

NEUROLOGICAL COMPLICATIONS OF SPINAL ANAESTHESIA

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THIS STUDY reports more than 20,000 consecutive spinal anaesthetics administered at the Veterans' Administration Hospital, Hines, Illinois, during the years 1948 to 1959, inclusive. In addition to the 20,000 cases analysed herein, approximately another 10,000 spinal anaesthetics were administered by the members of the staff of this hospital at other institutions (University of Illinois Research and Educational Hospitals and the Veterans' Administration West Side Hospital, Chicago) during the years mentioned. These have not been individually analysed (as are the cases in this paper), but a screening analysis has shown findings approximately the same in these 10,000 cases and certainly comparable to those in the 20,000 reported.

In analysing these cases, neurological complications were sought and the following types were looked for particularly:

Cerebrovascular accident within 10 days of spinal anaesthetic; transverse myelitis (para- or quadriplegia); peripheral nerve lesion; foot drop; persistent headache (longer than one week); neuritides; paralyses; muscular weakness; arachnoiditis, meningitis, meningismus; nerve deafness; strabismus or other cranial nerve lesions; herniated intervertebral disc; persistent lower bowel and bladder dysfunction; cauda-equina syndrome; chronic backache; any other neurological complications not listed here.

At this point, it should be emphasized that while these 17 categories were sought, not all of them were found in the cases studied.

The administration of these anaesthetics was, in a large part, performed by the resident staff in anaesthesiology, although residents in surgery, who were assigned to the anaesthesiology section, attending anaesthesiologists, consultants, and so on, performed a number of them.

The method of study of the 20,000 cases consisted in examining the operative notes and discharge summaries of all patients who were given spinal anaesthesia during the years listed. All records of subsequent admission of these same patients up to the present time were examined, and in every case in which a neurological diagnosis had been made, the entire chart of the patient was carefully gone over by several members of this team.

Of the 20,000 cases, approximately 1,300 charts were reviewed in detail,

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since these were the only patients carrying any neurological diagnoses. Upon review of these 1,300 charts, it was found that the neurological diagnoses in all but 34 instances were obviously not due to *sequelae* of spinal anaesthesia. The remainder of the cases were ruled out as being complications on the basis of one or more of the following reasons:

1. The neurological disease existed prior to the administration of spinal anaesthesia and was unchanged thereby.

2. The neurological disorder was obviously due to causes other than spinal anaesthesia, such as trauma.

3. Death, when it occurred, had no connection with anaesthesia.

4. Death was due to complications other than a neurological disorder.

5. The only complication was post-spinal headache of less than seven days' duration. (This length of time for a post-spinal headache was an arbitrary choice on our part, since we felt that while post-spinal headaches are certainly a neurological complication of spinal anaesthesia, we were more interested in permanent or semi-permanent *sequelae* than in the temporary self-limiting ones. This will be discussed more fully later in the paper.)

Of the 34 remaining cases in the study, after closer screening and perusal of the entire charts of these patients, 10 were found to have no real causal connection with the administration of spinal anaesthesia, although in several instances, first glance would lead one to believe that they had been due to spinal anaesthesia. When the 10 cases were carefully analysed, it was found that either they existed prior to anaesthesia and were not aggravated thereby, or that they were completely unrelated to anaesthesia. These ten are probably the most important of the entire group of cases. They are representative of the type of *sequelae* which are so often blamed on spinal anaesthesia both by laymen and professional people. In truth, the administration of spinal anaesthesia probably was a purely incidental thing and had nothing to do with the patient's neurological condition; yet it is cases of exactly this nature which are frequently the subjects of malpractice lawsuits. These cases will be discussed individually.

Case 1

A 50-year-old male had an established diagnosis of demyelination of the spinal cord and peripheral nerves on a vitamin B deficiency basis. Three days later before the report was in the patient's chart, he was given continuous spinal anaesthetic for biliary tract exploration. Postoperative course was completely uneventful. Had he suffered further progress in his disease, it would have been difficult to disprove the effect of the anaesthesia in aggravating it. The choice of spinal anaesthesia in cases of this kind is condemned because it is probable that the disease will progress and also that the anaesthetic agent may actually do harm.

Case 2

The patient was given a spinal anaesthetic for repair of right inguinal hernia. At that time, serology was not recorded in the chart. He was readmitted 18 months later with an apparent cerebrovascular accident. Examination revealed luetic taboparesis. This was not an anaesthetic complication, but it emphasizes the importance of careful pre-anaesthetic study of all patients, since any exacerbation of his condition might readily have been blamed on the anaesthesia. Here again, in retrospect, the choice of anaesthetic was a poor one. Any progress of the disease could be blamed on the anaesthetic agent.

Case 3

The patient was readmitted for treatment of weakness of the legs. He gave a history of "weakness of the legs" for six months prior to hospitalization. Shortly before the onset of weakness, he had a bilateral saphenous ligation and vein stripping under spinal anaesthesia. However, when the chart of the previous admission was closely scrutinized, the complaint of "weakness in legs" was revealed in the initial history prior to administration of the spinal. Neurological examination on the day prior to operation resulted in a diagnosed "quadriceps weakness, disuse" and cleared him for operation. It was an error of judgment to have given this patient a spinal anaesthetic since any aggravation may conceivably have been blamed on anaesthesia.

Case 4

A 50-year-old male had a repair of an inguinal hernia under spinal anaesthesia. He was discharged after an uneventful postoperative course. He was readmitted one month later with a history of having had a convulsion while unloading a truck that afternoon. There was confusion as to whether he convulsed then fell and struck his head, or whether he fell, struck his head, and then had a convulsion. The patient had a generalized epileptiform seizure while in the hospital admitting room. A diagnosis of post-traumatic epilepsy was made. He had no further episodes during his stay in the hospital.

This case is difficult to analyse because of paucity of information. Since no witnesses were present at the time of his injury, one cannot say whether there was any basis at all for assuming that this was anything more than concussion with subsequent epileptiform attack. Assuming that the seizure occurred prior to the injury, it is still rather difficult to connect this with an uncomplicated spinal anaesthesia more than a month previously and with no symptoms during the intervening time.

Case 5

A 36-year-old male had a gastric resection for duodenal ulcer under continuous spinal anaesthesia. He made an uneventful recovery. Eighteen months later, he was readmitted with complaints of dizziness, difficulty in walking, and weakness of the left leg for one year. He had loss of sexual power for nine months. There was no blurring of vision. He was diagnosed as having multiple sclerosis. This was confirmed on subsequent admissions. Had the neurological work-up been less careful, this could easily have been blamed on the anaesthesia.

Case 6

A 50-year-old male underwent a cholecystectomy and appendectomy in July 1953 under continuous spinal anaesthesia with 4 per cent procaine. Postoperatively, the patient failed to regain use of his legs. Laminectomy was performed two days later, at which time a tumour was found to be compressing the spinal cord. Biopsy of the tumour was made and diagnosed as Hodgkin's disease. This diagnosis had been unsuspected, but a few days subsequently, a record of a former admission which had been misfiled was found, and it was noted that in December, 1952, eight months previously, this diagnosis had been made on lymph node biopsy. The patient remained paraplegic and expired in May, 1954, in spite of therapy for Hodgkin's disease.

The spinal anaesthesia may have precipitated an earlier onset of paraplegia in this patient, but from the size of the spinal tumour the end result was inevitable whether or not it had been done. It is regrettable that the information as to the patient's diagnosis was not made available prior to surgical intervention, but even in the best regulated teaching institutions this can occasionally occur.

Case 7

A 36-year-old male underwent hemorrhoidectomy under spinal anaesthesia in April 1955. He was discharged asymptomatic one week later. Five months later, in October 1955, he was readmitted with complaints of "blackout episodes." Work-up at this time resulted in a diagnosis of grand mal epilepsy, probably secondary to a space-occupying lesion of the

left fronto-parietal region. The patient is still being followed as a brain tumour suspect. Surgery was not performed as the lesion could not be demonstrated either by means of carotid or vertebral angiograms or pneumoencephalogram.

While it is possible theoretically that this patient's symptoms could be secondary to his spinal anaesthesia, there are a number of reasons to rule this out. First, the anaesthetic agent was administered with the patient in the sitting position, and the height of anaesthesia at its most profound level was never above the twelfth thoracic segment. Second, there was no evidence of arterial hypotension which might have resulted in cerebral thrombosis at any time during or immediately following anaesthesia. Third, the patient's age and general physical condition were such that even had a transitory hypotension developed, one would not anticipate the occurrence of a cerebrovascular accident. Fourth, the onset of symptoms of this type was at a time sufficiently remote from the administration of the spinal that any connection with this event is unlikely. In the event of arachnoiditis or cauda equina syndrome, however, this time relationship would not necessarily hold true.

Case 8

A 68-year-old male had a repair of ventral hernia under spinal anaesthesia. Postoperatively, he had mental confusion, developed a right hemiparesis, and was transferred to the neurosurgical service where his work-up, including a carotid angiogram, revealed a space-occupying lesion. Approximately one month postoperatively, craniotomy was performed at which time a temporal astrocytoma was found. Two months later, the patient expired from bronchopneumonia.

This case is included to demonstrate instances in which the spinal anaesthesia can be blamed for occurrences which are actually due to some extraneous cause. This brain tumour was unsuspected prior to the initial neurological work-up after the hernia repair.

Case 9

A 29-year-old male had a hemorrhoidectomy under spinal anaesthesia. Postoperatively, he complained of episodes of numbness from the dorsum of the left foot to the buttocks. He was given a complete neurological work-up first by the department of anaesthesia and then by the neurology service. No organic basis for the complaints was demonstrated and a diagnosis of conversion reaction was established. Approximately 18 months later he was readmitted and at this time he did not mention the previous complaints. He returned at this time for treatment of varicose veins.

Case 10

A 31-year-old male had a right lumbar sympathectomy performed under spinal anaesthesia for recurrent dermatophytosis with vascular insufficiency of the right leg. At the time of operation, it was noted in the chart that the lumbar puncture was performed at the level of the third and fourth lumbar interspace and was an atraumatic tap with clear cerebrospinal fluid. The patient pursued an uneventful course and was discharged nine days following surgery. Eight days later, on the seventeenth postoperative day, he was readmitted complaining of pain in the posterior aspect of his right hip and lateral aspect of the thigh and calf. At this time, a diagnosis of sciatic neuritis, mild, was made and sciatic nerve block provided relief. An X-ray of the lumbosacral spine performed at this time revealed a narrowing of the *fifth lumbar-first sacral* interspace. A diagnosis of complication of spinal anaesthesia was made by the ward physician.

Neurological or orthopedic consultations were not noted in the record. Relief was obtained on conservative management, and the patient was discharged after about two weeks of treatment with no recall scheduled.

Two years later, he was readmitted with a complaint of a non-healing right plantar ulcer. Because of the history and the fact that the present study was underway, a neurological examination was requested by the anaesthesiologist. This revealed only one abnormal finding, namely, weakness in dorsiflexion of the right foot associated with an ulcer on the plantar surface of the foot, underlying the first metatarso-phalangeal joint. Diagnosis by

the neurologist was right peroneal palsy manifested by the above deficit. Electromyogram and rheobase and chronaxie testing of the lower extremities were performed which manifested slight slowing in the right lower extremity without definitive pathology.

The patient at this time has no symptoms referable to the right lower extremity.

Inasmuch as the patient had a right lumbar sympathectomy performed it is conceivable that the pathology shown could be on the basis of this neurological procedure or pre-existing vascular disease, casting further doubt on spinal anaesthesia being the etiological factor for this patient's findings.

The 24 neurological complications accepted by us as conceivably being due to spinal anaesthesia fell into five rather broad categories as noted in Table I.

TABLE I

TOTAL NEUROLOGICAL COMPLICATIONS ENCOUNTERED IN 20,000 CASES OF SPINAL ANAESTHESIA

	1948-51 10,000 cases	1952-55 6,000 cases	1956-59 4,000 cases	Total 20,000 cases
Cerebral vascular accident within 10 days of anaesthesia	4	2	0	6
Meningitis	1	1 (died)	1	3 (2 recovery)
Persistent headache (over one week)	3	5	1	9
Chronic backache	2	0	0	2
Cardiac arrest	3 (1 recovery)	1	0	4 (1 recovery)
TOTAL	13	9	2	24
PERCENTAGE	0 13	0 15	0 05	0 12

Representative examples of these cases are as follows:

Category 1. There were six cerebrovascular accidents which occurred within 10 days of spinal anaesthesia. One such case is as follows:

A 55-year-old male had a procaine spinal (100 mg. in 5 c.c.) for a circumcision. Blood pressure had previously been recorded at 180/100 on several occasions. Immediately pre-anaesthetic, it was 112/76 with pulse of 68. During anaesthesia, it fell as low as 100/60. Approximately 12 hours post-anaesthetic, at 3:30 A.M., the patient fell to the floor. Cerebrovascular accident was diagnosed. Complete right hemiparesis ensued. Blood pressure at that time was 136/80. There was no evidence available to show that the spinal caused this CVA. The blood pressure had already fallen prior to administration of the spinal anaesthetic. The pre-anaesthetic medication could be as much to blame as the anaesthetic. The five other cerebrovascular accidents were similar.

It is established that a profound fall in blood pressure can encourage cerebral thrombosis. This results regardless of the cause of the hypotension. It is also established that spinal anaesthesia can cause hypotension. Therefore, it is quite within the realm of probability that in susceptible individuals, for example, those with cerebral arteriosclerosis, any uncorrected hypotension following spinal anaesthesia might result in a cerebral vascular accident. Whether any of the six cases in this series were so caused is not absolutely determined. It is a possibility that spinal anaesthesia played a part in the causation of these accidents, and they are therefore reported. Regional anaesthesia was really indicated in these cases.

There were three cases of meningitis with one death. These will be reported in detail.

Case 11

A 40-year-old male underwent cholecystectomy under spinal anaesthesia. Three days postoperatively he developed severe headaches when he was allowed out of bed. The headaches were less severe when he was lying down. Photophobia and sensitivity to noise accompanied them as did nausea and nuchal rigidity. Forty-five days later, the spinal fluid pressure was very low. After injecting 40 c.c. of sterile saline, spinal fluid was obtained with 207 mg. per 100 gm. of protein and 133 cells. The headaches continued for a total of 55 days at which time the cell count was 10 and protein 130 mg. per 100 gm. Follow-up examination two years later revealed no residuals. Culture and smear of cerebrospinal fluid were negative at all times. This is an anaesthetic complication. It was probably due to chemical irritation or some break in technique. Low grade infection must be considered even in view of the negative smears and cultures.

Case 12

A 56-year-old male underwent transurethral prostatic resection in April 1955 under spinal anaesthesia. Four days later he developed a low grade fever and mental confusion which gradually increased and subsequently developed nuchal rigidity and signs of meningeal irritation. In May 1955, Klebsiella was cultured from both urine and cerebrospinal fluid. The patient was treated with antibiotics and was discharged as recovered in December, 1955. This patient was a diabetic and had tertiary lues with lowered resistance to infection so that it is dubious as to the aetiology of the CNS infection, that is, whether it was systemic or direct. Lacking evidence to the contrary, however, it must be included as a possible contamination by the lumbar puncture.

Case 13

A 65-year-old male had a history of suprapubic prostatectomy for carcinoma of the prostate and stormy postoperative course. This procedure was done under general anaesthesia. Eleven months later, litholapaxy was done under spinal anaesthesia, followed in two weeks by transurethral resection of the bladder neck, likewise under spinal anaesthesia. The postoperative course following this second spinal was uneventful, and he was discharged one week later to return "on call." He came back, however, in one week without being called and was admitted for the management of tonic convulsive seizures of 1 day's duration. This condition was preceded by headaches and visual difficulties which began three days after his discharge from the hospital. At the time of readmission, a diagnosis of Jacksonian seizures, aetiology unknown, and right flaccid hemiplegia were made. X-rays showed evidence of Pineal shift. Lumbar puncture was attempted but because of the patient's restlessness was not accomplished at this time.

Approximately three weeks after the second spinal anaesthetic, a carotid angiogram and lumbar puncture were done. At this time, the cerebrospinal fluid was cloudy and had 8,000 cells, principally polymorphonuclears. The patient had a full-blown meningitis. Blood cultures at this time and two weeks later were negative although the spinal fluid culture revealed coagulase positive staphylococcus aureus. Massive antibiotic therapy was begun. A subtemporal decompression was performed. The patient also required tracheostomy. His course was progressively downhill for approximately two months until he expired.

The final anatomical diagnoses made at autopsy were:

1. encephalomalacia of the left temporoparietal lobe, massive
2. adenocarcinoma of the prostate
3. adenocarcinoma of the proximal ascending colon
4. bronchopneumonia of left upper and right middle lobes with pulmonary edema
5. adrenocortical adenoma
6. septic splenitis
7. patent foramen ovale
8. recent infarct of the right kidney

It is extremely difficult to reconstruct the aetiology of this patient's brain abscess. His symptoms began approximately 10 days following the second spinal anaesthetic and could conceivably have resulted from bacterial contamination introduced at the time of spinal anaesthesia. However, this patient also had evidence of uraemia as well as a malignancy which could very possibly have metastasized to the brain. Further possibilities are presented by the presence of the patent foramen ovale which could have resulted in a transfer of organisms from the right side of the heart to the left with embolic bacterial transmission. The negative blood cultures with positive spinal fluid cultures present some evidence that the spinal fluid infection may have been primary, but it is well known that in many instances of meningeal contamination, the blood culture may return to negative while the spinal fluid still has a high bacterial count, so that this is not in itself a conclusive finding. The presence of the renal infarction is also evidence of a generalized bacteraemia, although again it cannot be determined which came first, the bacteraemia or the meningeal infection.

Lacking evidence to the contrary, we feel that this case must be included as a possible complication of spinal anaesthesia although it is far from conclusive.

Nine cases of persistent headache of more than one week's duration are reported. These differ from the preceding cases only in degree. One such case lasted two months, another two weeks, and a third one week. Cases of headache clearing in less than one week were not considered worthy of inclusion in this study, even though they are extremely undesirable and unpleasant and are economically and scientifically spinal complications, they were not part of the subject we chose to study.

Headache which follows spinal anaesthesia is probably due to the anaesthesia if it meets certain criteria, as follows:

1. The headache is usually occipital if due to spinal.
2. There may be nuchal rigidity accompanying the headache.
3. The assumption of the supine position ordinarily affords relief with return of the headache upon assuming the erect position.
4. Ordinary analgesics such as aspirin do not completely relieve the pain.
5. A tight abdominal binder or extradural injection will frequently relieve the pain.

A 44-year-old obese male was essentially well except for haemorrhoids. He was operated upon for this condition. Postoperatively, he developed headaches which lasted for a period of about one week. From perusing the chart, no evidence of any specific treatment for the headaches was mentioned. In postoperative follow-up after hospitalization, there was no further mention of any complication.

Two cases of chronic backache are reported. Both were given diagnoses of "chronic lumbosacral strain." A typical case history follows.

A 38-year-old male had a left inguinal hernia repaired under spinal anaesthesia. He had no history or complaints relative to his back at that time. Since then he has had three admissions for treatment of chronic lumbosacral strain.

Both patients were obese and there was no evidence that the spinal anaesthetic was to blame. On the other hand, there was no evidence to show that the spinal anaesthetic was completely blameless. The good muscular relaxation afforded

by spinal anaesthesia may result in flattening of the normal lumbar curve when the patient is placed in the supine position without a small pillow or other support in the lumbosacral region. Thus, it is difficult at this time to state whether the two cases of backache were or were not due to the spinal anaesthesia. This condition can follow any anaesthetic technique that relaxes the musculature and permits abnormal stresses to occur. It is especially likely to happen when lithotomy or other abnormal positions are employed.

Cardiac arrest coincident with spinal anaesthesia occurred in four cases. Two of these, however, were moribund patients scheduled for amputation following iliac thrombosis. In these, poor judgment as to the advisability of administering any anaesthetic other than perhaps refrigeration or some form of regional block is more to be blamed than the spinal itself. The third case is somewhat more complex.

A 29-year-old male law student was given a spinal anaesthetic for laparotomy for a perforated viscus. A perforated appendix was removed, but during the procedure the spinal anaesthesia was supplemented at first with thiopentone and later with inhalation agents. As the abdominal closure was being completed cardiac arrest occurred. Resuscitation was accomplished after the heart had been stopped approximately four to five minutes. Residuals of cerebral anoxia were present for several days in the form of convulsions, animal-like cries, and so on. He then proceeded to make an otherwise uneventful recovery.

This case could certainly not be blamed entirely on the spinal. Inhalation anaesthesia and thiopentone were also employed. The discussion of this case is difficult since such a multiplicity of agents and techniques were employed. It is established that a period of respiratory obstruction and respiratory depression occurred during the general anaesthesia. It is reasonable to suppose that this with or without the spinal could be sufficient to have produced the cardiac arrest.

The fourth case resembles the one who recovered in some respects, but this time the outcome was different.

A 25-year-old male was given continuous spinal anaesthesia in April 1954 for the removal of a ruptured appendix. Two doses of 4 per cent procaine consisting of 80 and 40 mg. were given during a 50-minute period. The patient was apparently doing very well when suddenly as the abdomen was about to be closed, his pulse stopped. The patient lost consciousness and the blood pressure fell to zero and respiration ceased. Cardiac resuscitation was undertaken through a thoracotomy at once, and he resumed spontaneous cardiac rhythm and respiration but failed to regain consciousness. He expired three days later.

It is difficult, if not impossible, for us to explain the demise of this patient who was a young, otherwise healthy, manual laborer. We have no choice, however, but to include his case as a complication of spinal anaesthesia. We are at a loss to explain why prompt, efficient cardiac resuscitation was ineffectual in affording a recovery in this case.

DISCUSSION

It will be noted that the incidence of complications in the final 4,000 cases in this series has dropped considerably from an average of 0.15 per cent in the first portion to 0.05 per cent in the last 4,000 cases. The over-all average incidence of neurological complications in the 20,000 cases in the series is exactly 0.12 per

cent. It must be especially noted that other complications (that is, cardiovascular) were not sought in making this study. It was noted, however, that in the final 4,000 cases, there were five occurrences of myocardial infarction with four deaths. These cases are not included in the statistics of this paper since it was not our province to study other than neurological complications. It is our opinion, however, that this rate of incidence compares favourably with that of vascular complications regardless of the modality of anaesthesia employed.

The type of agents that were used to produce spinal anaesthesia should be mentioned. In the vast majority (probably more than 90 per cent of the cases) Pontocaine® with 10 per cent dextrose as a solvent and weighting agent was the anaesthetic used. A few cases were performed with either Nupercaine® or procaine, but these are very few in number. In many of the anaesthetics, epinephrine was added to the other intrathecal agents. Both dextrose and epinephrine have been previously incriminated by some authors as being nerve-tissue or meningeal irritants and capable of causing neurological damage. It seems quite significant to us that there were no cases of adhesive arachnoiditis which has been pointed out by Courville³ and others as being one of the commonest complications of spinal anaesthesia. Nor did we note any cranial nerve lesions, particularly the sixth-nerve lesion, which have been pointed out as being the commonest cranial nerve lesion.

Several alleged complications of spinal anaesthesia have been called to the attention of this department, although on closer investigation and study of the records, they were seen to have been due to extraneous causes. An example was the case of a patient in the paraplegic section of the hospital. It was reported that he had been given spinal anaesthesia and subsequently developed a spastic paraplegia which the doctor calling this to our attention felt was due to the anaesthetic. On examination of the record, however, it was determined that the onset of the paraplegia occurred some time after discharge from the hospital following an automobile accident during which the patient sustained serious internal injuries. Another such case was that of a physician who was alleged to have had paraplegia as a result of a spinal anaesthetic. On investigation, it was found that this physician had been under anticoagulant therapy for thrombophlebitis of his leg. As a result of neurological symptoms, he had a diagnostic lumbar puncture which revealed the presence of haematomyelia, which undoubtedly was the cause of his paraplegia. The patient had never received spinal anaesthesia for any condition.

These two cases typify some of the many that are called to the attention of the anaesthesiologist allegedly as neurological complications of spinal anaesthesia. We have no doubt that neurological complications can and do occur. However, we feel that the incidence of these is extremely low as compared to patients having received general anaesthesia for surgical procedures.

It is a surprising finding to us that in the third portion of our series of 20,000 cases, namely the last 4,000 from 1956 through 1959, only two complications which could have been due to spinal anaesthesia were encountered. This is even less than we anticipated or than the number encountered in the first 16,000 cases. We have no way of explaining this except chance, since our technique has

remained essentially unchanged. The principal difference between the technique used prior to 1956 and that used at the present time has been the fact that since 1956 all of the spinal anaesthetic drugs have been autoclaved prior to their injection whereas, previous to that time, the drugs were sterilized by immersion for a period of time in a solution of antiseptic agent. We do not seriously believe that this would account for the difference in the number of complications found and merely mention it in passing.

As brought out in the previous papers,^{1,2} these anaesthetics were administered by a rather heterogeneous group varying widely in their training, from new residents fresh from an internship through staff anaesthesiologists to specialists of professorial rank. It is reasonably unlikely that any important complications were missed since in this hospital a large staff is employed solely for the purpose of maintaining adequate records, and, since the hospital is a 100 per cent teaching institution, this is done zealously. Follow-up of individual patients is easy to perform and is ordinarily complete, since this is a government institution and the individual recipients of care are usually quite willing to co-operate because of the involvement of compensation or pension for their problems, either real or fancied. In addition, because of the university affiliation, consultation service with the various specialties is both readily performed and well done. Third, there is no tendency on the part of the physician involved to evade the issues by minimizing complications since, should these occur, the government usually assumes financial responsibility. Therefore, the number of complications through inadequate follow-up is minimal, and should major complications occur, the likelihood of the patient returning is extremely great because they are aware of the possibility of compensation. It is possible that a few complications were missed because the patient went to another Veterans' Administration Hospital. However, this is rather unlikely. Furthermore, it is difficult to hide *sequelae* when they do occur because of the wide diversity of services involved in the hospital and the desire by each service to build up its own importance. Since it is both difficult and needless to hide complications, it can be assumed for all practical purposes that all have been reported.

While not denying that some cases could have been missed in the fashion described above, the number of cases (20,000) in which no appreciable number of complications occurred, is certainly significant in itself. During the time of this study, numerous cases of alleged complications of spinal anaesthesia were called to our attention. On closer investigation, all proved groundless. Some of these patients had general anaesthesia rather than spinal; some were due to trauma, some had no anaesthesia at all, and in spite of this, the stories were rampant that spinal anaesthesia had caused these paralyses and other neurological complications. These wild tales have harmed the reputation of an essentially safe and good technique, and in many instances caused patients to be subjected to the additional hazard of a less safe anaesthetic technique. We were amazed in this study at the frequency with which neurological complications appeared at first glance to be present, only to be shown by further investigation that they had no connection with the anaesthetic technique or administration,

as is demonstrated by the several cases which we have submitted above. Inadequate follow-up of these patients or early discharge perhaps would have been *prima facie* evidence of the spinal being at fault, while closer study disproved the original contention. Certainly, the cases as exemplified by Case 9 who exhibited findings of numbness and tingling in the left lower extremity following a spinal anaesthetic for hemorrhoidectomy are legion. Unless careful examination, as was performed on this patient, reveals that there is no organic basis for the complaint, it would definitely be blamed upon administration of the spinal. It is pertinent to this discussion to emphasize at this point that we have been rather unselective in choosing cases for spinal anaesthesia and the contraindications for this technique have been relatively few. That is, we have given spinals to patients with CNS lues and other lesions, sometimes because the diagnosis was not evident at the time of administration; yet our morbidity and mortality figures are extremely low. This does not imply that we condone or recommend this practice, but merely records the fact that we have done it and had no addition to our morbidity figures. It is also pertinent that the age of our hospital population is somewhat above that of the average hospital, comprising principally World War I and II veterans from the fourth decade up to the eighth, thus presenting a higher incidence of degenerative diseases than the average patient. Furthermore, spinal anaesthesia tends to be our technique of choice in acute abdominal emergencies, much more frequently than is the case in the average hospital.

Again we wish to emphasize the importance of an adequate neurological investigation when neurological disease or pathology follows spinal anaesthesia. This is as much to rule out other aetiological factors as to protect the patient, since it is quite evident to us, at least, that spinal anaesthesia is rarely the responsible precipitating factor.

We have also pointed out that we use dextrose, epinephrine, and catheter techniques, all of which are inclined to increase the morbidity and in spite of this our statistics are still good.

Pontocaine-dextrose is our predominant agent in most cases. Epinephrine is frequently used, and the catheter continuous spinal technique is also very frequently employed.

It is unfortunate, but true, that insurance companies, many physicians, and patients have serious doubt as to the safety of spinal anaesthesia. It is our belief that these doubts are not warranted on the basis of our group experience. We feel conversely that the intelligent employment of spinal anaesthesia may reduce morbidity. Rumour mongering may tend to prevent its use where it is best indicated and is, therefore, a doubly vicious thing.

SUMMARY

Twenty-four neurological complications attributable to spinal anaesthesia were found in a series of 20,000 consecutive spinal anaesthetics, an over-all incidence of 0.12 per cent. Of these 24, nine were persistent headaches lasting one week or longer with complete recovery. In three of these cases, the patients

probably should not have been subjected to spinal anaesthesia because they were moribund or nearly so prior to the administration of the anaesthetic and an error of judgment rather than an indictment of the technique should be blamed. Three cases of meningitis with two recoveries were also included because the spinal technique cannot be ruled out as the introducing factor in causing the meningitis, although there is reasonable doubt as to whether this was actually the case. Two cases of chronic backache were the remaining complications.

It is quite interesting that of the 17 neurological conditions sought in our study, only the above five occurred. There were no incidences of transverse myelitis, radiculitis, peripheral nerve lesions, foot drop, neuritides, paralyses, muscular weakness, deafness, cranial nerve lesions, persistent lower bowel and bladder dysfunction, or cauda equina syndrome observed.

CONCLUSIONS

In conclusion, it is our definite impression from the study of 20,000 consecutive spinal anaesthetics that this is the safe and recommended technique for administration of necessary anaesthesia for surgical conditions below the level of the diaphragm and where definite contraindications to this technique, neurological conditions, central nervous system lues, and so on, do not exist. Irresponsible rumour mongering and blaming of the technique for complications caused by extraneous conditions have been responsible for condemnation of spinal anaesthesia. We feel that this valuable technique has been much maligned in the past and deserves a better reputation than it now enjoys in some quarters. We shall continue to employ it as we have in the past, and we believe that it will continue to give us equally good results.

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