

INTERCOSTAL BLOCK WITH LONG-ACTING ANESTHETIC
IN UPPER ABDOMINAL OPERATIONS *

STANTON BELINKOFF, M.D.

New York, N. Y.

INTRODUCTION

THE high incidence of postoperative pulmonary complications in upper abdominal surgery has long been a source of deep concern to both surgeon and anesthetist. Until the sulfonamides were developed, this was the major cause of fatalities, patients tolerating the operative procedure but not being able to combat its consequences. Now that more effective methods are available for the treatment of pneumonia the results are more encouraging, but the problem is still not solved.

When spinal anesthesia was first popularized it was thought that the elimination of agents irritating to the respiratory passages, like ether, would reduce the number of patients developing pneumonia. However, controlled series with all types of anesthetic procedures showed no difference in the incidence of pulmonary complications.

Further investigations of the postoperative course of these patients revealed that usually an area of atelectasis developed, at the site of which the pneumonic process later occurred. This primary atelectasis was due to greatly reduced respiratory excursions produced by a combination of factors all dependent upon pain from the abdominal incision: splinting of the diaphragm, tight abdominal dressings and binders, reluctance to take deep breaths, morphine and other opiates, unwillingness to attempt to cough up gathering mucus, and the tendency of the patient to remain in one position. It is seen on close study of these factors that all are based on the pain from the abdominal wound and attempts to alleviate it. It is therefore logical to assume that if relief from the pain could be obtained, progress would be made toward the solution of this problem.

There have been several advances made in this direction. Gius (1) demonstrated that in two cases which developed postoperative atelectasis paravertebral block with procaine of the nerves supplying the operative area, in these instances lower thoracic and upper lumbar after appendectomy, eliminated the pain from the wound, allowing deep breathing, easy coughing, and freedom of movement. The offending plugs of mucus and bronchial secretions were dislodged and expectorated with rapid reexpansion of the involved lung areas.

Crile (2) recommended the use of anesthetic solutions around the wound to alleviate postoperative pain, injecting a $\frac{1}{4}$ to 0.5 per cent solu-

* From the Department of Anesthesia, Lenox Hill Hospital, New York, N. Y.

tion of quinine and urea hydrochloride. The anesthesia obtained was satisfactory, lasting for several days, but the method was discarded because it produced a fibrinous exudate with occasional suppuration at the sites of injection.

More recently Capelle (3) recommended the continuous administration of a procaine solution to alleviate the postoperative pain from surgical wounds. He used several large, thin, curved, hollow needles which were placed like retention sutures and served as outlets to irrigate the wound with the anesthetic solution when required. This method has been discarded for obvious technical reasons.

It was Bartlett (4) who, a few years ago, wrote the classical description of the blocking of the lower intercostal nerves to produce upper abdominal anesthesia. He showed that in the mid-axillary line they were easily accessible and could be reached with great accuracy. Bartlett described the use of the block of the sixth to eleventh intercostal nerves as producing anesthesia of the upper abdominal wall with relaxation of the musculature and showed how it could be used advantageously when combined with light general anesthesia in operations on the upper abdomen.

Starr and Gilman (5) carried the use of this method a step farther when in a series of cases they performed intercostal blocks about twenty-four hours postoperatively and showed that there was a marked increase in pulmonary ventilation. The relief of pain allowed the patients to move about more readily, coughing was much easier with ability to raise sputum enhanced, and there was an increase in vital capacity.

In a series of 15 cases Zollinger (6) performed intercostal blocks with a solution of eucupin in oil to obtain anesthesia of several days' duration. From 1.5 to 5 cc. were injected in each space. Measurements of vital capacity showed an increase over the readings obtained in a control group who did not receive the block. The resulting anesthesia using both unilateral and bilateral blocks was not uniformly good, but he stated that the method warranted further trial.

This form of regional anesthesia has proved practical for operative procedures in the upper abdomen, especially in poor risk patients, and its use in this way led to this attempt to produce anesthesia of the area of several days' duration. Two purposes were in mind; first the prevention of postoperative pulmonary complications, and secondly the relief of the postoperative pain which is their underlying cause.

METHOD

The agent used in this series of cases was Novest-Oil,* which is a solution of monocaine base, benzyl alcohol, and benzocaine in oil of sweet almonds. Its exact composition is:

* The Novest-Oil used in these investigations was generously supplied by the Novocol Chemical Manufacturing Co., Brooklyn, N. Y.

Monocaine base	0.02 Gm.
Benzyl alcohol	0.05 Gm.
Benzoecaine	0.03 Gm.
Oil of sweet almond	to 1.0 cc.

This solution had previously been used by Brenner (7) in a group of rectal cases for prolonged analgesia with good results and no untoward reactions, and was selected for use here.

The technic of injection was essentially the same as that described by Bartlett (4). In the midaxillary line the intercostal nerve runs in a closed compartment just beneath the inferior margin of the rib between the internal and external intercostal muscles. After preparation of the skin with a suitable antiseptic, the injections are made in the midaxillary line under ribs 6 through 11. The needle is inserted against the rib and then moved down until it just slips under the inferior border, the anesthetic agent being deposited here. The injections are made bilaterally, 1.5 cc. for each interspace. A number 20 needle is used, the bevel of which has been filed down so as to present an almost-blunt surface. It is felt that a long bevel might cause unnecessary trauma to the pleura since the interspace is so shallow. Aspiration is performed before the injection is made to ascertain whether or not the needle is in the pleura or intercostal vessels. The amount injected has been limited to 1.5 cc. since there is some danger of abscess formation from the pooling of large quantities of an oily solution. A total of twelve injections is made, six on each side. The total quantity of anesthetic solution used is 18 cc.

In the first few cases, the injections were made after local infiltration of the skin with 1 per cent procaine. This proved to be unsatisfactory due to loud and sustained complaints from the patients who objected to the manipulations and numerous injections which they felt. This was done so that the skin could be tested to determine the efficiency of the block. When more confidence and skill in the performance of the procedure was obtained, the technic was modified so that the intercostal block was done after the regular anesthetic to be used had been started. In those cases where spinal anesthesia was used, the block was performed after the level of sensory anesthesia had reached to the fourth thoracic segment. When using one of the inhalation agents, the patient was induced and carried in a very light plane, and while an assistant maintained the anesthesia, the injections were made. In this way the patient was spared the ordeal of what seemed to be innumerable "sticks in the ribs." The anesthesia was then deepened to the desired level, and the surgery started. In two of the cases the block was done after the operation had been completed and before the anesthesia had worn off.

RESULTS

A total of 20 cases having upper abdominal operations was treated in this manner. There was no attempt made to select the cases, the only

criteria being the cooperation of the surgeon and his permission to use the method. Age, mental attitude of the patient, magnitude of the procedure, and operative risk were not considered.

The operations performed were as follows: biliary 14, gastric 4, and herniorrhaphy 2. The operating time was from one to four hours, the average time being about two hours. Most of the operations were done by members of the house staff, which perhaps lengthens the operating time somewhat.

All types of anesthesia were used. In several cases there was a definite attempt made to produce a balanced anesthesia using the intercostal block for muscular relaxation and other agents for general anesthesia, as the combination with sodium pentothal for a gastroenterostomy. Usually it was used only for its postoperative effect and not taken into consideration when the anesthesia for the case was selected. The anesthetics used were:

Spinal	11
Continuous spinal	3
Inhalation	5
Intravenous	1

A brief summary of the cases is presented in table 1.

There was a failure in only one case, that of a man who developed a series of postoperative complications, which will be described later. In the other 19 cases relief from pain in varying degrees was obtained and is recorded as the number of doses of opiate that were given. Only 2 patients required two doses of morphine for sedation, 7 one dose, and the rest (10) had complete relief, requiring no sedation at all for pain. In those receiving just one dose, it was given mostly for apprehension rather than pain, usually in cases having had spinal anesthesia, the injection being given immediately upon return to the room even before the spinal had worn off. For the first two days nearly all patients received sodium luminal gr. ii for sleep.

There was only one pulmonary complication. An obese male who had had a cholecystectomy became severely distended and developed pneumonia on the seventh postoperative day. This is beyond the time limit of effectiveness of the intercostal block. The reduction in vital capacity and pulmonary excursions by the abdominal distention can in no way be affected by our procedure. Although a pulmonary complication did occur, it was not in the period in which we are primarily interested and should not really be classed as a poor result. The patient responded to sulfonamide therapy and had an otherwise uneventful recovery.

There were two deaths in the series, in neither of which was the intercostal block a contributing factor. One was a 64 year old female who was operated upon for cholecystectomy and plastic of the common duct lasting four hours; and she died on the third postoperative day from acute left ventricular failure. She had no postoperative pain.

TABLE 1

Case	Patient	Operation	Anesthesia	Age	Doses of morphine	Postoperative complications
1	E. G.	Gastroenterostomy	Intravenous and N ₂ O and Oxygen	64	0	None
2	A. S.	Cholecystectomy	Cyclopropane and Oxygen	59	q4h	Intestinal obstruction; atelectasis; pneumonia; evisceration; pulmonary embolus; death.
3	H. D.	Cholecystectomy	Spinal	40	0	None
4	M. S.	Cholecystectomy	Spinal	47	0	None
5	K. H.	Cholecystectomy; Hepatoduodenostomy	Cyclopropane; Oxygen; Ether	63	0	Acute left ventricular failure and death on 3rd postoperative day.
6	N. M.	Cholecystectomy and Appendectomy	Cyclopropane; Oxygen; Ether	20	1	None
7	E. S.	Cholecystectomy and Appendectomy	Spinal	42	1	None
8	J. K.	Ventral Hernia Repair	Spinal	64	1	None
9	J. L.	Cholecystectomy and Appendectomy	Spinal	49	1	Abdominal distention; pneumonia on 7th postoperative day.
10	L. B.	Cholecystectomy	Spinal	48	1	Evisceration on 4th postoperative day.
11	A. S.	Cholecystectomy	Spinal	44	0	None
12	C. J.	Exploratory and Biopsy of Liver	N ₂ O; Oxygen; Ether	54	1	None
13	A. G.	Gastric Resection	Continuous Spinal	54	0	None
14	J. M.	Ventral Hernia Repair	Spinal	30	1	None
15	C. W.	Gastrotomy	Cyclopropane; Oxygen; Ether	61	0	None
16	S. P.	Cholecystectomy; Appendectomy	Spinal	52	2	None
17	A. G.	Cholecystectomy; Appendectomy	Spinal	43	2	None
18	A. J.	Cholecystectomy	Spinal	56	0	None
19	C. E.	Cholecystectomy; Common Duct	Continuous Spinal	53	0	None
20	J. G.	Revision of Gastroenterostomy	Continuous Spinal	41	0	None

The second was a 55 year old male who developed a series of postoperative complications which constitutes a "surgeon's nightmare." They were, in order, intestinal obstruction, severe abdominal distention, atelectasis, pneumonia, evisceration, wound infection after the repair, and finally, while lying in bed talking to his wife the day before he was to get up, a pulmonary embolus with immediate death. This patient had no relief from postoperative pain, requiring sedation immediately upon reaction from the anesthesia. This was the second case in the series, and the failure was probably due to faulty administration of the block.

The site of injection was closely watched postoperatively for any reactions. In no cases were there any signs of inflammation or tissue

damage. When the drug was first being used there was a question of whether or not it would cause abscess formation with sloughing if pooled in the tissues. In the reports on rectal cases this seemed to be one of the dangers. In this series, however, we tried to obviate the possibility by using small quantities of solution at each space and massaging the area vigorously after the injections had been completed. There were no demonstrable systemic ill effects.

The duration of anesthesia obtained varied from eight hours to two days. Since only a few of the patients were skin-tested adequately, these determinations are not very accurate. The dressings were ordinarily not disturbed by the surgeon in the first few days when the examinations should have been done, and we were reluctant to expose the wound frequently, mindful of the danger of infection. Although the anesthesia was limited in its duration, it was followed by a period of analgesia which persisted until the pain from the wound had diminished or was completely absent, as demonstrated by the continued freedom from pain of the patient.

The block has had no effect at all upon wound healing. Sutures were removed on the same day as if there had been no block performed, the usual routine of the surgical services in this respect being carried out. There were no alterations of the wound noted, either favorable or unfavorable.

There have been no delayed or permanent ill effects noted when these patients returned to the clinic for follow-up examinations. The incisions are all firmly healed with no weakness of the abdominal wall or loss of sensory function from nerve damage.

DISCUSSION

The relief of postoperative pain in the first two or three days greatly reduces the incidence of the pulmonary complications which are prone to occur in this period. The method described to obtain this relief is very simple and involves no danger to the patient. In these cases there were no pneumonias in the danger period, the only one that developed being on the seventh postoperative day, where the etiological agent was undoubtedly the postoperative abdominal distention causing a reduction in pulmonary ventilation.

From the viewpoint of the patient, all were extremely happy and amazed at the absence of the severe pain which they anticipated following their operations. Those who had other operations were delighted at the comparison with their previous experience. For the most part they lie quietly in bed, are able to move about freely and turn from side to side at the nurse's request, with no pain. The most common complaint was weakness on the day of operation, but realizing that they had been through a major operation, they accepted it. All patients had regular orders for sedation if it was needed, depending upon the nurse's

discretion and the patient's complaints. There was no attempt made to withhold drugs for relief of pain if they were necessary. Sleeping medication, as one of the injectable barbiturates, was given routinely the first two nights, but after this only if required.

One of the most striking successes was obtained in a tall, 240 pound man, who was operated upon for cholecystectomy under spinal anesthesia. The day of operation he felt somewhat tired and weak, but on the following day was sitting up in bed reading a newspaper and inquiring why he was not back in the ward with his friends. When asked if he had any pain he replied, "No, I feel fine" and slapped his abdomen several times to prove it. However, all cases were not as favorable as this, most of them merely lying quietly in bed.

There were definite advantages obtained in regard to pulmonary ventilation. Although studies were not made of the vital capacity, clinically each patient showed full respiratory excursions. Deep breathing was encouraged by the nursing staff, and the patients responded well since it was not painful for them to attempt to expand their lungs fully. They were able to cough easily and expectorate, preventing the gathering of secretions and mucus in the tracheobronchial tree.

In one obese man, upon whom a cholecystectomy had been performed, who was told to cough freely and who followed instructions closely, there resulted an evisceration on the fourth postoperative day. This was closed under spinal anesthesia, and uneventful recovery resulted, but an interesting point is raised. If these patients have no pain and cough freely and strongly, will there be a greater incidence of evisceration? As yet no definite opinion can be ventured due to the small number of cases observed, and it would be unfair to state that the intercostal block was the cause. However, it must be born in mind and an evaluation made after more material has been studied.

CONCLUSION

The blocking of the intercostal nerves with Novest-Oil, a long-acting anesthetic, to produce prolonged anesthesia of the upper abdominal wall has proved of definite value in two respects. First, it relieves the patients of all or most of the postoperative pain which normally follows the operative procedure, and thus makes this period more tolerable for them. Secondly, by relieving this pain, there is little or no interference with pulmonary ventilation, and consequently a greatly reduced incidence of postoperative pulmonary complications results.

There are several relative disadvantages incident to the method. The discomfort of the patient from the multiple injections when the block is done under local anesthesia can be eliminated by withholding it until the anesthetic to be used for the operation has already been induced. The danger of abscess formation has been eliminated by using small quantities of the agent, depending upon accuracy in placement rather than a large volume of solution to obtain the result.

From the standpoint of the anesthetist it is not necessary for the operation itself and consumes extra time and effort, both in preparing the equipment and in administering the block. It demands patience on the part of the surgeon, who must wait the few minutes while the block is being done before starting the operation.

However, when all factors are considered, it is evident that the procedure has merit and should be further investigated in an effort to apply it to other types of operative procedures. Studies are now being carried out to broaden the application of this principle.

SUMMARY

The use of intercostal block with an anesthetic agent of prolonged action has been described and 20 cases presented in which an attempt was made to relieve the postoperative pain from upper abdominal procedures and reduce the incidence of postoperative pulmonary complications. The results indicate that the method is valuable and further studies are being undertaken.

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REFERENCES

1. Gius, J. A.: Paravertebral Procaine Block in the Treatment of Postoperative Atelectasis, *Surgery* 8: 832-838, 1940.
2. Allen, C. W.: Local and Regional Anesthesia, ed. 2, Philadelphia, W. B. Saunders Co., 1918, pp. 205, 206.
3. Capelle, W.: Die Bedeutung des Wundschmerzes und seiner Ausschaltung für den Ablauf der Atmung bei Laparotomierten, *Deutsche Ztschr. f. Chir.* 246: 466, 1935-1936.
4. Bartlett, R. W.: Bilateral Intercostal Nerve Block for Upper Abdominal Surgery, *Surg., Gynec. & Obst.* 71: 194-197 (Aug.) 1940.
5. Starr, A., and Gilman, S.: The Effect of Postoperative Intercostal Nerve Block on Pulmonary Ventilation, *New England J. Med.* 227: 102-104 (July 16) 1942.
6. Zollinger, R.: Observations on the use of Prolonged Anesthetic Agents in Upper Abdominal Incisions, *Surgery* 10: 27-36 (July) 1941.
7. Brenner, I. M.: Novest-Oil—A New Prolonged Oil Analgesic, *J. Nat. Proct. A.* 14: 244-247 (July-Aug.) 1942.

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