwent L5-S1 fusion for concordant pain on discography; those w/ concordant pain & abnormal MR did well 75% of the time; those w/ concordant pain & normal MR did well 50% of the time; authors found that MR predicted morphological changes on discography 100% of time	MR predicts morphological changes on discography well; patients w/ normal MR & concordant pain on discography do relatively poorly following fusion; PPV of abnormal MR in this setting is 74% (as opposed to 66% overall for concordant pain response)

TABLE 1, *continued**Summary of studies involving patients with back disorders in whom discography was performed**

Authors & Year	Class	Description	Conclusion
Grubb, et al., 1987	III	discography performed in 346 discs in 108 patients; 78% had pain reproduced at 1 or more levels; 37% had abnormalities on plain films or myelogram	discography more sensitive than plain radiography or myelography for evaluation of LBP
Heggeness, et al., 1997	III	retrospective review of 83 postdiscectomy patients who underwent discography	previously operated discs more frequently painful than nonop discs (72% vs. 38%); dye extravasation associated w/ pain 75% of the time
Holt, 1968	III	discography performed in 30 inmates w/out history of LBP; 37% reported onset of back (no leakage but irregularity of disc space noted) or back & leg (leakage of dye) pain w/ injection	discography unreliable for diagnosis of discogenic back pain because of high false-positive rate
Horton & Daftari, 1993	III	63 discs in 25 patients studied w/ MR & discography; MR signal patterns correlated w/ discographic findings	certain MR findings highly associated w/ concordant pain provocation & a normal image highly associated w/ no concordant pain; there are intermediate signal characteristics that do not reliably predict pain provocation
Ito, et al., 1998	I (MR vs. discography)	retrospective comparison MR HIZ vs. painful disc on discography	HIZ was sensitive for predicting a painful disc (87%) but not specific (65%, PPV 43%); "massive degeneration" or "severe disc space collapse" specific for painful discography; the PPV for nonconcordant pain or no pain for a normal MR was 97.3%
Johnson & Macnab, 1985	III	24 patients w/ surgically documented pseudarthrosis at 33 levels studied preop w/ discography; 20 of 29 successfully injected levels resulted in typical back pain; 3 false-positive & 9 false-negative discograms	discography appears to be useful in demonstrating pain related to pseudarthrosis
Knox & Chapman, 1993	III	22 patients w/ discography positive pain underwent ALIF based on discography; all 2-level fusions did poorly; of those w/ single-level fusions, 35% good, 18% fair, 47% poor	ALIF based on discography associated w/ poor results
Lam, et al., 2000	II (MR vs. discography)	92 HIZs identified in 73 patients w/ LBP considered for fusion; blinded comparison between MR HIZ & pain response; PPV for HIZ for pain response 87%	HIZ good predictor of painful discography
Linson & Crowe, 1990	I (MR vs. discography)	prospective comparison of T ₂ MR & discography; 94% correlation; PPV MR vs. painful discogram 98% & NPV 88%	abnormal MR has high PPV (98%) for painful disc on discography & normal MR has high NPV (88%) for same
Loneragan, et al., 1994	III	small series subjected to discography & MR; overall concordance for the 2 modalities 90%	concordance of MR & CT discography (morphology) is 90%
Maezawa & Muro, 1992	III	large series (1477) of discograms; imperfect relationship of pain to radiographic findings in patients w/ LBP	disc morphology & pain response not necessarily related
Milette & Melanson, 1982	III	retrospective review of large discographic series; 5% normal morphology had pain response, 37% abnormal morphology had pain response	discography useful for diagnosis of LBP; pain response is important
Milette, et al., 1999	I (MR vs. discography)	retrospective comparison of MR vs. discography	loss of disc space height, abnormal central signal intensity, protrusions & disc bulges predicted Stage 2 or 3 disruptions on discography; most of these were painful
Moneta, et al., 1994	III	correlation of discographic pattern & pain provocation; outer annular tears associated w/ pain; however, generalized degeneration was not	anular disruption seen on discography is associated w/ pain response
Murtagh & Arrington, 1992	III	discs adjacent to degenerative levels studied to determine whether to include adjacent level in fusion; morphological discographic abnormalities found in 54% of adjacent discs	morphological abnormalities are present in about half of discs adjacent to other degenerative discs
Park, et al., 1979	III	14 (of 400) patients w/ back pain had abnormal discography despite normal plain radiography &, in some cases, venography or radiculography	discography may disclose abnormalities in patients w/ back pain even though radiography is normal
Rankine, et al., 1999	III	observational study of 83 patients w/ back &/or leg pain; 45% had an HIZ noted on MR	HIZ a common finding in patients w/ LBP
Rhyne, et al., 1995	III	25 patients w/ LBP & concordant provocative discography followed nonoperatively for a minimum of 3 yrs; 68% improved, 8% unchanged, 24% worsened; most who worsened had significant psychiatric disease	most patients w/ discography concordant back pain improve w/out treatment
Ricketson, et al., 1996	III	studied MR & discography in 80 discs in 29 patients; no patient w/ HIZ had a morphologically normal disc; no definite relationship between HIZ & pain response (only 7 patients w/ HIZ; discrepancy between tables & reported results)	presence of HIZ does not necessarily predict painful disc

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TABLE 1, *continued*
Summary of studies involving patients with back disorders in whom discography was performed*

Authors & Year	Class	Description	Conclusion
Sachs, et al., 1987	III	new classification for CT discography applied to 59 patients; 13% had positive CT discogram findings w/out pain provocation	new classification of CT discography aids in diagnosis; false-positive rate still 13%
Saifuddin, et al., 1998	II (discography morphology vs. pain response)	morphology of discograms compared w/ pain response; pain response usually associated w/ isolated posterior annular tear	isolated posterior annular tears significantly associated w/ concordant pain
Saifuddin, et al., 1998	I (HIZ vs. painful annular tear)	HIZ presence compared w/ discography results; sensitivity 26.7%, specificity 95.2%, PPV 88.9%, NPV 47%	HIZ highly specific & associated w/ high PPV for pain provocation w/ discography; sensitivity is low
Sandhu, et al., 2000	III	Modic changes & results of discography compared in 53 patients w/ LBP; not all levels underwent discography; authors did not find relationship between Modic changes & pain provocation on discography	Modic changes on MR do not predict pain provocation w/ discography
Schellhas, et al., 1996	II (MR vs. painful disc on discography)	100 patients w/ HIZ discs & 67 w/ non-HIZ discs underwent discography; 87 of 100 HIZ discs & 2 of 67 non-HIZ discs painful; PPV HIZ 87%, NPV w/out HIZ 97%	presence of HIZ highly correlated w/ pain on discography
Schneiderman, et al., 1987	II (MR vs. discography morphology)	101 disc levels studied by T ₂ MR & discography; MR 99% accurate in predicting morphological discographic results	MR 99% accurate in predicting morphological discography results
Schwarzer, et al., 1995	III	92 patients w/ LBP studied w/ discography; provocation discography positive in 39%	provocative discography positive in many patients w/ back pain
Simmons & Segil, 1975	III	painful disc injection used as indication for op (simple discectomy or discectomy & posterolateral fusion) in large pre-MR & CT series; most patients did well	discography can help localize pathological levels in patients w/ back pain & radiculopathy
Simmons, et al., 1991	II (MR vs. discography as gold standard) III (MR or discography vs. painful disc disease)	164 patients w/ LBP underwent discography & MR; compared w/ pain-provoking discography, MR had an NPV of 94% & a PPV of 58%	MR oversensitive for diagnosis of painful disc disease; abnormal discography occurs despite negative MR 6% of the time
Slipman, et al., 2001	III	40 carefully selected discograms evaluated to determine relationship of annular tear & side of symptoms in patients w/ concordant back pain; none found	side of annular tear not related to side of back or leg pain
Smith, et al., 1998	II (HIZ vs. painful discography)	retrospective analysis of patients who had MR & discography in same yr; a Kappa value of 0.57 found between neuroradiologists evaluating images for HIZ; sensitivity of HIZ for annular disruption only 25%, but specificity 99%; sensitivity for pain response 23%, specificity 90%	HIZ is a specific but not very sensitive indicator of painful disc disruption
Vanharanta, et al., 1988	III	816 discograms in patients w/ multiple low-back disorders; many abnormalities seen	discographic abnormalities common in patients w/ low back disorders
Vanharanta, et al., 1989	III	790 discs studied w/ discography (scored by Dallas scale); 87% of normal discs were painless; slight degeneration associated w/ pain in 33% of younger patients & 12% of oldest group; this pattern was reproduced in moderately & severely degenerated discs	proportion of painless but degenerated discs on discography increases w/ age
Walsh, et al., 1990	III (no sensitivity able to be reported)	7 LBP patients & 10 volunteers underwent multi-level discography; discograms abnormal 17% of the time in asymptomatic patients but no patient w/ positive pain response	radiological results of discography unreliable; pain response reliable for determination of painful disc disease
Weishaupt, et al., 2001	II (MR vs. discography)	prospective study of 50 patients w/ LBP who underwent both MR & discography; normal MR had NPV for pain provocation of 98%; only moderate to severe endplate changes had high PPV (100%)	MR good tool for predicting pain provocation w/ discography
Wetzel, et al., 1994	III	48 patients treated w/ fusion based on symptomatic discography; 46% had excellent or good (satisfactory) outcome; of 23 w/ solid fusion, 22 had satisfactory clinical outcome	symptomatic discography predicts op results in 46%; this result may be related to fusion success
Zucherman, et al., 1988	III	18 patients w/ normal MR & abnormal discography	discography may be abnormal despite normal MR finding

* Abbreviations: LBP = low-back pain; MMPI = Minnesota Multiphase Personality Inventory; T₂ = T₂-weighted.

reported that in only 37% of patients with discography-documented morphological abnormality, concordant pain was evoked with injection (compared with 5% of those with normal morphological features). Sachs, et al.,⁴⁶ reported a 13% incidence of abnormal disc structure detected on postdiscography CT scanning without pain provocation in their large series. Heggeness, et al.,²³ found a significantly higher incidence of morphological abnormality in patients who had previously undergone discectomy compared with those who had not (72 and 38%, respectively); however, there was no difference between groups in terms of pain provocation. Saifuddin, et al.,⁴⁸ found that only annular tears could be reliably associated with the provocation of pain and that other degeneration patterns were not necessarily associated with a pain response. These findings were also reported by Moneta, et al.⁴⁰ It is therefore clear that discography-demonstrated morphological abnormality of the disc may or may not be associated with the production of concordant pain. Thus, abnormal morphological structure revealed on discography is considered to be too nonspecific to be of clinical use.

Abnormalities demonstrated on MR imaging have also been studied in patients with low-back pain. Findings such as loss of T₂-weighted signal intensity, Modic changes, and HIZs are very common in patients with low-back pain.^{9,44} As with discography, however, these abnormalities are also demonstrated in a smaller but still sizable fraction of asymptomatic patients.¹² It is apparent that MR imaging suffers from the same lack of specificity as discography with regard to morphological findings. Magnetic resonance imaging findings have been compared with pain provocation during discography in several series. Linson and Crowe³⁴ performed a prospective comparison of findings on T₂-weighted MR imaging and discography. They found a 98% PPV for an abnormal MR imaging–documented findings and concordant pain provoked using discography. Braithwaite and colleagues⁶ specifically examined Modic changes in a Class II study and found that they were a specific but not necessarily sensitive predictor of concordant pain provocation. Weishaupt, et al.,⁶² also found that moderate to severe endplate changes predicted a positive pain response in a 100% of the cases. In contrast, in their Class III study Sandhu, et al.,⁴⁹ noted no significant relationship between Modic changes and concordant pain responses. Ito and colleagues,²⁶ found that the presence of an HIZ was a sensitive (87%) but not specific (65%) predictor of a concordant pain response. In contrast, Saifuddin, et al.,⁴⁷ reported that the presence of an HIZ was a specific (96%) but not sensitive (27%) predictor of a concordant pain response. In a Class II study, Schellhas, et al.,⁵⁰ demonstrated that the PPV for an HIZ for a concordant pain response was 87% and the NPV of the absence of an HIZ was 97%. Lam and colleagues³² performed a prospective, blinded evaluation of HIZs compared with discography and found an 87% PPV of the HIZ for the provocation of pain in which sensitivity and specificity values were 81 and 79%, respectively. In a small Class III study, Ricketson, et al.,⁴⁵ were unable to identify a significant association between the presence of an HIZ and concordant back pain. It should be noted, however, that only seven HIZs were observed in their study, making the lack of a statistically meaningful result a foregone con-

clusion. Simmons, et al.,⁵⁵ Saifuddin, et al.,⁴⁷ Ito, et al.,²⁶ Horton and Daftari,²⁵ and Weishaupt, et al.,⁶² each noted that the NPV of a normal MR image was 94 to 100%, similar to the results reported by Schellhas, et al.^{25,26,50} Although the results of these series are in some cases conflicting and confusing, the higher-quality papers (Class II) do indicate that certain MR imaging findings, such as HIZ and endplate changes, are closely correlated with the imaging gold standard of provocative discography in patients with low-back pain. It is also apparent that a positive pain response is extremely rare when MR imaging has demonstrated a normal disc.

The management of these patients is intended to alleviate their low-back pain. Therefore, the knowledge of the relative ability of one neuroimaging study (such as MR imaging) to predict the results of another diagnostic test (such as pain-provocative discography) is useful for the selection of diagnostic tests; however, the true test is the modality's ability to predict the outcome of effective treatment based on its results. In the low-back pain population, surgical fusion is generally considered the gold standard for the treatment of discogenic back pain. Therefore, the next relevant question concerns the ability of discography or MR imaging to predict the outcome of fusion. If discography (or MR imaging) had an accuracy of 100%, then every patient in whom discography (or MR imaging) was positive and fusion was successful should experience relief of their low-back pain; likewise no patient in whom discography (or MR imaging) was negative would experience relief of their pain (making the acknowledged unfounded assumption that fusion is 100% effective for relieving pain derived from the pathological disc). There is one Class II study and several Class III studies identified in which the authors address this issue.

Gill and Blumenthal²¹ reported results obtained in 53 patients who underwent L5–S1 fusion, based primarily on discography-related concordant pain provocation. They found that patients with concordant pain and an MR imaging–documented abnormality did well 75% of the time. These results were compared with those acquired in patients with concordant pain provoked by discography but in whom MR imaging demonstrated normal findings. Patients in the latter group did significantly less well, with 50% experiencing a favorable outcome.²¹ Patients who underwent assessment with discography alone were treated surgically by Colhoun and colleagues.¹⁵ They reported an 89% favorable result rate in patients with concordant pain responses as opposed to a 52% favorable rate in those with morphological abnormality alone. Blumenthal, et al.,⁵ reported that 74% of their patients returned to work following ALIF that was performed based on discography. Other reports regarding the success of fusion for discography-diagnosed pain are not as encouraging. Wetzel, et al.,⁶³ and Knox and Chapman³¹ each reported surgical series in which patient selection depended primarily on results of discography. Outcomes in these series were somewhat disappointing, with success rates of 35 to 46%. These results are particularly distressing given the finding by Rhyne, et al.,⁵⁸ that the majority (68%) of patients with discography-documented concordant pain improved without surgical treatment over a 3-year period. To be fair, the fusion rates and fusion techniques used by various authors will influence the overall results. In fact, in a series report-

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ed by Wetzel, et al., the vast majority of patients in whom a solid fusion was demonstrated (23 of 48 cases) did experience satisfactory outcomes. There is also some information indicating that fusion technique is important. For example, Derby, et al.,¹⁸ have asserted that patients with “chemically sensitive” discs are better served by interbody fusion techniques than posterolateral techniques. Additionally, the ability to elicit pain by discographic study of disc spaces within solid posterolateral fusion masses has been described.²⁹ Therefore, although it is possible to obtain good results with surgical treatment in patients with discography-diagnosed low-back pain, the best evidence available (Class II) indicates that treatment of a disc in a patient with a positive discogram and a normal-appearing MR imaging study is not likely to influence favorably the natural history of the patient’s low-back pain.

Discography has been used in several unique circumstances. Because of its exquisite sensitivity, it is likely a valuable adjunct for the study of discs for which MR imaging findings are equivocal, particularly those adjacent to clearly pathological levels considered for fusion. Discs that are morphologically equivocal but painless may be excluded from the fusion level.⁴¹ Discography may also have a role in the diagnosis of painful pseudarthrosis, although the literature support is scant.²⁹ Another potentially useful role of discography is for identification of patients who are poor surgical candidates. The high false-positive rate for concordant pain provocation in patients with psychological abnormalities or secondary gain issues may be exploited.^{4,11} Provocation of pain at levels that are morphologically normal is a contraindication for surgical (or other invasive) intervention, and pain at multiple levels with equivocal findings would certainly raise a significant red flag for the presence of secondary gain or psychological factors known to be associated with poor surgical outcomes. Discography itself does not appear to contribute to the development of back pain in patients without somatization disorders, nor to morphological abnormalities of the disc.^{10,28}

CONCLUSIONS

Discography is exquisitely sensitive but not very specific when used to diagnose discogenic low-back pain. Restricting the definition of a positive study to one that elicits concordant pain improves its accuracy, but a significant false-positive rate still exists. Magnetic resonance imaging appears to be a reasonable and noninvasive substitute for discography for the diagnosis of degenerative disc disease. The treatment of patients with abnormalities only detectable by discography is not associated with substantial success. Discography does have a role in the evaluation of patients with low-back pain, but this role is best limited to the evaluation of equivocal radiographic or MR imaging findings, the investigation of adjacent-level disease, and the elimination of patients with psychogenic complaints from surgical consideration.

Directions for Future Research

A large cohort in which the results of discography are compared with those of MR imaging for predicting the success of a standard-protocol surgical intervention would

be a valuable addition to the literature. These data would provide at least Class II evidence for the value of either diagnostic technique for predicting the response of a patient to a given treatment.

Treatment Recommendations

Standards. There is insufficient evidence to recommend a treatment standard.

Guidelines. Magnetic resonance imaging is recommended as a diagnostic test for the management of low-back pain.

It is recommended that the presence of concordant pain response (pain identical or very similar to typical back pain) as well as morphological changes be required for the definition of a positive finding on discography.

It is recommended that discography not be performed as a stand-alone test for treatment decisions in patients with low-back pain.

Options. It is recommended that the use of discography be reserved for cases in which MR imaging findings are equivocal, especially at levels adjacent to clearly pathological levels.

It is recommended that patients with discography positive back pain but without other MR imaging or radiological signs of disc degeneration not be considered for any type of operative intervention.

In patients with a positive discography finding and equivocal MR imaging or plain radiographic findings, a thorough psychological evaluation is recommended. A diagnosis of a somatization disorder, or the presence of hysteria or hypochondriasis, are relative contraindications to surgical intervention of any type.

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