PATIENT PERCEPTION OF PAIN VERSUS OBSERVED PAIN BEHAVIOR DURING A STANDARDIZED ELECTRODIAGNOSTIC TEST

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ABSTRACT: *Introduction*: Clinicians often assume that observations of pain behavior are adequate for assessment of patient pain perception during procedures. This has not been tested during a standardized electrodiagnostic experience. *Methods*: During a prospective trial including extensive, standardized electrodiagnostic testing on persons with lumbar stenosis, vascular claudication, and asymptomatic volunteers, the subjects and an observer rated levels of pain. *Results*: In 60 subjects, observers significantly under-rated pain (Visual Analog Scale 3.17 ± 2.23 vs. 4.38 ± 2.01, $t = -4.577$, $df = 59$, $P < 0.001$). Perceived pain during testing related to bodily pain as measured by the visual analog, McGill, Pain Disability, and Quebec scales, but not age, duration of symptoms, Tampa kinesiphobia, Center for Epidemiological Studies Depression scale, or SF-36 health quality of life. *Conclusions*: Persons with worse pain syndromes may perceive more pain during testing than others. Clinicians and researchers should understand that patients may have more pain than they recognize.

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The needle insertions and electrical stimulations performed during electrodiagnostic (EDx) testing provide important clinical information and are frequently tolerated well by patients. However they are undeniably painful, and it is thus important to understand and diminish pain when possible.

Several studies have examined factors that predict pain. For example it appears that pain perception before testing also relates to the pain experience.[1] Most,[1–3] but not all[4] studies suggest that women perceive a greater level of pain during EDx. However, other possible predictors do not relate to pain during testing. Gans and Kraft[2] found no correlation between the pain of the exam and race, level of education, anxiety level, number of areas tested, or characteristics of the examiner. This literature hints at risk factors for suffering during testing. However, the results have low predictive value and are of limited practical use in the laboratory.

During individual testing, compassionate physicians will often seek to understand the level of pain their patients are experiencing. They can observe pain behavior or ask the patients to rate their pain. The latter may seem awkward, because some may fear that discussing pain can increase the pain experience. Some also may think that a discussion about pain could take time and thus decrease efficiency. However, if simple observation does not assess adequately the level of distress it may be necessary to ask patients about their pain. The validity of observation of pain experience versus perceived pain during EDx testing requires examination.

An excellent opportunity to examine the relationship between perceived and observed pain occurred as part of a prospective research study performed for other reasons. Aspects of that study that were useful for addressing the current question include an extensive EDx protocol which was the same for all subjects and extensive characterization of subjects in terms of pain, disability, emotional status, and masked physical examination. Finally, both persons with painful disorders (neurogenic and vascular claudication) and asymptomatic volunteers were tested.

The main hypothesis for this study is that, during EDx testing the pain levels judged by an outside observer relate to the pain reported by the person undergoing the test. Several additional questions were addressed. What is the level of pain experienced during EDx testing by persons who have no disease? Is the pain experienced by an asymptomatic volunteer different than the pain experienced by subjects with neurogenic claudication and subjects with vascular claudication? What factors relate to self-reported pain level during testing?

METHODS

As part of a study intended to compare EDx and imaging studies in the diagnosis of spinal

Abbreviations: EDx, electrodiagnostic

Key words: back pain; electrodiagnosis; electromyography; experimental pain; pain

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disorders, 2 groups of persons aged 55–90 were recruited from review of university clinic records. One included persons with lumbar spinal stenosis and neurogenic claudication sufficiently severe that they were offered surgery by university faculty spine surgeons, and another included persons with vascular claudication and positive ankle-brachial index. A third group of asymptomatic volunteers aged 55–90 was gathered from postings in the community.

For the purposes of the larger study several exclusions were applied. Through review of medical records and interviews, potential subjects were excluded from the study if they had previous back surgery, cardiopulmonary precautions for ambulation testing, or (except for the vascular group, who could have diabetes) risk factors for neuromuscular disease (diabetes, alcohol more than 12 drinks per week, personal or family history of neuromuscular disease, or history of previous significant focal lower limb nerve injury). Contraindications to MRI scanning (metal, obesity, unmanageable claustrophobia), relative contraindications or technical issues related to EDx testing (previous lumbar surgery, warfarin therapy, severe immune disorder, extreme obesity, 3+ or greater pitting edema, or implanted electrodes such as defibrillators), were exclusions. Among the groups with the recruitment diagnoses of neurogenic or vascular claudication, anyone who had another disorder that, in the investigator's opinion, might limit ambulation more than the vascular or neurogenic claudication were eliminated. Ankle-brachial index was performed on all subjects, and any subject with discordant ankle brachial index (abnormal in stenosis or asymptomatic persons; normal in vascular claudication subjects) was eliminated. Subjects were required to be competent and willing to travel to the testing appointments at their own expense. All subjects were compensated for their efforts. The study was approved by the university's ethical review board, and all subjects provided written informed consent for participation in the study.

The final cohorts also underwent other testing. This included the lengthy standard university spine program questionnaire with demographic, medical, social, family, and spine history, and an extensive review of systems. Standardized measures analyzed in this study included a 10 cm visual analog scale for pain,[5] the Pain Disability Index,[6] the McGill Pain Scale,[7] and the Quebec Back Pain Disability Scale.[8] Other validated scales administered included the Swiss Stenosis Questionnaire,[9] the Walking Impairment Questionnaire,[10] the Multidimensional Pain Inventory,[11] and the SF-36.[12] Before EDx testing, 1 of 3 faculty neurosurgeons and a single vascular surgeon performed a comprehensive spine and vascular history and physical examination. Subjects underwent MRI scanning unless it had been done previously for stenosis.

Perceived level of pain was rated by the subjects immediately after testing without consultation with the observers. Observed level of pain was observed by research assistants (not the physicians who were performing the tests) during EDx testing and was recorded immediately after the test was completed without consultation with the patient or physician tester. The research assistants were college graduates in health science related fields, but they were not experienced clinicians. They received special training in the research protocol, including the need to observe pain behavior, however no special instruction on observation or interpretation of physical signs of pain was given. The assistants were familiar with the subjects through at least an hour of personal interaction, including the obtaining of informed consent, assisting with and collecting surveys, performing standardized walking tests, and in most cases observing the subject during the surgeon's exams. Before EDx testing, the assistants coached the subjects on ways to keep the EDx physician masked. The subjects were allowed to voice discomfort related to the test, but if they experienced pain related to their diagnosis (e.g., back pain in a spinal stenosis subject) they were to tell the assistant, and the EDx physician was to leave the room while adjustments were made.

Pain was experienced through a standardized EDx protocol included paraspinal mapping, which involves insertion of a 50–75 mm monopolar electromyography needle into 12 locations on each side.[13] Needle examination included examination of 6 muscles in 1 limb, with 6 insertions in 4 directions and mild muscle contraction with the needle in the muscle for observation of motor unit potential recruitment. The muscles examined were the gluteus maximus, tensor fascia lata, vastus medialis, fibularis longus, anterior tibialis, and medial gastrocnemius. Nerve conduction studies included bilateral tibial H-reflexes, and unilateral sural sensory and fibular motor (ankle, fibular head, and popliteal stimulation) conduction. Occasionally a patient with unusual findings suggesting polyneuropathy underwent additional nerve conduction studies. In these cases the protocol included the possibility of an ulnar sensory nerve action potential, ulnar compound muscle action potential, and needle exam of the first dorsal interosseous of the hand.

The testing (not the observation of pain) was performed by an American Board of Electrodiagnostic Medicine certified physiatrist or neurologist trained in the study protocol. The EDx physician

Table 1. Demographic characteristics of the 3 study groups.

Demographics	All subjects (n = 60)
Neurogenic claudication	28
Vascular claudication	7
Asymptomatic	25
Age, years	63.7 ± 7.9
Gender	
Men	33 (55.0%)
Women	27 (45.0%)
Race	
White	51 (85.0%)
Non-white	9 (15.0%)
Marital status	
Married	37 (61.7%)
Not married	23 (38.3%)
Working status	
Working	21 (35.6%)
Not working	38 (64.4%)
Education, years	14.7 ± 2.9
BMI, weight (kg) / height (m^2)	30.4 ± 5.9

was allowed to greet subjects and make them at ease during testing. He or she was not allowed to ask about any spine or vascular symptoms and was discouraged from idle conversation that might result in unmasking. However, he or she could observe and ask about pain during testing and could provide reassurance or adjustment for pain.

Statistical Analysis. PASW Statistics 18 (SPSS Inc., Chicago, Illinois) was used for data analysis. A *t*-test for two-group comparisons and analysis of variance (ANOVA) for differences among 3 or more groups were used for continuous measures. A paired-sample *t*-test was used to compare ratings of observed and perceived pain by the observers. Chi-square tests were conducted to examine the relationship between categorical variables, for example, subjects' gender or race versus subject grouping. A Pearson correlation analysis was used to assess the relationship between 2 continuous variables. A *P*-value of <0.05 was considered significant in all analyses.

RESULTS

The population of the study comprised 60 persons, 55.0% men and 85.0% white with a mean age of 63.7 ± 7.9 years. The study included 3 groups of individuals: (1) asymptomatic community volunteers ($n = 25$; 41.7%), (2) patients who had a diagnosis of vascular claudication ($n = 7$; 11.7%), and (3) patients who were diagnosed to have neurogenic claudication ($n = 28$; 46.7%) (see Table 1).

Table 2 lists pain, psychological, functional, and quality of life variables. More detailed comparison between the 3 subject groups found no demographic differences except in education level ($F = 3.552$; $P = 0.036$), with asymptomatic volunteers being more educated than others. As expected, and not reported in detail here, highly significant ($P < 0.001$) differences between the diagnostic groups were found for the visual analog pain scale, McGill, Quebec, Tampa, Center for Epidemiological Studies Depression scale, Pain Disability Index, and all SF-36 categories except general health ($P = 0.018$) and general mental health ($P = 0.156$). More stenosis subjects (32.1%) had abnormal (greater than 4) paraspinal mapping electromyography scores than vascular (14.3%) or asymptomatic volunteers (16.7%), Despite the apparent sizable clinical difference in these groups, the association between the 2 groups and paraspinal mapping scores was not significant. Chi Squared value = 2.085, $P = 0.149$.

Table 3 lists the relationship between subject variables and pain. There was no relationship between volunteer status and pain. (Perceived pain $F = 0.816$, $P = 0.447$, observed pain $F = 0.038$, $P = 0.963$, ratio perceived/observed pain $F = 0.0991$, $P = 0.377$). Persons with normal strength on examination perceived but did not display more pain than others. This was not true of other objective neurological signs or of tenderness to palpation. No aspect of the vascular surgeon's examination related to observed or perceived pain.

Observers underrated the observed pain (3.17 ± 2.23) subjects experienced in comparison to the level of pain subjects reported (4.38 ± 2.01) on a 0–10 scale ($t = -4.577$, $df = 59$, $P < 0.001$). The pain ratio (calculated as observed pain/perceived pain) measured 0.78 ± 0.47, as displayed in Figure 1.

Table 4 analyzes variables that may contribute statistically to perceived pain. There was a

Table 2. Population pain, function, psychological and quality of life.

Parameter	All subjects (n = 60)
Pain variables	
Average weekly pain (visual analog in cm.)	2.7 ± 3.0
McGill total	15.1 ± 16.6
Quebec Back Pain Disability Scale	27.6 ± 26.5
Psychological characteristics	
Tampa somatic	10.0 ± 3.4
Tampa avoidance	16.9 ± 5.6
CESD Depression	8.5 ± 8.7
Functional status	
Pain Disability Index	16.6 ± 17.8
SF 36	
General Health	69.3 ± 18.8
Physical Functioning	57.2 ± 31.5
Social Functioning	80.0 ± 24.7
Role Limit.- Physical	54.7 ± 43.5
Role Limit.- Emotional	82.2 ± 33.2
General Mental Health	79.5 ± 16.7
Vitality (VT) Energy/Fatigue	59.6 ± 22.0
Bodily Pain	60.0 ± 28.1

Table 3. The relationship between clinical findings and pain variables.

	Perceived pain		Observed pain		Perceived pain / observed pain	
Clinical finding	Rating	*t*-test (*P*)*	Rating	*t*-test (*P*)*	Ratio	*t*-test (*P*)*
Neurogenic *N*=28	4.9 ± 2.0		3.3 ± 2.1		0.7 ± 0.4	3.518 (.001)
Vascular *N*=7	3.8 ± 2.2		3.1 ± 2.0		1.0 ± 0.7	0.738 (.244)
Asymptomatic *N*=25	4.2 ± 1.9		3.1 ± 2.5		0.7 ± 0.5	2.958 (.0035)
EMG (symptomatic side)						
Negative (*n*=45) (score < = 4)	4.3 ± 2.1	−0.532 (.597)	3.0 ± 2.0	−0.919 (.362)	0.8 ± 0.5	0.496 (.622)
Positive (*n*=14) (score > 4)	4.6 ± 1.7		3.6 ± 2.8		0.7 ± 0.5	
Neurosurgeon exam						
Strength						
Normal (*n*=49)	4.1 ± 1.9	−2.495 (.016)*	3.1 ± 2.2	−0.075 (.941)	0.8 ± 0.4	1.663 (.102)
Abnormal (*n*=5)	6.4 ± 2.1		3.2 ± 2.3		0.5 ± 0.2	
Reflex						
Normal (*n*=31)	4.1 ± 2.0	−0.810 (.421)	3.4 ± 2.5	−0.876 (.385)	0.9 ± 0.5	1.738 (.088)
Abnormal (*n*=23)	4.6 ± 2.1		2.8 ± 2.1		0.7 ± 0.3	
Great toe sensation						
Normal (*n*=53)	4.3 ± 2.1		3.1 ± 2.2	*	0.7 ± 0.4	*
Abnormal (*n*=1)	3.0		4.0		1.3	
Lumbar tenderness						
Normal (*n*=51)	4.3 ± 2.1	*	3.0 ± 2.1	*	0.8 ± 0.4	*
Abnormal (*n*=3)	4.7 ± 1.5		5.0 ± 3.6		1.0 ± 0.4	

**ANOVA test for all unless indicated otherwise.*

significant association between the perceived pain with the McGill Pain Index (r = .288, $P = 0.026$), Pain Disability Index (r = .314, $P = 0.014$), and Quebec Back Pain Disability Scale (r = .290, $P = 0.030$). The perceived pain however, was not found to be significantly ($P > 0.05$) related to age and duration of the problem, visual analog scale rating of the subjects' back and leg pain complaint, Tampa fear of movement / (re)injury, or Center for Epidemiologic Studies Depression Scale. Neither the perceived pain nor observed pain were found to be correlated with each of the 8 domains of the SF-36 (measuring physical functioning, role limitations due to physical health, bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems, and mental health).

DISCUSSION

This study provided a unique opportunity to understand pain perception and pain behavior in response to a controlled but realistic clinical stimulus. Although the study methodology has some limits, the findings may help electrodiagnosticians better understand their patients' experiences. The results also provide some information on pain behavior versus perception that may enlighten pain scientists.

One strength of the experimental design is the nature of the pain stimulus. The EDx was a real clinical experience in a real clinical setting. The testing, and thus the extent of tissue stimulation was highly standardized and rather extensive. Pain perception may have been affected by efforts of the electrodiagnosticians to comfort subjects, and this was not controlled. Likewise the observers, although trained research assistants, were not masked and were not clinicians. Thus, the results may not reflect how the EDx clinician would have rated the subjects' pain level. However, after spending some time with the subjects during other parts of the test, the observers were more personally familiar with the subjects than many EDx clinicians would be.

Previous literature informs us about the pain experience of persons who undergo EDx. However

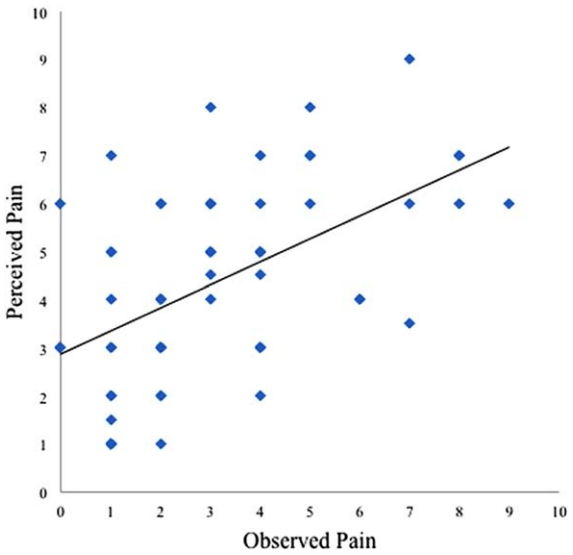

FIGURE 1. The relationship between perceived pain and observed pain behavior during EDx testing.

most of these studies did not standardize the stimulus (e.g., number and location of needle insertions). Very little previous work has compared observation of pain during testing to experienced pain.

One important exception includes a study which included some of the authors of the current study but involved a different population with different methods.[14] In that study, clinical EDx physicians who performed testing tended to overestimate patient pain and limited their testing when they perceived that the patient had greater pain. It is worthwhile to contrast these studies. In the other study, the EDx physician had a sense of responsibility to the patient. The amount of pain the patient experienced was linked directly to the EDx physician's actions, so a sense of empathy may lead to greater sensitivity to indications of patient pain than an observer. Neither the EDx physician nor the patient was blinded to the purpose of the study. Thus, the EDx physicians knew that the results of the study would reflect on their concern for their patients' well-being. Observers, on the other hand, have no reason to be dishonest, even subconsciously. Patients give both verbal and nonverbal clues that they are in pain, and EDx physicians may miss the nonverbal cues because their eyes are on the computer screen after the electrode is inserted. Observers, on the other hand, can watch and listen to the patient. Finally, EDx physicians are more experienced than observers in assessing pain. This experience may translate to a different interpretation of patient pain.

The result of this study showed that asymptomatic volunteers rated the extensive protocol as moderately painful (4.2 ± 1.9 cm on a visual analog pain scale). This information can be useful to ethical review boards and scientists as they weigh the risk-benefit ratio of EDx in research. Most studies would not be as extensive or painful as this one. The fact that the neurogenic and vascular claudication subjects (who undergo the test with a possibility of clinical consequences), experienced pain at the same level as asymptomatic volunteers supports further extrapolation of the pain levels of volunteers to those of people with disease. This may be helpful to scientists who study other painful procedures.

There was a significant relationship between subjects' perceived pain during EDx testing and their response to self-reported pain and disability during daily life and to psychosocial factors. It appears that people who rate their disease-related pain and disability higher also rate their test-related pain higher. One can speculate as to whether the disease state caused increased sensitivity to test-related pain, or whether these people are predisposed to be more sensitive to pain.

Because expectations of pain influence anxiety levels,[15,16] one might hypothesize that asymptomatic volunteers, with little personal stake in the results of the test, would have less pain. However volunteer status (asymptomatic, vascular claudication, or neurogenic claudication) did not relate to the level of perceived pain. Perhaps those who choose to participate in a study, whether symptomatic or asymptomatic, may differ in pain aversion or pain expression than others. More likely the experience and perception of research volunteers is not much different from that of patients.

There is a significant gap in pain ratings between the subjects' report and the observers' assessment. This revelation suggests that electrodiagnosticians may misunderstand and underestimate the pain their patients experience. Clinicians who understand that their patients may be suffering more than they think can take action.

The measurement of pain by nonclinician observers has positives and negatives that are not clearly delineated in the literature. In a Medline search of 460 articles gleaned through a search of "pain measurement" and "inter-observer measurement, we could find no article that compares the competency of clinicians versus unrelated untrained observers in rating the pain of other persons. Certainly it makes sense that mothers score their children's pain differently than clinicians.[17] There are also known biases among lay observers. For example, lay observers tend to rate the pain women experience as less than that experienced by men.[18] However, any assumption about the validity of observers versus trained physicians is not borne out in the literature that we could find. Possible assumptions might be that clinicians are more expert in interpreting pain behavior. Alternatively, clinicians may be hardened to the pain of patients, because they are exposed to so much pain compared with usual life experience. Clinicians may also be too busy during the procedure to notice pain behavior. It seems unlikely that nonclinician observers would be more calloused in their ratings of pain than clinicians. If that is true, then this methodology represents increased compassion compared with clinician observation. Even in this case, the observer under-rates pain compared with the patient.

These findings are consistent with the literature on patient and physician ratings of pain throughout the clinical interaction. Physicians underestimate the pain patients experience as a result of diseases ranging from gout to acute abdomen.[19] As in this study, they underestimate the pain patients experience in procedures including bone marrow

Table 4. Correlation of subjects' pain during EMG with demographic, self-reported pain, disability, functional, and psychological factors ($n = 60$).

	Observed pain / perceived pain		Observed pain		Perceived pain	
	R	*P*	*R*	*P*	*R*	*P*
Observed pain	.606†	.000				
Perceived pain	−.251	.053	.530†	.000		
Age, years	−.032	.811	−.097	.459	−.103	.433
Pain duration, years	−.080	.572	−.011	.938	.131	.356
Visual analog pain	.011	.935	.141	.308	.242	.077
McGill	.002	.988	.147	.263	.288*	.026
Pain Disability Index	−.053	.689	.115	.383	.314*	.014
Quebec Scale	−.153	.260	.036	.795	.290*	.030
Tampa Fear of Movement / (re)injury	.255	.095	.186	.226	.101	.515
CES-D‡	−.015	.909	.049	.718	.148	.271

Correlation is significant at the 0.05 level (2-tailed).

†*Correlation is significant at the 0.01 level (2-tailed).*

‡*Center for Epidemiologic Studies Depression Scale (CES-D), NIMH.*

biopsy and lymph node resection.[20–22] They overestimate the pain effect of treatments such as acupuncture by as much as 80%.[23]

Several studies over the last 50 years have suggested ways to make the EDx experience less uncomfortable. Ibuprofen reduces immediate perception of pain, but not memory of pain later.[24] Several studies have studied the contention that monopolar needles hurt less.[25,26] The needle technique used matters.[4] Topical anesthetics[27] and jet-injected lidocaine[28] have been shown to help, while acupuncture[29] has not. Behavior modification and relaxation techniques are thought to help.[30] Premedication can help, but it is not used frequently due to the long-term side-effects.[31]

Informed patients usually choose to complete this somewhat painful test in the hope that it will reveal useful information about their condition. However, clinicians who find patients are not comfortable during testing might try to make them more comfortable by providing reassurance, taking a break, or developing a strategy to minimize testing; the clinician should ask the patient rather than simply observing pain behavior.

An important limitation of this work is its linear, quantitative approach. This study and others that describe findings as means and standard deviations cannot accurately describe the myriad factors, often sequential rather than additive, that truly explain the pain experience of a patient. A more modern approach to methodology, action research methodology, can result in case-law logic in which experts outline certain factors that they believe relate to pain or pain relief and the steps taken to relieve pain in those circumstances. An increasingly complex model can be implemented as a checklist or flowchart. Where the model is believed to represent a sufficient percentage of experiences in the EDx lab it can be researched as a "black box" intervention to randomized controlled trials. It can be reproduced and taught. If subsequent research on pain in EDx is going to impact the pain experience of most patients meaningfully, it should examine the nonlinear logic that leads to these kinds of nonreductionist solutions

In conclusion, asymptomatic volunteers and persons with disease both experience moderate pain during this type of extensive EDx testing. The level of pain experienced is related to pain and disability they perceive from their disease. Observers appear to rate the pain of persons undergoing EDx lower than the persons being tested do. From a practical standpoint, EDx physicians should assume that patients experience more pain than they observe and use intelligent interventions to detect and manage pain.

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