Towards an Understanding of Chronic Pain Mechanisms:
The Use of Psychologic Tests and a Refined Differential Spinal Block

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Forty patients with chronic pain below the waist level were evaluated in a multidisciplinary pain clinic using a refined differential spinal block (DSB) technique. The refinements consisted of verbal instructions to prevent biasing the patients, coupled with a thorough evaluation of verbal and physiologic responses to the block. When demographic and psychologic data were assessed according to pain mechanisms, a pattern of patient groups emerged along a chronic pain continuum. Stress, anxiety, depression, and hysteria, as well as the neurophysiologic and demographic factors, modified the responses to the DSB. Long-term follow-up of these patients, including repeat DSB procedures and confirmatory anatomic blocks of sympathetic and somatic nerves, validated these impressions. The findings indicate a link between pain mechanisms and psychosocial factors that may directly influence responses to DSB. (Key words: Anesthetic techniques, regional: diagnostic, differential spinal. Pain: measurement.)

Previous studies 1–3 in which the differential spinal block (DSB) has been used to evaluate chronic pain have failed to specify 1) the criteria for selection of patients, 2) the verbal instructions to the patients prior to the block, 3) how the patients were to report increases or decreases in pain, and 4) what objective indicators of sensory or motor blockade were used. Our clinical experience suggests that each of these four aspects may influence how the patient responds to the DSB.

Therefore, we chose to study whether psychologic processes and demographic factors may influence the response to DSB. This study was part of a larger project designed to investigate neurophysiologic and psychosocial factors affecting responses of chronic pain to acupuncture. 4,5 In the present paper, we describe how demographic and psychologic variables influence responses to DSB in patients having psychogenic, sympathetic, somatic and central pain.

Method

The subjects were 40 patients between the ages of 21 and 78 years from the Multidisciplinary Pain Clinic at the University of North Carolina Medical Center. Subjects were drawn from a population of all the patients who were first admitted to the Pain Clinic between October 1974 and January 1975. All patients had primary complaints of pain below the waist. These complaints included backache, pelvic, flank, and extremity pains. 4 In many of the cases, previous medical, psychiatric, or surgical treatment had failed to provide permanent relief from the pain.

At least a third of the patients appeared to have abused medical resources (e.g., excessive physician contacts, nonproductive diagnostic and surgical procedures, and excessive use of analgesics and narcotics). In addition, evaluation by the referring physician, the consulting specialists, and the Pain Clinic staff all failed to indicate a discrete organic or psychophysio logic etiology for the pain.

Patients who had cardiovascular disease, progressive degenerative central nervous system disease, and extensive neurologic deficits were excluded from the study, as were patients with histories of chronic headache, blood dyscrasias, and allergic reactions to procaine. Also eliminated from the study were patients who had severe arachnoiditis and those receiving anticoagulant therapy.

In all phases of the study, subjects were seen as outpatients. Each patient received a medical, psychologic and neurologic evaluation, and a record was kept of the demographic and pain characteristics. The number of major surgical procedures performed within the five years preceding the first visit to the Pain Clinic was recorded. A surgical procedure was considered major when it necessitated hospitalization and general or regional anesthesia (other than local infiltration block). Based on the overall impression of the findings of the referring specialist, the radiologist, and the Multidisciplinary Pain Clinic consultants, the severity of neurologic and radiologic conditions was graded on a one-to-four scale for each type.

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of pain disorder observed in the patients. For example, severity of neurologic findings in a patient with signs and symptoms suggesting degenerative disc disease was rated on the combined evaluation of leg-raising tests, sensory and motor findings, and presence, absence, or diminution of deep reflexes in the inferior extremities.

Prior to the DSB all patients were asked to complete six psychologic tests. The Minnesota Multiphasic Personality Inventory (M.M.P.I.) was used as a comprehensive method of evaluating ten personality characteristics. The Spielberger State–Trait Anxiety Inventory measured the patient's routine anxiety level, as well as the level of anxiety at the time the patient took the test. The Zung Depression Inventory measured the level of depression. The Rotter's Scale was used to determine whether the patients perceived whether their behavior was determined by internal control or external influences. The Melzack Pain Language Questionnaire measured qualitative and quantitative aspects of the pain experience. The Holmes and Rahe Schedule of Recent Events (Social Readjustment Rating Scale) measured the recent stressful events that might have increased the pain experience. References to the techniques for administering these tests are given in previous publications.

The patients were instructed not to eat or drink for at least six hours prior to the test, and not to take any analgesics, tranquilizers, or sedatives in the 24 hours preceding the procedure. Prior to the study all patients were asked to make a subjective global estimate of their pain levels. The subjective global estimate was compared with the baseline level obtained during the earlier clinic visit. When a patient was without pain or had only slight pain at the time of the DSB testing, we attempted to elicit pain through minor mechanical manipulations of the affected area. When these maneuvers failed to elicit and sustain pain, the test was postponed. Also, the patient's previous experience with spinal anesthetics, myelograms, or other nerve blocks was noted, in order to detect any psychologic biases towards the testing procedure that might exist.

After informing the patients of the procedure and associated risks, their informed consent was obtained before testing proceeded. We emphasized that the DSB was not a therapeutic maneuver but merely a test procedure. In order to minimize the patients' bias in their self-reports, they were not told at the onset how many medications would be injected. In addition, it was suggested that the patient might have a full range of feelings in response to each injection. They were told that "your pain may get better, stay the same, or may get worse following injection of any medication." The instructions specifically avoided using such terms as "local anesthetic solution" or "Novocain" to prohibit the association of numbness with pain relief.

All patients were brought unpremedicated to the operating room, where resuscitation equipment was available. Each patient received intravenous fluids, and vital signs were monitored routinely every 5 min. We used a modified version of the DSB technique of Winnie and Collins. A lumbar puncture was accomplished with a 22- or 25-gauge spinal needle. After positioning the needle to obtain a free flow of cerebrospinal fluid (CSF), 5 ml of 1) physiologic saline solution, 2) procaine, 0.25 per cent, 3) procaine, 0.5 per cent, and 4) procaine, 1 per cent were injected through a Millex disposable filter at 10-min intervals. The procedure was stopped when pain was blocked. Thus, each subject received one to four injections during block evaluation.

Approximately 10 min after each injection and immediately prior to the next injection, the following objective and subjective information was obtained.

1) Pain rating: The patient's subjective pain level was recorded graphically. Prior to any injection, the pain was said to be 100 per cent—the baseline pain level. Any change in pain intensity following each injection was recorded on a scale ranging from 0 to 200, with "0" representing no pain, "100" the baseline pain level, and "200" a doubling of experienced pain.

2) Neurophysiologic responses: Sympathetic function was evaluated by measuring skin temperature under standardized conditions. Color changes, flushing, condition of the skin (dry or moist), vasodilatation, determination of venous filling time, and any subjective feelings of warmth by the patient were recorded. Neurosensory tests of the detection threshold for noxious stimuli in the region of pain complaint were performed using a pin mounted on a spring-loaded pressure gauge. From the force applied on the pin, the ability to discriminate the stimulus as "sharp" was determined at random in both anesthetized and unanesthetized areas. The difference in force applied from the baseline level was used as an indicator of sensory block. Motor function was assessed by noting the onset of motor paralysis in individual muscle groups, as well as the subjective experience upon movement of the painful part following each injection. Inability to straighten the legs while in a lateral position was considered evidence of motor block.

3) Behavior: Notations were also made of the patient's behavior that suggested anxiety, indecisiveness, depression, mood swings, and manipulativeness.

\[\text{Millipore Corporation, Bedford, Massachusetts.}\]
These behavioral responses and changes in the subjective pain experience were compared with the objective signs of sympathetic, sensory, or motor blocks. Medical complications, the extent and duration of pain relief, and the demand for sedatives, tranquilizers, and narcotics were also recorded.

Following DSB, the patient was observed in the recovery room until motor function was completely regained and vital signs stabilized to the pre-test level. The patient was then discharged from the recovery room.

The data collected were stored and analyzed by the Statistical Analysis System (SAS) implemented in the I.B.M. 360 computer at the University of North Carolina at Chapel Hill Computation Center. Multiple t tests were used in making comparisons of psychologic findings across various patient groups based on the DSB results.

Results

The patient's responses to the block were grouped into one of four mechanisms**: psychogenic, sympathetic, somatic, and central. Five patients reported complete or almost complete long-lasting relief of pain following an injection of isotonic saline solution (5 ml). This was interpreted as an indication of psychogenic mechanisms that controlled the pain. Sixteen patients reported complete or near complete relief of pain concurrently with the onset of sympathetic block without sensory loss. Nine patients reported complete or near complete relief of pain with the sensory or motor block. The pain in these patients was interpreted to be due to peripheral somatic disorder. Ten patients reported no relief of pain despite sensory and motor blockade with procaine, 1 per cent. The pain was interpreted to be "central" in these patients.

Patients who had psychogenic (and central) pain reported significantly more concern for bodily function, i.e., higher scores on the M.M.P.I. Scale 3, or the Hysteria Scale (table 2). Also, the psychogenic group endorsed more acute anxiety items on Spielberger's State-Trait Inventory than groups of subjects with sympathetic and central pain mechanisms (table 2).

The average clinical deficits for all the groups were equivalent. However, subjects who had sympathetic pain mechanisms had a significantly greater number of positive radiologic finding than those with the other types of pain mechanisms (table 1). These patients reported that they had significantly less obsessive thoughts and compulsive behaviors as evidenced by a lower score on the Psychasthenia Scale (M.M.P.I. Scale 7) than the other DSB groups. A comparison of psychosocial variables showed a trend for patients with sympathetic pain mechanisms to be less depressed than those with the other types of pain mechanisms (table 2). On the Melzack Pain Language Questionnaire, subjects who had sympathetic pain mechanisms endorsed fewer descriptors of their pain than any of the other pain mechanism groups. Also, patients who had sympathetic pain mechanisms 1) had few non-pain-related major surgical procedures, 2) had lower scores on the Psychopathic Deviate Scale (M.M.P.I. Scale 4), 3) endorsed lower levels of acute anxiety, and, finally, 4) had less frequent experiences of life stresses on the Psychosocial Stress Measure and the Social Readjustment Rating Scale, only when these comparisons were made using the combined score of patients with the other pain mechanisms (table 3).
Table 2. Means of Affective/Personality Measures in Various DSB Groups

<table>
<thead>
<tr>
<th></th>
<th>Psychogenic</th>
<th>Sympathetic</th>
<th>Somatic</th>
<th>Central</th>
<th>Combined Psychogenic, Somatic and Central</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMPI scales yielding significant values</td>
<td>(n = 5)</td>
<td>(n = 16)</td>
<td>(n = 9)</td>
<td>(n = 9)</td>
<td>(n = 23)</td>
</tr>
<tr>
<td>Scale 3</td>
<td>34 ± 6†</td>
<td>27 ± 6</td>
<td>27 ± 7</td>
<td>32 ± 5†</td>
<td>31 ± 6</td>
</tr>
<tr>
<td>Scale 4</td>
<td>26 ± 5</td>
<td>20 ± 7</td>
<td>25 ± 5</td>
<td>22 ± 3</td>
<td>24 ± 4†</td>
</tr>
<tr>
<td>Scale 7</td>
<td>33 ± 4</td>
<td>27 ± 8†</td>
<td>34 ± 5</td>
<td>31 ± 4</td>
<td>33 ± 5†</td>
</tr>
<tr>
<td>Zung Depression Inventory</td>
<td>(n = 1)</td>
<td>(n = 9)</td>
<td>(n = 9)</td>
<td>(n = 6)</td>
<td>(n = 12)</td>
</tr>
<tr>
<td></td>
<td>65 ± 0</td>
<td>45 ± 12</td>
<td>59 ± 4</td>
<td>53 ± 10</td>
<td>56 ± 8†</td>
</tr>
<tr>
<td>Internal–External Locus of Control Scale</td>
<td>(n = 4)</td>
<td>(n = 15)</td>
<td>(n = 8)</td>
<td>(n = 9)</td>
<td>(n = 21)</td>
</tr>
<tr>
<td></td>
<td>7 ± 6</td>
<td>8 ± 5</td>
<td>10 ± 4</td>
<td>7 ± 5</td>
<td>8 ± 5</td>
</tr>
<tr>
<td>State–Trait Anxiety Inventory</td>
<td>(n = 5)</td>
<td>(n = 9)</td>
<td>(n = 4)</td>
<td>(n = 7)</td>
<td>(n = 14)</td>
</tr>
<tr>
<td>State anxiety</td>
<td>60 ± 4†</td>
<td>40 ± 9</td>
<td>56 ± 6†</td>
<td>46 ± 14</td>
<td>51 ± 12†</td>
</tr>
<tr>
<td>Trait anxiety</td>
<td>(n = 5)</td>
<td>(n = 9)</td>
<td>(n = 4)</td>
<td>(n = 7)</td>
<td>(n = 14)</td>
</tr>
<tr>
<td></td>
<td>54 ± 17</td>
<td>43 ± 11</td>
<td>50 ± 6</td>
<td>41 ± 9</td>
<td>46 ± 11</td>
</tr>
<tr>
<td>Meltz score</td>
<td>(n = 2)</td>
<td>(n = 7)</td>
<td>(n = 4)</td>
<td>(n = 6)</td>
<td>(n = 12)</td>
</tr>
<tr>
<td>Raw score</td>
<td>10 ± 6</td>
<td>4 ± 3</td>
<td>9 ± 4</td>
<td>6 ± 3</td>
<td>8 ± 4†</td>
</tr>
</tbody>
</table>

* All scores "rounded off" to nearest whole number.
† P < 0.05.

Patients who had somatic pain were significantly younger, and although the number of pain-related major surgical procedures appeared to be higher for this group, this difference was not statistically significant. Subjects who had somatic pain mechanisms and psychogenic pain mechanisms endorsed more acute anxiety items on the Spielberger State–Trait Anxiety Inventory than those with sympathetic and central pain mechanisms.

Patients who had central pain were older than patients who were shown to have the other pain mechanisms, but this trend was not statistically significant. Also, patients with central pain reported a trend toward a longer duration of pain than the other groups. Comparisons of the scores of patients with different pain mechanisms on the M.M.P.I. Scales revealed that the patients who had central and psychogenic pain ranked higher than the patients with sympathetic and somatic pain on the Hystera Scale (M.M.P.I. Scale 3).

Frequently, the role of the psychologic component of chronic pain does not become apparent until the behavioral evaluation of the patients is analyzed. Material obtained from interview and observation of the patient during the procedure suggests that patients who had psychogenic, somatic, and central pain were more anxious, appeared to want more sympathy and attention, and were somatically more preoccupied than patients who had sympathetic pain.

Ten patients who had central pain did not derive any relief, and seven actually reported increases in pain following neural blockade, despite objective evidence that the anatomic and skeletal muscle disturbances were eliminated. Two patients from this group reported pain levels of 150, and two others requested that the procedure be stopped because of high pain levels above 200 (i.e., the pain intensity was more than doubled). When all four patients were blindfolded they were unable to localize their pain by pointing; however, they all described specific body areas where

Table 3. Mean Scores of Stress Measures.* Social Readjustment Rating Scale

<table>
<thead>
<tr>
<th></th>
<th>Psychogenic</th>
<th>Sympathetic</th>
<th>Somatic</th>
<th>General</th>
<th>Combined Psychogenic, Somatic and Central</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total events</td>
<td>(n = 4)</td>
<td>(n = 15)</td>
<td>(n = 8)</td>
<td>(n = 9)</td>
<td>(n = 21)</td>
</tr>
<tr>
<td></td>
<td>14 ± 7</td>
<td>11 ± 3</td>
<td>11 ± 3</td>
<td>12 ± 6</td>
<td>12 ± 5</td>
</tr>
<tr>
<td>Weighted frequency†</td>
<td>(n = 3)</td>
<td>(n = 14)</td>
<td>(n = 8)</td>
<td>(n = 7)</td>
<td>(n = 18)</td>
</tr>
<tr>
<td></td>
<td>202 ± 250</td>
<td>54 ± 45</td>
<td>123 ± 10</td>
<td>239 ± 300</td>
<td>181 ± 232‡</td>
</tr>
</tbody>
</table>

* All scores "rounded off" to nearest whole number.
† Weight of an item where yes is marked more than once x frequency.
‡ P < 0.05.
they were "hurting." A strong suggestion that their pain was to be removed by procaine, followed by actual injection of physiologic saline solution into these "painful" areas, resulted in complete pain relief in one patient and only partial relief in the others.

The three other patients with central pain mechanisms who reported increases in pain upon completion of all injections in this study received an additional DSB to confirm the results. The repeat procedure was performed in a technically identical manner except for the instructions. Instead of using the controlled, non-biasing approach, patients were given strong suggestions of pain relief such as "After performing a spinal tap on you, I am going to inject four medications, one by one, at 10-minute intervals, and I would like you to tell me which one relieves your pain." Each patient admitted complete relief after procaine, 1 per cent, was injected.

Using the unbiased verbal instructions we were able to reproduce the results of the DSB later in four subjects who had sympathetic pain and two subjects who had somatic pain. However, the reports of pain relief varied in three subjects with psychogenic pain. Two had another placebo response when the procedure was repeated, and one had complete relief at procaine, 1 per cent, concurrent with sensory and motor block.

**Discussion**

The results of the present study indicate that patients who have different pain mechanisms have different patterns of personality traits. These data are taken from a relatively small number of subjects per pain mechanism, and the findings should be considered tentative. However, they do tend to confirm our clinical impression and Sternbach’s opinion that the longer a patient has pain, the more the psychologic factors become important in influencing the neurophysiologic mechanism underlying pain behavior. Thus, the responses of patients with central pain mechanisms, for example, might be explained in part because they had had pain longer (52 versus 23 months) than patients with sympathetic pain mechanisms. The former group also appeared to be somewhat older than patients in the other groups.

M.M.P.I. data revealed that patients with psychogenic, somatic and central pain mechanisms are more likely to exaggerate and amplify somatic complaints while they deny emotional distress. In addition, the clinical impression suggests that patients in these groups are worriers and brooders and are likely to have difficulty in making decisions in general. The same patients also endorsed a greater mean number of adjectives to describe their pain despite less radiologic evidence of morbidity. Such an endorsement, then, probably reflects the more generalized characteristics of pain in these groups, coupled with the need to verbalize their experience with greater detail. This may well reflect the patient's increasing preoccupation with the subtleties and nuances of the pain the longer they experience pain.

The greater reported psychologic distress and discomfort in patients with psychogenic, somatic and central pain mechanisms are reflected in their higher scores on the anxiety and depression measures (State-Trait Anxiety Inventory, Zung Depression Scale). Patients who had less chronic (somatic) pain tended to report greater levels of anxiety and depression, and patients with more chronic central pain tended to attribute the source of distress and dissatisfaction to environmental stress, as reflected in the latter group's trend toward higher scores on the Social Readjustment Scale.

The placebo responses on the DSB and the lack of any effect of the analgesics in patients with central pain may be accounted for in learning terms. The report of pain could be considered a form of social communication, tied to the environmental consequences the report elicits. The placebo responders may be responding to their expectation that any medication may influence the pain, as well as a desire to please the physician and demonstrate that the patient is cooperative. The patient who has central pain mechanisms may be responding in such a way as to impress the physician that he or she is experiencing considerable pain, and in need of medication.

We therefore recommend a comprehensive behavioral evaluation of each patient during a DSB. Patients should be evaluated first in accordance with the objective neurophysiologic changes produced by the injection of the local anesthetics. Patients should then be evaluated by a series of objective psychologic tests, which highlight longstanding psychologic traits. Finally, patients should also be evaluated in light of their current psychologic "needs," such as the need to impress the physician or the need to acquire certain types of medication, such as sedatives, tranquilizers and narcotics. We should also note that the DSB as described here (with ambiguous instructions about how patients should behave) generally provides a good sample of how patients respond to stressful situations in their natural environments.

Thus, a global evaluation integrates psychologic traits and environmental factors, as well as the usual "organic" or physical causes of suffering, and a pattern of patient groups appeared to emerge along a chronic pain continuum. Should a correlation be validated using a larger population of subjects, it would be of
paramount clinical value accurately to use psychologic tests to reinforce and substantiate the diagnosis established by the DSB. In addition, the global evaluation provided an opportunity to study the role of learned behavior in each chronic pain patient and suggested that the psychologic component commonly seen in various chronic pain states may be one of the most important variables affecting the results of the DSB.

This study confirms the view expressed by others that DSB is a safe diagnostic procedure. In this study, four patients experienced post-spinal headaches lasting one to five days, which required simple medical management. There was no case of a delayed headache. Immediately following the spinal tap, two patients from the somatic pain group and eight patients from the central pain group had tension headaches, and usually needed mild analgesics. The headaches of these patients lacked the classic characteristics of the spinal headache.

Although the differential blocking of nerves was observed to proceed in a manner related to fiber size, beginning with the smallest and proceeding to the largest, an absolute relationship between fiber size and anesthetic concentration does not exist. In practice, the concept generally holds and can be useful in spite of difficulties in interpretation. We would like to stress that in our experiences it is safest to proceed under the assumption that a modality must be completely blocked in order to attribute the conduction of pain to the subservient nerve fiber, regardless of what concentration achieves that blockade.

The accuracy of the standard DSB technique was increased by refinements in the pinprick test. Evaluation of sensory function in the present study was more objective because sensory loss was determined by comparison of sharpness over a wide range of body area, not only the painful area, using a quantitative method.

It is important to mention that the results of the refined DSB can also be used therapeutically. A demonstration of pain relief by placebo or persistence of pain despite analgesic levels can be important information to the patient. However, this information must be presented in a nonthreatening manner. For example, these findings can help convince the patients of both their control over the pain complaint and the lack of benefit from somatically oriented therapy. The visual representation of pain as suggested in the present method enables patients to express their feelings more clearly, as well as clarifying to medical students how the technique can be used.††

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References