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AN ANALYSIS OF 500 OBSTETRICAL CASES WITH CONTINUOUS CAUDAL ANESTHESIA USING PONTOCAINE*

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REVIEW OF RECENT LITERATURE

THE history of single dose caudal anesthesia for obstetrical delivery was outlined by Baptisti (1) in 1939. Manalan (2) deserves credit for the first use of an ureteral catheter technic in 1940. Lahmann and Mietus (3), who reported in 1942 a series of 400 cases, and have since expanded this number to approximately 2,000 (4), are the chief current advocates of the single dose method. The single caudal injection is made near the end of the first stage of labor so that relaxation and anesthesia are sufficient for completion of the second and third stages of labor and perineal repair.

Mitchell (5) has discussed the question of single dose versus continuous caudal anesthesia in detail in recent publication. Our experience with pontocaine-suprarenin solution suggests this as a logical choice for physicians who prefer the single dose caudal method, since three to five hours' duration of anesthesia is commonly obtained with our technic. The injection can be made a little earlier in the second stage, when the parturient is likely to be more cooperative in maintaining the proper position for introduction of the needle.

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The application of Lemmon's (6) continuous spinal apparatus to caudal anesthesia to permit the intermittent injection of doses affording continuous relief of first stage labor pains was suggested by Ruth (7) and first reported by Hingson and Edwards (8, 9, 10, 11) in 1942. The method immediately received premature publicity in the lay press, which created a public demand for a method so new the medical profession was ill-prepared to satisfy it. Subsequent developments include the refinement of the catheter technic by Adams, Lundy and Seldon (12, 13, 14) employing a 13-gage introducing needle for a 5 French ureteral catheter, also employed by Siever and Mousel (15), Mengert (16), Irving, Lippincott and Meyer (17), Downing, Miller and Durfee (18) and others. Irving (17, 19) modified the catheter technic by reducing the size of the catheter to 4 French, introduced through a 15-gage spinal needle, with which he occasionally uses a preliminary 5½ inch 18-gage, hubless "guide" needle. We now use Irving's technic with a still smaller, 16-gage needle. The reliability, advantages and disadvantages of needle and catheter technics have been discussed by McCormick, et al. (20). Block and his associates (21, 22, 23), in 1943, described the continuous intracaudal drip method, and established the maximum drip rate as a useful criterion for quickly determining the possible locations of the needle tip (subcutaneous, caudal peridural, subarachnoid). Others (24) have developed modifications of this technic.

Employment of this technic was stimulated by demonstrations and instruction by Hingson and Edwards on a tour of medical schools and large hospitals in 1942 and 1943. The method is receiving widespread use, as indicated by numerous editorials (25, 26), publications of case series (4, 15, 16, 17, 18, 27, 28, 29, 30, 32, 33, 34, 35, 36, 37, 38) and commentaries (39, 40, 41, 42) culminating in the recent collection of results on 10,000 cases in *North American Clinics* by Hingson and Edwards (33) and the book on "Control of Pain in Childbirth" by Lull and Hingson (43). Excellent anatomical studies of the sacrum and caudal canal have been reported by Trotter and her associates at Washington University (44, 45). Motion picture films, useful in teaching the various technics, have been prepared for Hingson and Edwards, Irving, Block, and Southworth, but no one should attempt the method merely on the basis of observation of a motion picture, lecture, or a demonstration. Intensive practical instruction and demonstrations of the technic for physicians wishing to learn the method have been available since June 1943, in at least two centers (46, 47). Approximately 175 physicians took advantage of these opportunities during 1943 and 1944. The reports of mortality (33, 34, 52) and numerous complications (13, 15, 17, 21, 33, 48, 49, 50, 20, 51) serve warning that the administration of either single dose or continuous caudal anesthesia should not be undertaken without adequate safeguards, training and experience. The time, care and skill required for proper conduct of this method are the chief limitations to its use.

The present paper is an analysis of the first 500 cases of continuous caudal anesthesia performed at the Cook County Hospital between March 1943 and October 1944 in which pontocaine hydrochloride* (brand of tetracaine, U.S.P. XII) was employed in various concentrations both with and without a vasoconstrictor. A smaller number of cases in which novocaine (brand of procaine) or metycaine was used is not considered in this report. All of the 500 cases were vaginal deliveries. In a smaller series the method was used for cesarean section, which will be reported later.

Because of limitations of time and personnel, the continuous caudal method was employed in less than one-tenth of all obstetrical cases admitted to the Cook County Hospital during the eighteen-month period covered. Selection of cases was exercised mainly to suit our convenience as to time and personnel available.

CHOICE OF DRUG

The choice of pontocaine was deliberately made with the intention of reducing the frequency of injections by employing an agent having a greater duration than procaine. Pontocaine was chosen also on the basis of its low corrected toxicity ratio compared to procaine. Figures on comparative potency and toxicity of pontocaine vary considerably with the experimental animal and the source, but those quoted by Saklad (53) from the work of Nowak on cats based on intravenous injection are given in table 1.

TABLE 1
COMPARATIVE FATAL INTRAVENOUS DOSE OF LOCAL ANESTHETICS IN CATS (NOWAK 53)

	Av. fatal dose mg./Kg.	Ratio compared with procaine	Equivalent dosage ratio	Corrected toxicity ratio compared with procaine
Procaine	49.6	1.0	1.0	1.0
Metycaine	28.8	1.7	0.8	1.36
Pontocaine	8.6	5.8	0.1	0.58
Nupercaine	3.5	14.2	0.05	0.71

In this experiment the tenfold increase in potency of pontocaine more than offsets the sixfold increase in absolute toxicity compared with procaine, so that the corrected toxicity ratio favors pontocaine with the safest rating in this group. While no similar experiments have been performed, within our knowledge, to determine the comparative toxicity in the human subject, clinical experience with pontocaine, metycaine, and procaine in spinal and regional anesthesia in man suggests that the incidence of reactions and complications in our hands conforms to the comparative corrected toxicity ratios of Nowak. The

* Pontocaine Niphanoid, 250 mg. ampules, was supplied by Winthrop Chemical Company, Inc.

clinical experience of James (54) reveals that pontocaine (under British name, amethocaine) has been administered to humans in a large series in amounts as high as 2 mg. per pound of body weight without observing any toxic effects whatsoever. He employed pontocaine in concentrations of 1:1,000 and 1:2,000, with epinephrine added to make a 1:200,000 concentration, for extensive intercostal, splanchnic, and infiltration anesthesia. We have experienced the same freedom from toxic effects in a similar series of cases in which pontocaine was used for regional nerve blocks other than caudal.

Table 2 indicates the preference of drug and concentrations employed in the various reported series of caudal anesthesia in obstetrics.

TABLE 2

TABULATION OF AUTHORS TO SHOW THE AGENT, CONCENTRATION, AND USE OF VASOCONSTRICTOR PREFERRED OR RECOMMENDED FOR CAUDAL ANESTHESIA IN OBSTETRICS

Vasoconstrictor	Procaine	Metycaine	Pontocaine
Added	1% Manalan (2)	1.5% Adams (12)	0.15% Authors' series (35)
Optional (first dose)	1.5% Mousel (15)		
Omitted	1% Block (21, 22, 23) 1.5% Mengert (16) 2% Parrett (28) Posner and Buch (24, 36)	2% aq. Lahmann (3) 1.5% Hingson (9) Lull (55) Ellis and Sheffery (20) Gready (27) Parrett (28) Spahr (30) Bishop (32) McCormick, et al. (20) Downing, et al. (18) Lyons and Hansen (37) Lucas (38)	0.25% Irving (19)

Note.—Isotonic sodium chloride solution assumed as the solvent unless otherwise indicated.

Table 3 indicates the various concentrations of pontocaine suprarenin solution employed in this series. The second concentration listed, pontocaine 0.15 per cent (1:666) with suprarenin 1:200,000 in physiologic saline solution, is the solution recommended. Limitation of concentration and amount of solution injected to the least effective values constitutes an important safety factor. The average 125 pound subject will tolerate as much as 2 mg. per pound (250 cc. of 1:1,000) pontocaine subcutaneously without any toxic symptoms in our experience as well as that of James (54) if the rate of absorption is restricted by a vasoconstrictor. The size of ampule provided (250 mg. pontocaine hydrochloride niphanoïd for continuous caudal anesthesia) insures that

TABLE 3
TABLE OF PONTOCAINE-SUPRARENIN * SOLUTIONS

Concentration of pontocaine	Pontocaine hydrochloride "niphanoïd"	Suprarenin 1:1,000	Isotonic saline or Ringer's solution
0.10 (1-1,000)	250 mg.	1.25 cc.	qs. 250 cc.
0.15 (1-666)	250 mg.	0.83 cc.	qs. 167 cc.
0.20 (1-500)	250 mg.	0.63 cc.	qs. 125 cc.
0.25 (1-400)	250 mg.	0.50 cc.	qs. 100 cc.

* Suprarenin (Winthrop Chemical Company's brand of synthetic epinephrine) added to make 1:200,000 concentration.

all concentrations prepared conform to this limit. Single injections into the caudal canal, however, should never exceed 30 cc. The use of the greatest dilution (0.10 per cent or 1:1,000) insures the use of 60 per cent less drug than the highest concentration (0.25 per cent or 1:400). If 30 cc. is used for the first injection, the alternative between 30 mg. (0.10 per cent) and 75 mg. (0.25 per cent) becomes quite significant compared with the 5 to 10 mg. dosage range of pontocaine which we consider safe for subarachnoid spinal anesthesia in obstetrics. The size of the preliminary "test dose" must be held to these limits (5 to 10 mg. of pontocaine). We usually limited this to 8 mg. (8 cc. of 0.10 per cent, 6 cc. of 0.15 per cent or 4 cc. of 0.20 per cent) pontocaine.

USE OF A VASOCONSTRICTOR

We feel that the use of a vasoconstrictor in the caudal anesthetic solution is an important safeguard, limiting the rate of absorption from a rather vascular space. In addition, we have found that the suprarenin (brand of epinephrine) added to 1:200,000 concentration makes effective the lowest concentration (1:1,000) pontocaine, and greatly increases the duration of action of each injection. With this solution we obtain from three to five hours of relief of first stage labor pain from the first injection after the "test dose." Although subsequent doses frequently have a shorter duration, it is estimated that the average requirement of our patients has been within limits of 8 to 20 mg. per hour of 0.10 per cent pontocaine. Contrast this with the 400 to 600 mg. per hour of 1.5 per cent procaine, which Mengert (16) estimates was required throughout duration of labor in 240 cases in which the vasoconstrictor was omitted and a shorter-acting drug employed. The omission of the suprarenin with pontocaine may require increase in the concentration to 1:400 (0.25 per cent), as employed by Irving (19). This not only reduces the duration of effect of each injection to an average of sixty minutes, as Irving reported, but entails the use of 2½ times as much drug. Even though accidental intravascular or subarachnoid injection is avoided, the potentiality of systemic toxic symptoms due to absorption would appear far greater in the latter two instances. We have reduced the concentration of suprarenin in some hypertensive patients, with good results.

The fear that the suprarenin may have an undesirable relaxing effect on the uterus is apparently unfounded. Brown and Wilder (56), in uterine motility studies during labor and postpartum, demonstrated the fallacy of the use of epinephrine in the treatment of constriction rings, an apparent relaxation always being preceded by a period of increased activity. Goodman and Gilman (57) stated that "the human uterus is generally contracted by epinephrine, whether pregnant or nonpregnant, but this action is not marked and rarely, if ever, interferes with the use of the drug for other purposes, if needed, in pregnant patients."

INDICATIONS

Continuous caudal anesthesia is most appreciated in *primigravida* labor in which it affords pain relief for the latter part of the first stage, remarkable relaxation of the perineal floor for manual or instrumental delivery, and perfect skin anesthesia for the episiotomy and repair. In *prolonged labor* the parturient is afforded much needed rest and is more able to take and retain nourishment. The method is beneficial in *eclamptic* patients (15). There is less need and less time for caudal anesthesia in *multipara*, but, if used, anesthesia should be instituted earlier to insure its success. In every case the patient must desire relief, and be psychologically favorable. Caudal anesthesia should not be initiated until there is evidence that the patient is *definitely in active labor*, with regular and frequent hard contractions, and definite dilatation of the cervix in progress. If anesthesia is indicated in *premature labor*, continuous caudal should rank with local or pudendal nerve block as methods of choice because of freedom of pharmacologic depressing effects on the fetus, and perhaps less trauma to the fetal head. Torpin (58) considers caudal anesthesia the method of choice for patients with serious cardiac disease.

CONTRAINDICATIONS

Relative contraindications include *inexperience* of the operator or undue fear of the method by the patient. Technical skill and judgment are required which should limit the use of this method to physicians with long experience in regional technics, or to those who have obtained adequate personal instruction and practice under close supervision in a recognized training center (46, 47). Obstetrical complications (placenta praevia, abruptio placentae, cephalopelvic disproportion, unless caudal is to be used for cesarean) and contemplated obstetrical procedures requiring complete uterine relaxation (version and extraction), may make the method an unwise choice. Obesity, deformity, debility, severe anemia, neurologic disease, hysteria, syphilis, a pilonidal "dimple," and a history of sensitivity to local anesthesia may be added as deterring factors.

Absolute contraindications include local dermatitis, inflammation, and pilonidal disease. The method should be discontinued if subarachnoid puncture occurs with the caudal needle.

TECHNIC

Preparation of Patient:

A cleansing enema should always be given if feasible, to prevent soiling by feces expelled after the caudal anesthesia relaxes the anal sphincter.

Preliminary medication of a barbiturate ($1\frac{1}{2}$ grains of sodium pentobarbital or its equivalent) is recommended to reduce the incidence and severity of systemic reaction. (*Note:* Though recommended, this measure has not been routinely employed in our series.)

Adequate skin preparation involving a soap and water cleansing should be followed by the application of a tinted antiseptic tincture of zephiran 1:1,000 to a wide area (after rinsing and drying the skin).

Position of the patient for insertion of the caudal needle may be the lateral (Sims) position with the operator seated, or the right lateral position, employed by Siever and Mousel (15), in which the operator leans over the patient to reach the sacral area. These positions should be reserved for the more experienced operator, since the weight of the gluteal muscles will carry the gluteal crease to the under side of the skeletal midline. Ellis and Sheffery (29) found this so common that they apparently considered it a normal finding for the caudal canal to be "off center" 1 to 2 cm. (but always to the same side!). For teaching purposes, we prefer the more accurate orientation to midline and the bony landmarks obtained in a "modified kneechest" position. The patient kneels with buttocks high, slightly behind a line vertically above the knees. Head and shoulders are bowed low on the bed, with elbows out to the sides. A pillow may be inserted under the abdomen to help support the weight of the uterus, if desired. It is thought that this position should be avoided in patients with serious cardiac disease and in patients far advanced in the first stage. A pledget of cotton is placed between the gluteal folds to prevent drainage of antiseptic solution and unpleasant burning of the vulva. To prevent embarrassment in this position, the patient should be promptly draped with a sterile towel covering the gluteal and perineal regions and with a perforated sheet to cover the back.

Preparation of the Solution:

Pontocaine hydrochloride 0.10 per cent (1:1,000) with suprarenin 1:200,000 in sterile isotonic solution of sodium chloride is prepared in a calibrated 300 cc. Baxter Plasma-Vac bottle (59) or if the commercially prepared 100 cc. ampule of pontocaine-Ringer's solution is available, suprarenin is added in the proportion of $\frac{1}{2}$ cc. of 1:1,000 to each 100 cc. of anesthetic. The B-D 441 apparatus including the 19-gage



FIG. 1. Position of patient.



FIG. 2. Palpation of tip of coccyx.



FIG. 3. Skin wheal and subcutaneous injection.

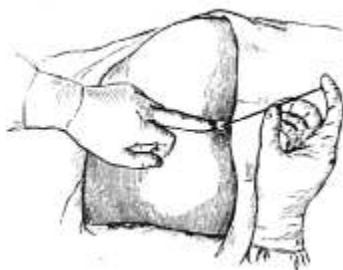


FIG. 4. Introducing 5 1/2 inch hubless guide needle.



FIG. 5. Testing guide needle with 20 G swedged tip needle.

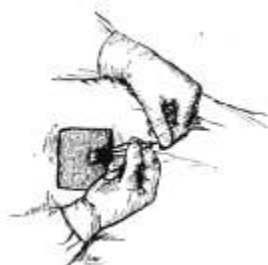


FIG. 6. Passing 16 G needle over guide needle.

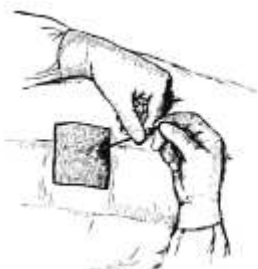


FIG. 7. Removing the guide needle.

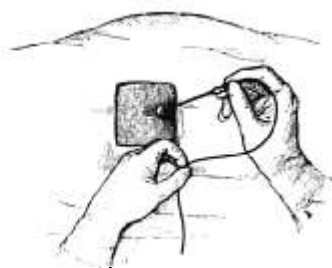


FIG. 8. Threading no. 4 Bard catheter through 16 G needle.

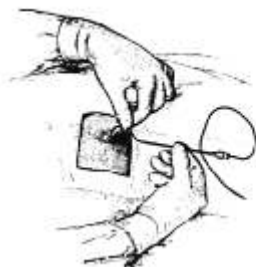


FIG. 9. Withdrawing 16 G needle over catheter.

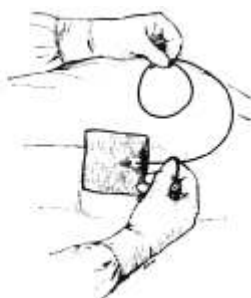


FIG. 10. Adjusting the depth of the catheter.

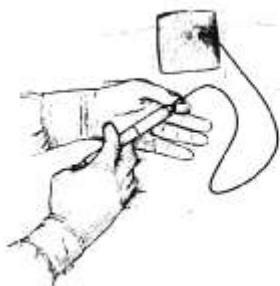


FIG. 11. Injecting test (spinal) dose.



FIG. 12. Fixation of catheter with waterproof adhesive dressing.

malleable beaded "safety-caudal" needle, designed by Schwidetzky (60), is employed, but we prefer the use of a 2 cc. syringe for all preliminary steps since the lessened glass resistance affords a more delicate sense of touch.

The *technic* followed in identifying landmarks and in inserting the caudal needle is that described in detail by Lundy (61). A similar technic is used for insertion of the 18-gage (5½ inch) guide needle in the catheter technic suggested by Irving (19). A number 4 nylon Bard caudal catheter is inserted through a special 16-gage (2¾ inch) introducing needle. Steps in the catheter technic are illustrated in figures 1 to 12, inclusive. Indications for and advantages of the catheter technic are given in table 4.

TABLE 4
INDICATIONS FOR CATHETER TECHNIC

1. Anticipated *long duration*.
2. Abdominal (cesarean) deliveries.
3. Caudal, if attempted in obese individuals.
4. Preference of operator.
5. Prophylactic insertion.

ADVANTAGES

1. Elimination of needle breakage.
2. Increased freedom of movement.
3. Insurance against interruption due to "needle slipping out."
4. Additional criterion of accurate placement.

CRITERIA VERIFYING ACCURATE PLACEMENT OF NEEDLE OR CATHETER

(1) *Typical sensations* on insertion of needle; a space is found after piercing a resistant membrane, and contact with bone is lost by reversing the bevel.

(2) *Contact with bone* superficial to the needle is made as it advances (Baptisti's sign) (1).

(3) Needle *parallels the midline* of back, and feels moderately well "gripped."

(4) *Extreme ease of injection*. Use ½ cc., then aspirate. Absence of resistance is comparable to that of injecting a spinal anesthetic.

(5) Appearance of *tinge of blood* on aspiration. If blood drips from needle or is aspirated freely, move the needle slightly and clear with ½ cc. of fluid before reaspirating. Before proceeding one must establish—

(6) *Freedom from aspiration* of blood or spinal fluid. Contrary to the usual practice, we prefer not to rotate the bevel of the malleable needle, because if it is slightly bent it may scrape the vascular plexus in the caudal canal and initiate considerable bleeding. The hole in the back of the bevel, slow injection, and the "test dose" are the precautions substituted for turning the needle.

(7) Negative "*impact test*" and absence of "*rebound phenomenon*." The "impact test" consists of injection of 2 cc. forcefully, with the ex-

tended fingers of the left hand laid gently across the sacrum in the region of the needle tip. If a "thump" is felt, the needle is in the tissues posterior to the sacrum. This impact is difficult to elicit in an obese patient. Tendency for the plunger to "rebound" when the injecting thumb is quickly removed from the plunger of the 2 cc. syringe also suggests placement outside the caudal canal.

(8) *Absence of crepitation* in the subcutaneous tissue when a small amount of air is used in the syringe in place of the solution is an additional criterion that may be used.

(9) We have found the negative "*gravity drip test*" of Block and Rotstein (21, 22, 23) useful only in cases in which doubt existed, as in obese patients, in whom we wanted immediate information of faulty placement posterior to the sacrum, if it existed, to permit prompt attempts at correct insertion. The drip rate was usually quite slow (30 to 60) when the needle was posterior to the sacrum, and pressure stopped the drip completely.* A possible location of the needle not described by Block and Rotstein, but which may occur in the experience of beginners using the lateral (Sims) position, is faulty placement anterior to the sacrum. The drip rate would probably be similar to that of a subcutaneous injection, but would be unaffected by pressure over the posterior surface of the sacrum. When unsuspected, a rectal examination should be performed, palpating for the needle in the hollow of the anterior surface of the sacrum. Pressure of the rectal finger would affect the drip rate. The danger of perforation of the rectum and a major pelvic infection is obvious. Birkbeck (62) noted that voluntary straining by the patient slows or stops the drip when the needle is in the caudal canal. This is due to an increase in the spinal fluid pressure transmitted to the epidural space.

(10) Positive *sciatic sign*: Cramping sensation and/or pain following the course of the sciatic nerve, associated with rapid injection.

(11) Ability to *pass the catheter freely beyond* the tip of the introducing needle (24).

MANAGEMENT

Test Dose the Imperative Precaution against Spinal:

Including the amounts used in verifying placement, a total of 8 cc. of 0.10 per cent pontocaine-suprarenin solution (containing 8 mg. of pontocaine—considered a safe subarachnoid dose) is injected at the maximum depth of the needle. The patient is then made comfortable on her left side, the special tubing connected to the needle, and she is asked to report her pains when they occur.

* In several cases, however, in which pressure slowed the drip but did not stop it, and we were tempted to consider it posterior, the needle proved to be in the caudal canal, and the anesthesia was effective without reinsertion. This phenomenon of pressure slowing the intracaudal drip rate is probably explained by interference with escape of solution through the posterior sacral foramina.

Wait ten minutes or until two unrelieved contractions have occurred. Question the patient for subjective evidence of relief of pain and test the skin with a needle for objective sensory evidence of spinal anesthesia. Some writers have unwisely emphasized inspection for motor loss, which will appear late, and may be unreliable as an early criterion of spinal anesthesia. If there is doubt, the test dose may be cautiously repeated. If evidence of spinal anesthesia develops, the method should be abandoned for that case (unless the operator is competent to manage the case as a continuous spinal). In our opinion in technics employing a full depth insertion of a malleable needle, the test dose should *never* be omitted.

Subsequent Management:

The initial therapeutic dose following the negative "test dose" is usually 20 or 30 cc. depending on the size of the patient and urgency of the case. The patient is usually turned within ten minutes (swinging over "facedown") to insure a bilateral effect. In rare cases in which the first dose is incompletely effective, a second (20 cc.) dose may be given in thirty to forty-five minutes with the patient lying on the least affected side. The original dose frequently is effective for three to five hours when pontocaine-suprarenin is used. The bladder is watched and catheterized when necessary, rectal examinations are made and the fetal heart tones, uterine contractions, blood pressure and level of skin anesthesia are checked periodically. Fluids and liquid nourishment are urged. Subsequent doses, usually restricted to 20 cc., are given when evidence of waning effect is noted. The duration of effect is less than the original dose but ranges between one and three hours.

The concentration of pontocaine and the use of vasoconstrictor (suprarenin) (11) were varied in an effort to compare the safety, effectiveness, and duration of various combinations, but a solution of 1:1,000 pontocaine hydrochloride (0.10 per cent) in sterile physiologic saline solution (59), with added suprarenin 1:200,000, is recommended as most satisfactory in all respects, and was employed in about four-fifths of the cases, as indicated in table 5.

TABLE 5
CONCENTRATIONS OF PONTOCAINE EMPLOYED IN A SERIES OF 500 CAUDAL ANESTHESIAS

	1-400 (0.25%)	1-500 (0.20%)	1-600 (0.15%)	1-800 (0.125%)	1-1,000 (0.10%)
Without suprarenin	20	11	5	0	0
With suprarenin					
1-200,000	1	31	20	13	378
With suprarenin					
1-400,000	0	0	0	0	21
Total	21	42	25	13	399

The commercially prepared ampule of 0.15 per cent pontocaine in Ringer's solution is more convenient, and quite effective if suprarenin is added.

The amount of solution given and the frequency of injection of maintenance doses varied considerably with the length of labor, time of starting the caudal, and type of solution employed. The longest administration was forty-four and a half hours and the largest amount 559 cc. of 1:800 solution. In the group of 399 cases employing the 1:1,000 solution, with suprarenin, the shortest administration was twenty-five minutes, and the smallest amount injected, 10 cc.

An analysis of the duration of labor after initiation of the caudal anesthesia, correlated with the degree of dilation of the cervix at the time of the caudal anesthesia, given in a previous publication on 200 cases (35), is here revised to include data from the first 500 cases (table 6).

TABLE 6
TIME REQUIRED TO COMPLETE CERVICAL DILATATION AFTER INITIATION OF
CAUDAL ANESTHESIA WITH PONTOCAINE

	Primipara			Multipara		
	Hours	Min.	No. of cases	Hours	Min.	No. of cases
3 cm.	11	12	26	5	18	35
4 cm.	8	19	41	4	20	38
5 cm.	6	32	54	3	48	28
6 cm.	5	39	35	2	20	29
7 cm.	3	53	53	1	36	15
8 cm.	2	16	62	1	6	12
9 cm.	1	32	32	1	42	3
Stage II	1	3	195	0	58	92

It is evident from the data in table 6 that we have not experienced the marked decrease in the length of labor resulting from increase in the rate of cervical dilation reported by other observers.

TYPE OF DELIVERIES

The incidence of spontaneous deliveries in this series was only 30.2 per cent. Table 7 indicates a high incidence of operative deliveries, for

TABLE 7
DATA ON PARITY AND INCIDENCE OF OPERATIVE DELIVERIES

	Spontaneous		Forceps and other operative deliveries		Total all cases	
	Cases	Per cent	Cases	Per cent	No. of cases	Per cent
Primipara	60	(17.7)	280	(82.3)	340	(68)
Multipara	91	(56.8)	69	(43.2)	160	(32)
Total all cases	151	(30.2)	349	(69.8)	500	(100)

which the caudal method provides excellent relaxation. The incidence of forceps deliveries in all cases during the eighteen-month period of this series was 8.55 per cent of 6,991 cases. In table 8 we have also noted the increased incidence of failure of rotation reported by others (15).

TABLE 8
DATA ON PRESENTATION AND METHOD OF DELIVERY

		Per cent
<i>Cephalic presentation</i>		
Occiput anterior	390	78.0
Occiput posterior and transvers:	99	19.8
Manual rotation	19	
Forceps rotation	78	
Version and extraction	1	
Delivered in posterior	1	
<i>Breech presentation</i>	3	
<i>Compound presentation (head and hand)</i>	1	2.2
<i>Unclassified (caudal discontinued, not in labor, etc.)</i>	7	
	500	100.0

FETAL MORTALITY

There have been no major complications imperiling the life of the mother in this obstetrical series. In the fetal mortality rate of 2.0 per cent, factors unrelated to the anesthesia account for 9 of the 10 cases. In 1 case aspiration of fluid and respiratory obstruction were the probable causes of neonatal death. The early onset of respiratory effort which is characteristic of infants delivered under caudal anesthesia, with an attempt to cry immediately after the head is delivered, is impressive, but this absolute lack of narcotization adds the hazard of aspirating fluid into the pulmonary tree. The obstetrician should be alert to clear the pharynx of fluid promptly and keep the head low to promote drainage until the cry is established. In the case in question, it is thought that the inexperience of the attendant (an intern) and inefficient resuscitation technic were the important factors. In 1 case in which the fetal heart tones had been good but the infant could not be resuscitated, necropsy revealed cerebral hemorrhage and congenital atelectasis. Fetal heart tones disappeared in 7 cases during labor under caudal anesthesia (1 intrapartum sepsis; 1 toxemia—Dührssen's operation was performed; 1 breech; 3 craniotomies, and in 1 case in which only one dose of 28 cc. was given, the caudal anesthesia was discontinued because of slow progress). Eleven and one-half hours later the fetal heart tones disappeared, and after twenty-five hours the patient delivered a stillbirth. One patient entered the hospital with a dead fetus, and because of failure of placement of the caudal needle, ether anesthesia was administered for a craniotomy.

EFFECT ON BLOOD PRESSURE

In 46 cases (9.2 per cent) a drop in systolic blood pressure of more than 20 points occurred, and in only 18 of these was the fall greater than 30 systolic. In these 18, the systolic pressure fell approximately 40 points in 12, 60 points in 3, and 80 points in 1 case. In 5 of these 18 cases the concentration exceeded the 0.10 per cent now recommended, and in 2 the vasoconstrictor had been omitted. In 1 patient with a blood pressure fall of less than 30 systolic (112/80-85/50), it persisted for three hours, and 1 with a systolic fall of 38 (118/80-80/40) responded promptly to ephedrine. One patient with a fall from 140 mm. to 90 mm. systolic and from 80 mm. to 50 mm. diastolic, and pulse of 130 associated with anesthesia, vomited for four and one-half hours. Three patients exhibited a marked fall in diastolic pressure with little change in systolic pressure and with only minimal symptoms. Undue fall in blood pressure is usually associated with too high a level of skin anesthesia, as illustrated in Case 62, in which the greatest fall occurred. The high caudal effect was deliberately produced in this case with 0.25 per cent pontocaine with suprarenin, 30 cc. given following a 7 cc. test dose, in an attempt to obtain, if possible, some relaxation of the uterus. Episiotomy and Dührssen's incision were performed, but relaxation was inadequate for a difficult forceps extraction in spite of a level of skin anesthesia to the second thoracic segment. The blood pressure, which fell abruptly from 150 mm. to 70 mm. systolic and from 100 mm. to 40 mm. diastolic, was promptly restored to safe levels by administration of intravenous saline infusion and injection in the tubing of 1 mg. of 1 per cent neosynephrine hydrochloride. The heart tones, which had been poor, failed during the slow and difficult extraction, and a still-birth resulted. In all other cases in which a fall in blood pressure was noted, live births were obtained.

COMPLICATIONS

There were no cases of respiratory or vascular collapse due to intravascular or subarachnoid injection even though in a few cases the level of skin analgesia rose above the xiphoid, indicating a high extension of the initial injection in the peridural space.

Only 3 cases of subarachnoid punctures by the caudal needle occurred even though the 3-inch caudal needle was inserted to the full depth in nearly every case in which it was used. In 2 cases complete relief was obtained from the test dose of 8 cc., resulting in anesthesia up to the umbilicus. They were delivered five and six hours later by forceps and episiotomy without further medication. In the other case the dura was punctured as evidenced by a spinal fluid drip. The needle was withdrawn a short distance and the caudal anesthesia continued successfully by giving small repeated doses. The 2½-inch needle was employed in relatively few, using it occasionally in some of the smaller patients.

To emphasize the danger of this complication, we should mention 1 case in which an attempt at single-dose caudal for cesarean section resulted in an extensive spinal anesthesia with respiratory paralysis requiring artificial respiration for one hour. Recovery was complete for both mother and baby and the operation was performed the next day under inhalation anesthesia. This was an isolated case, referred to by Gready (48), which occurred in Cook County Hospital several months previous to the inauguration of this series, and therefore not included in the statistics.

The needle technic was employed in 434 cases (85.8 per cent) and broken needles occurred in 4 cases. In each of these the break was near the "hub" of the Hingson "hubless" needle, and a small incision permitted prompt removal. Recent modification of the needle by addition of a "safety bead" has decreased the likelihood of this complication. The catheter technic was used in 66 cases (13.2 per cent). One catheter was broken 1 inch from the tip as a result of a technical error, without sequelae.

A superficial skin infection of short duration occurred at the site of the caudal puncture in 5 cases.

Less than one-fourth of the patients questioned postpartum on this point complained of tenderness in the sacral region for the first twenty-four to forty-eight hours. Postpartum emesis was recorded in only 12 cases.

Twelve of the patients complained of a pounding frontal headache during the initial injection. In 1 case this may have been due to intravascular injection. One patient complained of transient precordial pain; 1 of palpitation; and 7 had nausea and emesis briefly following the first injection. Twelve had chilly sensations. Six others suffered severe chills following injection, in one lasting fifty minutes, but in only 4 of these was there associated fever. In 1 the temperature rose to 104 F. following delivery, and she was disoriented for three hours. Nine patients suffered severe postpartum hemorrhage (3 patients required blood transfusions), but, in general, the blood loss seemed minimal, as reported by others. When episiotomies were performed, however, there was an apparent increase in bleeding from the episiotomy wound in caudal cases, probably because of lack of pressure of the head on the perineum as well as the absence of local ischemia produced by local infiltration with procaine and a vasoconstrictor otherwise employed in these cases.

In 3 patients relaxation was so marked that external protrusion of the cervix occurred following delivery. Twenty-seven patients presented postpartum evidence of mild endometritis, 7 of pyelitis, and 29 of urinary retention requiring catheterization. Two patients required retention catheters. This incidence is not greater than in those without caudal anesthesia.

In addition to adequate pain relief due to blocking of sensory nerve fibers, more or less weakness of motor control of the lower extremities

occurred in a majority of the cases during caudal anesthesia, and in some of these it was marked, so that the patients required assistance in turning or in being transferred to the delivery table. In most cases, however, the onset of motor paresis was delayed for some time after the first injection. The motor and sensory loss in the lower extremities usually disappeared within three to six hours after delivery, although in a few cases it persisted longer, and in 4 cases for longer than twenty-four hours. One of these had fecal incontinence for three days, but was normal thereafter.

Another had urinary and fecal incontinence for eleven days. Bladder incontinence occurred in 1 case for six weeks. There was one instance of a relaxed rectal sphincter at the six weeks' postpartum examination. The question of neurologic complications following caudal anesthesia has been raised by Parrett (28 and 31) who reported 1 primipara who had imperfect control of the bladder sphincter following caudal anesthesia (possibly attributable to Scanzoni maneuver), but was improving.

In 1 case the caudal anesthesia was discontinued when a cephalopelvic disproportion was recognized in order that the patient might be better able to aid in the delivery. During the following twenty-three hours the fetal heart tones disappeared and a craniotomy was performed. This patient exhibited paresis of the left lower extremity for four days postpartum but made an uneventful recovery. It is believed that the caudal anesthesia was not responsible for the fetal death in this case. The prolonged case is described in detail in the following:

Case 175.—A. S., a 22-year old colored primigravida, entered the Cook County Hospital on July 29, 1943, in labor. During the last twenty-eight of forty-six hours in labor, this patient received 15 injections of pontocaine solution by continuous caudal technic, totaling 258 cc. An original faulty insertion of the malleable needle posterior to the sacrum was corrected one-half hour later, and seven doses, totaling 133 cc. of 0.25 per cent pontocaine without vasoconstrictor, afforded relief for six of seven hours. Addition of suprarenin to make 1:200,000 potentiated the solution to reestablish relief for a longer time (fourteen hours) with less solution (six doses totaling 110 cc.). Anesthesia was inadvertently interrupted then by accidental withdrawal of the caudal needle, and reestablished by insertion of a catheter. With three hours of anesthesia resulting from the final 30 cc. dose of a lower concentration (0.15 per cent) of pontocaine with suprarenin (1:200,000), delivery by episiotomy and low forceps was completed, obtaining a normal infant.

Loss of bladder control and relaxation of the anal sphincter (without fecal incontinence) was noted for about five days postpartum. Bilateral foot drop, and painful feet were noted, and some paresis of the lower extremity. Bladder control was resumed in five days, the anal sphincter regained normal tone in about ten days, and the weakness of the leg muscles improved within twenty-one days so that the patient was able to walk well enough to go home, but the foot drop had improved very slowly, and even after three months muscular control was still imperfect. An incomplete reaction of degeneration was recorded, and

physiotherapy by galvanic stimulation at frequent intervals was advised. Six months later the patient reported that she had regained normal function.

The possible etiologic factors in this case may be summarized as follows:

(1) *Arsenical polyneuritis* in a luetic under treatment. Patient had had four neosalvarsan injections during pregnancy—2 neosalvarsan 0.3 with 0.13 bismuth, 2 neosalvarsan 0.6 with 0.13 bismuth, and 0.008 mg. of arsenic was recovered by the coroner's chemist from 1.5999 Gm. of hair postpartum.

(2) *Trauma* of continuous caudal technic: two entries into caudal canal, and one indwelling malleable needle present for twenty-five hours.

(3) *Chemical effect of high concentration* of drug employed. The longest case in which 0.25 per cent (the highest concentration) was employed, and to this a vasoconstrictor potentiating its action was added for fourteen hours.

(4) *Prolonged duration of caudal anesthesia*. The longest soaking of caudal nerve roots with the highest concentration of all 500 cases in this series.

RESULTS

An analysis of the entire series of 500 cases reveals that the anesthesia and analgesia were entirely satisfactory in 428 cases. Of the remaining 72, only 13 were definite failures due to inability to insert the needle into the caudal canal. In 28 cases the analgesia was incomplete because of insufficient time or inadequate dosage, but in one-third of these the deficiency was remedied by technical adjustments. In 16 there were technical interruptions such as the needle or catheter having been dislodged and slipping out of the caudal canal, excess bleeding through the needle, premature removal of the needle, and disconnected tubing so that the analgesic effect had worn off to some extent before delivery. Obstetrical conditions had caused the interruptions in 9 patients. These included disappearance of the fetal heart tones, constriction ring, abruptio placenta, version and extraction, cervical cystocia and prolonged labor. There were 6 miscellaneous instances such as "patient pulled the needle out," not in labor, and spinal anesthesia resulting from the test dose.

SUMMARY

1. Five hundred cases of continuous caudal anesthesia are reported, with details on technic, results and complications.

2. Pontocaine-suprarenin-isotonic saline solution, as recommended, is a safe and useful anesthetic solution for caudal anesthesia, when administered and controlled by competent personnel.

3. The use of a vasoconstrictor is advocated in concentrations of 1:200,000 epinephrine or equivalent.

4. One to five hours' duration of relief is obtained from each dose, reducing the frequency of injections and minimizing the likelihood of systemic effect resulting from absorption.

5. Caudal anesthesia gives complete relief to the mother and does not cause narcotization of the baby.

6. Minor complications and technical difficulties are reported, with 1 case of prolonged neurologic impairment.

7. The rate of cervical dilatation was not significantly altered by caudal anesthesia in this series.

8. Certain steps in the catheter technic are illustrated.

9. Emphasis is laid on the importance of obtaining initial training and personal practice in caudal technics under expert supervision in a training center.

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CHANGE IN LOCATION OF AMERICAN BOARD OF ANESTHESIOLOGY EXAMINATIONS

The American Board of Anesthesiology, Inc., announces a change in location of the Part II (Oral) Examinations for certification. The examinations will be held in Boston, instead of New York, October 9 to 15, 1946, at the Hotel Statler.

This Board will also hold an extra Written Examination at various places on September 20, 1946. Eligible candidates are being notified.

In addition, an extra Oral Examination will be held during the second week in April, 1947, in Los Angeles, California, further details to be announced later.