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Research Article / Araştırma

Evaluation of Cerebral Oxygenation During One-lung Ventilation in Diabetic Patients Undergoing Lung Resection: A Prospective and Observational Study

Göğüs Cerrahisinde Tek Akciğer Ventilasyonu Uygulanan Diyabetes Mellitus Olgularında Serebral Oksijenlenmenin Değerlendirilmesi: Prospektif, Gözlemsel Bir Çalışma

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ABSTRACT

Objectives: Cerebral oxygenation may decrease due to hypoxia during one lung ventilation (OLV) in thoracic surgery. Diabetic patients are at increased risk of cerebral and renal damage after major surgery due to microangiopathy. The primer aim of our study is to evaluate whether cerebral oxygenation is affected during OLV with near infrared spectroscopy (NIRS) and arterial/central venous oxygen saturation of the central venous blood ($ScvO_2$) blood gases in diabetic patients. The secondary aim of our study is to investigate whether there is a relationship between cerebral oxygenation and changes in renal functions in diabetic patients.

Methods: Diabetic patients underwent lung resection between 2018 and 2021 were included in our prospective, case-controlled study. Regional oxygen saturation (rSO_2) and hemodynamic parameters of the cases were recorded every 15 min from the pre-operative period to extubation. Central venous and arterial blood gas samples were taken from the patients during single lung ventilation and double lumen ventilation. They were recorded simultaneously with rSO_2 and hemodynamic data. Pre-, post-operative creatinine values were checked.

Results: Fifty-two patients were included in the study. It was completed with 19 diabetic and 22 normal blood sugar patients. rSO_2 decreased according to baseline measurements in both groups at 30 min during OLV. While rSO_2 values were lower in OLV 60 min and throughout the DLV in

ÖZ

Amaç: Torasik cerrahide tek akciğer ventilasyonu (OLV) sırasında hipoksiye bağlı olarak serebral oksijenasyon azalabilir ve bu durum yakın kızılötesi spektroskopisi (NIRS) ile noninvaziv olarak değerlendirilebilir. Yapılan çalışmalarda diyabetik hastalarda serebral dolaşımın etkisine bağlı olarak majör cerrahi sonrası nörobilişsel bozuklukların olabileceği gösterilmiştir. Çalışmamızda akciğer rezeksiyonu yapılan diyabetik hastalarda intraoperatif serebral oksijen satürasyonu ve kan gazlarının incelenmesi amaçlandı.

Yöntem: Prospektif, gözlemsel çalışmamız akciğer rezeksiyonu uygulanan diyabetik ve diyabetik olmayan hastalarda planlandı. Operasyon sırasında NIRS değerleri ve hemodinamik parametreler kaydedildi. OLV ve çift lümenli ventilasyon (DLV) sırasında hastalardan santral venöz ($ScvO_2$) ve arteriyel kan gazı örnekleri alındı. Tüm hastalarda ameliyat öncesi ve sonrası kreatinin değerlerine bakıldı.

Bulgular: Çalışmamız diyabetik (n=19) ve diyabetik olmayan (n=21) akciğer rezeksiyonu uygulanan hastalarda yapıldı. OLV sırasında NIRS değerleri her iki grupta da ilk ölçümlere göre 30. dakikada düşerken, bu düşüş sadece diyabetik grupta operasyon boyunca devam etti. Operasyon boyunca her iki grupta hemodinamik ve $ScvO_2$ değerleri benzerdi. Diyabetik hastalarda OLV 30. ve 60. dakika

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ABSTRACT

diabetic patients, it was around basal values in control group. Hemodynamic data and $ScvO_2$ values were similar. A correlation was observed between rSO_2 values and creatinine values during OLV in diabetic patients.

Conclusion: In our study, it was shown that cerebral oxygen values measured by NIRS during OLV in lung surgery decreased more in diabetic patients than control group, but were not within the pathological limits.

Keywords: Central venous oxygen saturation, creatinine, diabetes mellitus, near-infrared, one-lung ventilation, spectroscopy

ÖZ

rSO_2 değerleri ile postoperatif kreatinin değerleri arasında korelasyon bulundu.

Sonuç: Bu çalışmada, akciğer cerrahisinde OLV sırasında NIRS ile ölçülen serebral oksijen değerlerinin diyabetik hastalarda kontrol grubuna göre daha fazla düştüğü ancak patolojik sınırlar içinde olmadığı gösterildi.

Anahtar sözcükler: Santral venöz oksijen satürasyonu, kreatinin, diyabetes mellitus, yakın kızılötesi, tek akciğer ventilasyonu, spektroskopi

Introduction

While a better surgical field of view is obtained with one-lung ventilation (OLV) during thoracic surgery, lateral decubitus position (causes low cardiac output and mediastinal shift), hypoxic pulmonary vasoconstriction (causes pulmonary arterial vein shunts and increase in central venous pressure), inflammatory, and oxidative stress can cause a decrease in cerebral oxygenation. As a matter of fact, many studies conducted in recent years have reported that although there is no hypoxia in arterial blood gas or decrease in peripheral oxygen saturation (SpO_2), there may be a decrease in cerebral oxygenation during OLV. Therefore, the use of "near infrared spectroscopy" (NIRS) is recommended for monitoring of cerebral oxygenation in thoracic surgery.[1–5]

Cerebral regional oxygen saturation (rSO_2) can be monitored non–invasively, in real time, continuously with NIRS and has been used in intensive care and many major surgeries since the 1980s. Measurements are made with the principle of different absorption of oxyhemoglobin and deoxyhemoglobin as infrared light passes between 2 electrodes (1–1.5 cm deep, 1/3 arterial, and 2/3 venous blood) placed on the scalp. The measured rSO_2 value can also be defined as an indicator of oxygen transmission and consumption in the cerebral cortex.[6–9] Oxygen balance during the operation can also be routinely estimated from the oxygen saturation of the central venous blood ($ScvO_2$) taken from the central venous catheter. Conflicting results have been published in anesthetized patients regarding the relationship between NIRS (rSO_2) and $ScvO_2$.[1,10]

Diabetes mellitus is a metabolic disease that is common all over the world. In these patients, multiple organ damage may develop due to retinopathy, neuropathy, nephropathy and cardiovascular dysfunction due to functional and structural changes in the vascular structure, and the risk for increased postoperative mortality and morbidity.[11–15] Therefore, it is a great importance for anesthesiologists to have knowledge about the changing perfusion and oxygenation of the kidney and brain during major surgery in diabetic patients.[13–15] Cerebral oxygenation was monitored with $ScvO_2$ and NIRS measurements in cardiovascular surgery in diabetic patients and it was shown that measurements with NIRS may be more beneficial in preventing post-operative cerebral complications.[16] In the literature, we did not find any prospective study evaluating cerebral oxygenation during OLV in diabetic patients undergoing thoracic surgery. Therefore, the primer aim of our study is to evaluate whether cerebral oxygenation is affected during OLV with NIRS and arterial/central venous ($ScvO_2$) blood gases in diabetic patients. The secondary aim of our study is to investigate whether there is a relationship between cerebral oxygenation and changes in renal functions in diabetic patients.

Methods

Our prospective, case-control study was conducted in patients who will undergo lung resection between 2018 and 2021, after the approval of the ethics committee of our university (2018/1429) and written patient consent.

Patient Selection

Inclusion criteria for the Diabetic group

Persons who were diagnosed with type 2 diabetes in their medical records, used antidiabetic therapy such as diet, oral or insulin therapy, aged 20–80, and had a hemoglobin A1C (HbA1c) level above 6.4% and fasting blood sugar above 126 mg/dL.

Inclusion criteria for the control group

Persons who were not diagnosed with Type 2 diabetes in their medical records, did not use antidiabetic treatment such as diet, oral or insulin therapy, aged 20–80, had fasting blood sugar below 110 mg/dL and HbA1c level below 5.4%.

Exclusion criteria

Patients over 80 years old, under 20 years old, OLV duration <60 min, ejection fraction <40%, with a history of COPD, Alzheimer's, dementia, and stroke were excluded from the study. Patients diagnosed with diabetic cardiomyopathy, acute or chronic renal failure, receiving dialysis treatment, and pre-op-

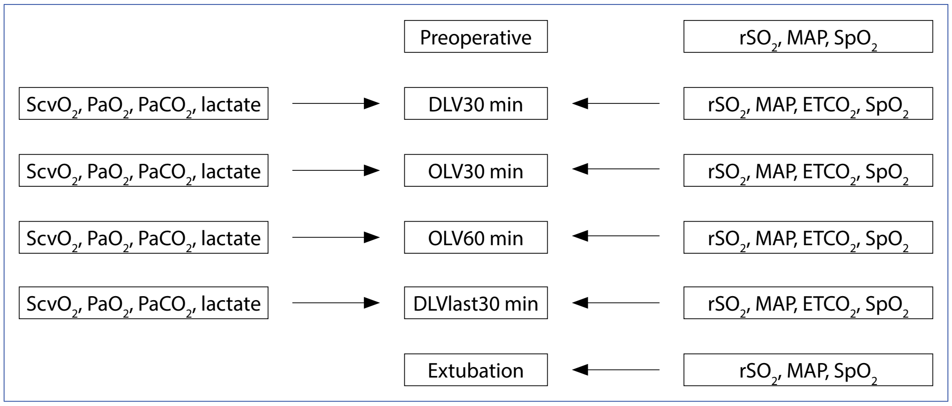

Figure 1. The measurement protocol of our study.

$ScvO_2$: Central venous oxygen saturation; MAP: Mean arterial pressure; $ETCO_2$: End tidal carbon dioxide; SpO_2: Oxygen saturation, and cerebral regional tissue oxygen saturation (rSO_2) were made at every 15 min. Arterial and central venous blood gases; taken at 30^{th} min of double-lumen ventilation (DLV), 30^{th} and 60^{th} min of one-lung ventilation (OLV), and 30^{th} min of DLV after resection completion (DLVlast30min).

erative glomerular filtration rate below 90 mL/min or creatinine values over 1.5 mg/dL were excluded from the study.

Operation type

The study was conducted in patients who will undergo lung resection (segmentectomy, lobectomy, and pneumonectomy) with open thoracotomy and whose OLV duration is not shorter than 60 min.

Anesthesia

After 0.03 mg/kg midazolam was given for premedication, anesthesia induction was achieved by intravenous administration of 1 mcg/kg fentanyl, 2 mg/kg propofol, and 0.6 mg/kg rocuronium. The location of the tube was confirmed with a fiberoptic bronchoscope. After intubation, anesthesia was maintained by sevoflurane (1 MAC) and infusion of remifentanil. Lung protective mechanical ventilation with low tidal volume and PEEP was applied to the dependent lung for OLV. During OLV period, the FiO_2 was adjusted to 90%. If saturation was below 90%, CPAP was used for independent lung.

Monitoring

Rutin monitoring

Pulse oximetry (SpO_2), ECG, invasive arterial blood pressure, and end-tidal carbon dioxide ($ETCO_2$) monitoring were performed on all patients admitted to the operating room. Perioperative heart rate (HR), mean arterial pressure (MAP), SpO_2, and $ETCO_2$ values of the patients were continuous measured from pre-induction to post-extubation.

Hypotension definition

Patients with MAP below 60 mmHg or a 20% decrease from baseline were considered to have developed hypotension and were treated with fluids or vasopressors (ephedrine and norepinephrine). The presence of hypotension and treatments applied was recorded throughout the operation.

Hypoxia definition

Hypoxemia during OLV is defined as SpO_2 below 95% when the fraction of inspired oxygen (FiO_2) is 90 % or higher. In cases where SpO_2 values are between 95% and 90%, arterial partial oxygen pressure (PaO_2) values, arterial blood gas analysis shows 75–60 mmHg values, and mild hypoxemia is considered. Severe hypoxemia is defined as SpO_2 <90% and PaO_2 values <60 mmHg.[2]

Perioperative hypotension and hypoxia, intraoperative vasopressor requirement was also recorded.

Cerebral oxygen saturation monitoring

For the measurement of regional cerebral oxygen saturation (rSO_2), Masimo Root® with O3® (USA) Regional Oximetry device was used. The measurements were recorded from the pre-operative period (baseline value) by measuring the right and left electrodes continuously and recorded throughout the operation until the extubation period. The rSO_2 value was established by taking the average of the values measured from the right and left electrodes. In our study, as in the literature, abnormal cerebral hypoxic threshold values were considered as a decrease of more than 20% compared to baseline, and all values below 50%.[7] All decreases in rSO_2 values calculated by the device during operation were recorded. Methods such as raising the MAP, normalizing $PaCO_2$, deepening anesthesia, or increasing FiO_2 were planned for the decrease in rSO_2 values (20% decrease according to the initial measurements or below the measured value). Simultaneously, rSO_2 and MAP, HR, SpO_2, and $ETCO_2$ values were also recorded.

Arterial and central venous blood were drawn at 30^{th} min of fist DLV, 30^{th} and 60^{th} min of OLV, and 30^{th} min of second DLV administration (Fig. 1). In our study, the first part of the double-lung ventilation period covers the period

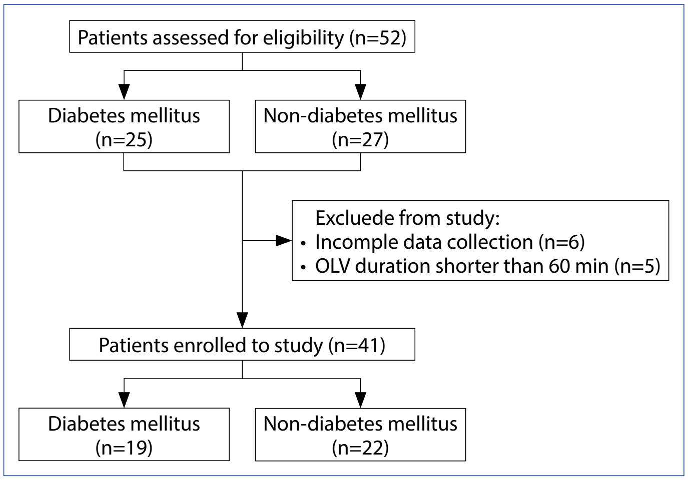

Figure 2. Flow diagram of the study.

OLV: One lung ventilation.

from the start of the patient's double-lumen tube intubation to the start of single-lung ventilation. During these periods, PaO_2, $PaCO_2$, pH, lactate, bicarbonate values in arterial blood, and $ScvO_2$ values in venous blood were also checked. rSO_2 and hemodynamic data were evaluated simultaneously with blood gases.

In the post-operative period, it was planned to apply the Sessler[17] agitation-sedation scale to all patients routinely.

Statistical Analysis

The Kolmogorov-Smirnov test was used to assess the normality of numeric variables. Independent samples for variables that were normal distributed were compared by independent sample t test, and descriptive statistics were shown as mean±standard deviation. Paired samples and independent samples for variables that were non-normal distributed were compared by Friedman test or Mann-Whitney U test, and descriptive statistics were shown as median (interquartile range). Chi-square test was used to compare qualitative variables according to groups, and descriptive statistics were shown as frequency (%). Relationships between variables were tested by Spearman's correlation analysis. A value of $p<0.05$ was accepted as statistically significant.

Results

Although 52 patients were included in the study, but the study could be completed with 41 (DM group=19 and Control group=22) patients (Fig. 2). There was no difference between the groups in terms of age, gender, type of surgery, duration of surgery and OLV, and length of stay in the intensive care unit and hospital (Table 1). There was no significant difference in SpO_2 between the two groups, and mild hypoxemia developed during OLV in three patients in the diabetic group, and only one patient in the control group (Table 2).

Table 1. Demographic values, type of operation, duration of operation and OLV, and length of stay in the intensive care unit and hospital

	DM group	Control group	p
Age (year)	63.1±8.7	62.2±9.5	0.89
Gender, %			0.70
Female	15.8	20.3	
Male	84.2	79.7	
Body mass index (kg/m²)	21.2±6.2	19.2±5.4	0.67
Operation type (n)			0.40
W	1	1	
L	18	19	
p	0	2	
OLV time (minute)	77.4±11.7	93.2±15.9	0.24
Operation time (minute)	167.5±34.3	188±23.4	0.41
ICU stay (day)	3.7±1.2	3.4±1.4	0.39
Hospital stay(day)	8±3.3	7.2±2.1	0.86
Hemoglobin (mg/dL)			
Pre-operative	13.73±2.1	13.47±1.5	0.64
Post-operative	11,95±1.38	11.63±1.48	0.52
Creatinine (mg/dL)			
Pre-operative	1.01±0.34	0.8±0,16	**0.009**
Post-operative	1.4±0.42	0.9±0.33	**0.0001**
Intraoperative fluids (mL)	1719±802	1833±547	0.64
Urine output (mL)	368±26	464±28	0.73
HbA1c (%)	7.2 (6.7–7.8)	5.4 (5.2–5.8)	**<0.001**

Values were presented as mean±SD. OLV: One lung ventilation; DM: Diabetes mellitus; ICU: Intensive care unit; W: Wedge; L: Lobectomy; p: Pneumonectomy; HbA1c: Glycated hemoglobin.

There was no statistical difference in blood gas in terms of pH, PaO_2, $PaCO_2$, and lactate. During OLV, $PaCO_2$ levels increased in both groups compared to baseline values, but there was no significant difference between the groups (Table 3).

Hemodynamic data, intraoperative fluids and urine output were similar in both groups. Hypotension developed during the operation in three patients in the diabetes group and two patients in the control group, and it was brought back to normal values with noradrenaline infusion. While there was no difference in hemoglobin values (pre-operative and post-operative), creatinine values were different in two groups. Pre-operative and post-operative creatinine values were higher in diabetic patients compared to the control group. While an increase in post-operative creatinine values compared to pre-operative values was observed in the DM group (p=0.002), it was not observed in the control group (Table 1).

The difference between right/left NIRS measurements was less than 5 in all patients. None of the patients had rSO_2 values below 50. Agitation after extubation (2–3 according to Richmond agitation-sedation scale) was observed only in

Table 2. Hemodynamic data of two groups

	DM group	Control group	p
MAP (mmHg)			
DLV30	83±14	76±15	0.51
OLV30	84±15	75±13	0.32
OLV60	77±10	76±8	0.43
DLVlast30	84±11	81±12	0.24
HR (beat/min)			
DLV30	72±15	76±9	0.44
OLV30	77±13	78±12	0.82
OLV60	80±13	77±10	0.73
DLVlast30	79±14	78±12	0.62
SpO_2 (%)			
DLV30	94.5±1.3	96.3±1.1	0.43
OLV30	92.2±0.7	92.5±0.9	0.82
OLV60	92.3±1.8	93.1±1.2	0.58
DLVlast30	96.6±1.3	95.7±1.4	0.48
$ETCO_2$ (mmHg)			
DLV30	36.8±6.9	37.4±5.5	0.73
OLV30	56.5±4.4	58.3±5.2	0.42
OLV60	61.3±4.6	66.6±5.2	0.08
DLVlast30	45.5±3.3	44.6±4.8	0.44

Values were presented as mean±SD. DM: Diabetes mellitus; MAP: Mean arterial pressure; DLV: Double lung ventilation; OLV: One lung ventilation; DLVlast30: 30th min of DLV after resection completion; HR: Heart rate; SpO_2: Oxygen saturation; $ETCO_2$: End tidal carbon dioxide.

Table 3. Arterial blood gases values

	DM group	Control group	p
PaO_2 (mmHg)			
DLV30	162±76	170 ±69	0.71
OLV30	144±55	147±49	0.63
OLV60	147±72	139±65	0.10
DLVlast30	162±55	163±38	0.17
$PaCO_2$ (mmHg)			
DLV30	47±5	49±6	0.41
OLV30	63±14*	61±13*	0.55
OLV60	61±11*	63±14*	0.83
DLVlast30	56±12**	54±11***	0.17
Lactate (mmol/L)			
DLV30	0.75±0.23	0.72±0.21	0.97
OLV30	0.81±0.33	0.84±0.52	0.85
OLV60	0.78±0.47	0.80±0.12	0.63
DLVlast30	0.82±0.53	0.84±0.43	0.17

Values were presented as mean±SD. P values show the comparison between the two groups, In both groups, PCO_2 values were found to be significantly lower at DLV 30 (first 30 min after the start of double lumen ventilation) than at other measurement times. *: 0.001; **: 0.028; ***: 0.034. Measurement times of arterial and central venous blood gases: In the first 30 min after the start of double lumen ventilation (DLV 30), at the 30th and 60th min of one-lung ventilation (OLV 30 and OLV 60), and at the 30th min of DLV after OLV (DLVlast 30). DM: Diabetes mellitus; DLV: Double lung ventilation; OLV: One lung ventilation; PaO_2: Partial oxygen pressure; $PaCO_2$: Partial arterial carbon dioxide pressure.

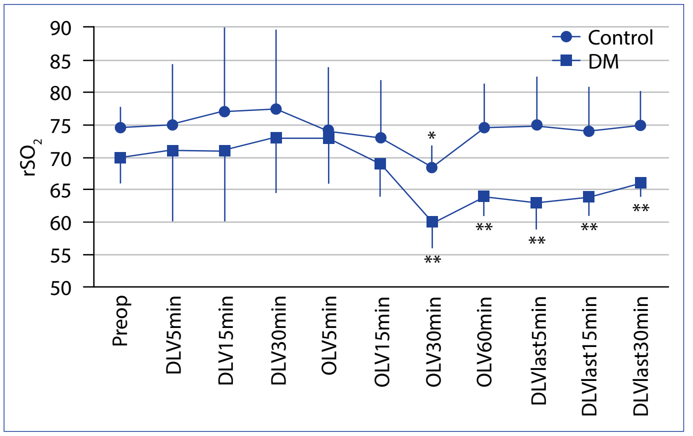

Figure 3. Cerebral regional oxygen saturation (rSO_2) values of the two groups.

During OLV, cerebral regional tissue oxygen saturation (rSO_2) decreased at 30th min according to the initial measurements in both groups, while this decrease continued throughout the operation only in the diabetic group (*p=0.003, **p=0.0001). Values were presented as mean±SD. DM: Diabetes mellitus; DLV: Double lung ventilation; OLV: One lung ventilation.

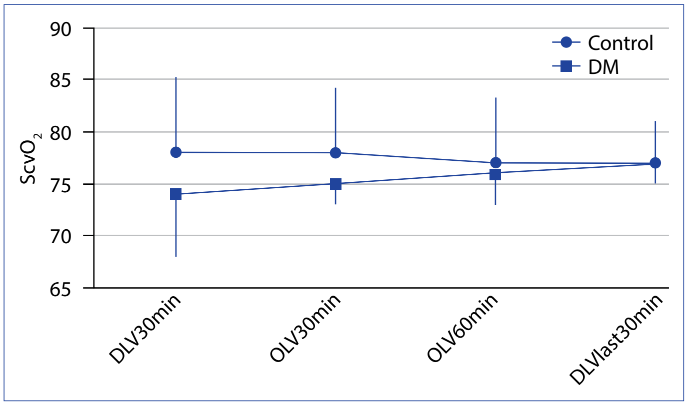

Figure 4. Central venous oxygen saturation ($ScvO_2$) values.

Central venous oxygen saturation values were similar in both groups during one-lung (OLV) and double-lung ventilation (DLV) times. Values were presented as mean±SD. Measurement times of central venous blood gases: In the first 30 min after the start of double lumen ventilation (DLV30), at the 30th and 60th min of one-lung ventilation (OLV30 and OLV60), and at the 30th min of DLV after OLV (DLVlast30). DM: Diabetes mellitus.

eight diabetic patients with rSO_2 values between 50 and 60. Compared to baseline values, rSO_2 measurements decreased in both groups at 30th min of OLV. This decrease in rSO_2 values continued only in the DM group at the 60th min and in the following periods (Fig. 3). $ScvO_2$ values were not significantly different from baseline values in either group (Fig. 4).

A correlation was found between OLV 30th ($r=0.661$, $p<0.001$) and 60th min ($r=0.547$, $p<0.001$) rSO_2 values and post-operative creatinine values in DM patients.

Discussion

In our study, rSO_2 values measured by NIRS at 30 min decreased in both groups during OLV compared to baseline measurements, while this decrease continued throughout the operation only in the diabetic group. To the best of our knowledge, no study has been conducted to evaluate cerebral oxygenation together with regional cerebral oxygenation (rSO_2), central venous saturation, and arterial blood gases during OLV in diabetic patients.

Studies in the literature suggest that NIRS should be used more as a "trend" monitor, since normal rSO_2 values may differ between individuals.[1,6,7] Normal rSO_2 values have been reported as 58–82, and measurements below 50 are defined as pathological values.[8,9] If measurements are below 40%, it has been reported as a risk for cerebral ischemia.[9] As mentioned in the literature, rSO_2 values were measured continuously from the pre-operative period to the post-operative period in our study. Again, pathological rSO_2 values defined in these literatures were not observed in any of our patients. However, in our study, the development of agitation in the post-extubation period (2–3 values on the Richmond[17] agitation-sedation scale) was observed only in eight diabetic patients whose rSO_2 values were among the 50–60 during the OLV. Similar to our study, Yao and colleagues[18] showed that an intraoperative rSO_2 of <40% was predictive of post-operative cognitive dysfunction. In our study, post-operative cognitive function tests were not evaluated.

Diabetes mellitus has started to be seen more frequently in thoracic surgery as in the general population. Komatsu et al.[12] reported that poor glycemic control (HbA1c levels over 8%) decreased survival and increased post-operative complications in diabetic patients undergoing lung resection in their retrospective study. In our study, HbA1c levels were below 8 and the maximum value was 7.8 (average: 7.2 and better glycemic control). Therefore, we may have found that the length of stay in the ICU and the risk of post-operative complications were similar in the diabetic and control groups.

It has been reported that arterial hypoxemia develops in 4–27% of patients undergoing thoracic surgery. In addition, cerebral saturation decreased more than 15% from preoperative values in 87% of these patients.[1,2] In our study, rSO_2 values decreased in both groups at 30th min of OLV compared to baseline values, while this decrease continued until extubation only in the diabetic group. The reason why rSO_2 values were not at pathological level in our study may be the selection of diabetic patients with good glycemic control level. Consistent with the literature, in our study, rSO_2 values were evaluated simultaneously with hemodynamic measurements, FiO_2, $PaCO_2$, and SaO_2 throughout the entire operation, starting from the pre-anesthesia period.[1,3,5] It has been reported that cerebral oxygenation may decrease due to pulmonary mechanisms rather than hemodynamic reasons in OLV.[1,3,7,10] In our study, hemodynamic values, amount of given fluid, and urine output were similar in the control and diabetic patient groups during the operation. We also evaluated lactate and $ScvO_2$ values in our patients. Low $ScvO_2$ and lactate levels increase the risk of complications after major operations and can be used in early targeted therapy protocol algorithms.[19–22] We thought that the decrease in rSO_2 could not be due to hemodynamic reasons (with reduction in cardiac output), since MAP, lactate, and $ScvO_2$ values were similar in both groups. Oxygen saturation measured from a central venous catheter ($ScvO_2$; normal value=65–70%) mostly refers to brain, lung, and cardiac circulation.[22] Our study is consistent with the study of study[16] and colleagues in diabetic patients who had undergone cardiac surgery. In their study, the authors found that rSO_2 decreased, but $ScvO_2$ remained unchanged during bypass in diabetic patients.[16] Although $ScvO_2$ indicates upper body oxygenation, it is not a specific parameter of cerebral oxygenation.[22] In addition to pulmonary changes, oxidative stress, and increased inflammatory response may cause a decrease in rSO_2 in the first 30 min of OLV in both groups.[1] The primary reason for the more pronounced rSO_2 reduction in diabetic patients may be the development of microangiopathy and impaired cerebral and pulmonary (arteriole/venules) microcirculation in these patients.[13–15] The second reason may be decreased vasodilator response in cerebral vessels due to hypercarbia. Carbon dioxide is a potent vasodilator in the cerebral and systemic circulation. High $PaCO_2$ values may increase cerebral blood flow and rSO_2 values by temporarily vasodilatation in cerebral arteries and arterioles during one-lung ventilation.[23] Lasek-Bal et al.[24] showed in their study that the cerebrovascular reactivity index was significantly worse in hypocapnia and hypercapnia in patients with DM compared to healthy volunteers, and that a longer time was required for blood flow velocity to normalize. In our study, the improvement in rSO_2 values at the 60th minute of OLV in the control group, whereas the low levels of rSO_2 levels in diabetic patients until the end of the operation may be due to the deterioration of cerebral vasodilatation response in these patients.

In our literature review, we could not find a study comparing creatinine values with cerebral oxygenation measured by NIRS during surgery in diabetic patients who underwent lung resection. Although creatinine values increased in the early post-operative period in diabetic patients, post-operative renal failure did not develop in any of our patients. In our study, we thought that the increase in creatinine was not caused by hemodynamic disorders, since there was no significant difference between the two groups in terms of intraoperative fluid, urine amounts, hemodynamic data, and lactate values. A significant correlation was found between pulmonary alveolo-epithelial basement membrane thickening and the thickness of the basal lamina in the renal tubules and capillaries in diabetic patients.[13] Since the microvascular beds of the kidney and the brain have similar hemodynamic properties, similar microvascular damage may develop in the brain and kidney tissues, which need oxygenation and energy the most, with increased oxidative stress and inflammatory response in diabetic patients.[13,15] Indeed, Uzu et al.[14] reported in their retrospective study that cerebral microvascular disease could predict renal failure in type 2 diabetes. The authors followed 608 patients with Type 2 diabetes mellitus (without microalbuminuria or cerebrovascular disease) and concluded that the presence of cerebral artery disease in these patients may be associated with poor renal prognosis.[14] Finally, near-infrared spectroscopy variability combined with clinical information has been shown to improve the discrimination of acute kidney injury in intensive care follow-up after pediatric cardiac surgery.[25] Since our study was conducted only in patients with good blood sugar control and no previous renal damage, acute renal failure may not have developed except for a slight increase in creatinine values in the post-operative period.

Limitations of Our Study

Post-operative neurocognitive function tests were not performed, and evaluation was made with Richmond sedation scoring only in the recovery period. Our study was not conducted in patients with irregular blood sugar or previous signs of renal failure.

Conclusion

It was shown that cerebral oxygen values measured by NIRS during OLV in lung surgery decreased more in diabetic patients than in the control group, but were not within the pathological limits. However, more prospective studies with large case series are needed to reach a definite conclusion on this subject.

Disclosures

Ethics Committee Approval: The study was approved by The Aydın Adnan Menderes University Non-interventional Clinical Research Ethics Committee (Date: 22/06/2018, No: 2018/1429).

Informed Consent: Written informed consent was obtained from all patients.

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Conflict of Interest: None declared.

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