Does a Paresthesia During Spinal Needle Insertion Indicate Intrathecal Needle Placement?

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Background and Objectives: Paresthesias are relatively common during spinal needle insertion, however, the clinical significance of the paresthesia is unknown. A paresthesia may result from needle-to-nerve contact with a spinal nerve in the epidural space, or, with far lateral needle placement, may result from contact with a spinal nerve within the intervertebral foramen. However, it is also possible and perhaps more likely, that paresthesias occur when the spinal needle contacts a spinal nerve root within the subarachnoid space. This study was designed to test this latter hypothesis.

Methods: Patients (n = 104) scheduled for surgery under spinal anesthesia were observed during spinal needle insertion. If a paresthesia occurred, the needle was fixed in place and the stylet removed to observe whether cerebrospinal fluid (CSF) flowed from the hub. The presence of CSF was considered proof that the needle had entered the subarachnoid space.

Results: Paresthesias occurred in 14/103 (13.6%) of patients; 1 patient experienced a paresthesia twice. All paresthesias were transient. Following a paresthesia, CSF was observed in the needle hub 86.7% (13/15) of the time.

Conclusions: Our data suggest that the majority of transient paresthesias occur when the spinal needle enters the subarachnoid space and contacts a spinal nerve root. Therefore, when transient paresthesias occur during spinal needle placement it is appropriate to stop and assess for the presence of CSF in the needle hub, rather than withdraw and redirect the spinal needle away from the side of the paresthesia as some authors have suggested.

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During attempts to insert a spinal needle into the subarachnoid space, patients occasionally experience paresthesias with a reported frequency ranging from 6.3% to 20%.[1–3] Although the etiology of paresthesias has not been precisely determined, the widely held conventional wisdom is that they result from needle-to-nerve contact. An important related, but heretofore unstudied, question is: where is the spinal needle tip when a paresthesia occurs?

Some anesthesiologists believe paresthesias occur when the needle contacts a spinal nerve within the epidural space or the intervertebral foramen and as such indicates that the spinal needle is laterally misdirected. In fact, several authors advocate withdrawing the spinal needle and redirecting it away from the side where the paresthesia occurred.[3–5] However, there is an alternative explanation for paresthesias, namely that they occur as the spinal needle enters the subarachnoid space and contacts one of the components of the cauda equina that are tightly packed into the lumbar subarachnoid space (Fig 1). In this scenario, a paresthesia would indicate that the needle tip is actually within the subarachnoid space.

Unfortunately there are no data to tell us which of these hypotheses is correct. Thus, we are left wondering how we should respond to paresthesias when they occur in our clinical practice. Consequently, we designed this study to determine how frequently a paresthesia indicates that the spinal needle tip is actually located in the subarachnoid space.

METHODS

This prospective, observational study was approved by the Virginia Mason Medical Center Institutional Review Board, and was exempted from informed consent. The number of subjects to be studied was chosen based on previous prospective studies indicating that the incidence of paresthesia during spinal needle insertion ranges between 8.5% and 20%. Thus, we anticipated that enrolling 100 subjects would yield approximately 14 paresthesias, which we judged was a sufficient number to assess whether paresthesia is frequently or infrequently associated with the spinal needle tip being in the subarachnoid space. In the end, 104 subjects were studied because of delayed return of some data collection forms.

All patients greater than 18 years old who were to receive a spinal anesthetic were considered for this study. The decision to have spinal anesthesia was made by the patient in consultation with the attending anesthesiologist. All aspects of the subarachnoid block (e.g., patient position, local anesthetic choice, amount of sedation, etc.) were left to the discretion of the attending anesthesiologist. All needles were "pencil-point" tip design (approximately 98% were 25-gauge Whitacre spinal needles [Arrow International, Reading, PA], the remainder were 22-gauge Gertie Marx spinal needles [IMD, Huntsville, UT]). Because of the concern that heavy procedural sedation might impair a patient's ability to either sense or to report a paresthesia, patients who were "overly" sedated were prospectively excluded from the study. The level of sedation was assessed by asking the patient, "How are you doing?" in a normal voice immediately before placement of the spinal needle. Failure to answer or responding with an unintelligible or inappropriate answer resulted in exclusion from the study prior to spinal needle insertion.

To maximize patient capture and to ensure accurate and uniform data collection, all members of our department were educated about the study (e.g., eligibility requirements, sedation assessment, data to be collected, etc.). Data collection sheets were taped to each spinal anesthesia kit to serve as a prompt for patient "enrollment" and data collection. The data collection form included labeled spaces for recording age, gender, weight,

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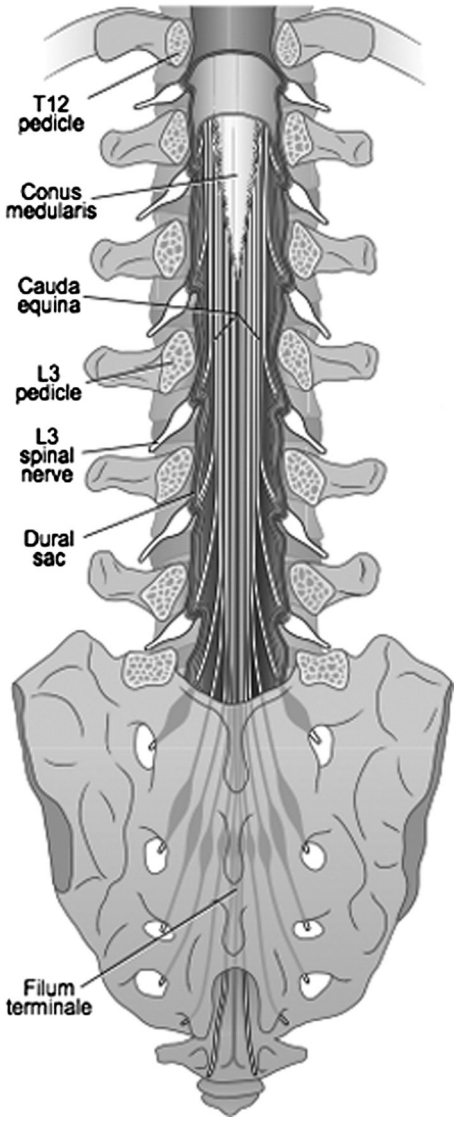

FIGURE 1. Diagram of the nerve roots of the cauda equina in the lumbar subarachnoid space demonstrating the lateral dural reflections surrounding the spinal nerves just medial to the intervertebral foramina.

height, local anesthetic used, presence or absence of a paresthesia, location of paresthesia, interspace used, presence or absence of cerebrospinal fluid (CSF) after paresthesia, and presence or absence of a discernable spinal block. In addition to data entry, the data collection forms provided a description of the sedation assessment requirements, and the definition of a paresthesia. For the purposes of this study, a paresthesia was defined as an electric, shooting or burning sensation, or pain felt in the leg, buttocks, or perineum. Pain or other sensation in the back was not considered a paresthesia.

Prior to beginning the block, the patient was told to let the person placing the needle know if they had any pain or unpleasant sensation during the procedure. Any time that the patient stated that they had pain or an unpleasant sensation, or if they suddenly jumped or vocalized, the person placing the needle immediately stopped advancing the needle and asked the patient to describe the sensation they experienced. If the pain met the criteria for a paresthesia, the needle's stylet was removed and the hub observed for free flow of CSF. If CSF was observed, the local anesthetic was injected and the study ended. If CSF was not evident after paresthesia, the needle was withdrawn and redirected while continuing to observe for paresthesias and CSF.

After performing the block, the attending anesthesiologist, resident, or nurse anesthetist filled out the data collection sheet and turned it in. Postoperative follow-up for inpatients was by the attending anesthesiologist, resident, or nurse anesthetist, and for outpatients by a telephone call from a recovery room nurse. Both follow-up methods are routine at our institution—even if patients are not part of a study.

We did not specifically track the local anesthetic used because it was not relevant to our study question. However, in excess of 90% of spinal anesthetics at our institution are performed with bupivacaine or chloroprocaine.

Differences between the paresthesia and nonparesthesia groups were analyzed for statistical significance using Student's unpaired t test (age, height, weight) and χ^2 test (interspace used, male:female ratio). For the analysis of the interspace used, χ^2 was initially performed on the entire data set using a 2×5 contingency table. The overall P value for this analysis was .0099, demonstrating a significant difference in the distribution of interspaces used between those with and those without a paresthesia. To determine where the differences were, we then performed posthoc pairwise comparisons using χ^2. Differences were considered statistically significant if $P < 0.05$.

RESULTS

104 subjects were studied. One record was excluded due to inadequate data. Of the 103 patients remaining, 14 patients reported 15 paresthesias (1 patient experienced 2 paresthesias; the first without, and the second with CSF flow), for an incidence of 13.6%. After removal of the stylet, CSF was observed in the needle hub in 13 of the 15 (86.7%) paresthesias. Subsequent injection of local anesthetic produced a successful spinal block in all subjects.

No patient experienced pain on injection. All patients developed spinal anesthesia; there were no patchy blocks. No patient complained of neurological symptoms at follow-up.

TABLE 1. Demographic Data

Parameter	Group		
	Subjects Without Paresthesia	Subjects With Paresthesia	All Subjects
n	89	14	103
Age (y)	65 ± 13	62 ± 15	62 ± 15
Height (cm)	166 ± 6	171 ± 11	170 ± 11
Weight (kg)	83 ± 15	82 ± 21	82 ± 20
Gender, M:F	43:46	7:7	50:53
Interspace, n (%)			
L1–2	2(2)	0	2(2)
L2–3	41(46)	5(36)	47
L3–4	29(33)	4(27)	33
L4–5	15(17)	3(20)	18
L5-S1	0	2(13)*	2
Unk	1(1)	0	1

NOTE. Data are mean ± SD except where otherwise noted.
F indicates female; M, male; Unk, unknown.
*$P < 0.05$.

There were no significant differences between the group that experienced paresthesias and the group that did not with regard to gender, age, weight, or height (Table 1). The paresthesia group had a higher incidence of needle insertion at the L5-S1 interspace ($P = .02$), although this interspace was used for only 2 of the 14 spinal needle insertions in the paresthesia group (Table 1). There was no difference between the groups in the frequency with which the other interspaces were used. Interestingly, 82% of all paresthesias occurred on the left side, and 83% of all paresthesias occurred in the legs.

DISCUSSION

We observed a 13.6% incidence of paresthesias during spinal needle placement. We chose a common and clinically applicable definition of a paresthesia that required any abnormal sensation or pain to have "neural" quality (ie, radiating, electric, burning) before considering it to be a paresthesia. This definition was an attempt to prevent other causes of pain during spinal needle insertion (e.g., periosteal contact, dural contact) from being considered paresthesias. The fact that the incidence of paresthesia in our study falls between values reported in earlier prospective studies by Knowles[6] (8.5%) and Tetzlaff[3] (20%) gives us confidence that our definition was appropriate.

The overwhelming majority of paresthesias were associated with the free flow of CSF when the stylet was removed, thereby indicating that the needle tip was within the subarachnoid space. Although the etiology of the paresthesias that occurred in this group cannot be proved by our study, the data are most consistent with the spinal needle contacting one of the spinal nerve roots comprising the cauda equina as it entered the subarachnoid space. In fact, given how tightly the spinal nerve roots comprising the cauda equina are packed into the subarachnoid space,[7] it is perhaps surprising that paresthesias do not occur more often. Importantly, it does not actually matter what caused the sensations we defined as paresthesias; the relation to free flow of CSF is independent of mechanism.

The etiology of the 2 paresthesias not associated with free flowing CSF is less clear. It is possible that the needle tip was in the subarachnoid space but that the aperture on the side of the Whitacre needle was not. It is also possible that the aperture was in the subarachnoid space but that it was covered, ie, occluded, by a spinal nerve root, or that the person placing the spinal needle did not wait a sufficient time for CSF to appear at the hub. Finally, it is also possible that the needle tip was off the midline and had contacted a spinal nerve outside of the subarachnoid space, e.g., epidural space, or intervertebral foramen.

An interesting and unexplained observation was that the majority of paresthesias occurred on the left side. We suspect that this may be related to patient position (ie, left vs. right side down) and effects that patient position may have on the position of the spinal cord/spinal nerve roots in the subarachnoid space. In turn, patient position may be biased because most people (patients and clinicians) are right-handed. However, because we did not track patient position, our data do not directly address this potential explanation.

Our observation of a statistically significant higher incidence of the L5-S1 interspace being used in patients who had paresthesias is of unknown significance, and given the small number of subjects involved (n = 2) it is premature to suggest a clinically relevant association.

Our study was neither designed nor powered to determine whether there is a relationship between paresthesias and neurological injury during spinal needle insertion. However, multiple studies have attempted to determine whether there is such a link, and our data can add to that ongoing discussion but should not be considered in any way definitive for the reasons noted above. Not 1 patient, with or without a paresthesia, reported neurological injury in our study. Given that the true incidence of an undetected event can be as large as 3/n (where "n" is the number of subjects),[8] our data would suggest that even if there is a relationship between paresthesias and neurological injury, one would expect fewer than 20% of paresthesias (3 out of 15) to be associated with injury; which does not preclude the possibility of no relationship between paresthesia and injury. This interpretation is consistent with a large retrospective study by Horlocker et al. who identified 298 paresthesias in 4,767 patients undergoing spinal anesthesia.[2] Of these 298 patients, only 6 (2%) reported persistent neurological injury after block resolution and 4 of these resolved within 1 week.

Unfortunately, the issue of the relationship between paresthesia and neurological injury cannot be adequately assessed from any of the currently available studies either because they are too small,[3] retrospective,[2,9] rely on volunteer reporting,[1] or include all of the unaccounted biases involved in the medicolegal system.[9] In fact, an appropriate study design would require that a group of patients who experience a paresthesia during spinal needle insertion not undergo the planned spinal anesthetic/surgery so that it can be determined whether it is the paresthesia per se that is related to neurological injury or some other aspect of the subsequent anesthetic/surgery.

This is not to suggest that paresthesias are necessarily trivial or that they should be ignored. Importantly, we treated paresthesias as if they might herald neurological injury and immediately stopped advancing the spinal needle when a paresthesia occurred. In all cases the paresthesia resolved immediately, and in the overwhelming majority of cases the paresthesia indicated that the needle tip was in the subarachnoid space. In no case did local anesthetic injection produce a paresthesia. In the event that a paresthesia persisted after spinal needle movement stopped, we would advocate prompt removal of the needle for fear that it was impinging a nerve. Too, if a paresthesia recurred during local anesthetic injection, we would recommend that injection cease and that the needle be removed in case the injection was being made into a neural structure.

A potentially important implication of our study with respect to neurological injury is that there may be a fixed background incidence of paresthesias that will occur regardless of technique. That is, our data suggest that the majority of paresthesias occur when the spinal needle enters the subarachnoid space, probably because of contact with elements of the cauda equina that are tightly packed into this small space. If there is any causal relationship between paresthesias and neurological injury, it may be impossible to reduce the incidence to 0 because it is difficult to envision how one could alter technique so as to avoid these paresthesias.

In summary, this is the first study to examine the relationship between paresthesias during attempted spinal needle insertion and location of the spinal needle's tip. Using our definition of a paresthesia as a burning, shooting, or electric sensation/pain in the leg, buttocks, or perineum, our data indicate that paresthesias during spinal needle insertion generally indicate that the spinal needle is in the subarachnoid space and that stylet removal will usually result in free flowing CSF, thereby confirming intrathecal needle placement. Routine withdrawal and redirection of the spinal needle away from the side where the paresthesia occurred, as is sometimes taught, is unnecessary. In fact, "blindly" removing the needle following a transient paresthesia and reinserting it may be harmful, because

it will necessarily increase the number of needle passes required, and potentially the number of holes made in the spinal meninges, which may increase back pain and the risk of postspinal headache. Whether proceeding with spinal anesthesia after a transient paresthesia and identification of free flowing CSF in the needle hub places the patient at any increased risk of neurological injury was not the subject of this study, and the sample size and study design are inadequate to draw firm conclusions regarding this issue.

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Drs. Pong and Gmelch contributed equally to this study and both deserve recognition as first author. All work was performed at Virginia Mason Medical Center.

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