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Risk factors associated with changes in oxygenation and pulse rate during colonoscopy

Kolonoskopi sırasında oksijenasyon ve kalp hızı değişiklikleri ile ilişkili risk faktörleri

Mustafa YILMAZ[1], Ahmet AYDIN[2], Zeki KARASU[2], Fulya GÜNŞAR[2], Ömer ÖZÜTEMİZ[2]

Pamukkale University Medical School, Department of Gastroenterology[1], Denizli

Ege University Medical School, Department of Gastroenterology[2], İzmir

Background/aims: *Although hypoxemia is a relatively common complication of colonoscoy, the possible predictive factors of oxygen desaturation and tachycardia in patients undergoing this procedure are not well known. In this study, the possible predictive factors of severe oxygen desaturation (SaO2<90%) and tachycardia in patients with undergoing colonoscopy were investigated.* ***Methods:*** *A total of 79 consecutive patients were evaluated in the study (46 men and 33 women). Significant oxygen desaturation was considered to be a reduction of arterial oxygen saturation (SaO2) to less than 90%. Tachycardia was defined as a heart rate above 100/min. Patients with inadequate colonoscopy were excluded from the study. The incidence of arterial hemoglobin oxygen desaturation and changes of heart rate during colonoscopy were evaluated and clinical factors in relation to these findings were assessed.* ***Results:*** *The SaO2 during colonoscopy fell below 90% in 19 of the 79 patients (24.1%). The risk factors for desaturation were advanced (>60yr) age (OR: 6.03; 95% CI, 1.35-26.99), receiving sedation (OR: 11.42; 95% CI, 2.05-63.49), chronic lung disease (OR: 4.54; 95% CI and 1.40-11.68), and obesity (OR: 8.95; 95% CI, 1.17-68.55). The presence of hypertension and anemia, a history of cigarette smoking and duration of the colonoscopy had no significant effect on arterial oxygen desaturation (p>0.05). The pulse rate was raised above 100/min during colonoscopy in 26 of 79 patients (32.9%). lncrease in heart rate was found to be related to arterial oxygen desaturation (OR: 13.72; 95% CI, 2.67-70.32), anemia (OR:6.17; 95% CI, 1.15-32.91) and advanced (>60 yr) age (OR: 6.08; 95% CI, 1.62-22.81). Gender, sedation, obesity, hypertension, chronic lung disease and smoking did not affect the heart rate (p>0.05). Two patients had transitional bradyarrythmia, which had no relationship with the parameters studied. There was no incidence of significant hypoxia or change in heart rate which might have caused termination of the procedure.* ***Conclusions:*** *Benign and transient arterial oxygen desaturation and tachycardia may occur during colonoscopy procedure. Sedation, obesity, advanced age and chronic lung disease might contribute to these adverse events.*

Key words: Colonoscopy, arterial oxygen saturation, heart rate, obesity, sedation.

Amaç: *Kolonoskopi sırasında hipoksemi gelişebilmektedir. Fakat kolonoskopi yapılan hastalarda oksijen desatürasyonu ve taşikardiye yol açabilecek olası faktörler iyi bilinmemektedir. Biz kolonoskopi yapılan hastalarda ciddi oksijen desatürasyonu ve taşkardi gelişimine yol açan faktörleri ortaya koymayı amaçladık.* ***Yöntem:*** *Çalışmaya 46 erkek ve 33 kadından oluşan toplam 79 ardışık hasta alındı. Arteriel oksijen saturasyonunun (SaO2) %90'ın altına düşmesi anlamlı desaturasyon, kalp hızının 100/dk üzerine çıkması taşikardi olarak tanımlandı. Kolonoskopik işlemi yetersiz olan hastalar çalışmadan çıkarıldı. Kolonoskopi sırasındaki arteriel oksijen desatürasyonu ve kalp hızındaki değişiklik insidansı ile buna etki eden klinik faktörler değerlendirildi.* ***Bulgular:*** *Kolonoskopi sırasında 79 hastanın 19'unda (%24.1) SaO2 %90'ın altına düştü. Oksijen desatürasyonu için risk faktörleri ileri yaş (>60yaş) (OR: 6.03; 95% CI, 1.35-26.99), sedasyon uygulanması (OR: 11,42; 95% CI, 2.05-63.49), kronik akciğer hastalığı (OR: 4.54; 95% CI, 1.40-11.68), ve şişmanlık (OR: 8.95; 95% CI, 1.17-68.55) olarak saptandı. Hipertansiyon, anemi sigara kullanımı ve işlem süresinin arteriel oksijen desatürasyonuna istatistiksel olarak anlamlı etkisi gözlenmedi (p>0.05). Kolonoskopi sırasında 79 hastanın 26'sında (%32.9) taşikardi gelişti. Kalp hızındaki artmanın, arteriel oksijen desatürasyonu (OR: 13.72; 95% CI, 2.67-70.32), anemi (OR: 6.17; 95% CI, 1.15-32.91) ve ileri yaş (>60 yaş) (OR: 6.08; 95% CI, 1.62-22.81) ile ilişkili olduğu belirlendi. Cins, sedasyon, obezite, hipertansiyon, kronik akciğer hastalığı ve sigara kullanımının kalp hızını etkilemediği saptandı (p>0.05). Geçici olarak bradikardi gelişen 2 hastanın bu parametrelerle ilişkisi bulunmadı. Hiç bir hastada kolonoskopik işlemi sonlandırmayı gerektirecek düzeyde hipoksi ve taşikardi gelişmedi.* ***Sonuç:*** *Kolonoskopik işlem sırasında benign, geçici arteriel oksijen desatürasyonu ve taşikardi gelişebilmektedir. Sedasyon, obezite, ileri yaş ve kronik akciğer hastalığı bu yan etkilere katkıda bulunuyor olabilir.*

Anahtar kelimeler: Kolonoskopi, arteriel oksijen desaturasyonu, taşikardi, obezite, sedasyon.

INTRODUCTION

The utilization of diagnostic and therapeutic endoscopy has steadily increased in Turkey as in the world because of both its benefit to patient care and its extraordinary safety. Colonoscopy

Address for correspondence: Dr. Mustafa YILMAZ
Pamukkale Üniversitesi Hastanesi, Doktorlar Cad No: 42, 20100, Denizli
Tel: 90 258 2410034-Fax: 90 258 2410040E-mail : kmustyil@yahoo.com

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achieves more than contrast radiology due to it's greater accuracy and also its biopsy and therapeutic capabilities. However, it is also associated with a number of complications and the complication rate for diagnostic colonoscopy is almost three times as high as for upper gastrointestinal endoscopy, with large combined series estimating it to be around 1 in 300-700 procedures (1). Cardiopulmonary complications have been estimated to account for less than 10% of the total morbidity, but the true incidence is unknown (2). With the introduction of pulse oximetry, it has become apparent that oxygen desaturation occurs frequently at the time of endoscopy and that cardiac arrythmias are observed particularly frequently when the patient becomes hypoxic (3-6). The widespread use of pulse oximetry has increased the endoscopist' s awareness this problem.

The cardiopulmonary effects of upper gastrointestinal endoscopy are well established and several studies have evaluated the clinical importance of hypoxia (7-9). The purpose of this study was to determine the frequency and clinical significance of arterial hemoglobin oxygen desaturation and tachycardia in patients undergoing routine colonoscopy.

MATERIALS AND METHODS

The study included 79 consecutive patients scheduled for elective colonoscopy at the Gastroenterology Department of Ege University Medical School between June 1998 and November 1998. The indications for colonoscopy were diagnostic or therapeutic (removal of polyps). A complete medical history was obtained from all patients prior to the procedure specifically addressing their colorectal disease as well as any history of cardiac disease (recent or past myocardial infaction, angina, arrythmias, congestive heart failure), hypertension, pulmonary disease and tobacco use. Patients using beta-adrenergic blocking drugs, or calcium antagonists were excluded from the study. Baseline arterial oxygen saturation (SaO2) was >90% and heart rate was within normal limits in all patients prior to the procedure. Anemia was defined as hemoglobin below 10gr/dl.

The height and weight of all patients was measured to calculate body-mass index (BMI). Somatotypes were classified as underweight, normal weight, or obese based on BMI. The patients were randomly and consequently allocated to groups that received either no sedation or sedation with midazolam (0.035 mg/kg). Baseline SaO2 levels were obtained for 5 min. prior to the colonoscopy and continuous measurements of SaO2 were obtained during the entire colonoscopic examination utilizing the Nellcor N-200 pulse oximeter with a finger-mounted sensor. When desaturation occurred, correct placement of the finger mounted sendor was checked to minimalize or eliminate false positive results. The SaO2 and pulse rate were monitored during the entire procedure. The lowest saturation during colonoscopy and saturation at the end of the procedure were recorded. Significant oxygen desaturation was considered to be reduction of SaO2 to less than 90%. Tachycardia was defined as a heart rate above 100/min.

Colonoscopy was performed with the patient in the left lateral decubitus position, using an Olympus CF 1T 10L colonoscopy device. Patients with inadequate colonoscopy, i.e. either because of insufficient bowel preparation or because of inability to advance the colonoscope to the caecum, were excluded from the study. Several parameters were assessed independently for their effect on SaO2 and heart rate. These included age, sex, weight, medical history (with emphasis on cardiopulmonary disease), duration of the examination, and presence or absence of sedation.

Data were entered into a computer and analyzed using the Statistical Package for the Social Science for Windows (SPSS) . Comparison of data was performed using the chi-square test, paired sample t-test, as appropriate. Multivariate analyses were performed using logistic regression analysis. The odds ratios (OR) and 95% CI for each significant variable in the final model were calculated from the coefficients estimated in the logistic regression models. Level of significance was chosen at $p<0.05$.

RESULTS

A total of 79 (46 men and 33 women) patients were evaluated, 9 with an age range of 22 to 81 years (mean 52.5±16.6yr). Patient characteristics are given in Table 1. Six of the original 85 patients were excluded because of incomplete colonoscopy (insufficient bowel preparation). Sixty-nine diagnostic and 10 therapeutic colonoscopies were performed. Twenty-nine patients had a history of smoking and in seven of them, lung disease

Table 1. Patients characteristics.

Mean age (min-max)	52 (22-83)
Male/female	46/33
Age > 60	30
Pulmonary disease	7
Smoking	29
Hypertension	17
Obesity	16
Mean duration of colonoscopy (min-max)	27 min (7-83)
Anemia	14
Total	79

(chronic obstructive pulmonary disease) was diagnosed. Seventeen patients had hypertension. On physical examination, 56 patients were of normal weight, while 16 were obese and seven were underweight. SaO2 fell below 90% during colonoscopy in 19 of the 79 patients (24.1%), occuring in 11 of 46 men (23.9%) and 8 of the 33 women (24.2%). The difference did not reach statistical significance (p>0.05). Pulse oximetry was recorded before the procedure as SaO2 96.64±1.9% and during the procedure as SaO2 93.25±3.67% (p<0.001) (Table 2). Logistic regression analysis was used to estimate the odds ratio (OR) with 95% confidence intervals (CI) for episodes of oxygen desaturation and heart rate associated with sex, age, sedation, smoking, chronic lung disease, hypertension, anemia, obesity, and duration of colonoscopy. The risk factors for desaturation were advanced (>60yr) age (OR: 6.03; 95% CI, 1.35-26.99), receiving sedation (OR: 11,42; 95% CI, 2.05-63.49), chronic lung disease (OR: 4.54; 95% CI, 1.40-11.68), and obesity (OR: 8.95, 95% CI, 1.17-68.55) (Table 3). A history of hypertension, anemia, smoking, and longer duration of the procedure had no significant effect on oxygen desaturation (p>0.05) (Table 3).

Table 2. Frequency of oxygen desaturation and changes in heart rate during colonoscopy

Data	*No of cases*
Desaturation episodes (SaO2< 90%)	19 (24%)
Tachycardia episodes (heart rate>100 min)	26 (33%)
Bradyarythmia episodes (heart rate 60< min)	2 (2.5%)

Pulse rate was recorded before the procedure as 84.20±12/min and during the procedure as 93.49±15% (p<0.0001). The pulse rate was raised above of 100/min during colonoscopy in 26 of 79 patients (32.9%), occuring in 11 of 46 men (23.9%) and 15 of the 33 women (45.5%). The difference did not reach statistical significance (p>0.05). Increase in heart rate was found to be related to arterial oxygen desaturation (OR: 13.72; 95% CI, 2.67-70.32), anemia (OR: 6.17; 95% CI, 1.15-32.91) and advanced (>60 yr) age (OR: 6.08; 95% CI, 1.62-22.81). Gender, sedation, obesity, hypertension, chronic lung disease, and smoking did not affect the heart rate (p>0.05) (Table 4).

Two patients had transitional bradyarrythmia, which had no relationship with the parameters studied. There was no incidence of significant hypoxia or change in heart rate which might have caused termination of the procedure.

DISCUSSION

The increase in the use of colonoscopy for evaluation and treatment of lower parts of the gastrointestinal tract has focused attention on their relative complications. Colonoscopy is generally safe. It is increasingly performed in the elderly and

Table 3. Frequency of arterial oxygen desaturation during colonoscopy

Variable	**SaO2 desaturation**		
	n	*OR*	*p*
Sedation	27	11.42	0.0054
Age>60	30	6.03	0.018
Chronic pulmonary disease	7	4.54	0.012
Obesity	16	8.95	0.035
Hypertension	17	2.7	0.23
Smoking	29	1.08	0.91
Anemia	14	0.30	0.24
Duration >30min	27	0.94	0.93
Sex (M/F)	46/33	0.44	0.28

Table 4. Relation of various factors in the frequency of tachycardia during colonoscopy

Variable	**Tachycardia**		
	n	*OR*	*p*
Arterial oxygen desaturation		19	13.72
0.0017			
Age> 60	30	6.08	0.0075
Anemia	14	6.17	0.033
Hypertension	17	4.76	0.094
Sex (M/F)	46/33	2.25	0.22
Duration >30min	12	1.04	0.94
Sedation	27	0.90	0.88
Smoking	29	0.57	0.45
Chronic pulmonary disease	7	0.63	0.44
Obesity	16	0.15	0.080

very ill patients. Adverse effects are not common, but fatalities have been reported (9).

Intravenous sedation is usually used in gastrointestinal endoscopic examinations. During upper gastrointestinal endoscopy, sedation increases the incidence of desaturation and hypoxia (3,10,11,12). The results of several studies have demonstrated that hypoxia during upper gastrointestinal endoscopy is associated with an increase in cardiac abnormalities, including serious arrythmia and myocardial ischemia (13). In recent years, the "to sedate or not sedate" debate has alsofocussed on colonoscopy (11,12).

The earliest study assessing arterial oxygen tensions in patients undergoing colonoscopy was published in 1979 (14). Harward et al reported that patients undergoing colonoscopy developed hypoxia even more frequently than those undergoing upper endoscopy (13). There are numerous reasons for the decrease in SaO2 associated with endoscopy, which include respiratory depression because of intravenous sedation, mechanical airway obstruction, aspiration during upper endoscopy, distention of the stomach and colon with elevation of the diaphragm, restriction of ventilatory function, and possible vasovagal reflex secondary to hollow viscus distention (13,15). However, the exact mechanism of the development of hypoxia has not been clearly demonstrated.

Vasovagal reactions initiated by colonic distention and mesenteric stretching have been thought to contribute to hypoxemia during colonoscopy, but no significant association has been found between instrument manipulation or air insufflation and hypoxemia (16). Colonic distention, with elevation of the diaphragm and mechanical restriction of ventilatory function, can produce hypoxemia during colonoscopy, but changes in ventilation do not correlate with episodes of arterial desaturation (4,13). Respiratory depression secondary to intravenous sedation has been described during upper and lower endoscopy and a higher incidence of hypoxemia has been reported for the benzodiazepine-opioid combination than for either drug alone (11,17). In a prospective study of 45 patients undergoing routine colonoscopy who received meperidine, diazepam or midazolam as a premedication, desaturation occurred in 60%. Half of these episodes of desaturation occurred transiently post-anesthesia. However, appreciable desaturation has also been reported in unsedated patients undergoing colonoscopy, and some authors have found no correlation between the dose of medication and arterial hypoxemia (18).

Obesity can profoundly alter pulmonary function and diminish exercise capacity by its adverse effects on respiratory mechanics, resistance within the respiratory system, respiratory muscle function, lung volumes, work and energy cost of breathing, control of breathing, and gas exchange. Weight loss and upright body position can reverse many of the alterations of pulmonary function produced by obesity (19,20). Oxygen desaturation during colonoscopy in obese patients may be caused by respiratory dysfunction appearing after diaphragm elevation with obesity. The exact mechanism for the development of hypoxaemia during colonoscopy remains unknown.

In further studies, desaturation and tachycardia have been observed at various rates during routine colonoscopy procedure (21). In these patients, it was reported that there is no correlation between hypoxic attack and sedation, weight, history of hypertension, diabetes mellitus, pulmonary disease or age. Bilotta et al had similar results in their study of approximately equal number of patients. In a recent study it was reported that, age was correlated with desaturation (18). In this study it was confirmed that arterial desaturation is common during colonoscopy. We found that there was a relationship between arterial oxygen desaturation, age, sedation, obesity and pulmonary disease. Other factors evalvated, which included use of tobacco, hypertension, age and duration of procedure had no effect on arterial oxygen desaturation in this study. The significance of transient decrease in SaO2 has been shown in several studies. Oxygen desaturation also occurs during natural sleep and the incidence of desaturation in this population can be correlated with increasing age. In one study of randomly selected asymptomatic adults, 43% of men developed desaturation below 90% while sleeping, and in 13% of them SaO2 dropped to between 68% and 72% (22). Arterial desaturation is asymptomatic and not associated with any cardiac or other complication. This conforms with previous studies in which no adverse outcome was associated with arterial oxygen desaturation during colonoscopy (18,21,23). The clinical importance of arterial desaturation during colonoscopy has yet to be proved, and pathogenic mechanisms other than hypoxemia may prove to be more important in

producing cardiac morbidity during lower endoscopy.

An increased heart rate has consistently been reported during colonoscopy and tachycardia has been ascribed to anxiety, increased catecholamine release or premedication with anticholinergic agents (23) Thompson et al. found that 27% of patients undergoing colonoscopy had tachycardia, and that one patients developed myocardial infarction during the procedure (24). Fennerty et al. reported significant changes in pulse rate during colonoscopy in 15% of patients, although there was no apparent association with pain or manipulation of instruments in 42% of them (25). Holm et al found tachycardia in 32% of patients. There was no difference between the groups receiving and not receiving O2 therapy according to change in heart rate (19).

In this study the observations of previous investigators were confirmed as we found a high incidence of tachycardia in our patients. There was a correlation only between tachycardia and advanced age among other parameters studied. A significant correlation between tachycardia and desaturation was found. Even though tachycardia was also observed in patients without hypoxia, a significant difference was found only in patients with hypoxia. Some previous studies however, do not support this finding. Reslef et al and later Holm et al found that during colonoscopy procedure, there was a less frequent occurrence of hypoxia in patients who received oxygen compared to those who did not. There was no difference between these groups as far as heart rate was concerned. No clear association was found between tachycardia and hypoxia in our patients.

In summary, benign and transient arterial oxygen desaturation and tachycardia episodes were observed during colonoscopy procedure. Advanced age, sedation, chronic lung disease, and obesity contribute to these adverse events. Even though pulse oximetry is useful in the detection of hypoxia and tachycardia, the significance of these findings in the prevention of cardiopulmonary complications is unknown.

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