Retrospective Analysis

Analgesic Efficacy of Epidural Patient-Controlled Analgesia on Cancer Pain: A Retrospective Observational Study

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Background: In patients with severe cancer pain, systemic analgesics are often refractory or have limited application due to the side effects of opioids. In these cases, epidural analgesia may be effective. However, data on the effects of epidural patient-controlled analgesia (PCA) on cancer pain are limited.

Objectives: To evaluate the analgesic efficacy of epidural PCA in patients with cancer pain through a retrospective chart review.

Study Design: Retrospective analysis.

Setting: A single academic center in Daegu, South Korea.

Methods: The analgesic efficacy of epidural PCA on cancer pain was analyzed in patients who underwent epidural PCA using a disposable balloon pump with a flow regulator between 2012 and 2021. The pump was filled with a 600-mL mixture of 6 ampoules of 0.2% ropivacaine, 1 mg fentanyl, and normal saline. For the first use of epidural PCA, the basal rate, bolus dose, and lockout time were set as 4 mL/h, 2 mL, and 15 min, respectively. The basal rate was increased and decreased depending on the degree of pain relief effect and occurrence of side effects, respectively. To increase the usage time of epidural PCA and reduce the patient's cost burden, the fentanyl dose was increased by 1 mg when the disposable balloon pump was replaced with a new one after exhaustion of the drug if no side effects from the previous dose were observed. Analgesic efficacy was confirmed by comparing the number of types and the total amount of opioids used in patients before and after epidural PCA application in terms of the equivalent dose of oral morphine.

Results: Epidural catheterization was performed 105 times, and PCA was refilled 257 times in 88 patients. On average, epidural catheterization was performed 1.2 ± 0.4 (1–3) times, and epidural PCA was refilled 3.2 ± 2.3 (1–11) times per patient. The mean duration of PCA use was 15.6 ± 13.4 (1–82) days. The mean number of opioid types used the day before the procedure and the mean smallest number of opioids used per day up to 5 days after the procedure were 3.4 ± 1.2 and 2.4 ± 1.4, respectively ($P < 0.05$). The total amount of opioids used the day before the procedure and the smallest total amount of opioids used per day up to 5 days after the procedure were converted into oral morphine equivalent doses, respectively, and the mean doses were 449.5 ± 555.9 and 331.9 ± 462.8 mg, respectively ($P < 0.05$).

Limitations: The study results are the author's observations from a single center. Epidural PCA was performed only on hospitalized patients. Individual differences were not considered in the composition of drugs for PCA. Transmucosal immediate-release fentanyl was not accurately converted to oral morphine; thus, it was excluded from the analysis of the total amount used, and the effect of adjuvant analgesics could not be considered.

Conclusion: Epidural PCA using subcutaneous tunneling is a useful cancer pain control method. Furthermore, it can be safely used for a longer duration owing to its low infection risk.

Key words: Cancer pain, epidural, epidural analgesia, fentanyl, pain, patient-controlled analgesia, ropivacaine, tunneling

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Apart from death, patients with cancer are known to be most worried about uncontrollable pain (1). Although interest in the evaluation and management of cancer pain has continued to increase, many patients still experience chronic pain (2). The results of a 2016 study on the prevalence of pain in patients with cancer indicated pain prevalence rates of 39.3% after curative treatment, 55.0% during anticancer treatment, and 66.4% in advanced, metastatic, or terminal disease. Moderate to severe pain (Numeric Rating Scale score ≥ 5) was reported in 38.0% of all patients with cancer (3).

In most patients with cancer, pain control is effectively achieved by following the 3-step analgesic ladder recommended by the World Health Organization (WHO) (4). However, despite the adequate and aggressive implementation of the ladder, pain control remains difficult in more than 20% of patients (5). Continued medication failure may reach a point wherein the ladder is no longer helpful to the patient. Therefore, physicians specializing in pain medicine have proposed adding a fourth step to the ladder to provide an interventional approach to pain management as part of an individualized treatment plan for patients with cancer pain (6).

There are various interventional methods for cancer pain management, such as nerve blocks and neurolysis, epidural and intrathecal analgesia, spinal cord stimulation, vertebral augmentation and radiofrequency ablation, and other surgical options (7,8). Among these, intrathecal analgesia using an implanted pump is useful when cancer pain is severe or dose-limiting side effects occur despite appropriate pharmacological treatment (9). However, it is not easy to choose intrathecal analgesia considering the characteristics of cancer pain, such as uncertain life expectancy, and the fact that it is invasive and expensive. Therefore, epidural analgesia is often preferred for patients with relatively short life expectancy and improperly controlled cancer pain as it is less invasive, easy to perform, and less expensive (10).

This study aimed to improve the management of cancer pain by analyzing the analgesic effects and complications of epidural patient-controlled analgesia (PCA) in patients with cancer pain.

Methods

Patients

This retrospective study was approved by the Institutional Review Board (2022-01-003) before the initiation of the study, and the need for informed consent was waived. In this study, a retrospective chart review of inpatients who complained of severe cancer pain at Kyungpook National University Chilgok Hospital in Daegu, South Korea between March 2012 and December 2021 was conducted. Epidural PCA using a disposable balloon pump with a flow regulator was administered to these patients by the author due to either failure to respond to sufficient systemic pharmacotherapy, including opioid analgesics; insufficient pharmacotherapy because of severe side effects despite complaints of severe cancer pain; or inadequate control of cancer pain even after performing other forms of interventional treatment, such as nerve block or neurolysis, vertebroplasty, and cementoplasty, along with pharmacotherapy. Cases that involved perioperative anesthesia and postoperative analgesia administration and those that were performed for non-cancer pain or not completed due to severe pain during the procedure were excluded.

Epidural Catheterization

All epidural catheterization procedures were performed in the prone or lateral decubitus position under fluoroscopic guidance, except for one patient in whom the Tuohy needle needed to be advanced into the epidural space under ultrasound guidance as the lateral decubitus position was impossible due to severe pain. Epidural catheterization in the lateral decubitus position was performed in patients who could not be placed in the prone position due to severe pain or breathing difficulties. A 20G epidural catheter and an 18G Tuohy needle (Perifix® Soft Tip 700 Filter Set, B. Braun Melsungen AG, Melsungen, Germany) were used for epidural catheterization, which was tunneled into the nearby trunk. Under routine anesthesia monitoring, the patient was placed in the prone position with a pillow under their lower abdomen, unless the patient had exceptional reasons, to reduce lumbar lordosis, and a sterile dressing was applied to the treatment area. In most cases, the skin puncture sites for Tuohy needles were at the T11-T12 or T12-L1 level, and the procedure was performed using the interlaminar approach. After placing the Tuohy needle in the epidural space employing the loss-of-resistance method using a 5-mL syringe containing normal saline, an epidural catheter was inserted into the epidural space at a length equal to the depth of the Tuohy needle plus 7 cm. After confirming the correct positioning of the epidural catheter within the epidural space by injecting a small amount of ra-

diolucent dye, 5 mL 0.5% lidocaine was injected. This process made it possible to not only prevent the 3 holes through which the drug is discharged from the tip of the epidural catheter from being blocked by the radiolucent dye during the procedure, but also to determine whether epidural PCA was effective. It also led to pain reduction, allowing the patients to remain comfortable until the procedure was completed. Subsequently, the Tuohy needle was removed, and subcutaneous tunneling was performed into the surrounding trunk using a 16G 45 mm intravenous catheter. After the application of local anesthesia on the skin entry points where the Tuohy needle was inserted into the nearby trunk area, the 16G intravenous catheter was subcutaneously tunneled along the route, and the needle was removed. The hub of the 16G intravenous catheter was cut off, and the epidural catheter was passed through the 16G intravenous catheter. The cut 16G intravenous catheter and the epidural catheter inside it were pulled out of the skin together to complete subcutaneous tunneling. To finally confirm adequate drug injection through the catheter, 5-mL 0.5% lidocaine was injected again, and after ensuring there was no problem with the patient, a disposable balloon pump with a flow regulator was connected (Fig. 1).

Epidural PCA

The initial epidural PCA was prepared by connecting a disposable balloon pump with a flow regulator (Auto Selector®, ACEMEDICAL, Seoul, Korea) filled with a 600-

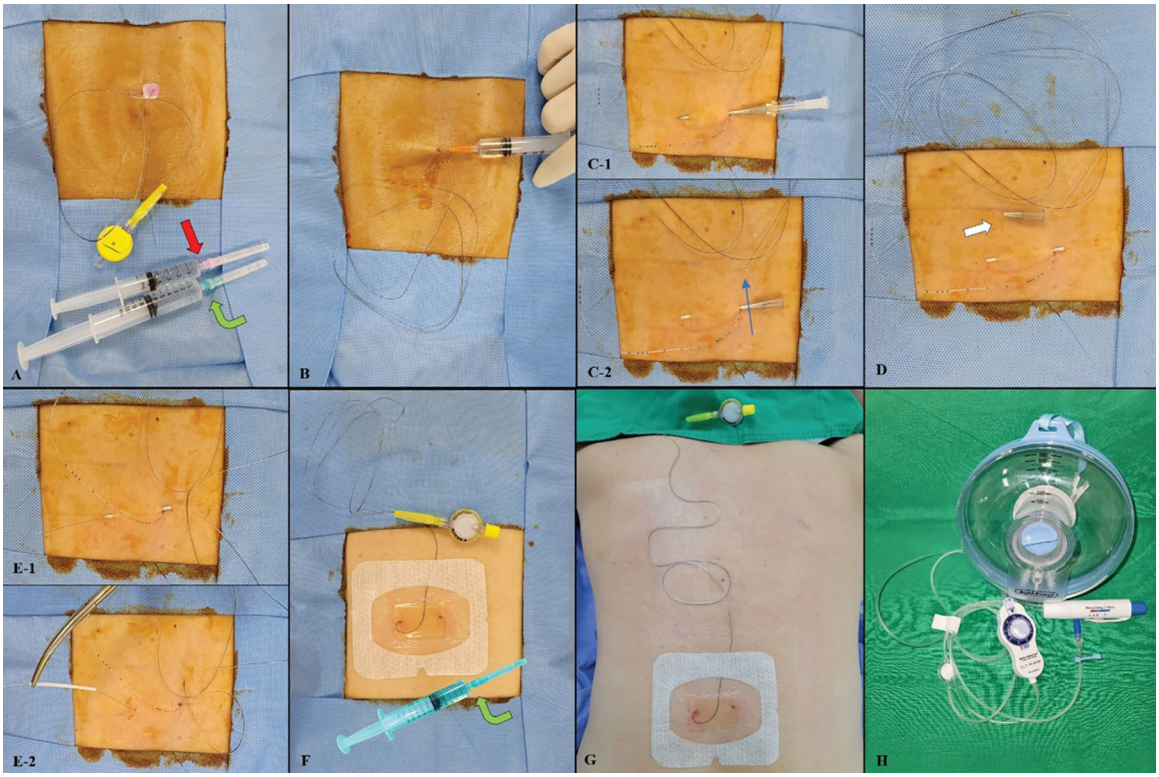

Fig 1. *Epidural catheterization with subcutaneous tunneling. A) After correct positioning of the epidural catheter within the epidural space by injecting a small amount of radiolucent dye, 5 mL of 0.5% lidocaine was injected. Radiolucent dye (arrow), 0.5% lidocaine (curved arrow). B) The Tuohy needle was removed and local anesthesia was applied on the skin entry points where the Tuohy needle was inserted into the nearby trunk area. C) The 16G intravenous catheter was subcutaneously tunneled along the route of application of local anesthesia and the needle was removed. Cutting line (arrow). D) The hub of the 16G intravenous catheter was cut off. Truncated hub (arrow). E) The epidural catheter was passed through the cut 16G intravenous catheter. The cut 16G intravenous catheter and epidural catheter inside it were pulled out of the skin simultaneously to complete subcutaneous tunneling. F) To confirm adequate injection of the drug through the catheter, 5 mL of 0.5% lidocaine was injected again. 0.5% lidocaine (curved arrow). G) A relatively weak adhesive dressing with the transparent film was applied. H) A disposable balloon pump with a flow regulator was connected.*

mL mixture of 6 ampoules of 0.2% ropivacaine, 1-mg fentanyl, and normal saline to an epidural catheter. To prepare epidural PCA easily and consistently and reduce medical expenses for patients by extending the period of epidural PCA use, when the patient experienced no severe side effects at the previous administration rate, the fentanyl dose was increased by 1 mg when connecting a new epidural PCA to increase the concentration. Accordingly, the use period was extended by adjusting the PCA administration rate. However, in all epidural PCAs included in the study, fentanyl was used at 3 mg or less. The first connected epidural PCA was always initiated at a basal rate of 4 mL/h, bolus dose of 2 mL, and lockout time of 15 min. The rate was increased by 2 mL/h in the case of insufficient analgesic effect if no specific side effect occurred and decreased by 2 mL/h otherwise.

Data Analysis

The patient's gender, age, primary cancer, number of epidural catheterizations, surgical position, surgical site, reason for reinsertion, PCA total usage time, mean duration of epidural PCA use, number of refills, and time from the first PCA implantation to death were analyzed. The correlation of primary cancer with the end of the catheter was confirmed by assessing the correlation of primary cancer with surgical level and position, which probably indicates the same. Complications by epidural PCA were also confirmed, and if catheter removal midway was needed, the reason was identified. To determine the analgesic effect of epidural PCA, the number of opioid types used the day before the procedure and the smallest number of opioid types used per day up to 5 days after the procedure were determined. In addition, the total amount of opioids used the day before the procedure and the smallest amount of opioids used per day up to 5 days after the procedure were assessed and converted into oral morphine equivalent doses (11,12).

Statistics

The results were expressed as mean ± SD or incidence (percentage). The correlation between primary cancer and surgical level and position was confirmed using χ^2 tests. The difference between the number of opioid types used before and after epidural PCA and the total amount of opioids converted to oral morphine equivalent doses were statistically verified using the paired-sample t-test. Statistical analyses were conducted using SPSS version 27.0, and $P < 0.05$ was considered statistically significant.

Results

Between March 2012 and December 2021, 105 patients underwent epidural PCA using a disposable balloon pump with a flow regulator. Among them, 4 were operated on by anesthesiologists other than the author; 9 had undergone epidural PCA for postherpetic neuralgia and complex regional pain syndrome, not cancer pain; and 4 were unable to complete the procedure due to excessive pain during radiolucent dye injection or epidural catheter insertion into the epidural space during the procedure were excluded. Thus, only 88 patients were included in the final analysis (Fig. 2).

The patients' characteristics, such as age, gender, and primary cancer, are listed in Table 1. Their age ranged from 31 to 103 years; only 3 patients (3.4%) were over 80 years old. For primary cancers, those indicated as others included hepatoma (n = 2), nasopharyngeal cancer (n = 1), gum cancer (n = 1), melanoma (n = 1), thyroid cancer (n = 1), esophageal cancer (n = 1), gallbladder cancer (n = 1), lymphoma (n = 1), chondrosarcoma (n = 1), and cancer of unknown primary (n = 1).

Table 2 presents details about epidural catheterization, which was performed on average 1.2 ± 0.4 times per patient under fluoroscopic guidance. The lateral decubitus position was impossible for one patient due to subcutaneous pitting edema and severe pain in the lumbar region. Therefore, with a pillow placed under the patient's right knee, an 18G epidural needle was inserted at the L4-L5 level under ultrasound guidance and the correct position of the epidural catheter was confirmed under fluoroscopic guidance. A total of 65 patients (73.9%), except for one, were placed in the prone position and 22 (25.0%) in the lateral decubitus position. One patient had neck pain that persisted even after epidural PCA was performed on the lumbar area in the lateral decubitus position; thus, another epidural PCA was performed 2 days later on the cervical area in the prone position. During this time, the patient's condition significantly improved and the patient could bend his neck in the prone position. Epidural catheterization was performed on 2 regions in 4 patients (3.4%). In 16 patients (18.2%), the procedure was performed more than once due to the following reasons: 2-region procedure (n = 3, 17.6%), careless self-removal (n = 9, 52.9%), catheter occlusion (n = 2, 11.8%), leakage (n = 2, 11.8%), and medical staff error (n = 1, 5.9%). No statistically significant correlation was found between primary cancer and surgical level ($\chi^2 = 35.134$, $P > 0.05$) and position ($\chi^2 = 24.992$, $P > 0.05$).

Table 3 presents information related to epidural

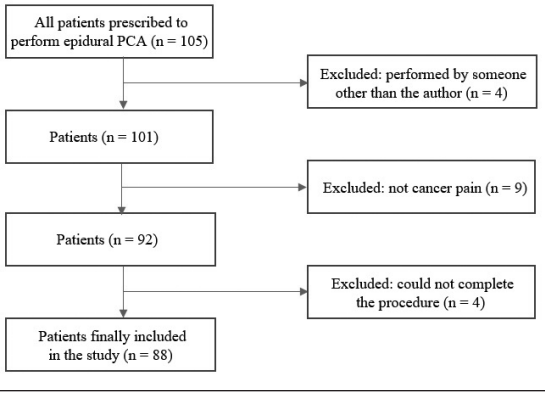

Fig. 2. *Patient selection diagram*.
PCA: patient-controlled analgesia

Table 1. *Patient characteristics*.

Total (n = 88)	
Age (years)	< 60: 38 (43.2%); 60–79: 47 (53.4%); ≥ 80: 3 (3.4%)
Gender (n)	Men, 42 (47.7%); Women, 46 (52.3%)
Primary cancer (n)	Lung: 30 (34.1%) Pancreas: 12 (13.6%) Breast: 11 (12.5%) Urological: 6 (6.8%) Prostate: 5 (5.7%) Stomach: 5 (5.7%) Gynecological: 4 (4.5%) Colorectal: 4 (4.5%) Others: 11 (12.5%)

PCA. The total time of using PCA ranged from a minimum of one to a maximum of 82 days; the mean duration of epidural PCA use was 15.6 ± 13.4 days; the maximum number of epidural PCA refills was 11; and the mean number of refills was 3.2 ± 2.3. After epidural PCA, lower extremity weakness occurred in 4 patients as well as vomiting and drowsiness, chest discomfort and dyspnea, and superficial skin infection in one patient each. The reasons for the final epidural PCA removal were improvement (n = 27, 30.7%), death (n = 25, 28.4%), discharge (n = 7, 8.0%), self-removal (n = 6, 6.8%), carelessness (n = 5, 5.7%), delirium (n = 4, 4.5%), malfunction (n = 3, 3.4%), and others (dementia, oozing, vomiting and drowsiness, superficial skin infection, chest discomfort, and dyspnea [n = 11, 12.5%]). For 62 patients whose death was confirmed, the time from the first epidural PCA to death ranged from at least 6 to 516 days (mean, 63.3 ± 81.0 days).

The mean number of opioid types used the day before the procedure and the mean smallest number of opioid types used per day up to 5 days after the procedure were 3.4 ± 1.2 and 2.4 ± 1.4, respectively, indicating a significant difference ($P < 0.05$) (Fig. 3).

Table 2. *Epidural catheterization*.

Number of catheterizations per patient (n)	1 time: 72 (81.8%) 2 times: 15 (17.0%) 3 times: 1 (1.1%)	Total: 105 times
Surgical position	Prone: 65 (73.9%) Lateral decubitus: 22 (25.0%) Other: 1 (1.1%)	
Surgical level	Thoracic: 53 (60.2%) Lumbar: 31 (35.2%) Thoracic and lumbar: 2 (2.3%) Cervical and lumbar: 1 (1.1%) Sacral: 1(1.1%)	
Reason for reinsertion (n)	Two-region procedure: 3 (17.6%) Careless self-removal: 9 (52.9%) Catheter occlusion: 2 (11.8%) Leakage: 2 (11.8%) Medical staff error: 1 (5.9%)	

Table 3. *Epidural patient-controlled analgesia*.

Mean duration of epidural PCA (mean ± SD, days)	15.6 ± 13.4 (1–82)
Refill times (n, %)	1 time: 26 (29.5%) 2 times: 14 (15.9%) 3 times: 16 (18.2%) 4 times: 13 (14.8%) 5 times: 7 (8.0%) 6 times: 4 (4.5%) 7 times: 2 (2.3%) 8 times: 2 (2.3%) 9 times: 1 (1.1%) 10 times: 2 (2.3%) 11 times: 1 (1.1%)
Complications (n, %)	Both lower extremity weakness: 4 (4.5%) Vomiting and drowsy mentality: 1 (1.1%) Chest discomfort and dyspnea: 1 (1.1%) Superficial skin infection: 1 (1.1%)
Reason for removal (n, %)	Improvement: 27 (30.7%) Death: 25 (28.4%) Discharge: 7 (8.0%) Self-removal: 6 (6.8%) Carelessness: 5 (5.7%) Delirium: 4 (4.5%) Malfunction: 3 (3.4%) Both lower extremity weakness: 3 (3.4%) Dissatisfaction: 2 (2.3%) Others: 6 (6.8%)
Time from the first PCA implantation to death (mean ± SD, days)	63.3 ± 81.0 (6–516)

PCA, patient-controlled analgesia

The total amount of opioids used the day before the procedure and the lowest amount of daily opioids used up to 5 days after the procedure were converted into oral morphine equivalent doses, respectively. The mean doses were 449.5 ± 555.9 and 331.9 ± 462.8 mg, respectively, indicating a statistically significant difference ($P < 0.05$) (Fig. 4). However, transmucosal immediate-release fentanyl drugs, such as Actiq®, Fentora®, and Abstral®, which had been used at the hospital during the study period, were excluded due to the lack of direct conversion rate with oral morphine to date (11,12).

Discussion

The results of this study confirm that epidural PCA not only exerts analgesic efficacy, but also reduces the amount of opioids used in patients with severe cancer pain. The mean duration of epidural PCA use for all patients in this study and the mean time from the first PCA implantation to death in patients whose deaths were confirmed 15.6 ± 13.4 and 63.3 ± 81.0 days, respectively. Thus, it is considered effective for cancer pain not controlled by medication in patients with terminal cancer whose life expectancy is less than 3 months.

A pain control protocol was implemented in this study wherein various interventional treatments were used for patients with pain in a specific area. Epidural PCA was performed in patients who complained of severe pain in more than 2 regions that could not be treated through medication or interventional treatment. As previously described, it was difficult to accurately determine the location of the catheter tip in patients included in this study due to the radiopaque nature of the epidural catheter used. However, since the catheter was left within 7 cm of the epidural space as a rule, it was presumed that the effect of the type of primary cancer on the location of the catheter tip would be similar to its effect on the surgical level. The absence of a statistically significant correlation between primary cancer and surgical level and position can be attributed to the fact that epidural PCA was performed in patients who complained of pain in 2 or more sites. A statistically significant correlation between the primary cancer and surgical level and position is highly likely to be observed in patients with pain in a specific area related to primary cancer.

Although not used before the procedure, 2 patients used 1.8 and 0.2 mg of Actiq®, respectively, and one patient used 1.2 mg of Abstral® after the procedure. Furthermore, 2 patients used 2.4 and 1.6 mg of Actiq® before the procedure and increased the doses to 4.8 and 2.4 mg after the procedure, respectively. However, to date, the direct conversion rate of these drugs to oral morphine remains unknown, and the effect on total opioid consumption was not significant. Thus, these drugs were included in the calculation of the number of opioid types used, but not in the total amount of opioids used. A total of 13 patients (15%) used an oral morphine equivalent dose of 1,000 mg or more per day, except for one whose accurate opioid dose could not be determined. Currently, the opioid epidemic is a concerning issue worldwide. Although opioids were used

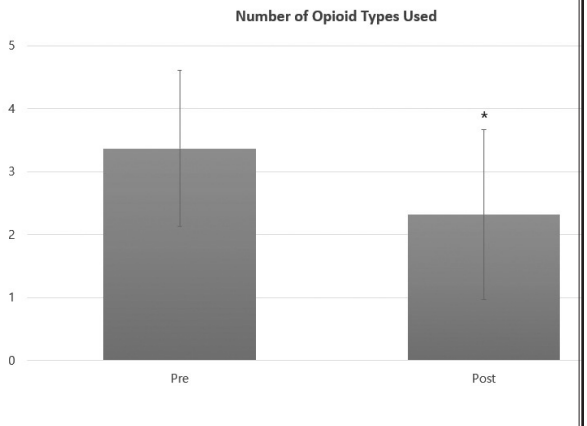

Fig. 3. *Number of opioid types used before and after epidural patient-controlled analgesia.*
*: $P < 0.05$

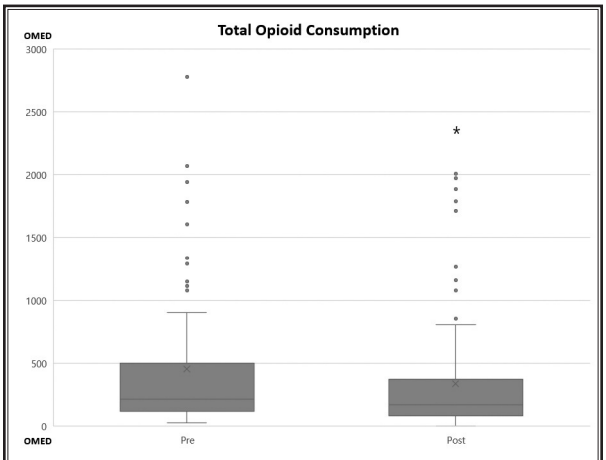

Fig. 4. *Total opioid consumption before and after epidural patient-controlled analgesia.*
*: $P < 0.05$, OMED: oral morphine equivalent dose

in patients who suffered severe cancer pain, it is crucial to consider the fact that the dose used was quite high (13,14). Considering that only one patient in the years 2017, 2018, and 2021 used an oral morphine equivalent dose of over 1,000 mg, it is believed that interventional treatment, including epidural PCA, needs to be used earlier. This would lead to freedom among patients from the side effects of excessive opioid use. To achieve this, a multidisciplinary and multimodal approach is indispensable.

Despite its well-known potential for significant benefits, the main reason for the reluctance to administer epidural PCA for a long time is the risk of infection (15,16). However, no deep infection occurred in this study and only one patient required an epidural catheter removal after 3 days due to suspicion of a superficial infection. Although the rates of epidural catheter-related infection vary among studies, the incidence of deep infections, such as meningitis as well as paraspinal and epidural abscesses, is known to range from 0% to 0.7% (17). As was the case in this study, not all details regarding superficial infections are recorded in studies; thus, reports on superficial infections are fewer than those on deep infections. Furthermore, unlike deep infections, which have very clear risks and diagnostic criteria, the criteria for superficial infections are different for each researcher. In a retrospective study of patients who underwent epidural catheterization for chronic cancer pain control, Smitt et al (16) defined superficial infection as purulent drainage or significant cutaneous inflammation at the catheter exit site; they reported that both mild superficial infection and deep infection, such as epidural abscess, occurred in 43% and 13% of patients, respectively. Holt et al (18) also reported a catheter exit site infection rate of at least 4.3% for epidural catheters, similar to that for intravascular devices. Darchy et al (19) reported that 12% of patients had a local infection in a study of patients who underwent epidural analgesia at the intensive care unit and that local and epidural catheter infections can be strongly suspected if erythema and local discharge are present. In their prospective study, Burstal et al (20) defined erythema as > 5 mm or the presence of induration or discharge from the catheter exit site as skin site inflammation, which occurred in 5.3% of the patients. They concluded that the infection rate was likely overestimated as the presence of erythema alone was also defined as an infection and that it was not a sufficient reason for catheter removal. In this study, the yellowish pus-like abnormal finding at the catheter exit site in one patient was defined as a superficial infection. The exact number of patients in this study who only had redness or swelling at the catheter exit site is unknown. The catheter was maintained even if redness or swelling developed at the catheter exit site after it was disinfected once every day for 3 consecutive days, as most abnormal findings disappeared; therefore, these cases were not defined as superficial infections. In one patient with a suspected superficial infection, the epidural catheter was immediately removed. After wound disinfection for 3 days, the yellowish pus-like abnormal finding completely disappeared, and the patient had no specific symptoms due to infection.

In this study, complications caused by epidural PCA were observed in 7 patients (7.8%). Four patients developed lower extremity weakness, of whom 3 required catheter removal as the symptoms did not improve despite the reduced basal rate. A 63-year-old woman had a reduced basal rate of 2 mL/h and retained PCA due to symptom improvement. However, the symptoms of a 65-year-old woman and a 103-year-old man only improved when the basal rate was reduced to zero and the PCA was eventually removed. A 77-year-old man developed lower extremity weakness and poor urination; thus, the basal rate was reduced to 0, and PCA was removed. Epidural PCA has the advantage of increasing the analgesic effect with the addition of a local anesthetic, but it should be kept in mind that this can cause complications in patients, particularly the elderly ones. Therefore, the author recommends that if the patient exhibits a significant analgesic effect at the current basal rate with no special side effects, a bolus for breakthrough pain is used to the extent that the side effects of local anesthetics do not appear. If side effects are anticipated, the author recommends managing breakthrough pain with intravenous or other types of analgesics. One of the biggest advantages of using PCA for patients with severe cancer pain is that the patient can directly take the drug when needed (21). The ultimate goal of cancer pain management is to maintain patients' quality of life and self-esteem until death (22). Considering this core value, additional research on the appropriate local anesthetic concentration that can be safely used as a bolus is warranted.

Side effects, such as vomiting and drowsiness or chest discomfort and dyspnea, were reported in one patient each. Considering that both used 3 and 4 opioid types before the procedure and the times from the first PCA implantation to death were 52 and 11 days, respectively, the effects could have been caused by the

opioids they took or by disease progression. A few patients also complained of constipation, nausea and vomiting, dizziness, urticaria, and respiratory depression, which are relatively common side effects of opioids. Development of these conditions may be attributed to the fact that most patients already used large amounts of opioids for a long time and were used to such side effects. As the positive pain-reducing effects of epidural PCA outweighed the negative side effects, patients may not have mentioned them.

Eikermann et al (23) reported that pain was more dramatically reduced by the use of epidural analgesia during bed rest than when walking or sitting. They used externalized nontunneled epidural catheter, which rarely causes serious side effects. Superficial and deep infections were observed in 10.8% and 2.1% of patients, respectively. The most common reason for catheter removal was migration/dislocation (32.3%). Considering that self-removal due to carelessness (52.9%) was the most common cause of undergoing epidural catheterization more than once in this study, it is crucial to constantly instruct patients to prevent the catheter from escaping from the body. Furthermore, considering that there were 2 cases of reinsertion due to catheter occlusion and leakage, respectively, careful attention should be paid to catheter malfunction to reduce the frequency of unnecessary and excessive opioid use.

Fixing the epidural catheter properly to the body is difficult owing to its extreme thinness. Crul et al (24) reported that the most frequent complications in 50% of patients with terminal cancer who underwent nontunneled epidural analgesia with spinal morphine for more than 10 days were catheter occlusion and dislocation, probably due to the development of epidural fibrosis. In a retrospective registry analysis of 22,411 surgical patients who underwent continuous thoracic epidural analgesia, Bomberg et al (25) reported that tunneling was associated with a low risk of thoracic epidural catheter-related infection. Epidural catheter tunneling has the advantage of reducing not only the spread of infection, but also catheter movement, which can reduce various problems (26). Although a short-term epidural catheter was used for postoperative analgesia, a study reported that using subcutaneous tunneling with the looping method was effective for fixing the epidural catheter (27). On the other hand, tunneling without the use of the looping method was recently found to significantly reduce catheter migration (28). These conflicting results and the short duration of use warrant further research on patients with cancer pain who are likely to use epidural PCA for a long time. Recent studies have demonstrated that the Lockit epidural device (Smiths Medical International Limited, Ashford, UK) can reduce epidural catheter migration (29,30). However, these studies only focused on short-term use; thus, further studies focusing on long-term use are needed. An instrument similar to the Lockit epidural device had been initially used in some patients in this study, but it was discontinued as the patients felt uncomfortable with the instrument when lying down. This was probably because patients with terminal cancer often have extremely little physical activity or lie down for a long time and thus require long-term use of epidural catheters. As epidural catheter migration is inevitable, it is more effective to check the normal function of the epidural catheter as often as possible and provide continuous education to the patient than using the Lockit epidural device, which can cause discomfort in patients and increase the risk of foreign body infection.

Because there was no way to firmly secure the epidural catheter to the body, the author initially used a very strong adhesive catheter fixation dressing device for the epidural catheter containing a device similar to the Lockit epidural device. However, in one patient, while an intern was disinfecting the catheter exit area, the epidural catheter was pulled out while removing the strong adhesive dressing. Since then, all disinfection procedures were performed by the author in principle and, in the author's absence, medical personnel who were well aware of the fact that the epidural catheter could easily fall out. Furthermore, a relatively weak adhesive dressing (3M Tegaderm™ CHG, ACEMEDICAL, Neuss, Germany) that was easy to remove was used thereafter, which led to the frequent disinfection of the patients and made it possible to observe the applied area through the transparent film.

Afshan et al (31) reported that the most appropriate length of an epidural catheter to remain in the epidural space was 5 cm to minimize catheter-related complications. Because epidural catheterization was performed for postoperative analgesia in their study, the period of epidural catheter placement was very short. However, a much longer placement period was expected in the patients in the present study; thus, it was necessary to leave the epidural catheter 7 cm in the epidural space to enable stable placement. Because the epidural catheter used in this study was radiopaque, the exact position of the tip could not be confirmed; however, a small amount of radiolucent dye was injected during the epidural catheterization to confirm the position of the tip, and it was corrected if necessary.

Limitations

This study was limited by the absence of a comparison group and the possibility that inaccurate medical records may be obtained by using a retrospective chart review. This study is the result of the author's observation from a single center; thus, validating the results of this study in a multicenter setting is necessary to generalize it. However, considering that the author has already had a lot of experience in the field of pain medicine before this study period, it seems that the risk of the learning curve can be excluded from the results of this study, and similar results can be obtained if the procedure is performed in the same manner. Epidural PCA was performed only on hospitalized patients and had to be removed upon discharge. It was difficult to determine whether epidural PCA could be used continuously when the patient was transferred to another hospital or discharged home. In this regard, additional research is needed through cases conducted after the study period. To date, transmucosal immediate-release fentanyl drugs, such as Actiq®, Fentora®, and Abstral®, have not been accurately converted to oral morphine, and the effects of the adjuvant analgesic used in this study could not be considered. For convenience and consistency of work, individual differences were not considered in the composition of drugs for PCA.

Conclusion

Epidural PCA with subcutaneous tunneling is a useful pain control method that is relatively inexpensive and simple; it can also be removed easily, if necessary, in patients with severe cancer pain that is not controlled by medication. Owing to its low infection risk, it can be safely used for a long time, making it particularly useful for patients with terminal-stage cancer whose life expectancy is less than 3 months. By allowing patients to reduce the number of types and total amount of opioids used, the side effects of opioids can also be reduced. Furthermore, epidural PCA has the advantage of maintaining patients' quality of life and self-esteem until death through the use of an appropriate bolus.

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