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Akut İnme Hastalarında Vücut Pozisyonunun Arteriyel Oksijenasyona Etkisi / *Effects of Body Position on Arterial Oxygenation in Acute Stroke Patients*

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ABSTRACT

Effects of Body Position on Arterial Oxygenation in Acute Stroke Patients

Scientific background and objective: *Hypoxemia is an important factor that increases cerebral damage in acute stroke patients. In conjunction with the growing importance of stroke intensive care units, there has been an increase in studies reporting on the correlation between oxygenation and the body position in acute stroke patients with hemiparesis. This study was planned to evaluate the relationship between oxygen saturation (SaO_2) and position in acute stroke patients.*

Materials and methods: *Acute stroke patients followed in the Neurology Department of Ankara Numune Hospital between July 2000 and June 2001 were included in this study. The SaO_2, pulse and blood pressure values were recorded initially, and at the 15^{th}, 30^{th} and 60^{th} minutes in patients lying on either their paretic or healthy side in the lateral decubitus position on the 1^{st}, 3^{rd} and 7^{th} days. Characteristics of the lesions were determined on computerized tomography (CT). Clinical parameters (consciousness, degree of paresis, functional disability, coma scores, and prognosis) were also recorded.*

Results: *The 50 patients (19 male, 31 female) included in this study with the diagnosis of acute stroke had a mean age of 68.32±12.02. CT imaging revealed hematoma in 19 of the patients, infarct in 30 and hemorrhagic infarct in 1. Arterial oxygen saturation (SaO_2) values of the subjects recorded initially and at the 15^{th}, 30^{th} and 60^{th} min from the healthy side in the lateral decubitus position in the first day of stroke were found to be higher than the paretic side ($p<0.05$ initially; $p=0.002$ 15^{th} min; $p=0.013$ 30^{th} min; and $p=0.024$ 60^{th} min). In female patients, SaO_2 values were found to be lower than male patients in both recumbent positions ($p=0.017$ and $p=0.020$). SaO_2 values in the hematoma group were lower than in the infarct group ($p=0.038$). SaO_2 values of patients who died were lower than of those alive on the 3rd day ($p=0.013$ initially; $p=0.012$ 30^{th} min; $p=0.020$ 60^{th} min). SaO_2 values in the sustained recumbent position demonstrated improvement over time ($p=0.042$). There was no relation between position and the pulse rate, whereas systolic blood pressure values were found to be higher in patients lying on the healthy side ($p=0.013$ initially; $p=0.009$ 15^{th} min; $p=0.017$ 30^{th} min).*

Conclusion: *Our findings suggest that positioning of the patient in the lateral decubitus position on the healthy side may provide optimal oxygen saturation in addition to medical treatment.*

Keywords: cerebral hematoma, cerebral infarct, oxygen saturation, position

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ÖZET

Bilimsel zemin ve amaç: İnme hastalarında akut dönemde hipoksemi, serebral hasarı artıran önemli bir faktördür. Akut inmeli hemiparezik

Anahtar kelimeler: serebral hemoraji, serebral infarkt, oksijen saturasyonu, pozisyon

hastalarda, hastanın vücut pozisyonu ile oksijenasyon arasında ilişki olduğunu bildiren çalışmalar, son yıllarda strok yoğun bakımlarının önem kazanmasına paralel olarak artmaya başlamıştır. Bu çalışma akut inme hastalarında pozisyonun oksijen saturasyonu ile ilişkisini araştırmak amacıyla planlandı.

Gereç ve yöntemler: Çalışmaya, Ankara Numune Eğitim ve Araştırma Hastanesi Nöroloji Kliniği'nde Temmuz 2000-Haziran 2001 tarihleri arasında izlenen akut inme hastaları dahil edilmiştir. Hastaların paretik ve sağlam taraflarına lateral dekubit pozisyonunda, başlangıç, 15., 30. ve 60. dakikalardaki O_2 saturasyonu (SO_2), nabız, kan basıncı değerleri, 1., 3. ve 7. günlerde kaydedildi. BBT'de lezyon özellikleri belirlendi. Klinik parametreler (bilinç, parezi dereceleri, fonsiyonel dizabilite, koma skorları, prognoz) kaydedildi.

Sonuçlar: Çalışmaya alınan 50 hastanın (19 erkek, 31 kadın) yaş ortalaması 68,32±12,02 bulundu. BBT'de 19 hastada hematom, 30 hastada infarkt, 1 hastada hemorajik infarkt tespit edildi. Strokun 1. günü SO_2 değerleri başlangıç, 15., 30. ve 60. dakikada sağlam tarafına lateral dekubit pozisyonda yatan hastalarda paretik tarafına yatanlardan belirgin olarak yüksek bulundu (sırasıyla $p<0,05$, $p=0,002$, $p=0,013$, $p=0,024$). Kadın hastalarda SO_2 düzeyleri her iki yatış pozisyonunda da düşük bulundu ($p=0,017$, $p=0,020$). Hematomlu hasta grubunda SO_2 değerleri infarktlı hasta grubundan daha düşüktü ($p=0,038$). 3. gün SO_2 değerleri eksitus olan hastalarda, yaşayan hastalara göre daha düşüktü (başlangıç $p=0,013$, 30. dakika $p=0,012$, 60. dakika $p=0,020$). SO_2 düzeyleri aynı yatış pozisyonunda zaman ile düzelme göstermekteydi ($p=0,042$). Pozisyon ile nabız değerleri ilişki göstermezken, sistolik kan basıncı değerleri sağlam tarafa yatan hastalarda daha yüksek bulundu (başlangıç $p=0,013$, 15. dakika $p=0,009$, 30. dakika $p=0,017$).

Yorum: Bulgularımız, sağlam tarafa lateral dekubitus pozisyonunun, medikal tedaviye ek olarak, optimal oksijen saturasyonu sağlamak üzere hastalar için en uygun yatış pozisyonu olduğunu düşündürmüştür.

INTRODUCTION

One of the main targets of stroke treatment in the acute phase is to minimize cerebral damage to the extent possible.[1] Following an ischemic cerebrovascular event, in order to protect the oxygen supply of a penumbra area, which can potentially be saved, systemic and also cerebral oxygenation should be maintained.[2]

In conjunction with the growing importance of stroke intensive care units, in recent years, there has been an increase in studies reporting the correlation between oxygenation and body position in acute stroke patients with hemiparesis or hemiplegia.[3]

Therefore, to monitor the systemic and cerebral arterial oxygen saturation (SaO_2) in these patients, in addition to clinical symptoms, methods such as intermittent analyses of arterial blood gases, pulse oximeter, jugular bulb oximeter, cerebral oximeter, and analyses of transcutaneous blood gases are used.

This study was planned to investigate the relationship between systemic oxygenation and patient position, lesion nature and other clinical properties in acute stroke patients.

MATERIAL and METHOD

Fifty patients with acute stroke (31 female, 19 male; age range: 30-88 years; mean: 68.32±12.02) followed in the Neurology Department of Ankara Numune Hospital between July 2000 and June 2001 were included in this study.

The inclusion criteria were:

1. Hemiparesis or hemiplegia with evidence of stroke both clinically and by computerized tomography (CT) which is obtained in the first 24 hours
2. First-ever stroke
3. No previous history of disease of lungs or thorax, thoracic trauma or thoracic surgery
4. No development of massive edema of lungs or pulmonary embolism during the study
5. No physical state which would disturb the positional stabilization of the patient or hinder adaptation to the detailed examination.

The diagnosis of stroke in these patients were determined by clinical examination and confirmed by CT. Medical history was questioned for smoking habits and presence of cardiac disease, diabetes mellitus, hypertension, and continuous alcohol or drug intake.

CTs of all patients were obtained in the first 24 hours. The nature of the lesion according to CT was evaluated as hemorrhagic and ischemic. The size of the lesions determined in CT was calculated as "width x length x appearing cross-section number", using as a basis of the widest appearing cross-section of a lesion. Whether the hemorrhagic lesions are opened to the ventricle or not was noted. Properties

accompanying lesions such as edema, mass effect, periventricular hypodensity, and atrophy were also recorded.

Glasgow Coma Scale was applied during the clinical evaluations, and levels of consciousness were grouped. The degree of paresis was determined. Functional states were evaluated using the Rankin index.

The SaO_2, pulse and blood pressure values were recorded initially, and at the 15th, 30th and 60th min in patients lying on either their paretic or healthy side in the lateral decubitus position at the end of a two-hour monitorization on the 1st, 3rd and 7th day. Patients were evaluated using a "Flexisensor S.D. (A)" pulse oximeter with a semi-flexible finger probe affixed to the patient's finger on the hemiparetic side. SaO_2 measurements were monitored via bedside "Datascope Passport" monitors.

1st day stroke parameters including hemogram and biochemistry, ECG, and posteroanterior lung radiograph examination results of every patient were also recorded.

Student's t-test was used in statistical evaluations for group comparisons, paired t-test was preferred for intragroup comparisons, and Pearson correlation test was applied for correlations. A value of $p<0.05$ was regarded as indicating statistical significance.

RESULTS

The mean age of the 19 male and 31 female patients (totally 50 subjects) with acute stroke included in the study was 68.32±12.02. 11 of these patients had diabetes, 23 had cardiac disease, and 42 had history of hypertension. The consciousness levels of the patients were determined as; open (n=9), somnolent (n=17) and stuporous (n=24). Types of lesions in CT were classified as hematoma in 19, infarct in 30, and hemorrhagic infarct in 1 patient. Lesion localizations on CT were frontal in 3, temporal in 7, parietal in 18, occipital in 1, and basal ganglia in 11 subjects (Figure 1).

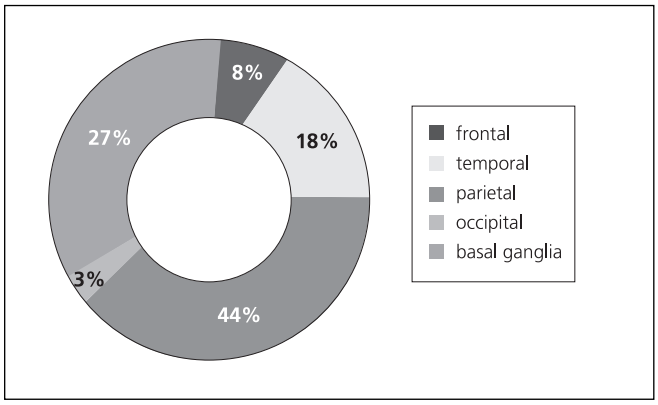

Figure 1. Distribution of lesion localizations on CT

Arterial oxygen saturation (SaO_2) values of the subjects recorded initially and at the 15th, 30th and 60th min from the healthy side in the lateral decubitus position in the first day of stroke were found to be higher than the paretic side ($p=0.000$ initially; $p=0.002$ 15th min; $p=0.013$ 30th min; and $p=0.024$ 60th min).

In female patients, SaO_2 values were lower than male patients in both recumbent positions ($p<0.05$). SaO_2 values of patients who died within 10 days were lower than of those alive on the 3rd day ($p<0.05$ initially; 30th min; and 60th min). SaO_2 values in the sustained recumbent position demonstrated improvement over time ($p=0.042$). There was no relation between position and the pulse rate, whereas systolic blood pressure values were found to be higher in patients lying on the healthy side than in the patients lying paretic side (systolic blood pressure values for the healthy side; paretic side as mean±SD (157.00±29.55; 150.00±28.21 initially, 155.90±28.22; 148.80±27.85 at 15th min, 152.78 ±27.05; 147.90±25.61 at 30th min) ($p=0.013$ initially; $p=0.009$ 15th min; $p=0.017$ 30th min).

To investigate the effect of lesion type on SaO_2 values on the paretic side, SaO_2 values measured at the 60th min of the first day in patients with hematoma (90.210±3.705) were found to be significantly lower than in the group of patients with an infarct (92.433±3.451) ($p=0.038$). This difference continued to demonstrate statistical significance on the third day ($p=0.034$) (Figure 2). When

investigating the relation of recumbent position, and the paretic side, with prognosis, no difference was found on the first day. SaO_2 values were markedly lower in patients who died later, than of those alive at the 3rd day (first day initially p=0.013; 30th min p=0.012; 60th min p=0.020) (Figure 3).

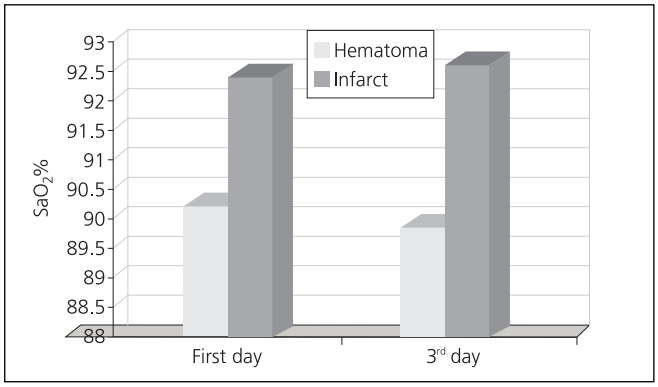

Figure 2. SaO_2 values with respect to the cerebral lesion type

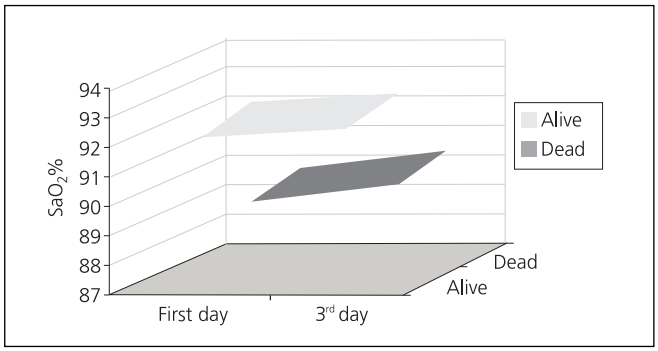

Figure 3. SaO_2 values with respect to the prognosis

In regard to the relation of SaO_2 values and time in the two groups of patients (lying on the healthy or paretic side) in the first day, a statistically significant difference was found (p=0.028) between initial SaO_2 values (91.360±3.569) and 30th min values (91.890±3.561) of patients lying on their healthy side. Similarly, in patients lying on their paretic side, a significant difference was obtained between the initial (90.640±3.756) and 30th min SaO_2 values (91.480±3.598) (p=0.012). As the position was maintained over time, an increase in the SaO_2 values in both positions was noted. The correlation between age and SaO_2 values in different recumbent positions is also evaluated. No difference was observed with positioning on the healthy side, however a statistically significant correlation between age and SaO_2 values at the 30th, and 60th min at the first day was observed in patients lying on their paretic side (15th min p=0.054, r=0.194; 30th min p=0.028, r=0.311; 60th min p=0.032, r=0.304). Diastolic blood pressure and pulse rate showed a negative correlation with the patient age (diastolic blood pressure p=0.043, r=-0,287; pulse rate p=0.050, r=-0.279). When we evaluated the relation of the first day systolic blood pressure values with position, the initial, 15th min, and 30th min systolic blood pressure values were found to be significantly higher in patients lying on their healthy side (p=0.013, p=0.009 and p=0.017, respectively). This difference had disappeared at the 60th min (p=0.910).

DISCUSSION

Patients with acute stroke are at risk of hypoxemia. It is thought that the degree of oxygen desaturation is related to the posture.[3] During acute stroke, a decrease in thoracic wall movement is frequently observed.[4] There are also studies showing a decrease in electromyographic activity in intercostal muscles and hemi-diaphragm on the paretic side.[5] However, desaturation of arterial oxygen is regarded as an independent factor significantly increasing the risk of morbidity and mortality in the post-stroke period.[6] As a result, improving the ratio of ventilation to perfusion by providing the optimal patient position has been considered as another means of improving the tissue-oxygen distribution.[7] Such an approach is an accepted application in the management of respiratory conditions.[8,9]

Patients with dens hemiplegia can be hypoxic and hypocapnic in the 48-hour period of the post-stroke phase.[10,11] A possible factor is the inefficient perfusion and ventilation of lungs on the paretic side, and this mechanism is thought to be related to patient's posture.[3]

In hemiplegia originating from lesions in the supratentorial part of the brain, automatic respiration is affected. During hyperventilation induced by CO_2 and automatic spontaneous

respiration in hemiplegic patients,[12] it is reported that movements of the diaphragm are synchronized with spontaneous EMG activity.[13]

Elizabeth et al. reported the relation of arterial oxygen saturation and posture in acute stroke.[3] Oxygen saturation values were measured by pulse oximeter in lateral decubitus on healthy and affected sides, and supine, propped-up, and sitting positions. Periods of desaturation (SaO_2 values < 90%) in patients lying on the hemiplegic side were determined to be 55% more than in the other positions. The study demonstrated that oxygen saturation values measured in a sitting position in stroke patients are higher than in other positions. In order to minimize other complications, the appropriate investigating position of the acute stroke patient was suggested to be the sitting position.[3]

Chatterton et al. could not determine any correlation between position and SaO_2 values or between position periods and SaO_2 values. Their patients did not have a severe stroke.[7] Similarly Brainin et al. showed no difference between bodyposition in stroke patients but they suggested positioning on the paretic side to prevent aspiration, to have the uneffected extremities free and easier communication with the hepler.[14] In their meta analysis Thyson and Nightingale have reported that acute stroke patients without respiratory co-morbidities can adopt any body position, and people with respiratory co-morbidities should be positioned as upright as possible.[15]

In our study group, motor deficits and alteration of consciousness were more severe than those of the other studies. Alteration of consciousness is thought to be an important factor in explaining the different results observed between studies.

It is suggested that acute hemiplegic patients frequently lie on the paralytic side in order to more easily move their healthy sides, which causes an increase in hypoxia and pulmonary shunt by increasing the blood flow to the hypo-ventilated lungs.[16] It has been shown that these results in hypoxic ventilation followed by acute respiratory alkalosis, and this state is compensated by a metabolic acidosis for a period of a few hours. It is thought that the lower serum bicarbonate concentrations determined in hemiplegic patients reflect this situation.[17] Our findings with respect to oxygen saturation, revealed marked differences in acute stroke patients lying on their healthy versus paretic side in the lateral decubitus position. In patients lying on the healthy side, SaO_2 values were significantly higher than those determined while lying on the paretic side. During the first day, this difference was observed to be maintained from the beginning to the 60th min of the lying position. On the 3rd and 7th days, SaO_2 value differences were not as constant as observed on the first day. These results are concordant with the results of studies that found SaO_2 values lower in patients lying on their paretic side[3,16] and with the results of studies that showed a decrease in movement and respiratory muscle activation in acute stroke patients lying on their hemiplegic side.[4,18]

We found no difference between the lateralization of the lesion and SaO_2 values in patients lying on their paretic side. This result also complies with results of studies have reported the double-sided cortical sampling of respiratory muscles.[4,10,19]

No detailed study has been made about the relation of position on SaO_2 values considering the effect of consciousness level, because stroke patients in such studies are classified in homogeneous groups as having open or significantly lower consciousness levels.[7,3] We observed markedly lower SaO_2 values in patients who died in the first 10 days than of those who recovered. We were unable to compare our prognostic evaluation results with those of previous studies since they did not include longitudinal and prognostic evaluations of their results. However, when we consider the known effects of oxygen saturation on the prognosis of cerebral lesions, use of this value as a prognostic factor is supported by indirect results.[6,3]

While maintaining the patient's position, we observed that SaO_2 values obtained at the 30th and 60th min in patients lying on their healthy side were higher than initial values. A similar trend was observed with patients lying on their paretic side. Though this pattern was evident in the first days, it disappeared on the 7th day.

It has been reported that less frequent changes in the position of patients had a positive effect on SaO_2 values. Evelyn et al. claimed that though position changing was a frequently used method, a position change in every two hours could be harmful to oxygenation. Therefore, they put forward that it would be more useful prognostically, after determining the most appropriate position, to then maintain the patient in this position for a longer time.[20] Some of the studies investigating the effect of position on SaO_2 values in acute stroke patients which reported differences in blood pressure and pulse according to position, also reported that these could be effective in changing values of SaO_2.[20] Rowat et al. evaluated arterial oxygen saturation and heart rate in acute stroke patients to determine whether routine positioning affected these physiological parameters. They reported that patients mostly had less severe strokes, had a significantly higher mean SaO_2 and heart rate when sitting in the chair than when placed in any other position. About 10% of patients, especially those with a severe stroke, with right hemiparesis and concomitant chest disease, experienced falls in SaO_2 to 90% or less for >/=2 min in certain positions; the hypoxia was more likely when they were lying on their left side.[21]

For improving of cerebral blood oxygenation, some investigators evaluated effect of head of bed as body position. They suggested that adequate cerebral perfusion pressure is considered more desirable than the absolute level of ICP, and the horizontal position is optimal for these patients.[22,24,25] New information from these studies for positions of the acute stroke patients must be evaluated for additional effect in stroke treatment in further studies.[26]

In conclusion, considering the importance of achieving sufficient oxygen perfusion in the acute phase of stroke patients, in addition to medical therapy, we suggest that positioning of the patient in the lateral decubitus position on the healthy side can provide optimal oxygen saturation.

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