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Is Dynamic Non-Invasive Monitoring Helpful for Fluid Responsiveness in Lateral Decubitus Position in Thoracic Surgery Population?

Toraks Cerrahisi Hastalarında Lateral Dekübit Pozisyonda, İnvaziv Olmayan Dinamik Monitörizasyon Sıvı Yanıtlılığını Değerlendirmede Faydalı mıdır?

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ABSTRACT

Objective: The Pleth Variability Index (PVI) is a non-invasive and continuous dynamic trend monitoring that reflects a patient's volume status. The threshold value of PVI varies significantly across patient groups and surgical types. In this study, we evaluated patients' volume status using PVI and mean arterial pressure (MAP) while they were in the lateral position and after a mini fluid-responsiveness test.

Methods: After obtaining approval from the hospital ethics committee and patient consent forms, a total of 63 patients scheduled for open thoracotomy in the Right lateral decubitus (RLD) or left lateral decubitus (LLD) position were included in the study. Patients who had undergone fasting for 8–10 hours and were in the supine position were monitored at baseline (T1) using standard monitoring along with PVI measurement via Masimo Root-7. Measurements were recorded after induction (T2) and once the patients were turned to the RLD or LLD position (T3). After administering 3 mL kg^{-1} of ringer lactate over 3 minutes based on the patients' ideal body weight (T4) data was recorded, and the study was concluded before the incision. Changes in MAP and PVI in either a positive or negative direction were recorded, and their correlations were analyzed. Data was analyzed using SPSSv25 software.

Results: When patients were positioned in the RLD position after induction, a significant decrease in MAP was observed, while no significant change was noted in PVI values. However, during the mini fluid-responsiveness test, the PVI trend indicated a shift in favor of increased volume in both decubitus positions. No correlation was found between MAP and PVI values at T3-T4 time points.

Conclusion: During the minimal fluid-responsiveness test, the trend monitor PVI decreased in both decubitus positions, indicating increased volume status in unit values. However, we were unable to establish the expected correlation with MAP, which can be influenced by multiple variables.

Keywords: Thoracic anesthesia, pleth variability index, fluid responsiveness

ÖZ

Amaç: Pleth variability indeks (PVI), perioperatif ve yoğun bakımda hastanın volüm durumunu gösteren invaziv olmayan ve sürekli dinamik ölçüm yapan bir trend monitörüdür. Pleth variability indeks eşik değeri pek çok hasta grubu ve cerrahi tipinde büyük değişiklik göstermektedir. Torasik cerrahide az rastlanılan bu çalışmada hastaların lateral pozisyonda iken ve daha sonra yapılan mini sıvı cevaplılık testi sonrası volüm durumunu, PVI ve ortalama arter basıncı (OAB) ile değerlendirdik.

Yöntem: Hastane etik komitesi izni ve hasta onam formları alındıktan sonra sağ veya sol yan pozisyonda açık torakotomi yapılacak toplam 63 hasta çalışmaya dahil edildi. Preoperatif rutin 8-10 saat aç kalan ve supin yatan hastalara (T1) rutin monitörizasyon yanında Masimo Root-7 ile PVI ve invazif arter monitörizasyonu yapıldı. İndüksiyonu takiben (T2) ve hastalar sağ veya sol yana çevrilip stabil olduktan sonra (T3) tüm değerler yazıldı. Hastalara ideal vücut ağırlığına göre 3 mL kg^{-1} ringer laktat 3 dakika içinde verildikten sonra (T4) son kayıtlar yapıldı ve insizyon öncesi çalışma bitirildi. Ortalama arter basıncı ve PVI ölçümlerinde pozitif veya negatif yönde her bir birim değişiklik dikkate alındı ve birbirleriyle korelasyonlarına bakıldı. Veriler IBM SPSS v25 programı ile analiz edildi.

Bulgular: Hastalar indüksiyon sonrası sağ lateral dekübit pozisyonuna alındığında OAB anlamlı oranda düşerken PVI değerinde anlamlı bir değişiklik gözlenmedi. Mini sıvı cevaplılık testinde ise PVI da trend her iki pozisyonda doluluk lehine değişim gösterdi. Çalışmada MAP ve PVI değerlerinde T3 ve T4 zamanlarında herhangi bir korelasyon saptanmadı.

Sonuç: Minimal sıvı cevaplılığı testinde trend monitörü PVI her iki pozisyonda da düşerek birim değer olarak doluluğu gösterdi. Pek çok değişkenden etkilenebilecek olan OAB değeriyle aralarında beklediğimiz korelasyonunu yakalayamadık.

Anahtar sözcükler: Torasik anestezi, pleth variability indeks, sıvı cevaplılığı

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INTRODUCTION

Pleth variability index (PVI) is a non-invasive continuous dynamic monitoring of volume status of patients during perioperative period or intensive care unit. It is widely used dynamic preload indices for fluid therapy and hemodynamic optimization under positive pressure ventilation (1). Change of PVI under mechanical ventilation can predict the volume change of a patient (2).

The Masimo Root 7 pulse oximeter (Masimo Corp., Irvine, CA, USA) displays a processed and filtered photoplethysmosgraphic waveform which drives two indices: perfusion index (PI) and PVI. Perfusion index is calculated by indexing the infrared pulsatile signal against the non-pulsatile signal, expressing the number as a percentage. The PVI is a measurement that continuously calculates respiratory variations in the photoplethysmosgraphic waveform. The PI value is the scale of absorption of red and infrared light. The division of pulsatile fraction caused by blood flow (AC) and non-pulsatile fraction, effected by skin (DC) of the red and infrared light is as the following formula: PI = (AC/ DC) x 100 (%). Pleth variability index is measurements of ventilation induced respiratory changes in PI over a constant period of time and is formulated as: $PVI = [(PI_{max} – PI_{min}) / PI_{max}] \times 100$ (%) (3). Waveform changes during respiratory cycle help to assess the physiological status and fluid responsiveness of patients (4). The utility and effectiveness of PVI is proven in many meta-analyses (5-8). Pleth variability index is suitable for mechanically ventilated patients without irregular heart rhythm, open chest, right ventricular failure or inversed intraabdominal pressure (9). Respiratory variations in the pulse oximeter plethysmographic waveform amplitude (ΔPOP) are sensitive to changes in preload and can predict fluid responsiveness in mechanically ventilated patients. Masimo PVI automatically calculates ΔPOP. Perfusion index should be > 0.5, recommended by the manufacturer.

The best cut-off value for the PVI varied within great ranges, and the best cut-off value for different types of patients and surgeries remains to be studied (8). When the PVI value is 11–12%, the patient can be considered euvolemic. If the PVI value calculated through respiratory variation rises to 14, 15, or higher, it indicates that the patient is dehydrated and in need of fluid resuscitation. Conversely, when the PVI value drops to 9, 8, or lower, it suggests that the patient is fluid-overloaded and does not require additional fluids.

Fluid management is particularly critical in thoracic surgery, as keeping the lungs dry necessitates a shift toward a restrictive fluid strategy (10). The predictive ability of PVI in thoracic surgery is limited since when the chest is opened assessment of waveform changes during respiratory cycle is impaired (9). That is why PVI can be accurate only when the thorax is closed such as during video-assissted thoracoscopic surgery.

This prospective observational study was conducted on patients undergoing thoracic surgery in the lateral decubitus position. Lateral position adds a dynamic aspect to the study. The study began with patients in the supine position before induction and was terminated after patients were placed in either the right or left lateral position and before the surgical incision opened the thoracic cavity. We hypothesized that, as pulse contour analysis is capable of measuring PVI, it may also provide predictive insights into blood pressure responsiveness, in addition to its established role in predicting fluid responsiveness. One of our objectives was to determine whether there are changes in invasive mean arterial pressure (MAP) and non-invasive PVI values measured with the Masimo® pulse oximeter after anesthesia induction when patients are positioned in the lateral decubitus position, and if so, whether there is a correlation between MAP and PVI, and whether the Right lateral decubitus (RLD) or left lateral decubitus (LLD) position makes a difference. Another aim was to investigate whether, within 3 minutes after patients were placed in the lateral decubitus position, administering 3 mL kg^{-1} (ideal body weight) of Ringer's lactate solution (a mini fluid challenge simulating the passive leg-raising test) would result in changes in MAP and PVI measurements, and if such changes occur, whether there is a correlation between them.

MATERIALS and METHODS

This prospective observational study was approved by the Institutional Ethics Committee (E1-22-2533, 06/15/2022) and informed consent was obtained from each patient. The Helsinki Declaration's ethical principles for medical research were considered. All patients aged 20-80 years, with American Society of Anesthesiologists physical status I-II-III, who underwent elective open thoracic surgery in the lateral decubitus position between June 2023 and March 2024, were included in the study.

Patients with fasting period longer than 10 hours, arrythmia, atrial fibrillation, congestive heart disease, coronary artery or valvular heart disease, diuretic use before surgery, hypothermia, who had diseases such as Raynaud which disrupts peripheral perfusion and PI detected below 0.5 which misdirects pulse probe, patients received vasoactive drugs during the study period were excluded. A total of 63 patients who met the inclusion criteria were included in the study for 1 year period. Ten of them were excluded for various reasons; figure 1, flowchart of the study. Post-hoc power analysis was performed after study completion using G*Power 3.1.9.2. With an observed effect size of 0.46, a sample size of 53, and a significance level of 0.05 (two-sided), the power achieved was approximately 90%.

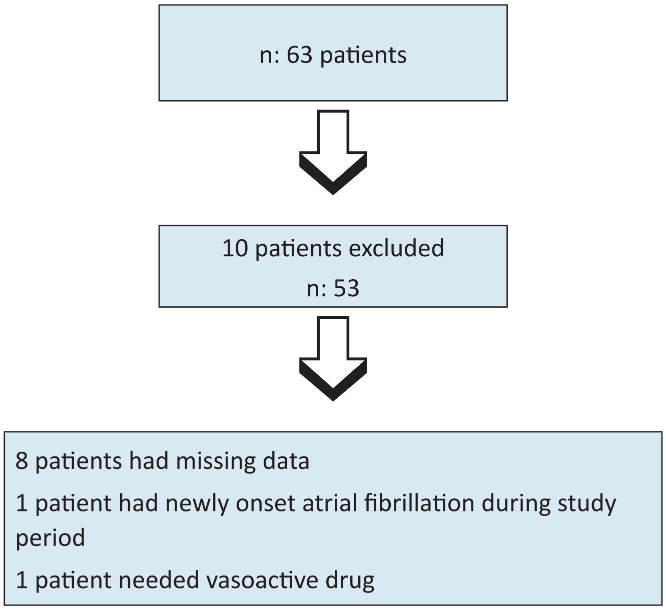

Figure 1. Flow chart.

All patients fasted from midnight the day before surgery, which is routine practice of thoracic surgery in our hospital, and patients with an eight to ten hours fasting were included in the study. In the operating room, all patients were monitored with ECG, non-invasive blood pressure, pulse oximetry (SpO_2), PI and PVI % with Masimo Root-7® placed on the hand third fingertip. Heart rate, systolic, diastolic and MAP, PI and PVI were recorded during four different time periods. All values were recorded as "supine position pre-induction" (T1) data. Anesthesia was induced by lidocaine 1 mg kg^{-1}, midazolam 0.025 mg kg^{-1}, fentanyl 1-1.5 µg kg^{-1}, propofol 1.5 mg kg^{-1} and rocuronium 0.6 mg kg^{-1}. Maintenance was with sevoflurane, remifentanil 0.03-0.08 µg kg^{-1} min^{-1} infusion and rocuronium boluses while BIS score was kept between 40-60 throughout the operation. A tidal volume of 6 mL kg^{-1} of predicted body weight with FiO_2 50 % and positive end-expiratory pressure was set 5 cmH_2O. Balanced solution 6 mL kg^{-1} $hour^{-1}$ commenced intra venously. A radial arterial catheter was placed on the arm of the opposite surgical site. All the data (heart rate, systolic, diastolic and mean blood pressure, PI and PVI) obtained during post-induction (T2) and following right or left lateral decubitus position after waiting for three minutes of hemodynamic stabilization (T3), were recorded. After being hemodynamically stable, all patients received 3 mL kg^{-1} (ideal body weight) ringer lactate (RL) solution within 3 minutes during lateral decubitus position. Then all the data was recorded again (T4). Pleth variability index and MAP values during supine post-induction, lateral decubitus position and following mini fluid challenge test were compared with each other. The difference of PVI and MAP values between LLD or RLD decubitus position following all time periods were also assessed. Each unit of positive or negative change in MAP and PVI was taken into consideration.

Statistical Analysis

Data was analyzed by using SPSS v.26 (IBM Corp., Armonk, NY, ABD). Normality was assessed by using Kolmogorov-Smirnov or Shapiro-Wilk tests, as well as the Q-Q plot and histogram. Continuous variables are presented as the mean ± standard deviation (SD) Categorical variables are presented as frequencies (n) and percentages (%). Two dependent group comparisons were analyzed by Paired Sample T Test and Wilcoxon T Test. Association between continuous variables was analyzed with Spearman and Pearson Correlation Test. Correlation coefficient; <0.25 was considered as a very weak correlation; 0.26-0.49 as weak correlation; 0.50-0.69 as moderate correlation; 0.70-0.89 as high correlation; 0.90-1.0 as very high correlation. A p value < 0.05 was accepted for statistical significance.

RESULTS

A total of 63 patients were included in the study, while 10 patients were excluded due to the reasons mentioned in Figure 1. The demographic and operational data of the patients are summarized in Table I. The number of patients placed in the RLD and LLD positions was similar. Most of the patients were American Society of Anesthesiologist II and had lung malignancy. The majority underwent lobectomy via thoracotomy or video-assisted thoracoscopy. Regulated hypertension was observed in 12 out of 53 patients, and chronic obstructive pulmonary disease was present in 9 patients. The data for all time points are summarized in Table II.

When patients were placed in the RLD or LLD position after induction, MAP significantly decreased (from a mean of 95.3 mmHg to 83.7 mmHg); however, no significant change was observed in PVI measurements (Table III). On the other hand, when the RLD and LLD positions were analyzed separately, it was noted that the MAP decrease occurred only in the RLD position. The PVI change, however, was observed only in the LLD position, indicating fluid deficit in the patient trend monitor, as it increased from a mean of % 11.6 to % 15.9 (Table III).

When 3 mL kg^{-1} RL was administered within 3 minutes, no significant increase in MAP was observed, whereas a significant decrease in the mean ± SD PVI value was detected in favor of fluid responsiveness on the trend monitor (Table IV). When we examined whether the PVI value differed based on whether the patients were in the RLD or LLD position, the trend was significantly in favor of fluid responsiveness in both positions. However, despite an average MAP increase of 3 mmHg, the difference was not statistically significant (Table V). When we analyzed the correlation between the reference MAP change

Table I. Demographic and Operational Data, n=53

Characteristics	n = 53 (n, %)
Gender, n (%)	
Male	39 (73.6)
Female	14 (26.4)
Age (years)	58 ± 14.2
Height (cm)	169.8 ± 8.9
Weight (kg)	77.4 ± 16.6
Operation Position, n (%)	
Right lateral decubitus	29 (54.7)
Left lateral decubitus	24 (45.3)
ASA score[a], n (%)	
I	1 (1.9)
II	44 (83)
III	8 (15.1)
Pre-operative diagnosis, n (%)	
Lung cancer (2 bronchial cancer)	44 (83)
Mediastinal mass lesions	4 (7.6)
Metastatic lesions	2 (3.8)
Bullous lung	1 (1.9)
Empyema	1 (1.9)
Thymic mass lesion	1 (1.9)
Co-morbidities (some had more than one), n (%)	
Regulated hypertension	12 (22.6)
COPD	9 (17)
DM	6 (11.3)
Operated malignancies other than lung	4 (7.5)
Hypothyroidism	2 (3.8)
CABG operated (7 years ago)	1 (1.9)
Obesity	1 (1.9)

COPD: Chronic obstructive pulmonary disease, **DM:** Diabetes mellitus, **CABG:** Coronary artery bypass grafting.

Table III. Comparison of MAP and PVI Values While on Supine or RLD / LLD During Post-Induction and Lateral Decubitus Position

Characteristics	Post-induction (T2)	Lateral decubitus (T3)	p-value
MAP (n= 53)	95.3±17.7	83.7±13.7	**<0.001**
PVI % (n= 53)	13.1±5.4	14.4±5.8	0.345
RLD (n= 29) MAP	94.4±18.5	80.2±12.0	**0.001**
LLD (n= 24) MAP	96.5±17.1	87.9±14.7	0.085
RLD (n= 29) PVI	14.4±5.7	13.2±5.6	0.371
LLD (n= 24) PVI	11.6±4.5	15.9±5.9	**0.003**

***:** Paired Samples t Test. Values are mean ± SD, **MAP:** Mean arterial pressure, **PVI:** Pleth variability index, **RLD:** Right lateral decubitus. **LLD:** Left lateral decubitus position.

Table IV. Comparison of MAP and PVI Values During Lateral Decubitus Position and 3 min After RL Infusion

Characteristics	Lateral Decubitus (T3)	3 min. after RL infusion (T4)	p value*
MAP (n=53)	83.7 ± 13.7	84.5 ± 15.7	0.687
PVI % (n=53)	14.4 ± 5.8	11.8 ± 5.5	**0.001**

***:** Paired Samples t Tests. Values are mean ± SD **MAP:** Mean arterial pressure, **PVI:** Pleth variability index, **RL:** Ringer lactate.

Table II. Monitoring Data During Specific Time Periods, n=53

	Pre-induction (T1)	Post-induction (T2)	Lateral decubitus (T3)	3 min after RL infusion (T4)
Heart rate (beats min^{-1})	81.4 ± 13.4	87.8 ± 17.5	74.6 ± 15.2	69.1 ± 13.4
MAP (mmHg)	98.3 ± 12	95.3 ± 17.7	83.7 ± 13.7	84.5 ± 15.7
PI	2.9 ± 1.7	3.7 ± 1.9	3 ± 1.9	2.6 ± 1.8
PVI (%)	18.2 ± 6.1	13.1 ± 5.4	14.4 ± 5.8	11.8 ± 5.5

Values are mean ± SD. **MAP:** Mean arterial pressure, **PI:** Perfusion index, **PVI:** Pleth variability index, **RL:** Ringer lactate.

and the PVI value in the minimal fluid responsiveness test, no significant p-value was obtained (Table VI).

DISCUSSION

This study is one of the rare studies in which non-invasive PVI measurement is used for dynamic hemodynamic monitoring in thoracic surgery population. In the study, we considered each unit change as meaningful in non-invasive PVI measurement, which is a non-invasive trend monitor, during the specified time intervals at the beginning of thoracic surgery. However, we were unable to examine the correlation of this PVI change with stroke volume variation (SVV) and pulse pressure variation (PPV) values measured by more reliable but relatively more expensive invasive monitors, which were not available to us. Instead, we evaluated its correlation with MAP values measured by invasive arterial monitoring, which is influenced by many variables like cardiac output and systemic vascular resistance. Additionally, we assessed the variability of these values not only when the patient was in the lateral position but also separately in the RLD and LLD positions. We also examined the response to the mini fluid responsiveness test performed with RL while patients were in the lateral position.

There was no data in the demographic characteristics of the patients that could mislead the sample group (Table I). In all surgical procedures, it is crucial to understand the effects of volume, cardiac output, venous return, and positive pressure ventilation to properly manage intraoperative fluid therapy (11,12). Protecting organs and tissues from hypoperfusion is one of the most important priorities for anesthesiologists (13-15). Various monitoring methods have been developed to determine whether a patient requires fluid therapy. Some of them are derived from analysis of the arterial waveform which requires placement of an arterial catheter as well as access to a monitoring unit with appropriate software. With these sophisticated monitors, we can obtain information about preload and cardiac output through calculations such as SVV and PPV (16). Pleth variability index also provides insight into fluid responsiveness (9). The fact that PVI measurement is non-invasive and relatively less sophisticated makes it more affordable and seemingly more widely used. In this study, we aimed to investigate the reliability of this simpler monitor in thoracic surgery population during right or left lateral decubitus position.

Table V. MAP and PVI Values of RLD or LLD Position During Lateral Decubitus Position and 3 min After RL Infusion

Characteristics	Lateral Decubitus (T3)	3 min. after RL infusion (T4)	p value*
RLD (n= 29) MAP	80.2 ± 12.0	83.9 ± 16.2	0.223
LLD (n= 24) MAP	87.9 ± 14.7	85.3 ± 15.4	0.465
RLD (n= 29) PVI %	13.2 ± 5.6	11.4 ± 5.2	**0.022**
LLD (n= 24) PVI %	15.9 ± 5.9	12.4 ± 5.8	**0.014**

***:** Paired Samples t Test and Wilcoxon t Test. Values are mean ± SD **MAP:** Mean arterial pressure, **PVI:** Pleth variability index, **RLD:** Right lateral decubitus. **LLD:** Left lateral decubitus, **RL:** Ringer lactate.

There are not many studies monitoring PVI changes in the lateral decubitus position. Particularly in thoracic surgeries, which often require restrictive fluid management, we hypothesized that the patient's MAP response to a mini fluid responsiveness test before the surgical incision and the corresponding PVI change could be useful in adjusting maintenance fluid therapy at the beginning of surgery. When patients were placed in the lateral decubitus position, their MAP values significantly decreased, whereas the PVI value did not show a significant change (Table III). The number of patients placed in the RLD and LLD positions was similar. Therefore, when examining whether there was a difference depending on whether the patient was positioned to the right or left side, it was observed that MAP significantly decreased only in the RLD position (Table III). This is a situation we frequently encounter in clinical practice, and we demonstrated it in this study. We hypothesized that the MAP decrease in the RLD position was due to reduced venous return to the heart caused by compression on the superior and inferior vena cava, which are positioned on the right side. In this case, we would have expected PVI to increase in the RLD position, indicating fluid deficiency (Table III), as PVI is a trend monitor. However, contrary to our expectations, in the LLD position, while MAP remained unchanged, the PVI value indicated a fluid deficit, rising from an average of %11.6 to %15.9. We did not find a correlation between MAP and PVI values, which led us to question the reliability of the PVI monitor.

Intraoperative fluid management in thoracic surgery is more special compared to other surgical procedures. Poor fluid management such as excessive fluid administration can lead to pulmonary edema, while being overly restrictive can re-

Table VI. Correlation Between MAP and PVI

Characteristics			MAP (mmHg)			
			Lateral decubitus (T3)		3 min. after RL infusion (T4)	
			r	p*	r	p*
RLD	PVI %	Lateral	-0.065	0.737	0.207	0.282
		RL 3.min	-0.093	0.632	0.146	0.451
LLD	PVI %	Lateral	0.172	0.422	-0.095	0.660
		RL 3.min	0.111	0.606	0.332	0.113
Total	PVI %	Lateral	0.119	0.396	0.078	0.577
		RL 3.min	0.040	0.777	0.235	0.091

***** Spearman and Pearson Correlations Test, p<0.05.. **MAP:** Mean arterial pressure, **PVI:** Pleth variability index, **RLD:** Right lateral decubitus. **LLD:** Left lateral decubitus, **RL:** Ringer lactate.

sult in organ hypoperfusion and complications such as acute kidney injury. Studies suggest that a restrictive approach in thoracic surgery leads to more complications compared to a less restrictive approach (17).

The predictive ability of PVI in thoracic surgery is limited since when the chest is opened assessment of waveform changes during respiratory cycle is impaired. Therefore, the study was concluded in the time before thoracotomy. However, we considered that the data obtained during this limited period could be meaningful for fluid management. In a study conducted on thoracoscopic surgeries, where the thorax was not exposed to the atmosphere and single-lung ventilation was used, patients whose SVI increased by ≥15% after a fluid challenge were defined as fluid responders, based on more reliable invasive monitoring parameters such as SVV and PPV. However, in this study involving forty patients, dynamic indices were found to be insufficient in predicting fluid responsiveness (18). On the other hand, another study investigated the ability of SVV to predict fluid responsiveness in patients undergoing thoracoscopic surgery with single-lung ventilation. In this study, which included thirty patients, those whose stroke volume index (SVI) increased by ≥25% after a fluid challenge were defined as fluid responders. This study, using the Vigileo-FloTrac system, found that SVV was successful in predicting fluid responsiveness (19). However, the monitors used in these studies are invasive and expensive and they can provide information about hemodynamics and fluid status both when the thorax is open and during open lung ventilation (OLV).

On the other hand, even in studies utilizing invasive methods that are considered more reliable in thoracic surgery, the value of dynamic indices in predicting fluid responsiveness remains controversial, with contradictory results reported. This discrepancy may be due to differences in the accepted cut-off values, response percentages, and patient groups in various studies (9,14,17,19).

The situation is no different for non-invasive dynamic indices such as PVI. The best cut-off value for PVI has been reported to vary widely and determining the optimal cut-off value for different types of patients and surgeries remains an area of study (8).

Observing the hemodynamic effects of the lateral position in patients who have fasted preoperatively for 8–10 hours and assessing their response to a mini fluid challenge test before surgery may guide intraoperative fluid management. Unfortunately, prolonged fasting in our patients results from our hospital's clinical practice. After such a fasting period, we expected patients to respond to an infusion of 3 mL kg^{-1} RL based on their ideal body weight. We considered each unit decrease in PVI as significant in fluid responsiveness, given that PVI is a trend monitor. Our test showed that PVI measurements changed significantly in all patients who received RL infusion, shifting towards the "full" side (Table IV), which is consistent with the meta-analysis results by Chu et al. (5).

When fluid responsiveness was analyzed separately in the RLD and LLD positions, PVI values shifted towards the "full" side in both positions (Table V). This finding does not correlate with the study in thoracoscopic surgery that found no difference in fluid responsiveness between the RLD and LLD positions when assessed using invasive dynamic indices such as PPV and SVV (18). On the other hand, SVV was found as a predictor of fluid responsiveness in 30 thoracic surgery patients undergoing OLV (19). It seems that there is a lot to study about this subject.

However, MAP changes did not follow the same trend, like the study by Yüksek A., which investigated the use of PVI in anesthesia-induced hypotension in geriatric patients and found no correlation with MAP (20). This can be explained by the many factors affecting MAP and the absence of monitors in our study design capable of distinguishing influences such as cardiac output or systemic vascular resistance.

As shown in Table VI, the lack of correlation between PVI and MAP changes in response to RL infusion suggests that arterial pressure, which is influenced by multiple variables, may not be an appropriate reference parameter for comparison in this study.

In our hospital's thoracic surgery department, a preoperative fasting policy of 8–10 hours is still being followed. This does not comply with current Enhanced Recovery After Surgery (ERAS) protocols and represents a shortcoming. We assumed that such prolonged fasting would lead to fluid deficits in all patients. Therefore, we did not perform a fluid responsiveness test in the supine position after induction. We avoided administering approximately 200–250 mL of Ringer's lactate in this position, as we believed it could alter the results obtained later in the lateral decubitus position.

CONCLUSION

Our study is one of the studies investigating the effectiveness of non-invasive dynamic index PVI monitoring in assessing fluid responsiveness in the lateral decubitus position in thoracic surgery population. The study examined the correlation between MAP and the dynamic index PVI, which is a relatively inexpensive technology. Each unit change in MAP and PVI values was considered. When patients were moved from the supine position to the RLD position, MAP decreased more significantly compared to the LLD position. In the minimal fluid responsiveness test, PVI decreased in both positions showing fluid response indicating volume status as a trend. However, we were unable to establish the expected correlation between MAP and PVI across all variables. This study serves as a preliminary study for our upcoming research, which aims to evaluate fluid responsiveness in closed chest video-assisted thoracoscopic surgery operations using invasive parameters such as SVV and SVI and to analyze their correlation with PVI.

AUTHOR CONTRIBUTIONS

Conception or design of the work: HY, HYO
Data collection: HY, SS, HYO, MB
Data analysis and interpretation: HY, SNA
Drafting the article: HY, HYO
Critical revision of the article: HY, SS, HYO
Other (study supervision, fundings, materials, etc): HY, SS, HYO
The author (HY, SS, HYO, MB, SNA) reviewed the results and approved the final version of the manuscript.

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