# A TECHNIQUE TO MINIMIZE THE OCCURRENCE OF HEADACHE AFTER LUMBAR PUNCTURE BY USE OF SMALL BORE SPINAL NEEDLES * † ‡

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In an analysis of 40,000 cases of cyclopropane anesthesia, Waters found that 10 per cent of the patients suffered from postoperative headache. When present, this symptom although annoying, was not as persistent or as severe as postlumbar puncture headache (1).

It is the purpose of this paper to show that spinal headache may be almost completely eliminated by the use of small bore (in particular the 25 gauge 2½ inch) dural puncture needles.

The complications arising from spinal anesthesia are manifold. Included are nausea and emesis, urinary retention, atelectasis, bronchopneumonia, headache, abducens nerve paralysis (2, 3), arachnoiditis, hypoglossal nerve paralysis, neurogenic dysfunction of the bladder, flaccid crural paraplegia, hysterical gait, and fatal massive pulmonary collapse (4, 5). Of these, headache is the one of which the patient is most aware and most fearful.

## Development of Spinal Anesthesia

One hundred years ago Alexander Wood introduced the hollow needle and a suitably fitting syringe. This, plus the discovery of the local anesthetic properties of cocaine by Koller in 1884, was the first step leading to what we know today as spinal analgesia.

One year after Koller's work, a neurologist, J. L. Corning, unintentionally injected cocaine into the subarachnoid space. He continued with this work, but only as a means of alleviating pain; the possibilities of its use as an operative anesthetic agent were overlooked.

In 1891, a technique of lumbar puncture from which the practice of present day spinal anesthesia is a direct consequence, was described by Quinke. This year also heralded the use of spinal anesthesia for surgical procedures. It was in these original papers by Bier and Tuffier that headache was first recorded as a postspinal complication.

In 1901, Tuffier published the results of operations on 60 patients under spinal anesthesia. For the first time attention was paid to

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aseptic technique and also to the level of anesthesia necessary for various procedures. This small but momentous series recorded an incidence of headache of 40 per cent. In the majority of these cases the head down position proved to be the most satisfactory treatment (6).

Hosemann, in 1909, did repeat taps on patients with spinal headache; 86 per cent exhibited a decrease in cerebrospinal fluid pressure. The others, those that did not respond favorably to the head down position, had an elevated cerebrospinal fluid pressure. In a larger series published in 1914, 82 to 83 per cent had lowered cerebrospinal fluid pressures.

Thorsen performed repeat taps on 21 patients with headache three to eleven days after spinal anesthesia. In 17 cases the pressure was

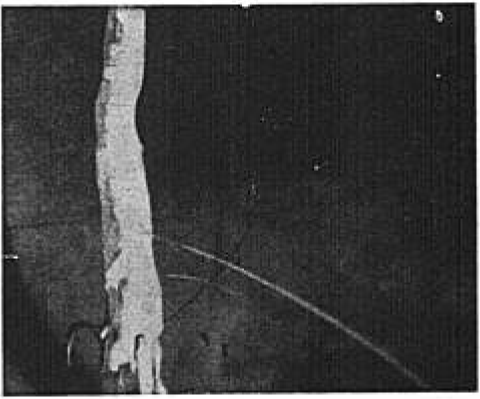

FIG. 1. Spinal dural sac suspended and filled with water. Upper opening was made with a 19 gauge cutting point needle; lower opening by a 22 gauge round point.

[Greene: J.A.M.A. 86: 391–392 (Feb.) 1926.]

reduced. In 4 of these cases the pressure was so low that no spontaneous flow was obtainable. In the remaining 4 cases, the pressure was considered normal (7).

Offergeld found that drainage of cerebrospinal fluid improved patients with headache who did not respond to the head down position. In these cases, it was noted by Hosemann that the cerebrospinal fluid pressure was elevated.

The majority of investigators doing experimental pressure studies on patients with postlumbar puncture headache found that in 80 to 90 per cent of all cases the headaches are the result of a lowered cerebrospinal fluid pressure (7, 8).

Franksson and Gordh in their follow-up studies revealed that 87 per cent of patients had a lowered pressure for one week or more; and Gordh drew attention to the fact that the epidural pressure became positive after lumbar puncture and remained so in some cases for about one month (9).

Two distinct entities, therefore, are present: (1) low pressure headache, the most common, and (2) high pressure headache.

The term high pressure headache is a misnomer, for it has been shown conclusively that an increase in pressure alone does not cause symptoms. The etiologic factor here is the development of an aseptic meningeal reaction to the injected solutions, to introduced antiseptic, or to blood. Reaction to the introduction of organisms is rare (6, 10).

In any discussion of headache, the patients psychic make-up must be considered, and psychoneurosis must be presented as a distinct type of postoperative headache (1).

The earliest theory as to the etiologic factor involved in the production of postlumbar puncture headache has become the one most widely accepted. In 1902, Sicard postulated the causative factor to be spinal fluid leakage through the dural rent.

In 1923, Ingvar observed that a methylene blue solution, injected intraventricularly, remained in an intradural position, but if lumbar puncture was performed before the experiment was started, the dye was located extradurally (11).

During postmortem examinations, Greene, in 1926, showed that leakage followed puncture of the spinal dura in every instance in which the membrane was filled with water, and noted that the amount of leakage was in direct relation to the size of the needle used (12) (see fig. 1). Further autopsy and laminectomy demonstrations by Thorsen revealed the existence of persistent dural puncture holes following lumbar taps (13) (see fig. 2).

Lipiodal studies using fluoroscopy for the diagnosis of intraspinous lesions was undertaken by Dr. R. A. McPherson, radiologist of Winnipeg General Hospital. After reviewing a series of several hundred cases, using 14 and 15 gauge lumbar puncture needles, he concluded that postspinal headache was attributable solely to the hole made in the dura (14).

Franksson and Gordh in experiments on human beings, showed that with a pressure of 100 to 200 mm. of water, a leakage of 0.17 ml. per minute into the extradural space is possible. This means a loss of 240 ml. per twenty-four hours. With the production of cerebrospinal fluid estimated at 100 to 500 ml. per twenty-four hours (9), the inference is drawn that if one desires to reduce the frequency of headache (due to leakage), the size of the puncture site should be reduced (figs. 3 and 4).

When spinal fluid is withdrawn, intentionally or otherwise, an imbalance is set up between intravascular and extravascular pressures, resulting in dilatation of the venous system and displacement of the

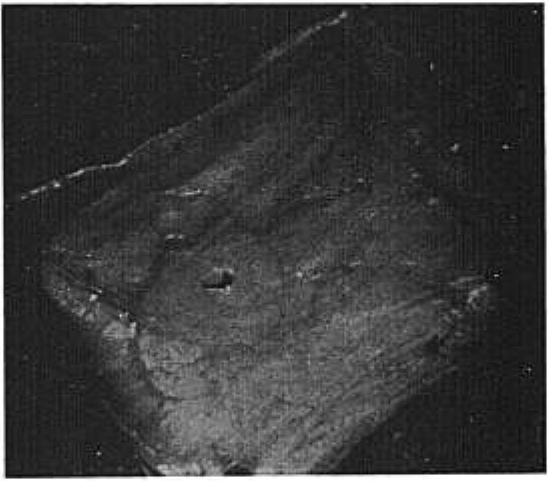

FIG. 2 A. Puncture openings in the dura: Two days old. Diameter of the needle was 0.7 to 0.9 mm. (magnification 4 times).
[Franksson and Gordh: Acta Chir. Scandinav. 94: 443–454 (Sept.) 1946.]

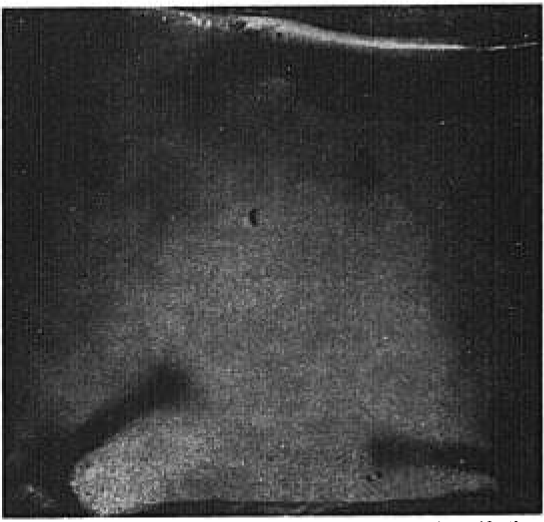

FIG. 2 B. Fourteen days old. Needle diameter was 0.7 to 0.9 mm. (magnification 4 times).
[Franksson and Gordh: Acta Chir. Scandinav. 94: 443–454 (Sept.) 1946.]

brain. Traction or pressure on the pain sensitive dilated veins and arteries, particularly at the base of the brain, as well as on the nerves and dura, is responsible for the characteristic headache. Pain referred to the frontal portion of the head arises from above the tentorium cerebelli and is transmitted by the fifth nerve. The ninth, tenth, and upper three cervical nerves transmit pain from on or below the inferior surface of the tentorium cerebelli to the posterior half of the head. When the patient assumes the supine position, "brain-sag" is overcome and the headache disappears (15).

Headaches have been induced experimentally by Kunkle and others in normal human subjects by the free drainage of approximately 20 cc. of spinal fluid (15).

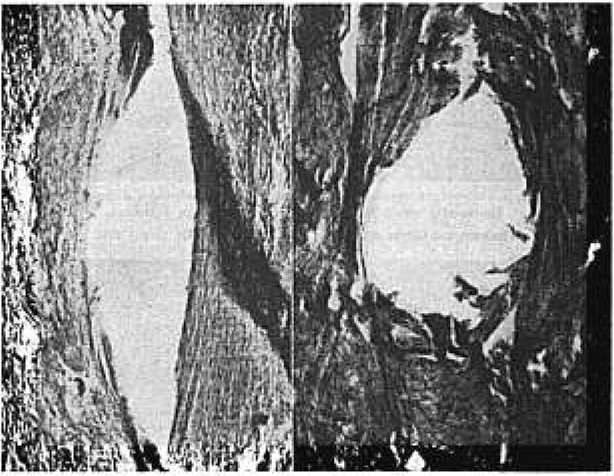

FIG. 3. Diameter of needle 1 mm. Sections in plane of dura (magnification 75 times). a. Needle bevel parallel to dural fibers. b. Needle bevel at right angles to dural fibers.

[Franksson and Gordh: Acta Chir. Scandinav. 94: 443–454 (Sept.) 1946.]

Other factors contributing to postspinal headache (16, 17) are: (1) increased frequency in patients over 30 years; (2) presence of a decrease in muscular and vascular tone; (3) females more prone to headache than males; (4) multiplicity of taps; (5) traumatic taps, and (6) position during the operative procedure, particularly the lithotomy position.

## PREVENTION OF HEADACHE

Various prophylactic measures have been instituted to lessen the incidence of headache (9, 13, 16, 18–22). These measures include (1) preoperative and postoperative hydration; (2) antihistaminics given preoperatively and postoperatively; (3) Trendelenburg position during recovery; (4) epidural saline injections, and (5) a decrease in needle size.

Greene, in 1926, reported that dural fibers run lengthwise, and that a beveled needle causes more leakage if inserted across the line of the fibers than if inserted parallel to them (12) (see figs. 3 and 4).

Following along these lines, Whitacre introduced the "pencil-point needle." It is a 20 gauge needle with a tapered point, the orifice appearing on the side of the shaft above the point. The pencil point spreads the dural fibers rather than cutting them. Hart and Whitacre, in 3,489 cases, had an incidence of headache of 2 per cent. Those headaches which occurred, however, were of shorter duration and of less severity than those after the use of the customary needles (23).

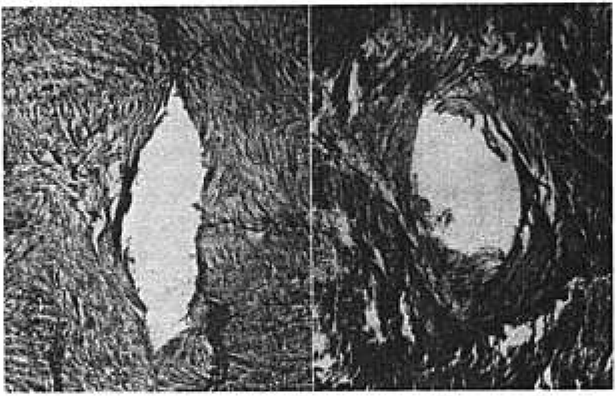

FIG. 4. Diameter of needle 0.5 mm. Sections in plane of dura (magnification 75 times). a. Needle bevel parallel to dural fibers. b. Needle bevel at right angles to dural fibers.

[Frankson and Gordh: Acta Chir. Scandinav. 94: 443–454 (Sept.) 1946.]

*Fine Gauge Needles*

At present, the most acceptable method for the prevention of headache is the use of small bore needles. Needles of 24 through 27 gauge have been used with varying degrees of success.

Reports appeared as early as 1894 (Corning) on the use of fine gauge needles. The majority of the techniques required the use of introducers and dilators before the needle was inserted intradurally, and thereby seemed to lose favor with anesthesiologists until the last eight to ten years.

Gordh, using a needle 0.5 mm. in diameter by 110 mm. in length in 100 consecutive cases, reported that no spinal headaches occurred. He used a 2 inch introducer; his only adverse comment concerning the technique was that the finer needle occasionally became clogged during insertion (9). Bowman, using a similar needle, reported an incidence of headache of 0.63 per cent in 632 patients (22).

Huston, using a 24 gauge needle in conjunction with a 20 gauge, 1½ inch introducer, in 1,000 cases of obstetrical vaginal delivery, noted an incidence of headache of 2.8 per cent. In an earlier series of 1,000 cases the incidence of headache was 4.6 per cent (24).

Kaufman and Kaufman, using a 25 gauge, 2 inch needle in 200 cases, in which the dura was successfully punctured in 197, noted that spinal

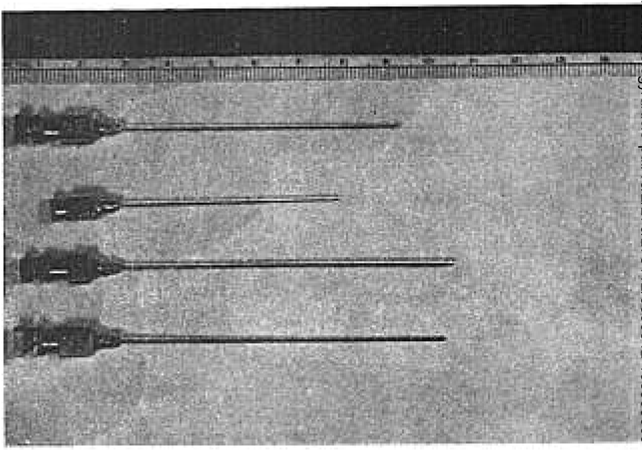

FIG. 5. Needles used for spinal anesthesia. From above downward: 25 gauge 2½ inch; 25 gauge 2 inch; 22 gauge 3 inch; 20 gauge 3 inch.

headache did not occur in any case. In a new series of 1,000 cases in which the needle was too short in 30 patients, four instances of mild headaches occurred. This is in marked contrast to Kaufman's review of 93,409 cases (by 29 anesthesiologists) over the last forty-five years, in which the incidence of headache was 11.5 per cent (14, 21).

Greene, of Brooklyn, has used a 26 gauge needle for anesthesia in vaginal deliveries. It is inserted through a 21 gauge spinal introducer. In a series of 700 patients, all of whom received 2,500 cc. of fluid orally for three days after spinal anesthesia, the incidence of headache was 0.4 per cent. The dura of 5 patients was inadvertently punctured by the introducer. The introducer must be passed to within 1 cm. of the dura, or the 26 needle meets with great resistance to its passage (25).

Cann and Wycoff attempted to use a 27 gauge needle for operative anesthesia. The technique was found to be unsatisfactory for routine cases. The time necessary to make the puncture was increased, two needles had to be manipulated, and occasionally a satisfactory level of anesthesia was not obtained. Furthermore, spinal fluid did not leak out of the needle when a tap was successfully made, since the neeedle bore offered too much resistance (26).

*The 25 Gauge 2½ Inch Needle*

Taking all the preceding facts into consideration, we at the Flower and Fifth Avenue Hospitals decided to have Becton, Dickinson and Company make a 25 gauge 2½ inch needle (with its own stilet)§ for our usage (see fig. 5).

The 25 gauge needle has the smallest bore that can be used practicably for spinal anesthesia without an introducer. The one needle technique is far simpler and speedier, and the possibility of dural puncture, which occurs when a large needle is employed, is removed.

The 2½ inch length was chosen because longer needles were too unstable during insertion. Furthermore, it has been observed by most anesthesiologists that the average distance to the subarachnoid space is between 4 and 6 cm. Guiterrez measured the distance from the skin to the epidural space in 3,200 cases (27). According to his findings, the 2½ inch needle would perform satisfactory subarachnoid taps in 98.2 per cent of the cases.

## TECHNIQUE

Our technique is as follows: The operator scrubs and is gowned and gloved. The patient is placed in position by an assistant. The skin of the back is prepared and draped. A vasopressor is given intramuscularly. Usually it is not necessary to infiltrate the puncture site with procaine. It may be helpful to grasp the needle at or near its point for the initial thrust through the skin. Insertion is continued until the dural "give" is experienced. The stilet is then withdrawn. Spinal fluid does not flow quite as readily as with larger needles, and as long as ten to fifteen seconds may elapse before fluid is perceived in the needle hub. If puncture is adequate, however, a regular, slow, free flow of fluid will result. Spinal anesthetic drugs are then injected, and the patient is placed in position.

In the well medicated patient, the spinal puncture is not felt.

## RESULTS

The needle described has been used in 203 cases chosen at random from the operating schedule. Three taps were unsuccessful; all of these patients weighed more than 200 pounds. The needle, however, has proved satisfactory in patients as heavy as 250 pounds.

§ Known as the Brace Spinal Needle.

TABLE 1

RESULTS IN 200 CASES

| Type of Anesthesia | No. of Cases | Sex | | I.V. Fluid | Epinephrine, intrathecal | Pontocaine/ Dextrose | Position | | | Number of Taps | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Male | Female | | | | Prone | Supine | Lithotomy | 1 | 2 | 3 | 4 | 5 | Traumatic tap |
| High | 28 | 14 | 14 | 21 | 20 | 28 | — | 28 | — | 24 | 1 | 2 | 1 | — | — |
| Medium | 137 | 101 | 36 | 100 | 86 | 137 | 12 | 121 | 4 | 124 | 5 | 4 | 1 | 1 | 2 |
| Low + Saddle | 30 | 21 | 9 | 8 | 8 | 30 | 3 | 12 | 15 | 29 | 1 | — | — | — | — |
| Obstetrical Saddle | 5 | — | 5 | — | — | 5 | — | — | 5 | 4 | — | — | 1 | — | — |
| Total | 200 | 136 | 64 | 129 | 114 | 200 | 15 | 161 | 24 | 181 | 7 | 6 | 3 | 1 | 2 |

The results and clinical data in the 200 cases are given in table 1. The usual preoperative and postoperative routines were carried out as for any surgical case. Following operation, the patient was returned to the recovery ward. No special measures were taken regarding position, hydration or sedation. All gynecological patients were placed in semi-Fowler position, and the use of pillows was the rule rather than the exception.

The patients were visited for the first three postoperative days, and their charts were thoroughly scrutinized for the entire period of

TABLE 2

ANALYSIS OF CASES OF HEADACHE

| Case | Age, years | Wt. | Sex | Operation | Premedication | Mixture | Level | Fluids | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 30 | 154 | F | Inguinal Hernia | Nembutal, 1½ grain<br>Morphine ¼ grain<br>Atropine, 1/150 grain | P-D-A* | D 9 | 1,000 cc. | Headache 2 days postop. requiring no medication; lasted only two hours; not related to position. |
| 2 | 52 | 150 | F | Rectal Polyp | Nembutal, 1½ grain<br>Morphine, ¼ grain<br>Atropine, 1/150 grain | P-D† | D 10 | — | Headache 3 days post op.; immediate relief with aspirin, 5 grains. |
| 3 | 47 | 175 | M | Inguinal Hernia | Nembutal, 1½ grain<br>Morphine, ¼ grain<br>Atropine, 1/150 grain | P-D | D 10 | 1,000 cc. | Aspirin, 5 grains, gave prompt relief to a headache which appeared 2 days postop. |
| 4 | 70 | 94 | F | Vaginal Plastic | Demerol, 50 mg.<br>Atropine, 1/150 grain | P-D-A | D 6 | 500 cc. | Headache complaint only after careful questioning; cleared within a few hours. |
| 5 | 22 | 170 | F | Section | Demerol, 50 mg.<br>Atropine, 1/150 grain | P-D-A | D 6 | 500 cc. blood | 54 hours postop. patient complained of stiff neck and headache; 2 doses of aspirin, 10 grains, resulted in relief on awakening the following morning. |

* P-D-A—Pontocaine/Dextrose/Epinephrine.
† P-D—Pontocaine/Dextrose.

hospitalization. Five patients were found to have headaches, and one 66 year old man suffered a stroke four days after operation. The medical consultants ruled out anesthesia as a contributory cause. Data on the patients who had headache are listed in table 2. The first 4 patients cases were considered to have routine postoperative complaints of feeling "headachy"; the headaches were considered to be completely unrelated to the type of anesthesia employed. The last patient, because

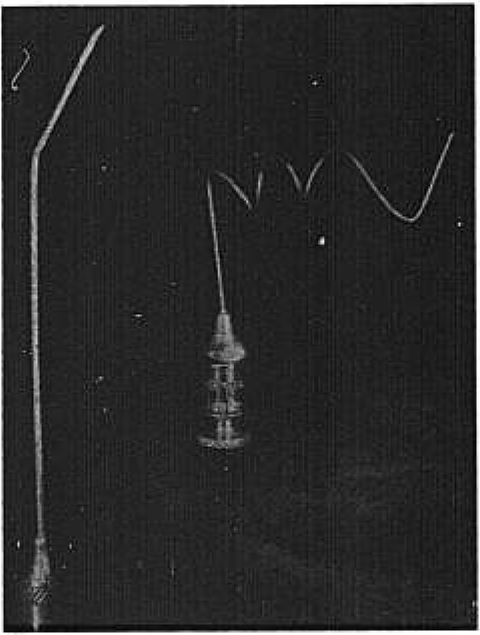

FIG. 6. Flexibility of needles is demonstrated. A fine gauge needle will wind around a forceps without breaking, whereas larger needles (in this case 19 gauge) will break during bending at any point between 45 and 90 degrees.

[Greene: J.A.M.A. 86: 391–392 (Feb.) 1926.]

of an associated stiff neck, was placed in the category of a minimal postspinal headache. No actual postspinal headache appeared in the entire series.

No other complications have become evident. In fact, in over 2,000 cases of spinal anesthesia done at our institution with a 2 inch 25 gauge needle [with which the percentage of unsuccessful taps was too high, Kaufman reported 30 in 1,000 cases (21)], there was an average of three mild headaches per 1,000 cases. There were no complications of presistent backache, infection or nerve involvement (28).

The smaller bore needles are less prone to breakage than any of the more popular spinal trochars. Dessloch, in 1939, surveyed the reports of 100 prominent anesthesiologists on "The problem of broken needles in spinal anesthesia." He revealed that the breakage rate was higher with 20 and 22 gauge needles than with 24 and 25 gauge needles (29). This can readily be demonstrated (fig. 6).

## FACTORS WHICH MAKE THE 25 GAUGE 2½ INCH NEEDLE IDEAL FOR SPINAL ANESTHESIA

These factors may be listed as follows:

1. Small puncture hole in the dura (also the skin and subcutaneous tissues, making for a smaller portal of entry).
2. Loss of spinal fluid is negligible.
3. Headache as a postspinal complication is eliminated.
4. Needle breakage need no longer be feared.
5. One needle technique is employed.
6. Needle insertion is rapid and painless, and the patient no longer fears spinal anesthesia.

## SUMMARY AND CONCLUSIONS

The complications following spinal anesthesia are listed.

A brief history of spinal anesthesia precedes the discussion of post-lumbar puncture headache. It is concluded that the etiologic factor in headache is the size of the dural opening with its consequent spinal fluid loss.

To decrease the dural opening, the 25 gauge 2½ inch spinal needle is used. The technique of puncture and results are described.

The needle has been used in 203 cases, in 200 of which successful punctures were made. One patient experienced a very mild spinal puncture headache, 4 had the routine postoperative complaint of headache, and one patient suffered a cerebrovascular accident completely unrelated to the anesthesia.

From the standpoint of rapidity, comfort and safety to the patient during the performance of the lumbar tap, and also decrease in post-operative headaches and other complications following surgical procedures performed under spinal anesthesia, the 25 gauge 2½ inch needle is presented as the ultimate in spinal puncture needles.

## ADDENDUM

Since this article was written, lumbar puncture has been performed with the Brace spinal needle in an additional 297 cases. The results were: 2 spinal headaches, 4 complaints of mild headache postoperatively (considered not spinal in origin), and 4 failures, 3 of which were owing to insufficient needle length. Of the 2 cases of spinal headache, one was of moderate severity and occurred in a patient who had a fifteen year history of recurrent migraine attacks; the other followed a bloody tap (in which spinal anesthesia was unsatisfactory), lasted twenty-four hours and was very mild.

Two interesting and significant cases appeared in this series. Case 1 was a 30 year old man who had previously had five orthopedic operations under spinal anesthesia, each followed by a moderate to severe headache. The sixth procedure, in which the Brace spinal needle was used, resulted in no postoperative complaints attributable to the anesthesia. Case 2 was a 24 year old man who had had two moderately severe headaches after spinal anesthesia. Following the third procedure, in which the 25 gauge needle was used, he was headache-free.

This technique has been employed in 500 cases to this date. The results are as follows:

| | Number | Per Cent |
|---|---|---|
| Total cases | 500 | 100.00 |
| Unsuccessful taps | 7 | 1.40 |
| Spinal anesthesias | 493 | 98.60 |
| Headaches | 11 | 2.23 |
| Nonspinal | 8 | 1.62 |
| Spinal | 3 | 0.60 |

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