Journal of Anesthesia & Clinical Research
ISSN: 2155-6148

EL-Shmaa and El-Baradey, J Anesth Clin Res 2014, 5:12
DOI: 10.4172/2155-6148.1000480

Research Article Open Access

# The Efficacy of Etomidate-Fentanyl versus Dexmedetomidine-Ketamine for Procedural Sedation and Analgesia during Upper Endoscopy and Biopsy: A Prospective, Randomized Study

**Nagat S EL-Shmaa* and Ghada F El-Baradey**

*Department of Anesthesia and Surgical ICU, Faculty of Medicine, Tanta University, Egypt*

## Abstract

**Objective:** To assess the effectiveness of a combination of etomidate-fentanyl versus dexmedetomidine-ketamine for Procedural Sedation and Analgesia (PSA) in patients undergoing upper endoscopy and biopsy.

**Patients and methods:** This is a prospective randomized observer-blinded study. This study was carried out in Tanta university hospital on 100 patients of both sexes; ASA physical status I and II, age range from 20-60 years undergone upper endoscopy and biopsy. All patients were randomly divided into two groups (each group 50 patients) Group E (etofen): patients received an initial IV bolus dose of etomidate 0.15 mg/kg + fentanyl 1 mcg/kg IV, followed by etomidate infusion at 0.01-0.03 mg/kg/min. Group D (dexmedetomidine-ketamine): patients received an initial IV bolus dose of dexmedetomidine (1 µg/kg) +ketamine (1 mg/kg) followed by dexmedetomidine infusion (0.5-1 µg/kg/hr) with supplemental bolus doses of ketamine (0.5 mg/kg) as needed. Sedation started and adjusted according to bispectral index level (BIS) range 60-80. Patients were then observed by an anesthesiologist who was blinded about sedative/analgesic received. The primary outcomes were onset, level and time of sedation and the secondary outcomes were recovery time, Length of recovery room (RR) stay (min), duration of hospital stay, VAS score, hemodynamic changes (HR, MBP, $SPO_2$, RR), surgeon satisfaction, side effects, and patient satisfaction.

**Results:** There was significant rapid onset of sedation in group E as compared to group D, Sedation level by BIS, showed significant increase ($P<0.05$) in group E in comparison with group D. Recovery time, Length of recovery room (RR) stay (min) and Length of hospital stay (hr) showed significant decrease ($P<0.05$) in group E in comparison with group D.

**Conclusion:** The etomidate/fentanyl combination provides an effective and safe procedural sedation and analgesia for upper endoscope and biopsy. Etomidate/Fentanyl combination provides shorter sedation times and lighter sedation level (but enough for the procedure) when compared to the dexmedetomidine/ketamine combination.

**Keywords:** Procedural sedation and analgesia PSA; Ketamine; Etomidate; Fentanyl; Dexmedetomidine

## Introduction

Procedural sedation and analgesia defines as the technique of administering sedatives or dissociative agents with or without analgesics to induce an altered state of consciousness that allows the patient to tolerate painful or unpleasant procedures while preserving cardiorespiratory function [1].

There is no ideal drug for analgesia and sedation during Gastrointestinal (GIT) endoscopy. Providing adequate sedation/analgesia regimen through drug combination is an art. Targeting a moderate level of sedation that gives a better safety margin than deeper level [2,3].

Level of sedation/analgesia in endoscopy depends on the procedure; in rigid or flexible, diagnostic uncomplicated upper endoscopies moderate sedation is enough. While in prolonged or complex procedures (e.g. ERCP) deeper levels of sedation may be required [4].

Choice of sedation regimen depend on; characteristics of the procedure (length; complexity) and individual patient factors (age; existing medical conditions; prior experience with endoscopic procedures; patient anxiety; current use of opiates or other sedatives) [5].

A highly selective alpha 2-adrenoreceptor agonist dexmedetomidine has sedative, analgesic and antisialagogue effects with hemodynamic stability, minimal effects on respiration and cognitive functions [6].

Etomidate is imidazole derivative work at the g-aminobutyric acid receptor to produce hypnosis without analgesia. Etomidate offers a rapid onset, short recovery time, and minimal effect on the respiratory and cardiovascular systems. The recorded myoclonus with the initial use of etomidate, resolves without intervention [7,8].

Bispectral Index (BIS) monitoring is an advanced Electroencephalogram (EEG)-method of monitoring depth of anesthetic [9]. BIS is a number scaled from 100 to 0, with decreasing values indicating more sedation and hypnosis. BIS value of 100 indicates a normal cortical electrical activity (an awake EEG) and a value of zero indicates a cortical electrical silence (cortical suppression) [10]. BIS values of 95-100 reflecting awake state, 70-95 reflect light to moderate sedation, 60-70 reflecting deep sedation with low possibility of explicit recall. BIS values between 40 and 60 indicate a sufficient

***Corresponding author:** Nagat S EL-Shmaa, Department of Anesthesia and Surgical ICU, Faculty of Medicine, Tanta University, Egypt, Tel: 0201211865637; E-mail: nagat_elshmaa@yahoo.com

**Received** October 24, 2014; **Accepted** December 03, 2014; **Published** December 10, 2014

**Citation:** EL-Shmaa NS, El-Baradey GF (2014) The Efficacy of Etomidate-Fentanyl versus Dexmedetomidine-Ketamine for Procedural Sedation and Analgesia during Upper Endoscopy and Biopsy: A Prospective, Randomized Study. J Anesth Clin Res 5: 480. doi:10.4172/2155-6148.1000480

depth of anesthesia excluding intraoperative awareness and below 40 reflecting deep hypnotic state [11].

The objective of this study was to assess the effectiveness of a combination of etomidate-fentanyl versus dexmedetomidine-ketamine for procedural sedation in patients undergoing upper endoscopy and biopsy.

## Patients and Methods

This is a prospective randomized observer blinded study conducted at Tanta university hospital and carried out on 100 adult patients of both sex's undergone upper endoscopy and biopsy during the period from April 2011 to February 2013 after approval by the hospital Ethical Committee.

Inclusion criteria were American Society of Anesthesiologists (ASA) physical status I-II and age between 20 and 60 years.

Exclusion criteria were known drug allergy, ASA physical status of more than II, history of a major psychiatric disorder, history of substance abuse and current opioid use.

All included participants were asked to take part in the study by the study personnel soon after admission to the ward and a written informed consent was obtained from each patient. Patients were randomly allocated into two groups of 50 patients each according to sedative/analgesic drugs used.

All patients had intravenous access secured and kept in place for duration of sedation and recovery. Lactated Ringer's solution started at rate 10 ml/kg/h IV perioperatively. Patients were connected to nasal prong at 3L/min.

The patients were given a spray of lidocaine 10% to the posterior pharynx to diminish discomfort (gag reflex) during the endoscopy. All patients were fasting for a minimum of 8 h. In the endoscope room, after wiping the skin of the forehead with an alcohol swab and allowing it to dry, a BIS-XP Quatro sensor (Aspect Medical Systems, Newton, MA, USA) was applied to the forehead of the patient according to the manufacturer's guidelines. Four electrodes are integrated in one sensor to obtain the electroencephalographic signal from the forehead. The sensor was connected to a BIS-XP monitor (BIS XP, A-2000, Aspect Medical Systems, Newton, MA, USA). This was done to evaluate the degrees of sedation for each patient. The BIS sensor was placed simultaneously with other standard monitors before induction of sedation. A baseline BIS value, blood pressure (BP), heart rate (HR) and oxygen saturation were recorded every 5 min thereafter during the procedure by the anesthesiologist blinded about sedative/analgesic received. Patients were randomly assigned to receive either etomidate/fentanyl (E group; 50), or dexmedetomidine/ketamine (D group; 50), using the sealed envelope method.

Group E (etofen): patients received an initial IV bolus dose of etomidate [Etomidate ampoule (Hypnomidate) etomidate in propylene glycol and water is supplied in a clear glass ampoule containing 10 ml (2 mg/ml) (JANSSEN-CILAG, JANSSEN PHARMACEUTICA (PTY) LTD)] 0.15 mg/kg + fentanyl 1 mcg/kg IV, followed by etomidate infusion at 0.01-0.03 mg/Kg/min . Group D (dexmedetomidine-ketamine): patients received an initial IV bolus dose of dexmedetomidine (1 μg/kg) 2 mL clear glass ampoule/vial, 100 mcg/ml (Precedex; Hospira Worldwide, Lake Forest, IL) over 3 min +ketamine (1 mg/kg), followed by dexmedetomidine infusion (0.5-1 μg/kg/hr) with supplemental bolus doses of ketamine (0.5 mg/kg) as needed. Sedation started and adjusted according to bispectral index level (BIS) range 60-80. Onset of sedation measured from end of bolus injection till reach BIS level <80.

All endoscopies were performed in the left lateral position by the same doctor. The anesthesiologist continued monitoring after completion of endoscopy until recovery of full consciousness. Side effects occurring during the study and 2 h thereafter were recorded. Side effects included a decrease in mean blood pressure of more than 30 mmHg and an oxygen saturation of less than 92% at any time during the procedure, or airway obstruction with cessation of gas exchange at any time.

At the end of the procedure, the doctor was asked to rate the ease of the procedure on a three-point scale (easy, adequate, impossible) [12].

Also, modified Aldrete score was assessed at 5 min intervals. Patients were discharged from recovery room and shifted to the postoperative ward, when they achieve a modified Aldrete score ≥ 9 [13]. Length of stay in the recovery room was recorded. Patients' assessment was performed by an anesthesiologist who was blinded to the anesthetic technique used.

Pain was assessed using the Visual Analogue Scale (VAS) where zero (0) represented no pain and 10 meant the worst possible pain [14]. Postoperative rescue analgesic in form of paracetamol 30 mg/kg IV if VAS (4-6) or pethidine 30 mg IV if VAS >6.

Hemodynamic variables (heart rate, mean arterial pressure, oxygen saturation and RR). Any adverse effects such as nausea, vomiting, bad dream, hallucination, myoclonus, hypotension, hypertension, bradycardia or tachycardia…etc.

In addition, overall patient satisfaction with analgesia was assessed by a second anesthesiologist before hospital discharge by the use of a 4-point verbal scale ranging from very satisfied to very dissatisfied (1: very dissatisfied, 2: dissatisfied, 3: satisfied, 4: very satisfied) [15]. Also length of hospital stay was assessed (Figure 1).

### Statistical analysis

Sample size calculation was performed before patient recruitment [13]. Samples data have normal distribution. The Windows version of SPSS 11.0.1 (SPSS Inc., Chicago, IL) was used for statistical analysis. All results presented in form of mean ± standard deviation (SD). Data compared using unpaired students *t*- test, P value<0.05 was considered statistically significant.

## Results

There were no statistically significant differences (P>0.05) between both groups with respect to demographic data and duration of endoscopy (Table 1).

There was significant rapid onset of sedation in group E as compared to group D. Sedation level by BIS, showed significant increase (P<0.05) in group E in comparison with group D. Recovery time, Length of recovery room (RR) stay (min) and Length of hospital stay (hr.) showed significant decrease (P<0.05) in group E in comparison with group D (Table 2). There were no statistically significant changes in hemodynamic (P>0.05) (Table 3).

Adverse events in group D (28%) were significantly higher than in group E (22%) (p<0.05). Myoclonus was significantly higher in group E (16%) in comparison with group D (2%) (p<0.05). Only 4 patients in group D and 1 patient in group E required bag-mask ventilation and none of them were intubated. Higher incidence of postoperative

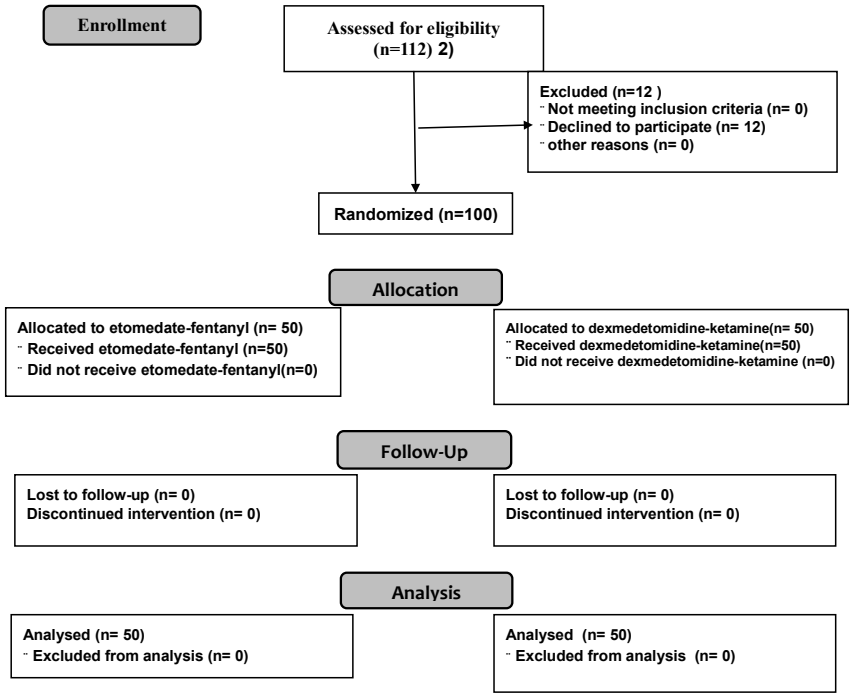


**Figure 1:** The randomized trial flow diagram, including enrollment, intervention allocation, and analysis.

| Parameter | 0 | 1 | 2 |
|---|---|---|---|
| Level of consciousness /analgesia | Unresponsive or responsive only to painful stimuli | Respond to verbal stimuli but fall asleep readily | Awake and oriented or equivalent to preoperative status |
| Circulation | SBP<100 mm Hg | SBP>100 mm Hg | SBP within normal limits for patient |
| Respiration | Apneic | Shallow, irregular breathing | Able to breathe deeply or equivalent to preoperative status. |
| $O_2$ saturation | $SpO_2$ ≤ 92% on oxygen. | $SpO_2$ ≥ 92% on oxygen. | $SpO_2$ ≥ 92% on room air or equivalent to preoperative status |
| Activity level | Unable to lift head or move extremities voluntarily or on command. | Lifts head or moves extremities on command | Lifts head and moves all extremities spontaneously. Is able to ambulate consistent with surgical procedure or equivalent to preoperative |

Recovery criteria: minimum score of 8 in criteria 1-5, with a minimum of 2 in respiratory and $O_2$ saturation.
SBP: Systolic Blood Pressure

**Table 1:** Modified aldrete scale [13].

| Mean ± SD / Parameter | Group E (N=50) | Group D (N=50) | P value |
|---|---|---|---|
| **Age (years)** | 40.8 ± 11.3 | 43.15 ± 11.3 | P= 0.52 |
| **Sex (male: female)** | 21:29 | 19:31 | ------ |
| **Duration of endoscopy (minutes)** | 56.2 ± 16.8 | 44.5 ± 8.6 | P= 0.15 |
| **Onset of sedation (minutes)** | 1.02 ± 0.5 | 5.3 ± 0.75* | P= 0.04 |
| **Sedation level (BIS level)** | 71.5 ± 4.4 | 65.4 ± 6.2* | P= 0.02 |
| **Recovery time (minutes)** | 4.8 ± 1.3 | 10.9 ± 3.2* | P= 0.03 |
| **Length of recovery room stay (min)** | 8.8 ± 3.4 | 15.5 ± 2.9* | P= 0.0002 |
| **Length of hospital stay (hr)** | 1.96 ± 0.3 | 2.48 ± 0.4* | P= 0.008 |

*Indicates statistical significance P<0.05 in comparison with group E

**Table 2:** Demographic data, duration of endoscopy, onset of sedation, sedation level, recovery time, length of recovery room stay and Length of hospital stay in both groups.

nausea and vomiting in group D18% while 4% in group E. In addition, no significant difference was observed between two groups with respect to average postoperative VAS pain scores (P=0.2) (Table 4).

Patient satisfaction score was significantly higher in group E as compared to group D (P=0.04), however surgeon satisfaction score was significantly higher in group D as compared to group E (P=0.03), (Table 4).

## Discussion

The ideal sedation/analgesia drug combination must be with shortest duration and lightest sedation level possible to finish the procedure successfully and painlessly, Also, should maintains hemodynamic stability with no unpleasant emergence reaction, and should have antidote [16].

| Parameter | Group | Presedation | 5 min after drug injection | 15 min after drug injection | 30 min after drug injection | Postsedation |
|---|---|---|---|---|---|---|
| **MAP (mmHg) Mean ± SD** | **Group E (N=50)** | 76.6 ± 11.2 | 75.4 ± 9.6 | 78.9 ± 8.9 | 77.3 ± 9.4 | 79.7 ± 10.2 |
| | **Group D (N=50)** | 87.9 ± 12.7 | 89.5 ± 11.8 | 84.6 ± 9.6 | 83.2 ± 13.5 | 76 ± 12.6 |
| | **P value** | 0.12 | 0.23 | 0.15 | 0.34 | 0.25 |
| **HR (beat/min) Mean ± SD** | **Group E (N=50)** | 84.3 ± 6.5 | 58.4 ± 4.6 | 64.8 ± 7.4 | 75.4 ± 8.1 | 76.6 ± 11.2 |
| | **Group D (N=50)** | 80.6 ± 8.2 | 76.3 ± 9.3 | 70.3 ± 6.5 | 68.3 ± 12.2 | 81.3 ± 10.4 |
| | **P value** | 0.36 | 0.11 | 0.13 | 0.5 | 0.42 |
| **$SpO_2$ (%) Mean ± SD** | **Group E (N=50)** | 97 ± 0.9 | 98 ± 0.5 | 96 ± 1.2 | 97 ± 0.8 | 98 ± 0.4 |
| | **Group D (N=50)** | 98 ± 1.2 | 96 ± 0.5 | 97 ± 1.4 | 96 ± 1.9 | 97 ± 1.5 |
| | **P value** | 0.45 | 0.22 | 0.16 | 0.32 | 0.19 |
| **RR (cycle/min) Mean ± SD** | **Group E (N=50)** | 13 ± 3.4 | 12.3 ± 2.7 | 11.6 ± 0.5 | 13.3 ± 2.5 | 15.9 ± 1.8 |
| | **Group D (N=50)** | 15 ± 1.4 | 13.6 ± 2.7 | 13.2 ± 3.8 | 12.1 ± 0.8 | 14.3 ± 3.3 |
| | **P value** | 0.18 | 0.3 | 0.22 | 0.16 | 0.21 |

*Indicates statistical significance P<0.05 in comparison with group E

**Table 3:** Hemodynamic and respiratory parameters in both groups.

| Mean ± SD / Parameter | Group E (N=50) | Group D (N=50) | P value |
|---|---|---|---|
| **VAS score** | 3.2 ± 0.9 | 4.5 ± 0.4 | P= 0. 2 |
| **Surgeon satisfaction** | 2.6 ± 0.4 | 1.4 ± 0.3* | P= 0.03 |
| **Patient satisfaction with analgesia and sedation** | 3.6 ± 0.6 | 2.8 ± 0.8* | P= 0.04 |
| **Adverse effect** (n, %) | 11 (22%) | 14 (28%)* | p<0.05 |
| Myoclonus (n, %) | 8 (16%)* | 1 (2%) | p<0.05 |
| $O_2$ desaturation (≤92) n, %) | 1 (2%) | 4 (8%) | p<0.05 |
| Nausea and vomiting (n, %) | 2 (4%) | 9 (18%) | p<0.05 |

*Indicates statistical significance P<0.05 in comparison with group E

**Table 4:** VAS score, surgeon satisfaction, patients satisfaction and adverse effects in both groups.

In this study, we evaluated the effects of a combination of etomidate-fentanyl versus dexmedetomidine-ketamine for procedural sedation in patients undergoing upper endoscopy and biopsy.

To the best of our knowledge; the present study is, to date, the first to compare etomidate-fentanyl combination and dexmedetomidine-ketamine combination for procedural sedation and analgesia in patients undergoing upper endoscopy and biopsy.

The major finding of the current study is that combination of etomidate-fentanyl, under BIS monitor, was associated with statistically significant rapid onset and recovery, less recovery room stay, less total hospital stay and higher patient satisfaction with analgesia and sedation compared to the combination of dexmedetomidine-ketamine with no significant difference in postoperative VAS scores of pain.

Using BIS monitor to guide anesthetic administration would allow optimization of drug delivery to the individual needs of each patient in order to avoid unnecessarily too deep or too light sedation due to overdosage or underdosage of the hypnotic medications [17].

BIS values in both groups signifies that increasing depth of sedation was associated with a decrease in BIS values and the decreasing level of sedation was associated with increasing BIS values. Similar findings have previously been found in a study done by Liu et al. [18].

The present study showed that there was no significant difference in the intraoperative hemodynamic parameters while 8 patients (16%) had myoclonus with bolus dose of etomidate and 1 patient (2%) had $O_2$ desaturation during procedure and 2 patients (4%) had nausea and vomiting.

Falk and Zed in their retrospective study on etomidate as a sedative in emergency department found no significant hemodynamic effects while 10% of patients had respiratory depression or apnea resulting in oxygen desaturation to <90% and the most prominent adverse effect reported with etomidate was myoclonus, occurring in 20-45% of patients [8].

Use of dexmedetomidine as the sole sedative/analgesic agent in invasive procedures was not successful due to its limited analgesic effects. In this study dexmedetomidine/ketamine combination showed long duration of sedation analgesia with cardiovascular stability these two agents have limited effects on ventilatory function [19].

In this study use of dexmedetomidine/ketamine had deeper sedation level with no significant change in hemodynamic parameters with $O_2$ desaturation in 4 patients (8%), higher nausea and vomiting (9 patients 18%) more surgeon and less patient satisfaction.

The hemodynamic stability explained by the addition of ketamine may prevent the bradycardia, hypotension and speeds the slow onset of sedation recorded with dexmedetomidine. Also, dexmedetomidine prevent the tachycardia, hypertension, salivation, and emergence phenomena associated with ketamine [20].

Kako et al. compared 2 doses of dexmedetomidine in combination with Ketamine (1 $mg \cdot kg^{-1}$) loading dose [21]. They found dexmedetomidine (0.5 μg/kg loading dose followed by an infusion at 0.5 μg/kg/h) achieved an adequate sedation level with shorter total recovery times in the perioperative unit compared with a higher dose regimen of dexmedetomidine (1.0 μg/kg loading dose followed by an infusion at 1.0 μg/kg/h). In this study the deeper sedation level and the longer recovery time may be due to use of high dose of

dexmedetomidine at induction combined with ketamine.

Koruk et al. found Sedation with dexmedetomidine-ketamine had insignificant changes in hemodynamic and respiratory parameters. Additionally, there was significant decrease in the incidence of nausea and vomiting [22].

Zor et al. in their study reported improved analgesia and a decreased incidence of adverse effects, including emergence phenomena and hallucinations related to ketamine in patients who received dexmedetomidine [23]. In this study we found more satisfaction of the doctor in dexemiditomedine-ketanine group than Etofen group and these may be due to surgeon may have subjectively felt more satisfaction to finish the procedure with longer and deeper sedation. They may also dislike the fact that etofen required more additional doses. These results are in keeping with those obtained by Sanri et al. [24].

In our study Etomidate-fentanyl combination offers lighter (yet enough depth) and shorter sedation, whereas dexmedetomidine-ketamine offers a deeper and longer sedation It was also associated with a very high overall patient satisfaction with analgesia without significant adverse events.

Bordo et al. demonstrated Etomidate is well tolerated with very high patient satisfaction and low adverse events for orthopedic reductions in the emergency department [25].

In conclusion, the etomidate/fentanyl combination provides an effective and safe procedural sedation and analgesia for upper endoscope and biopsy it was also associated with a very high overall patient satisfaction with analgesia without significant adverse events.

### Acknowledgement

The authors would like to thank the nurses at the Operation Theatre of Tanta University Hospital, Tanta; for their assistance in conducting the study.

### References

1. Godwin SA, Caro DA, Wolf SJ, Jagoda AS, Charles R, et al. (2005) Clinical policy: procedural sedation and analgesia in the emergency department. Ann Emerg Med 45: 177-196.
2. Bell GD (2004) Preparation, premedication, and surveillance. Endoscopy 36: 23-31.
3. Faigel DO, Baron TH, Goldstein JL, Hirota WK, Jacobson BC, et al. (2002) Guidelines for the use of deep sedation and anesthesia for GI endoscopy. Gastrointest Endosc 56: 613-617.
4. Rex DK (2006) Review article: moderate sedation for endoscopy: sedation regimens for non-anaesthesiologists. Aliment Pharmacol Ther 24: 163-171.
5. American Society for Gastrointestinal Endoscopy (2003) Guidelines for conscious sedation and monitoring during gastrointestinal endoscopy. ASGE 58: 317-322.
6. Venn RM, Karol MD, Grounds RM (2002) Pharmacokinetics of dexmedetomidine infusions for sedation of postoperative patients requiring intensive caret. Br J Anaesth 88: 669-675.
7. Burton JH, Bock AJ, Strout TD, Marcolini EG (2002) Etomidate and midazolam for reduction of anterior shoulder dislocation: a randomized, controlled trial. Ann Emerg Med 40: 496-504.
8. Falk J, Zed PJ (2004) Etomidate for procedural sedation in the emergency department. Ann Pharmacother 38: 1272-1277.
9. Thøgersen B, Ording H (2000) Bispectral index monitoring: comparison of two types of electrode. Anaesthesia 55: 242-246.
10. Sinha PK, Koshy T (2007) Monitoring Devices for Measuring the Depth of Anaesthesia - An Overview. Ind J Anaesth 51: 365-381.
11. Ekman A, Lindholm ML, Lennmarken C, Sandin R (2004) Reduction in the incidence of awareness using BIS monitoring. Acta Anaesthesiol Scand 48: 20-26.
12. Ringland R, Early S (1997) Conscious sedation: documenting the procedure. J Emerg Nurs 23: 611-617.
13. Tosun Z, Aksu R, Guler G, Esmaoglu A, Akin A, et al. (2007) Propofol-ketamine vs propofol-fentanyl for sedation during pediatric upper gastrointestinal endoscopy. Pediatric Anesthesia 17: 983-988.
14. Laiq N, Khan MN, Arif M, Khan S (2008) Midazolam with bupivacaine for improving analgesia quality in brachial plexus block for upper limb surgeries. J Coll Physicians Surg Pak 18: 674-678.
15. Wang F, Shen X, Guo X, Peng Y, Gu X; Labor Analgesia Examining Group (2009) Epidural analgesia in the latent phase of labor and the risk of cesarean delivery: a five-year randomized controlled trial. Anesthesiology 111: 871-880.
16. Mahajan C, Dash HH (2014) Procedural sedation and analgesia in pediatric patients. J Pediatr Neurosci 9: 1-6.
17. Sebel PS (2001) Can we monitor depth of anesthesia? Anesthesia & Analgesia 92: 95-98.
18. Liu J, Singh H, White PF (1997) Electroencephalographic bispectral index correlates with intraoperative recall and depth of propofol-induced sedation. Anesth Analg 84: 185-189.
19. Tobias JD (2012) Dexmedetomidine and ketamine: an effective alternative for procedural sedation? Pediatr Crit Care Med 13: 423-427.
20. Munro HM, Felix DE, Nykanen DG (2009) Dexmedetomidine/ketamine for diagnostic cardiac catheterization in a child with idiopathic pulmonary hypertension. J Clin Anesth 21: 435-438.
21. Kako H, Corridore M, Kean J, Mendell JR, Flanigan KM, et al. (2014) Dexmedetomidine and ketamine sedation for muscle biopsies in patients with Duchenne muscular dystrophy. Paediatr Anaesth 24: 851-856.
22. Koruk S, Mizrak A, Gul R, Kilic E, Yendi F, et al. (2010) Dexmedetomidine-ketamine and midazolam-ketamine combinations for sedation in pediatric patients undergoing extracorporeal shock wave lithotripsy: a randomized prospective study. J Anesth 24: 858-863.
23. Zor F, Ozturk S, Bilgin F, Isik S, Cosar A (2010) Pain relief during dressing changes of major adult burns: ideal analgesic combination with ketamine. Burns 36: 501-505.
24. Sanri E, Karacabey S, Akoglu H, Guneysel O (2013) ketamine/propofol versus etomidate/fentanyl for procedural sedation and analgesia in the emergency department: a prospective, randomized trial. MEMC 7.
25. Bordo D, Chan SB, Shin P (2008) Patient satisfaction and return to daily activities using etomidate procedural sedation for orthopedic injuries. West J Emerg Med 9: 86-90.