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ASSESSMENT: PREVENTION OF POST-LUMBAR PUNCTURE HEADACHES

Report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology

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Headache (HA) is a common sequel to lumbar puncture (LP), whether performed for diagnosis or anesthesia.¹⁻⁶ In their monograph summarizing the world literature through 1960, Tourtellotte et al.¹ considered separately three principal patient populations: 1) patients undergoing diagnostic LPs (excluding myelography, pneumoencephalography, and cisternal puncture), excluding also patients whose condition might reduce the reliability to report HA; 2) patients undergoing nonobstetric spinal anesthesia; and 3) patients undergoing obstetric spinal anesthesia. They reported several observations.

1. The average frequency of post-LP HAs (PLPHA) in patients after diagnostic LP (excluding myelography, pneumoencephalography, and cisternal puncture), excluding also patients whose condition might reduce the reliability to report HA, was 32%. For nonobstetric spinal anesthesia, the average frequency was 13%. For obstetric spinal anesthesia, the average frequency was 18%.
2. In reports in which patients received special measures to prevent PLPHA, the average frequencies were 6% for diagnostic LPs, 5.5% for nonobstetric spinal anesthesia, and 6.2% for obstetric spinal anesthesia. The actual frequencies in individual series ranged from 0 to 18%.
3. The frequency of PLPHA was 36% in their own series of 105 normal individuals, 30% in 317 patients with diagnostic LPs, and 2% definite and 2% probable in 100 patients undergoing spinal anesthesia (but 30 patients with HAs of other types were excluded from the latter count).

In analyzing risk factors for PLPHA, they concluded that the evidence, including their own prospective series, was convincing to consider younger age and female gender as definite risk factors. They attributed the difference of PLPHAs in obstetric and nonobstetric patients undergoing spinal anesthesia at least in part to these factors. They further considered the data fairly convincing that the smaller the needle size, the lower the frequency of PLPHA, but were unable to show this in their prospective series. They commented that the great variability of HA frequency for the same needle size between authors may reduce the reliability of this observation. With regard to all other risk factors, they concluded that the evidence was inconclusive. With regard to all preventive or therapeutic measures, they commented that proponents of a particular treatment, in general, found it to be beneficial; however, some of the reports were uncontrolled and some results could not be replicated by others. Today, we would consider the latter findings a result of publication bias—if one first tried a new approach to reducing the incidence of PLPHA, one would be less likely to publish a failure than a success.

They commented on the different frequency of PLPHA in patients undergoing diagnostic LP compared with those undergoing spinal anesthesia, and considered the following factors in their series: age, gender, needle size, fasting, hydration, premedication and postoperative medication, minimal amount of trauma to the meninges, duration of recumbency, and the amount of CSF removed. Even after controlling for age and gender, the frequency of PLPHA in the spinal anesthesia group was low. They speculated that "if patients undergoing an LP for diagnostic purposes were treated like patients undergoing spinal anesthesia the incidence ['frequency'] of PLPHAs could be markedly reduced."¹

The work of Tourtellotte et al.¹ demonstrated the large variability in the frequency of PLPHA in different settings and in different series, and the apparent ability to reduce this frequency, based on uncontrolled reports. The average frequency that they reported in their monograph has been replicated or even exceeded in more recent experience (e.g., 37% in the

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series by Kuntz et al.⁷), and thus is not a problem of the past. The reason for this review is to identify risk factors that could be modified to reduce the frequency of PLPHAs in patients undergoing diagnostic LPs.

The large variability in reported frequencies of PLPHA is significant and should be considered at the outset. When Fishman² commented that the frequency of PLPHA in many of the published reports is greater than in his personal experience, he may have been echoing the thoughts of many readers, although this perception may be due in part to underascertainment in an uncontrolled setting. Furthermore, in testing an intervention to reduce the frequency of PLPHA, if the baseline rate were low (e.g., 5 to 10%), a fairly large sample size would be needed for any intervention to show significant reduction in frequency. Not surprisingly, the baseline rate in most studies with significant findings has been closer to the 20 to 30% range.

Treatments for PLPHA that have shown efficacy in the management of PLPHA once it has occurred include oral or IV caffeine, epidural saline, and epidural blood patches.⁶ These and other possible treatments are not considered further, as the management of PLPHA was not the focus of this review.

Case definition. PLPHA has been defined in different ways. Definitions range from any HA after LP to HA after LP with definite characteristics—in particular, a constant HA appearing or worsening significantly upon assuming the upright position and resolving or improving significantly upon lying down. Some of the definitions used do not permit excluding possible overlap between the PLPHA described and migraine without aura, at least in some of the patients. We elected to accept all definitions of PLPHA uncritically, but recommend that future studies of PLPHA adhere to rigorous definitions that will permit excluding other etiologies of HAs. Similarly, there is no uniform definition of "severe" PLPHA. Future studies should use established and well-defined criteria for PLPHA and its severity.^{8,9}

Methods. A literature search conducted by one of the authors (R.W.E.) served as the basis for this report. Appropriate literature was identified by MEDLINE searches back to 1966 using the following key words and phrases: post-lumbar puncture headache, prevention of post-lumbar puncture headache, complications of lumbar puncture, atraumatic and pencil point lumbar puncture needles, and Whitacre and Sprotte lumbar puncture needles. Additional articles were found through bibliographies of these articles and by checking pertinent textbooks. Articles deemed pivotal for making recommendations were reviewed by members of the Therapeutics and Technology Assessment (TTA) Subcommittee (C.A., D.G., E.F.) for the purpose of classification of the evidence as it pertained to the recommendations at hand. Some of the background literature was also reviewed independently by TTA Subcommittee members.

Analysis of the evidence. Frequency of PLPHA continues to vary among contemporary series and between diagnostic and spinal anesthesia cases.

The following definite demographic risk factors were identified, based on Class II evidence: younger age, female gender, and HA before or at the time of the LP. Less certain risk factors included lower body mass index (a significant factor in some series, but of small magnitude), and prior PLPHA (not a consistent observation).

PLPHA occurs twice as often in women as in men.^{7,10,11} The increased frequency of PLPHA in female patients is based upon a comparison of equally sized groups of females and males and also based upon diagnostic LP studies.^{7,11} Most of the increased frequency in women is during the child-bearing years.¹¹ The highest frequency is in the 18- to 30-year-old age group.^{12,13} The frequency is less in children younger than 13 years¹⁴ and in both men and women older than 60 years.¹¹ One study reports that the incidence is greater in patients with small body mass index (weight/height²).⁷ Younger female patients with a small body mass index may have the highest risk of developing PLPHA.⁷

Patients with HAs before the LP are at greater risk for PLPHA.^{7,15,16} The HAs are more severe and last longer than in those without a previous or current HA.^{7,16} Patients with a history of PLPHA are also at increased risk.¹⁷

The following technical factors were identified:

1. **Needle size:** Convincing Class I evidence in anesthesiology series and either Class I or Class II evidence in neurology series indicate that smaller needle size is associated with lesser risk of HA.^{3,4,11,17-19} When using the Quincke (conventional) needle, the incidence of PLPHA decreases with a smaller needle diameter, which is consistent with the CSF leakage theory of PLPHA. A smaller needle diameter produces a smaller tear in the dura, and thus there is less potential for leakage.¹⁸ The incidence of PLPHA decreases with higher gauge Quincke needles as follows: 16 to 19 G, about 70%; 20 to 22 G, 20 to 40%; and 24 to 27 G, 5 to 12%.⁴ Thinner needles are technically harder to use. For diagnostic LP, use of needles with a diameter smaller than the 20 G may not be practical unless only a small volume of fluid is needed, because the time for the transduction of the opening pressure using the manometer may be too long and the flow rate too slow.¹⁹ However, smaller diameter needles are satisfactory for spinal and epidural anesthesia and myelography.
2. **Direction of bevel:** There is Class I evidence in anesthesiology literature that less incidence of PLPHA results if the bevel of the Quincke is inserted parallel to the dural fibers, rather than perpendicular.^{17,20-23} Parallel insertion means that a plane passing through the flat part of the bevel, going through both edges of the bevel, is parallel to the long or vertical axis of the spine. The dural fibers run parallel to the long axis of the spine.²⁴ When the dura is punctured with

the bevel perpendicular to the fibers, more fibers are severed than when the bevel is parallel to the fibers.²¹ Five studies of patients receiving spinal anesthesia have demonstrated a reduction in the incidence of PLPHA by 50% or greater when the bevel is parallel rather than perpendicular.^{17,20-23}

3. *Replacement of the stylet before withdrawing the needle:* Replacement of the stylet before withdrawing the needle results in less incidence of PLPHA when using a noncutting needle.²⁵ Strupp et al.²⁵ randomly assigned 600 patients undergoing LPs with Sprotte (noncutting) 21-G needles to one of two groups. In one group, the stylet was reinserted before withdrawal. In the other group, the stylet was not reinserted. PLPHA was reported in 16% of the patients in the group without reinsertion and in 5% of the patients in the group with reinsertion of the stylet ($p < 0.005$). Their explanation is that a strand of arachnoid may enter the needle with the CSF and, when the needle is removed, the strand may be threaded back through the dural defect and produce prolonged CSF leakage. Whether reinserting the stylet following an LP with a Quincke needle would reduce the incidence of PLPHA is not known, although there is no reason to believe the experience would be different than with a Sprotte needle (Class III). There are reports of rare complications with both techniques. Rarely, a nerve root can herniate through the dura due to aspiration by the needle during rapid withdrawal.^{26,27} There is a single case report of transection and withdrawal of a nerve filament due to replacement of the stylet (into a hollow needle with an end-hole-side-hole needle) following a lumbar myelogram.²⁸ Bacterial meningitis, a rare complication of diagnostic LP,²⁹ might theoretically be caused by reintroducing a stylet contaminated with respiratory droplets. The stylet should always be used on insertion through the skin and the subcutaneous tissue whether using a Quincke or atraumatic needle. Rarely, a needle without a stylet may implant a plug of skin which can grow into an intraspinal epidermoid tumor.^{30,31}

4. *Needle design:* The "pencil point," noncutting, or atraumatic needles such as the Whitacre³² or Sprotte³³ (a modification of the Whitacre needle with a longer lateral opening) have a duller tip and an oval opening just proximal to the tip in contrast to the Quincke needle (figure). Although atraumatic needles are commonly used by anesthesiologists, most neurologists have never heard of these needles and only 2% use them.³⁴ There is conflicting evidence as to whether their use reduces PLPHA. There is convincing Class I evidence in the anesthesiology literature for less incidence of PLPHA with a noncutting needle compared with a cutting needle with the bevel parallel to dural fibers.³ However, one report using thin needles showed a similar incidence of PLPHA (4%) for a cutting and a noncutting needle in women undergoing postpartum tubal ligation under spinal anesthesia.³⁵ There is limited evidence in diagnostic LPs. In particular, the two studies that report benefit for a noncutting needle compared with a cutting needle^{36,37} did not state that bevel direction was parallel to the dural fibers in patients in whom a cutting needle was used. The second of the two reports was mainly a myelography series. Thus, neither would be accepted as evidence regarding diagnostic LPs according to the Halpern and Preston criteria.³ Moreover, one article showed less PLPHA incidence with the cutting needle than with the noncutting needle.³⁸ In summary, there is convincing evidence in the anesthesia literature that PLPHA is reduced using noncutting (atraumatic) needles. The data are conflicting in the diagnostic LP literature, but the studies have, in general, been inadequate to assess the question.

Potential problems and hazards of noncutting needles. A few LPs with the Sprotte needle are usually necessary for a physician to feel comfortable with its use. Because the tip of the needle is relatively dull, a sharp, short introducer is provided with the Sprotte needle. The introducer should be inserted to 2/3 of its length before inserting the Sprotte needle. Unlike the Quincke needle, in which the direction can be easily changed, the direction of the introducer has to be changed if the needle is not in the proper location. The procedure can be performed without the introducer by using the anesthetic needle to make a skin entry first, but use of the introducer is simpler for most physicians and may result in less damage to the needle tip. The feel of the noncutting needle is different than that of the Quincke needle and the physician has to push harder with the introduction of the needle. Occasionally, the LP cannot be performed with the Sprotte needle and the physician will have to change to the Quincke.³⁹ Sprotte needles can be damaged during LP.⁴⁰⁻⁴² Based upon the large

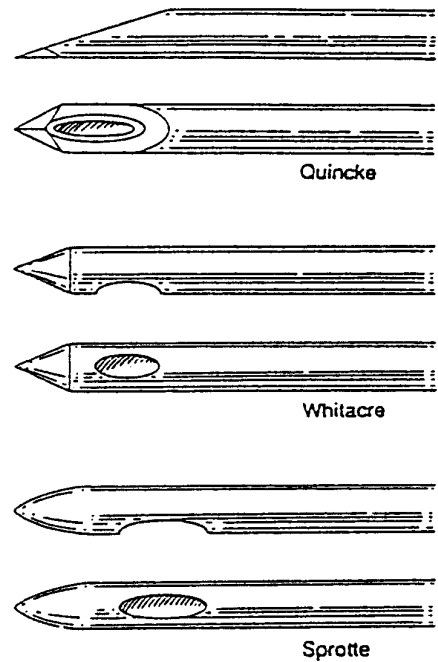


Figure. Three types of spinal needle tips: the Quincke, Whitacre, and Sprotte. From: Peterman SB. Postmyelography headache rates with Whitacre versus Quincke 22-gauge spinal needles. *Radiology* 1996;200:771-778. Reprinted with permission.

number of reported procedures using the Sprotte needle, the risk of significant needle damage appears to be extremely low. Sprotte needles have a cost of about \$12 per needle compared with about \$4 per Quincke needle. LP trays including the Sprotte needle are available at about the same price as a tray with the Quincke needle.

5. *Volume of spinal fluid removed:* The amount of spinal fluid removed is not a risk factor for PLPHA.⁷
6. *Duration of recumbency after the LP:* There is no evidence that the duration of recumbency after the LP has a role in preventing PLPHA. In 1899, following his experiments with spinal anesthesia, Bier⁴³ reported the PLPHA of himself and his associate. His recommendation for prevention, strict bed rest, is still advised by many physicians today. Class I evidence shows no benefit for prevention of PLPHA by bed rest for up to 24 hours in the supine, prone, or head down position.⁴⁴⁻⁵⁰ Two studies showed a mildly increased frequency of PLPHA in recumbent patients as compared with patients immediately mobilized.^{7,51} Although the reports available show no effect for the duration of recumbency after diagnostic LPs, the failure to demonstrate an effect is not the same as showing that there is no effect. Because there are serious methodologic concerns regarding the existing studies, it is not possible to make such a strong conclusion. Thus, there are important differences in technique, study methodology, and definition of PLPHA and its severity, as well as questions regarding the representativeness of the study populations. For example, the available studies have not reported what patients do after they get up for the first time after an LP (for example, do they stay up, or do they lie down again?). Indeed, in the only study in which patient compliance is reported, only about half of the patients (60.5%) actually followed the instructions regarding mobilization or recumbency.⁵⁰
7. *Increased hydration following the LP:* There is no evidence for the use of increased fluids in the prevention of PLPHA. Some physicians recommend fluid intake post-LP, even though the single prospective study of this practice found that increased intake of oral fluids after the LP had no impact on the occurrence of PLPHA.⁵²

Recommendations.

1. Class I and Class II data in the anesthesiology literature and either Class I or Class II data in the neurology series show that smaller needle size is associated with reduced frequency of PLPHA (Type A). The actual choice of needle size will be influenced by balancing other considerations, such as ease of use, the need to measure pressures, and the flow rate, with the desire to prevent PLPHA.
2. Class I data in the anesthesiology literature show that, when using a cutting needle, ensuring that the bevel direction is parallel to the dural fibers reduces the frequency of PLPHA. (Type A)
3. Class I data using a noncutting needle show that replacement of the stylet before the needle is withdrawn is associated with lower frequency of PLPHA. (Type A)
4. For spinal anesthesia, Class I data show that noncutting needles reduce the frequency of PLPHA (Type A). However, for diagnostic LPs, the data are inconclusive.
5. Class I and Class II data have not demonstrated that the duration of recumbency following a diagnostic LP influences the occurrence of PLPHA.
6. There is no evidence that the use of increased fluids prevents PLPHA.

Recommendations for future research.

1. Future studies of PLPHA should use the International Headache Society (IHS) criteria for PLPHA⁸ and published criteria for severity of PLPHA,⁹ and should report the amount and depth of placement of local anesthetic. A description of PLPHA conforming to the IHS criteria^{6,8} is as follows: Bilateral HA that develops within 7 days after an LP and disappears within 14 days after the LP. HA occurs or worsens within 15 minutes of assuming the upright position and disappears or improves within 30 minutes of resuming the recumbent position.
2. To identify candidates for a prospective study of the magnitude of the PLPHA problem while overcoming publication and recall biases, survey a random sample of neurologists to identify those performing at least two LPs per month.
3. To determine the magnitude of the PLPHA problem while overcoming publication and recall biases, request that a sample of neurologists performing two or more LPs per month (identified within the first survey) to participate in a 12-month prospective study. All LPs performed would be recorded, including the following information: pertinent patient demographic data, the indication for LP, the presence of past or concurrent HA, history of migraine (to identify patients prone to PLPHA), caffeine consumption for 48 hours before and after the LP, needle type and needle size, and the amount and depth of local anesthesia. The frequency of PLPHA would be determined by contacting all patients 8 and 15 days after the LP in order to monitor the frequency of occurrence of PLPHAs and severe PLPHAs, using standardized definitions for PLPHA^{6,8} and severity of PLPHA.⁹ These neurologists would agree to practice taking into consideration recommendations 1 through 3 above. If differences were encountered that could not be accounted for by the known risk factors, further surveys may help determine their causes.
4. To evaluate the role of the noncutting needle in diagnostic LPs, select two high-volume practices using the cutting needle that are already complying with recommendations 1 through 3 and documenting a greater than 10% frequency of severe PLPHA, to perform independent, double-blinded, prospective, studies of same-gauge cutting versus noncutting needles, using standardized methods and controlling for age, gender, HA at the time of the LP, amount

and depth of local anesthesia, history of previous HA or migraine, and caffeine consumption for 48 hours before and after the LP. If two similar practices can be identified that currently use a noncutting needle, perform the same study in those practices.

5. More definitive studies of the role of recumbency using contemporary techniques, current definitions of PLPHA, and broadly represented patient populations are required.
6. Repeat surveys 2 and 3 after 3 years to see if there have been any changes in the frequencies of PLPHAs and in neurologists' practices.
7. If the results of survey 6 support that severe PLPHAs occur frequently (>10% of LPs), even in the hands of neurologists complying with recommendations 1 through 4, develop a collaboration with anesthesiologists to determine which additional technical, patient-specific, or perioperative (or peripartum) factors may contribute to the lower frequency of PLPHA reported in spinal anesthesia and obstetric series.

Disclaimer. This statement is provided as an educational service of the American Academy of Neurology. It is based on an assessment of current scientific and clinical information. It is not intended to include all possible proper methods of care for a particular neurologic problem or all legitimate criteria for choosing to use a specific procedure. Neither is it intended to exclude any reasonable alternative methodologies. The AAN recognizes that specific patient care decisions are the prerogative of the patient and the physician caring for the patient, based on all of the circumstances involved.

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Appendix 1

American Academy of Neurology Therapeutics and Technology Assessment Subcommittee Members: Douglas Goodin, MD (Chair); Elliot Mark Frohman, MD, PhD; Robert Goldman, MD; John Ferguson, MD (Facilitator); Philip B. Gorelick, MD, MPH; Chung Hsu, MD, PhD; Andres Kanner, MD; Ann Marini, MD; Carmel Armon, MD; David Hammond, MD; David Lefkowitz, MD; and Edward Westbrook, MD.

Appendix 2

Quality of evidence ratings for therapeutic modalities

Class I. Evidence provided by one or more well-designed randomized controlled clinical trials.

Class II. Evidence provided by one or more well-designed clinical studies, such as case-control, cohort studies, etc.

Class III. Evidence provided by expert opinion, nonrandomized historical controls, or reports of one or more.

Strength of recommendations

Type A. Strong positive recommendation based on Class I evidence, or based on overwhelming Class II evidence when circumstances preclude randomized clinical trials.

Type B. Positive recommendation based on Class II evidence.

Type C. Positive recommendation based on strong consensus of Class III evidence.

Type D. Negative recommendation based on inconclusive or conflicting Class II evidence.

Type E. Negative recommendation based on Class II or Class I evidence of ineffectiveness or lack of efficacy.

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