

EPIDURAL ANESTHESIA IN GENERAL SURGERY

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DURING the past few years, numerous articles have appeared in the medical literature dealing with epidural anesthesia. The historical background as well as the anatomy and the physiology of epidural anesthesia has been described adequately in the current medical literature (1-18). We feel that a majority of the articles mention the advantages of this type of conduction anesthesia but fail adequately to stress the pitfalls, the complications, and the risks involved, particularly in the hands of a novice. It is with this point of view in mind that we wish to present our experiences and impressions in a series exceeding 2,100 consecutive epidural anesthetics.

TECHNIQUE

The patient is placed in the lateral decubital position with his back flexed and a pillow under his head. The operating table is so inclined that the longitudinal axis of the body is slightly above the horizontal. If somnolence is desired, the patient is induced with 0.25 to 0.4 Gm. of Surital® sodium intravenously. A skin wheal is made at the selected interspace with a local anesthetic agent containing a vasopressor agent. A nontraumatic puncture of the skin is made with an 18 gauge needle and the blunt epidural needle is inserted in the midline parallel with the spinous processes. The epidural needle is advanced slowly and deliberately through each ligamentous layer of resistance. If periosteum is encountered, the needle is withdrawn and is inserted at a more desirable angle. When the needle point is inserted into the third layer of resistance, the ligamentum flavum, the stylet is removed, and a 5 cc. syringe filled with distilled water is attached to the hub of the needle. The needle is advanced slowly with the left hand, which is braced firmly against the patient's back while constant pressure is applied to the plunger of the syringe with the right thumb. The feeling of a slight snap and the sudden forward motion of the plunger of the syringe indicates that the ligamentum flavum has been pierced and the epidural space entered. The water causes a burning pain if the patient is awake and slight movements if the patient is asleep, which is further evidence that the needle point is in the epidural space. Five cubic centimeters of the desired local anesthetic solution is administered quickly, followed by aspiration in all 4 planes to test for the presence of spinal fluid. If fluid

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cannot be aspirated and no warm solution drips from the hub of the epidural needle, the desired amount of local anesthetic agent is administered slowly with a 20 cc. syringe. The patient is then positioned as desired but the operating table is maintained in a slight reverse Trendelenburg position for approximately five to ten minutes. An intravenous infusion is started, and the patient managed as followed subarachnoid block.

Continuous epidural anesthesia is induced by threading a plastic catheter through an ordinary or a directional epidural needle. The tip of the plastic catheter, which prior to the insertion is placed in hot water until soft, usually is passed only a few centimeters beyond the tip of the epidural needle.

TOTAL SERIES

Table 1 illustrates a brief summary of the 2,110 consecutive epidural anesthetics performed in this series. Surital sodium was administered intravenously to 1,229, or 58 per cent, of the patients to allay apprehension or to render the induction of this form of anesthesia painless. In addition, 156 patients, or 7.4 per cent, were supplemented with Surital sodium because of pain or a desire to be unconscious throughout the operation. The ultrashort acting muscle relaxant, succinylcholine chloride, was administered to 33 patients (1.5 per cent) because of unsatisfactory relaxation or to facilitate closure of the peritoneum. Sup-

TABLE 1
TOTAL SERIES

Types of Operation	No. of Cases	Surital Induction	Supplementation		
			Surital	Anectine	CiH ₄
Gastrectomy	21	15	1	1	1
Cholecystectomy	249	183	16	12	1
Upper abdomen	28	17	0	1	0
Thoracic and sympathectomy	8	3	2	0	1
Appendectomy	197	142	6	3	1
Pelvic and lower abdomen	233	165	13	2	1
*Total hysterectomy	374	287	23	7	6
Caesarean section	82	0	33	0	1
Herniorrhaphy	368	237	16	5	1
Laminectomy and spinal fusion	89	7	25	0	0
Genito-urinary	92	51	7	1	0
Orthopedic	89	42	6	0	0
Rectal and plastic	195	75	5	1	0
Abdominal perineal resection	10	5	2	0	0
Vaginal delivery	9	0	0	0	0
Therapeutic	66	0	1	0	0
	2110	1229 or 58%	156 or 7.4%	33 or 1.5%	13 or 0.6%

* Includes 70 vaginal hysterectomies.

plementation with cyclopropane inhalation anesthesia was required in 13 patients (0.6 per cent). A majority of the unsatisfactory epidural anesthetics in this series occurred relatively early and generally were due to entering the epidural space at too low a level or to the administration of an inadequate amount of anesthetic solution. In a few cases, however, the needle was placed incorrectly.

LOCAL ANESTHETIC AGENTS

The following local anesthetic agents were administered: Xylocaine®, 1½ to 2 per cent solution, in 1,870 cases; Cyclaine®, 1½ to 2 per cent solution, in 200 cases; 2-chloroprocaine, 3 per cent solution, in 35 cases, and Pontocaine®, 0.2 per cent solution, in 5 cases. The volume of anesthetic solution injected depends on numerous variables, such as the site of epidural puncture; the type and the duration of the operative procedure; the age, the height, the weight, and the physical status of the patient. In this series, the smallest dose administered by the single injection technique was 10 cc. of 1½ per cent Xylocaine for a thoracotomy while the largest was 50 cc. of 2 per cent Xylocaine for a subtotal gastrectomy. However, the maximum amount given was 85 cc. of 2 per cent Xylocaine by the continuous catheter technique for an involved abdominal procedure which required five hours and twenty-five minutes operating time. Table 2 illustrates the average dosage range of Xylocaine employed for various operations in this series.

AGE

Table 3 illustrates the age distribution by decades. All degrees of surgical and anesthetic risks ranging in age from 10 to 93 years are represented in this series.

TABLE 2
INJECTION SITE AND DOSEAGE

Procedure	Site	Xylocaine 2%	
		Minimum	Maximum
*Thoracic	C ₇ -T ₁ . . . T ₈ -T ₁₀	10 cc.	20 cc. ↓
Gastrectomy	T ₁₀ -T ₁₁ . . . T ₁₂ -L ₁	35 cc.	50 cc. ↑
Cholecystectomy	T ₁₀ -T ₁₁ . . . T ₁₂ -L ₁	30 cc.	45 cc. ↑
Appendectomy	L ₁ -L ₂ . . . L ₂ -L ₃	20 cc.	30 cc. ↑
Inguinal herniorrhaphy	L ₂ -L ₃ . . . L ₃ -L ₄	15 cc.	25 cc. ↓
Total hysterectomy	L ₁ -L ₂ . . . L ₂ -L ₃	20 cc.	35 cc. ↑
Vaginal hysterectomy	L ₁ -L ₄ . . . L ₄ -L ₅	20 cc.	25 cc. ↓
Hemorrhoidectomy	L ₂ -L ₄ . . . L ₄ -L ₅	15 cc.	20 cc. ↓
Lower extremity	L ₂ -L ₄ . . . L ₄ -L ₅	20 cc.	25 cc. ↓

↑—Bevel of needle directed cephalad.
↓—Bevel of needle directed caudad.
* Thoracic—1½% xylocaine.

TABLE 3

Age Distribution	Age	
	No.	%
10-20	56	2.6
20-40	758	35.9
40-60	927	43.9
60-70	266	12.7
70-80	80	3.8
80-100	23	1.1
Total	2110	100%

EPIDURAL PUNCTURE SITES

It is recommended generally that the site of epidural puncture correspond as closely as possible to the center of the segments which are to be anesthetized. We tend to select a lower puncture site than this accepted ideal for upper abdominal procedures, and, conversely for pelvic, rectal, and lower extremity procedures, a slightly higher level generally is utilized. For example, usually it is easier to enter the epidural space at the second or the third rather than at the fourth or the fifth lumbar interspace. Table 2 illustrates roughly the puncture sites we have employed for various operative procedures. The direction of the level of the epidural needle is indicated by means of arrows.

COMPLICATIONS OCCURRING DURING ANESTHESIA

Table 4 illustrates briefly the major complications which were encountered in this series. (1) In 8 cases, rather marked falls in blood pressure occurred, which were due chiefly to blood loss or extensive traumatic surgery. Seven of these cases responded to blood volume replacement and vasopressors. The eighth case will be referred to later. (2) Marked hypertension occurred in 1 case which we attributed to the epinephrine in the local anesthetic solution. The blood pressure gradually returned to normal following the administration of hexamethonium. (3) Massive epidural block occurred in 4 instances; in 2 cases it was due probably to the rapid administration of rather large doses of anesthetic solution, 40 cc. of 2 per cent Xylocaine and 40 cc. of 2 per cent Cyclaine, respectively. In the other 2 cases, moderate volumes were injected rapidly. All made complete and uneventful recoveries. (4) Marked depression or drowsiness occurred in 4 cases. This phenomenon owing to the rapid absorption of the local anesthetic agent is accompanied by rather shallow respirations, pallor, low or normal blood pressure, tachycardia, and very large pupils. Recovery was complete and uneventful in each case. (5) Massive or total subarachnoid block occurred in 2 cases accompanied by the classical signs; that is, apnea, cyanosis, precipitous fall in blood pressure with a thready pulse, and large pupils. Both responded to standard resuscitative measures, including controlled respirations, endotracheal oxygen,

and vasopressors. The 1 patient who received 35 cc. of 1½ per cent Xylocaine remained apneic for forty-five minutes, following which he made a completely uneventful recovery without untoward sequelae. The other patient who received 20 cc. of 2 per cent Cyclaine remained apneic for approximately two hours; the postoperative course will be described later. (6) Mild convulsive seizures occurred in 5 patients despite previous induction with Surital Sodium. In 1 case, epidural anesthesia was induced with 30 cc. of 2 per cent Cyclaine while the other 4 received the following amounts of Xylocaine, 35 cc. of 1½ per cent, 30 cc. of 1½ per cent, 25 cc. of 2 per cent, and 15 cc. of 2 per cent. These mild convulsions were controlled with 5 to 10 cc. of Surital sodium intravenously.

TABLE 4

ANESTHESIA COMPLICATIONS	
Complications	No.
Hypotension (precipitous)	8
Hypertension	1
Massive epidural block	4
Total subarachnoid block	2
Marked depression and/or drowsiness	3
Convulsions	16
	—
Total	34

Eleven severe convulsions occurred; 5 followed the administration of the following volumes of 2 per cent Cyclaine—40 cc., 35 cc., 40 cc., 30 cc., and 30 cc., respectively. Four followed the administration of the following volumes of 2 per cent Xylocaine—50 cc., 20 cc., 20 cc., 20 cc., and of the 1½ per cent solution 35 cc. and 20 cc. Induction with Surital sodium had been carried out in 2 of the Cyclaine group but in only 1 of the Xylocaine group. In each case, the convulsions were controlled with Surital sodium intravenously. Respiration was controlled with oxygen and vasopressors administered when indicated. The anticipated surgical procedure was completed in each instance and recovery was uneventful without sequelae. These patients were checked very closely postoperatively by both the surgeons and the anesthesiologists, but no ill effects of the convulsions became apparent.

The incidence of convulsions following Cyclaine 2 per cent solution was 5 in 200 epidural anesthetics or 2.5 per cent; while following Xylocaine it was 5 in 1,870 cases or 0.27 per cent. We believe that the absence of epinephrine in the Cyclaine solution was an important factor in the occurrence of this systemic toxic reaction.

MINOR POSTOPERATIVE COMPLICATIONS

The incidence of minor postoperative or postanesthetic complications such as headache, backache, nausea, and vomiting is remarkably low following epidural anesthesia. Table 5 illustrates the incidence

TABLE 5
MINOR POSTOPERATIVE COMPLICATIONS (1,700 CASES)

Complaint	Postoperative Day					
	First	%	Second	%	Third	%
Headache	25	1.5	27	1.5	17	1.0
Backache	28	1.6	29	1.7	18	1.0
Nausea	46	2.7	44	2.5	34	2.0
Vomiting	48	2.8	40	2.4	28	1.6

of these complaints in the first 1,700 cases. Headache of sufficient intensity to require medication occurred in just over 1 per cent on the first 3 postoperative days; and in less than 0.5 per cent on the fifth day. One patient following a bilateral saphenous vein ligation developed a very severe typical lumbar puncture headache which persisted for 3 weeks. She refused special therapy such as epidural saline, but 2 weeks following her discharge the headache suddenly disappeared. There was no indication that the dura had been punctured, thus we are at a loss to explain this incident. Backache was present in less than 2 per cent of the cases during the first 3 days. Nausea and vomiting following all types of operative procedures were present in less than 3 per cent of the cases during the first 3 postoperative days.

MINOR NEUROLOGICAL SEQUELAE

One patient developed numbness along the posterior and the medial aspects of the right thigh which gradually disappeared. We believe that it was due to intramuscular injections close to the sciatic nerve. One patient following an inguinal herniorrhaphy was unable to discern bladder fullness the first seven postoperative days. This annoying symptom disappeared spontaneously. A nervous female complained of vague spasm in her legs and feet following a nephropexy. Tolserol® quickly relieved this complaint, thus we believe that it was functional in origin. Some patients complain of a persistence of numbness postoperatively. We believe that this sensory analgesia is a distinct advantage and decreases the demand for narcotics.

MAJOR POSTANESTHETIC SEQUELAE

One patient in whom an inadvertent subarachnoid block followed the administration of 20 cc. of 2 per cent Cyclaine developed a partial paralysis of the left leg with absence of ankle and knee jerks and a hyperesthesia over most of the leg. This patient was also unable to void and required catheterization for thirty days. Two months later, she regained use of the left leg but it was weak and tired readily. She was also able to void spontaneously but difficulty with bladder sphincter control still persisted. Further improvement is expected.

DEATHS

There were 10 deaths during the first five postoperative days in this series. In 7 of these, in our opinion at least, anesthesia could not be considered as a causative factor in the mortalities. The cause and the time of death relative to the surgery in these 7 cases were as follows: 1—generalized peritonitis, fourth day; 1—metastatic carcinoma of the colon, third day; 2—coronary occlusion occurring on the third and the fifth days; 2—massive uncontrollable hemorrhage, three hours and six hours postoperatively, one following a splenectomy and the other following multiple injuries; 1—extensive mesenteric thrombosis with death occurring three hours postoperatively. In the remaining 3 cases, anesthesia cannot be excluded as a contributory factor to the sudden deaths:

(1) *Exploration of the common duct, sphincterotomy (Oddi), and release of adhesions.*—Time, two hours forty-five minutes. This operation was performed on a 51-year-old obese arteriosclerotic female who had had numerous previous hospital admissions. Anesthesia was conducted with continuous epidural analgesia, the catheter being inserted at T₁₂-L₁, and 35 cc. of per cent Xylocaine was administered initially and later 5 cc. of the same solution was injected through the catheter. A precipitous fall in blood pressure with unobtainable radial pulse occurred early during manipulation of the biliary ducts. Resuscitative measures including intravenous Neo-synephrine® and controlled endotracheal oxygen inhalations rapidly restored pulse and blood pressure to the preoperative level. Thirty minutes later, a marked pulse irregularity developed and rapid digitalization with Cedilanid® was instituted. The patient left the operating room with a strong pulse and a blood pressure of 110/75. Approximately thirty minutes after returning to her ward, the patient developed an acute coronary occlusion and died suddenly. We believe that a prolonged stay in a recovery room might have been of benefit in this case.

(2) *A subtotal hysterectomy, salpingo-oöphorectomy and appendectomy.*—Operating time, two hours. Single dose epidural anesthesia conducted with 40 cc. of 2 per cent Xylocaine injected at L₂-L₃. This operation was performed on a 48-year-old extremely obese female weighing 260 lb. This patient also suffered from hypertensive arteriosclerotic heart disease, having a blood pressure of 200/120. The operation was technically difficult with considerable bleeding, but the anesthetic course was completely uneventful. Relaxation was excellent and on completion of the surgery the pulse and the blood pressure were 84 and 155/90, respectively. Ninety minutes after return to her room, as the anesthesia wore off, the blood pressure began falling. Seven hours later, the patient died despite resuscitative efforts. Death was believed due to acute myocardial insufficiency secondary to coronary ischemia and shock caused by blood loss and surgical trauma. The anesthesia may also have added to the shock.

(3) *Cesarean section.*—A repeat cesarean section was performed on a 29-year-old nervous female. Single dose epidural anesthesia was induced with 25 cc. of 1.5 per cent Xylocaine injected at L₂–L₄. The anesthesia course was uneventful until the uterus was entered, at which time the patient developed a typical massive pulmonary embolus (amniotic fluid?) which was followed shortly by cardiac arrest. Circulation was re-established by manual artificial circulation following a thoracotomy. A live baby was obtained but the patient died six hours later of cerebral anoxia. We do not believe that the anesthesia was a causative factor, but it is difficult not to implicate anesthesia when a catastrophe occurs on the operating table.

DISCUSSION

Technique.—The administration of an intravenous anesthetic agent prior to the epidural anesthesia renders this form of conduction anesthesia more readily acceptable by the patient because of the painless induction followed by unconsciousness and the absence of the obvious similarity to spinal anesthesia. We believe that the utilization of distilled water in the manner described makes it possible to administer epidural anesthesia with safety to an unconscious patient. This saves time because it is unnecessary to wait for the effect of the classical test dose which is a requisite of the various currently popular standard epidural anesthesia techniques.

The cephalad portion of the spine and the head of the patient are kept above the horizontal throughout the period of injection and for five to ten minutes thereafter to prevent the diffusion of anesthetic solutions toward the bulbar centers in the event of an inadvertent subarachnoid injection.

Systemic Absorption Reactions.—The reactions which are caused by the rapid absorption of local anesthetic agents by the blood stream are manifested by a variety of signs and symptoms varying from a tachycardia to drowsiness or convulsions. Nearly all can be controlled by an intravenous barbiturate and the incidence is decreased markedly by the addition of epinephrine to the anesthetic solution. In this series, the incidence of these reactions was much higher proportionally with Cyclaine than with Xylocaine. No systemic toxic reactions were noted in the small number of cases conducted with Chlorain® or 2-chloroprocaine. The results obtained by Foldes (19) and our own clinical impression indicates that 2-chloroprocaine possesses most of the essentials of an ideal local anesthetic agent except prolonged duration. It has a high degree of potency, a short latent period, a high degree of diffusibility, and a low absolute and relative toxicity.

Technical Problems: (1) *Blood in the Epidural Space.*—This series has indicated definitely that, if a bloody epidural tap occurs, this form of anesthesia should be abandoned. If only faint traces of blood are

seen on aspiration, it is safe to inject a few cubic centimeters of the anesthetic solution and then wait several minutes. If there is no evidence of blood on re-aspiration and the patient does not exhibit any evidence of a toxic reaction, the remainder of the solution is injected very slowly. The alternate procedure is to re-enter the epidural space at another site and as before if no free blood is seen, the anesthetic solution is injected very slowly. However, if blood is encountered again, the method should be abandoned in favor of another type of anesthesia. In several of the cases in which convulsions occurred, blood had been encountered during the induction of the epidural anesthesia. Thus we found that free blood in the epidural space even in apparently small amounts may be clinically significant, particularly when Xylocaine or Cyclaine are the local anesthetic agents administered. In 2 instances, 2-chloroprocaine, was injected despite the presence of a moderate amount of free blood in the epidural space without the development of any toxic symptoms. A strict observance of the above principles has decreased the incidence of toxic reactions to such an extent that no convulsions have occurred in the last 850 cases anesthetized with 2 per cent Xylocaine.

(2) *Puncture of the Dura.*—Single dural puncture occurred in 36 and multiple puncture in 6 patients. In each instance, however, satisfactory epidural anesthesia was induced at another interspace without any evidence of subarachnoid block having occurred. It was further noted that none of these patients developed postanesthetic headaches probably because of the anesthetic solution in the extradural space prevented or decreased the leakage of the spinal fluid from the subarachnoid space (20).

(3) *Effects of Age.*—The intervertebral foramina become more or less stenosed with age (9), thus solutions injected epidurally will spread farther in the epidural space of the aged than in the young. A fibrous change or calcification of the interspinous ligaments and the ligamentum flavum makes it necessary to use excessive force in piercing them with a blunt needle, thus it may be practically impossible to check the advance of the needle before the dura also has been punctured.

(4) *Inability to Induce Epidural Anesthesia.*—The incidence of this occurrence varies inversely with the criteria used in the selection of the patients for epidural anesthesia as well as with the experience and the ability of the anesthesiologist. As a general rule, epidural anesthesia is relatively difficult to perform in patients who are senile, are extremely obese, or suffer from various diseases of the spine such as arthritis. We encountered one patient in whom epidural anesthesia could not be induced because the dura was adherent to the ligamentum flavum. This was verified during surgical exploration for an extruded nucleus pulposus. While compiling this series, for example, approximately 60 cases were encountered in which we were unable to induce

epidural anesthesia within a reasonable period of time. Most of these were then given a subarachnoid block. Furthermore, if there is any doubt about the location of the tip of the epidural needle, a new puncture site should be selected or the method abandoned.

SUMMARY

A series of over 2,100 consecutive epidural anesthetics has been presented. In each case, this form of anesthesia was induced with our modifications of the standard classical techniques, which we believe not only includes safety factors but also saves time and renders this form of conduction anesthesia more readily acceptable by the patient. The complications encountered are discussed, particular emphasis being placed on their prevention and management. It is stressed that meticulous care and attention must be paid to detail if the inherent dangers and risks of epidural anesthesia are to be avoided.

CONCLUSION

Epidural anesthesia, despite the hazards involved, should be added to the armamentarium of the modern anesthesiologist because it induces less physiological disturbances than any other method which provides comparable relaxation. The enthusiastic acceptance afforded this type of conduction anesthesia by the patient as well as the surgeon indicates that epidural anesthesia, in selected cases, deserves much wider acceptance than it receives at the present time.

ADDENDUM

This series now exceeds 3,200 cases. In over 200 of these epidural anesthesia has been induced with 2-chloroprocaine without any sign of toxic reaction. No convulsions have been encountered in the last 1,600 cases in which anesthesia was induced with 2 per cent Xylocaine.

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