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Provocative Discography in Patients After Limited Lumbar Discectomy

A Controlled, Randomized Study of Pain Response in Symptomatic and Asymptomatic Subjects

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Study Design. This was a prospective observational study of patients with low back pain and those without after laminotomy and discectomy.

Objectives. To determine, using a strict experimental design, the relative pain intensity response to provocative discography in symptomatic and asymptomatic subjects after lumbar discectomy for intervertebral disc herniation.

Background. Provocative discography frequently is used to evaluate persistent or recurrent low back pain syndromes in patients who have undergone posterior discectomy. The validity of interpreting painful injections during this procedure has not been critically assessed. The prevalence of significantly painful disc injections in a group with good outcomes after surgery is not known. Knowing the rates of significantly painful injections in asymptomatic patients after lumbar discectomy may clarify the meaning of painful injections in symptomatic patients.

Methods. From a cohort of 240 patients who had undergone single-level limited discectomy for sciatica, 20 asymptomatic volunteers were recruited for experimental three-level lumbar discography. Inclusion criteria required nearly perfect scores on standardized back pain rating instruments, no other spinal pathology, and normal psychometric screening. A control group of 27 symptomatic patients, after single-level discectomy with intractable low back pain syndrome, and without other spinal pathology, underwent discography. Seven patients in the control group had normal psychometric tests. Experienced raters who were blinded to control *versus* experimental status of the subjects scored the magnetic resonance imaging, discogram, psychometric tests, and discography videotapes of the subjects' pain behavior.

Results. There were 8 of 20 (40%) positive injections of discs that had previous surgery in the asymptomatic group and 17 of 27 (63%) positive injections in the symptomatic group. Specifically with regard to the symptomatic group, there were 3 of 7 (43%) positive injections (all concordant) in patients with normal psychometric scores, as compared with 14 of 20 (70%) positive injections (12 concordant) in patients with abnormal psychometric scores. Injections of discs that had previous surgery resulted in a mean pain score of 2.1 of 5 in the asymptomatic group, 2.1 in the symptomatic group with normal psychometric scores, and 3.4 in the symptomatic group with abnormal psychometric scores. Of the discs not treated with surgery, 2 were positive in the asymptomatic group (10%), 3 in 2 symptomatic subjects with normal psychological testing (29), and 18 in 13 symptomatic subjects with abnormal psychometric testing (76%).

Conclusions. A high percentage of asymptomatic patients with normal psychometric testing who previously have undergone lumbar discectomy will have significant pain on injection of their discs that had previous surgery (40%). This is not significantly different from the experience of symptomatic patients with normal psychometric testing undergoing discography on discs that had previous surgery. Patients with abnormal psychological profiles have significantly higher rates of positive disc injections than either asymptomatic volunteers or symptomatic subjects with normal psychological screening. [Key words: back pain, disc herniation, discography, laminotomy, spine, surgery] **Spine 2000;25:3065–3071**

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Many patients seen for evaluation of low back pain (LBP) syndromes have had previous lumbar surgery, including discectomy. In some studies, the majority of patients with intractable disabling LBP have undergone previous surgery without success. Discography in two modes has been proposed for use in these circumstances. One mode is used primarily as an imaging tool in persistent or recurring radiculopathies to outline disc architecture and possibly identify occult displaced fragments missed by other imaging techniques. In the other mode, discography has been used as a subjective provocative test to identify symptomatic levels associated with the so-called "pain generator" in predominantly axial pain syndromes.

In this second scenario, discography has been recommended in the evaluation of postoperative LBP, although its role in general, and specifically in the spine that had previous surgery, has remained controversial. Despite the lack of consensus regarding the indications and interpretation of discographic results, the procedure is used widely, and spinal arthrodeses often are planned on the basis of discographic findings. The clinical problem of the "failed back" has escalated in the past decade, and the numbers of patients, medical costs, and "salvage" surgeries are staggering. Yet, there is no basic information regarding the reliability of provocative discography used to identify symptomatic discs at levels at which surgery has been performed. Strong opinions pro and con have been put forth. However, the scientific groundwork exploring the use of discography in this setting has yet to be done.

With this in mind, the authors undertook to perform some elementary experimental work to define the use of discography in the context of the spine that had previous surgery. The objective for this study was to test the pain response to the provocative injection of discs that had previous surgery in asymptomatic subjects after posterior lumbar discectomy. These injections in asymptomatic subjects were to be assessed blindly in a group of subjects with chronic, persistent, or recurrent LBP syndromes after the same discectomy procedure. The authors used the experimental discography method originally developed by Walsh et al[23] as more recently modified by Carragee et al[3] to test asymptomatic individuals for their response to discography. The authors were interested in discovering whether any of these asymptomatic individuals would have significant pain on disc injection. If some positive injections were found in the asymptomatic group, the authors were interested learning how the rates of significantly painful injection would compare with the incidences of positive injections previously reported by researchers using the same protocol on discs never subjected to surgery.[3,23]

Previous work has shown that subjects with chronic pain syndromes, occupational disability, and abnormal psychological testing are more likely to have false-positive disc provocative injections.[3] In the current trial the authors were interested in looking at the "best case scenario" for the use of discography. Therefore, they recruited asymptomatic volunteer subjects without any chronic pain states, with normal psychometric testing, and without current occupational disability. The symptomatic control group with chronic LBP syndromes also were stratified accordingly into subgroups with and without abnormal psychometric studies. In this manner, the authors sought to establish perhaps the minimal expected false-positive rates if or when the test would be used with a group very unlikely to have exaggerated pain responses. Such patients then could be compared with symptomatic controls having normal and abnormal pain response potentials.

■ Methods

Asymptomatic Participant Recruitment. Participants were recruited from the Orthopaedic Spine Clinic at Stanford University School of Medicine. From a concurrent project evaluating outcomes in 240 patients 2 to 10 years after posterior limited lumbar discectomy, the authors tried to identify who did extremely well after surgery. Using a previously described spine instrument,[6] wherein 10 points reflected no back or leg pain, full activities, no medications, and complete satisfaction with treatment, subjects with scores of 9.5 or greater were identified. All the subjects with these scores were solicited at follow-up assessment to undergo "testing to assess the state of their discs that had previous surgery."

Approval was obtained from the Institutional Review Board (IRB) and the Administrative Panel of Human Subjects in Medical Research according to U.S. Department of Health and Human Services (DHHS) regulations at the Stanford University School of Medicine. The IRB guidelines and case-specific recommendations also were used in the initial patient pool selections and screening described earlier. Informed consent according to University and DHHS guidelines was obtained from all prospective participants, for whom the potential risks of magnetic resonance imaging (MRI) and discography were outlined. Participants could withdraw at any time. Participants consented separately from the ongoing discectomy study, and patient records were encoded separately to ensure blinded review of the clinical information, discographic results, and imaging scores from each protocol. There was no monetary compensation to the participants for any part of this study. Some travel expenses were reimbursed.

From the pool of 211 subjects with completed follow-up examinations, 67 had outcome scores meeting the aforementioned criteria. Of these subjects, 36 agreed to participate in the study. Predetermined exclusions included patients with structural spinal abnormalities found on screening as described later; women of childbearing potential unless they agreed to mandatory pregnancy screening, contraceptive usage and confirmation (by IRB guidelines); subjects with allergy to any contrast media, iodine, or cephalosporin antibiotics; individuals unable to undergo MRI scanning because of ferromagnetic implants, subjects with severe claustrophobia or inability to tolerate positioning for either MRI or discography procedures; patients with significant pain syndromes in nonspinal areas; subjects disabled from work for any reason; and individuals who had undergone previous discography.

Of the 36 volunteers, 24 not disqualified by the exclusion criteria were invited to participate in the study. As described earlier, previous work by Carragee et al[3] had shown a very high rate of positive disc injection in patients with abnormal psychometric findings and long-term persistence of pain in many of these patients. For this reason, psychometric screening was performed on the 24 volunteers. A Modified Zung Depression Test and the Modified Somatic Perception Questionnaire (MSPQ)[14,15] were administered to each subject at the interview session before discography. Two subjects had depression scores indicating possibly significant depression and were dropped from the study group. Two of the remaining subjects could not make the discography appointment dates or backup dates, and also were dropped from the study. Thus 20 patients (9% of the recruitment pool) participated in the complete study. The demographic and clinical profiles of the eligible recruitment pool (n = 67) and final subject group (n = 20) are shown in Table 1.

Second Screening for Current Low Back Problems. Twice during a 6-week period before the discography, the participants were asked to complete a second standardized questionnaire with a telephone interviewer to ensure that they were asymptomatic. Both of these screenings had to be negative for the subject to proceed with the study. The subjects did not know whether their reports of ongoing low back troubles would disqualify them from the study. Therefore, over a 6-month period, three assessments were performed on all the subjects indicating whether they had back or leg problems.

If these screenings were negative and the patient agreed to participate in the study, he or she was examined with plain radiographs and a lumbar spine MRI taken from 0 to 8 days before discography. Disc degeneration at each level was rated according to previously established guidelines[19] by at least two experienced readers. The patient was again interviewed and examined immediately before discography. Physical examina-

Table 1. Subject Characteristics of Control and Asymptomatic Groups and Subsets of Each With Positive Discograms at the Discs That Had Previous Surgery

	Control Group (n = 27)	Control Positive Discograms (n = 17)	Asymptomatic Recruitment Pool (n = 67)	Asymptomatic Discography Group (n = 20)	Asymptomatic Positive Discogram (n = 8)
Age (yrs)	35.3 ± 9.9	31.1 ± 7.7	37.5 ± 11.0	35.4 ± 7.7	37.5 ± 8.1
Gender (%)					
Men	16 (60)	10 (58)	53 (79)	18 (90)	7 (88)
Women	11 (40)	7 (42)	14 (20)	2 (10)	1 (12)
Work type (%)					
Light	11 (44)	6 (37)	32 (48)	8 (40)	3 (37.5)
Medium	5 (20)	3 (19)	12 (18)	2 (10)	2 (25)
Heavy	9 (36)	7 (44)	16 (24)	8 (40)	3 (37.5)
None	2 (8)	1 (6)	7 (10)	2 (10)	0
Litigation (%)					
Yes	6 (21)	6 (37)	3 (4)	0 (0)	0 (00)
No	21 (79)	11 (63)	44 (96)	20 (100)	8 (100)
Worker's compensation (%)					
Yes	12 (45)	11 (63)	9 (13)	4 (20)	0 (0)
No	15 (55)	6 (37)	58 (87)	16 (80)	8 (100)
Follow-up time (mos)	24.6 ± 9.0	18.3 ± 10.5	55.7 ± 18.6	58.2 ± 20.7	61.8 ± 22.0
Total score (0–10)	5.4 ± 1.2	4.7 ± 1.0	9.8 ± 0.2	9.8 ± 0.2	9.7 ± 0.2
MSPQ	11.8 ± 11.2	23.6 ± 12.7		4.8 ± 1.2	8.1 ± 4.0
Zung	26.7 ± 8.1	39.8 ± 17.7		6.1 ± 2.1	8.9 ± 3.2

MSPQ = Modified Somatic Perception Questionnaire, Zung = Modified Zung Depression Test.

tion was performed to test low back range of motion and for the presence of any deformity or tenderness of the thoracolumbar spine, lower extremity neurologic problems, or sciatic and femoral root tension signs.

Symptomatic Control Participants. The subjects in the symptomatic group were scheduled to undergo discography for evaluation of chronic persistent or recurrent low back and leg problems 14 months to 6 years after posterior discectomy (Table 1). These subjects, who had consented to enter the study, had, in addition to previous studies, a protocol MRI, physical examination, psychometric testing, and the same standardized low back questionnaires as those completed by the asymptomatic group. Altogether, 27 patients met the inclusion criteria. Of these patients, 7 had "normal" psychometric scores according to the Distress and Risk Assessment Method of Main et al[15] Of the 27 patients accepted into the study, 11 were randomly mixed with the asymptomatic group during four discography sessions. The remaining 16 patients underwent discography using an identical protocol on other days. The discographer and assistant were blinded as to whether the study subjects were undergoing discography on any given day.

Discography. Before the study, the participants were instructed on the use of the pain thermometer, a visual analog scale (VAS) with scoring options of 0 to 5, which would be used during the test for pain intensity responses. The participants were brought into the fluoroscopy suite individually and debriefed in a separate examining area to avoid sample contamination. Discography was performed using the double-needle technique after intravenous administration of a sedative (up to 0.1 mg/kg diazepam) and antibiotics (cefazolin 1 g). Discography needles (18-gauge outer and 22- and 25-gauge inner) then were placed into the caudal three mobile discs in each participant using the posterolateral approach. Omnipaque, a water-soluble contrast agent, was used for disc injections (Winthrop-Breon Laboratory, New York, NY). In some instances, additional levels also were tested in an attempt to document a control disc (no pain, normal pattern), as in the current authors' usual clinical practice. Needle placement was assessed on fluoroscopic images as being in the central one third of the disc in two planes (caudorostral and anteroposterior) and in line with the spinous processes in the left–right plane. Anteroposterior fluoroscopic images were made parallel to the vertebral endplates in a modified Ferguson view.

Pressure measurements were made during the injection showing continuous recordings in pounds per square inch on a manometer, indicating each 0.5 mL of the injection (Hewlett-Packard, Palo Alto, CA). A pressure relief valve limited the maximum possible injection pressure to 100 pounds per square inch. The static disc pressure (relative to the opening pressure) associated with a pain response was noted. In the patients without pain on injection, the highest pressure attained during injection is presented in Table 3.

Evaluation of Discogram. Permanent radiographic films were developed after the discograms. The authors were concerned primarily with pain response. In the interest of limiting radiation exposure, computed tomography (CT) scans were not performed after discography. The biplanar postdiscography radiographs were evaluated by two examiners or more and rated as normal or abnormal on the basis of a modal rating in the event of disagreement in evaluation.

Evaluation of Pain Response. The criteria used for pain response, pain behavior, and determination of a "positive" injection were the same as those used in the original work of Walsh et al.[23] Pain responses were recorded with each of the disc injections. With each injection, the patient indicated the magnitude of discomfort on a "pain thermometer" using a VAS with response options of 0 (no pain), 1 (minimal pain), 2 (moderate pain), 3 (bad pain), 4 (severe pain), and 5 (unbearable pain). Pain-related behavior and the fluoroscopic image of the injection were simultaneously recorded by videotaping. Each

Table 2. Rates of Pain Response Reported on Injection of Discs That Had Previous Surgery in Control and Asymptomatic Groups

Pain Response Score	Control Group (n = 27) (%)	Control Abnormal Psychometrics (n = 20) (%)	Control Normal Psychometrics (n = 7) (%)	Asymptomatic Group (n = 20) (%)
None (0)	3 (11)	1 (5)	2 (29)	4 (20)
Minimal (1)	2 (7)	1 (5)	1 (14)	6 (30)
Moderate (2)	5 (19)	4 (20)	1 (14)	2 (10)
Bad (3)	5 (19)	4 (20)	1 (14)	2 (10)
Severe (4)	4 (15)	3 (15)	1 (14)	4 (20)
Unbearable (5)	8 (30)	7 (35)	1 (14)	2 (10)
Mean pain response score	3.1 ± 1.7	3.4 ± 1.9	2.1 ± 1.7	2.1 ± 1.7

was reviewed by two of three research assistants. Five types of pain behavior were recorded. A "positive" discographic injection was scored if the pain response was 3 (bad pain) or greater *and* if two or more pain behaviors were documented on the videotape of the injection.

Follow-Up Evaluation. The participants were followed for approximately 1 month after disc injections by telephone and questioned regarding back symptoms.

Data Analysis. Data were analyzed using the statistical computer program Statview (Abacus, Mountain View, CA). Analyses of continuous data were made using Student's *t* test, and categorical data were analyzed use χ^2 testing.

■ Results

Altogether, 20 asymptomatic volunteers completed the study in a random fashion and were compared with 27 control participants who had undergone concurrent discography for LBP syndromes. All the control and experimental participants who began the discogram completed at least three disc injections. No complications occurred during or after the procedure. The caudal-most disc in four participants (two control and two asymptomatic participants) could not be injected because of difficulty in entering the disc space. However, in no participant did the authors fail to inject the disc that had previous surgery.

The demographic data on the control and asymptomatic participants are given in Table 1. The mean outcome score after the original discectomy in the symptomatic patients reflects their continued symptoms and activity restrictions and differs significantly from the corresponding score in the asymptomatic group ($P < 0.0001$). In the symptomatic group, a higher percentage were women, received workers' compensation benefits or were involved in ongoing litigation, and their follow-up time was shorter than in the asymptomatic group. Finally, psychometric testing in the symptomatic group suggested significant depression and increased somatic awareness tendencies in the group as a whole ($P < 0.001$). The asymptomatic group had "normal" psychometric scores, as required by an entry criterion. Work type, age, and levels of previous surgery were similar in the asymptomatic and control groups.

Following the criteria set forth by Walsh et al, the authors found positive provocative disc injections in 8 of 20 asymptomatic participants (40%) and 17 of 27 control participants (63%) at the levels where their previous surgery had occurred. Of 17 control injections, 15 were felt to reproduce similar or exactly concordant pain responses. Table 1 shows the demographic data for the participants with positive injections of the discs that had previous surgery. More abnormal psychometric testing correlated with positive injections in the symptomatic group (($P < 0.05$), and there was a trend toward relatively higher (*i.e.,* more distressed) scores in the asymptomatic group as well, although this was not significant.

In the symptomatic group, litigation and workers' compensation claims were significantly more frequent in those who had a positive disc injection than in those with negative injections ($P = 0.02$).

According to the classification of Main et al,[15] symptomatic participants were divided into those with normal psychometric scores (n = 7) and those with abnormal scores (n = 20). Positive disc injections were elicited in 3 of 7 controls with normal psychometric scores (43%, all concordant), and 14 of 20 controls in those with abnormal psychometric scores (70%, 12 concordant).

The distribution of pain responses at injection of the discs that had previous surgery is given in Table 2 and Figure 1. When the symptomatic and asymptomatic participants with normal psychometric scores are compared, no significant difference in their pain ratings can be seen. On the contrary, the pain responses of the group with abnormal psychometric scores are significantly different in both the control and experimental groups with normal psychometric scores. Rated on a 0- to 5-point pain thermometer scale, injections of the discs that had previous surgery had a mean score of 2.1 in the asymptomatic group, 2.1 in the symptomatic group with normal psychometric scores (not significant), and 3.4 in the symptomatic group with abnormal psychometric scores ($P = 0.006$).

Of the discs that had previous surgery, 2 discs were positive in the asymptomatic group (10% of the participants), 3 discs in 7 patients in the control patients with normal psychological testing (29% of the participants), and 18 discs in 13 of 17 controls with abnormal psycho-

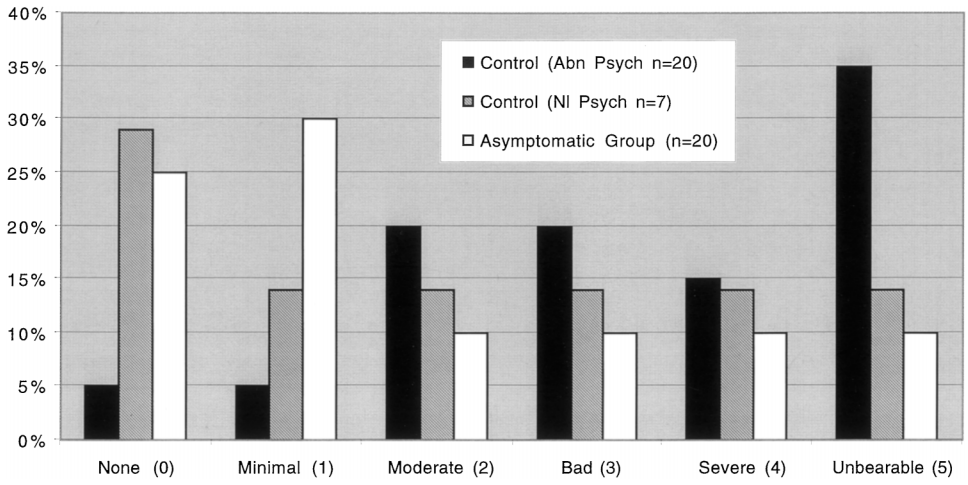

Figure 1. Pain response in control and experimental (asymptomatic) groups by percentage of each group reporting levels of pain at injection of discs that had no previous surgery. The control group with abnormal psychometric scores has statistically fewer subjects reporting none or minimal pain ($P < 0.001$) and more subjects reporting unbearable pain ($P < 0.002$) with injection than either the control or experimental groups with normal psychometric scores.

metric testing (75% of the participants). The data for each disc injection in the asymptomatic participants are given in Table 3, which is formatted for comparison with the work of Walsh et al[23] and Carragee et al.[3] Grades 2 and 3 discograms with dye penetrating to or through the outer anulus were seen in all injections with significant pain responses in discs that had previous surgery.

■ Discussion

The evaluation of patients with severe LBP syndromes despite lumbar surgery is a challenging and often frustrating task. The common correctable causes of persistent or recurrent symptoms include recurrent frank herniation, postoperative infection, gross radiographic instability, and facet or pars fractures related to the decompression. These usually can be evaluated expeditiously and diagnosed without invasive procedures. Most patients, however, do not have a clear lesion identified after this workup is complete. Speculative diagnoses at that point of the evaluation include epidural scarring, central pain syndromes, subtle segmental instability, arachnoiditis, discogenic pain, and psychological/emotional disorders, among others. Patients in whom it is felt that discogenic pain or segmental instability may be the cause of their pain have been considered candidates for spine fusion if conservative methods were unhelpful. Discography has been advocated to help confirm the diagnosis of discogenic pain when suspected, and often is used in the postoperative setting.[1,7–9]

Some authors have questioned the reliability of discography in any setting.[10,16] Others have pointed out theoretical reasons why a false-positive rate in discs that had previous surgery may be very high.[17] Despite these arguments for and against the use of discography, little

Table 3. Disc Imaging and Injection Data in 20 Asymptomatic Volunteers

	L2/L3 Discs					L3/L4 Discs					L4/L5 Discs					L5/S1 Discs				
Patient	MRI Grade	Disc Grade	Press (psi)	Pain Response	Pain Behavior	MRI Grade	Disc Grade	Press (psi)	Pain Response	Pain Behavior	MRI Grade	Disc Grade	Press (psi)	Pain Response	Pain Behavior	MRI Grade	Disc Grade	Press (psi)	Pain Response	Pain Behavior
1	0	0	100	0	0	2	1	25	3	3	3	2	80	1*	1	2	3	30	2	1
2						2	1	80	0	0	0	0	100	1	1	2	2	100	1*	1
3	—	—	—	—	—	3	3	80	2	2	3	3	12	2	2	3	3	5	4*	4
4	—	—	—	—	—	0	0	100	0	0	3	3	40	0	0	3	3	10	4*	2
5	0	0	100	0	0	1	2	100	1	2	3	3	80	0*	0					
6						2	1	30	2	2	0	0	100	0	0	3	3	12	5*	3
7	—	—	—	—	—	0	0	100	0	0	0	0	100	0	0	2	2	80	3*	1
8	—	—	—	—	—	2	3	80	2	2	3	3	5	5*	5	3	3	20	3	2
9	—	—	—	—	—	1	1	100	0	0	0	0	100	0	0	2	3	20	1*	1
10	—	—	—	—	—	0	0	100	0	0	3	3	50	4*	3	3	2	80	3	1
11	—	—	—	—	—	0	0	100	0	0	2	3	25	4*	4	2	3	20	0	0
12	—	—	—	—	—	0	0	100	0	0	2	1	80	0	0	2	3	40	0*	0
13	—	—	—	—	—	2	3	80	2	3	3	3	50	0	0	3	3	20	2*	2
14	—	—	—	—	—	0	0	100	0	0	3	3	80	1	1	2	3	25	0*	0
15	—	—	—	—	—	0	0	100	0	0	3	3	30	0	0	2	3	10	1*	1
16	—	—	—	—	—	0	0	100	0	0	1	3	30	0*	0	2	1	100	0	0
17	—	—	—	—	—	0	0	100	0	0	0	0	100	0	0	3	3	50	1*	1
18	—	—	—	—	—	0	0	100	1	0	2	2	100	2*	1	1	1	100	2	1
19	0	0	100	0	0	0	0	100	0	0	3	3	10	3*	2					
20	—	—	—	—	—	1	1	100	0.5	0	2	1	80	1	0	2	3	30	1*	1

* Disc that had previous surgery.
MRI = magnetic resonance imaging; psi = pounds per square inch.

experimental work has been reported to support either claim.

Heggeness et al,[8] in the most extensive review of patients undergoing discography after lumbar discectomy and laminectomy, reported on 83 patients. They found, on retrospective review, that 72% of the patients had a positive concordant pain response on injection of the disc that had previous surgery. They also found that this response was associated with dye extravasation posteriorly, and that the incidence of both dye extravasation and positive injections was higher in the discs that had previous surgery than those not treated surgically. This effect also was seen in the current participants. Heggeness et al[8] could not address the rate of false-positive injections or whether any occurred in their series. In that study, all positive injections were assumed to be true positives for identifying the source of the patient's pain. No psychometric data were given.

False-positive injections in clinical and experimental discography have been reported to be virtually nonexistent,[20,21] rare,[23] variable,[2,3] or common,[10,16] depending on the literature cited. None of these studies evaluated discs that had previous surgery.

The results presented in this article demonstrate a disturbingly high rate of significantly painful injections (40%) in discs that had previous surgery in asymptomatic participants. If even one half of these patients in a clinical context were to report the provoked pain as being similar to their usual pain, the clinical false-positive rate would be 20%, a rate much too high for clinical use. The participants in the current study had been screened on three occasions, in which they repeatedly denied back problems. They also, on the average, were approximately 5 years beyond their surgery. In the authors' opinion, it is very unlikely that significant LBP problems existed in this group around the time of the study. Because all the participants were unpaid volunteers, bias in this group to underreport pain before the study, as suspected in the study of "volunteer" prisoners by Holt,[10] also is very unlikely.

Findings in previous work by Block et al[2] and Carragee et al[3] suggest that psychological issues may increase the false-positive rate in discography. In the current study, however, the volunteer participants were screened specifically for abnormal psychometric studies. The high positive injection rate in the asymptomatic group (40%), even after elimination of serious psychological factors, would argue that the disc that had previous surgery is much more likely to be painful on injection than the discs that had no previous surgery. In normal subjects, the rate of positive injections per patient reported by Walsh et al[23] (0–10%) and Carragee et al[3] (10%) was determined using the same protocol. Indeed, the rate of positive injections in the discs that had no previous surgery in the asymptomatic group of the current study was again 10%, correlating well with the findings from previous investigations. Still, it is interesting to compare the psychometric questionnaire scores among the asymptomatic patients, all of whom had "normal" psychometric testing. The participants who went on to have positive disc injections tended to have higher average Zung Depression (8.9 ± 3.2) and MSPQ (8.1 ± 4) scores than to those who later would have negative injections (4.8 ± 1.2 and 6.1 ± 2.1, respectively).

The reliability of the discography in this setting then hinges on the subjective assessment of pain concordance as the discriminating factor in determining true- from false-positive injections. However, it is not clear that patients can in fact make this type of discrimination. Neurophysiologic studies suggest that qualitative and comparative pain assessment is fraught with inconsistency and overlapping sensory attribution.[11–13,18,22] These studies have indicated the difficulties involved in discriminating central from peripheral pain syndromes through provocative testing, and one peripheral pain generator from another. Using experimental disc injections, the authors have previously shown that subjects without discogenic LBP very often will confuse the pain of discography with known nonspinal pelvic pain.[5] Other work has reported clinical instances of patients claiming concordant pain on disc injection for what later was found to be nondiscogenic pain.[4] Therefore, relying on the subjective report of pain similarity to establish a diagnosis of a back pain syndrome is without demonstrable merit.

The current study had some significant limitations. As in all studies of asymptomatic subjects, there is no way to rate concordancy of provocative testing. The motives and pain tolerances of volunteers agreeing to such a study may not be generalizable to all patients. The lack of monetary compensation hopefully mitigated some biases, but probably not all. The omission of computed tomography scanning after injection, in an effort to limit radiation exposure, necessarily resulted in the loss of architectural data that may have been helpful in determining the structural predictors of positive injection, if any existed.

On the other hand, the strengths of the study resulted from the use of the previously validated standardized protocol of Walsh et al.[23] The number of asymptomatic subjects who entered the current study[20] was twice the number in the original cohort of Walsh et al,[23] ensuring greater study validity. The blinded methods of scoring pain responses and behavior by videotape eliminated the subjective impressions of the discographer. The study entry requirements eliminating multilevel surgery, other spinal abnormalities, and previous discography allowed the study to focus on a relatively homogeneous group. Finally, the elimination of measured psychological abnormalities and chronic pain states in the "asymptomatic" group should have served to give a "best case" baseline regarding pain responses in the disc that had previous surgery.

The results of this study lay a basic foundation for further research on provocative testing in the postoperative individual with continued or recurrent pain. The study design limits the ability to identify clearly the pa-

tients in whom the test will be most useful. On the other hand, this and other work indicate that caution should be used in the interpretation of discographic results at a postoperative disc level, particularly in subjects with significant emotional distress. It appears from this work that the incidence of painful injections may be unacceptably high in discs that had previous surgery, and previous work casts serious doubt on the suggestion that subjective concordancy alone can determine a true positive disc.[5] Further work is underway to identify, if possible, the type of disc herniations (contained *vs* extruded) and surgical techniques at disc excision (limited *vs*. complete curettage) associated with pain, which may help to illuminate the nature of pain provocation during discography in the postoperative setting. Whether there is a clinical use for discography in patients with persistent or recurrent back problems after lumbar discectomy remains to be seen.

■ Conclusion

A high percentage of asymptomatic subjects with normal psychometric testing will have significant pain on injection of a disc that had previous surgery (40%). This is not significantly different from symptomatic patients with normal psychometric screening undergoing discography on discs that had previous surgery. Patients with abnormal psychological profiles have significantly higher rates of positive disc injections that either asymptomatic volunteers or symptomatic subjects with normal psychological screening.

■ Key Points

- In both symptomatic and asymptomatic subjects, lumbar discs that had previous surgery are more frequently painful on disc injection than discs that had no previous surgery.
- Asymptomatic subjects with normal psychometric testing had painful disc injections at levels that had previous surgery in 40% of the patients studied.
- Painful disc injections in symptomatic patients after simple discectomy appears to be related in part to psychological and chronic pain issues.
- Caution should be used in interpreting results from discography at postoperative disc levels, particularly in subjects with significant emotional distress.

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