Assessment of Depth of Anesthesia: PRST Score Versus Bispectral Index

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Assessment of depth of anesthesia is the basis in anesthesiologists work because the occurrence of awareness during general anesthesia is important due to stress, which is caused in the patient at that moment, and due to complications that may arise later. There are subjective and objective methods used to estimate the depth of anesthesia. The aim of this study was to assess the depth of anesthesia based on clinical parameters and on the basis bispectral index, and determine the part of bispectral monitoring in support to clinical assessment. Material and methods: Sixty patients divided into two groups were analyzed in a prospective study. In first group (group 1), the depth of anesthesia was assessed by PRST score, and in the second group (group 2) was assessed by bispectral monitoring with determination PRST score concurrently. In both groups PRST score was assessed in four periods, while bispectral monitoring is used continuously. For analysis were used the BIS index values from the equivalent periods as PRST scores. PRST score value 0-3, and BIS index 40-60 were considered as adequate depth of anesthesia.

The results showed that in our study were not waking patients during the surgery. In the group where the depth of anesthesia assessed clinically, we had a few of respondents (13%) for whom at some point were present indicators of light anesthesia. Postoperative interview excluded the possibility of intraoperative awareness. In the second group of patients and objective and clinical assessment indicated at all times to adequate depth of anesthesia. Conclusion: The use of BIS monitoring with clinical assessment allows anesthesiologists precise decision-making in balancing and dosage of anesthetics and other drugs, as well as treatment in certain situations. Key words: depth of anesthesia, PRST score, bispectral index

1. INTRODUCTION
Surgical anesthesia should be harmless and reversible state of insensibility of the patient, whose characteristics are sleep, analgesia, muscle relaxation and loss of reflexes. One of the achievements of modern anesthesia is the possibility of monitoring the depth of anesthesia. Adequate depth of anesthesia is present when the concentrations of drugs are sufficient to provide comfort to patients and perform surgery (1, 2). Clinical signs of "shallow" anesthesia (increases in blood pressure, heart rate, sweating and tearing) in conjunction with surgical stimulation were used and are still used to titrate anesthetic to the patient’s needs. PRST score (pressure, rate, sweating, tears) was proposed for the detection of inadequate depth of anesthesia. The control parameter value is the value that was before the induction. Adding up the points of all four parameters determine the total amount which can range from 0 to 8. There is inadequate depth of anesthesia if score is more than three (3).

To estimate the depth of anesthesia can be used objective methods that are based on recording and analysis of brain electrical activity. This electrical activity has a significant direct physiological correlation with the depth of anesthesia. Anesthetics act on brain physiology and lead to changes in cortical neural activity, resulting in changes in electrical brain activity with a reflection on the electroencephalogram (EEG). EEG is a noninvasive indicator of brain function when the patient is unconscious and without sensitivity (4, 5).

Bispectral index (BIS index) is a numerical processed, clinically confirmed EEG parameter obtained by combining more advanced EEG techniques such as bispectral analysis, a powerful spectral analysis and time analysis. These components are combined to optimize the correlation between EEG and clinical effects of anesthesia. BIS index is a number between 0 and 100 arranged to correlate with clinical status during the application of anesthetics. BIS value near 100 is a clinical state of alert, while 0 means the greatest possible effect on the EEG (isoelectric EEG). Administration of hypnotics leads to the
fallof the BIS index value of 100 in the waking state. Loss of consciousness occurs at BIS values between 70 and 80. BIS index of 40-60 indicates adequate hypnotic effect of general anesthesia with postoperative rapid return of consciousness. BIS value below 40 indicates a deep hypnotic state. BIS values decline below 70, the possibility of explicit survival is less. With the BIS index values of less than 60 is very small chance of awareness (6, 7).

2. AIM
The aim of this study was to evaluate the depth of anesthesia based on clinical parameters and bispectral monitoring, and to determine the value of bispectral monitoring in support to clinical assessment of depth of anesthesia.

3. SUBJECTS AND METHODS
The study was prospective and 30 patients who underwent inguinal hernia surgery at the Department of Surgery, University Clinical Centre Tuzla were analyzed. Subjects were of both sexes, aged 20-70 years, according to the classification of the American Society of Anesthesiologists (ASA) I and II operational risk. Two groups of 30 subjects have been selected consecutively. All patients preoperatively signed the consent to be included in the study. In the first group (group 1) depth of anesthesia was assessed by PRST score, and in the second group (group 2) by BIS index. Before induction, all patients were premedicated using midazolam (0.05 mg / kg). For introduction to anesthesia was used propofol (1.5 to 2.5 mg/kg), for muscle relaxation atracurium (0.6 mg/kg), while the anesthesia was maintained with O₂, N₂O and sevoflu- ran and, analgesia with fentanyl (0, 15 to 0.25 mg). Depth of anesthesia was assessed at the moment of intubation (t₁), at first skin incision (t₂), twenty minutes after the first incision (t₃), and immediately after placing the last suture in the skin (t₄). In the first group of respondents, before the introduction of anesthesia blood pressure and heart rate values were noted (t₀). At the time of intubation (t₁), the first skin incision (t₂), 20 min after the first incision (t₃), and immediately after placing the last suture in the skin (t₄) values of blood pressure and heart rate were again recorded, also the occurrence of tears in the closed eye or while opening the eye, and as well as the degree of skin moisture. Each parameter was scored from 0 to 2 and by summing up all the points obtained by the PRST score, depth of anesthesia was estimated. Values greater than three were considered as inadequate depth of anesthesia. In the second group of subjects to estimate the depth of anesthesia was used by appliance of BIS XP, Aspect Medical System. Before the introduction of anesthesia unilateral BIS sensor, that record the EEG waves, was mounted on cleaned and dried forehead. BIS sensor is with the appropriate cable connected with the BIS monitor that displays the EEG waves and BIS index value. Using a sensor that is placed on the patient’s forehead BIS monitoring translates information from the electroencephalogram into a simple number that is read on a monitor and represents a patient’s state of mind. BIS index was monitored continuously, and we recorded the value at the time of intubation (t₁), the first skin incision (t₂), 20 min after the first incision (t₃), and immediately after placing the last suture in the skin (t₄).

<table>
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<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
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</thead>
<tbody>
<tr>
<td>PRST t₁</td>
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<td>30</td>
<td>1.5667</td>
</tr>
<tr>
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<td>30</td>
<td>0.8333</td>
</tr>
<tr>
<td>PRST t₃</td>
<td>1</td>
<td>30</td>
<td>0.5333</td>
</tr>
<tr>
<td>PRST t₄</td>
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<td>30</td>
<td>0.9333</td>
</tr>
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Table 1, PRST score mean values in the first group of respondents

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</tr>
<tr>
<td>PRST t₂</td>
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<td>0.2000</td>
</tr>
<tr>
<td>PRST t₃</td>
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<td>30</td>
<td>0.0667</td>
</tr>
<tr>
<td>PRST t₄</td>
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<td>30</td>
<td>0.1000</td>
</tr>
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Table 2, The mean of PRST score in second group of respondents

<table>
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<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
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<tbody>
<tr>
<td>BIS t₁</td>
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<td>0</td>
<td>.</td>
</tr>
<tr>
<td>BIS t₂</td>
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<td>30</td>
<td>38.9333</td>
</tr>
<tr>
<td>BIS t₃</td>
<td>2</td>
<td>30</td>
<td>46.5667</td>
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<tr>
<td>BIS t₄</td>
<td>2</td>
<td>30</td>
<td>49.6667</td>
</tr>
</tbody>
</table>

Table 3, The mean value of BIS index in group 2
patients were male (90%) and 6 females (10%). In both groups, a larger number of subjects were those who underwent surgery of left inguinal hernia and had the first surgery. The average duration of surgery in the first group was 60.5 ± 5.46 min, while in the second group, 54.93 ± 2.14 min (p < 0.0001).

The results of the PRST score in the first group showed that ten patients had a value of almost 3, three patients had the value of almost 4, and one respondent had a value of PRST score 5. In other subjects PRST scores were lower than 3 (Figure 1).

The highest mean of PRST score was in t1 and its values in other periods were lower (Table 1). There is a statistically significant difference at t1 and t2, t1 and t3, t1 and t4, t2 and t3 (p < 0.05). The other combinations of PRST scores within this group do not have statistically significant difference. In all periods of measurement the subjects of the first group had a higher mean value PRST score, compared to the second group. There is a statistically significant difference in PRST scores in equivalent periods between the two studied groups (Figure 3).

Monitoring bispectral index in the second group got the lowest values in t1 and the highest in t4 (Figure 4). There is a statistically significant difference in BIS index values in all periods of measurement, and it is the most intensive between t1 and t2, t1 and t3, t1 and t4 (p < 0.05) (Table 3).

All respondents were interviewed 24 hours after surgery. According to a prepared questionnaire we asked questions about the immediate preoperative, intraoperative and postoperative memory. There was no significant difference in that what is the last what they remember before surgery, p = 0.1724. A significant difference exists in that what is the first thing to remember after the surgery. Greater number of respondents in the first group recalled sickroom, while the majority of the second group recalled the operating room, p =
0.0217. In both groups, all respondents gave a negative answer to the question of whether they remember something from a period of induction in anesthesia until the waking period.

5. DISCUSSION

In their daily work anesthesiologists assess the depth of anesthesia based on clinical signs, which represent a response of the autonomic nervous system of the organism to shallow anesthesia—tachycardia, hypertension, sweating, tearing, and dilation of the pupil. Evans and Davies in 1984 introduced a scoring system for clinical assessment of depth of anesthesia (PRST score). In the clinical practice, for assessing depth of anesthesia hemodynamic response to laryngoscope, intubation and skin incision is used. The signs of increased autonomic activity may be absent when there are opioids, cholinergic, beta blockers, vasodilators and antihypertensive drugs used. Increasing the parameter values of PRST score can cause hypovolemia, inadequate analgesia, hypoxia or hypercapnia. Signs of a shallow anesthesia often occur, but the correlation with awakens is low. In our study, depth of anesthesia in the first group of subjects was assessed only on the basis PRST score. The highest mean of PRST score we had in t1 (1.56). According to the mean value at this time we had an adequate depth of anesthesia, but by analyzing the individual values in one patient score was 4, which indicated a shallower anesthesia. During surgery, the t2 PRST score values were below 3, and in t4 in one patient score was the four. After placing the last suture (t3) in two subjects score was above the three. So, in three periods of assessment of depth of anesthesia by PRST score, we could conclude that in some respondents was not achieved an adequate depth of anesthesia. When we performed the postoperative interview after 24 h with the subjects, all of them gave a negative answer to questions about whether something is heard, seen or felt during the general anesthesia. In the second group of our patients anesthetic titration and assessment depth of anesthesia was done on the basis of bispectral index. Before giving midazolam to subjects BIS index value was between 97 and 100, after giving midazolam and fentanyl, it was over 80, and after injection of the intravenous anesthetics value was below the 60. Parallel to continuous monitoring of the BIS index, we assessed PRST score in the equivalent time as in the first group of subjects. The lowest mean of BIS index, we had in t1, and the highest in t4, which was expected because for induction to anesthesia we titrated an intravenous anesthetic to BIS index values below 40, and at the end of surgery reduced the concentrations of volatile anesthetic accompanying EEG and BIS. Monitoring PRST score parameters in the second group got the values that were significantly lower and different from values in the first group at the equivalent times. In the second group, in any period of analysis we had no PRST score higher than three. In this group of subjects we titrated the anesthetic by the BIS index values, keeping it in the range 40-60, which according to an activity level of the central nervous system is required for general anesthesia. In addition to this objective method, neither did the clinical assessment of depth of anesthesia by PRST score in this group of respondents indicate the being of “shallow” anesthesia and intraoperative awareness. And the second group of respondents in the postoperative interview after 24 hours gave a negative statement about being something heard, seen or felt during the surgery.

Myles and colleagues conducted a study which examined the two groups. In one group of subjects (N=1225) the depth of anesthesia was assessed by bispectral index, and in second group (N=1238) by clinical parameters. Two patients from the BIS group postoperatively declared that at one moment during surgery they were awake, and from the group that has been clinically evaluated for intraoperative wakefulness declared eleven patients (p=0.022). The results showed that the use of bispectral index in assessing depth of anesthesia reduces the risk of intraoperative awareness by 82% (8). In our study, the average duration of general anesthesia in the first group of subjects was 60.5 ± 5.46 min, while in the second group it was 54.93 ± 2.14 min (p <0.0001). Considering the shorter duration of general anesthesia in the second group, we can conclude that our respondents in the BIS group had a faster recovery than those whose depth of anesthesia was assessed by clinical parameters. Use of BIS monitoring during surgical procedures, aside from preventing the occurrence of intraoperative awareness, it allows more precise dosing of anesthetics, shorter staying in the recovery room and reduces the incidence of postoperative nausea and vomiting. In a study conducted by Gan and colleagues, it was analyzed the rate of recovery from general anesthesia in two groups. In one group depth of anesthesia was assessed by clinical parameters, and in second group on the basis of the clinical parameters and bispectral index. The results showed that the respondents in the BIS group before opened their eyes, carried out the orders and before were extubated after surgery (9).

Bispectral index allows to anesthesiologists directly and accurately monitoring the central nervous system during the application of anesthetics or sedatives, and assessment of the hypnotic effect of anesthesia (10, 11). Bispectral index monitoring assesses the depth of anesthesia and facilitates titration of anesthetics. In the operating room changes in blood pressure and heart rate are not uncommon, and the task of anesthesiologists in these situations is to make a prompt diagnostic evaluation and timely intervention to eliminate the cause of these changes. BIS monitoring provides new information that can facilitate the anesthesiologist in making decisions and treatment of many of these situations (12, 13).

6. CONCLUSION

Evaluation of intraoperative depth of anesthesia is one of the main tasks of anesthesiologists. In their daily work anesthesiologists assess depth of anesthesia by clinical parameters. The use of bispectral monitoring facilitates anesthesiologist assessment the depth of anesthesia. Assessing the depth of anesthesia using BIS monitoring is a noninvasive method. BIS monitoring is not a substitute for clinical assessment
of depth of anesthesia. With bispectral monitoring it is necessary to observe clinical parameters, and the ultimate decision about the measures, which should be taken, make on the basis of bispectral index and clinical parameters in the equivalent time. The use of BIS monitoring with clinical assessment allows anesthesiologists precise decision-making and balancing a dosage of anesthetics and other medicines such as analgesics and cardio active agents, especially in patients with higher operative risk

REFERENCES