Original Article

Epidural Fibrosis After Permanent Catheter Insertion and Infusion

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Abstract
Forty-six permanent epidural catheters and life-port units were implanted in 43 patients with severe, recurrent low back pain who had been considered not to be candidates for surgical intervention and in whom other therapeutic modalities had failed. Eight cases developed epidural fibrosis (EF). For analgesia, patients received either infusions with preservative-free solutions of fentanyl and bupivacaine or daily boluses of morphine and bupivacaine. Catheters remained from 75 days to 433 days. Signs of EF appeared from 21 days to 320 days after implantation. Pain at injection or resistance to injection were initial manifestations of EF, followed by poor, and eventually, nil analgesic effect. The epidural catheters were made of either polyamide, silicone, or polyurethane. Epidurograms revealed encapsulation, narrowing, and loculation of epidural space with gradually reduced spread of the contrast material. The occurrence of EF limits the permanency of implanted epidural catheters. The infusate does not cause this complication, which appears to be a foreign body reaction due to the presence of the catheter in the epidural space. J Pain Symptom Manage *1995;10:624–631.*

Key Words
Epidural, fibrosis, catheters

Introduction

Fibrosis surrounding the distal end of implanted epidural catheters has been reported in cancer patients who receive long-term epidural opioid infusions.[1,2] As most of these patients have had a relatively short survival, experience has been limited. Of late, the implantation of permanent epidural catheters for continuous infusions or for bolus injections has been applied to the treatment of chronic nonmalignant pain.[3,4] This report describes eight cases of epidural fibrosis (EF), which occurred among 46 patients with nonmalignant pain who received permanently implanted epidural catheters and life-port reservoir units. These descriptions emphasize the clinical manifestations and radiological findings that were encountered during attempts to preserve the function of the devices.

Methods

Of 46 permanent epidural catheters (PEC) inserted in 43 patients with severe longstanding nonmalignant low back pain, eight developed EF. This complication occurred in eight adult patients, ages 32–52 years (average 46.4 years). Initial diagnoses were: chronic adhesive

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arachnoiditis (two patients), failed lumbar spine fusion (four patients), and immune system deficiency (two patients).

Before instituting the insertion of a PEC for analgesic administration, every patient received diagnostic imaging studies [magnetic resonance imaging and/or computerized tomographic (CT) scan] to confirm the diagnosis, psychological counseling, and neurosurgical evaluation. Each patient had failed to benefit from multiple physical therapy sessions, series of lumbar steroid epidural blocks, and treatment with hydrocodone, muscle relaxants, and antidepressants (when indicated). Two to six temporary lumbar epidural catheter infusions with low dose fentanyl-bupivacaine solution temporarily afforded good to excellent pain relief. Every patient who continued to complain of severe lower back pain and had radiculopathy symptoms was considered a candidate for insertion of a permanent epidural catheter.

Procedure

Explicit informed consent for the procedure was obtained. The patient was placed on an operating table under sterile conditions and under intravenous sedation. A 6-cm skin incision was made 3 cm parallel to the midline down to the lumbar fascia. A 17-ga epidural needle was introduced paramedially, and the epidural space was identified by the loss of resistance method. A 20-ga catheter was introduced cephalad 5–7 cm; the catheter's position was verified by fluoroscopy with the aid of water soluble contrast media injected through the catheter. The catheter was anchored to the fascia and tunneled through the subcutaneous tissue connecting it to a Pharmacia Deltec (Minneapolis, MN) metal life-port reservoir buried in the flank. The subcutaneous tissue was approximated with nylon sutures and the skin incisions were closed with metal staples.

In most cases, analgesia was obtained by continuous infusion of an opioid (fentanyl in three, sufentanil in one) and bupivacaine (0.125%). In four cases, daily bolus injections of morphine were administered. All substances employed were preservative free.

Patients were visited by specially trained home-care nurses, who provided them with supplies and medications, and inspected the skin over the life-port at least once per week. When appropriate, the nurses instructed either the patients or their spouses to inject the medications using sterile technique.

When patients reported either inadequate analgesia, increased resistance to injection, pain at injection, or a "bulge" at the catheter entry into the lumbar fascia following injection, they visited the Center for Pain Management. After confirming the clinical symptoms, an epidurogram, using water soluble contrast, was ordered. The images obtained were compared with previous studies. Radiological images representative of EF such as the width and length of the visualized epidural spaces were noted and compared to previous observations. The type of epidural catheters used, as well as the different medications employed, were also recorded.

For the infusions, the dosages of fentanyl ranged from 0.2 to 0.5 μg/kg/hr. The dosages of sufentanil ranged from 0.04 to 0.09 μg/kg/hr, and the dosages of bupivacaine ranged from 0.2 to 0.5 mL of 0.25% per hr. Bolus injections did not exceed 3 mg of morphine and 1.0 mL of 0.25% bupivacaine every 12 hr.

Once diagnosis of epidural fibrosis was made clinically and radiologically, the following protective measures were instituted:

1. The volume of injectate was decreased and the concentration of the substances used was increased, if feasible.
2. If necessary, the drug was changed to a more potent medication.
3. Bolus injections were made over a 2-hr period, with the aid of a programmable infusion pump.
4. Bolus injections were replaced by continuous infusions.
5. Methylprednisolone 40 mg diluted in 1 mL of 0.75% bupivacaine was injected every 4–6 weeks into the epidural space.
6. Volume-pressure curves were determined in three cases during their late phases of increased resistance to injections, using a pressure transducer attached to the epidural catheter at the Tuohy connector site. Measurements were taken and recorded at 15-sec intervals after injections of 0.5 mg were made.

Table 1
Demographic Data, Diagnosis, Medications, Mode of Administration, and Permanency

Case no.	Gender	Age (years)	Diagnosis	Administered by	Medications	Catheter material	Permanency in days
1	F	32	Immune system deficiency	Bolus	Morphine/ bupivacaine	Polyamide	181
2	M	40	Failed fusion/ lumbar spine	Bolus	Morphine/ bupivacaine	Polyamide	433
3	F	43	Adhesive arachnoiditis	Infusion	Fentanyl/ bupivacaine	Silicone	165
4	F	33	Immune system deficiency	Infusion	Fentanyl/ bupivacaine	Silicone	75
5	M	48	Adhesive arachnoiditis	Bolus	Morphine/ bupivacaine	Polyurethane	113
6	M	37	Failed fusion/ lumbar spine	Infusion	Fentanyl/ bupivacaine; sufentanil/ bupivacaine	Polyurethane	90
7	M	49	Failed fusion/ lumbar spine	Bolus	Morphine/ bupivacaine	Polyurethane	317
8	F	60	Failed fusion/ lumbar spine	Infusion	Fentanyl/ bupivacaine; sufentanil/ bupivacaine	Polyurethane	182

Results

Age, patient diagnosis, and permanency of catheter, type of medication, and catheter material are shown in Table 1. The onset of symptoms and subsequent examinations, including epidurograms or CT scans are shown in Figure 1, noting the time in days when the catheters and the life-ports were

Fig. 1. The clinical course of the occurrence of epidural fibrosis in eight patients is shown, noting the onset of symptoms such as pain (PI), resistance to injection (RI), or the report of inadequate analgesia (IA). The days from insertion to when methylprednisolone (S) was injected epidurally or when epidurograms (E) were obtained, are also noted. The numbers at the end of the bars indicate the total number of days of cathether permanency.

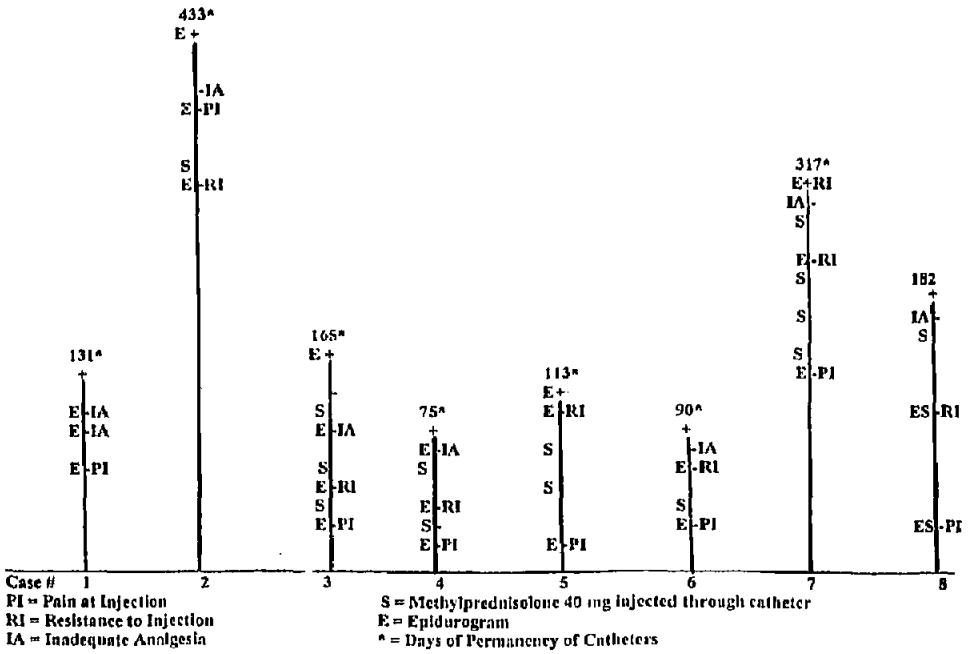

Table 2
Signs and Symptoms of Epidural Fibrosis Noted

	Number	Percentage (%)
Pain at injection	8	100
Resistance to injection	8	100
Inadequate analgesia	7	87.5
Retrograde dissection along catheter	3	37.5
Leak around life-port	1	12.5

Table 3
Radiological Signs of Epidural Fibrosis Noted

	Number	Percentage (%)
Decreased spread	8/8	100
Encapsulation	6/8	75
Loculation	4/8	50
Narrow vertical distribution	4/8	50
Rat tail sign	3/8	37.5
Retrograde leak along catheter	3/8	37.5
Leak at life-port reservoir	1/8	12.5
Leak at connection	1/8	12.5

finally removed. The measures used in each case in an attempt to preserve catheter functioning are also noted.

The eight permanent epidural catheters that developed EF remained functional for an average of 188.2 days (SD ±26.8; range, 75–443 days). The onset of symptoms of EF occurred as early as 21 days, but averaged 82.5 days. Radicular pain at the time of injection was the earliest manifestation in 87% of the cases. Inadequate analgesia usually followed after pain and resistance during injection. The frequency of the various symptoms appearing in the course of the treatment are depicted in Table 2. Similarly, the radiological signs and

Fig. 2. Pressure/volume curves developed in three patients with EF. Measurements were made on line as changes of pressure took place when increments of 0.5 mL of saline 0.9 solution were injected at increments of 15 sec. Changes in compliance were correlated to the occurrence of slight, moderate or severe pain at injection.

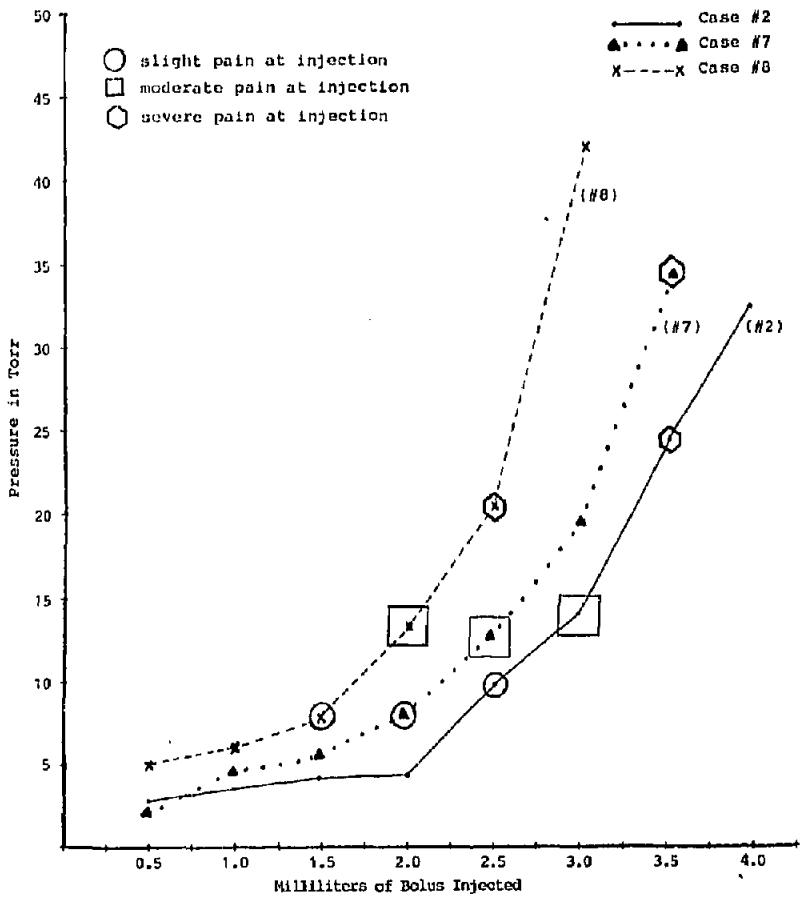

Fig. 3. Progressive reduction of distribution of contrast material both vertically and laterally (case 2) on the 351st (left) and the 418th (right) day after insertion of the catheter. Vertical distribution was reduced from 4½ to 2½ vertebrae.

their onset of appearance, in days, are shown in Table 3.

Two catheters that developed EF after 320 days were made of different material. Both patients received morphine-bupivacaine in bolus injections, but had no other peculiarity that might have delayed the occurrence of EF.

The pressure-volume curves in three cases of EF are illustrated in Figure 2. The reduction of spread of contrast media in the epidural space is shown in Figures 3–7. Specific narrowing and even loculation with a thin extension (rat tail sign) is shown in Figure 5.

Even when protective measures were implemented, signs and symptoms of EF continued to progress, and, in every case, the life-port catheter units eventually had to be removed. Subsequent epidural blocks, or insertion of temporary epidural catheters, were done on most of these patients, with effective results. Three of 43 patients had PEC reinserted again.

Discussion

A variety of causes have been proposed as the origin of EF appearing after long-term insertion of plastic catheters for intraspinal opioid therapy by bolus injection or infusion.[1–3,5] These include local irritation from toxic substances such as preservative-containing local anesthetics or opioids; foreign body reaction from polyurethane catheters, polyethylene catheters, polyamide catheters, or talcum powder; the use of blood patches; or infections. Prior intraspinal interventions, such as diskectomies, laminectomies, papain injections, etc., may also be involved.

Of the four patients who began receiving boluses in the late stages of treatment, two were given continuous infusion through a Hubbard needle inserted into the life-port reservoir. The progression of the EF appeared to continue. Other attempts to eliminate it, including the intermittent injections of methylprednisolone, higher analgesic concentra-

Fig. 4. Early sign of EF, manifesting pain at injection on the 34th day (Case 8) after insertion. Marked narrowing is indicated by arrow on an otherwise irregular bulbous distribution of the dye at the epidurogram study.

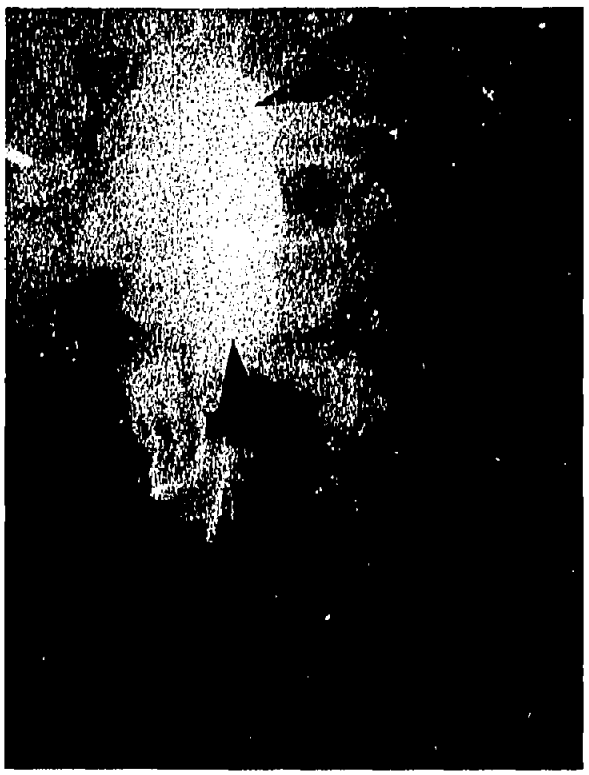

Fig. 5. Loculation of contrast material limiting distribution to only 1½ vertebral segments. Note the thin prolongation, resembling "rat's tail" image. The epidurogram was taken 101 days after inserting the catheter. Twelve days later it was removed because of persistent inadequate analgesia.

tions, smaller volumes, etc., were also ineffective. As epidural therapeutic instrumentation was done again (epidural blocks or insertion of temporary epidural catheters), the author assumes that EF does not preclude the use of this route subsequently.

Some animal[6–10] and human[5,11–14] studies have been done on the possible local tissue neurotoxicity of epidurally administered local anesthetics and opioids. These studies have not incriminated these medications when they were preservative free. These observations suggest that reaction to the long-term presence of the catheters in the epidural space is a more likely explanation for EF. As a matter of fact, epidural catheters in the absence of drugs or vehicle injections, induced EF within 28 days in dogs.[15]

All the substances used in the cases reported herein were preservative free, so this particular factor may be rejected. The mode of administration, whether bolus or infusion, did not appear to influence the occurrence of EF. Even when the patients who were receiving boluses were later treated with continuous infusions at a very low rate, the pressure alarms of the infusion pumps were triggered by the resistance against infusion.

Wulf and Striepling[11] reported postmortem findings in hospitalized patients who had epidural catheters infused for postoperative analgesia from 2 to 21 days. They noted cellular infiltration and early signs of infection, even after 10 days of catheter placement in patients with severe medical illnesses, including nonspinal infections. These observations may not necessarily apply to ambulatory patients. One can only propose that EF may be the result of a foreign body reaction occurring in the epidural space where fibrosis and scarring are also common after surgical procedures.[16] Materials from which the permanent epidural catheters were made included polyamide, polyurethane and silicone. Though their specific advantages have been discussed previously,[9,12,17] it appears that there is still need

Fig. 6. Retrograde dissection of the dye along the path of the catheter, between the spinous processes, spreading vertically along the lumbar fascia.

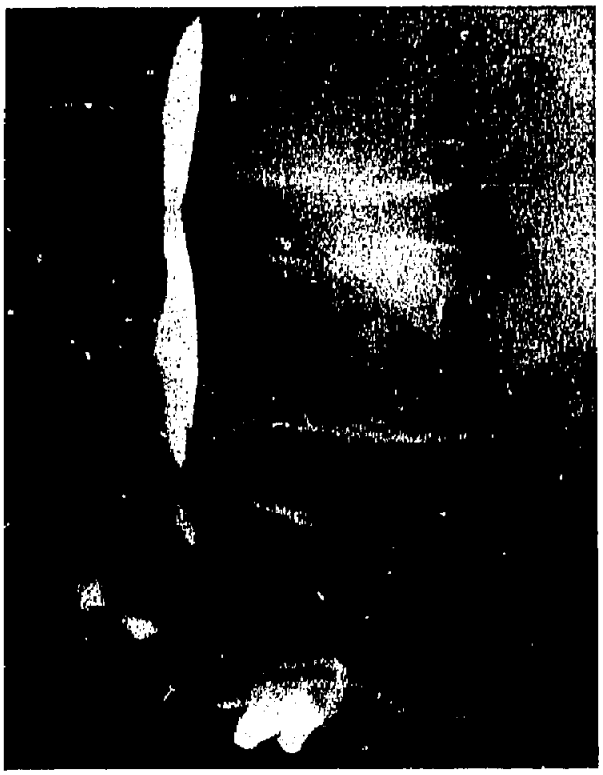

Fig. 7. "Thinning" vertical distribution of the dye encompassing 2½ vertebral segments. The metal clips securing the epidural catheter anastomosis are shown below.

for improvement, specifically the introduction of catheters made of inert material that would not elicit this reaction.

As this local tissue response does not appear to occur in the subarachnoid space, we have now abandoned the implantation of permanent epidural catheters for patients with noncancer pain when long-term permanency is desired. At present, we prefer the insertion of intrathecal catheters infused by an implantable pump. However, patients with cancer who have an expected survival of 6–12 months or less can be managed, at a lower cost, with temporary epidural catheters infused by disposable pumps. For shorter treatment periods, plain epidural catheters have been used temporarily for up to 86 days, using an intermittent patient-activated infusion of analgesics,[18,19] whether they have chronic pain from cancer or from nonmalignant origin.

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