

ORIGINAL ARTICLE

The Effects of Different End Tidal CO₂ Values on Hemodynamics and Surgery in Endoscopic Endonasal Transsphenoidal Pituitary Surgery

Endoskopik Endonazal Transsfenoidal Hipofiz Cerrahisinde Farklı End Tidal CO₂ Değerlerinin Hemodinami ve Cerrahiye Etkileri

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ABSTRACT

Objective : We aimed to examine the effect of different intervals of end tidal CO₂ (etCO₂) values on hemodynamics and surgery in endoscopic endonasal transsphenoidal pituitary surgery.

Material and Methods: Two groups were evaluated retrospectively according to the maximum etCO₂ values at the time of mass sellar resection. Group 1: 21 patients, etCO₂ =25-37 mmHg and Group 2: 21 patients, etCO₂=38-50 mmHg. The demographic characteristics, mean arterial pressure (MAP), heart rate (HR), etCO₂, arterial CO₂ pressure (PaCO₂) at the time of anesthesia induction, sellar excision moment and pre-extubation periods , total amount of bleeding, ease of surgery (good-moderate-bad) were obtained from computer records, anesthesia receipts and surgical reports.

Results: There was no difference between the two groups in terms of demographic data, complications or bleeding. A significant relationship was found between PaCO₂ values of two groups at the time of sellar excision. Surgical satisfaction was evaluated as "good" in 9 patients in Group 1 and 12 patients in Group 2.

Conclusion: High etCO₂ 2 values (38-50 mmHg) facilitated surgical excision of the mass and did not affect hemodynamics. Surgery satisfaction has increased. Keeping etCO₂ slightly higher than normal may be a good choice in these cases. Well-designed prospective studies are needed.

Key words: pituitary surgery, anesthesia, etCO₂, pCO₂

ÖZ

Amaç: Endoskopik endonazal transsfenoidal hipofiz cerrahisinde farklı aralıklardaki end tidal CO₂ (etCO₂) değerlerinin hemodinamiye ve cerrahiye etkisini incelemeyi amaçladık.

Gereç ve Yöntem: Retrospektif olarak sellar rezeksiyon anındaki maksimum etCO₂ değerlerine göre iki grup değerlendirildi. Grup 1:21 hasta, etCO₂ =25-37 mmHg ve Grup 2: 21 hasta ,etCO₂=38-50 mmHg. Hastaların demografik özellikleri, anestezi induksiyonu sonrası, sellar ekzizyon anı ve ekstübasyon öncesi dönemlerde ortalama arter basıncı (OAB), kalp hızı (KH), etCO₂, arteriyel CO₂ basıncı (PaCO₂) , total kanama miktarı, cerrahinin kolaylığı (iyi-orta-kötü) bilgisayar kayıtlarından, anestezi fişlerinden ve cerrahi raporlarından elde edilmiştir.

Bulgular:iki grup arasında demografik veriler, komplikasyon ve kanama açısından fark bulunmamıştır. İki grup arasında sellar ekzizyon anındaki PaCO₂ değerleri arasında anlamlı ilişki saptanmıştır. Grup1'de 9 hastada, Grup2'de ise 12 hastada cerrahi memnuniyet "iyi"olarak değerlendirilmiştir.

Sonuç: Yüksek etCO₂ değerleri (38-50 mmHg) kitlenin cerrahi ekzizyonunu kolaylaştırmış ve hemodinamiyi etkilememiştir. Cerrahi memnuniyeti artırmıştır. EtCO₂ 'yi normalden biraz daha yüksek tutmak bu vakalarda iyi bir seçim olabilir. İyi kurgulanmış prospektif çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: hipofiz cerrahisi, anestezi, etCO₂, pCO₂

Introduction

One of the surgical methods used for the treatment of pituitary tumors today is endoscopic endonasal transsphenoidal pituitary surgery. Tumors in the sella tursica or suprasellar region can be seen well by the endoscopic method and excisions can be performed safely. It can sometimes be difficult to visualize tumors that are distressed and small in terms of location. Various techniques have been described to increase intracranial pressure to reduce the suprasellar

component of the tumor to the pituitary fossa. These are the valsalva maneuver, intrathecal air/saline injection and bilateral jugular venous compression. There are no clear results on the effectiveness of these methods (1). Hypercarbia is also known to increase intracranial pressure (2). Increasing the CO₂ pressure in a controlled manner will increase the intracranial pressure and allow the suprasellar tumors to fall into the pituitary fossa and be removed more easily surgically. Although the level

of controlled hypercapnia is not clear in the literature, etCO₂ was kept at 50 mmHg, and arterial CO₂ pressure (PaCO₂) was kept at 60 mmHg in the studies (3). It has been shown that PaCO₂ at these levels does not affect hemodynamic parameters too much. In our retrospective study, our aim was to determine whether there was a difference between patients with different etCO₂ values in terms of hemodynamic parameters, amount of bleeding, development of complications, and surgical satisfaction.

In line with the results, we aim to share the CO₂ pressure range, which will not disrupt the hemodynamics of the patient but can positively affect the surgical outcome.

Material and Methods

After obtaining the approval of the ethics committee (E-17-1549), 42 patients with ASA I-II between the ages of 18-65 who underwent endoscopic endonasal transsphenoidal pituitary surgery were included in the retrospective study. Tumors of all patients were microadenoma (<10 mm) in size. Those with hydrocephalus, severe heart failure, coronary artery and chronic obstructive pulmonary disease were excluded from the study.

The patients were divided into two groups according to their etCO₂ levels during sellar mass excision. Group 1: 21 patients with etCO₂ levels of 25-37 mmHg; Group 2: 21 patients with etCO₂ levels of 38-50 mmHg. The demographic characteristics of the patients, mean arterial pressure (MAP) (mmHg), heart rate (beats / min), etCO₂, PaCO₂ (mmHg) values in arterial blood gas at the time of post-anesthesia induction, sellar mass excision and pre-extubation period, total amount of bleeding (ml), ease and difficulty of surgery were obtained from computer records, anesthesia receipts and surgical reports. All patients were operated by the same surgeon and followed up by the same anesthesiologist. When the surgery started, arterial blood gas samples were studied. When the sellar wall was removed and the dura was opened, the cases in whom the surgeon had difficulty during excision, and the etCO₂ was allowed to rise to a maximum level of 50 mmHg were defined as Group 2 (1). The circle absorber was switched off and the tidal volume and respiratory rate were decreased, monitoring the rise in end-tidal CO₂ every minute. EtCO₂, hemodynamic parameters and arterial blood gas were also monitored at the time of mass removal. After the mass was removed, the dura and sellar bases were closed after bleeding control, and nasal buffer was placed in the nose. Patient was extubated and awakened. In terms of surgical satisfaction, the surgeon was asked to evaluate the operation from the video recordings. The comfortable appearance of the mass was evaluated as 1:good, 2:moderate, or 3:bad depending on whether there were complications. Intraoperative bradycardia (<50 beats/min), tachycardia (>100 beats /min), hypotension (MAP <60 mmHg) and hypertension (20% more than the entry blood pressure) were accepted as complications.

Statistical evaluation was performed with SPSS (Version 22.0 Inc., Chicago, IL) program. Considering the effect size specified for 80% power and the 5% significance level between the two groups, it was deemed appropriate to evaluate 21 patients in each group and 42 patients in total. Descriptive values are specified as numbers. Student's t test was used to compare the two groups, and Fisher's Pearson test was used for categorical data. Dependent values were compared over percentage changes. If p<0.05, it was considered significant.

Results

There was not significant difference between two groups according to their demographic characteristics and bleeding volume (Table 1).

The operations of nine patients in group 1 and twelve patients in group 2 were found satisfactory by the surgeon and were evaluated as "good". In Group 1, three patients, who were normally hypertensive, developed intraoperative hypertension, and two therefore, required an esmolol infusion. In Group 2, bradycardia developed in only one patient and this resolved in a short time with atropin. Table 2 shows MAP, HR, etCO₂, PaCO₂ values after anesthesia induction, at the time of sellar mass excision and before extubation. A significant difference was found between the two groups in terms of PaCO₂ at the time of sellar excision (p<0.05) (Table 2). There was not significant difference between hemodynamic parameters (p>0.05) (Table 2). Although not very important, there was about 2 mmHg gradient difference between etCO₂ and PaCO₂ in all times (Table 2).

Table 1. Demographic data of the patients.

	Group 1 (n=21)	Group 2 (n=21)	p value
	Mean± SD	Mean± SD	
Age (years)	46±14	50± 8	>0.05
Height (cm)	167.73±9.7	167.46±6.4	>0.05
Weight (kg)	81.3±13.6	75.5±7.2	>0.05
Female/male *	12 /9	10 /11	>0.05
Surgical satisfaction*	6 / 6 / 3	11 / 2 / 2	>0.05
Good / moderate / bad			
Intraop. complication*	3	1	>0.05
Total Bleeding (ml)	160 ± 84	140 ± 68	>0.05

SD: Standart deviation, * Given of the number of patients

Table 2. Comparison of MAP, HR, etCO₂ and PaCO₂ at various stages in the two groups during endoscopic endonasal transsphenoidal pituitary surgery (Mean±SD)

	Group 1 (n=21) (Mean±SD)	Group 2 (n=21) (Mean±SD)	p value
After anesthesia induction MAP (mmHg)	85.9±9.0	84.0±8.3	>0.05
After anesthesia induction HR (bpm)	94 ± 9.5	93.2 ± 16.8	>0.05
After anesthesia induction etCO ₂ (mmHg)	28.7 ± 3.1	33.6 ± 3.5	>0.05
After anesthesia induction P _a CO ₂ (mmHg)	29.8 ± 3.3	35.5 ± 3.7	>0.05
Sellar dissection time MAP (mmHg)	61.7±10.1	60.5±11.8	>0.05
Sellar dissection time HR (bpm)	77.0 ± 11.3	75.2 ± 12.0	>0.05
Sellar dissection time etCO ₂ (mmHg)	31±3.8	45 ± 3.6	>0.05
Sellar dissection time P _a CO ₂ (mmHg)	34±0.6	46 ± 3.9	<0.05
Before extubation MAP (mmHg)	104.3 ± 11.3	101.3 ± 15.4	>0.05
Before extubation HR (bpm)	84.8 ± 11.4	84.4 ± 15.2	>0.05
Before extubation etCO ₂ (mmHg)	30.2 ± 4.0	39.1 ± 2.8	>0.05
Before extubation P _a CO ₂ (mmHg)	33.5 ± 0.4	41.0 ± 4.2	>0.05

SD: Standart deviation

Discussion

Although there was no hemodynamic difference in different etCO₂ values in endoscopic endonasal transsphenoidal pituitary surgery, surgical satisfaction was found higher in Group 2 with high etCO₂ values. Although there was no significant difference in terms of surgical complications and bleeding amounts, fewer complications and bleeding were observed in Group 2 in terms of numbers.

Keeping the etCO₂ value high in endoscopic endonasal transsphenoidal pituitary surgery can help the mass to be easily removed and hemodynamic parameters to remain stable. There are methods that can be used if the mass is not spontaneously prolapsed. Some of these include giving 15-20 cc air or Ringer's lactate solution from the lumbar drainage catheter, performing bilateral jugular vein compression, giving PEEP, and creating permissive hypercapnia (4). Among these methods, in our cases, we mostly use the valsalva maneuver and sometimes the etCO₂ upgrade. The effect of moderate hypercapnia on facilitating surgery has been reported in a small number of studies. In the study conducted by Korula et al. (1), etCO₂ was allowed to increase up to 50 mmHg. PaCO₂ increased to a maximum of 60 mmHg in these etCO₂ values, and no hemodynamic complications

occurred at this value. At this level, CSF pressure reached up to 20 mmHg, and no complications, such as hypertension, tachycardia or increased myocardial load, were observed. Both therapeutic and permissive hypercapnia increased cardiac output by increasing peripheral vascular resistance. When etCO₂ is elevated, PaCO₂ levels should also be checked in arterial blood gas. Arterial blood gas is routinely examined in neurosurgery cases in our center.

Knowing the intracranial pressure or CSF pressure allows us to be on the safe side for these techniques to be applied easily (5). The fact that the catheter is not inserted in any way does not prevent us from applying these techniques. The lumbar drainage catheter was not inserted by the surgeon in our retrospective patients. However, there are no symptoms or findings of high intracranial pressure. If there had been, our study would have been stronger. As in all neurosurgery cases, intraoperative monitoring of etCO₂ and PaCO₂ values in pituitary surgery is very important, and our goal is to keep these values within normal limits. However, creating moderate hypercapnia can facilitate the removal of the mass only in such cases.

An increase in etCO₂ may be allowed by lowering the tidal volume and frequency. In the meantime, it is necessary to ensure close monitoring of the patient in terms of hemodynamics.

Although it has been mentioned in the literature that high CO₂ levels may impair hemodynamics and may cause cardiovascular depression when the pH drops below 7.2, values characterized as "high" have not been given (6,7).

It has been reported that hypercapnia causes catecholamine discharge and may increase bleeding as a result of developed hypertension and peripheral vasodilation (6). There were no intraoperative bleeding complications in our patients.

In some cases, hypercapnia can be used to provide hyperkinetic circulation in patients with high blood pressure and tachycardia (8,9).

Increased PaCO₂ in awake patients may cause CO₂ narcosis, which may lead to impaired consciousness, a tendency to sleep, and delayed waking under anesthesia (10). Therefore, at the beginning of the study, those with respiratory system diseases were excluded from the study. In addition, none of our patients had late waking problems.

PaCO₂ 50-60 mmHg levels have been successfully used to facilitate the procedure in interventional neuroradiology cases such as dural fistulas and arteriovenous malformation (11).

If hypercapnia is deep and prolonged, hypoxia and acidosis may develop (12). In our study, CO₂ elevation was short-term and acceptable, and it was applied until the mass was removed. Therefore, no acidosis or

hypoxia was observed.

The gradient difference between etCO₂ and PaCO₂ can be seen normally. This difference may be even higher in hypotensive patients (13). Voluntary hypotension is usually induced in patients undergoing endoscopic hypophysectomy. This results in an increase in the difference between PaCO₂ and etCO₂, so we think that this is why the gradient difference in our patients developed.

Conclusion

In tumors that might be difficult to remove during surgery, a slightly higher etCO₂ value did not affect hemodynamics and facilitated surgical procedure. Surgery satisfaction has increased. Keeping etCO₂ between 38-50 mmHg may be appropriate for these cases. However, there is a need for well-designed prospective studies on this subject.

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