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Derin Beyin Stimülasyonu (DBS) uygulanan hastaların entegre pulmoner index (IPI) monitörizasyonu ile takibi

Evaluation of Integrated Pulmonary Index monitoring during sedation for Deep Brain Stimulation

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ÖZ

GİRİŞ ve AMAÇ: *Entegre pulmoner indeks (EPİ); oksijen satürasyonu, End-tidal karbondoksit konsantrasyonu,solunum sayısı ve kalp hızı değerlerinin ortak matematiksel analiziyle elde edilen indeks değeridir. Derin Beyin Stimülasyonu (DBS) ameliyatı, parkinson hastalığı, esansiyel tremor ve distoni gibi hareket bozukluklarının tedavisinde sedasyon altında beyine elektrod yerleştirilmesi işlemidir. Genellikle bu hasta grubu, orta yaş ve üstü olup, çoğu zaman yandaş bir sistemik hastalıkları da vardır. Çalışmamızda DBS için sedasyon uygulanan hastaların takiplerinde EPİ ve oksijen satürasyonu (SpO2) kullanımının solunumu etkilemesi ve erken farkındalık yaratması üzerine olan etkilerini görmeyi hedefledik.*

YÖNTEM ve GEREÇLER: *Etik komite onayı sonrası 2015-2017 yılları arasında sedasyon ile dexmedetomidine uygulanan ve monitörizasyonda EPİ kullanılan (Grup EPİ) ve kullanılmayan (Grup PO) hastaları retrospektif olarak inceledik. Hastaların yaş, cinsiyet, ASA sınıflaması, yandaş hastalıkları ve kullandıkları ilaçlar ile sedasyon sırasındaki kan basıncı, kalp hızı, SpO2, solunum sayısı, ve EPi kullanılan hastalarda EPİ değerleri, işlem süreleri ve erken postoperatif komplikasyonlar incelendi. Sedasyon değerlendirmesi Observer Assessment of Alertness/Sedation Skor(OAA/SS) kullanılarak yapıldı. Ağrılı işlemler sırasında uygulanan propofol ve midazolam dozları da karşılaştırıldı.*

BULGULAR: *Çalışmamızda sedasyon için deksmedetomidin uygulandığımız hasta gruplarında benzer hemodinamik ve solunumsal değişiklikler gözlendi. Grup PO'de sedasyon için ilaç uygulanan dönemlerde EPİ değerlerinin hafif düşmesine rağmen yeterli solunumun sağlandığını izledik. SpO2 değeri 2. sedasyon dönemi dışında Grup EPİ'de anlamlı yüksek bulundu ($p<0,01$). Grup EPİ'de sadece 1 hastada, Grup PO'da 2 hastada solunumsal desteğe ihtiyaç duyuldu. Grup EPİ'de EPİ değerleri sedasyon döneminde daha yüksekken, nörolojik muayene sırasında düşük ($p<0,01$) bulundu.*

TARTIŞMA ve SONUÇ: *EPİ monitörizasyonunun uzun sedasyon gerektiren DBs hasta grubunda ani solunumsal değişikliklerde erken farkındalık oluşturmasıyla faydalı olabileceğini düşündük.*

Anahtar Kelimeler: *Entegre pulmoner indeks, Derin beyin stimülasyonu, Sedasyon*

ABSTRACT

INTRODUCTION: *The Integrated Pulmoner Index (IPI) is a mathematically determined factor calculated from measured end tidal carbon dioxide (ETCO2), respiratory rate, Oxygen saturation (SpO2) and pulse rate. Deep Brain stimulation (DBS) is a minimally invasive surgery for various movement disorders. During this procedure, electrodes and placed in target nuclei and performed under sedation. DBS patients were especially old and have comorbid medical conditions. We aimed to assess the early detection of respiratory adverse effects by the use of IPI andSpO2 monitorization.*

METHODS: *After receiving Ethics committee's approval, we reviewed retrospectively, patients' characteristics of age, gender, ASA status, coexisting diseases, sedation technique, drugs used, prosedüre durations and early complications. The study groups were determined as having IPI monitorization (Group IPI or not (Group PO). We also revised patients' heart rate, respiratory rate, SpO2, mean arterial pressure. Sedation was assessed with Observer Assessment of Alertness/Sedation Score (OAA/SS) and total amount of propofol and midazolam added during pain.*

RESULTS: *We observed similar hemodynamic and respiratory effects during sedation with dexmedetomidine. Group IPI have lower IPI values during sedation period compared with period of neurological assessment but respiratory status was sufficient. SpO2 data was found higher in Group IPI ($p<0,01$). In Group IPI only one patient and in Group PO 2 patients need respiratory support. In Group IPI, IPI values were found higher in sedation than neurological assessment duration ($p<0,01$).*

DISCUSSION AND CONCLUSION: *Currently, there is limited data validating in DBS practice. IPI monitoring can early detect sudden respiratory changes in patients during DBS.*

Keywords: *Integrated pulmonery index, Deep brain stimülation, Sedation*

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INTRODUCTION

Deep Brain Stimulation (DBS) is a minimally invasive procedure used for the treatment of neurological disorder such as Parkinson's Disease, movement disorders and certain psychiatric conditions (1). DBS has become an increasingly common procedure over the past few years due to technological evaluation and increasing experience. DBS surgery is performed in two stages: 1) Placement of electrodes in target nuclei and 2) Internalization of leads and subcutaneous placement of the implantable pulse generator. The first period is performed with conscious sedation and the second period of subcutaneous placement is performed under general anesthesia. The long operative period and patient's discomfort during the procedure are the main requirements for sedation. The patients are unable to alter their position which leads to back and neck pain.

Preoperative assessment, pre-anesthetic check-up must be done carefully and include general condition of the patient, psychiatric history, cognitive function, level of disability, risk factors for complications and response to medical treatment. Conscious sedation and efficient analgesia allow surgeon to do neurological examination (1). Use of propofol and dexmedetomidine infusion has been described for sedation. Drug induced respiratory depression and airway obstruction are the leading causes of morbidity during sedation. Respiratory and cardiac complications could be lowered with monitorization and assessment of sedation (2).

The Integrated Pulmonary Index (IPI) is an early-warning score against apnea-induced hypoxemia. A numeric value can easily recognize the changes of respiratory pattern (3). This tool is a single index value ranging from 1 to 10 (Table-1) based on 4 physiological parameters: end tidal carbon dioxide (EtCO2), respiratory rate (RR), oxygen saturation (SpO2) and pulse rate (PR). The IPI uses a fuzzy logic mathematical model.

Currently there is limited data validating IPI in DBS practice. The aim of this retrospective study is to assess to compare the ability of IPI to detect respiratory adverse events with standard SpO2 monitorization in patients receiving sedation for DBS.

MATERIALS AND METHODS

After receiving Ethics Committee approval, 57 DBS procedures at our institution were retrospectively reviewed. We reviewed anesthetic records, discharge summaries and operative reports for procedures performed between 2015-2017. Patient characteristics records including age, gender, ASA physical status, accompanying diseases, sedation technique, drugs used for sedation, procedure durations, and early complications.

Patients from whom informed consent was not found in records, procedures done under local, general anesthesia or sedation drug other than dexmedetomidine were excluded.

34 patients' DBS procedures were done under conscious sedation. All procedures were done in supine position and because of the retrospective nature of this study, the authors did not influence the anesthetic management of these procedures.

Patients were divided into two groups according to measurement of IPI during sedation. In both groups standard monitoring included clinical observation, pulse oximetry, automated blood pressure monitoring, and electrocardiogram and data were collected in 5 min intervals. All patients received 2lt/min supplemental oxygen via nasal cannula. IPI values are derived from FilterLine® EtCO2 sampling line (Covidien, Medtronic, USA). IPI group (Group IPI) has additional data of EtCO2 during expiration and IPI score **(Table 1).**

Table 1. Patient status as documented by the Integrated Pulmonary Index (IPI)

IPI	Patient Status
10	Normal
8-9	Within normal range
7	Close to normal range; requires attention
5-6	Requires attention and may require intervention
3-4	Requires intervention
1-2	Requires immediate intervention

Physiological and hemodynamic parameters were recorded in the beginning of operation without sedation, the first electrode implantation period (under sedation), at the time of neurological confirmation of the electrode location, at the second

electrode implantation and the second confirmation of electrode implantation and at the second confirmation of electrode by neurological examination.

In our practice, all patients' sedation scores were written on anesthesia records with Observers Assessment of Alertness/Sedation Scale (OAA/S) **(Table 2).**

Table 2.Responsiveness scores of the Observer's Assessment of Alertness/sedation Scale (OAAS/S)

Response	Score level
Responds rapidly to name spoken in normal tone	5
Lethargic response to name in normal tone	4
Responds only after name is called loudly or repeatedly	3
Responds only after mild prodding or shaking	2
Does not respond to mild prodding or shaking	1

In the IPI group (Group IPI) patients with a value under 7 and in SpO2 group (Group PO) an oxygen saturation below 93% were recorded as hypoventilation or apnea. An intervention which consisted of 1) Patient stimulation, 2) Withdrawing medication, 3) Chin lift or jaw trust maneuver, 4) Increasing fraction of inspired oxygen to 5 lt/min, and 5) Insertion of a nasopharyngeal airway.

Drug doses used during the procedure were analyzed. Patients with OAA/S score of 5 and during urinary tract instrumentation first 1 mg midazolam were added, if midazolam was not sufficient 0,5 mg/kg propofol were added.

Data analysis of physiological parameters (EtCO2, RR, SpO2 and PR) between the groups were performed by repeated measurements of one-way Analysis of Variance (ANOVA) and Tukey-Kramer Multiple Comparisons tests. Group comparisons of categorical data were conducted using Student's t-test. A p value of less than 0,05 was considered to be statistically significant.

RESULTS

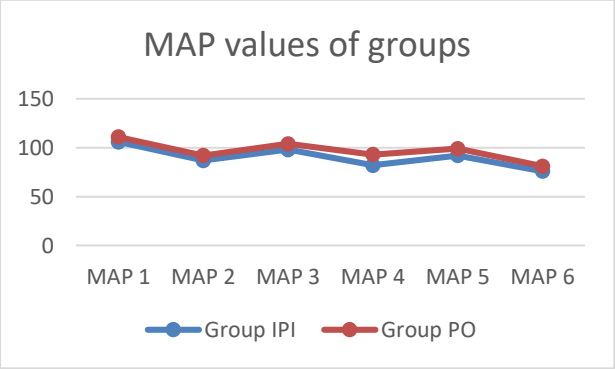
The study included 34 patients in whom IPI analysis were done in 17 patients (Group IPI). The demographic data (age, gender, ASA physical status), coexisting diseases and operation indications and median DBS procedure durations are well matched between both group **(Table 3).** The median procedure duration was not differing significantly between groups.

Table 3. Comparing 2 Groups of Patients' Variables

	Group EPI		Group PO	
	%	n	%	n
Male	70	12	47	8
Female	30	5	53	9
ASA Status II	47	7	53	9
ASA Status III	53	9	47	8
Age (years)	56,71 ± 10,08		62,06 ± 7,27	
Procedure duration (min)	343,82 ± 33,14		356,18 ± 33,05	
Sedation duration (min)	252,06 ± 24,17		258,24 ± 24,23	
Total Dexmedetomidine amount (mcg)	1370 ± 276		1720 ± 572	
Mean propofol dose (mg)	31,76 ± 10,97		54,12 ± 17,84	

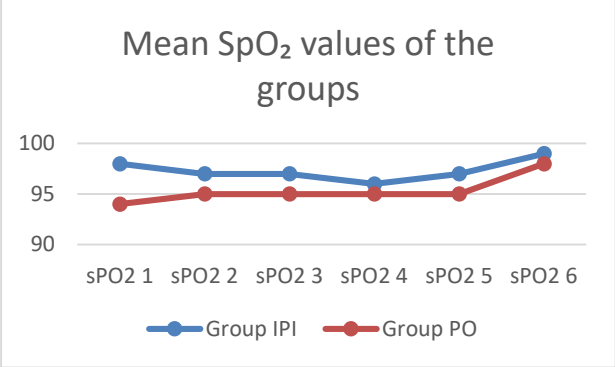
Indications of DBS patients were similar between groups. In Group IPI 15 patients had Parkinson's Disease and 2 patients had Dystonia as in Group PO 16 patients had Parkinson's disease and 1 patient had essential tremor.

Hemodynamic parameters were also similar between groups. Mean arterial pressures (MAP) of the groups were not statistically different (p>0,05) **(Graphic1).** In both groups MAP before the operation were statistically higher than the sedation period (p<0,01). There was no statistical difference of PR between and beside groups.



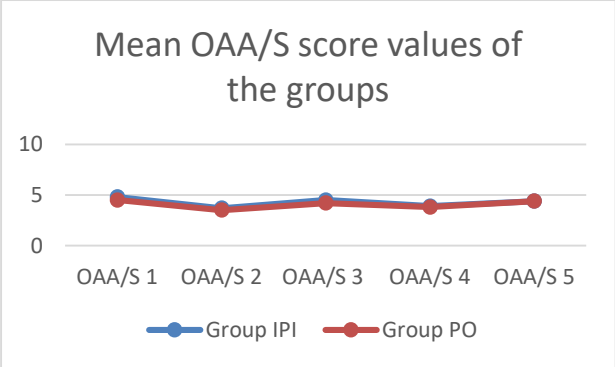
Graphic 1. Mean Arterial Pressure (MAP) values

Oxygen saturation levels were higher in Group IPI except during the second period. In Group IPI only one patient had an IPI value ≤6 and patient was successfully stimulated verbally and tactilely. In Group PO, 4 patients had an SpO2 value ≤ 92% and 2 higher fractions of inspired oxygen (**Graphic 2**). This means that the sensitivity of IPI was better than that of pulse oximetry to detect relevant impairment of the respiratory function.



Graphic 2. Mean Oxygen Saturation (SpO2) values

Patient cooperation during DBS was rated by OAA/S between 1 and 5. There were no statistical difference between groups (p>0,05). Neurological examination periods have higher OAA/S scores than the sedation periods (p>0,001) as expected **(Graphic 3).**



Graphic 3. Mean Observer's Assessment of Alertness and Sedation (OAA/S) score

IPI values in Group IPI range in time where highest levels obtained at neurological examination periods. (p<0,01).

Drug doses used during the procedure were analyzed. The mean total dexmedetomidine dose was 1370 ± 276 mcg in Group IPI, and 1720 ± 572 mcg in Group PO. The propofol added during pain or for extra sedation were higher in Group PO (p<0,05). Mean propofol dose used in Group IPI was 31,76 ± 10,97 mg and 54,12 ± 17,84 mg in Group PO.

DISCUSSION

Deep brain stimulation is a procedure which presents many anesthetic challenges. These procedures tend to be long, the patients should be in supine position for this long duration, which causes cervical and back pain during and after the procedure (1). The presence of head frame, down sliding of the patient on the operative table with the head fixed and neck flexed complicate the situation DBs procedure especially for the airway management. Therefore, adequate sedoanalgesia is essential. Procedure-related considerations include difficult airway access due to the presence of head frame. Drug-induced respiratory depression and airway obstruction are the leading causes of morbidity during sedation (2). Pulse oximetry and supplemental oxygen are routinely used during sedation, but this does not guarantee adequate ventilation. Sudden changes in ventilation obligates the need for additional monitorization. IPI aims to act as a warning system against hypoventilation based on respiratory rate and EtCO2 (3,4).

IPI was tested on 523 patients' data retrospectively on clinical signs of SpO2, RR, PR and PetCO2 which demonstrates high levels of sensitivity and specifity. Ronen et al. suggests that IPI can identify patients' respiratory status in an objective manner (4).

Garah et al. studied on pediatric patients for different endoscopic procedures. IPI alerted all apnea episodes and hypoxia episodes whereas pulse oximetry only detected the hypoxia episodes. They calculated IPI sensitivity as =1 and specifity was 0,98 and positive predictive value was 0,95 (5).

IPI was used in many procedural sedations. Patients' ages, drug selection and morphological characteristics that alter respiratory parameters may affect IPI values. Our patients with Parkinson's disease, dystonia and essential tremor were over middle age and had accompanying systemic diseases.

Berkenstdat et al reported that IPI is indicated mainly for events requiring immediate intervention and in selected patient populations such as obese patients (6).

Sedation drugs can depress ventilatory drive, especially during long lasting DBS procedures, which also require deep sedation. Dexmedetomidine is a good alternative for intravenous sedation with a half-life of 6 min and elimination half-life of 2 hours. It has been considered as an ideal sedative agent for DBS surgery due to its ability to produce sedation, minimal respiratory depression and easy arouse (7). Hypotension and bradycardia are disadvantages especially in old patients; and old age is a common characteristic of patients with an induction for DBS (8).

In this study, there were no cases of severe bradycardia, hypotension, or respiratory depression during sedation with dexmedetomidine. There were only mild decreases in IPI scores. These sudden were as a result of decreases in either RR, EtCO2 or SpO2. However, IPI monitorization is a helpful tool to the anesthesiologist in reducing the incidence of apnea.

There was no significant difference between groups but there were higher SpO2 levels in Group IPI. Nasal cannula of the IPI apparatus is anatomically better suited to the nasal airways, which may provide a better oxygenation.

Riphaus et al. assessed the efficacy of the IPI monitorization in reducing total midazolam and propofol dose. They concluded that addition of IPI monitorization did not fulfill this promise; however, provided a significantly better detection rate for longer lasting (>15s) apnea episodes compared with pulse oximetry (9). IPI monitorization enabled earlier recognition of respiratory problems than SpO2 in colonoscopy/endoscopy patients (10) and gave an advantage to the researchers.

Patients in IPI group of this study received lower amounts of sedative drugs and had less respiratory depression. Another study about IPI monitorization demonstrated earlier detection of apnea and hypopnea in 100 patients of maxillofacial surgery under sedation (11).

Gazal et al noted that especially in deep sedation of children, IPI monitorization can detect all respiratory problems such as hypoxia, hypercarbia, and apnea (specifity %98) (12). In addition, an important advantage of using IPI in children is that, it allows non-anesthesiologists, to rapidly and easily evaluate the respiratory statues of their patients. In another study, IPI detected all hypoxia and apnea episodes of 109 children under sedation for endoscopic procedures, where SpO2 only detected hypoxia episodes (5). A prospective IPI study should be planned to verify these benefits in DBS.

This study showed that, IPI monitorization is capable to warn against hypopnea episodes. However, none of the patient had an apnea episode under sedation, and none required any intervention. Sudden changes of the IPI monitor cause an alarm that aroused anesthesiologist attention.

CONCLUSION

IPI monitoring can early detect sudden respiratory changes in old and patients with respiratory diseases during sedation in DBS.

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