VIA MEDICA

ORIGINAL AND CLINICAL ARTICLES

Anaesthesiology Intensive Therapy
2016, vol. 48, no 4, 239–247
ISSN 1642–5758
10.5603/AIT.2016.0044
www.ait.viamedica.pl

A comparison of BIS recordings during propofol-based total intravenous anaesthesia and sevoflurane-based inhalational anaesthesia in obese patients

Tomasz Gaszyński[1], Andrzej Wieczorek[2]

[1]*Department of Emergency Medicine and Disaster Medicine, Medical University of Łódź, Poland*
[2]*Department of Anaesthesiology and Intensive Therapy, Medical University of Łódź, Poland*

Abstract

Background: Intraoperative awareness is a rarely occurring phenomenon. Obesity is considered as one of the factors increasing the probability of intraoperative awareness due to problems with the dosing of anaesthetics. In a randomized prospective study we compared bispectral index (BIS) recordings during propofol-based total intravenous anaesthesia (TIVA) and sevoflurane-based inhalation anaesthesia in morbidly obese patients as a sign of possible intraoperative awareness.

Methods: 120 morbidly obese patients were randomly allocated into two subgroups: TIVA or SEVO. Propofol TIVA was performed following the Servin formula, while sevoflurane was administered based on the age of the patients. The physician administering anaesthesia was blinded to the BIS recordings while the evaluation of the depth of anaesthesia was conducted based on the clinical symptoms of adequate anaesthesia. BIS recordings were evaluated for periods of BIS > 60. Blinded structured interviews were conducted 2 hours after anaesthesia was administrated.

Results: The incidence of BIS > 60 occurred in 90% vs. 91.67% of patients while the mean duration of periods of BIS > 60 was 13.74 ± 21.74% vs. 14.21 ± 18.78% of the duration of anaesthesia in TIVA and SEVO groups, respectively ($P > 0.05$). There was no correlation between the BMI value and the duration of elevated BIS values observed during anaesthesia in both studied methods of anaesthesia, nor between the total time of anaesthesia and the duration of elevated BIS values above 60 in this study. No patient complained of intraoperative awareness when asked in the post-operative period, probably due to the administration of midasolam.

Conclusions: Although the incidence of BIS > 60 are very common in obese patients, true awareness during anaesthesia infrequent in this group of patients despite the type of anaesthesia, whether intravenous or inhalation.

Key words: obese patient; anaesthesia, general, depth; anaesthesia, monitoring, bispectral index; anaesthetics, volatile, sevoflurane; anaesthetics, intravenous, propofol

Anaesthesiology Intensive Therapy 2016, vol. 48, no 4, 239–247

The Royal College of Anaesthetists in the UK have coordinated five national audit projects over the past ten years. The fifth National Audit Project (NAP5) was a study into the patterns of Accidental Awareness under General Anaesthesia (AAGA) [1]. Although the overall incidence in the UK was estimated at 1 in 19,000 cases, in cases where neuromuscular blockade was used this was 1 in 8,000 cases. Awareness occurred most frequently at induction, in over 50% of cases. For bariatric anaesthetists this is worth further discussion. The use of total intravenous anaesthesia (TIVA) was associated with a doubling of the risk of AAGA. Although obesity or morbid obesity was present in 22% of the general anaesthetic population overall, it represented 35% of AAGA cases at induction. The mechanisms by which awareness occurs are identified as (a) failure to deliver sufficient anaesthetic agent to the body and (b) individual patient resistance to an otherwise sufficient dose of anaesthetic agent. In obese patients there are clear reasons by which the first process

may occur, particularly at induction. Such individuals have a raised baseline cardiac output, and increased fat mass into which induction agents can be rapidly distributed (and which may need to be saturated with a volatile agent in cases of those which are gaseous. Thus, although i.v. induction agents need to be dosed to one's lean body weight, these two factors tend to result in the washout of these agents, and therefore the reduction in brain concentrations occur more rapidly than in the non-obese (www.espcop.org). The widely recognized issues with propofol TIVA dosing in obese patients (the limitations of the Marsh and Schnider models in higher-weight patients) may also have lead to problems during the maintenance of anaesthesia.

Among the patients undergoing elective surgery, nearly 50% experience fear related with the possibility of intraoperative awareness, while 37% are afraid of death [2]. Although intraoperative awareness is a rare phenomenon (occurring during 0.1–0.2% of general anaesthesia procedures) [3, 4], it is classified as a serious anaesthetic incident. Especially dangerous are incidents of conscious awareness with explicit recall and those with severe pain (less frequent than 1 per 3000 of general anaesthetics) [3]. While both the occurrence and intensity of the fear related to this risk may be investigated with the use of special preoperative check forms, they have been rarely used in clinical practice [4]. Among possible risk factors for the occurrence of intraoperative awareness, severe obesity is listed [3, 4]. A consensus exists that the traditional approach to anaesthesia adequacy evaluation with the use of the indirect methods based on the circulatory parameters variation assessment may be inadequate and difficult [5]. In order to ensure the avoidance of unaccepted intraoperative awareness occurrence, many methods of anaesthesia depth evaluation have been tested in previous years.

Anaesthesia adequacy evaluation primarily consisted of the assessment of patient movements, vegetative disorders, contractility of the lower part of the oesophagus and EEG analysis. Unfortunately, the classical method of EEG analysis has no value for intraoperative assessment due to the complicated structure and subtle changes in the observed waveforms, as well as additional disturbances generated by electrical devices placed in the operational theatre [6]. BIS usage for bariatric surgery is described and recommended [6].

Today, there are new methods available which may help limit the risk of inadequate anaesthesia and intraoperative awareness [7], namely BIS (bispectral index) and AEP (auditory evoked potentials).

The possibility of using such methods has a special value for increased-risk populations, such as obese patients. In advanced countries, obesity is starting to be an important healthcare problem with growing consequences. On the other hand, the rules of proper dosage and administration of the anaesthetic agents in the obese patient population have not been precisely established up to this moment while there are still subjects under discussion. Following the recommendations of European Society for Perioperative Care of the Obese Patient (www.espcop.org), in every case of general anaesthesia in an obese patient, it is recommended to employ monitoring of the depth of anaesthesia.

The aim of this study was to establish the real risk of intraoperative awareness for obese patients undergoing elective surgery analyzing BIS recordings during general anaesthesia. We compared two techniques of administering anaesthesia, namely TIVA using continuous infusion of propofol and the inhalation of anaesthesia using sevoflurane. Additionally, we estimated the correlation between the grade of obesity and the risk of incidence of increased BIS levels, indicating possible intraoperative awareness.

METHODS

After gaining the approval of the appropriate ethics committee, 120 obese patients (BMI > 33 kg m^{-2}) undergoing elective surgery (bariatric surgery) were included into the study. All participating patients were randomly allocated into two subgroups: TIVA using propofol infusion (TIVA group) or inhalation anaesthesia using sevoflurane (Fig. 1). In the TIVA group, propofol infusion was used following the Servin formula: for the induction of anaesthesia 1.5–2.0 mg kg^{-2} of corrected body weight (calculated as follows: IBV [ideal body weight] + 0.4 × [total body weight–ideal body weight]); then continuous infusion using Robert`s formula (step-down infusion): 10 mg kg^{-1} h^{-1} for first 10 minutes of anaesthesia; subsequently 8 mg kg^{-1} h^{-1} for the next 10 minutes; and then 6 mg kg^{-1} h^{-1} to the end the administration of the anaesthesia. The rate of infusion was modified depending on clinical parameters: hemodynamic parameters were kept within normal values for the age of the patients.

In the SEVO group, sevoflurane was administrated according to patient`s age, modified depending on clinical parameters in order to maintain haemodynamic stability during anaesthesia. At the beginning of anaesthesia, fresh gas flow (FGF) was set at 4 L min^{-1}, and after 10 minutes was changed to 1 L min^{-1}, after 1 hour to 2 L min^{-1}.

Other similar anaesthetic drugs were administrated in both groups: for muscle relaxation rocuronium was administered according to the IBW while a neuromuscular blockade was monitored using a TOF-Guard device. At completing the procedure, sugammadex for reversing the neuromuscular block was given. A dose of 0.05 mg kg^{-1} of IBW of midazolam i.v. was administered for premedication on arrival in the operating theatre. Intraoperative analgesia was achieved using intravenous fentanyl.

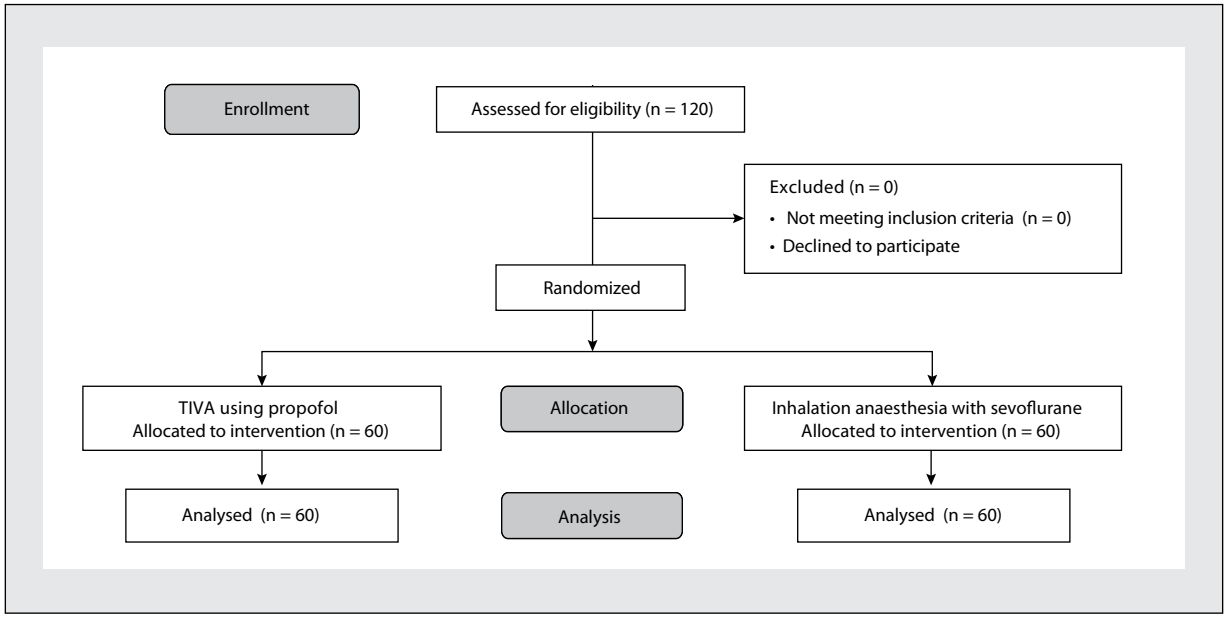

Figure1. Flow Diagram for the study

Each patient was monitored with the use of the BIS VISTA™ Monitoring System (Aspect Medical Systems Inc, Norwood, USA), connected via a frontal-temporal set of electrodes. BIS-registered results from all patients were analyzed after collection. The anaesthesiologist performing the anaesthesia was blinded to the BIS monitor and administered the anaesthesia following his experience and the clinical parameters of the patient.

An independent investigator checked for the presence of BIS values above 60 and the time of anaesthesia with such a high BIS value. Blinded structured interviews with patients were conducted 2 hours after anaesthesia was administered. A questionnaire was employed consisting of 16 questions (Appendix 1) in which memories of anaesthesia were evaluated. The patient could answer "yes", "no" or "I do not know". If patient answered "yes" to any question, further analysis was performed evaluating whether this was true awakening or a dream.

A statistical analysis of the collected data was performed with the use of the Microsoft Excel Package.

RESULTS

The TIVA group consisted of 20 men and 40 women, aged from 17 to 64 years (mean 35.9 years), with a BMI from 35 to 58.1 (mean 42.7) kg m^{-2}. BIS values above 60 were noticed in cases of 54 patients (90%), while in 30 cases (37%) the BIS values reached more than 80, which may represent, with a high probability, intraoperative awareness.

For further analysis of the correlation between BIS and BMI, the studied groups were divided into subgroups basing on the grade of obesity:

- BMI < 30.0–34.9 > — first grade obesity
- BMI < 35.0–39.9 > — second grade obesity
- BMI < 40.00 — third grade obesity

In the TIVA group, a comparison of the patients with second and third grade obesity showed that third grade obesity was connected with longer periods of high BIS values (43.53 vs. 18.16 % respectively). In first grade of obesity, a time of BIS > 60 was 8.54% of the time of anaesthesia. There was no correlation between the duration of the procedure and the duration of BIS > 60 occurrence. There was no correlation between BIS > 60 kg m^{-2} and BMI in the TIVA group (Fig. 2).

In the TIVA group, the mean total consumption of propofol was: 2012 ± 310.19 mg (range: 1620–2350). The mean time of infusion was 127.5 ± 21.62 min while the mean rate of infusion was 10 mg kg^{-1} h^{-1}.

The SEVO group consisted of 12 men and 48 women, from 18 to 65 years (mean age 40 years), with a BMI from 33.79 to 57.37 kg m^{-2} (mean 45.09). BIS values above 60 were noticed in cases of 55 patients (91.67%), while in 5 cases (8.33%) the BIS values reached more than 80, which may represent, with a high probability, intraoperative awareness.

When checking the correlation between the BMI value and the time of an elevated BIS value observed during anaesthesia in the SEVO group, the results showed no significant correlation (Fig. 3). Moreover, there was no correlation between the total time of anaesthesia and the time of BIS elevation above 60 (Fig. 4). A comparison of the patients with first and second grade obesity showed that second grade obesity was connected with longer periods of high BIS values (18.08 vs. 6.14% respectively). Additionally, the longest periods of high BIS values were

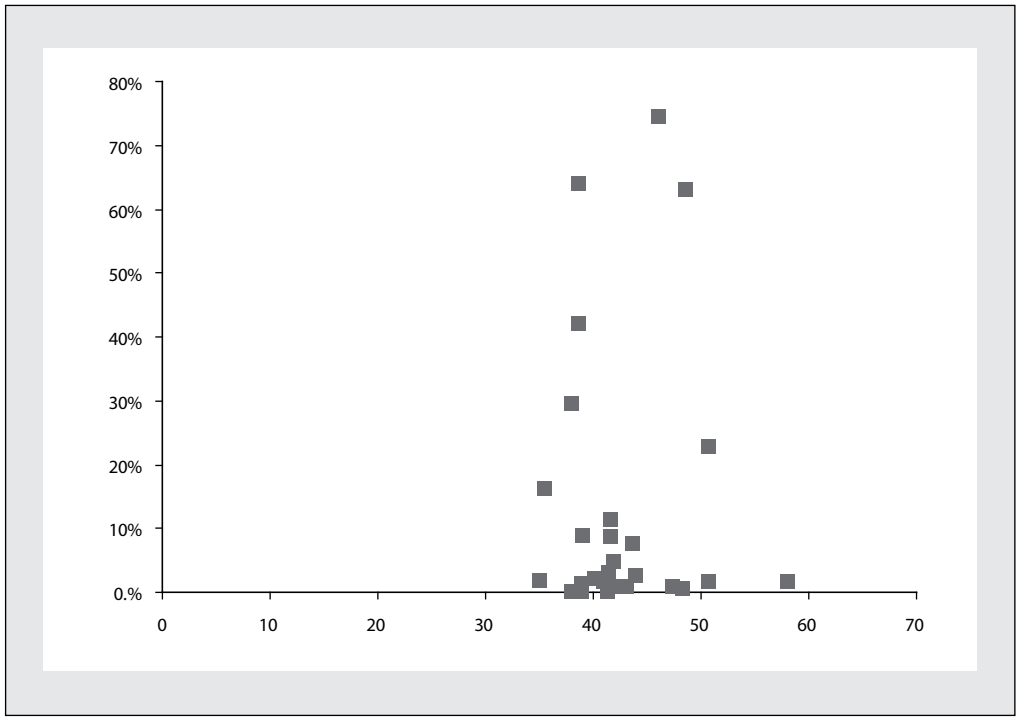

Figure 2. Correlation between the BMI value and the time of BIS > 60 during anaesthesia in the SEVO group

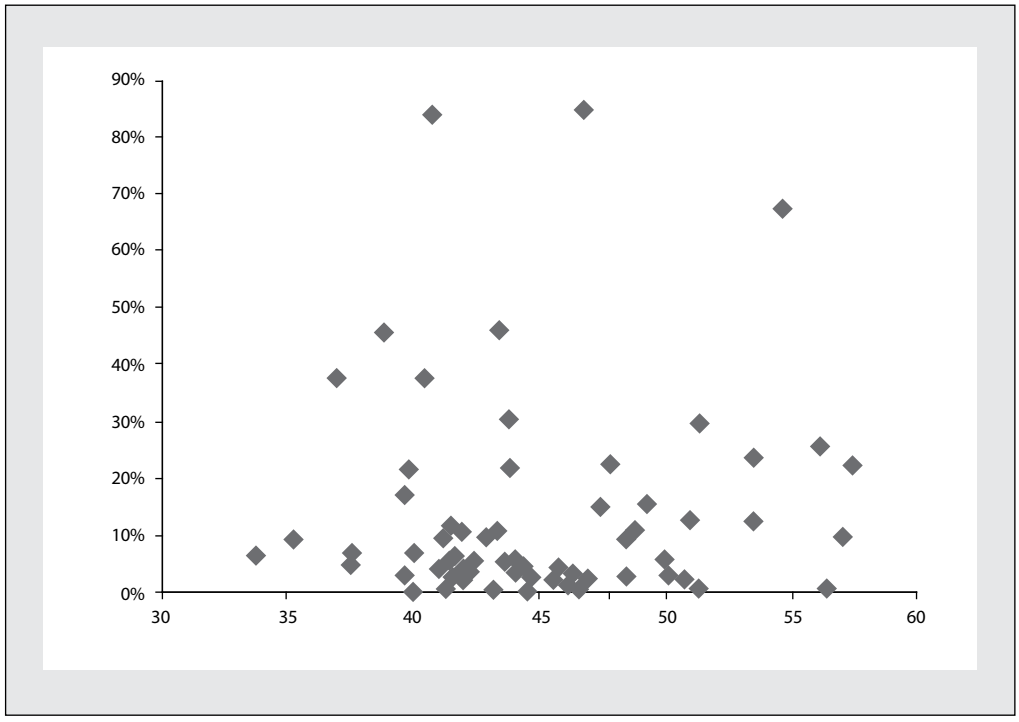

Figure 3. Correlation between the BMI value and the time of BIS > 60 during anaesthesia in the SEVO group

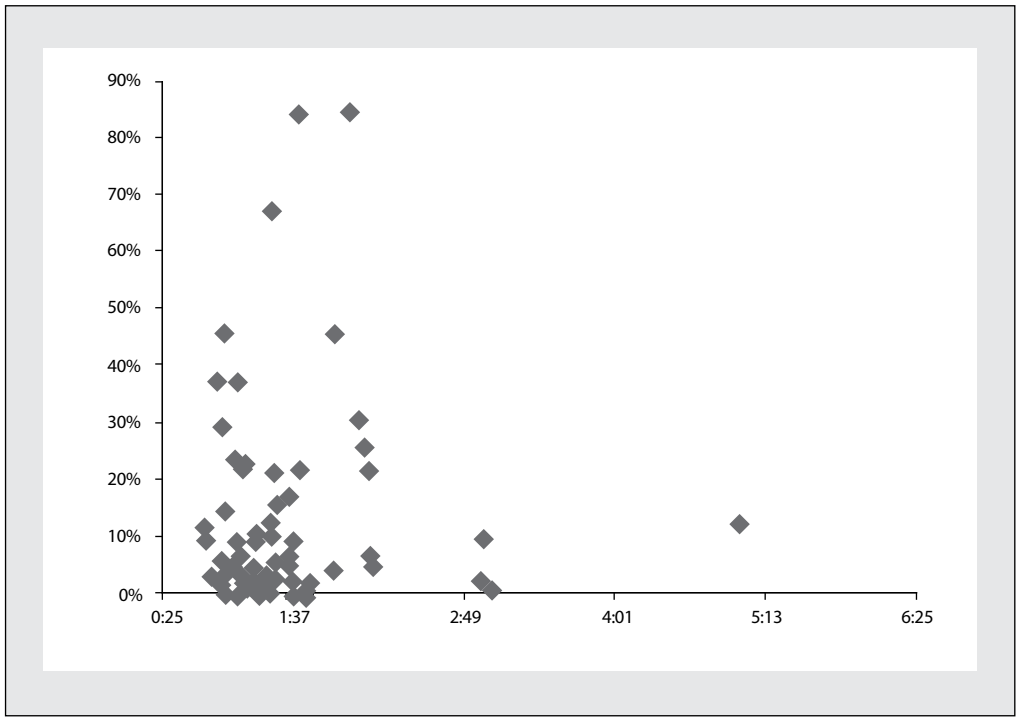

Figure 4. Correlation between the total time of anaesthesia and the time of BIS elevation above 60 in the SEVO group

present during relatively short anaesthetic procedures (50–90 min). There was no correlation between the patient's age and periods of BIS value elevation. The longest period of BIS value elevation occurred in the age group 18–30 years and the shortest in the age group 31–40 years (18.4 vs. 8.55% respectively).

In the SEVO group, the mean consumption of sevoflurane was 57.94 ± 25 mL while the mean duration of anaesthesia was 109.8 ± 32.9 min.

When comparing these two groups, there was no difference, either in the mean occurrence of BIS > 60 (90% vs. 91.67%) between the TIVA and SEVO groups, or in the duration of periods of BIS > 60 (13.74 ± 21.74% vs. 14.21 ± 18.78% of duration of anaesthesia, respectively, $P > 0.05$).

Although there was one case in the propofol group of prolonged intubation, no patient complained on intraoperative awareness when asked in the post-operative period. Moreover, 16% of patients had dreams in both groups: in the TIVA and SEVO groups respectively, 10% vs. 12.5% pleasant dreams, while 6% vs. 4% had those difficult to estimate. No patient revealed direct memories of the period of surgery, such as feeling pain, touch, hearing conversations or noise.

DISCUSSION

The intraoperative awareness perception is a subjective patient's feeling, which may be confirmed after awaking. The fear of such a situation is present in more than 50% of patients and has been identified as one of the main perioperative stress factors [8]. In many cases the results of intraoperative awareness may be temporal as excitation, depression, prolonged fear and sleep disorders. However, in some cases it may be cause of the Post Traumatic Stress Disorders Syndrome (PTSD). The frequency of PTSD occurrence as a consequence of intraoperative awareness is estimated at 4–40% of awareness cases [9, 10]. The gravity emodynamic instability, multitrauma and cardiac surgery with the use of external circulation are considered as factors for an increased risk of PTSD. The diagnosis of intraoperative awareness is simple only from the theoretical point of view. In clinical practice, however, there are many factors which may influence changes in observed patients' parameters. Thus, monitoring methods focused on brain responsiveness and reactivity, such as BIS [2–4, 11], Entropy, Narcotrend [12], AEP [9, 13–18] are especially important for the possible control of this risk. The published data suggests that among patients confirming intraoperative awareness, this occurs much more frequently regarding people under 60 years (89%), women (77%), those in good physical form — ASA I and II (68%), as well as those under elective surgery (87%) [9, 19]. In cases of obesity, the incidence of intraoperative BIS value elevation, which may be the equivalent of intraoperative awareness, was observed in up to 10% of cases [20]. The data gained by our study may suggest that the problem of intraoperative awareness among patients with significant obesity may be much more frequent than previously considered (91.7% patients faced intraoperative BIS

elevation, which may be the equivalent of temporal limited intraoperative awareness — i.e. conscious awareness without explicit recall). Severe forms of intraoperative awareness were identified in 8.3% of cases, with BIS values above 80, which represent a risk of conscious awareness with explicit recall and severe pain. This incidence is much higher than observed in the general population (below 0.03%) [3, 21]. It may be one of the causes for disturbances observed much more frequently among the patients presenting obesity, such as postoperative agitation and depression. Additionally, even anaesthesia causing safe BIS values may be not enough protection against intraoperative awareness [22]. We used a specially prepared computer algorithm which evaluated BIS elevation over 60 in BIS recordings (Fig. 5–7). Although we are aware that this method is very simple, we decided that this is objective method in order to estimate the possible risk of intraoperative awareness. The type of BIS > 60 may be different: thus from that which is very short (Fig. 6) related possibly to intubation stimulus; to that which is long, covering almost the whole duration of anaesthesia (Fig. 7). However, there was no correlation either between the duration of BIS > 60 or the grade of BIS elevation and patient complaints. BIS elevation may be related to artifacts, namely: the patient`s head movement, facial muscle activity, as well as electrocoagulation used by surgeons [23]. We tried to eliminate all such possible factors influencing BIS monitoring.

BIS monitoring is described and recommended for anaesthesia in obese patients [6, 24]. It prevents intraoperative awareness and helps to individualize the dosage of anaesthetics [25].

In the morbidly obese, the dosing of intravenous anaesthetics can be based on Ideal Body Weight [26], Corrected Body Weight [27] or Total Body Weight [28]. We used CBW for the calculation of the dosage of propofol [27]. BIS may be used for the estimation of dosages of propofol in the morbidly obese [29]. In the obese the dosing of inhalation anaesthetics may be similar to dosing in non-obese patients, and may be based on the age of the patient [30, 31].

There is a limited number of papers on intraoperative awareness in morbidly obese patients. Two cases described by Japanese researchers were observed during propofol TIVA anaesthesia [32]. The latest review of reported cases in the literature revealed that obesity may not be a risk factor of intraoperative awareness any longer [33]. However, still we think that the estimation of propofol dosage in the morbidly obese should be based not only on clinical symptoms of the depth of anaesthesia but also on monitoring of brain function [34].

Despite the high incidence of BIS > 60, no patient complained of intraoperative awareness during anaesthesia. This may be related to the administration of midasolam which causes amnesia. The administration of midasolam is recommended in cases of patients who may be exposed to risk of intraoperative awareness in order to prevent PTSD [9]. In cases of prolonged intubation, anaesthetics should be administered in order to prevent awakening of the patient [35]. Having occurred once, awareness during anaesthesia does not have to occur during the next period of anaesthesia [36]. However, patients who reported awareness during previous anaesthesia should be monitored for adequate depth of anaesthesia for subsequent procedures.

This study has several limitations: first of all, we could only use psychological testing for estimating the real number of intraoperative awareness. Unfortunately, such tests are complicated and difficult to perform by non-psychiatrists. More studies involving not only anaesthesiologists, but also psychiatrists are needed to evaluate the real incidence of intraoperative awareness among obese patients.

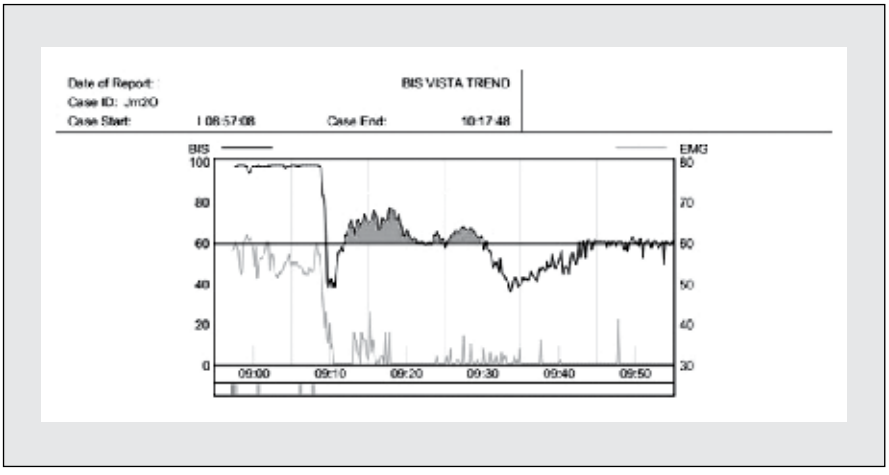

Figure 5. BIS registration example 1 — dark grey area under BIS > 60 may indicate possibility of intraoperative awareness

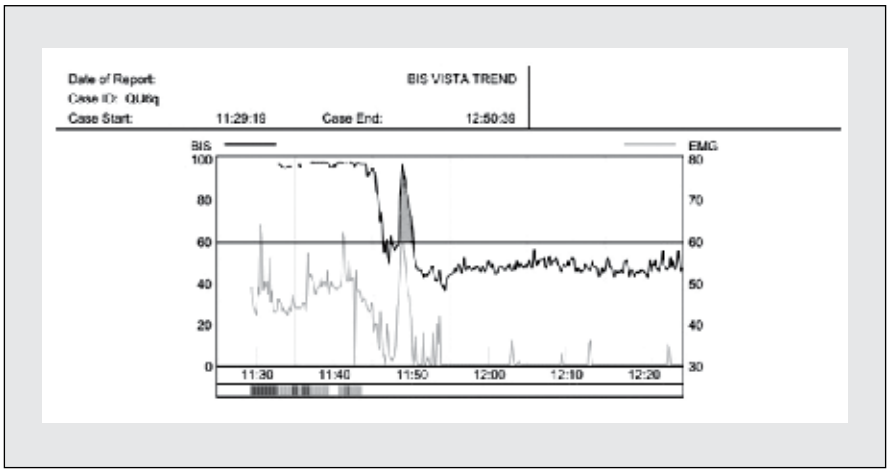

Figure 6. BIS registration example 2 — dark grey area indicate short-time intraoperative awareness, related possibly to intubation stimulus

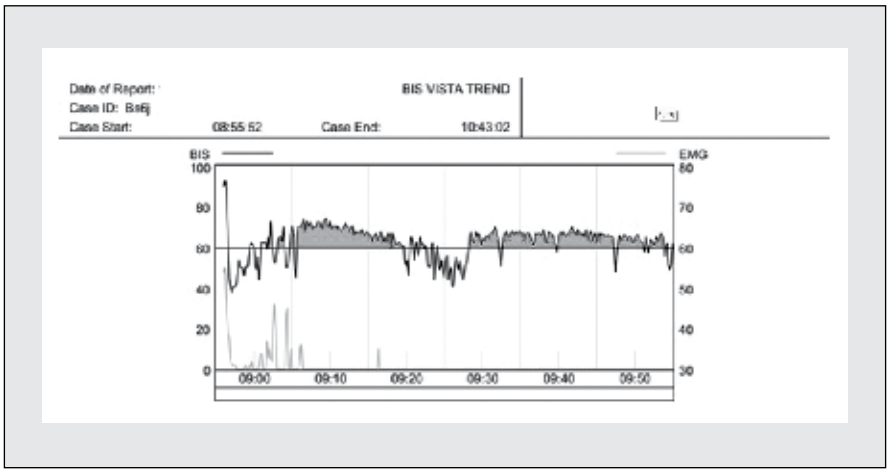

Figure 7. BIS registration example 3 — dark grey areas indicate prolonged periods of high electrical brain activity — may be representative of multiple intraoperative partial awareness

CONCLUSIONS:

1. Although the incidence of BIS > 60 are very common in obese patients, true awareness during anaesthesia infrequent in this group of patients, despite type of anaesthesia, namely intravenous or inhalation.
2. There was no correlation between the BMI value and the duration of an elevated BIS value observed during anaesthesia in both studied methods of anaesthesia, namely TIVA or inhalation anaesthesia.
3. There was no correlation between the total time of anaesthesia and the duration of BIS elevation above 60 in this study.
4. Further studies in this population of patients are necessary for better recognition and evaluation of the risk of intraoperative awareness.

ACKNOWLEDGEMENTS

1. We would like to thank Mr Kamil Kajak for conducting a mathematical analysis of the BIS recordings.
2. Source of funding — none.
3. Conflict of interest — none.

References:

1. *Pandit JJ, Andrade J, Bogod DG, Hitchman JM, Jonker WR, Lucas N:* The 5th National Audit Project (NAP5) on accidental awareness during general anaesthesia: summary of main findings and risk factors. Anaesthesia 2014; 69: 1089–1101.
2. *Duda I, Grzybowska K, Karpel E, Czechowski M, Seifert B, Was M:* Monitorowanie BIS w zabezpieczeniu przed niezamierzonym powrotem świadomości w czasie znieczulenia ogólnego — opis przypadku. Anestezjol Intens Ter 2006; 4: 240–242.
3. *Ghoneim MM:* Incidence of and risk factors for awareness during anaesthesia. Best Pract Res Clin Anaesthesiol 2007; 21: 327–343.
4. *Sandin RH, Enlund G, Samuelsson P, Lennmarken C:* Awareness during anaesthesia: a prospective case study. Lancet 2000; 26: 707–711.

5. *Romanik W, Kański A, Soluch P, Szymańska O:* Kwestionariuszowy i deklaratywny poziom lęku chorych przed operacją. Anestezjol Intens Ter 2009: 2: 94–99.
6. *Lemmens HJ, Brodsky JB:* General anesthesia, bariatric surgery, and the BIS monitor. Obes Surg 2005; 15: 63.
7. *Skora P, Machala W:* Awareness anaesthesia as a problem of modern anaesthesiology. Anestezjologia i Ratownictwo 2011; 5: 276–282.
8. *McCleane GJ, Cooper R:* The nature of pre-operative anxiety. Anaesthesia 1990; 45: 153–155.
9. *Zietkiewicz M, Nestorowicz A:* Intraoperative awareness — recommendations of the Committee on Quality and Safety in Anaesthesia, Polish Society of Anaesthesiology and Intensive Therapy. AnaesthesiolIntensive Ther 2012; 44: 57–62.
10. *Leslie K, Chan MT, Myles PS, Forbes A, McCulloch TJ:* Posttraumatic stress disorder in aware patients from the B-aware trial. Anesth Analg 2010; 110: 823–828. doi: 10.1213/ANE.0b013e3181b8b6ca.
11. *Wojcieszek E, Wojarska-Tręda E, Woźniakowska W, Kołosza Z, Dyaczyńska-Herman A, Lassota-Korba B:* Porównanie oceny klinicznej głębokości znieczulenia ogólnego z monitorowaniem za pomocą indeksu bispektralnego. Anestezjol Intens Ter 2005; 3: 165–169.
12. *Kreuer S, Molter G, Biedler A, Larsen R, Schoth S, Wilhelm W:* Narcotrend stages and end-tidal desflurane concentrations. An investigation during recovery from desflurane/remifentanil anaesthesia. Anaesthesist 2002; 51: 800–804.
13. *Schultz A, Siedenberg M, Grouven U, Kneif T, Schultz B:* Comparison of Narcotrend Index, Bispectral Index, spectral and entropy parameters during induction of propofol-remifentanil anaesthesia. J Clin Monit Comput 2008; 22: 103–11. doi: 10.1007/s10877-008-9111-6.
14. *Myles PS, Leslie K, McNeil J, Forbes A, Chan MT:* Bispectral index monitoring to prevent awareness during anaesthesia: the B-Aware randomised controlled trial. Lancet 2004; 29: 1757–1763.
15. *Anderson RE, Jakobsson JG:* Entropy of EEG during anaesthetic induction: a comparative study with propofol or nitrous oxide as sole agent. Br J Anaesth 2004; 92: 167–170.
16. *Weber F, Hollnberger H, Gruber M, Frank B, Taeger K:* The correlation of the Narcotrend Index with endtidal sevoflurane concentrations and hemodynamic parameters in children. Paediatr Anaesth 2005; 15: 727–732.
17. *Chen X, Tang J, White PF et al.:* A comparison of patient state index and bispectral index values during the perioperative period. Anesth Analg 2002; 95: 1669–1674.
18. *Willand M, Rudner R, Olejarczyk E et al.:* Próba wykorzystania analizy sygnałów EEG metodą wymiaru fraktalnego do określania stopnia zniesienia świadomości podczas indukcji znieczulenia ogólnego. Anestezjol Intens Ter 2008; 4: 217–222.
19. *Domino KB, Posner KL, Caplan RA, Cheney FW:* Awareness during anesthesia: a closed claims analysis. Anesthesiology 1999; 90: 1053–1061.
20. *Gaszynski TM, Strzelczyk JM, Gaszynski WP:* A total propofol consumption in morbidly obese during general anaesthesia according to BIS monitoring. Eur J Anaesthesiol 2003; 20 (suppl. 30): 39–40.
21. *Daunderer M, Schwender M:* Unwanted wakefulness during general anesthesia. Anaesthesist 2004; 53: 581–592.
22. *Avidan MS, Zhang L, Burnside BA et al.:* Anesthesia awareness and Bispectral Index. N Engl J Med 2008; 358: 1097–1108. doi: 10.1056/NEJMoa0707361.
23. *Dahaba AA:* Different conditions that could result in the bispectral index indicating an incorrect hypnotic state. Anesth Analg 2005; 101: 765–773.
24. *Pandazi A, Bourlioti A, Kostopanagiotou G:* Bispectral Index (BIS) monitoring in morbidly obese patients undergoing gastric bypass surgery: experience in 23 patients. Obes Surg 2005; 15: 58–62.
25. Gaszynski T, Strzelczyk J, Machala W, Gaszynski W: Reduction of a total propofol consumption in morbidly obese patients during general anesthesia due to BIS monitoring. Obes Surg 2005; 15: 1084.
26. *De Baerdemaeker LEC, Mortier EP, Struys M:* Pharmacokinetics in obese patients. Contin Educ Anaesth Crit Care Pain 2004; 4: 152–155. doi: 10.1093/bjaceaccp/mkh042.
27. *Servin F, Farinotti R, Haberer JP, Desmonts JM:* Propofol infusion for maintenance of anesthesia in morbidly obese patients receiving nitrous oxide. Anesthesiology 1993; 78: 657–665.
28. *Casati A, Putzu M:* Anesthesia in the obese patient: pharmacokinetic considerations. J Clin Anesth 2005; 17: 134–145.
29. *Albertin A, Poli D, La Colla L et al.:* Predictive performance of 'Servin's formula' during BIS®-guided propofol-remifentanil target-controlled infusion in morbidly obese patients. Br J Anaesth 2007; 98: 66–75.
30. *Casati A, Marchetti C, Spreafico E, Mamo D:* Effects of obesity on wash-in and wash-out kinetics of sevoflurane. Eur J Anaesthesiol 2004; 21: 243–245.
31. *Torri G, Casati A, Comotti L, Bignami E, Santorsola R, Scarioni M:* Wash-in and wash-out curves of sevoflurane and isoflurane in morbidly obese patients. Minerva Anestesiol 2002; 68: 523–527.
32. *Igarashi T, Nagata O, Iwakiri H, Ikeda M, Uezono S, Ozaki M:* Two cases of intraoperative awareness during intravenous anesthesia with propofol in morbidly obese patients. Masui 2002; 51: 1243–1247.
33. *Ghoneim MM, Block RI, Haffaman M and Mathews MJ:* Awareness during anesthesia: risk factors, causes and sequelae: a review of reported cases in the literature. Anesth Analg 2009; 108: 527–535. doi: 10.1213/ane.0b013e318193c634.
34. *Masuda T, Yamada H, Takada K et al.:* Bispectral index monitoring is useful to reduce total amount of propofol and to obtain immediate recovery after propofol anesthesia. Masui 2002; 51: 394–399.
35. *Gaszynski T:* Clinical experience with the C-Mac videolaryngoscope in morbidly obese patients. Anesthesiol Intensive Ther 2014; 46: 14–16. doi: 10.5603/AIT.2014.0003.
36. *Czarko K, Kwiatosz-Muc M, Fijalkowska A, Kowalczyk M, Rutyna R:* Intraoperative awareness — comparison of its incidence in women undergoing general anaesthesia for Caesarean section and for gynaecological procedures. Anaesthesiol Intensive Ther 2013; 45: 216–220. doi: 10.5603/AIT.2013.0039.

Corresponding author:

Prof. Tomasz Gaszyński MD, PhD
Department of Anaesthesiology and Intensive Therapy
Medical University of Łódź, Poland
Barlicki University Hospital, ul. Kopcinskiego 22,
90–153 Łódź, Poland
e-mail: tomasz.gaszynski@umed.lodz.pl

Appendix 1.

Questionnaire evaluating patient`s memories of anaesthesia.

Patient could answer "yes", "no" or "I do not know".

1. Do you remember being transferred to the operating theatre and preparation for anaesthesia?
2. Do you remember the end of the operation?
3. Do you recall that you were sleeping during the operation?
4. Do you remember the moment of falling asleep?
5. Do you recall any dreams during anaesthesia?
6. If yes, were they pleasant?
7. If yes, were they unpleasant?
8. Did you feel pain during anaesthesia?
9. Do you remember that you could not take a breathe during anaesthesia?
10. Do you recall anything from the duration of surgery?
11. Did you hear anything during surgery?
12. If yes, could you specify whether it was personal conversation?
13. Did you hear any noise during surgery?
14. Did you feel anything during surgery?
15. If yes, did you feel touch?
16. If yes, did you feel something in your throat or mouth?