Original Article

Enhanced Recovery after lumbar laminectomy using combined epidural and general anesthesia with tolerable endotracheal tube: Randomized controlled study

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ABSTRACT

Background: Enhanced recovery after surgery (ERAS) protocols are multimodal perioperative management pathways that can facilitate early recovery. This prospective randomized controlled study was to investigate if combining single shot epidural blockade and general anesthesia (CEGA) using a tolerable endotracheal tube (TET), can enhance recovery after lumbar laminectomy. 40 patients were included in the study and allocated into one of two groups (20 patients each); group I (general anesthesia (GA) group) and group II (CEGA using TET group) in which patients received an epidural single shot bupivacaine 15 ml of 0.25 % followed by a standard general anesthetic technique using TET through its side small channel, a dose of 2 mg/kg, lidocaine 2 % was instilled immediately after intubation and repeated 10 minutes before anesthetic discontinuation. The primary objectives were post-anesthesia care unit (PACU) stay, time to tracheal extubation, and hospital stay.

Results: PACU stay was significantly shorter in in CEGA with the TET group (median 10 IQR 8.25 - 14.25 mins) compared to GA group (median 24.5 IQR 18.5 - 31.5) ($p < 0.001$) and time to extubation was also significantly shorter in CEGA with the TET group (median 12 IQR 10- 14.75) compared to GA group (median 15.5 IQR 15 - 18) ($p < 0.001$) with no difference regarding hospital stay ($p = 0.341$).

Conclusion: CEGA, including a single shot epidural bupivacaine 0.25 % and laryngeal lidocaine instillation through TET can reduce time to tracheal extubation and PACU stay and the incidence of peri-extubation cough with no effect on the time to home readiness after lumbar laminectomy.

Key Words: Analgesia, Enhanced Recovery, Epidural, Laminectomy.

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BACKGROUND

Enhanced recovery after surgery (ERAS) protocols are multimodal perioperative management pathways that can help early recovery (Calimli *et al.*, 2012, Khajavi *et al.*, 2013, Bugada *et al.*, 2016). Using general anesthesia (GA) alone for spine surgeries can be accompanied by poorly controlled perioperative pain and prolonged recovery (Khajavi *et al.*, 2013). Epidural analgesia can be a part of ERAS protocol as it can improve postoperative analgesia and facilitate early mobilisation (Calimli *et al.*, 2012, Kaye *et al.*, 2019). Combining epidural analgesia and GA can take the benefits of both techniques and address their disadvantages (Calimli *et al.*, 2012). Enhancing patient's tolerability of the endotracheal tube (ETT) can provide smooth emergence from GA, facilitate earlier discontinuation of general anesthetics and hence a faster recovery (Gonzalez *et al.*, 1994, Diachun *et al.*, 2001). The current study was conducted to investigate if combining single-shot epidural blockade and general anesthesia (CEGA) using a tolerable endotracheal tube (TET) can enhance recovery after lumbar laminectomy compared to the classic general anesthetic technique.

METHODS

This prospective controlled study was conducted during the period from January 2017 to April 2018. The study was conducted after obtaining informed patients' consents, institutional review board (IRB) approval (IRB #3225-18-12-2016).

Patients of both sexes were included in the study if they were aged 18- 50 y, ASA grade I-II, had a body mass index (BMI) < 30 kg/m2 and assigned to a single or double level lumbar laminectomy or discectomy.

Exclusion criteria included patient's refusal, local infection at the site of epidural catheter insertion, recurrent disc surgery, emergency surgery, coagulopathies, history of stroke or psychiatric disease, baseline neurological deficit, active upper respiratory tract infections, history

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of either laryngeal / tracheal surgery or pathology, uncontrolled hypertension or diabetes mellitus (DM), cardiac, pulmonary, hepatic or renal dysfunction, any contraindication for study technique or medications as well as being on regular steroids, opioid analgesics or alpha 2 agonists.

Withdrawal criteria were failed epidural block or TET insertion, bloody epidural tape, difficult airway (Elganzouri score ≥ 4 (El-Ganzouri *et al.*, 1996)), operative time > 120 min or the need for postoperative mechanical ventilation.

All patients were preoperatively evaluated according to local protocol and preloaded with lactated Ringer's solution (15 ml/kg) immediately before admission to the operating room (OR). On admission to the operating room, standard monitoring was applied. ECG, arterial oxygen saturation (SaO2) and end-tidal CO2 (ETCO2) were continuously monitored. Non-invasive blood pressure (NIBP) was measured every 5 mins starting from patient admission to OR till 15 mins after endotracheal intubation, then every 15 mins after that PACU discharge. If hemodynamic instability was diagnosed at any time, NIBP was measured every 5 mins until hemodynamic instability subsided.

All Patients were premedicated with midazolam 0.05 mg/kg and atropine 20 µg/kg. Eligible patients were randomized according to randomization list generated software and allocated into one of two groups (20 patients each); group I (GA group, control group) in which patients underwent a standard general anesthetic technique and group II (CEGA using TET group) in which patients received a single shot of epidural bupivacaine followed by a standard general anesthetic technique using TET.

Patients of group I were induced by propofol (1 - 2 mg/kg) and fentanyl (2 µg/kg). Muscle relaxation was achieved by atracurium (0.5 mg/kg) followed by endotracheal intubation. After correct positioning of the ETT, mechanical ventilation was started (tidal volume (VT) (6 - 8 ml/kg) and appropriate respiratory rate (RR) to achieve ETCO2 between 30 - 35 mmHg). Anesthesia was maintained by isoflurane in 100 % oxygen based on minimum alveolar concentration (MAC) of 1.25 % and muscle relaxation was maintained by atracurium (0.1 mg/kg every 20 min).

Patients of group II were kept in a sitting position then, an 18-gauge Tuohy needle was inserted into the epidural space of the same level or one level below that of surgical intervention and an epidural catheter was introduced within two segments in the epidural space. After exclusion of either intravascular or intrathecal catheter migration, 15 ml of 0.25 % bupivacaine was injected through it. After confirming the success of epidural blockade by assessing the level of sensory blockage using the pin prick discrimination technique, the catheter was removed, and general anesthesia was induced and maintained by the same technique described in Group I, but the trachea was intubated by a manually designed and approved TET (Academy of Scientific Research and Technology (ASRT), Egypt Patency No. 26322, 31 July 2013). The TET contains an additional small-bore channel incorporated within the concave surface of the tube. Ten small holes at the distal 13 cm of the additional tube were made to allow the injected medication to be sprayed both above and below the TET cuff onto the pharyngeal, laryngeal, and upper tracheal mucosa circumferentially (Gonzalez *et al.*, 1994, Diachun *et al.*, 2001) (suppl.1). Through the side small channel, a dose of 2 mg/kg, lidocaine 2 % was instilled immediately after intubation while the patient was in a supine position. The same dose of lidocaine was repeated 10 minutes before anesthetic discontinuation and after oropharyngeal suctioning.

In both groups, an adequate general anesthetic state was considered when heart rate (HR) and mean arterial blood pressure (MAP) remained stable in supine position for 10 min or more after confirmation of endotracheal intubation. Patients were turned into prone position with adequate eye seal and protection of all pressure points.

If the MAP was elevated by ≥ 30 % from baseline value with or without tachycardia (HR increase by ≥ 30 % from baseline value), isoflurane was increased by 0.5 % increments up to 2.5 % and another IV bolus dose of fentanyl (1 µg/kg) was administered. IV crystalloids were infused and manipulated as guided by the attending anesthetist. Packed RBCs were transfused if blood loss exceeded 20 % of total blood volume. Intraoperative hypotension, defined as systolic arterial blood pressure (SAP) < 90 mmHg, was corrected by decreasing the anesthetic depth by 0.5 %, IV fluids plus ephedrine 5mg IV increments as appropriate. Intraoperative bradycardia, defined as HR < 60/min, was managed by confirming adequate oxygenation, atropine 1mg IV increments up to 3 mg and/or ephedrine 5mg IV increments when associated with hypotension.

At the end of the surgical procedure, isoflurane was discontinued. After surgical incision dressing the surgical incision, the patient was repositioned in supine position and muscle relaxation was reversed using IV neostigmine (0.05 to 0.06 mg/kg) and atropine (0.01- 0.02 mg/kg). Trachea was extubated when extubation criteria had been met regular spontaneous respiration (spontaneous RR >10 and < 30, spontaneous VT > 6 mL/kg and SaO2 > 92 % on room air, being able to follow commands (e.g., Open your eyes) or attempting self-extubation and full reversal of neuromuscular blockade (train of four (TOF) 4/4 with no fade) with minimal cough (Gray *et al.*, 2013).

Postoperatively, the visual analogue scale for pain (VAS for pain) was assessed where 0 (no pain) and 10 (the extremely intolerable pain). Rescue analgesia in

the form of IV nalbuphine increments of 5 mg and up to 20 mg/dose were administered for moderate to severe pain (VAS for pain ≥ 0.4). Ondansetron 4mg was intravenously administered over 5 mins for postoperative nausea and vomiting (PONV).

If the patient had achieved phase I recovery criteria in the form of modified Aldrete score ≥ 9 (McGrath and Chung, 2003) (suppl. 2) at OR, he/she was able to safely bypass the PACU stay and transferred directly to the ward but if a PACU stay had still been needed to achieve phase I recovery criteria, standard monitoring was continued during the PACU stay. Basic monitoring of HR, ABP and the degree of postoperative pain was maintained during the ward stay until achievement of phase II recovery criteria in the form of the post anesthesia discharge scoring system (PADSS) for determining home readiness ≥ 9 (McGrath and Chung, 2003) (suppl. 3). In the ward, postoperative complications were managed by the neurosurgeon on duty.

Collected data included patient characteristics (age (y), gender, BMI (kg/m^2)), intraoperative maximum percentage of the required isoflurane inhalation, total IV fentanyl consumption (µg), anesthetic time (starting from anesthetic induction (group I) or epidural bupivacaine injection (group II) to tracheal extubation), surgical time (from start of skin incision till complete skin closure), the incidence of intraoperative bradycardia and/or hypotension (%), time to extubation (min) ((from neuromuscular reversal to extubation), Incidence of successful PACU bypass (%), Time to the achievement of phase I recovery criteria (min) (starting from extubation to the achievement of modified Aldrete score ≥ 9), Time to achievement of phase II recovery criteria (h.) (starting from extubation to the achievement of PADSS ≥ 9), time to 1st postoperative rescue analgesia (min.) (starting from time of extubation to 1st nalbuphine administration), total postoperative rescue analgesic requirement (nalbuphine (mg)) for the first 24 hours and incidences of postoperative complications (%) including agitation (Ramsay sedation score (RSS)=1 (Sessler *et al.*, 2008) (suppl. 4)) on emergence from GA as well as persistent coughing ((defined as any evidence of irritation from having a tube in the trachea occurring after neuromuscular reversal), hypoxemia (SaO2 < 92 % on room air), excessive sedation (RSS ≥ 5), respiratory depression (defined as respiratory rate < 8 breaths per min with or without hypoxemia), hypotension (defined as SAP < 90 mmHg) or bradycardia (HR < 60 mmHg) until PACU discharge. The total period of intraoperative hypotension or bradycardia was calculated as the sum of the durations of each intraoperative hypotensive or bradycardic episode. Data also included the incidences of PONV, the need for urinary catheterization, hospital readmission or newly developed neurological deficits during the postoperative period, as well as the patient satisfaction score on discharge from the hospital (was assessed by a grading scale from 0 (completely unsatisfied) to 10 (fully satisfied)). Patient dissatisfaction was considered when the satisfaction score < 5.

Sample size was calculated to be 32 using Epi Info 6, based on an expected time to PACU discharge of 13.1 ± 3.7 min and 7.9 ± 3.2 min in group GA and in group CEGA respectively (Calimli *et al.*, 2012) when the confidence interval (CI) was 95 % and the power of test was 80 %. Eight patients were added to compensate for dropouts, so the total number of patients was 40 patients.

Statistical analysis was performed in Statistical Package for the Social Sciences (SPSS) version 24. Continuous parametric data were presented as mean and standard deviation (SD) and compared using an independent t- test. Nonparametric data were presented as median, and interquartile range and compared using Mann Whitney test. Qualitative data were presented as numbers (ratios) and compared using Chi-square test (X2) or Fisher exact test, as appropriate. *P* value < 0.05 was considered significant.

RESULTS

Of the 49 patients who were eligible for the study, five were excluded due to either patient refusal, uncontrolled hypertension, or active respiratory tract infection, 43 patients were enrolled and randomized, 22 patients were allocated to group I (GA group) and 21 patients were allocated to group II (CEGA with TET group). Three patients were withdrawn from the study: two patients in group I due to cancellation of surgery and one patient in group II due to failed epidural insertion. Forty patients completed the study and were considered for statistical analysis Figure 1.

There was no significant difference between both groups regarding patients' characteristics and operative times ($p > 0.05$) Table 1.

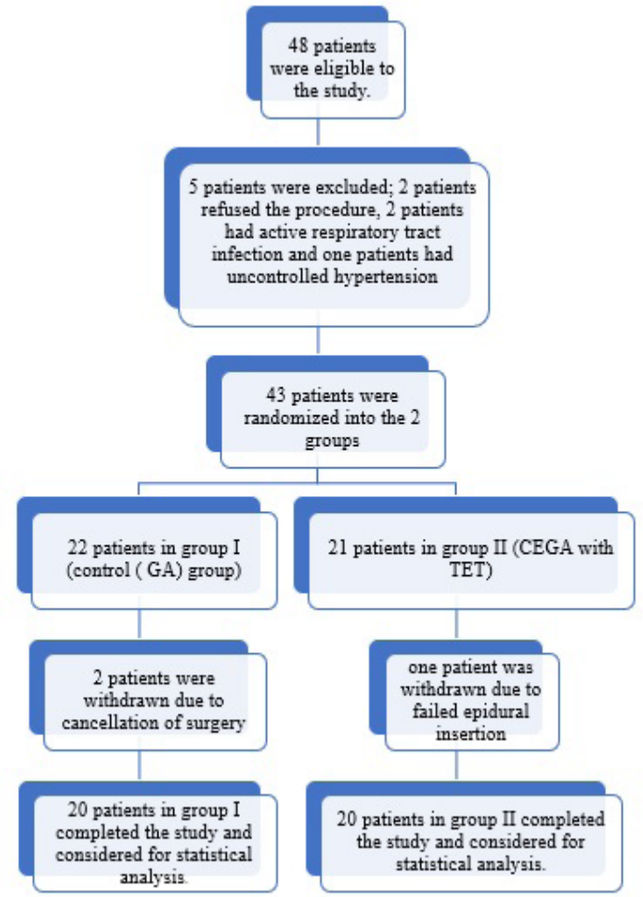

Figure 1: Study flowchart:
GA: general anesthesia, CEGA: combined epidural/general anesthesia, TET: tolerable endotracheal tube.

Table 1: Patients' characteristics and operative times among the studied groups:

	Group I (N=20)	Group II (N=20)	*P*
Age (y.) ‡	38.05 ± 9.48	36.25 ± 6.7	0.494
BMI (kg/m^2) ‡	25.4 ± 2.62	24.8 ± 2.4	0.452
Gender: Male / Female ratio†	9/11	12/8	0.342
ASA I/II†	15/5	14/6	0.723
Surgical time (min.) ‡	118.7 ± 27.1	114.8 ± 23.1	0.628
anesthetic time (min.) ‡	135.1 ± 29.9	135.5 ± 24.1	0.968

No significant differences between both groups.
‡Data were presented as mean ± SD, compared by Independent-t-test.
†Data were presented as ratio, compared by chi-square test.
SD: standard deviation, BMI: body mass index, ASA: American society of anesthesiologists' classification.

There was a significant reduction in maximum intraoperative Isoflurane ($p < 0.001$), and fentanyl consumption ($p < 0.001$), as well as postoperative nalbuphine requirements ($p < 0.001$), among patients of group II compared to those of group I. The time to the 1st postoperative rescue nalbuphine was significantly longer in patients of group II compared to those of group I (*P* 0.011) Table 2.

There was no significant difference between both groups regarding intraoperative complications, except for significantly longer periods of hypotension ($p = 0.009$) and a smaller volume of blood loss ($p < 0.001$) in patients of group II compared to patients of group I Table 3.

Table 2: Intra and postoperative operative anesthetic and analgesic requirements:

Parameter	Group I (N=20)	Group II (N=20)	*P*
Maximum inhalational isoflurane (%)‡	1.8 (1.5 - 2.2)	1.2* (0.9- 1.4)	< 0.001
Total rescue fentanyl(µg) ‡	100 (62.5 - 200)	0 * (0.0 - 0.0)	< 0.001
Time to 1st rescue analgesia (min) †	19.6 ± 5.96	109.5 ± 37.6#	< 0.001
Total postoperative nalbuphine requirements (mg) †	21.0 ± 10.5	14.0 ± 4.16*	0.011

‡ Data were presented as median, and IQR, compared by Mann Whitney test. †Data were presented as mean ± SD, compared by Independent-t- test.
* significantly lower compared to GA group ($p < 0.05$).
# Significantly longer compared to GA group ($p < 0.05$).
IQR: interquartile range, SD: standard deviation.

No patient in either group bypassed PACU stay; however, PACU stay was significantly shorter in in CEGA with the TET group (median 10 IQR 8.25 - 14.25 mins) compared to the GA group (median 24.5 IQR 18.5 - 31.5) ($p < 0.001$) and time to extubation was also significantly shorter in CEGA with the TET group (median 12 IQR 10- 14.75) compared to GA group (median 15.5 IQR 15 - 18) ($p < 0.001$). no difference regarding hospital stay between both groups (median 35 IQR 26.8 - 40 h. in group GA versus median 31 IQR 26.25- 37.5 h. in group CEGA with TET) ($p = 0.341$). Figure 2.

Table 3: Intraoperative hemodynamic instability and blood loss:

Parameter	Group I (N=20)	Group II (N=20)	*P*
Incidence of intraoperative bradycardia#	3 (15 %)	3 (15 %)	1
Total duration of intraoperative bradycardia (min.)	5 (3 – 5)	18 (16- 18)	0.050
Incidence of intraoperative hypotension#	10 (50 %)	15 (75 %)	0.234
Total duration of intraoperative hypotension† (min.)	7 (3.7 - 12.7)	15* (11.5 - 30.5)	0.009
Incidence of intraoperative bradycardia and hypotension#	1 (5 %)	3 (15 %)	0.605
Bleed loss‡ (ml)	464.5 ± 172.5*	279 ± 112	$P < 0.001$

#Data were presented as number and percentage, compared by fisher's exact or chi-square test as appropriate, †Data were presented as median and IQR, compared by Mann Whitney, ‡ Data were presented as mean ±SD, compared by Independent-t- test.
* Significantly higher compared to other group ($p < 0.05$).
IQR: interquartile range, SD: standard deviation.

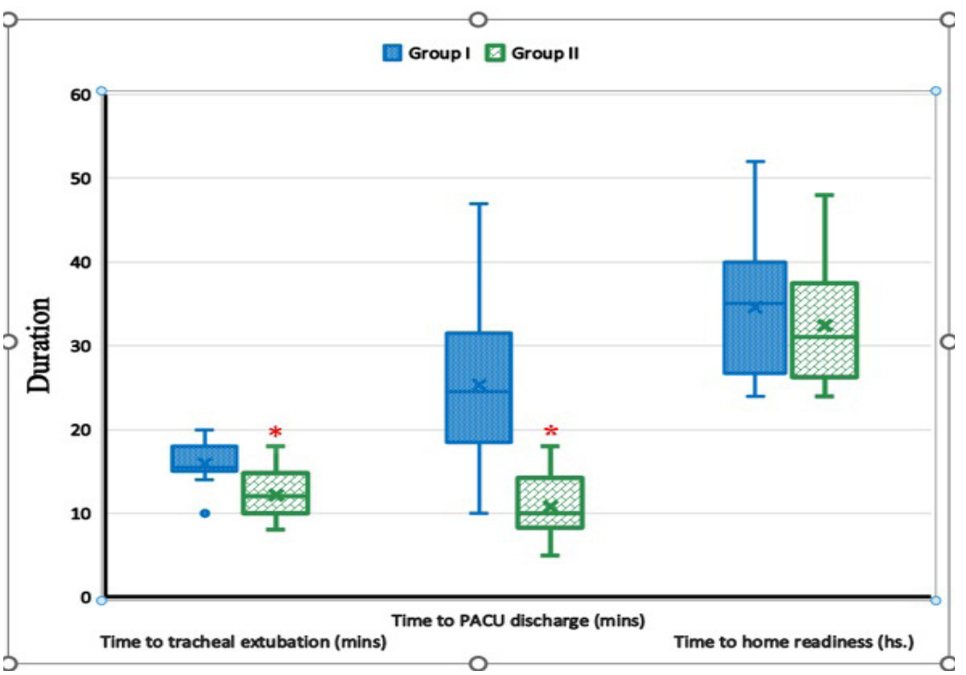

Figure 2: Recovery profile of the studied groups
Data were presented as median, IQR and range, compared using Mann Whitney test.
Group I: general anesthesia group. Group II: Epidural/general anesthesia with tolerable endotracheal tube group. *Significantly shorter compared to the other group of patients.

Patients of group II were significantly more satisfied than those of group I (median 6.5 range 3 - 9 interquartile range (IQR) 6 - 8 vs. median 4.5 range 2 -7 IQR 3 - 5) ($P = 0.017$).

No patient in either group suffered postoperative respiratory depression, hypoxemia, hypotension, newly developed neurological function, or hospital readmission. Only one patient in CEGA with TET group suffered postoperative bradycardia 10 min after extubation without hemodynamic instability and recovered spontaneously. The incidences of both postoperative persistent coughing and patient dissatisfaction were significantly lower in patients of group II than those of the control group ($P < 0.05$). No significant difference was found between both groups as regards the incidences of agitation on emergence from anesthesia, excessive sedation after extubation, PONV and urine retention necessitating catheterization ($P > 0.05$) Table 4.

Table 4: Incidences of postoperative complications (%) among studied groups:

Parameter	Group I (N=20)	Group II (N=20)	*P*
Agitation	3 (15 %)	2 (10 %)	1.000
Persistent coughing	17 (85 %)	4 (20 %)*	$P < 0.001$
Excessive sedation	3 (15 %)	0 (0 %)	0.231
PONV	8 (40 %)	12 (60 %)	0.206
Urine retention necessitating catheterization	1 (5 %)	2 (10 %)	1.000
Patient dissatisfaction	16 (80 %)	8 (40 %)*	0.01

Data were presented as number and percentage, compared by fisher's exact or chi-square test as appropriate.*Significantly lower compared to GA group ($p < 0.05$). PONV: postoperative nausea and vomiting.

DISCUSSION

The current study shows that CEGA, including a single shot of epidural bupivacaine and the TET, can reduce the time to tracheal extubation and PACU stay with no effect on the time to home readiness compared to using conventional GA alone. No patient could bypass PACU, but this combined regimen reduced the incidences of persistent coughing; during the peri-extubation period and patient dissatisfaction, as well as intraoperative blood loss and perioperative analgesic consumption. No increased incidence of intra- and postoperative complications was associated with using CEGA with TET compared to GA alone, but periods of intraoperative hypotension were longer in the former group.

ERAS can increase surgical workflow rates and facilitate performing more surgical procedures, including lumbar laminectomy, on an ambulatory basis.

To enhance patient recovery, all available elements of ERAS protocols must be used (Ljungqvist *et al*, 2017). Multimodal analgesia, including epidural, local anesthetic techniques, can improve perioperative analgesia, reduce opioid requirements, and fasten postoperative recovery (Calimli *et al.,* 2012, Bugada *et al*., 2016, Licina *et al*., 2021, Bansal *et al.*, 2022). Coughing during emergence from GA represents a common complication of ETT that intensifies the stress response and may lead to myocardial ischemia, bronchospasm and or delayed recovery from anesthesia (Gonzalez *et al.*, 1994). Lidocaine topicalization through a modified laryngotracheal instillation of topical anesthesia (LITATM)tube (Sheridan Catheter Corp., Argyle, NY)) which is similar to the current TET (Mallick *et al.*, 1996). Reduced the stress response and increased the tolerability of awake patients to ETT, allowing a chance of earlier discontinuation of anesthesia and hence earlier patient recovery (Diachun *et al.*, 2001). A few studies investigated the effect of improving ETT tolerability on the recovery time from GA.

To our knowledge, this is the 1st trial that investigated the effect of combining single shot epidural blockade and GA using TET, as components of ERAS protocol for patients undergoing lumbar laminectomy, on the postoperative recovery profile.

CEGA protocols, including either single shot of bupivacaine/ fentanyl or continuous epidural infusion of ropivacaine/ fentanyl also provided better analgesia, earlier mobility, and more patient satisfaction after spine surgeries (Ezhevskaya *et al.*, 2013, Khajavi *et al.*, 2013). Similar results for CEGA approaches were recorded after various abdominal procedures (Akarsu Ayazoğlu *et al.*, 2015). The reduction of intraoperative analgesic and anesthetic requirements in CEGA with TET group of patients in the current study can be attributed to the combination of epidural/GA approach (Calimli *et al.*, 2012) in part and in improving endotracheal tube (ETT) tolerability in the other part, and this is similar to Mallick and associates' findings (1996), who demonstrated a reduction in sedative/ analgesic requirements for mechanically ventilated patients and hence faster weaning from mechanical ventilation when conventional ETT is replaced with LITATM tube. Reduced postoperative analgesic consumption in patients with CEGA using TET group may be due to preemptive analgesic effects or residual sensory blockade (Lee *et al*., 2021).

Longer periods of intraoperative hypotension were currently associated with a significant reduction of intraoperative blood loss in CEGA with the TET group of patients. Similar findings were demonstrated

during radical mastectomy, major abdominal and spinal surgeries with CEGA approach (Akarsu Ayazoğlu *et al.*, 2015, Ezhevskaya *et al.*, 2013, Khajavi *et al.*, 2013, Tikuisis *et al.*, 2009).

Suppression of persistent cough in CEGA with TET group was demonstrated in 17/20 patients. Diachun and associates (2001) showed cough suppression and smooth emergence from anesthesia in 75 % of cases treated with lidocaine 4 % (2 mg/ kg) through the LITATM tube, 30 min before extubation. Gonzalez and associates (1994) showed cough suppression in 36 % of cases given the same current dose and concentration of lidocaine through the LITA™ tube, but contrary to current results, they found no difference in time to extubation compared with the classic intubation group. The difference may be due to the combination of epidural and GA in the current study, while in Gonzalez's study, patients who had undergone CEGA, were excluded. In agreement with current findings, CEGA was associated with a shorter time to extubation and PACU stay compared to GA alone after radical prostatectomy, total hysterectomy, and various abdominal procedures (Akarsu Ayazoğlu *et al.,* 2015, Calimli *et al.*, 2012, Tikuisis *et al.,* 2009). Epidural analgesia, after colorectal surgery, could not shorten hospital stay or reduce incidences of PONV or urine retention compared to using patient-controlled analgesia (PCA) with morphine (Cox *et al.*, 2023). The current protocol also did not reduce the hospital stay or the incidence of PONV and urine retention compared to the conventional approach.

This study had three limitations: first, a small sample size; second a non-blinded study design. Complete blindness of all patients and study members, to interventions, was difficult to apply. Patients, healthcare providers and data analyzers were blinded when possible; third, the reduction in intraoperative blood loss can shorten the operative time and this was not clear in the current study, this was not an objective for the study and may appear with a larger sample size; fourth, the risk of tracheal aspiration with the use of topicalization through TET was not investigated due to the rarity of this complication, especially in such empty stomach patients.

CONCLUSION

CEGA, including a single shot of epidural bupivacaine 0.25 % and TET, can reduce the time to tracheal extubation and PACU stay with no effect on the time to home readiness. This combined regimen can also reduce the incidence of persistent coughing on emergence from GA, improve perioperative analgesia and increase patient satisfaction after lumbar laminectomy.

LIST OF ABBREVIATIONS

- ABP: arterial blood pressure.
- ASA: American society of anesthesiologists.
- BMI: body mass index.
- CEGA: combined single shot epidural blockade and general anesthesia.
- CI : confidence interval.
- DM : diabetes mellitus.
- ERAS: Enhanced recovery after surgery.
- ETT: endotracheal tube.
- GA: general anesthesia.
- HR: heart rate.
- IQR: interquartile range.
- IRB: institutional review board.
- IV: intravenous.
- LITA: laryngotracheal instillation of topical anesthesia.
- MAC: minimum alveolar concentration.
- MAP: mean arterial pressure.
- PACU: post-anesthesia care unit.
- PADSS: post anesthesia discharge scoring system.
- PCA: patient-controlled analgesia.
- PONV: postoperative nausea and vomiting.
- R: range.
- RR: respiratory rate.
- RSS: Ramsay sedation score.
- SaO2: arterial oxygen saturation.
- SAP: systolic arterial pressure.
- SD : standard deviation.
- TET : tolerable endotracheal tube.
- VT: tidal volume.

CONFLICT OF INTEREST

There are no conflicts of interests.

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