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Incidence of Neurologic Complications Related to Thoracic Epidural Catheterization

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Background: **Due to potential neurologic sequelae, the risk:benefit ratio of thoracic epidural analgesia is controversial. Surprisingly, however, few available data address neurologic complications. The incidence of neurologic complications occurring after thoracic epidural catheterization was studied in patients scheduled for abdominal or abdominothoracic surgery.**

Methods: **A total of 4,185 patients were studied, including 2,059 during the prospective phase of the study and 2,126 during the retrospective phase. After thoracic epidural catheterization, all patients received general anesthesia. Patients' neurologic status was assessed by an anesthesiologist using clinical criteria after operation and after epidural catheter removal. If neurologic complications were suspected, a neurologist was consulted. The incidence of specific complications was compared for different thoracic puncture sites: upper (T3/4–6/7), mid (T7/8–8/9), and lower (T9/10–11/12) catheter insertion levels.**

Results: **The overall incidence of complications after thoracic epidural catheterization was 3.1% (n = 128). This included dural perforation (0.7%; n = 30); unsuccessful catheter placement (1.1%; n = 45); postoperative radicular type pain (0.2%; n = 9), responsive to catheter withdrawal in all cases; and peripheral nerve lesions (0.6%; n = 24), 0.3% (n = 14) of which were peroneal nerve palsies probably related to surgical positioning or other transient peripheral nerve lesions (0.2%; n = 10). No signs suggesting epidural hematoma were recognized, and there were no permanent sensory or motor defects attributable to epidural catheterization. Unintentional dural perforation was observed significantly more often in the lower (3.4%) than in the mid (0.9%), or upper (0.4%) thoracic region. A single patient experienced severe respiratory depression after receiving epidural buprenorphine but recovered without sequelae.**

Conclusions: **Thoracic epidural catheterization for abdominal and thoracoabdominal surgery is not associated with a high incidence of serious neurologic complications. In fact, the incidence of puncture- and catheter-related complications is less in the mid and upper than in lower thoracic region, and the predicted maximum risk for permanent neurologic complications (upper bound of the 95% confidence interval) is 0.07%. (Key words: Analgesia: postoperative. Analgesics: buprenorphine. Anesthetic techniques: epidural. Complications: hematoma epidural; neurologic deficit.)**

SOME investigators believe that thoracic epidural analgesia reduces perioperative stress response and provides better analgesia than intravenous or intramuscular administration of analgetics.[1-3] It may improve myocardial oxygen balance,[4] postoperative degree of patient awareness,[5] and hasten gastrointestinal recovery after surgery.[6,7] However, despite many studies, whether perioperative thoracic epidural analgesia improves postoperative morbidity or mortality remains controversial.[8-12] In fact, complications such as epidural hematoma and damage to the spinal cord have been reported that may limit the indications and increase the risk:benefit ratio for thoracic epidural analgesia.[13,14]

Based on the commonly held assumption that thoracic epidural catheterization is technically more difficult than lumbar epidural catheterization, some standard textbooks[2] suggest a greater incidence of complications with the former technique. However, it has been difficult to determine the incidence of neurologic complications.[15-17] Although no permanent neurologic sequelae were reported in several studies,[18-20] these studies were either performed retrospectively with many patient records[18] evaluated or, if performed prospectively, rather enrolled few patients or focused on complications after epidural opioid application.[19,20]

Therefore this study in more than 4,000 patients was performed to provide a better assessment of the incidence of complications associated with thoracic epidural catheterization in patients having abdominal or abdominothoracic surgery and receiving thoracic epidural analgesia.

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Patients and Methods

The study was performed in accordance with the Helsinki Declaration. After approval of the local ethics committee, written informed consent for thoracic epidural catheterization was obtained from all patients or their next of kin. Initially 4,707 patients were considered. After exclusion of patients (see below) from the study, a total of 4,185 patients undergoing thoracic epidural anesthesia were studied. A total of 2,059 patients undergoing thoracic epidural anesthesia were studied prospectively from September 1988 to December 1994. In addition, in 2,126 patients receiving thoracic epidural anesthesia between January 1983 and August 1988, the incidence of neurologic complications was investigated retrospectively from patient hospital records. Catheter insertion techniques, perioperative analgesic management, and neurologic surveillance protocol were identical in both groups.

All patients were scheduled for elective upper abdominal or abdominothoracic surgery; that is, intestinal and colorectal (20%), hepatobiliary (21%), esophageal (7%), pancreatic (8%), or vascular surgery (11%). Before operation, full medical histories were taken with emphasis on detecting bleeding disorders and anatomic or neurologic abnormalities. A clinical examination was performed and followed by measurement of clotting parameters.

Intravenous heparin (>20,000 IU/day) or subcutaneous low-dose heparin (5,000–7,500 IU three times a day) was discontinued 6 h before epidural catheter placement or removal. After operation, subcutaneous heparin (5,000–7,500 IU three times a day) was continued in all patients.

Excluded from the study were 157 patients because epidural analgesia had not been administered due to either more than one abnormal preoperative clotting parameter; that is, prothrombin time < 70% (Thromborel; Behring, Marburg, Germany; normal reference value, 70–130% or 9–11.5 s), activated partial thromboplastin time > 55 s (Pathromtin; Behring; normal reference value, 25–55 s), platelet count < 150,000 μl^{-1} (Coulter Counter, model STKR; Coulter Electronics GmbH, Krefeld, Germany; normal reference value, 140,000 – 440,000 μl^{-1}), or clinical signs of potential bleeding disorders suggested by bruising, petechiae, or ecchymosis.

In two patients of the group studied prospectively platelet counts were less than 50,000 μl^{-1}, in five patients activated partial thromboplastin times were prolonged (>55 s), and in 52 patients abnormal prothrombin times (<70%, >16 s) were found before operation. Despite these single abnormal values, epidural anesthesia was administered in these 59 patients. In 48 patients of the retrospectively studied group, epidural catheterization was performed despite one abnormal clotting parameter.

After most patients with coagulation problems were excluded, thoracic epidural anesthesia was recommended for 4,550 patients. However, 365 of these patients did not consent to thoracic epidural catheter insertion and thus were excluded from further study. Therefore the final study population included 4,185 patients (set as 100%).

The patients' ages ranged from 16 to 90 years (56 ± 14.2 years; mean ± SD) in the prospective and from 17 to 94 years (54.4 ± 15.7 years) in the retrospective group. In the prospective group, 936 patients were women and 1,123 were men. In the retrospective group, 978 were women and 1,148 were men.

After surgery, 1,283 (62.3%) of the prospectively and 1,314 (61.8%) of the retrospectively studied patients were transferred to an intensive care unit (ICU), whereas the remaining patients were treated on the surgical ward. The epidural catheters were left in place after operation for approximately 4 days (prospective group: 4.2 ± 1.9 days; range, 1–53 days; retrospective group: 3.9 ± 2.1 days; range, 1–55 days).

General Intraoperative Management

Patients were premedicated with 1–2 mg flunitrazepam given orally 2 h before surgery. After cannulation of a peripheral vein and infusion of 500 ml Ringer's solution, a thoracic epidural catheter (Portex 18-G Tuohy needle, closed-end catheter with three lateral eyes; outer catheter diameter, 0.9 mm; Hythe, Kent, UK) was inserted under local infiltration anesthesia (1% mepivacaine) with the patient in the sitting position. In a few patients requiring prolonged analgesia because of chronic pain, the catheter was tunneled subcutaneously.

Epidural catheters were placed at a vertebral level considered appropriate for the scheduled operation, taking into account each patients' specific anatomy. Therefore, epidural puncture was performed near the vertex of the vertebral column's kyphosis and at the convexity of a scoliosis. Epidural puncture was always performed *via* the paramedian approach at T8/9 and above and *via* the median approach further caudally. The epidural space was identified by the loss-of-resis-

tance technique using a 10-ml glass syringe filled with saline. After insertion to 5 cm, subarachnoidal or subdural catheter placement was tested by injection of 3 ml 0.5% bupivacaine or 1% etidocaine without epinephrine. To minimize unrecognized intravascular catheter placement, the catheter was gently aspirated with the bacterial filter removed. Additional doses of 3–5 ml 0.25%–0.5% bupivacaine or 1% etidocaine were given during operation if considered appropriate. All epidural catheterizations were performed by either one of six staff anesthesiologists or by first- to third-year residents under direct supervision. Thoracic epidural catheterization was omitted when attempts to insert the catheter were unsuccessful at two vertebral levels. Epidural catheter placement was always followed by general anesthesia consisting of etomidate, oxygen/nitrous oxide, isoflurane (0.5–1%) or enflurane (0.6–1.5%), and fentanyl and muscle relaxation (alcuronium or vecuronium), as required.

Postoperative Management

Patients were transferred to an ICU if indicated by preexisting risk factors or by the nature and course of the specific surgery performed. All other patients were monitored in the recovery room for at least 2 hours by pulse oximetry, electrocardiograph, and noninvasive blood pressure measurement until the responsible anesthesiologist decided they were ready for transfer to the general ward. On the surgical ward, arterial blood pressure, heart rate, and respiratory rate were measured by the nursing staff every 15 min for 4 h, hourly thereafter for the first day, and every 2–4 h during the ensuing days. Patients transferred from the ICU to the surgical ward were observed according to the same protocol.

After operation, 0.15–0.3 mg buprenorphine in 5–10 ml 0.9% saline was administered epidurally every 4 to 6 h, and in patients transferred to the ICU it was supplemented by a continuous epidural infusion of bupivacaine (0.125%–0.375%, 3–5 ml/h), if required. In contrast, while also receiving epidural buprenorphine, patients transferred to the general ward received bupivacaine (0.125%–0.375%, 4–8 ml) by bolus injection every 4 to 6 h, if required. All patients were instructed to report immediately any new back pain, radiating symptoms, or muscular weakness. Uncomplicated epidural analgesia was assumed when fewer than six dermatomes showed sensory block, motor function was unaffected, an no other symptoms were present. The epidural catheter was always aspirated before any epidural drug was administered to minimize the risk of unintentional subdural or subarachnoidal application. Dislodgment of the epidural catheter was assumed if no sensory blockade could be observed after a test dose of 0.25% bupivacaine that under normal conditions would yield a sensory blockade of at least four dermatomes.

Study Protocol

Any difficulties or unusual events during epidural puncture and catheterization as well as the following data were collected: unsuccessful catheter placement (impossible to insert a catheter at two vertebral levels), vertebral interspace punctured (count of spinal processes of vertebrae starting with C 7), surgical procedure performed, postoperative transfer (peripheral ward/ICU), and day of removal of the epidural catheter. Furthermore, any postoperative neurologic complications were recorded. Dural perforation was defined as cerebral spinal fluid return through either the catheter or needle. Peripheral nerve lesions were assumed if disturbed function was observed in areas strictly distal to a lesion with, depending on a given nerve's composition, motor, sensory and vegetative (*e.g.,* sweat secretion) deficits. In contrast, spinal root damage was assumed with radiation of pain and diminished sensitivity corresponding to a dermatome. Generally, unlike peripheral nerve lesions, the hypalgetic area is greater than the hypesthetic area in case of root damage. To verify spinal root damage, therefore, hypalgetic or analgetic areas corresponding to a specific root must be demonstrated. Accordingly, pain during puncture or catheter insertion was qualified as "radicular" if it occurred segmentally; that is, it corresponded to a dermatome of an irritated spinal root.

Postoperative neurologic surveillance consisted of determination of patient sensitivity to pinprick within all dermatomes potentially affected by epidural anesthesia and of motor function, particularly mobility of arms and legs, every 6–8 h by a staff anesthesiologist. Any abnormal findings were recorded. Electromyography was not routinely performed to test for motor blockade in the thoracic region. Reports of intense back pain associated with sensory or motor deficits were considered signs of an expanding mass in the spinal canal. Neurologic sequelae were assessed by an independent physician on the first and second postoperative day as well as after removal of the epidural catheter by examining the patients' sensory and motor function as previously described. In case of any positive neurologic finding, a full neurologic examination was performed

by a consultant neurologist. If damage to a spinal root close to the catheter insertion site was suspected, electromyography was also performed. In patients with postoperative radicular-type pain at a level adjacent to the catheter insertion site, the epidural catheter was either withdrawn for 1–2 cm or removed. Cessation of pain after catheter removal or withdrawal was assumed to indicate catheter-related irritation of a spinal nerve root.

Respiratory-depressant side effects were defined as clouding of consciousness or a decrease in the respiratory rate below 8 min^{-1}. Blood gas measurements were not routinely performed except during supervision in an ICU.

Statistical Analysis

Data were expressed as mean ± SD unless indicated otherwise. The following *a priori* null hypothesis was tested: The incidence of defined complications between prospectively and retrospectively studied patients does not differ between upper- (T3/4–6/7), mid- (T7/8–8/9), and lower-level (T9/10–11/12) catheter insertion. Incidences of defined complications were compared using the chi-squared test for an increasing or decreasing trend in the proportions over the columns. If a significant trend emerged, we compared the levels. Thus three chi-squared *post hoc* tests had to be performed. Statistical significance was assumed when the α error (P) was less than 0.05/3; that is, $P \leq 0.016$.

The predicted maximum risk of complications was calculated using the upper bounds of the 95% confidence interval.[21]

Results

The upper thoracic region was chosen for catheterization in almost 66%, the mid-thoracic region in approximately 28%, and the lower thoracic region in 7% of all cases in both the prospectively and retrospectively studied patients. The overall incidence of neurologic complications after thoracic epidural catheterization was 3.1% (n = 128). Although significantly more complications were observed in the prospectively studied group (3.6%) compared with the retrospectively studied group (2.5%), this difference could be entirely attributed to a significantly greater incidence of primary dural perforations in the former group. There were no significant differences between groups in the incidences of other neurologic complications and no patient had more than one complication.

In all but 14 (0.7%) prospectively studied patients, epidural catheter placement was associated with efficient postoperative epidural analgesia. Table 1. shows neurologic complications and their incidence as related to the epidural puncture site and the calculated maximum risk of complications using the upper bounds of the 95% confidence interval.

Unsuccessful catheter placement (1.1%; n = 45) and primary dural perforation (0.72%; n = 30) were the most frequent complications, followed by radicular-type pain during epidural puncture or catheter insertion (0.48%; n = 20) and peripheral nerve lesions (0.57; n = 24). Postoperative radicular-type pain was observed in nine additional patients (0.22%). In all these 29 patients, radicular pain always stopped shortly after needle or catheter withdrawal, respectively. None of these problems required further treatment or led to sequelae.

In 14 (0.33%) of 24 (0.57%) patients suffering from a peripheral nerve lesion, a peroneal nerve palsy was found. All of these 14 patients (nine prospectively studied and five retrospectively studied patients) had been operated on while in the lithotomy position (Quenu's procedure), which probably explained this type of nerve damage. The other 10 patients (0.24%) with peripheral nerve lesions—five in each study group—showed transient irregular dysesthesias, transient loss of sensory function, or transient motor weakness in the perineal region or lower extremities, respectively. These complaints persisted for a median of 4 days (range, 1–20 days). However, the consultant neurologist found no evidence of damage to spinal roots adjacent to the catheter insertion site in these cases.

There were no signs or reports of postspinal headache or subarachnoid or subdural catheter migration. No symptoms or signs suggesting epidural hematoma or meningeal inflammation were recognized. In fact, no complications were observed even in the subgroup of patients receiving epidural analgesia despite impaired coagulation.

Of note, there is a significant trend of an increasing incidence of unintentional dural perforation with epidural puncture toward lower thoracic interspaces in both the prospectively ($P = .0001$) and retrospectively ($P < 0.0001$) studied patients, and in the total study population ($P < 0.0001$). The incidence of dural perforation doubled for mid-thoracic, and increased seven times for lower-thoracic epidural analgesia when compared with high-thoracic epidural analgesia at the T3–7 level.

Thus no persistent neurologic deficits related to tho-

Table 1. Incidence of Neurological Complications Following Thoracic Epidural Catheterization in Prospectively and Retrospectively Studied Surgical Patients

	Prospective (n = 2,059)				Retrospective (n = 2,126)				Total Study Population				Maximum Risk (%) at 95% Confidence
Site of Epidural Puncture	T3-7	T7-9	T9-12	All	T3-7	T7-9	T9-12	All	T3-7	T7-9	T9-12	All	
No. of Cases	1,348	575	136	2,059	1,372	597	157	2,126	2,720	1,172	293	4,185	
Primary dural perforation (%)	8*	7	6	21†	2‡	3	4	9	10*	10§	10	30	
	0.6*	1.2	4.4	1.0†	0.2‡	0.5	2.5	0.4	0.4*	0.9§	3.4	0.7	1.0
Unsuccessful catheter placement (%)	15	8	3	26	11	5	3	19	26	13	6	45	
	1.1	1.4	2.2	1.3	0.8	0.8	1.9	0.9	1.0	1.1	2.0	1.1	1.4
Radicular pain during epidural puncture or catheter insertion (%)	5	2	—	7	7	5	1	13	12	7	1	20	
	0.4	0.4	—	0.3	0.5	0.9	0.7	0.6	0.4	0.6	0.3	0.5	0.7
Postoperative radicular type pain (%)	4	1	1	6	2	—	1	3	6	1	2	9	
	0.3	0.2	0.7	0.3	0.1	—	0.6	0.2	0.2	0.1	0.7	0.2	0.4
Peripheral nerve lesion (%)	9	5	—	14	6	3	1	10	15	8	1	24	
	0.7	0.9	—	0.7	0.4	0.5	0.6	0.5	0.6	0.7	0.3	0.6	0.8
Peroneal nerve palsy (%)	6	3	—	9	3	2	—	5	9	5	—	14	
	0.5	0.5	—	0.4	0.2	0.3	—	0.2	0.3	0.4	—	0.3	0.5
Other peripheral nerve lesions (%)	3	2	—	5	3	1	1	5	6	3	1	10	
	0.2	0.4	—	0.2	0.2	0.2	0.6	0.2	0.2	0.3	0.3	0.2	0.4
Total	41	23	10	74	28¶	16**	10	54	69*	39††	20	128	
%	3.0	4.0	7.4	3.6	2.0¶	2.7**	6.4	2.5	2.5*	3.3††	6.8	3.1	3.4

* $P < 0.0001$ *versus* lower thoracic level.

† $P = 0.035$ *versus* retrospectively studied population.

‡ $P = 0.0001$ *versus* lower thoracic level.

§ $P = 0.002$ *versus* lower thoracic level.

¶ $P = 0.003$ *versus* lower thoracic level.

** $P = 0.0006$ *versus* lower thoracic level.

†† $P = 0.0105$ *versus* lower thoracic level.

racic epidural catheterization were observed in this study of 4,185 patients. The predicted maximum risk of permanent neurologic complications, using the upper bound of the 95% confidence interval, was calculated as 0.07%.

In a 51-yr-old man who underwent Hartmann's procedure, postoperative respiratory depression was observed on the surgical ward. Twenty minutes after having received 0.3 mg buprenorphine epidurally, he was drowsy with a respiratory rate of 4 min^{-1}, a Pa_{O_2} of 59 mmHg, and a Pa_{CO_2} of 60 mmHg. After tracheal intubation and mechanical ventilation for 4 h he recovered without further complications.

Discussion

This study is a survey of more than 4,000 thoracic epidural catheterizations performed for postoperative pain relief at a single university teaching hospital where thoracic epidural catheterization is frequently performed. The population includes all patients scheduled for elective upper abdominal or thoracoabdominal surgery and eligible for thoracic epidural or general anesthesia during an 11-y period. The data suggest that thoracic epidural catheterization can be performed with a low incidence of neurologic complications.

This study focused on neurologic complications, the incidence of which remains controversial and may increase the risk:benefit ratio of thoracic epidural anesthesia. In contrast, unsuccessful catheter function ("failure of analgesia") was not assessed in the retrospectively studied patient group, and catheter entry into an epidural vein was only assumed if blood returned from the catheter, either spontaneously or with aspiration of the catheter, and was not relied on using epinephrine with the test dose. Furthermore, because general anesthesia was always induced shortly after thoracic epidural catheterization, primary failure of epidural block despite seemingly acceptable catheter placement cannot be distinguished from secondary catheter dislodgment. However, epidural catheter placement in the prospective group was followed by efficient postoperative epidural analgesia in all but 14 patients (99.3%). Therefore, failed block despite seemingly acceptable catheter placement, which is a complication after all, occurred with an overall incidence of only 0.7%. This incidence is less than the numbers previously reported[18] and supports the assumption that a concerted effort had been made to place the epidural catheters.

As might be expected, a greater overall incidence of complications was noted in the population studied prospectively when compared with patients studied retrospectively. However, this difference between groups was entirely attributable to primary perforation of the dura but was not significant for any other neurologic complication. Data recording may not have been as complete in the retrospective group, presumably inducing a minor bias toward better outcome. However, because the protocol of the prospective part of the study was adapted from the routinely performed neurologic postoperative surveillance protocol during the last decade, the routine neurologic examination protocol in the retrospectively studied epidural catheter placement group did not really differ from that of the prospectively studied group. In addition, even in the retrospective group, all patients with suspected or claimed possible neurologic damage, transient or permanent, had been recorded by name for medicolegal reasons. This argues for and is supported by data that the incidence of neurologic complications is similar in both groups and does not appear to have changed in the 12 y of study in our hospital.

Accidental dural puncture is the most common complication of lumbar and lower thoracic epidural catheterization.[18-20] Its incidence may depend on the experience and skill of the anesthesiologist and, in most university training programs, dural perforation is noted in approximately 3-5% of cases, with an incidence of probably less than 1% in private practice.[19] The incidence observed in our retrospectively studied population (0.42%) for thoracic epidural anesthesia is in the same lower range and is similar to results reported by others (incidence = 0.61%).[18] However, these latter data are based exclusively on patient records assessed retrospectively.

Despite a greater incidence of dural perforation (1.02%) found in our patients studied prospectively, our data confirm a low incidence of dural perforation with thoracic epidural catheterization. The incidence of dural perforation is even lower than reported previously (1.2%) in 1,071 patients.[19] Of greater interest, our data now indicate in a large prospectively studied population that the incidence of dural perforation after epidural puncture and catheterization is similar to or even smaller than that reported in the lumbar region, and in our large population, it was not associated with neurologic complications or other sequelae.

The incidence of dural perforation increased as a more caudal puncture site was chosen; that is, in lower

thoracic segments regardless whether prospectively or retrospectively studied patients were considered. This is consistent with a retrospective study[18] reporting significantly more unintentional dural perforations in the lower thoracic (0.85%) and lumbar regions (1.16%) than in more cranial vertebral regions (0.20–0.29%). The lower incidence in the upper thoracic region may be due to the fact that with the paramedian approach the epidural space is approached in a more tangential fashion than with the midline approach often used for lower thoracic or lumbar puncture, possibly resulting in a greater margin of safety. Thus our prospective data contradict the view[2] that dural perforation occurs more often with thoracic epidural catheterization because of its suspected greater technical difficulty.

Headache subsequent to lumbar dural puncture develops with an incidence as high as 70%[22] when a large-gauge needle is used. Routine epidural administration of opioids may be one explanation for the notable absence of postdural puncture headache in the patients in our study, regardless of whether they were studied prospectively or retrospectively. Another explanation for the low incidence of postdural puncture headache could be the decreased cerebral spinal fluid pressure in the thoracic regions compared with lumbar regions secondary to gravity in the sitting position, but this is speculative. Of note, despite 30 documented dural perforations in the thoracic region (*i.e.,* very close to the spinal cord), no serious neurologic complications or persistent sequelae were observed.

Paresthesias and other neurologic complications after epidural catheterization occur even less frequently than dural perforation, with an estimated incidence (based on retrospective data) of 1:100,000 to 1:625 for minor and reversible lesions[18,23] and 1:3,637 to 1:11,000 of lumbar epidural punctures for irreversible lesions.[24,25] Unfortunately, only a few prospective studies have addressed the incidence of neural complications after thoracic epidural catheterization.[19,20,26] De Leon-Casasola and associates[26] calculated a maximum overall risk of 0.07% for neurologic injuries based on prospectively studied patients with cancer undergoing epidural catheterization for pain relief. Extracting from their data the patients receiving a thoracic epidural catheter (n = 1,979), then the maximal risk would be estimated as 0.16%. However, the authors did not specify whether lower or upper thoracic epidural interspaces were punctured. Scott and colleagues[20] prospectively studied 948 patients, but the upper epidural space was not punctured in any patients. Two of their patients developed an epidural hematoma, with one recovering completely with conservative management and the other having permanent neurologic deficit. Unfortunately, the authors did not specify which interspaces were punctured. Thus studies performed previously are limited with regard to the size of study populations, study design, and incomplete information. When we evaluated 4,185 thoracic epidural catheterizations performed in the patients at a single institution who had no persisting neurologic sequelae, we calculated a 0.07% maximum risk at 95% confidence for permanent neural lesions after thoracic epidural catherization. This risk is even lower than the risk of 0.3% calculated from previous results reported.[19]

In our study, neurologic complications such as radicular pain during puncture or postoperative radicular-type pain always subsided shortly after needle or catheter withdrawal. None of these problems required further treatment or led to sequelae, confirming the generally low overall incidence of neural lesions with thoracic epidural catheterization. In fact, of 24 cases with peripheral nerve lesions, 14 were diagnosed as peroneal nerve palsy, which were related to the surgical procedure and positioning rather than to epidural puncture. The other 10 patients had transient peripheral nerve lesions in the peroneal region or lower extremities, respectively. Because these lesions did not correspond to dermatomes innervated by thoracic spinal roots, no sensory or motor deficits, therefore, could be attributed to thoracic epidural catheterization. However, although we studied more than 4,000 patients, our large population size may still be considered too small to properly assess the incidence of severe and permanent neurologic complications of thoracic epidural anesthesia such as paraplegia. Furthermore, because our data have been collected from a single center where thoracic epidural catheterization is performed frequently, the relative incidence of complications after this procedure in the hands of clinicians who perform these procedures less regularly may be different than the observed incidence.

The risk of epidural hematoma formation after epidural catheterization appears to be increased in patients with coagulation disorders and those treated with anticoagulants.[14,27,28] However, administration of anticoagulants may still not be an absolute contraindication for epidural anesthesia, because lumbar epidural anesthesia has been performed without major complications in patients receiving heparin, warfarin, or antiplatelet drugs.[29–31] Furthermore, the incidence of bleeding and intravascular epidural cannulation was reported to be

significantly greater with lumbar (1.31%) than with thoracic (0.34–0.48%) epidural anesthesia, similar to the results reported for unintentional dural puncture.[18] We adopted rather liberal limits with regard to values of coagulation variables in those patients considered candidates for epidural catheterization.[16,32] In those patients in whom catheterization was performed despite a definitely abnormal single coagulation parameter, epidural catheterization was always atraumatic and no complications occurred in this subgroup. However, the incidence of epidural hematoma-induced paraplegia associated with thoracic epidural anesthesia remains unknown. No apparent catheter-related epidural hematoma was observed in another study,[26] and a recent meta-analysis estimated the risk for a major spinal hematoma after epidural anesthesia to be approximately 0.0007%.[17] Accordingly, upper- and mid-thoracic epidural anesthesia may in fact carry a smaller risk for epidural hematoma than does lumbar epidural anesthesia, although intuitively the reverse situation is usually considered.

The incidence of respiratory depression after an intravenous or epidural morphine regimen for analgesia is approximately 0.9%.[33,34] An incidence of 0.07% was observed and a maximum risk of 0.20% calculated after thoracic and lumbar epidural administration of morphine.[26] A greater incidence of respiratory depression (0.6–1.2%) has been reported for epidural fentanyl[35] and during continuous epidural infusion of 6–100 μg/h fentanyl when combined with 0.1% bupivacaine.[20] In our study, buprenorphine was used for postoperative epidural analgesia. Due to its lipophilicity, its distribution along the spinal column is presumably limited to neighboring segments of the puncture site, in contrast to hydrophilic morphine.[36] This may explain why we observed only a single case of respiratory depression in our population.

In summary, thoracic epidural catheterization does not appear to be associated with more complications or more serious complications than reported in the literature for lumbar epidural catheterization. In fact, no permanent nerve injuries related to thoracic epidural catheterization were observed in our study, which included more than 4,000 patients having abdominal or abdominothoracic surgery, and the predicted maximum risk for permanent neurologic complications, using the upper bounds of the 95% confidence interval, is 0.07%.

References

1. Kehlet H, Dahl JB: The value of multi-modal or balanced analgesia on postoperative pain relief. Anesth Analg 1993; 77:1048–56

2. Badner NH: Epidural agents for postoperative analgesia, Current concepts in acute pain control. Anesthesiology Clinics of North America. Edited by Sandler AN, Benumof JL. Philadelphia, WB Saunders, 1992, pp 321–37

3. Rosenberg PH, Heino A, Scheinin B: Comparison of intramuscular analgesia, intracostal block, epidural morphine and on-demand-i.v.-fentanyl in the control of pain after upper abdominal surgery. Acta Anaesthesiol Scand 1984; 28:603–7

4. Blomberg S, Emanuelsson H, Kvist H, Lamm C, Ponten J, Waagstein F, Ricksen S-E: Effect of thoracic epidural analgesia on coronary arteries and arterioles in patients with coronary artery disease. ANESTHESIOLOGY 1990; 73:611–18

5. Hasenbos M, Van Egmond J, Gielen M, Crul JF: Postoperative analgesia by high thoracic epidural versus intramuscular nicomorphine after thoracotomy, part III. Acta Anaesthesiol Scand 1987; 31:608–15

6. Bredtmann RD, Herden HN, Teichmann W, Moecke HP, Kniesel B, Baetgen R, Tecklenburg A: Epidural analgesia in colonic surgery: Results of a randomized prospective study. Br J Surg 1990; 77:638–42

7. Liu SS, Carpenter RL, Mackey DC, Thirlby RC, Rupp SM, Shine TM, Feinglass NG, Metzger PP, Fulmer JT, Smith SL: Effects of perioperative analgesic technique on rate of recovery after colon surgery. ANESTHESIOLOGY 1995; 83:757–65

8. Yeager MP, Glass DD, Neff RK, Brinck-Johnson T: Epidural anesthesia and analgesia in high-risk surgical patients. ANESTHESIOLOGY 1987; 66:729–36

9. Baron J-F, Bertrand M, Barre E, Godet G, Mundler O, Coriat P, Viars P: Combined epidural and general anesthesia versus general anesthesia for abdominal aortic surgery. ANESTHESIOLOGY 1991; 75:611–18

10. Christopherson R, Beattie C, Frank SM, Norris EJ, Meinert CL, Gottlieb SO, Yates H, Rock P, Parker SD, Perler BA, Williams GM, the Perioperative Ischemia Randomized Anesthesia Trial Study Group: Perioperative morbidity in patients randomized to epidural or general anesthesia for lower-extremity vascular surgery. ANESTHESIOLOGY 1993; 79:422–34

11. Hendolin H, Lahtinen J, Lansimies E, Tuppurainen T: The effect of thoracic epidural analgesia on postoperative stress and morbidity. Ann Chir Gynecol 1987; 76:234–40

12. Liu SS, Carpenter RL, Neal JM: Epidural anesthesia and analgesia. ANESTHESIOLOGY 1995; 82:1474–1506

13. Gustafsson H, Rutberg H, Bengtsson M: Spinal haematoma following epidural anaesthesia. Report of a patient with ankylosing spondylitis and a bleeding diathesis. Anaesthesia 1988; 43:220–22

14. Dickman CA, Shedd SA, Spetzler RF, Shetter AG, Sonntag VK: Spinal hematoma associated with epidural anesthesia: Complications of systemic heparinization in patients receiving peripheral vascular thrombolytic therapy. ANESTHESIOLOGY 1990; 72:947–50

15. Wulf H, Striepling E: Postmortem findings after epidural anaesthesia. Anaesthesia 1990; 45:357–61

16. Breivik H: Safe perioperative spinal and epidural analgesia: Importance of drug combinations, segmental site of injection, training and monitoring. Acta Anaesthesiol Scand 1995; 39:869–71

17. Renck H: Neurological complications of central nerve blocks. Acta Anaesthesiol Scand 1995; 39:859–68

18. Tanaka K, Watanabe R, Harada T, Dan K: Extensive application of epidural anesthesia and analgesia in a university hospital: Incidence of complications related to technique. Reg Anesth 1993; 18:34–8

19. Scherer R, Schmutzler M, Giebler R, Erhard J, Stocker L, Kox

WJ: Complications related to thoracic epidural analgesia: A prospective study in 1071 surgical patients. Acta Anaesthesiol Scand 1993; 37:370-4

20. Scott DA, Beilby DSN, McClymont C: Postoperative analgesia using epidural infusions of fentanyl with bupivacaine. ANESTHESIOLOGY 1995; 83:727-37

21. Hanley, JA, Lippman-Hand A: If nothing goes wrong, is everything all right? JAMA 1983; 249:1743-5

22. Neal JM: Management of postdural puncture headache, Epidural and Spinal Analgesia and Anesthesia: Contemporary Issues. Anesthesiology Clinics of North America. Edited by Batra MS, Benumof JL. Philadelphia, WB Saunders, 1992, pp 163-78

23. Dawkins CJM: An analysis of the complications of extradural and caudal block. Anaesthesia 1969; 24:554-63

24. Bonica JJ, Backup PH, Anderson CE, Hadfield D, Crepps WF, Monk BF: Peridural block: Analysis of 3637 cases and a review. ANESTHESIOLOGY 1957; 18:723-84

25. Usubiaga J: Neurological complications following epidural anesthesia. Int Anesth Clin 1975; 13:1-14

26. de Leon-Casasola OA, Parker B, Lema MJ, Harrison P, Massey J: Postoperative epidural bupivacaine-morphine therapy. Experience with 4,227 surgical cancer patients. ANESTHESIOLOGY 1994; 81:368-75

27. Schmidt A, Nolte H: Subdural and epidural hematomas following epidural anesthesia: A literature review. Anaesthesist 1992; 41:276-84

28. Kane RF: Neurodeficits following epidural or spinal anesthesia. Anesth Analg 1981; 60:150-61

29. Rao TK, El-Etr AA: Anticoagulation following placement of epidural and subarachnoid catheters. ANESTHESIOLOGY 1981; 55:618-20

30. Horlocker TT, Wedel DJ: Does preoperative antiplatelet therapy increase the risk of hemorrhagic complications associated with regional anesthesia? Anesth Analg 1990; 70:631-4

31. Liem TH, Booij TH, Hasenbos MA, Gielen MJ: Coronary artery bypass grafting using two different anesthetic techniques: I. Hemodynamic results. J Cardiothorac Vasc Anesth 1992; 6:148-55

32. Carpenter RL, Cullen BF: Hematologic and immune function. Risk and outcome in anesthesia. Edited by Brown DL. Philadelphia, JB Lippincott, 1988, pp 91-2

33. Miller RR, Greenblatt DJ: Drug effects in hospitalized patients. New York, John Wiley and Sons, 1976, pp 151-2

34. Stenseth R, Sellevold O, Breivik H: Epidural morphine for postoperative pain: Experience with 1085 patients. Acta Anaesthesiol Scand 1985; 29:148-56

35. Weightman WM: Respiratory arrest during epidural infusion of bupivacaine and fentanyl. Anaesth Intensive Care 1991; 19:282-4

36. Gregg R: Spinal analgesia, Management of Postoperative Pain. Anesthesiology Clinics of North America. Edited by Oden RV, Benumof JL. Philadelphia, WB Saunders, 1989, pp 79-100