

Relationship Between Depth of Anesthesia and Severity of Pain after Abdominal Surgeries

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Abstract

Background: Pain control during and after surgeries can reduce subsequent complications, improve the recovery period of the patient after the surgery and immediately after discharge from the hospital, and shorten the length of stay in the hospital.

Objectives: The present research aimed to study the relationship between the depth of anesthesia and severity of pain after general anesthesia.

Methods: This prospective study carried out on 57 patients undergoing hernia surgery during the summer of 2014. The subjects were selected based on convenience sampling method. The same technique of anesthesia was used for all patients. The depth of anesthesia was monitored using bispectral index (BIS) and recorded at five-minute intervals. In addition, the severity of pain in the recovery and during the first 6 hours after the surgery was measured by a numerical scale. The obtained data were statistically analyzed using ANOVA and correlation coefficient in SPSS-18 at a significant level of $P < 0.05$.

Results: According to the results, the mean age of subjects was 45.54 ± 13.46 . In terms of gender, 36 subjects were male and 21 of them were female. The normal depth of anesthesia (40-60) was experienced by 59.6% of patients. The results also showed that there is a significant correlation between depth of anesthesia and severity of pain in the recovery ($P=0.001$, $r=0.694$) and during the first 6 hours after the surgery ($P=0.001$, $r=0.734$).

Conclusion: The present study showed that monitoring depth of anesthesia during surgery, in addition to helping nurses to monitor patients more accurately, can prevent some of the complications of anesthesia such as severe pain.

Key words: *Depth of anesthesia, Pain, Abdominal surgery*

Introduction

Lack of consciousness induced by drugs is called anesthesia which involves three components of analgesia, amnesia, and immobility during the surgery [1]. Surgery and anesthesia cause a number of physiological disorders that affect different body organs and may lead to some

complications during the recovery from anesthesia [2]. Bispectral index (BIS), firstly introduced in 1992, is the most common method of processing the electrical activity of the brain which is well related to the sedative-hypnotic effects of intravenous and inhaled anesthetics [3]. According to the Food and Drug Administration

(FDA), BIS index has the adequate sensitivity to assess the depth of anesthesia. In addition, it is generally assumed that processing the electrical activity of a patient's brain is useful in the detection of the depth of anesthesia [5, 6].

BIS uses a specific algorithm for converting the individual channels of EEG into the indicator causing sleep which ranges between 0 (isoelectric EEG) and 100 (awake). Special ranges from 40 to 60 are recommended to reduce the risk of awareness during general anesthesia [7]. Anesthesia is differentiated from normal sleep by the severity of the stimulus required for stimulating the brain and waking up [1]. The patient may go to sleep during anesthesia but feels pain during the surgery due to the lack of proper suppression of pain and sensory perception [8].

Prevention and treatment of pain are considered one of the fundamental human rights [9], as the new standards especially emphasize the routine evaluation of pain or the so-called fifth vital sign [10]. In the absence of control, postoperative pain can cause a range of acute and chronic effects. In the case of pain control during and after the surgery through intervening in pathophysiological changes that occur during the surgery, subsequent complications can be reduced and the recovery period of the patient after the surgery and immediately after discharge from the hospital can be shortened [11].

Incomplete pain control activates the sympathetic system, increases the myocardial oxygen consumption, and raises the risk of myocardial ischemia [12]. Increased activity of the sympathetic nervous system leads to a delay in the return of gastrointestinal motilities and causes paralytic ileus [13]. As previous studies demonstrate, about 80% of patients experience the postoperative acute pain and almost 25% of them are afflicted with the side effects caused by drug treatments. However, postoperative pain is the most common concern among 59% of these patients [14]. On the other hand, there is a strong relationship between moderate to severe postoperative pain and patient dissatisfaction [15,16]. The incidence of moderate to severe pain in heart, abdominal, and orthopedic surgeries has been reported in 25-75% of cases [17-19].

Overuse of analgesics to control pain in these patients can be followed by side effects which can prolong the recovery period [20]. Physical dependence and addiction are among the clinical concerns which may prevent the appropriate prescription of drugs and, in turn, lead to inadequate pain management [21]. Given the high prevalence of postoperative pain and its impact on the recovery process, the present research aims to study the relationship between the depth of anesthesia and severity of pain after general anesthesia in order to improve the quality of healthcare services and reduce treatment costs.

Methods

The present research was a prospective study which was carried out on 57 patients undergoing hernia surgery in Shahid Beheshti Hospital of Sabzevar during the summer of 2014. After obtaining the approval of the ethics committee, Golestan University of Medical Sciences, Sabzevar University of Medical Sciences, Shahid Beheshti Hospital of Sabzevar, patients were examined by the researcher on the day before surgery and eligible patients were selected as the sample. The inclusion criteria were as follows: being aged 18-65, non-addiction to drugs and alcohol, non-use of psychotropic, non-affliction with chronic pains, the ability of communication and adequate perception, non-affliction with liver, kidney, cardiovascular, and neurological diseases (according to a physician's consultation and diagnosis), and having a BMI of less than 35.

Since the surgical technique may be effective in the occurrence of complications, the patients undergoing surgery by only one surgeon were selected as the sample in this study. After selecting the subjects, they were briefed on the numerical scale of pain in order to get a complete understanding of it. Patients and their families were assured that no extra cost will be imposed on and their information will be kept confidential. After entering the operating room, patients were directed to the surgery room by a nurse to get prepared for general anesthesia by the anesthesiologist.

Routine monitoring techniques included electrocardiograms, pulse oximetry, non-invasive

measurement of blood pressure, and measurement of the depth of anesthesia. In this study, BIS Vista Medical Systems Aspect device (made in the US) was used for measuring the depth of anesthesia. Anesthesia protocol was the same for all patients, as all of them received 0.04 mg/kg midazolam and 2.5 µg/kg fentanyl in the prodrug. Anesthesia was induced using 5 mg/kg sodium thiopental and intubation following the administration of 0.5 mg/kg atracurium. To maintain isoflurane anesthesia with 1% MAC, 50% nitrous oxide and 50% oxygen were administered.

After induction of anesthesia by an anesthesiologist, depth of anesthesia was permanently monitored by BIS device and recorded at five-minute intervals. There was no manipulation and intervention on the depth of anesthesia and only the values were recorded by a trained nurse during the surgery. Respiration rate was kept constant for all patients during the surgery by a ventilator. Given the short period of surgery and the effects of analgesics, there was no need for medication renewal during the surgery. After the surgery and the patient's breathing returned, neuromuscular blockers were neutralized by administering 0.05 mg/kg neostigmine and 0.02 mg/kg atropine.

With the arrival of the patient to the recovery, the severity of pain was measured by a numerical scale every 10 minutes and recorded by the researcher who was unaware of BIS values of patients during anesthesia. Recovery signs were recorded from the moment when the patient was conscious enough to verbally answer the questions. After transferring the patient to the surgical ward, severity of pain during the first 6 hours was measured and recorded using the numerical scale. This scale ranges between 0 and 10; 0 indicates no pain and 10 represents very severe pain. The amount of analgesics administered in the recovery (fentanyl) and the first 6 hours after the surgery (methadone) was also recorded. The researcher was not involved in the prescription or non-prescription of these

drugs. The obtained data were statistically analyzed using ANOVA and correlation coefficient in SPSS-18 at a significant level of $P < 0.05$.

Results

Ten participants were excluded in the follow-up. In the present study, 57 patients with a mean age of 45.54 ± 13.46 (in the range of 18-65) were selected as subjects. Out of them, 36 patients were male and 21 patients were female. The mean operation time was 42.98 ± 11.41 minutes. In terms of BMI, 23, 33, and 1 patients were normal (18.5-24.99), overweight (25-29.99), and obese (over 30), respectively. Values of the depth of anesthesia were in three ranges of normal (40-60), deep anesthesia (below 40), and surface anesthesia (over 60). As shown in Table 1, 40.4% of patients in this study experienced the depth of anesthesia out of the normal range during the surgery.

Table 1: Frequency distribution of patients undergoing elective abdominal surgery by depth of anesthesia

Depth of Anesthesia	Number	Percent
Shallow (> 60)	12	21/1
Normal (40-60)	34	59/6
Deep (< 40)	11	19/3

The correlation coefficient between BIS values and severity of pain in the recovery and during the first 6 hours after the surgery was calculated (Table 2). According to the results, there is a positive significant correlation between BIS values and severity of pain in the recovery and during the first 6 hours after the surgery. This means that severity of pain increases with the increase in BIS values (reduced depth of anesthesia).

Table 2: Correlation coefficient between BIS values and severity of pain in the recovery and during the first 6 hours after the surgery

BIS Severity of pain	r	P-value
Recovery	0/694	0/001
6 hours after the surgery	0/734	0/001

*** Pearson s correlation coefficient**

The mean and standard deviation of BIS values in terms of the amount of analgesics in the recovery showed that there is a significant difference between BIS values and the amount of analgesics

administered in the recovery, as BIS values were higher during the surgery in the two groups received this drug (Table 3).

Table 3: The mean and standard deviation of BIS values during the surgery in terms of the of analgesics intake in the recovery based on ANOVA

Analgesics intake	Number	BIS values Mean±SD	P-value*
Not taking	38	45/19±7/19	0/0001
1CC Fentanyl	17	57/09±6/91	
2CC Fentanyl	2	57/20±8/42	

*** Anova**

Based on the study results, there was a significant difference between BIS values and the amount of analgesics consumed in the first 6 hours after the surgery. Tukey test showed BIS values during the surgery were higher in patients who had received

2 cc of methadone compared to the other two groups. This suggests that reduction of depth of anesthesia during the surgery increases the need for analgesics after the surgery (Table 4).

Table 4: The mean and standard deviation of BIS values during the surgery in terms of the analgesic intake in the first 6 hours after the surgery based on Anova

Analgesic intake	Number	BIS values Mean±SD	P-value*
Not taking	35	45/30±7/69	<0/001
Methadone 1CC	17	53/35±7/49	
Methadone 2CC	5	61/92±0/958	

*** Anova****Discussion**

The present research aimed to study the relationship between the depth of anesthesia and severity of pain after surgeries. The study findings indicated that 59.6%, 19.3%, and 21.1% of patients experienced a normal (40-60), deep (below 40), and surface level of anesthesia (over 60), respectively. Given that depth of anesthesia in 21.1% of the patients was not enough and they

experienced a light anesthesia during the surgery, some of them would had felt awake during the surgery which was not measured in this study. In addition, 19.3% of patients experienced anesthesia deeper than the usual range. In the present study, a significant positive correlation was found between BIS values recorded during the surgery and severity of pain in the recovery and in the first 6 hours after the surgery. This

means that severity of pain in the recovery and in the first 6 hours after the surgery increases with the increase in BIS values during the surgery, which represents a reduction in depth of anesthesia.

Fentanyl was administered to patients in the recovery as an analgesic at 0, 1, and 2 cc. Nineteen patients needed treatment with fentanyl, 17 of whom were relieved with only 1 cc and 2 of whom received 2 cc of fentanyl. In addition, methadone was used at 0, 1, and 2 cc for pain relief after the patient recovery. Out of the subjects, 22 patients needed treatment with this drug (17 patients with 1 cc and 5 patients with 2 cc). The results showed that BIS values during the surgery are significantly lower in patients who did not receive methadone or fentanyl in the recovery (45.19 ± 7.19) and in the first 6 hours after the surgery (45.30 ± 7.69) than those who needed these drugs for treatment. The results suggested that BIS values have a significant relationship with severity of pain and amount of analgesic consumption after the surgery.

Therefore, it can be argued that increased depth of anesthesia during the surgery (reduced BIS values) can reduce the severity of pain and postoperative analgesic consumption. These results are consistent with the findings of Sahni et al. (2011) [20] who showed that severity of pain and analgesic consumption after the surgery are lower in patients who experienced deeper anesthesia during the surgery. In addition, the study findings are consistent with the results of Henneberg et al. (2005) who studied the effects of monitoring the depth of anesthesia using AEP (another method of measuring the depth of anesthesia) on the severity of pain and analgesics consumption. Their results showed that pain management control (patient controlled analgesia) is used more frequently during the first 24 hours after surgery for patients who experience a more surface depth of anesthesia [22]. Researchers believe that creating a deeper depth of anesthesia during surgery somewhat inhibits the painful stimuli affecting the severity of pain and reduces the dosage of analgesics.

The present study showed that monitoring depth of anesthesia during surgery, in addition to helping nurses to monitor patients more

accurately, can reduce some of the complications of anesthesia such as severe pain. The use of objective and non-invasive methods for monitoring depth of anesthesia and better control of complications after anesthesia can lead to improved quality of healthcare services in the first stage of patient care. One of the limitations of the present study was the low number of subjects which is due to shortage of equipment such as the device for recording depth of anesthesia and the high price of sensors required for recording depth of anesthesia.

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References

1. Bruhn J, Myles PS, Sneyd R, Struys MM. Depth of anaesthesia monitoring: what's available, what's validated and what's next? *Br J Anaesth.* 2006; 97(1): 85–94.
2. Poorsheykhian M, Emami Sigaroodi A, Kazamnejad E, Raouf M. Incidence of Post General Anesthesia Complications in Recovery Room. *J Guilan Univ Med Sci.* 2012; 21(82): 8-14. [In Persian]
3. Chan MT, Cheng BC, Lee TM, Gin TM. BIS-guided Anesthesia Decreases Postoperative Delirium and Cognitive Decline. *J Neurosurg Anesthesiol.* 2013; 25(1): 33-42.
4. Musizza B, Ribaric S. Monitoring the depth of anaesthesia. *Sensors (Basel).* 2010; 10(12): 10896-935.

5. Chung AL, Kim DY, Lee HS, et al. The effect of using sevoflurane for cesarean section on the bispectral index (BIS) and on neonates. *Korean J Anesthesiol.* 2004; 47: 188-91.
6. Tsai PS, Huang CJ, Hung YC, Cheng CR. Effects on the bispectral index during elective caesarean section: a comparison of propofol and isoflurane. *Acta Anaesthesiol Sin.* 2001; 39(1): 17-22.
7. Miller R, Pardo M. Basics of anesthesia. Abtahi D, Kamali F, Mahdavi N, Farajzadeh AR. (Persian Translators). 1st ed. Tehran: Andisheh rafi; 2011. [In Persian]
8. Avidan MS, Jacobsohn E, Glick D, et al. Prevention of Intraoperative Awareness in a High-Risk Surgical Population. *N Engl J Med.* 2011; 365: 591-600.
9. Asadi Fakhr A, Salehi I, Emani B, Mozaffari H. Evaluation of Continuous Electroencephalogram Recording for Assessing and Control of Depth of Anesthesia in Elderly Patients. *ZUMS Journal.* 2012; 20(28): 73-8. [In Persian]
10. White MC, Wolf AR. Pain and stress in the human fetus. *Best Pract Res Clin Anaesthesiol.* 2004; 18(2): 205-20.
11. Wu CL, Raja SN. Treatment of acute postoperative pain. *Lancet.* 2011; 377(9784): 2215-25.
12. Kehlet H, Holte K. Effect of postoperative analgesia on surgical outcome. *Br J Anaesth.* 2001; 87(1): 62-72.
13. Wu CL, Fleisher LA. Outcomes research in regional anesthesia and analgesia. *Anesth Analg.* 2000; 91(5): 1232-42.
14. Apfelbaum JL, Chen C, Mehta SS, Gan TJ. Postoperative pain experience: results from a national survey suggest postoperative pain continues to be undermanaged. *Anesth Analg.* 2003; 97(2): 534-40.
15. Mei W, Seeling M, Franck M, et al. Independent risk factors for postoperative pain in need of intervention early after awakening from general anaesthesia. *Eur J Pain.* 2010; 14(2): 149.e1-149.e7.
16. van den Bosch JE, Bonsel GJ, Moons KG, Kalkman CJ. Effect of postoperative experiences on willingness to pay to avoid postoperative pain, nausea, and vomiting. *Anesthesiology.* 2006; 104(5): 1033-39.
17. Gerbershagen HJ, Aduckathil S, van Wijck AJ, Peelen LM, Kalkman CJ, Meissner W. Pain Intensity on the First Day after Surgery. *Anesthesiology.* 2013; 118 (4): 934-44.
18. Rocchi A, Chung F, Forte L. Canadian survey of postsurgical pain and pain medication experiences. *Can J Anaesth.* 2002; 49(10): 1053-56.
19. Svensson I, Sjöström B, Haljamäe H. Influence of expectations and actual pain experiences on satisfaction with postoperative pain management. *Eur J Pain.* 2001; 5(2): 125-33.
20. Sahni N, Anand LK, Gombar K, Gombar S. Effect of intraoperative depth of anesthesia on postoperative pain and analgesic requirement: A randomized prospective observer blinded study. *J Anaesthesiol Clin Pharmacol.* 2011; 27(4): 500-505.
21. Benyamin R, Trescot AM, Datta S, et al. Opioid complications and side effects. *Pain Physician.* 2008; 11 (2 Suppl): 105-20.
22. Henneberg S, Rosenborg D, Weber Jensen E, Ahn P, Burgdorff B, Thomsen L. Perioperative depth of anaesthesia may influence postoperative opioid requirements. *Acta Anaesthesiol Scand.* 2005; 49(3): 293-96.