1951

Post-lumbar-puncture headache : its etiology, clinical picture, prophylaxis and therapy

Robert L. Jones
University of Nebraska Medical Center

POST-LUMBAR-PUNCTURE HEADACHE;
ITS ETIOLOGY, CLINICAL PICTURE,
PROPHYLAXIS AND THERAPY.

Robert L. Jones

Submitted in Partial Fulfillment for the Degree of Doctor of Medicine

College of Medicine, University of Nebraska

January 15, 1951

Omaha, Nebraska.

INTRODUCTION.

This work is an attempt to derive from Medical Literature the concensus regarding the mechanism, therapy, and prophylaxis of headaches consequent to lumbar puncture. "Spinal Taps", as these punctures are usually termed, are widely employed in current medical practice; they are routinely used in several diagnostic procedures, and their use for administering anesthesia in General Surgery and Obstetrics and Gynecology is increasing. Because any process that may engender marked apprehension or severe discomfort in the patient, whether or not prolonged disability may result, is a matter of practical interest to the practicioner. When, in addition, such a process may result in needless and unpleasant extension of hospitalization for the patient, it becomes even more a matter of interest to the physician.

It is not the purpose of this paper to take part in the current controversy regarding the merits of spinal anesthesia compared with those of other methods in use. Suffice it to say that such procedures are in general use, and the attendant complications, therefore, worthy of investigation.

Criteria for diagnosing post-lumbar-puncture headache most generally accepted, and those which will be employed throughout this work, were advanced by Pickering (19):

> Mild to severe pain in the head, usually sub-occipital, but often frontal or vertex; following dural puncture anytime from one hour to several days; rapidly aggravated by

sitting or standing; relieved in the supine position; accompanied only rarely by signs of mild meningeal irritation.

For the sake of brevity, this complex of symptoms will, hereinafter be referred to as spinal headache.

HISTORY.

The literature on the subject of spinal headache is voluminous and has been contributed to with irregular bursts of enthusiasm since around the turn of the Century, when spinal anesthesia enjoyed its first popularity in Europe, and shortly thereafter, in the United States. The practice has never lacked for both ardent supporters and bitter condemnation.

Following the discovery of the anesthetic properties of Cocaine by Koller in 1884, the effect of the drug on various tissues was observed with widespread interest. Corning (1), an American Neurologist, was the first to cocainize spinal cords, both animal and human. His conception of the pharmacology involved would now be considered crude and inaccurate, but he clearly foresaw the present multitude of uses for spinal anesthesia. Just as clearly, he was unable to interest the surgeons of his day in using the drug as he suggested. The method was first employed clinically by Arthur Sicard (2), in France, in 1897, and popularized during the next three years in Germany by Bier (5), and in France by Tuffier (3). The latter gave dramatic demonstrations of surgery performed with spinal anesthetic. In answer to some of his detractors, he denied emphatically that the occasional fatal cases of surgical shock were in any way contributed to by the anesthetic.

The work of Sicard is worthy of much more space than can be allotted here. He was the first to conduct carefully-

controlled experiments, both in the clinic and in the laboratory, with a view to determining the physiology and pharmacology of normal and pathologic spinal fluid. Without doubt, the great bulk of his conclusions are accepted today. A review of his work would have saved much time for his contempories and the clinicians of a later day. He determined most of the values of normal C.N.S. fluid that are present clinical standards. In addition, he showed that substances, other than water, outside the arachnoid envelope, permeated slowly, if at all, but were rapidly eliminated if placed within the envelope. Injecting as much as 300 cc of physiologic saline into the cauda equina of dogs, at the rate of 10 cc/sec., he noted no ill effects. Moreover, he found the rapid injection of large amounts produced coma and paralysis of brief duration, or death, if more were injected after coma had been achieved. More conservative with humans, he demonstrated that as much as 60 cc might be injected into the sub-arachnoid space, or 25 cc withdrawn, without harm to the patient. Of more importance in this discussion, he determined the rapid secretion of C.N.S. fluid by measuring the concentrations in samples of serial aspirations and injections. Without determining the mechanism, he reported the variable appearance of severe headache, precipitous blood-pressure and body temperature changes, and emesis, following dural puncture. It is of incidental interest that Sicard concluded the lumbar region the safest, as well as the most convenient area of access to the sub-arachnoid space.

In the United States, in 1900 and 1901, Fowler (4), and other workers who investigated the use of cocaine for spinal anesthetic, concluded that the method held certain grave dangers that precluded more than limited use of it. In the years that followed, the number of spinal taps decreased until the justly famous work of Wasserman produced a successful diagnostic aid for luetic infection. Thereafter, the number of such taps increased rapidly, and, along with then, an increased concern with spinal headaches. Many theories to explain the malady were offered. Dana (6) stated that the incidence of these headaches was higher in those patients whose spinal fluid Wasserman was negative, however, his conclusion was not confirmed by other workers, and was actively refuted by McRobert (8).

Much of the work on this subject was not well-supported by investigation. Lott(7), for example, in 1917, purported to show from a series of 700 taps, that the intensity and duration of spinal headaches was in direct proportion to the initial spinal fluid pressure. He made no manometric studies, and his work was, therefore, considered of little value.

In 1918, McRobert (8) proposed the theory, still generally accepted, that spinal headache resulted when a persistent leak of spinal fluid into the epidural space caused the fluid pressure to drop below the level necessary to support the basilar structures of the brain. He found the dura to be a thick, fibrous sac, with no elastic or contractile tissue, and that any hole

made in the sac persisted until healing took place - - usually seven to eight days. Further, he reasoned, and confirmed, that a needle entering the sac at an angle is less likely to leave a patent aperture when withdrawn, because of the flap-valve action of arachnoid against dura. In work on cadavers, he found that needles with sharply angled points and cutting edges, left larger, less regular holes, than those with a round point. For the same reason, he suggested the use of needles smaller than the 17-, 18-, and 19-gauge instruments commonly employed. He postulated that the pain experienced by the patient was caused either by contact of the brain with its bony case, following loss of its cushioning fluid, or else to a sudden increase in venous pressure when flow through the basilar plexus was blocked. He favored the latter theory, as have numerous other authorities (10), (12), (13), (15), (16), (19), (23), (28). In a series of 252 cases, McRobert reported an incidence of spinal headache of 4% - - incidences of 30% to 50% had not been considered remarkable, prior to his work in 1918.

Much investigation of the mechanism of spinal headache has been carried on since McRobert propounded his theory, and most of it, either directly or indirectly, tends to confirm that theory.

Baar (9), in 1920, reported a marked decrease in the number of headaches following lumbar puncture when infusions of 500 to 750 cc of 0.5% saline were given post-puncture.

Hoyt (1), in 1922, suggested that, since a very small needle was unable to pass through the spinal ligaments without bending, a needle large enough to enclose a smaller inner needle, until the dura was reached, might be efficacious. Using this technique, he achieved good results in a small series. The work of Cann and Wycoff (29), B. A. Greene (31), and Erskine and Johnson (12), was later based on Hoyt's technique.

H. M. Greene (12), in 1926, confirmed, by post-mortem examinations, McRobert's statements that the hole in the dura was proportional to the diameter of the needle used, and also to the taper of the needle point. Of further interest are Greene's findings that the dural sac in the thoracic and lumbar regions is not firmly attached to bone, and less firmly attached to the posterior surface than to the anterior. He showed that the sac moves up and down as the spine is flexed and extended, and that the sac was damaged further if movement occurred while a needle was in place - demonstrating, incidentally, that such damage was greater with a 19-gauge than with a 22-gauge needle. From the standpoint of safety it is important to note Greene's observation that, using needles manufactured by the same company of identical material, a 19-gauge needle usually snaps when bent past 30 degrees, while a 22-gauge needle may be bent into a cork-screw without breaking.

Alpers (8), in 1926, reviewed the work of two German workers (H. Baruch, 1920, and H. Stecher, 1924) who confirmed

the theory of McRobert regarding the mechanism of loss of C.N.S. fluid following lumbar puncture. By using various dyes (indigo carmine, for one) which are not excreted from the C.N.S. fluid, but are removed from the epidural space and excreted in the urine, they were able to show that dye injected into the sub-arachnoid space does not appear in the urine while the needle is left in place, but can be detected there within eight minutes following removal of the needle. Alpers also observed, as had Sicard, in 1897, that symptoms showed no direct relation to the amount of C.N.S. fluid lost from the system. He found that in every case of spinal headache studied there was a marked drop in fluid pressure after withdrawal. In the most severe cases, the pressure was at, or near, 0 mm of water. As for therapy he stated that pituitary extract often benefited the less severe cases, hypotonic saline infusions sometimes aiding the more severe. In any case, improvement was coincident with a rise in spinal fluid pressure. Evans (11), in 1928, while discussing the complications of lumbar puncture on a broader basis, concurred with Alpers as to cause and therapy of headaches due to decreased spinal fluid pressure.

Probably the most extensive and carefully controlled researches by a contemporary authority were made by Nelson (16), in 1930. Observing the reactions of both dogs and humans, with necropsies on both to support his findings, he corroborated the conclusions of McRobert. He also developed an apparatus for

placing chrome-gut suture in the dural defect following lumbar puncture, reducing the incidence of headache to negligible proportions. All of Nelson's patients were evaluated as to:

1. Sex, weight and temperament.
2. Amount of fluid withdrawn.
3. Time required for operation.
4. Difficulty in placing needle.
5. Number of wounds made in dura.
6. Presence or absence of fresh blood in the fluid removed.

In addition, only headaches obeying the criteria set forth in the introduction to this paper were considered. His principal conclusion was, that in all cases of spinal headache the spinal fluid pressure was remarkably low, while it was at normal levels in those not suffering from such headaches. By means of necropsy, Nelson was able to demonstrate that human dura varies markedly in thickness in different areas, and that it is vascular in some portions, avascular in others, with no regular pattern. He further demonstrated that headache is more likely to develop when dura is pierced in a thin area, and also, when punctured prependicularly rather than diagonally. Also at necropsy, Nelson demonstrated a patent needle tract in a patient whose dura had been punctured eleven days prior to death.

W. M. Sheppe (17) reported in 1934, that by using a 22-gauge needle with a tapered point, he had reduced his incidence of spinal headache in ambulatory patients to less than 10%.

Of more interest, however, is the fact that manometric measurement had convinced him, as it had Heldt and Maloney (14), in 1928, that there is often a lower pressure in the epidural than the subdural space, thus promoting the aspiration of fluid following dural puncture. Especially did he find this true in patients immediately post-partum. He observed that, by withdrawing the stylet while the needle-end was in the epidural space and allowing air to enter the space for about 30 seconds, the epidural pressure was raised and the flow of fluid into that space inhibited. After employing this procedure routinely, he reported a 3% incidence of mild headaches with no severe reactions.

Further work with small needles was done, in 1938, by Erskine and Johnson (18). They reported on the use of Harrison's modification of the Dattner needle (a 25-gauge needle within a 20-gauge), giving an incidence of four headaches in 118 cases. They offered a careful description of their technique, which does not seem impractically difficult.

Discussing the mechanism of headache, in 1939, Pickering (19) concluded that most pain in the head is caused by tension on the blood vessels and perivascular structures, especially any factor that causes an expansion of the arteries and sinuses at the base of the brain. In 1948, he delt particularly with spinal headache, finding in each case a spinal fluid pressure below normal or at the lower limits of normal. He noted, also, that in about one-third of his cases, the pain was pulsating in

nature and relieved by pressure on the carotid arteries. With little modification of his previous conclusion, he stated that pain in spinal headache may be ascribed to caudal displacement of the brain, with tension on the anchoring structures, particularly, the large arteries at the base. Kunkel, Ray, and Wolfe, (23), after much careful investigation, had published similar findings, in 1943.

Further convincing evidence of persistent dural leakage following lumbar puncture is offered in an article written by J. L. Pool (22) in 1942. He stated that the myeloscope frequently revealed spinal fluid in the epidural space when routine taps had been done within four days previously.

The elimination of rest following lumbar puncture was recommended, in 1942, by Blau (20), and again in 1946, by Underwood (26). Underwood divided a series of 500 cases into two groups, those resting after the puncture, and those ambulatory. Using a 22-gauge, Quincke-type needle, he found a 15% incidence of headache in the ambulatory group, compared with a 25% incidence in the resting group. Adler (24), in 1943, published the opinion that the sooner a patient goes to bed following lumbar puncture, the more likely he is to have a headache. Strongly stressing the psychogenic factors involved, he recommended that as little "fuss" as possible be made over the operation of tapping. His incidence, in 108 cases, was 13%. Levin (25), in 1944, with an impressive series of 2,217 cases, recommended the same

procedure, with the exception that he employed a 20-gauge needle and rapid fluid withdrawal. Even more impressive is Levin's claim of less than 1% incidence of headache, a figure quite possibly open to some question. Obviously the above statistics apply to punctures done for diagnostic purposes and have little bearing on the handling of surgical and obstetric patients.

In the Obstetrics field, Weintraub, Antine, and Raphael (27), in 1947, recommended the use of a tight, well-padded abdominal binder for the relief of headaches following saddle-block anesthesia. They had observed that headaches were more common, with this anesthetic, after vaginal delivery than after delivery by section. In severe cases of spinal headaches, they observed that orthostatic hypotension and tachycardia often accompanied. Reasoning that these complications might be on the basis of a sudden decrease in abdominal pressure with consequent splanchnic pooling of blood and less constriction of the lumbar epidural space, they tried the binder and found symptoms relieved in every case. They recommended, further, that the binder be applied in all cases of spinal headache, whether or not the patient was ambulatory.

A more direct approach to the problem of spinal headache was made by Ahearn (28), in 1948. By the intra-thecal injection of not more than 20 cc of 5% glucose, in either plain water or saline, he achieved one to two hours of relief in 14 cases of severe spinal headache. With a view to obtaining longer

enduring remission of symptoms, Rice and Dabbs (29) experimented with the injection of saline into the epidural space via the caudal canal, in the manner of continuous caudal anesthetic. In a series of 22 cases reported by them early in 1950, the average total volume of saline injected was 82 cc. The usual initial dose was 20-30 cc, and, in about half of their cases, no more than the initial amount was required for immediate and permanent relief. By means of the indwelling catheter, they were able to control symptoms easily in every case. In addition to the above information, they reported a decrease in the incidence of spinal headache when the 24-gauge needle-within-a-needle technique was adopted.

Small needle operations are perhaps approaching their ultimate with the recently published work of B. A. Greene (31), who utilizes a 26-gauge needle guided by a 21-gauge needle. Greene, who had encountered a 26% incidence of spinal headache while using a 22-gauge needle, reduced the figure to 0.4% in 700 obstetric cases with his 26-gauge instrument. Even more recently, Cann and Wycoff (30) have disclosed a reduction of incidence to 5% by the use of a 27-gauge needle. By all reports, the technique of using very small needles is not difficult to acquire. They are, however, more time-consuming, since forceful aspiration is requisite for assuring entrance into the subarachnoid space.

DISCUSSION.

Regarding the mechanism of Post-Lumbar-Puncture Headache, there would appear to be no reasonable doubt that McRobert's theory of persistent loss of spinal fluid resulting in inadequate support for the pain-sensitive structures of the brain is generally accepted by the out-standing workers on the subject. Necropsy observations as well as myeloscopy and dye-excretion studies lend strong support to the theory. Further evidence accrues with a review of the effective methods of therapy and prophylaxis: Increased abdominal pressure, admission of air or saline into the lumbar peridural space, intrathecal injection of saline, hypotonic saline infusions, small needle techniques, and walking (again, an increase in abdominal pressure). Any of these procedures may be assumed to be effective either by inhibiting the escape of C.N.S. fluid or accelerating its replacement.

In evaluating the comparitive merits of the methods listed above, it must be remembered that the size and type of needle employed, and the effectiveness of hypotonic saline infusions are the only procedures which have been investigated often enough to determine general agreement, or the lack of it. The author's limited experience of 100 lumbar punctures is not great enough to be statistically sound. Experience has indicated, however, that 22-gauge needles give better results than those of

larger bore, only if the number of attempts at puncture is kept at a minimum. Abdominal binders have given relief in the three cases in which they were tried.

Because of the special apparatus and time required, it is not likely that Nelson's (16) chrome-gut plug will ever be widely accepted in practice.

Of the prophylactic measures suggested in this review, anatomic and physiologic considerations tend to favor: Sheppe's (17) admission of air into the peridural space following puncture, the use of small needles, and optimum preoperative hydration of the patient. In addition, in many cases, an abdominal binder might be applied as a precaution. On the same basis of consideration, the most promising therapeutic procedures appear to be peridural injection of saline of Rice and Dabbs (29), and the abdominal binder of Weintraub, Antine, and Raphael (27).

The selection of any method will, of course, depend on the experience and equipment available to the operator, as well as the exigencies of time and place. The success of the method selected will reflect, to a material degree, the skill of the user — witness the wide variations in the incidence of spinal headache reported by different workers utilizing similar equipment and procedures.

CONCLUSIONS.

The mechanism of Post-Lumbar-Puncture Headache is generally accepted to be the one proposed by McRobert: A dural defect resulting from puncture and withdrawal of a needle allows the escape of C. N. S. fluid with consequent diminished support to the brain and its pain-sensitive structures.

Most of the presently available prophylactic and therapeutic measures require more extensive investigation before their worth for general use can be assessed.

Skill of the operator is a factor in any of the suggested procedures.

BIBLIOGRAPHY.

1. Corning, J. L.: Spinal Anesthesia, N. Y. J. of Med. lxxii: 790-792, 1900 (reprint of article published in 1885).

2. Sicard, Arthur: Les Injectiones sous-arachnoidiennes et le liquide cephalorachidien, rechercher experimentales et cliniques. Paris 1899. Bull. Acad. de med. Par. 3a, xliv: 476,1900.

3. Tuffier, T.: Analgesie cocainique par voie rachidienne, La Semaine Med., xx: 423-425, 1900.

4. Fowler, G. R.: Cocain Analgesia from Subarachnoid Spinal Injection. Phila. M. J. vi: 843-849, 1900.

5. Bier, A.: Weitere Mittheilungen uber Ruckemarksanasthesie, Transl. aux Francais, Presse Med. i: 196, 1901.

6. Dana, C. L.: Lumbar Puncture Headache, J. A. M. A. 68:1017. (April 7) 1917.

7. Lott, Y. C.: Observation and Technique of Lumbar Puncture in 700 Cases, M. Rec. 92:717, 1917.

8. McRobert, R. G.: The Cause of Lumbar Puncture Headache, J. A. M. A., 70:1350, (11 May) 1918.

9. Baar, Bustan: New Procedure for the Prevention of Spinal Puncture Headache, M. Rec. 98:598 (9 Oct.) 1920.

10. Hoyt, Randall: An Apparatus for Withdrawing Spinal Fluid without Post-Puncture Reaction, J. A. M. A. 78:428.

11. Solomon, H. C.: Raising Cereb. Sp. Fluid Pressure, J. A. M. A., 82:1512 (10 May) 1924.

12. Greene, H. M.: Lumbar Puncture and the Prevention of Post-Puncture Headache, J. A. M. A. 86:391 (6Feb.) 1926.

13. Alpers, B. J.: Lumbar Puncture Headache, Arch. Neuro. & Psychiat. 14:806 (Dec.) 1926.

14. Heldt, T. J. and Maloney, J.C.: Manometric Studies of the Central Nervous System, Am. J. Med. Sc. 175:371, 1928.

15. Evans, C. H.: Possible Complications with Spinal Anesthesia, Am. J. Surg. 5:581-593 (Dec.) 1928.

16. Nelson, M. O.: Post-Puncture Headache, Clinical and Experimental Study of Cause and Prevention, Arch. Dermatol. & Syphylology 21:615-627 (April) 1930.

17. Sheppe, W. M.: The Relation of Negative Pressure in Epidural Space to Post-Puncture Headache, Am. J. M. Sc. 188:247-252 (Aug.) 1934.

18. Erskine, D., and Johnson, A. G.: Lumbar Puncture in Out-Patients, Lancet 2:371-73 (13 Aug.) 1938.

19. Pickering, G. W.: Experimental Observations on Headache, Brit. J. J. 1:907, 1939.
Lunbar Puncture Headache, Brain 71:274 (Sept.) 1948.

20. Blau, A.: Reactions Following Spinal Puncture, Urol. & Cutan. Rev. 45:239-242 (April) 1942.

21. Patterson, J. H.: An Investigation into the Effect of I.V. Injections of Sucrose on the Cerebrospinal Pressure as Measured by Lumbar Puncture, Proc. Royal Soc. Med. 35:520 (June) 1942.

22. Pool, J. L.: Myeloscopy: Intraspinal Endoscopy, Surgery, 11:169, 1942.

23. Kunkel, E. C., Ray, B. S., and Wolff, H. G.: Experimental Studies on Headache, Arch. Neuro. & Psychiat. 49:323, 1943.

24. Adler, H.: A Study of Headache Following Diagnostic Spinal Taps, N. Y. State J. M. 43:1328, (July) 1943.

25. Levin, M. J.: Lumbar Puncture Headaches, Bull. U. S. Army Med. Dept. 82:107-110 (Nov.) 1944.

26. Underwood, L. J.: Lumbar Puncture Headache, Am. J. Sphy., Gonor., & Ven. Dis. 30:264-271 (May) 1946.

27. Weintraub, F., Antine, W., and Raphael, A. J.: Post-Partum Headache after Low Spinal Anesthesia in Vaginal Delivery, Am. J. Obst. & Gyn. 54:682, 1947.

28. Ahearn, R. E.: Management of Severe Post-Lumbar Puncture Headache, N. Y. State J. of Med. 48:1495-1498 (July) 1948.

29. Rice, G. G., and Dabbs, C. H.: The Use of Peridural and Subarachnoid Injections of Saline Solution in the Treatment of Severe Post-Spinal Headache, Anesthesiology (Jan.) 1950.

30. Cann, J. E. and Wycoff, C. C.: Incidence of Headache with the Use of 27-Gauge Needle, Anesthesiology (May) 1950.

31. Greene, Barnett A.: A 26-Gauge Lumbar Puncture Needle: Its Value in Prophylaxis of Headache Following Spinal Analgesia for Vaginal Delivery, Anesthesiology (July) 1950.