ORIGINAL RESEARCH

Postoperative pain and patient-controlled epidural analgesia-related adverse effects in young and elderly patients: a retrospective analysis of 2,435 patients

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Abstract: In this retrospective study, data of 2,435 patients who received fentanyl and ropivacaine-based patient-controlled epidural analgesia (PCEA) for pain relief after elective surgery under general or spinal anesthesia were reviewed. Differences in postoperative pain, incidence of patient-controlled analgesia (PCA)-related adverse effects, and risk factors for the need for rescue analgesics for 48 hours postsurgery in young (age 20–39 years) and elderly (age ≥70 years) patients were evaluated. Although there were no significant differences in postoperative pain intensity between the two groups until 6 hours postsurgery, younger patients experienced greater postoperative pain intensity compared with older patients 6–48 hours postsurgery. While younger patients exhibited greater incidence of numbness, motor weakness, and discontinuation of PCA postsurgery, elderly patients exhibited greater incidence of hypotension, nausea/vomiting, rescue analgesia, and antiemetic administration. Upon multivariate analysis, low fentanyl dosage and history of smoking were found to be associated with an increased need for rescue analgesia among younger patients, while physical status classification III/IV and thoracic surgery were associated with a decreased need for rescue analgesia among the elderly. Discontinuation of PCA was more frequent among younger patients than the elderly (18.5% vs 13.5%, *P*=0.001). Reasons for discontinuation of PCA among young and elderly patients, respectively, were nausea and vomiting (6.8% vs 26.6%), numbness or motor weakness (67.8% vs 11.5%), urinary retention (7.4% vs 8.7%), dizziness (2.2% vs 5.2%), and hypotension (3.1% vs 20.3%). In conclusion, PCEA was more frequently associated with numbness, motor weakness, and discontinuation of PCA in younger patients and with hypotension, nausea/vomiting, and a greater need for rescue analgesics/antiemetics among elderly patients. Therefore, in order to minimize the adverse effects of PCEA and enhance pain relief, different PCEA regimens and administration/prevention strategies should be considered for young and elderly patients.

Keywords: adverse effect, age, elderly, epidural analgesia, pain management, patient-controlled analgesia

Introduction

Patient-controlled epidural analgesia (PCEA) is a very effective method of postoperative pain control in various surgeries. Epidural analgesia (EA) with a local anesthetic in combination with an opioid provides effective pain relief and might improve postoperative outcomes.[1] However, administration of high dosages of opioids via the epidural route can cause nausea, vomiting, and respiratory depression.[2] In addition, excessive administration of local anesthetics can cause adverse effects, such as hypotension and motor blockade, thus compromising postoperative mobility and delaying postoperative recovery.[3]

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Elderly patients comprise a large and rapidly increasing proportion of surgical patients. Proper assessment and management of postoperative pain and patient-controlled analgesia (PCA)-related adverse effects are important, because of the high rates of morbidity and mortality associated with inadequate pain control in elderly patients.[4] The pharmacokinetic and pharmacodynamic properties of a pharmacological agent vary with increasing patient age.[5] Elderly patients exhibit decreased hepatic/renal excretion and cardiac output and increased susceptibility to central nervous system-active medications. They also exhibit increased body fat and consequently an altered volume of distribution to drugs.[6–8] In addition, because of changes in cognitive function and behavioral/socioeconomic conditions, elderly patients exhibit altered expression of pain.[8,9] Therefore, despite exposure to the same procedure or drugs, the effectiveness and adverse effects of PCEA among elderly patients might differ from those among younger patients. However, to the best of our knowledge, no study has evaluated these differences in PCEA between young and elderly patients. Therefore, in this retrospective study, we investigated differences in postoperative pain, incidence of PCA-related adverse effects, risk factors for the need for rescue analgesics, and reasons for discontinuation of PCA during a 48-hour postoperative period between young and elderly patients who received fentanyl and ropivacaine-based PCEA.

Subjects and methods

This study was approved by the institutional review board of Gangnam Severance Hospital, Seoul, South Korea (3-2016-0134) and registered at ClinicalTrials.gov (NCT02849730). The requirement for written informed consent was waived for this medical record-review study under the regulations of the institutional review board. Patient-identification data were encoded and scrambled using a restricted computer to protect the privacy of all subjects.

In our hospital, a PCA service team consisting of two specialized nurses collected multidisciplinary clinical data from all patients using PCEA during a 48-hour postoperative period since 2010. These data included clinical outcomes, such as pain intensity, additional rescue analgesic/antiemetic administration, and adverse effects, including nausea/vomiting, numbness/weakness, sedation, hypotension, headache/dizziness, pruritus, and discontinuation of PCA. Intensities of pain and nausea were both measured using an 11-point numeric rating scale (NRS; 0–10: 0= no pain/nausea, 10= worst imaginable pain/nausea). Rescue analgesics/antiemetics were administered according to our institutional guidelines.

For pain scores >4, rescue analgesia was administered with 30 mg ketorolac (Keromin; Hana Pharm, Seoul, South Korea) or 25 mg pethidine (Jeil Pharmaceutical, Seoul, South Korea). Rescue antiemetics were administered at nausea scores >4; 10 mg metoclopramide (Macperan; Dong Wha Pharmaceutical, Seoul, South Korea) was administered as the first-line rescue antiemetic, followed by 4 mg ondansetron (Onseran; Yuhan, Seoul, South Korea) or 0.3 mg ramosetron (Nasea; Astellas Pharma, Tokyo, Japan) when refractory.

Data of patients who received PCEA for pain following elective surgery under general or spinal anesthesia between September 2010 and November 2015 were reviewed. Patients were divided into two groups according to age: young (20–39 years) and elderly (≥70 years) groups. Patients aged 40–69 years and those aged <20 years were excluded, as were patients who received routine analgesics/antiemetics and those with incomplete data.

PCEA was delivered through a disposable PCA pump (Ambix Anaplus [Fresenius Kabi, Bad Homburg, Germany] or Accufuser Plus [Woo Young Medical, Jincheon, South Korea]) with fentanyl and ropivacaine. Dosages of fentanyl (1–10 μg/mL) and ropivacaine (0.1%–0.25%) for PCA, background infusion rate (2 or 5 mL/h), on-demand bolus dose (0.5–2 mL), and lockout time (15 or 30 minutes) were determined by the anesthesiologists who induced anesthesia during surgery. Demographic and clinical variables – age, sex, body mass index, American Society of Anesthesiologists (ASA) physical status, history of smoking, motion sickness, and postoperative nausea/vomiting – were evaluated. In addition, anesthesia and surgery-related variables, including the type and duration of anesthesia and type of surgery (abdominal, thoracic, orthopedic, or urogenital), were investigated. All postoperative variables were recorded at 0–6 (including postanesthesia care unit stay), 6–12, 12–18, 18–24, and 24–48 hours postoperatively.

Postoperative pain intensity using the NRS was compared between groups. During the 48 postoperative hours, the percentage of patients who required rescue analgesics or antiemetics at least once was investigated, as well as incidence of any adverse effects. Factors associated with rescue analgesic requirements were investigated.

Statistical analyses were performed using SAS 9.2 software (SAS Institute Inc., Cary, NC, USA). Demographic and anesthesia/surgery-related variables were analyzed by independent t-test or Mann–Whitney U-test after the Shapiro–Wilk test for normality for continuous variables and χ^2 or Fisher's exact test for categorical variables. Univariate logistic regression analyses were performed to identify factors

related to the need for rescue analgesia and discontinuation of PCA. Factors with *P*-values <0.05 in the univariate logistic regression model, as well as those considered clinically important, were evaluated by multiple logistic regression analysis. Odds ratios and 95% confidence intervals were estimated, and *P*-values <0.05 were considered statistically significant.

Results

Among a total of 7,448 patients, data of 2,435 patients were included in the present analysis. The young and elderly groups comprised 1,344 and 1,091 patients, respectively. While 403 patients were excluded because of routine use of analgesics/antiemetics, 17 were excluded because of incomplete data (Figure 1).

Patient demographic characteristics and details regarding PCA, anesthesia, and surgery are presented in Table 1. Elderly patients exhibited lower body mass index and higher incidence of diabetes mellitus and history of smoking than younger patients. The proportion of female patients and incidence of spinal anesthesia and motion sickness among younger patients were higher compared to elderly patients. Elderly patients received lower fentanyl dosage and higher ropivacaine dosage per hour than young patients. The most common type of surgery among young and elderly patients was abdominal (81.7% and 44.4%, respectively). Thoracic (9.2% vs 1.7%), lower extremity (39.5% vs 15.6%), and urogenital (7% vs 0.9%) surgeries were more common among the elderly group than the younger group of patients.

With regard to postoperative pain profiles, while younger patients exhibited higher NRS pain scores than the elderly at 6–48 postoperative hours, there was no statistically significant difference in NRS pain score at 0–6 hours between the two groups (Table 2). However, more elderly patients used rescue analgesics than young patients in the early postoperative period (Figure 2).
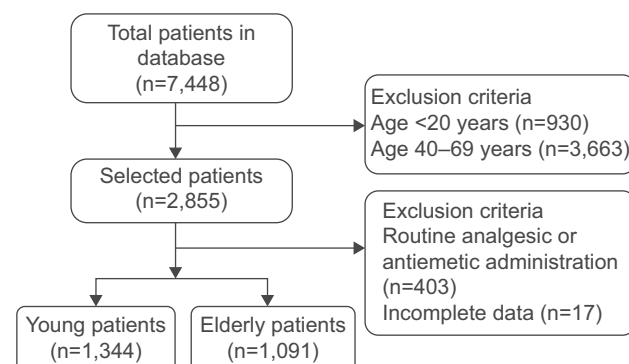
Table 1 Preoperative characteristics of patients using epidural PCA

Preoperative characteristics	Young patients (n=1,344)	Elderly patients (n=1,091)	*P*-value
Patient characteristics			
Women*	1,040 (77.4)	588 (48.2)	<0.001
Age (years)*	31.9±4.7	74.6±3.8	<0.001
BMI (kg/m²)*	25.3±3.9	23.9±3.4	<0.001
ASA physical status*			<0.001
I	830 (63)	179 (16.8)	
II	463 (35.1)	583 (54.8)	
III	24 (1.8)	291 (27.4)	
IV	1 (0.1)	11 (1)	
Mixed PCA amounts			
Fentanyl (µg/h)*	11.7±4.4	11±6	0.003
Ropivacaine (mg/h)*	7.5±1.5	8±2.8	<0.001
Medical history			
Hypertension*	22 (1.6)	515 (47.2)	<0.001
Diabetes mellitus*	16 (1.2)	227 (20.8)	<0.001
Motion sickness*	128 (9.5)	52 (4.8)	<0.001
Previous PONV	12 (0.9)	10 (0.9)	0.951
Smoking*	83 (6.2)	221 (20.3)	<0.001
Anesthesia-related conditions			
Anesthesia duration (minutes)*	147±104.7	214±130.9	<0.001
Type of anesthesia*			<0.001
General	397 (29.8)	674 (62.3)	
Spinal	934 (70.2)	408 (37.7)	
Type of surgery*			<0.001
Abdominal	1,083 (81.7)	470 (43.4)	
Thoracic	23 (1.7)	97 (9.2)	
Lower extremities	206 (15.3)	418 (39.5)	
Spinal	1 (0.1)	0	
Urogenital	12 (0.9)	74 (7)	

Notes: *P<0.05. Values are presented as mean ± standard deviation or number (%) of patients.
Abbreviations: PCA, patient-controlled analgesia; BMI, body mass index; ASA, American Society of Anesthesiologists; PONV, postoperative nausea and vomiting.

Table 2 Postoperative numeric rating scale for pain intensity

Postoperative hours	Young patients (n=1,344)	Elderly patients (n=1,091)	*P*-value
0–6 hours	4.2±3.1	4.3±3.1	0.921
6–12 hours*	4.8±2.6	4.1±2.9	<0.001
12–18 hours*	4.1±2.3	3.3±2.6	<0.001
18–24 hours*	3.5±2.1	3.0±2.4	<0.001
24–48 hours*	3.2±1.8	3.1±2.1	<0.001

Notes: *P<0.05. Values are presented as mean ± standard deviation.

With regard to adverse effects, the incidence of numbness and motor weakness among younger patients was higher compared to the elderly. However, the incidence of sedation, hypotension, and nausea and vomiting among the elderly was higher compared to younger patients. The elderly patients also exhibited more frequent use of rescue analgesics and antiemetics compared with the younger patients. Discontinuation of PCA was more frequently observed among younger
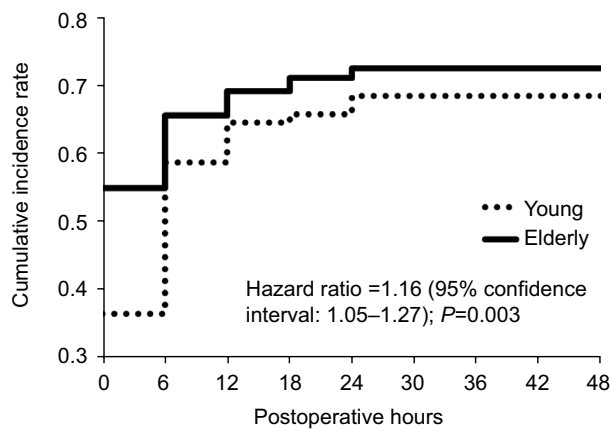

Figure 1 Flowchart indicating patient selection and exclusion criteria.

Total patients in database (n=7,448)

Exclusion criteria
Age <20 years (n=930)
Age 40–69 years (n=3,663)

Selected patients (n=2,855)

Exclusion criteria
Routine analgesic or antiemetic administration (n=403)
Incomplete data (n=17)

Young patients (n=1,344)   Elderly patients (n=1,091)

Figure 2 Kaplan–Meier curve demonstrating the incidence rate of patients who used rescue analgesics at least once during the study period.

patients than among the elderly (18.5% vs 13.5%, *P*=0.001; Table 3). Reasons for discontinuation of PCA among the young and elderly patients were nausea and vomiting (6.8% vs 26.6%), numbness or motor weakness (67.8% vs 11.5%), urinary retention (7.4% vs 8.7%), dizziness (2.2% vs 5.2%), and hypotension (3.1% vs 20.3%).

Univariate logistic regression analysis was performed for factors associated with rescue analgesic requirements

Table 3 Incidence of epidural PCA-related complications in young and elderly patients

Complications	Young patients (n=1,344)	Elderly patients (n=1,091)	*P*-value
Numbness*	509 (37.9)	54 (4.9)	<0.001
Motor weakness*	153 (11.4)	11 (1)	<0.001
Urinary retention	78 (6.1)	66 (6.7)	0.536
Headache	20 (1.5)	9 (0.8)	0.134
Dizziness	54 (4)	52 (4.8)	0.368
Sedation*	2 (0.2)	15 (1.4)	<0.001
Pruritus	40 (3)	37 (3.4)	0.56
Hypotension*	20 (1.5)	78 (7.2)	<0.001
Nausea/vomiting*	144 (10.7)	210 (19.3)	<0.001
Discontinuation of PCA*	248 (18.5)	147 (13.5)	0.001
Rescue analgesics*	920 (68.5)	792 (72.5)	0.03
Rescue antiemetics*	32 (2.4)	64 (5.9)	<0.001

Notes: *P<0.05. Values are presented as number (%) of patients.
Abbreviation: PCA, patient-controlled analgesia.

(Table 4). Factors with *P*-values <0.05 and those considered clinically important were evaluated by multiple logistic regression analysis. Upon multivariate analysis, low fentanyl dosage per hour and history of smoking were found to be related to increased use of rescue analgesia among young patients. In contrast, ASA classification III/V and thoracic/

Table 4 Univariate analysis of factors associated with rescue analgesic requirements

Predictors	Young patients (n=1,344)		Elderly patients (n=1,091)	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Female sex	0.98 (0.75–1.29)	0.899	1.98 (1.5–2.6)*	<0.001
BMI	0.98 (0.96–1.01)	0.258	1.05 (1.01–1.09)*	0.019
ASA physical status				
1	1 (reference)		1 (reference)	
2	1 (0.78–1.27)	0.974	0.74 (0.49–1.1)	0.133
3	0.64 (0.28–1.47)	0.292	0.61 (0.4–0.94)*	0.026
4	NA	1	0.33 (0.1–1.15)	0.083
Fentanyl (µg/h)	0.98 (0.95–1)	0.056	0.94 (0.92–0.97)*	<0.001
Ropivacaine (mg/h)	0.99 (0.92–1.07)	0.657	1.01 (0.96–1.06)	0.605
Total PCA amount (mL)	1 (1–1)	0.648	1 (1–1)	0.596
History of DM	0.77 (0.28–2.12)	0.607	0.98 (0.71–1.36)	0.923
History of hypertension	0.99 (0.4–2.44)	0.978	1.20 (0.92–1.56)	0.192
History of motion sickness	0.9 (0.61–1.33)	0.601	0.47 (0.16–1.37)	0.172
History of PONV	2.32 (0.51–10.63)	0.279	3.44 (0.43–27.24)	0.242
Smoking history	1.71 (1–2.93)*	0.048	0.63 (0.46–0.86)*	0.004
Anesthesia duration (minutes)	1 (1–1)	0.496	0.99 (0.99–1)	0.602
Type of anesthesia				
General	1 (reference)		1 (reference)	
Regional	1.01 (0.79–1.3)	0.912	3.17 (2.31–4.34)*	<0.001
Type of surgery				
Abdominal	1 (reference)		1 (reference)	
Thoracic	0.85 (0.36–2.03)	0.722	0.55 (0.35–0.86)*	0.008
Lower extremity	1.11 (0.8–1.54)	0.536	2.61 (1.86–3.65)*	<0.001
Spinal	NA	1	–	–
Urogenital	0.46 (0.15–1.42)	0.176	0.49 (0.3–0.8)*	0.005

Notes: *P<0.05. '–' indicates no patient.
Abbreviations: OR, odds ratio; CI, confidence interval; BMI, body mass index; ASA, American Society of Anesthesiologists; NA, not available; PCA, patient-controlled analgesia; DM, diabetes mellitus; PONV, postoperative nausea/vomiting.

urogenital surgery (in comparison with abdominal surgery) were found to be related to decreased use of rescue analgesia among elderly patients (Table 5).

Discussion

In this retrospective study, we evaluated postoperative pain and PCEA-related adverse effects and identified risk factors for the need for rescue analgesia and reasons for discontinuation of PCEA among young and elderly patients. The 6- to 48-hour postsurgery NRS pain scores of elderly patients were lower compared to those of the younger patients. While the younger patients exhibited higher incidence of numbness and motor weakness than the elderly, sedation, hypotension, and nausea and vomiting were more common among elderly patients than the younger ones. Low fentanyl dosage and history of smoking were associated with an increased need for rescue analgesia among young patients, while physical status classification III/IV and thoracic surgery were associated with a decreased need for rescue analgesia among elderly patients.

In elderly patients, decrease in myelinated fibers in the dorsal and ventral roots, which results in increased sensitivity to local anesthetics,[10] reduction in epidural fat, and increased permeability, may cause EA to be more potent than in younger patients.[10,11] This might explain the NRS pain scores of the elderly patients being lower compared to the younger patients during the postoperative 6–48 hours in the present study. Additionally, the proportion of patients who underwent abdominal surgery, which induces intense postoperative pain,[12] in the younger group was higher compared to the elderly group. However, there was no significant difference in NRS pain score between the two groups during the postoperative 6-hour period, which might have been because of differences in type of anesthesia between the two groups. The proportion of patients who received spinal anesthesia in the younger group was higher compared to the elderly group. Therefore, despite the relatively low potency of PCEA in young patients, the lower overall NRS pain scores of the younger group in comparison with the elderly group might have been because of the residual effect of spinal anesthesia during the immediate postoperative period.

The overall proportion of patients who required rescue analgesia at least once during the postoperative 48-hour period in the present study (70.31%) was higher compared to patients with postoperative IV PCA in our previous study (51.28%).[13] In terms of effectiveness of pain control, PCEA did not appear to be superior to IV PCA, except during the immediate postoperative period in the present study, which is not consistent with the results of previous studies.[14,15] This might have been because PCEA was usually administered to patients who were expected to experience severe postoperative pain. Paradoxically, the incidence of rescue analgesia was higher among the elderly patients than the younger

Table 5 Multivariate analysis of factors associated with rescue analgesic requirements

Predictors	Young patients (n=1,344)		Elderly patients (n=1,091)	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Female sex	1.16 (0.78–1.73)	0.457	1.02 (1.71–1.47)	0.907
BMI	0.98 (0.95–1.02)	0.286	1 (0.95–1.05)	0.941
ASA physical status				
1	1 (reference)		1 (reference)	
2	1.04 (0.81–1.35)	0.738	0.76 (0.5–1.16)	0.202
3	0.56 (0.23–1.33)	0.185	0.61 (0.38–0.99)*	0.047
4	NA	1	0.26 (0.07–0.95)*	0.042
Fentanyl (μg/h)	0.97 (0.95–1)*	0.046	0.98 (0.95–1.01)	0.139
Ropivacaine (mg/h)	0.99 (0.92–1.08)	0.886	1.03 (0.97–1.09)	0.38
History of DM	0.65 (0.23–1.86)	0.426	1.05 (0.72–1.53)	0.809
History of hypertension	1.06 (0.42–2.7)	0.898	1.14 (0.83–1.55)	0.424
Smoking history	2.63 (1.37–5.04)*	0.004	1.01 (0.68–1.48)	0.977
Type of anesthesia				
General	1 (reference)		1 (reference)	
Regional	0.99 (0.73–1.33)	0.927	0.49 (0.05–4.48)	0.53
Type of surgery				
Abdominal	1 (reference)		1 (reference)	
Thoracic	0.64 (0.25–1.66)	0.36	0.58 (0.36–0.93)*	0.025
Lower extremity	1.11 (0.72–1.71)	0.648	4.9 (0.53–45.07)	0.161
Spinal	NA	1	–	–
Urogenital	0.53 (0.16–1.74)	0.297	0.54 (0.32–0.91)	0.019

Notes: *P<0.05; '–' indicates no patient.
Abbreviations: OR, odds ratio; CI, confidence interval; BMI, body mass index; ASA, American Society of Anesthesiologists; NA, not available; DM, diabetes mellitus.

ones, despite the lower NRS scores of the former. One of the possible reasons could be that a greater proportion of elderly patients required rescue analgesia in the immediate postoperative period (54.8% vs 36.3%) in comparison with the younger patients, whose requirement for rescue analgesia was lower, because of the residual analgesic effect of spinal anesthesia during the period in question. However, the difference between the two groups did not appear to be clinically relevant.

Among younger patients, low fentanyl dosage and history of smoking were related to the use of rescue analgesia. There are several reports of increased postoperative pain and analgesic requirements among smokers. Though the precise mechanism is not yet clear, changes in neuromodulation due to chronic exposure to nicotine and depression or stress because of smoking cessation appear to be related to the increased need for rescue analgesia among smokers.[16–18] Among elderly patients, ASA class III/IV and thoracic/urogenital surgery were associated with lower need of rescue analgesia, which is in accordance with the results of previous studies demonstrating that patients with better physical status require higher opioid dosages compared with those with poor physical status.[12,19] Possible reasons for this tendency include increased sensitivity to local anesthetics, preexisting neuropathy in patients with metabolic diseases, such as diabetes mellitus,[20] and decreased help-seeking behavior among patients with chronic illnesses.[9] With regard to epidural opioids, lipophilic opioids, such as fentanyl, are considered appropriate analgesic agents, with rapid onset and fewer side effects than hydrophilic opioids; however, in comparison with the latter, epidural fentanyl covers only a relatively small area of the surgical dermatome.[21] For this reason, thoracic or urogenital surgery, where the skin is incised parallel to the dermatome or the area of dermatome is relatively small, could be associated with a lower requirement of rescue analgesia compared with abdominal surgery.

Numbness and motor weakness are among the more common complications of PCEA, and higher concentrations of local anesthetics have been reported to increase the incidence of numbness and motor block.[22,23] The concentration of ropivacaine used in the present study (0.1%–0.25%) is considered to be within the clinically acceptable range.[24,25] Interestingly, the incidence of numbness and motor weakness among younger patients was substantially higher compared to the elderly. In addition, numbness or motor weakness was the most common cause for discontinuation of PCA among younger patients (67.8%). These results suggest that younger patients might be more susceptible to changes in sensation

and have lower tolerance for unpleasant feelings compared with elderly patients. In contrast, the proportion of elderly patients who discontinued PCA because of numbness or motor weakness was relatively low (11.5%), which could possibly be because of the altered characteristics of sensory perception among the elderly, though the mechanism is not clear,[26] or their tendency of not regarding a complication as problematic unless it is too serious. These factors might have caused a high proportion of cases of numbness/weakness to go unreported among the elderly patients.[9,27] Further research might help explain these findings more clearly.

Elderly patients exhibited higher incidence of sedation and hypotension compared with younger patients in the present study. Though the anesthesiologists reduced the dosage of fentanyl administered to the elderly patients, a greater proportion of elderly patients (1.4% vs 0.2%) were sedated in comparison with younger group. This might be explained by the increased sensitivity to and decreased metabolism of fentanyl among elderly patients.[28,29] Several reports have described the hypotensive effects of EA.[6,30,31] In addition, epidural administration of ropivacaine in combination with fentanyl has been reported to be associated with an increased incidence of hypotension.[25,32] Decline in autonomic control and easier cephalic spread of epidural analgesics might explain the relatively high incidence of hypotension among the elderly patients,[10,33] although the results may be debatable.[34]

According to previous studies, incidence of nausea and vomiting in patients receiving PCEA is not directly related to age.[35,36] In contrast, in the present study, the incidence of nausea and vomiting and requirement for rescue antiemetics among the elderly patients were higher compared to the younger patients. The higher incidence of hypotension among the elderly patients relative to the younger patients might have partly contributed to the higher incidence of nausea and vomiting among the former. In addition, nausea and vomiting were the most common causes of discontinuation of PCA among the elderly patients. With regard to the present results, improper management of nausea and vomiting in elderly patients might lead to failure of PCEA as a postoperative pain-management modality. The relationship between incidence of nausea and vomiting during PCEA and patient age requires further investigation.

This study had several limitations. Because of the retrospective study design, we could not precisely control the method or drug used for anesthesia or the specifics of epidural anesthesia, which might have influenced the present findings regarding adverse effects. However, given the large sample

size, we believe that the present results are still reliable. In addition, such differences in preoperative characteristics, including types of anesthesia or surgery, may themselves be regarded as characteristics of elderly and young patients undergoing surgery. Another limitation is that most of the included patients were either South Korean or of Asian descent. Therefore, the present results might not be generalizable to other races or ethnicities.

According to the results of the present study, younger patients were more susceptible to numbness and motor weakness compared with the elderly, and these side effects were closely associated with discontinuation of PCA. Therefore, in young patients receiving fentanyl and ropivacaine-based PCEA, ensuring adequate dosage of fentanyl and avoiding excessive administration of ropivacaine appears to be a good strategy to increase the effectiveness of PCEA and decrease its associated adverse effects. On the other hand, in elderly patients receiving PCEA, reducing the dosage of the opioid rather than that of the local anesthetic and administration of preventive antiemetics are necessary in order to avoid sedation and nausea/vomiting. However, caution should be taken to avoid insufficient pain control.

Conclusion

In conclusion, there are differences in PCEA-related adverse effects and the associated risk factors between young and elderly patients. Therefore, in order to minimize the adverse effects of PCEA and enhance pain relief, different PCEA regimens and administration/prevention strategies should be considered for young and elderly patients.

Author contributions

All authors contributed toward data analysis, drafting and revising the paper and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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