

THE USE OF PONTOCAINE IN SUBPOSOLOGIC QUANTITIES FOR BRONCHOSCOPY AND BRONCHOGRAPHY*

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REVIEW of the literature shows a considerable variety of technics in laryngo-tracheo-bronchial anesthesia for the procedures of bronchoscopy and bronchography. The variation is noticed in the procedures themselves as well as in the type and quantity of the topical anesthetic agent. The adjuvant medication also shows a considerable difference in the types of drugs used. The most common surface anesthetic agents are cocaine and pontocaine. Others in use are nupercaine (1), larocaine (2), butyn (3), and methycaine (1). Larocaine appeared to be a promising drug which the author and others (2, 4, 5) have used with good results. Unfortunately, the manufacturer (Hoffmann-La Roche) no longer produces this drug. In a survey conducted by Moorhead (5) it was noted that 50 per cent of his correspondents used cocaine as an anesthetic. Different authors have employed these drugs alone or in combination. The quantities used vary tremendously and at times it was difficult to determine the actual amount administered as the published article merely gave the percentage of the solution without specifying the total amount. In many instances an undeterminable amount was used in sprays, swabs or tampons, making a quantitative appraisal impossible. For these reasons comparative tabulation of the amounts of the drugs used by various authors could not be made in all cases. Even in the articles tabulated provision had to be made for the unmeasured loss in swabs and so forth.

In this study it was decided to employ pontocaine since it was thought that more and more use was being made of this drug, and that it was freer from the toxic reactions which occurred with cocaine (6, 7). A preliminary study (8) had been made and a series of 167 cases reported which indicated that pontocaine could be used in small dosages and, when thus used, was devoid of any complications attributable to the drug. The enthusiastic response and inquiries from physicians were such that I decided that by study of a larger series the procedure could be standardized and the chance that the results were a fortuitous

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occurrence would be disproved. Accordingly, a series of 621 bronchoscopies, which includes the original 167, is presented in this paper.

With respect to the adjuvant drugs, each author appears to have his own favorite. This is an understandable situation since long-continued use of any one particular drug soon makes one familiar with its potency in various patients as well as with its idiosyncrasies. The drugs most commonly used were morphine, either alone or in combination with atropine, dilaudid, scopolamine, codeine, nembital, sodium pentobarbital and demerol. It was no surprise to find that the barbiturates were almost universally used in conjunction with pontocaine because of their neutralizing action in preventing the toxic symptoms occasionally seen with pontocaine. Epinephrine hydrochloride (1 to 1000) also was employed by most authors in various amounts added to the pontocaine to reduce too rapid absorption of the anesthetic agent.

Pontocaine as presently used is not in itself free from its measure of toxicity and its quota of deaths (9-17). Toxicity is manifested by local as well as constitutional reactions which may result in death. In the eye, pontocaine may cause urticaria, eczema of the lid, allergic conjunctivitis and allergic keratoconjunctivitis (18-23). On the skin and mucous membranes, dermatitis, urticaria and eczematoid lesions of various types have been noted (24, 25). Occasionally, edema of the pharynx associated with dyspnea has been encountered (26). Constitutional reactions ranged from sweating, dizziness, nystagmus, loss of equilibrium, palpitation, tachycardia, twitching of the facial muscles, cyanosis, general clonic spasms with failure of the pulse and respiration to unconsciousness and death (9, 16, 17, 27-39).

Reported and unreported cases of sudden death have been fairly well attributed to the drug alone and critical reviews of these deaths indicate that in almost all cases excessive quantities of the drug have been given. C. E. Field (29) and C. A. Jackson (40) both stated that over-dosage and faulty technic more often are the cause of death than individual idiosyncrasy, as well as occasionally the failure to incorporate epinephrine in the solution. Penman (35), however, reported a case to show that on occasions idiosyncrasy and not overdosage may be the danger. His patient received only 0.5 cc. of a 2 per cent solution of pontocaine when a severe constitutional reaction occurred. The advent of the barbiturates supposedly controlled the toxic reactions. Palmer (34) stated that without barbiturates the incidence of reactions is 1 in 100 cases and with barbiturates 1 in 500 cases. Deaths have been observed, however, in spite of the apparent safety which the barbiturates conferred.

If the recommendations of the manufacturer on the maximal safe dosage of pontocaine to be used for the procedures of bronchoscopy and bronchography is correct, it would appear that practically all workers who stipulate the quantity of pontocaine are employing excessive and unsafe dosages. Tuohy (41) stressed that the important

point to remember in the use of local anesthetics is that they must be used in small amounts. There is no question that the main difficulty in the successful use of pontocaine is one of quantity. The barbiturates, although helping considerably, are not the entire answer in preventing reactions or deaths. In the pamphlet that accompanies the stock bottle, the manufacturer plainly stipulates that the maximal *safe* dose for endotracheal instillation should not exceed 1 cc. of the 2 per cent solution or its diluted equivalent. This is the equivalent of 20 mg. Another admonition which the pamphlet stresses is that, to prevent entrance of the drug into the lungs, the patient should not inhale too deeply. Any bronchoscopist or bronchographer can readily see the impossibility of attempting to follow these tenets and yet be able to perform either one of these procedures properly under local anesthesia. The amount of the solution recommended is definitely too small for proper manipulation with spray and cannula, and no patient can be kept from unconsciously taking deep breaths while being anesthetized. As a matter of fact, in most cases the patient is encouraged to take deep breaths to spread the solution throughout the tracheobronchial tree. A self-consciousness on solution strengths was apparently present in the minds of almost all users of pontocaine since their articles revealed the use of several percentages below 2 in order to increase the bulk of the solution for proper manipulation.

Review of the literature confirmed the variations between the recommendations of the manufacturer and the practical use of the solution. It was discovered that almost no worker employed the recommended dose but always exceeded it. The amounts actually used (table 1) varied from 2.5 cc. (42) for bronchoscopy to 15 cc. (40) of the 2 per cent solution for bronchography. My results (8) in the previously reported series of 167 bronchoscopies have been included for comparison. Many authors, especially bronchoscopists, could not be included in the tabulation because their articles were too vague on the actual amount of the solution used, merely mentioning the percentage of the solution.

In view of these concepts and impracticalities, and on the premise that the manufacturer probably had ample experimental work upon which to base the maximal dosage, it was decided to study the generally used strengths in the hope of finding an effective low strength with sufficient volume for properly anesthetizing the tracheobronchial tree. It was believed that pontocaine was potent enough in low dilutions to be used for these purposes. The lowest uniform strength that would be effective could not be learned from the literature since most authors employed a combination of strengths beginning with the 2 per cent solution and decreasing the strength to 1 and 0.5 per cent or even lower. The higher strength was usually employed in the preliminary anesthetization of the mouth and pharynx, apparently on the theory that these structures are more tolerant to the stronger solution (14) than the larynx, trachea or bronchi. In one article (47) mention was

made of the use of 2 to 4 cc. of the 2 per cent solution for the mouth and pharynx and 0.25 per cent or even 0.15 per cent for the trachea and bronchi. On occasions these same authors have used a 1 to 1000 solution.

It was at once apparent from study of the literature that the solution must be of sufficient bulk to permit instillation and spread into the tracheobronchial tree. At the same time this solution had to be nontoxic but still produce an effective, sustained anesthesia to permit a leisurely performed bronchoscopy or bronchography, and yet meet the manufacturer's limit on total dosage. No such one-strength solution was used according to articles in the literature. By trial and error, a solution of 0.25 per cent was found to be effective. This solution

TABLE 1
REVIEW OF THE LITERATURE ON QUANTITIES OF PONTOCAINE USED FOR BRONCHOSCOPY AND BRONCHOGRAPHY

Procedure	Pontocaine			Author
	Mg.	Equivalent of 2% Solution, cc.	Working Dilutions, per cent	
Bronchoscopy	17.37	0.865	0.25	Carabelli (8)**
Bronchoscopy	50.00	2.5	2-0.5	Titche (42)
Bronchoscopy	50.00*	2.5*	2-0.5	Heublein (44)
Bronchoscopy	80.00	4.0	2	Wilton (39)
Bronchoscopy	80.00	4.0	2	Jackson (40)
Bronchography	20.00*	1.0*	1	Sommerfield (45)
Bronchography	40.00*	2.0*	2	Boyer (46)
Bronchography	50-100	2.5-5.0	2, 0.25, 0.15, 0.001	Castellanos (47)
Bronchography	60.00	3.0	2	Harwood (48)
Bronchography	65.00	3.5	0.5	Hughes (49)
Bronchography	120, 140, 160*	6, 7, 8*	2	Dell (50)
Bronchography	300	15.0	1	Poppe (43)

* Indicates undetermined amounts used in addition to the above quantities in sprays, swabs or tampons.

** Series of 167 cases previously reported (average dosage).

was made by placing 1 cc. of 2 per cent pontocaine into a 10 cc. glass cylinder, adding 8 minims of epinephrine hydrochloride (1 to 1000) and diluting to 8 cc. with sterile physiologic saline solution. This solution was considered ideal since it had already been tested for sufficient surface, anesthesia and had what appeared to be the proper bulk for manipulation. It also had the vasoconstrictor action which most workers desired because of the epinephrine content.

Having standardized the one-strength solution, it was decided to standardize the adjuvant medication for purpose of control. Morphine in combination with atropine in full doses was used simply because the author was more familiar with its action than that of other drugs. No barbiturates were added in this study. It was noticed that with this

combination and with the use of the 0.25 per cent solution excellent control of the patient and surface anesthesia were obtained. It was noticed, however, that with the standard equipment (DeVilbiss atomizer, laryngeal mirror and laryngeal cannula) more than 8 cc. of the solution was administered, thus defeating the theoretical intended use of only 20 mg. of pontocaine or 8 cc. of the 0.25 per cent solution. For quantitative conservation of solution the use of the standard instruments left much to be desired. It was thought that something could be done to effect "economy of solution" by better armamentarium.

One improvement, of course, was the elimination of the third hand about the mouth orifice. In the usual method the operator first holds the atomizer in both hands (some are skilled enough to use the standard atomizer as a "one-hand" type) while the patient or an assistant re-

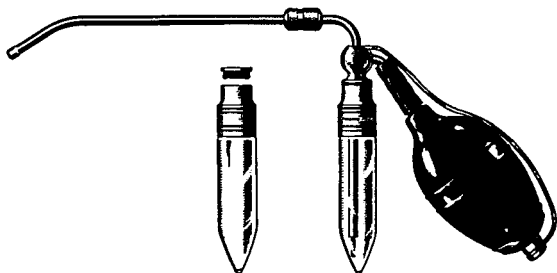


FIG. 1. This micro-atomizer was developed from the stock Clerf atomizer in frequent use by bronchoscopists. The original cannula was shortened and given the oropharyngeal curve. The atomizer was made with a special handle to make it of the "one-hand" type with a double valve in its bulb which gives better, sustained compression as well as easier hand pressure than the one valve type. The reservoir is of boilable glass with a capacity of about 8 cc. and is the same as that used on the Clerf atomizer so that the residual anesthetic can be transferred to the Clerf atomizer by simply exchanging reservoirs.

tracts the tongue for the spraying procedure. It was thought that the use of a "one-hand" atomizer could dispense with the third hand at this stage. A special atomizer was designed which met the specifications of a small reservoir and a fine spray (fig. 1) to offset the disadvantages of the standard types.

The next step studied was the use of the separate laryngeal mirror and cannula. Here the greatest waste was noted. In spite of the fact that I had used this method for many years, its shortcomings were not apparent until the present critical study. The operator has no choice but to have either the patient or an assistant hold the tongue. When the patient held the tongue, its dorsum would eventually be humped up and almost completely block the line of vision. The operator had to work more or less blindly, most of the time instilling the solution

with the hope that it would drop upon the vocal cords and into the trachea. Even with the most cooperative of patients, it was noticed that a full view of the cords was only rarely obtained. A goodly portion of the solution trickled down the pyriform sinuses and was automatically swallowed. When an assistant held the tongue, usually too much traction was made, resulting in pain or excessive salivation or gagging. If too little traction was made, there was humping of the dorsum, again with poor visibility. It is true that some operators are skilled in effectively using this procedure, but when critical quantities of solution are being considered, it was thought that a more accurate localization of the structures involved as well as the direction of flow of the anesthetic agent was needed so that only those structures intended were anesthetized and the solution was not wasted into the esophagus.

To facilitate this second step a simple mirror cannula was devised (fig. 2) which permits the operator to hold the tongue and make the necessary traction coordinate with the instillation of the solution. The

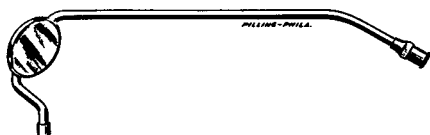


FIG. 2. This mirror cannula is an adaptation of the original mirror cannula [Carabelli (51)] which was improvised from a stock Abraham laryngeal cannula with a malleable tip to adjust for the various anomalies of the larynx. The improved cannula gives an unobstructed view of the larynx and vocal cords and needs no adjustment of its tip because of the special contours inherent in its construction. It is made for either right-handed or left-handed operators, and is boilable.

posterior portion of the epiglottis as well as of the vocal cords is completely visible at all times with this cannula. Solutions can be accurately instilled only where intended, without waste.

TECHNICS FOR BRONCHOSCOPY AND BRONCHOGRAPHY USING THE MICRO-ATOMIZER AND THE MIRROR CANNULA.

1. *Basic "One-Strength Solution (0.25 per cent pontocaine).—*This solution is made by adding 1 cc. of 2 per cent stock pontocaine solution to a 10 cc. glass cylinder. Eight minims of epinephrine hydrochloride (1 to 1000) is then added and the solution brought to a total volume of 8 cc. with sterile physiologic solution.

2. *Adjuvant Medication.—*This consists of morphine sulfate, 15 mg., and atropine sulfate, 0.4 mg. The dosage may be increased or decreased "secundum artem," depending upon the type of case and size of the patient.

3. *Bronchography.*—The basic solution is made up and placed in the reservoir of the micro-atomizer. The patient reports without breakfast, is given a full dose of morphine and atropine hypodermically and permitted to rest for about three quarters of an hour. After this interval, the tongue is retracted, the patient made to breathe deeply and several applications of the spray are made deep into the pharynx. It was not found necessary to spray too heavily for effective anesthesia. Two or three squeezes of the bulb usually suffice. Ten minutes later a second spray is applied and again repeated in another ten minutes. In about five minutes it will be discovered that the patient experiences the sensation of numbness and, occasionally, inability to swallow which indicate the presence of adequate surface anesthesia. At this point he is placed on a chair employed for ear, nose and throat operations. The remaining solution in the reservoir of the micro-atomizer is placed in a medicine glass and 1 cc. aspirated into a 5 cc. syringe attached to the mirror cannula. The tongue is retracted, the mirror heated in a spirit lamp, the cords visualized, and about 1 cc. of the solution slowly dripped between the cords. At the first impact of the droplets on the vocal cords, the patient may cough a little, but after a short interval it will be possible to continue dropping the solution gently between the cords with no cough reflex being elicited. The solution is introduced gently and deliberately, drop by drop. Following the first instillation, the patient is asked to cough with his mouth closed. This permits the solution to be spread evenly throughout the tracheobronchial tree. Five minutes later a second instillation of about 1 cc. is again made in the same manner. At this time the cough is considerably obtunded, with a marked change in its timber, indicating completed surface anesthesia. If the cough is still high-pitched, a third instillation may be indicated. The entire procedure must not be hurried, nor too great quantities of solution instilled. One must refrain from "pouring in" the solution as the quantities recommended will be found to be of sufficient strength for adequate surface anesthesia. If the procedure is properly done, only about 4 to 5 cc. of the basic solution will have been used at this point.

When complete anesthesia has been effected the larynx is visualized with a standard laryngeal mirror and a rubber catheter (usually No. 14 or 16 F) is introduced between the vocal cords on a Thompson wire introducer. The patient or an assistant may retract the tongue so that both hands of the operator will be left free for this procedure. On occasions, if the patient has not been properly prepared, the presence of the tube in the trachea or bronchi will elicit a cough which can be controlled by introducing about 0.5 cc. of the basic solution through the catheter.

In bronchography the adjuvant medication may be omitted, although, of late, I have used it routinely with much better results and

on many occasions I have been able to perform five-lobe bronchograms at one sitting by its use.

4. *Bronchoscopy*.—The procedure for bronchoscopy is exactly the same as for bronchography except that the adjuvant medication is used in all cases. When the character of the cough indicates that the patient is ready, he is placed on the bronchoscopic table and given the "sermon" on relaxation as advocated by Jackson and Jackson (4). This, as well as a darkened room, quiet, and a sympathetic attitude, is of the utmost importance in successful bronchoscopy. I make it a rule to describe the procedure to the patient, but only when he is on the table.

Before the bronchoscope is introduced, the remaining solution in the medicine glass is transferred to the reservoir of the micro-atomizer which is then attached to the Clerf atomizer for endobronchial spraying. It may be noted that both the micro-atomizer and Clerf atomizer have the same type of reservoir. The bronchoscope is then introduced in the usual manner, with or without the aid of the laryngoscope. When it reaches the carina, the right and then the left main stem bronchi are anesthetized by spraying very sparingly with the Clerf atomizer, which now contains the residuum of the basic solution. On occasions it will be found that spraying of the bronchi will not be necessary. After several minutes of waiting, it will be possible to proceed with the bronchoscopy satisfactorily. Occasionally a patient is encountered who will cough when the bronchoscope is introduced far down, distending the lumen of the bronchus with its bulk. When this occurs, the bronchoscope is withdrawn slightly, relieving the pressure, and the area gently sprayed with the Clerf atomizer. This procedure usually controls the cough reflex satisfactorily.

Following the completion of the bronchoscopy, the residual solution in the reservoir is placed in the 10 cc. glass cylinder and the total quantity used for the entire procedure of oro-pharyngo-laryngo-tracheo-bronchial anesthesia determined by subtracting what is left from the original volume of 8 cc. It is advocated that this be done in every case and recorded as it enables the operator to become "solution conscious" and makes him strive to conserve at all stages.

In the series of bronchoscopies reported, oxygen insufflation through the side arm of the bronchoscope was used at the rate of 6 liters per minute as it was thought that the entire procedure was facilitated and the patient relieved of the sense of suffocation which is frequently noticed during bronchoscopy without oxygen.

5. *Simultaneous Bronchoscopy and Bronchography*.—I have recently been performing both bronchoscopy and bronchography at the same sitting with the same amount of anesthetic agent as is used for bronchoscopy. When bronchoscopy has been completed the bronchoscope is left in place and a No. 12 ureteral woven catheter introduced through the lumen. Usually the tip of the catheter is located in the

left main stem bronchus. The bronchoscope is then gently withdrawn and the catheter pushed in during the withdrawal. The standard length of the ureteral catheter is sufficient so that this procedure can be carried out and the tip still located in the left main stem bronchus. The patient is then placed on the x-ray table and the catheter attached to a 10 cc. syringe, containing the opaque oil, with a special adapter. The catheter need not be radiopaque since it becomes visible under the fluoroscope by gently filling it with the opaque medium. Careful posturing, as well as tilting on the horizontal x-ray table will result in excellent five-lobe bronchograms with this technic. Table 2 shows the amount of anesthetic agent used in 85 cases in which this combined procedure was employed.

6. *Combined Endoscopic Procedures.*—As a corollary to this study various types of endoscopic procedures have been combined, with minor

TABLE 2
COMBINED ENDOSCOPIC PROCEDURES WITH PONTOCAINE*

No. Cases	Procedure	Pontocaine 0.25%			Adjuvant Medication (mg.)	
		Min.	Max.	Av.	Morphine Sulfate (Average)	Atropine Sulfate (Average)
85	Bronchoscopy-bronchography	1.50	10.80	6.12	13.73	0.357
26	Broncho-esophagoscopy	2.80	8.40	5.33	15.00	0.400
3	Broncho-gastroscopy	5.40	7.60	7.90	15.00	0.400
9	Broncho-esophago-gastroscopy	3.00	6.40	5.07	15.00	0.400
	"Normal" Dosages			8.00	15.00	0.400

* This group of combined procedures is included in the series of 621 bronchoscopies discussed.

variations in the technic of anesthesia to show the effectiveness of pontocaine in low dilution. These combined procedures and the amount of anesthetic agent used are indicated in table 2.

RESULTS

A total of 621 consecutive, unselected bronchoscopies in adults was performed with the technic and innovations of instruments previously mentioned. All but 17 of the patients were ambulatory. These 17 patients were already in the hospital for other reasons and while there developed indications for bronchoscopic study or therapy. The series was considerably varied and included the following conditions: "normal" cases with manifestations indicating bronchoscopy; bronchitis; chronic asthma; heart disease of various types, compensated; coronary thrombosis, stabilized; hypertensive cardio-vasculo-renal syndromes, moderate to moderately severe; pulmonary abscess; bronchiectasis; broncho-pulmonary suppuration; bronchial ulceration; broncho-stenosis; atelectasis; postoperative and suppurative types; empyema;

pulmonary tuberculosis; tuberculous tracheo-bronchitis; bronchial hemorrhage of undetermined or determined origin; pulmonary neoplasms; Hodgkin's disease, mediastinal; lymphoblastoma, mediastinal and pulmonary; chronic lymphatic leukemia; metastatic hydronephroma; thoracoplasty; unilateral pneumothoraces; bilateral pneumothoraces; extrapleural pneumothorax with pneumoperitoneum; tumor of the superior sulcus; pleural effusion; foreign bodies; emphysema, severe; silicosis, advanced cervico-dorsal kyphoscoliosis, severe, associated with bronchiectasis; Loeffler's syndrome; advanced age (75 years); early adolescence (12 years), and obesity (240 pounds).

It will be seen from the above types of cases that the series gave an opportunity to study the technic and its value in the usual collection of cases that may come to bronchoscopy. Many patients proved to

TABLE 3
ANALYSIS OF CASES OF "OVER-DOSAGE" (12 CASES)

Age, years	Weight, pounds	Sex	Pontocaine 0.25% Solution		Morphine Sulfate	Atropine Sulfate	Diagnosis
			Cc.	Mg.	Mg.	Mg.	
46	171	M	16.00	40.00	22.50	0.60	Chronic alcoholism
65	165	F	16.00	40.00	7.50	0.20	Bronchogenic carcinomas
46	121	F	12.00	30.00	15.00	0.40	Normal findings
54	136	F	12.00	30.00	15.00	0.40	Pulmonary abscess
48	155	F	12.00	30.00	7.50	0.20	Normal findings
38	129	M	12.00	30.00	7.50	0.20	Pulmonary abscess
46	156	M	10.80	27.00	15.00	0.40	Asthma, bronchial
34	180	M	10.00	25.00	15.00	0.40	Normal findings
29	180	M	10.00	25.00	15.00	0.40	Normal findings
49	135	F	10.00	25.00	15.00	0.40	Bronchopulmonary suppuration
24	156	M	9.00	22.50	15.00	0.40	Bronchiectasis
60	214	M	9.00	22.50	15.00	0.40	Normal findings

have negative findings in spite of the fact that they presented pulmonary symptoms of what could have been either tracheal or bronchial lesions. The average age of the series was 41.4 years and the average weight 140.0 pounds.

To judge the adequacy of the anesthetic agent from the point of view of the behavior of the patient, notes were kept on his cooperation as well as on the amount of coughing occurring during bronchoscopy. With the exception of 12 patients, all behaved well, coughed very little, and the bronchoscopy was carried out leisurely and deliberately. In these 12 cases, however, there was considerable cough which necessitated additional surface anesthesia. This group is analyzed in table 3. Only one failure was encountered in the entire series—a patient with partial ankylosis of the temporomandibular joints with a dental angle that made the introduction of the bronchoscope a physical impossibility. Since bronchoscopy was not done, this case is not included in the series.

A head holder was not used in any case and the entire procedure was carried out by the operator with the aid of one instrument nurse. All patients were strictly ambulant except those previously mentioned who were already in the hospital for other reasons. No ambulatory patients required hospitalization after bronchoscopy for any reason whatsoever.

Excessive secretions in the oropharynx were noted in only 8 patients. These patients required aspiration before bronchoscopy could be per-

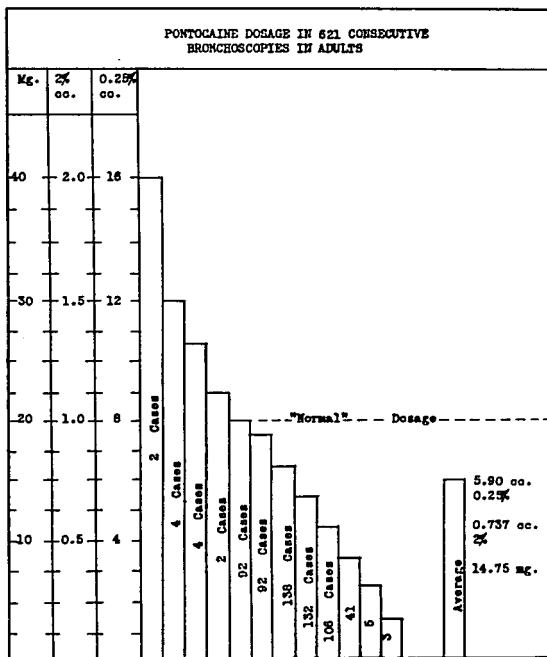


FIG. 3.

formed. In one case salivation was so profuse that the secretions ran into the lung alongside the bronchoscope and required continuous aspiration. Figure 3 gives the actual dosage of the pontocaine in milligrams as well as equivalents of the 2 per cent and of the 0.25 per cent solutions in cubic centimeters. Comparison with the 2 per cent solution is made because a better concept is had of the small amounts of pontocaine used. The dosages of morphine and atropine are shown in Figure

4. It may be noted that of the series of 621 cases only 12 patients required dosages higher than those recommended by the manufacturer, but still less than the dosages for bronchoscopy reported in the literature by other authors. Three patients had only 7.5 mg. of morphine, and it is thought that the total quantity of pontocaine could have been reduced had full doses of morphine been employed. One patient was an alcoholic of such physical mien that the full dose of 40 mgm. of pontocaine and 22.5 mgm. of morphine was needed. He was the most difficult of the series. One patient with a chronic pulmonary abscess had the entire tracheobronchial tree coated with a tenacious mucopurulent secretion which prevented the anesthetic from reaching the

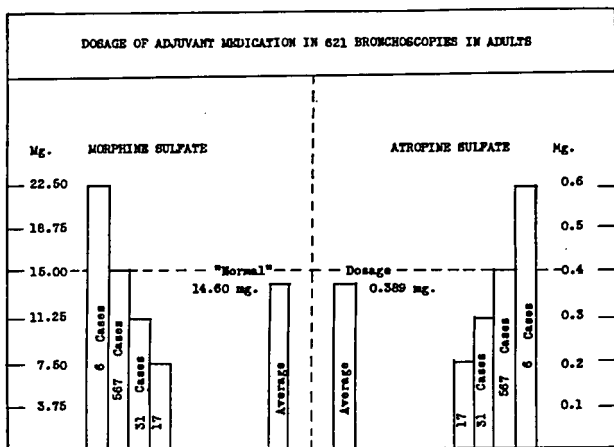


FIG. 4.

mucosa. It was noted throughout the series that patients with pulmonary abscess and advanced bronchiectasis were difficult to anesthetize for the same reason. It is also to be noted that 8 of these cases of "overdosage" were included in the first group of 167 cases originally reported (8), and that only 4 cases have made their appearance in the additional group of 454 cases. The decrease in the incidence of "overdosage" gives some indication of what can be done to conserve the solution once the technic has been properly mastered.

The actual chronologic protocol of cases roughly parallels the decrease in dosage as shown in the bar graphs of figure 3. Several large groups (92, 92, and 138 cases) had more or less uniform doses. These standardizations occurred when it was thought that a minimal level

had been reached, below which the effect of the anesthetic would have been lost. Subsequent cases proved, however, that a personal variable existed with each patient and that each had his own level of susceptibility to the action of pontocaine. The operator soon got the "feel" of the anesthetic action and instilled only sufficient quantities. In most of the series (517 cases) the doses were well below the "normal" dose.

The average dose for the entire series was 14.75 mg. or its equivalent of 0.737 cc. of the 2 per cent and 5.90 cc. of the 0.25 per cent solutions of pontocaine. The average dose of morphine was 14.6 mg. and that of atropine 0.389 mg. All dosages are well within the safe limits of posologic tables and, with respect to pontocaine, well below the maximal recommended dose.

COMPLICATIONS AND SEQUELAE

In spite of the fact that no barbiturates were used in any case of the series, no patient presented any symptoms which could be construed as a reaction to pontocaine. The 12 cases of "over-dosage" were watched carefully and showed no immediate or delayed ill-effects from this drug. Some degree of nausea and vomiting was noted in about 30 per cent of the cases, and was attributed to the morphine. All patients were watched personally and none showed evidence of facial twitching or any other incipient convulsive state. The series included 33 patients with chronic bronchial asthma, in most of them severe, and some in an acute crisis of a mild type. These patients were closely watched for any toxic manifestations or precipitation of asthmatic crises inasmuch as reactions to pontocaine in asthmatics have occurred with sufficient frequency that Jackson and Reynolds, as quoted by Benedict (6), stated that pontocaine is contraindicated in asthmatics. Criciani and Nogeura (10) reported the production of asthmatic crises by the endotracheal instillation of pontocaine. The 24 cases mentioned constitute too small a series to draw any definite conclusions from the results, and the absence of complications may have been purely a fortunate coincidence.

SUMMARY

Review of the literature shows that all authors committing themselves on the actual quantity of pontocaine used for bronchoscopy or bronchography are using far more of the drug than is recommended by the manufacturer. In one case as much as fifteen times the recommended dose was used for bronchography.

Unnecessarily large amounts of pontocaine are used for these procedures because of the inadequacies inherent in present technics and available instruments.

A "one-hand" micro-atomizer and a mirror cannula which permit the use of small doses of pontocaine are described.

A technic which makes possible bronchoscopy and bronchography

with the use of subposologic doses of pontocaine with only morphine and atropine in full doses as adjuvant medicants is described.

An unselected, consecutive series of 621 bronchoscopies in adults performed with these technics, using an average of 14.75 mg. of pontocaine (0.737 cc. of a 2 per cent solution), with no complications attributable to the pontocaine, is reported.

No barbiturate was used in any case of the entire series to counteract the reactions to pontocaine.

Pontocaine in 0.25 per cent solution is a safe, effective and long-lasting surface anesthetic agent suitable for bronchoscopy and bronchography.

All the instruments mentioned in this paper including the micro-atomizer and the mirror cannula are available from the George P. Pilling & Sons Company, 3451 Walnut Street, Philadelphia, Pennsylvania, to whom the author has given the specifications for the manufacture of both these instruments.

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