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## Guideline update for the performance of fusion procedures for degenerative disease of the lumbar spine. Part 6: Discography for patient selection

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Identifying the etiology of pain for patients suffering from chronic low-back pain remains problematic. Non-invasive imaging modalities, used in isolation, have not consistently provided sufficient evidence to support performance of a lumbar fusion. Provocative testing has been used as an adjunct in this assessment, either alone or in combination with other modalities, to enhance the diagnostic capabilities when evaluating patients with low-back pain. There have been a limited number of studies investigating this topic since the publication of the original guidelines. Based primarily on retrospective studies, discography, as a stand-alone test, is not recommended to formulate treatment strategies for patients with low-back pain. A single randomized cohort study demonstrated an improved potential of discoblock over discography as a predictor of success following lumbar fusion. It is therefore recommended that discoblock be considered as a diagnostic option. There is a possibility, based on a matched cohort study, that an association exists between progression of degenerative disc disease and the performance of a provocative discogram. It is therefore recommended that patients be counseled regarding this potential development prior to undergoing discography.

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**KEY WORDS** • fusion • lumbar spine • discography • discoblock • practice guidelines

### Recommendations

There is no evidence that conflicts with the previous recommendations published in the original version of the “Guidelines for the performance of fusion procedures for degenerative disease of the lumbar spine.”

#### Grade C

It is recommended that discoblock be considered as a diagnostic option during the evaluation of a patient presenting with chronic low-back pain (single Level II study).

*Abbreviations used in this paper:* AAOS = American Academy of Orthopaedic Surgeons; JOA = Japanese Orthopaedic Association; MODEMS = Musculoskeletal Outcomes Data Evaluation and Management System; ODI = Oswestry Disability Index; VAS = visual analog scale.

It is recommended that lumbar discography not be used as a stand-alone test on which treatment decisions are based for patients with low-back pain with abnormal imaging studies (single Level II study).

It is recommended that within the discussion of potential risks for patients undergoing provocative discography, the potential for acceleration of the degenerative process be included as there is evidence to suggest an association between advanced degenerative spondylosis and a history of undergoing provocative discography.

### Rationale

Surgical intervention for the treatment of chronic low-back pain has demonstrated inconsistent and less favorable results than procedures performed for other degenerative spine disorders. This is in part due to an inability to ac-

curately determine the specific source of a patient's pain. It is well known that degenerative changes identified on an MRI may occur in asymptomatic patients, and therefore such findings cannot be used as the sole justification for surgery and are not predictive of clinical outcome.<sup>1</sup>

In an effort to isolate the source of pain, provocative testing (intended to reproduce a patient's pain), has been integrated into the evaluation of patients presenting with chronic low-back pain. Discography has been used in conjunction with MRI in an attempt to better identify specific patients who might benefit from lumbar fusion for chronic low-back pain. The purpose of this review is to examine the medical evidence regarding the utilization of discography as a diagnostic modality in the evaluation of patients presenting with chronic low-back pain being considered for lumbar spine fusion. Additional information regarding the methodologies and criteria used to evaluate the evidence discussed below is located in the first article in this issue (Part 1: Introduction and methodology).<sup>12</sup>

### Literature Search

The database of the National Library of Medicine was searched for articles published between July 2003 and December 2011 using the following search terms: ((discography OR discogram) AND lumbar fusion AND (patient selection OR predictive value of tests) AND (“2003”[PDat]: “3000”[PDat]) AND (Humans[MeSH]) AND (English[lang])) OR ((discography OR discogram) AND (“Lumbosacral Region”[MeSH] OR “Lumbar Vertebrae”[MeSH]) AND “Spinal Fusion”[MeSH] OR “lumbar fusion”[All Fields] OR (“lumbar”[title] AND “fusion”[title])) AND (patient selection OR predictive value of tests) AND (“2003”[PDat]: “3000”[PDat]) AND (Humans[MeSH]) AND (English[lang])). Search results were limited to human studies, English language, and age between 18 and 65 years. The titles and abstracts of these articles were reviewed, and duplicates, technical notes, reviews, and papers that did not describe the use of discography for the diagnosis and management of patients with low-back pain were discarded. The reference lists of the remaining articles were inspected, and additional relevant papers were identified. From this group of citations, 6 were selected as the most relevant and are briefly described in the evidentiary table (see Table 1). The remaining references provided additional background information and are included in the bibliography.

### Scientific Foundation

The use of discography for the diagnosis of lumbar intervertebral disc abnormalities in patients with low-back pain has been well described.<sup>9,15</sup> The key components of discography that aid in the diagnosis of patients with low-back pain include a reproduction of the patient's concordant pain, visualization of the disc morphology, and injection pressures. If each of these factors is found to suggest symptomatic disc degeneration, the test is considered to be positive. By recreating the patient's pain, proponents of discography argue that it is more sensitive and specific than other imaging modalities, including plain radiographs,

myelography, and MRI, which are known to identify both symptomatic and asymptomatic abnormalities.<sup>2-4</sup> However, critics question the reliability and specificity of discography since concordant pain has been suggested to originate from nonspine sources and can be reproduced in patients without any prior history of back pain.<sup>5,8,11</sup>

A prospective study intended to evaluate the predictive value of provocative discography following lumbar fusion was performed by Carragee et al.<sup>7</sup> Lumbar fusions were performed in 32 patients with presumed discogenic pain and a positive discogram (see Table 1). A circumferential fusion was performed in a single day and consisted of an anterior lumbar interbody fusion with femoral ring allograft, buttress screw, and local bone/ allograft inserted within and around the structural graft. The posterior approach included an intertransverse fusion with allograft and pedicle screw instrumentation. Clinical outcomes were measured using a visual analog scale (VAS), American Academy of Orthopaedic Surgeons (AAOS) Musculoskeletal Outcomes Data Evaluation and Management System (MODEMS) instrument, Oswestry Disability Index (ODI), psychological testing, and the Fear Avoidance and Behavior Questionnaire. Clinical success at the 2-year follow-up point was defined by a VAS score of 2 or less, an ODI score of less than 15, return to work, no use of narcotic medications, and no daily pain medication requirement. Surgical comorbidity was compared with a control cohort of 34 patients undergoing lumbar fusion for unstable isthmic spondylolisthesis. Successful outcomes were observed in 72% of the control spondylolisthesis group as compared with only 27% in the discography group. The percentage of patients achieving a minimally acceptable improvement in the control group was 91% versus 43% for the discography group. The positive predictive value of discography was estimated to be between 50% and 60%. This study suffered from several design limitations, including the lack of an appropriate control group and is therefore considered to provide only Level IV evidence against utility of discography as a predictive tool.

Wetzel et al. performed a retrospective case review of 48 patients with a diagnosis of discogenic low-back pain based on positive discography and CT or MRI.<sup>18</sup> All patients underwent lumbar fusion of the levels determined to be symptomatic based on discography. The number of levels fused ranged from 1 to 4, and a wide variety of fusion techniques were used, including anterior or posterior approaches, with or without instrumentation. Clinical outcomes were subjectively graded as excellent, good, fair, or poor. Radiographic evidence of fusion was defined as 4° or less of motion on flexion-extension radiographs with the presence of mature trabecular bone across all levels. Twenty-three (47.9%) went on to successful radiographic fusion, and 22 of those had a satisfactory clinical outcome. Overall, 46% of patients were found to have a satisfactory clinical outcome. This study provided Level IV evidence against the use of discography in predicting clinical success following lumbar spine fusion. Limitations of the study included a variety of surgical techniques and lack of quantitative and validated clinical outcomes measures (see Table 1).

A retrospective case series of 53 patients undergoing

**TABLE 1: Discography for patient selection: summary of evidence\***

Authors & Year	Level of Evidence	Description	Comments
Ohtori et al., 2009	II	42 pts undergoing noninstrumented ALIF w/ iliac crest autograft were evaluated w/ discography or discoblock in a randomized fashion. 12 were eliminated due to a lack of response w/ either technique. VAS, ODI, & JOA scores were obtained preoperatively & at 1, 2, & 3 yrs. All pts achieved solid fusion by 2 yrs based on plain radiographs & CT. Significantly improved pain & disability scores were achieved in pts w/ a positive discoblock vs those w/ positive discography (p < 0.05). The authors concluded that discoblock was a superior predictor of success following lumbar fusion vs discography.	This study provided Level I evidence for the benefits of the discoblock technique over the traditional discogram technique. It is downgraded to Level II due to failure to perform a power analysis to determine sample size for randomization & the small sample size for each cohort.
Carragee et al., 2009	II	This prospective, matched-cohort study was performed to determine if provocative discography was associated w/ DDD progression. 75 pts undergoing provocative discography underwent baseline MRI & were compared to a matched cohort. At 10 yrs following the procedure, 50 discography pts & 52 controls underwent repeat MRI. All qualitative & quantitative parameters were more advanced in the discography group. The authors concluded that provocative discography was associated w/ progression of DDD & should be considered in discussion of risks.	This prognostic study is limited by significant loss to follow-up; over 30% of pts were not available for final MRI evaluation. It is therefore downgraded to Level II evidence that an association exists between provocative discography & progression of lumbar DDD.
Gill & Blumenthal, 1992	II	Retrospective comparative study of 53 pts who underwent ALIF at L5-S1. All had preop MRI & discography & follow-up of at least 24 mos. 19 had Type I discography findings of an annular tear that did not extend to the periphery of the disc w/ normal MRI. The remaining pts had Type II or III discography finding of extension of the annular tear to the periphery of the disc w/ abnormal MRI. Clinical outcomes were ODI, VAS, & pain drawing. Successful functional outcome was return to work or normal activities & no use of narcotics. In pts w/ Type II or III discography findings & abnormal MRI there was a 75% success vs 50% in those w/ Type I discography findings & normal MRI.	This study provided Level II evidence against use of discography in the presence of a normal MRI scan in predicting results following lumbar fusion.
Carragee et al., 2006	IV	Lumbar fusion performed in 32 pts w/ discogenic pain & positive discogram. Circumferential fusion performed w/ ALIF & FRA combined w/ intertransverse fusion w/ allograft & pedicle screw instrumentation. Clinical outcomes were measured w/ VAS, AAOS MODEMS instrument, ODI, psychological testing, & Fear Avoidance and Behavior Questionnaire. Clinical success at 2-yr follow-up was defined by VAS score $\leq$ 2, ODI score $<$ 15, return to work, no narcotics, & no daily pain medication requirements. Clinical results compared to results in control cohort of 34 pts undergoing lumbar fusion for spondylolisthesis. Successful outcomes observed in 72% of control group vs 27% of discography group. The percentage of pts achieving a minimally acceptable improvement in the control group was 91% vs 43% for the discography group. Positive discography had a positive predictive value of 50–60%.	This case series provides Level IV evidence against utility of discography as a predictive tool.
Wetzel et al., 1994	IV	Retrospective case series involving 48 pts w/ discogenic back pain w/ positive discography & CT or MRI. All had lumbar fusion of the levels determined based on discography. Number of levels fused ranged from 1 to 4, w/ a wide variety of techniques. Clinical outcomes were subjectively graded as excellent, good, fair, or poor. Radiographic fusion defined as 4° or less motion on flexion-extension radiographs & mature trabecular bone across all levels. 23 (47.9%) went on to successful radiographic fusion, & 22 of those had a satisfactory clinical outcome. Overall, 46% had satisfactory clinical outcome.	This study provided Level IV evidence against the use of discography in predicting clinical success following lumbar spine fusion. Limitations of the study included a variety of surgical techniques & lack of quantitative & validated clinical outcomes measures.
Knox & Chapman, 1993	IV	Retrospective case series of 22 ALIF pts w/ positive discogram. Subjective clinical outcomes were reported as good in 35% of pts, fair in 18%, & poor in 47%.	This study provided Level IV evidence against the use of discography in predicting clinical success following lumbar spine fusion. Limitations of this study included a small sample size & lack of quantitative & validated clinical outcomes measures.

\* AAOS = American Academy of Orthopaedic Surgeons; ALIF = anterior lumbar interbody fusion; DDD = degenerative disc disease; FRA = femoral ring allograft; JOA = Japanese Orthopaedic Association; MODEMS = Musculoskeletal Outcomes Data Evaluation and Management System; ODI = Oswestry Disability Index; pts = patients; VAS = visual analog scale.

anterior lumbar interbody fusion at L5–S1 was performed by Gill and Blumenthal.<sup>10</sup> All patients had preoperative MRI and discography and at least 24 months of follow-up. Nineteen of the patients had Type I discography findings of an annular tear that did not extend to the periphery of the disc with normal MRI findings. The remaining patients had a Type II or III discography finding of extension of the annular tear to the periphery of the disc with abnormal MRI findings. Clinical outcomes were measured by the “Oswestry Pain Questionnaire” (ODI), VAS, and a pain drawing. A successful functional outcome was defined as the ability to return to work or normal activities and no use of narcotic medications. In the patients with Type II or III discography findings and abnormal MRI findings, there was a 75% success rate postoperatively, while there was a 50% success rate in those with Type I discography findings and normal MRI findings. This study provided Level IV evidence against the use of discography in the presence of normal MRI findings in predicting results following lumbar fusion. The limitations of this study include being a retrospective case series and having a small sample size (see Table 1).

Additional Level IV evidence against the use of discography for the prediction of clinical success following lumbar fusion was provided by Knox and Chapman.<sup>14</sup> They performed a retrospective analysis of a case series involving 22 patients who had positive discogram findings and underwent anterior lumbar interbody fusion. Subjective clinical outcomes were reported as good in 35% of patients, fair in 18%, and poor in 47%. Limitations of this study included a small sample size and lack of quantitative and validated clinical outcomes measures.

Willems et al. conducted a retrospective review of a series of cases to determine whether preoperative discography of adjacent-level discs could predict clinical outcome in patients undergoing lumbar fusion.<sup>19</sup> This study began with 209 patients, but 12 were eliminated for lack of data, and an additional 115 received conservative treatment. The remaining 82 patients had lumbar fusion and their cases were used in the analysis. Outcomes measures included a VAS pain scale and Odom’s criteria. The preoperative discography results for adjacent levels did not affect clinical outcomes in this series of patients. This study provides Level IV evidence against the use of adjacent-level discography as a predictor of clinical success after lumbar fusion.

An alternative to the traditional technique of discography is the technique known as a “discoblock,” which involves injecting the disc with an anesthetic agent instead of a contrast agent in an effort to eliminate as opposed to reproducing a patient’s pain. This modified technique was compared with traditional discography by Ohtori et al.<sup>16</sup> Forty-two patients undergoing a noninstrumented anterior lumbar interbody fusion with iliac crest autograft were evaluated preoperatively with either provocative discography or discoblock in a randomized fashion. Twelve patients were eliminated from the study due to a lack of response with either technique. Outcome measures including VAS, ODI, and Japanese Orthopaedic Association (JOA) scores were obtained preoperatively and at 1, 2, and 3 years postoperatively. All patients reportedly achieved a solid fusion by 2 years following surgery

based on plain radiographs and CT scans. Significantly improved clinical outcomes with respect to both pain and disability scores were achieved following lumbar fusion in patients with positive discoblock findings as compared with those with positive discography findings ( $p < 0.05$ ). The authors suggested that the discoblock technique proved to be a better predictor of success following lumbar fusion than provocative discography. This study provided Level II evidence for the benefits of the discoblock technique over the traditional provocative discography. Limitations of the study included a small sample size and lack of a power analysis.

More recently, concern has developed over the possibility that diagnostic disc injections may lead to iatrogenic injury to the disc and accelerate the rate of disc degeneration. Animal studies have demonstrated degeneration of an intervertebral disc due to a needle puncture of the annulus fibrosis.<sup>13,17</sup> Carragee et al. conducted a comparative prospective cohort study over a 10-year period, during which they followed the progression of disc degeneration in patients with and without a history of discography.<sup>6</sup> MRI studies were performed at baseline and 10 years following provocative discography. Two blinded radiologists and 2 blinded orthopedic surgeons evaluated the images. All outcome measures, including progression of disc degeneration, occurrence of new herniations, loss of disc height, and loss of disc signal intensity, were found to be significantly worse in the patients who had undergone discography. Of the original sample cohort of 150 patients enrolled, only 68% were available at the time of follow-up. This study was classified as a prognostic study regarding the outcome after performance of a provocative discography and was downgraded to Level II evidence of the potential risk associated with the use of provocative discography due to the 32% loss to follow-up.

## Summary

The use of discography to aid in patient selection for lumbar fusion remains controversial. Based on the current literature, there is insufficient evidence to suggest that discography should be used as an independent predictor of success following lumbar fusion for low-back pain. There is limited evidence to suggest that a discoblock or anesthetizing the disc instead of injecting contrast material provides superior predictive value. More recent evidence, however, suggests a possible risk of discography leading to an acceleration of disc degeneration.

## Key Issues for Further Investigation

Determining the diagnostic potential of a specific test rests on the ability to compare results between a “gold standard” and the test under investigation. Due to the lack of a “gold standard” when attempting to identify the source of a patient’s low-back pain, such evaluations are extremely difficult to design and interpret. With respect to discography, there remains insufficient evidence to support its routine use as a diagnostic modality when evaluating patients with low-back pain. While further investigation may help elucidate the potential of discog-

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raphy, such trials may not be feasible given the recent evidence that accelerated rates of disc degeneration are associated with a history of previous discograms.

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