Epidural block for hemicolectomy in a patient with bilateral diaphragmatic paralysis[1]

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A patient with respiratory function embarrassed by bilateral diaphragmatic paralysis after cardiac surgery was anesthetized for colectomy with a combined epidural-general technique using controlled ventilation. Spontaneous respiration resumed quickly after surgery, acceptable levels of blood gases were maintained postoperatively, and the overall perioperative course was uneventful.

Index terms: Anesthesia, epidural • Respiratory paralysis

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Bilateral phrenic nerve palsy has been reported following open-heart surgery and attributed to neuronal damage from topical cardiac hypothermia.[1-3] We report the use of epidural analgesia for removal of an adenocarcinoma of the colon in a patient with this condition.

Case report

The patient, a 56-year-old man, was scheduled for a hemicolectomy 25 days after coronary artery grafting. He was found to have bilateral phrenic paralysis. The cardiac surgery was done three months after a myocardial infarction. The patient had had a similar operation four and a half years previously.

The patient was 1.73 m tall and weighed 76 kg. His hemoglobin concentration was 10 g/100 mL, the ECG showed "myocardial changes," and a resolving small left pleural effusion was present. Medications for hypertension and gout included propranolol hydrochloride, 80 mg b.i.d.; triamterene and hydrochlorothiazide (Dyazide), 1 capsule q.d.; and probenecid, 500 mg q.i.d. Isosorbide dinitrate (Isordil) was also prescribed.

A diagnosis of phrenic nerve paresis was made by observing paradoxical inward retraction of the abdominal muscles during inspiration, by demonstrating elevation of both hemidiaphragms on plain radiographs, and by measuring an esophageal transdiaphragmatic pressure gradient of 0 cm H_2O on inspiration against a closed glottis.

The effects of diaphragmatic paralysis were most marked when the patient lay supine, with FVC and FEV_1 values more than 50% lower in this position than when he was sitting (*Table 1*); a lower PaO_2 (64 mm Hg supine versus 80 mm Hg standing) also suggested increased intrapulmonary shunting. Ventilation volumes, however, were adequate to maintain at least a normal $PaCO_2$, independent of posture. The position he chose, for ease of breathing and for normal sleep, was sitting or semirecumbent, when his respiratory rate averaged 20/min.

Premedication was with diazepam 10 mg orally. An intra-arterial line was established with the patient in Fowler's position. Preinduction arterial pressure was 180/100 mm Hg, heart rate 85. With the patient seated, 24 mL of

Table 1. Respiratory mechanics before and after surgery (L/min)

	Patient seated		Patient supine	
Day	FVC	FEV_1	FVC	FEV_1
−2	2.4	1.5	1.1	0.50
+1	1.1	0.77	0.50	0.35
+2	1.2	0.91	0.61	0.45
+5	1.5	1.2	0.85	0.68

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Table 2. Blood gases before, during, and after anesthesia (mm Hg)

	$PaCO_2$	PaO_2	Vent
Preinduction; air	31	80	S
Start closure; 0.5*	27	157	C
Pre-extubation; 1.0*	35	218	S
Recovery + 40 min; mask, 0.5*	34	105	S
Recovery + 160 min; mask, 0.5*	24	123	S
Recovery + 18 hours; mask, 0.5*	34	91	S

* Fractional inspired oxygen concentration.
S = spontaneous ventilation; C = controlled ventilation.

mepivacaine 2% was injected epidurally at the 3–4 lumbar interspace; a catheter was then inserted. Immediately afterward, he was placed supine, and a light plane of general anesthesia was induced with thiopental sodium 250 mg; succinylcholine chloride 100 mg was given for endotracheal intubation, and nitrous oxide 60% with 0.2 to 0.4% isoflurane in oxygen for maintenance. Mechanical ventilation was used throughout the operation, without neuromuscular blocking drugs.

The presence of high epidural blockade was confirmed by observing abdominal muscle tone, by the lack of reflex response to sensory stimulation, and by a declining arterial pressure 12 to 15 minutes after epidural injection. Then and subsequently, ephedrine, 5 to 10 mg, was given intravenously to maintain a systolic level of 90 to 100 mm Hg.

The surgical incision extended almost to xiphisternum, and the procedure, which lasted 100 min, was carried out satisfactorily without supplement except for a sleeping level of general anesthesia.

Table 2 shows the blood gases at the start of abdominal closure, when ventilation was controlled, and the values soon after, during spontaneous respiration before extubation. An adequate minute volume was sustained, although the patient was still supine and lightly anesthetized.

In the recovery room, arterial pressure and blood gases remained satisfactory (*Table 2*), although the PaO_2 value indicates considerable shunting, probably intrapulmonary.[4] Forty minutes after the patient arrived in the recovery room, morphine 2 mg was given intravenously, followed by 5 mg epidurally. By this means, pain was relieved for approximately 12 hours, at which time the patient was discharged from the recovery room. In the ensuing five days, during which meperidine was administered parenterally, pulmonary mechanics gradually improved, short of complete recovery to the preoperative values (*Table 1*). Overall, the perioperative course was satisfactory.

Discussion

References to anesthesia in patients with bilateral diaphragmatic paralysis are rare or nonexistent (we found none). Our choice of epidural analgesia was based mainly on our clinical experience that, when combined with light general anesthesia, the technique can achieve excellent results in major abdominal surgery. Thus, patients recover early to full alertness without central respiratory depression and can maintain satisfactory tidal volumes because of residual analgesia. We believe that ablation of intercostal activity was more limited in effect and time with this technique than it would have been with neuromuscular blocking drugs; we intended also to match the duration of analgesia approximately to that of the surgery and to relieve early postoperative pain by means of epidural narcotics, with the patient seated.[5]

In our experience, adequate sensory block for abdominal exploration requires a lumbar epidural dose of 22 to 25 mL, preferably injected as an initial volume through the needle. Similar results might have been achieved, at considerable cost in time and tolerance for this particular patient, by graded injections through the epidural catheter, with continuous assessment of the ascending sensory level. Our preference to induce light general anesthesia as soon as possible after epidural injection inevitably precluded accurate testing of segmental analgesia. Lacking objective criteria for determining motor function, we were compelled to rely on observation of abdominal muscle tone. However, the proximal level of sensory block must have been sustained to at least T5, since analgesia was adequate for surgical exploration, and the upper abdominal muscles were fully relaxed for opening and closure.

It was perhaps fortuitous, although our intention, that an adequate minute respiratory volume was attained so quickly at the end of surgery, and one may question whether the high epidural block in fact depressed intercostal effort and pulmonary ventilation to the extent expected in this patient. The respiratory neurons in the intercostal nerve roots, which show an increased discharge in experimental diaphragmatic paresis,[6] may have been relatively resistant to blockade. Impaired intercostal function sufficient to seriously reduce minute respiratory volume does not seem, at least, to be inevitable in upper abdominal surgery performed under epidural analgesia.

Thus, we have described a combined epidural-general technique of anesthesia for major abdominal surgery that proved to be entirely satisfactory in a patient with complete diaphragmatic paralysis.

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Commentary

Michael B. Howie, M.D., Department of Anesthesiology, The Ohio State University, Columbus, comments: The authors present a rare problem, but their solution can be applied in many similar situations. All patients who have chronic lung disease and need anesthesia for major abdominal surgery present this dilemma.

Chronic lung impairment is a major problem during anesthesia, surgery, and the postoperative period. It is potentially a significant cause of mortality, considering the number of patients anesthetized per year nationwide.

The authors successfully anesthetized this patient by tailoring their anesthetic technique to his abnormal physiology. They minimized the effect on respiratory capacity by limiting the segmental level of the epidural block at T_5, which probably left the patient able to cough postoperatively.

I understand the authors' reason for the "one-shot" technique of administering 24 mL of 2% mepivacaine: they wished to minimize the patient's wait and discomfort. However, that amount of local anesthetic administered at once could have produced an untoward cardiovascular and respiratory effect. Also, the segmental level attained could have been higher and could have produced respiratory embarrassment that continued postoperatively, negating the advantage of the light anesthetic approach.

I believe that slower titration and attainment of the desired segmental level would have been more judicious. The stepwise blocking of segments could have been accomplished quite satisfactorily, with patient comfort, by introducing the epidural catheter, giving a test dose (most importantly), and then proceeding with incremental doses of 5 mL to the desired level.

An important advantage of the epidural catheter was that it allowed epidural administration of morphine postoperatively. A major reason for postoperative respiratory complications is inadequate ventilation because of pain. I would have relied more on the epidural route for administering analgesia than on the intravenous route.

Success, however, is the best judge. A major reason for the success with this patient was the authors' careful and caring approach to his management. The report is encouraging, enabling others to approach the same dilemma, should the occasion arise. As always, the choice of anesthesia should be individualized for each patient after a thorough preoperative evaluation, and the authors exemplified this approach.