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Research Article

Correlation of integrated pulmonary index with clinical observation in unilateral and bilateral spinal anaesthesia in geriatric patients

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ABSTRACT

Background: In present study, we aimed to determine the role of integrated pulmonary index (IPI) in monitorising geriatric cases that have spontaneous ventilation under unilateral and spinal block during partial hip prosthesis and total knee arthroplasty.
Methods: 24 patients who were over 65 years of age and with ASA I-IV, femoral neck fracture, intertrochanteric fracture and in whom gonarthros had developed were simply randomised into two groups. Values of blood pressure, pulse rate (PR), SPO_2, $EtCO_2$, respiratory rate (RR), IPI were recorded. Unilateral spinal block was administered with 7.5 mg, 0.5% bupivacaine and 25 mcg fentanyl in Group I and with 12.5 mg 0.5% bupivacaine and 25 mcg fentanyl in Group II. Values were recorded in intervals of 5 and 15 minutes and continued to be recorded from the moment of cement application. Preoperative mask ventilation or intubation need was recorded.
Results: For $EtCO_2$, bilateral spinal block scores at post-cement 15 minutes; postop 5 minutes were found to be high providing that they were within the clinically normal limits compared to the unilateral scores. A correlation between IPI and SpO_2, $EtCO_2$, respiratory rate, pulse rate was identified. In both groups, IPI was found to be in normal range and a correlation was identified through clinical observation.
Conclusions: IPI might be the sole numerical value in early identification of clinical correlation and respiratory failure. For the IPI monitor is small and easy to be handled along with its screen that shows many parameters together makes the device be easily used.

Keywords: IPI, Monitorisition, Spinal block, Geriatric anaesthesia

INTRODUCTION

The Integrated Pulmonary Index (IPI) is an algorithm that incorporates four real-time respiratory parameters (end-tidal CO_2, respiratory rate, pulse rate, SpO_2) into a single number that stands for respiratory profile including these parameters. For IPI evaluates patient's respirtory status promptly, clinicians use IPI in order to determine if there is a need for aditional clinical assessment and intervention.[1,2] In patients who will go under geriatric hip prothesis and total knee arthroplasty, usually spinal anaesthesia is administered. Spinal anaesthesia may be unilateral or bilateral. Along with standard monitorisation parameters (blood pressure, heart rate, peripheral oxygen saturation), end tidal carbondioxide measurement can be performed through nasal canula. IPI score has begun to go into use clinically as an additional monitorisation parameter by the analysis of these four parameters (pulse rate, respiratory rate, peripheral oxygen saturation, end-tidal carbondioxide measurement) (Figure 1).

In present study, we aimed to determine the place of IPI (integrated pulmonary index) in monitorisation of geriatric cases that have spontaneous breathing under

unilateral and spinal block during partial hip prosthesis and total knee arthroplasty. Also, we targeted to evaluate reflections of changes in respiratory parameters to IPI monitorisation in unilateral or bilateral spinal block.

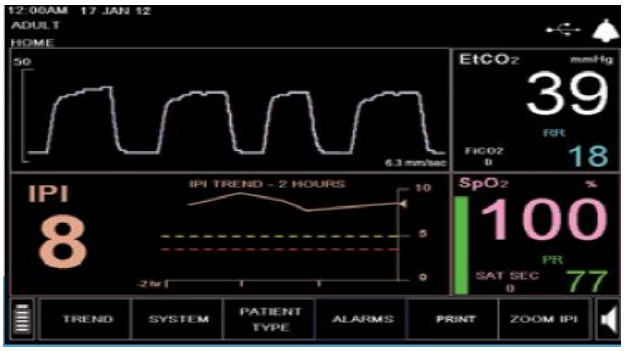

Figure 1: Integrated pulmonary index monitor.

METHODS

Fatih Sultan Mehmet Teaching and Research Hospital Ethics Committee approved the study (No. 2015/15). After receiving patients' informed consent, 24 patients who were over 65 years of age and with anaesthesia risk ASA I-IV, femoral neck fracture, intertrochanteric fracture and gonarthros development were simply randomised into two groups prospectively by a computer program. Patients were taken onto the operation table and monitorised. Baseline measurements were recorded. Blood pressure, heart rate, SPO_2, $EtCO_2$, respiratory rate (RR), pulse rate (PR), IPI (integrated pulmonary index) scores were recorded.

Table 1: IPI score is between 1 and 10.[3,4]

IPI	Patient status
10	Normal
8-9	In normal range
7	Near normal range – needs attention
5-6	Needs attention and may require intervention
3-4	Requires intervention
1-2	Requires emergent intervention

Table 2: Ramsay sedation scale.[5]

Score	Sedation scale
1	Awake, agitated/restless and/or crying
2	Awake, cooperative oriented, tranquil
3	Asleep, responsive to commands only
4	Asleep, but brisk response to glabellar tactile stimulus
5	Asleep, but sluggish response to glabellar tactile stimulus
6	No response to stimulus

Providing that the target score is to be 2 and 3 according to the Ramsay Sedation Scale, patients were given 0.01 mg/kg midazolam IV before spinal anaesthesia and, if necessary intraoperatively.

Patients were given appropriate position for spinal anaesthesia after being re-informed prior to the procedure. Under sterile conditions; unilateral spinal block was done with 7.5 mg 0.5% (1.5 ml) heavy bupivacaine and 25 mcg fentanyl intrathecal in Group 1; and bilateral spinal block was done with 12.5 mg 0.5% (2.5 ml) heavy bupivacaine and 25 mcg fentanyl intrathecal in Group II. In both groups, 22 G Quincke spinal needle was used. In patients under unilateral spinal block, necessary position for surgery was given after keeping them waiting for 5 minutes in lateral position of spinal blocking administration.

Sensory block level (pinprick test) and motor block level (according to the Bromage scale) were checked after 5 minutes of spinal anaesthesia.

Table 3: Bromage scale.[6]

Score	Sedation scale
0	No paralysis, the patient is capable of complete flexion of feet and knee.
1	Just able to flex knees with free movement of feet, not able to lift up legs.
2	Unable to flex knees, but free movement of feet.
3	Unable to move feet joint or thumb, paralysis.

Then, score values were recorded by five and fifteen minutes intervals. Scores continued to be recorded from the moment on the cement (polymethyl methacrylate) was applied by the surgery team. All over the operational procedure, 2 L/min O_2 was administered intranasally. Records were obtained in the end of the postoperative 1 and 5 minutes. The need for postoperative mask ventilation and intubation were also recorded.

Statistical analysis

As a result of power analysis, as we took Δ:1.5 SD:1 for IPI parameter, sampling number for Power: 0.80 and α:0.005 was determined to be n:8 at minimum being specified for each group.

For statistical analysis, IBM SPSS Statistics 22 (IBM SPSS, Turkey) program was used. Convenience of parameters to the normal distribution was assessed with Shapiro Wilks test while assessing the study data.

As the study data were evaluated, Student t test was used in comparing quantitative data besides descriptive statistical methods, for comparing parameters that showed normal distribution between the two groups, while Mann Whitney U test was used in comparing data that did not show a normal distribution between the two

groups. Paired sample t test was used in the comparing parameters that showed normal distribution, and Wilcoxon signed-rank test was used in comparing parameters that did not show normal distribution.

Fisher's Exact Chi-square test was used in comparing qualitative parameters. Pearson correlation analysis was used in studying relationship between parameters that showed convenience to normal distribution, and Spearman's rho correlation analysis was used in studying relationship between parameters that did not show convenience to normal distribution. Significance was evaluated by $p<0.05$.

RESULTS

Demographic features are shown in Table 4. As a result of present study, no difference was found between two groups in hemodynamic parameters (blood pressure, heart rate).

Table 4: Demographic properties.

	Unilateral spinal block	Bilateral spinal block	p
	Mean±SD (median)	Mean±SD (median)	
Age	80.33±7.38	66.58±8.31	[1]0.001**
Body mass index	23.35±4.77	31.86±7.62	[1]0.003**
Duration of surgery (minute)	103.75±20.24	120.83±51.65	[1]0.298
ASA Score	2.67±0.65 (3)	2.58±0.51 (3)	[2]0.818
5th min Bromage Score	3.00±0 (3)	2.67±0.89 (3)	[2]0.149
Ratio of mask ventilation (n.%)	0 (%0)	1 (%8.3)	[3]1.000

[1] Student t test; [2] Mann Whitney U Test; [3]Fisher's Exact Test; ** p<0.01.

Table 5: Assessment of the IPI mean with sedation in each groups.

Sedation	IPI Mean	
	Unilateral Spinal Block	Bilateral Spinal Block
	Mean±SD (median)	Mean±SD (median)
No	8.63±1.05 (8,72)	9.26±0.49 (9.38)
Yes	8.23±1.29 (8,07)	9.15±1.08 (9.6)
p	**0.522**	**0.626**

Mann-Whitney U Test.

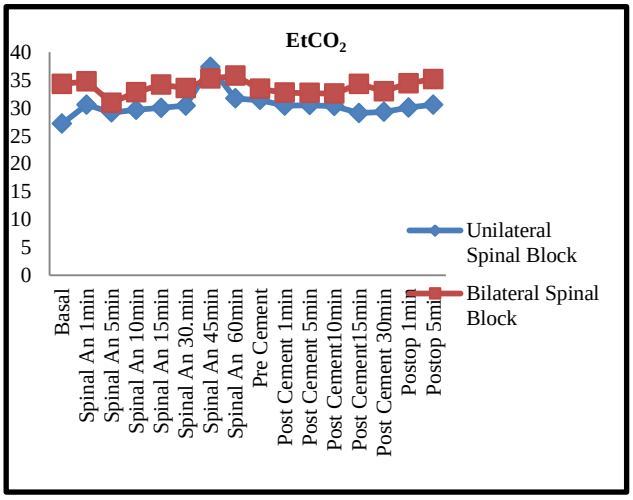

Figure 2: $ETCO_2$ values.

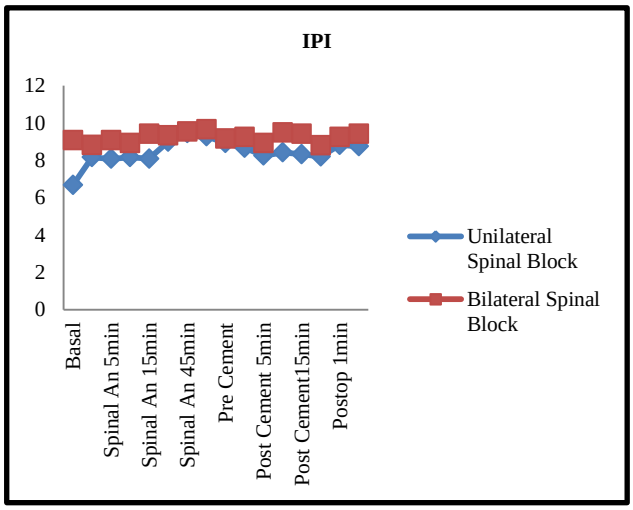

Figure 3: IPI values.

There was no significant difference between two groups regarding SpO_2, respiratory rate, pulse rate that are the components composing IPI score. In $EtCO_2$ evaluation, bilateral spinal block values were found to be higher in normal range than unilateral values in 1 min, 15 min, 60 min and post-cement 15 min., postop 5 min (Figure 2).

IPI scores were found to be in normal range in both groups (Figure 3). In bilateral spinal block group, mask ventilation need was clinically observed only in one patient and correlation was observed between IPI and clinical status.

With sedation, there found to be no difference between two groups in IPI scores (Table 5).

DISCUSSION

High risk in geriatric patient population implies operation with the most possible number of monitorisation parameter. Along with the advances in technology, significant progresses in patient monitorisation during anaesthesia have been obtained. IPI is a new monitorisation method that gathers respiratory parameters under one score particularly in patients who are monitorised while in spontaneous ventilation.

Gozal et al conducted a study with the purpose of evaluating the validity and reliability of IPI index during pediatric sedation.[1] Seventy-seven pediatric patients were included in the study who were under deep sedation; mean age was 4.8 years.

These patients stayed connected to the monitor for at least 30 minutes. In all cases, IPI displayed 6 and the other values under 6. Ninety percent of alarms generated by the IPI monitor were true positive alarms. A good correlation between clinical assessment performed and IPI score was demonstrated. Thus, close correlation between IPI and respiratory status of pediatric patients who are under deep sedation has been demonstrated.

Kumar et al, in their study, tested the hypothesis stating that IPI score is higher in successful spontaneous ventilation trials than unsuccessful spontaneous ventilation trials.[2] Twenty four obese patients who had gone under cardiopulmonary bypass operation. IPI was continuously recorded during spontaneous ventilation trials. The result of each spontaneous ventilation trial was determined by intensive care unit team independently of IPI. Records were analysed in order to determine the efficacy of IPI in estimating the results of weaning assessment; statistical analysis showed that mean IPI score was higher in successful spontaneous ventilation trials than in unsuccessful spontaneous ventilation trials.

In another study conducted with the same purpose by Kumar et al, 43 intensive care unit patients with a mean age 59.7±13.6 years and who were intubated with a surgical or medical indication were enrolled.[3] Also in this study, statistical analysis demonstrated that mean IPI score was higher in successful spontaneous ventilation trials than in unsuccessful spontaneous ventilation trials.

The study conducted by Berkenstadt et al, aimed to compare respiratory pattern to prospective IPI in patients who would go under colonoscopy in moderate sedation.[4] In groups with low (1-3), moderate (4-6) and high (7-10) IPI scores, there was no difference regarding respiratory rate (RR), SpO_2, pulse rate (PR), but $EtCO_2$ value was found to be higher in high IPI group. Those results are similar with our results and a general correlation between IPI and SpO_2, $EtCO_2$, respiratory rate and pulse rate was found. There observed to be a correlation between clinical respiratory failure and IPI.

Schier et al, in their study, mentioned that IPI was a clinically useful monitor.[7] They stated that there needed to conduct further studies in order to find out if it is sensitive to environmental factors (cautery usage, tremors in the patient, etc.) compared to the monitors used widely in the clinics. In our study, we did not experience any problem with environmental factors with respect to IPI.

Sabbatani et al, in a study they conducted, aimed to evaluate the efficacy and safety of sedation with midazolam by capnometry and IPI in patients in whom electrical external cardioversion was applied due to atrial fibrilation.[8] 45 patients with atrial fibrillation in whom electrical external cardioversion would be applied were enrolled in the study.

Patients were sedated with 5 mg bolus midazolam followed by an additional 5 mg dose of midazolam within 2 minutes. Following cardioversion, within 30 minutes after a 0.5 mg bolus anexate dose, an additional 0.5 mg dose of anexate was administered. In induction $EtCO_2$ values, there found to be no significant difference when compared to imitial values. And in IPI index, there found to be significant differences in induction compared to baseline, in awake phases compared to induction and in awake phases compared to baseline. However, all of the value ranges was found to be in normal limits. Apnea and hypoxia were not seen in any patients, and one incident of hypotension that ended within 2 minutes following shock in one patient. In our study, only in one patient, temporary mask ventilation was applied for a short time it was found to be correlated with IPI.

In the study of Garah et al, it was aimed to evaluate the place of IPI monitor in pediatric endoscopy procedures. Patients were enrolled in 3 groups according to the drugs they were using. Five patients using only propofol were enrolled in the first group, 89 patients using propofol and midazolam were enrolled in the second group and 15 patients using propofol, midazolam and fentanyl in the third group.[9]

As a result, IPI scores in Group 2 and 3 were found to be significantly higher than the values in Group 1. IPI values in 4-6 age group were found to be significantly lower than the values in 7-12 age group. High midazolam doses were correlated with low IPI scores.

IPI values were found to be lower in patients who received anaesthesia than the values in patients who did not receive anaesthesia. While IPI was alarming in all apnea (58 cases, IPI:1) and hypoxia (26 cases, IPI $\leq$3) episodes, pulse oximetry could catch only hypoxia episodes. Usage of propofol unaccompanied in young patients and high doses of midazolam and aneaesthesia were found to be correlated with low IPI scores. In the study of Kuzkov et al, it was aimed to study the place of

IPI after coronary artery bypass grafting.[10] Twenty three adult patients (age: 62±6) who went under elective off-pump coronary artery bypass grafting were enrolled in the study. Patients were enrolled in two group's according to the postoperative IPI scores: optimal IPI (IPI>8, n=11) ve suboptimal IPI (IPI≤8, n=12). As a result, suboptimal IPI group was found to be composed of frequently smoking patients. In addition, smoking patients were found to be prone to have low IPI scores after 12 hours of intervention. They reported that IPI could be a valuble contributor in postoperative monitorisation by easing early detection of respiratory problems.

In another study conducted by Kuzkov et al, it was aimed to study the role of IPI in weaning stage after off-pump coronary artery grafting.[11] Seventy-two patients were randomised to four groups following elective off-pump coronary artery bypass grafting.

Different postoperative ventilation approaches were applied in three groups: CPAP 40 cm H_2O for 40 seconds in Group 1, PEEP 15 cmH_2O for 5 minutes in Group 2, increased tidal volume for 40 seconds in order to provide peak pressure 40 cmH_2O during inspiration in Group 3. When compared to control group, duration of mechanical ventilation following off-pump coronary artery bypass grafting was found to be shorter in PEEP 15 cm H_2O recruitment manoeuvre group (Group 2). In 12 hours following extubation, IPI scores were found to be inversely propotional to body mass index. Thus, they shared the reports stating that IPI could estimate postoperative mechanical ventilation time and be a valuable contributor in off-pump monitorisation.

In a study conducted by Restrepo et al, clinical correlation between blood gases collected in intensive care unit and IPI was evaluated.[12] Twenty-one patients under mechanical ventilation were enrolled in the study. Respiratory status reflecting to arterial blood gas was found to be correlated with IPI.

It was demonstrated that $PaCO_2$ had been correlated with IPI in a moderately inversely proportional manner and SpO_2 had been correlated with IPI in a directly proportional manner. Thus, they reported their opinion indicating that IPI was a potential candidate for being a more dynamic measurement for assessing respiratory status compared to arterial blood gas.

As a consensus and conclusion of all studies, it has been emphasised that IPI is a pratical and a noninvasive monitorisation score-tool indicating respiratory status of the patient. Anaestesia in geriatric patients requires a specific approach that should include physiological and psychological changes due to aging. Many monitorisation parameters are used in this approach. IPI provides a valuable and a single numerical value to aware respiratory failure in early phases by correlating clinical respiratory status.

IPI facilitates patient monitorisation which is under the support of mechanical ventilation or in spontaneous ventilation under sedation in intensive care units, postoperative monitorisation units, endoscopy units and radiology units along with its usage in operating theatre. For IPI monitor is a small monitor and monitorisation with an IPI tool is a non-invasive method along with its specification that displays so many parameters on a single screen, it enables ease of use.

As a matter of fact, it may stand for being a potentially more dynamic measurement than arterial blood gas. We have the opinion that Integrated Pulmonary Index might take place in practical usage by far in due course.

CONCLUSION

IPI might be the sole numerical value in early identification of clinical correlation and respiratory failure. For the IPI monitor is small and easy to be handled along with its screen that shows many parameters together makes the device be easily used.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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