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Assessment the Effect of Midazolam Sedation on Hypoxia During Upper Gastroimtestimal Endoscopy

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Abstract: The aim of this study was to evaluate the prevalence of hypoxia related to midazolam sedation during upper gastrointestinal endoscopy. This single blind randomized placebo control clinical trial, carried out on 180 patients who referred to endoscopy clinic at Imam Khomeini Hospital for selective upper gastrointestinal endoscopy from April to July in 2008. Informed consents obtained from all participants. Patients under 18 years old, obese, pervious history of asthma, COPD and cigarette smoking were excluded. Arterial hemoglobin saturation controlled by finger probe pulse oximetry. After pharyngeal lidocaine spray, midazolam was administered intravenously in case group and patients in controlled group received placebo. Demographic characteristics and other variables were recorded in a questionnaire and data analyzed using SPSS software. Gastrointestinal disturbances and epigastric pain were major indications of endoscopies. The most common endoscopic diagnoses were deudonitis, esophagitis or gastroesophagial reflux. No patients had any serious episode of hypoxia and the incidence of mild hypoxia was not significant in both studied group ($p = 0.823$). There was no significant difference in arterial oxygen saturation recorded by the three endoscopists ($p = 0.734$). Our data showed that optimal dose of sedation had no hypoxia. So that, we recommend sedative endoscopy in patients without risk factors for hypoxia.

Key words: Midazolam, sedation, hypoxia, upper gastrointestinal, endoscopy

INTRODUCTION

Over 20 recent years, GI endoscopy is being current in clinical practice. However, the complications associated with the endoscopy were not considered carefully (Wang *et al*., 2000). There are several indications for GI endoscopy including upper GI diseases, achalasia, incomplete treatment, familial polyposis, heartburn, bleeding, legation or dilatation of the stenosis, gastrostomy, foreign body extraction and etc. (Freeman, 2003). Performing a reliable endoscopy needs an expert endoscopist, certificate assistant and facilities such as vidioscope or other portable device for necessary graphy. Similar to each diagnostic or therapeutic procedure, considering patient's age, type of disease and general condition of the patients are significant to decrease the possible side effects (Freeman, 2003).

At least six cardiac complications may be accompanied with endoscopy such as hypoxia, respiratory depression, pulmonary expiration, cardiac arrhythmia, myocardial ischemia, haemodynamic instability and allergic reactions (Freeman, 2003).

Hypoxia is one of the most frequent complications during endoscopy that present SaO_2 <90% in 40% of upper GI endoscopies (Wang *et al*., 2000; Freeman, 2003; Lieberman *et al*., 1985; Freeman, 1994).

There are several predisposing factors to hypoxia during GI endoscopy for instance sedative drug

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consumption, endoscope tube diameter, inexperienced endoscopist, active GI bleeding, old patient, anemia and emergency endoscopy (Bilotta *et al*., 1990; Bell, 1990, 1991; Katz *et al*., 1981; Reshef *et al*., 1996; O'Connor and Jones, 1990; Yen *et al*., 1997; Dharival *et al*., 1992). Supplemental oxygen and continues monitoring of the patient is advisable (Lieberman *et al*., 1985; Bilotta *et al*., 1990; Rozen *et al*., 1979; Malbotra *et al*., 1991).

As a whole, endoscopy may be performed with or without sedation. Although, use of sedation increases prevalence of hypoxia, it will increase patient's tolerance for the endoscopy procedure (Fisher *et al*., 1998; Thompson *et al*., 1980).

There are several studies circumstance of the effect of sedatives during endoscopy.

Wang *et al*. (2000) in Malaysia had studied 200 patients, who underwent elective diagnostic endoscopy. From total 100 patients in case group received midazolam. Pulse oxymertry was done for all patients before and after endoscopy to determine hypoxia.

SaO_2 <92% for 15" or more was detected in 17 and 6% of case and control group, respectively. Mild hypoxia (SaO_2 <94% for 15") was observed in 47% of case and 12% of control groups (Wang *et al*., 2000).

Sarwar *et al*. (2006) in Spanish investigated possible predictive factors of severe oxygen desaturation (SaO_2 <90%) in nonsedated patients undergoing endoscopy. They used multivariate logistic regression analysis to evaluate factors related to the patient, the examination and the monitoring data that would predict severe desaturation during endoscopy. Mild hypoxia (90%≥ SaO_2 ≤94%) was reported in 27 and 6.4% of the patients had sever hypoxia (SaO_2 ≤90%). The variables found to predict severe desaturation were basal SaO_2 <95% (OR: 67.7%), respiratory disease (OR: 30.5), more than once try to intubations (OR: 39.4), emergency managements (OR: 14.9) and ASA score was between III and IV (OR: 3.9) (Sarwar *et al*., 2006).

Several local drugs including local anesthetic agents, anti spasmodics, anticholinergics, short and long acting benzodiazepines, opioids such as morphine, fentanyl and some other drugs include propofol and depridamol were applied to better performance of endoscopy.

This study was made to identify the prevalence of hypoxia during sedative endoscopy and the benefit of sedation through the procedure.

MATERIALS AND METHODS

This single blind randomized placebo control clinical trial was performed on 180 patients with elective Upper Gastrointestinal (UGI) sedative Endoscopy who referred to endoscopy clinic at Imam Khomeini Hospital in sari/Iran from April to July in 2008. Midazolam was used as sedative agent in this study, because of shorter elimination half life. Letter of satisfaction were obtained from all the participants before entrance the study. Patients younger than 18 years, obese, patients with BMI>30, anemic patients (Hbs<10 mg dL^{-1}), history of asthma, COPD, disagreed patients for entrance in the study, patients with SaO_2 ≤94% detected by pulse oximetry just before performing the endoscopy, cigarette smoking (at least a cigarette per day), emergency endoscopy and non-sedated patients despite of receiving 10 mg IV midazolam were excluded. Then all patients were divided in 4 age blocks; 18-39, 40-49, 50-59 and equal or higher than 60 years old, respectively. In each age block patients were separated in two case (receiving midazolam IV) and control group (receiving placebo). The SaO_2 was checked and recorded by pulse oximeter finger probe (Nemoxy 421 Set) continuously before endoscopy and 30 sec after placing finger probe. All patients lie on left side and lidocaine pharyngeal spray 10% was given to anesthetize the pharynx. After that, intravenous midazolam was given to patients in case group to achieve optimal level of sedation and in control group, patients received placebo intravenously. Data were recorded in nameless questionnaires and then analyzed using SPSS software and descriptive analysis tests such as χ^2, mean and Independent t-test. $p \leq 0.05$ was considered significant.

RESULTS

One hundred-eighty patients (90 cases and 90 controls) underwent selective UGI endoscopy. Demographic characteristics of the patients were shown in Table 1.

Table 1 shows the mean age, sex, weight, height and BMI was similar in both groups and the patients were matched for variables mentioned above. Also, the patients were placed in different groups based on indication for endoscopy. Dyspepsia and epigastric pain were the most common cause of endoscopy in more than half of patients in case and control groups. As shown in Table 2, according to indications of endoscopy, patients were placed in four groups. The most common causes of endoscopies were dyspepsia (56.7%) in group 1, dysphasia, weight loss and iron deficiency anemia (22.8%) in group 2, gastric cancer and gastrointestinal bleeding (13.3%) in third group. There was no significant differences in frequency and kinds of endoscopies between case and control groups ($p = 0.634$).

Table 1: Demographic characteristics of the patients in case and control groups

Variables	Group: Case	Group: Control	p-value
Sex			
Male	49	43	0.371
Female	41	47	
Age (Mean±SD)	46.9±17.5	47±17.5	0.959
Height (Mean±SD)	163.6±7.9	163.5±5.6	0.984
Weight (Mean±SD)	61.2±10.2	62.6±10.5	0.409
BMI (Mean±SD)	22.9±3.2	23.3±3.3	0.329

Table 2: Distribution of the studied patients according to indications of endoscopy

Indication	Group: 1	2	3	4
Frequency (Case)	50 (54.4)	22 (24.4)	11 (12.2)	7 (7.8)
Frequency (Control)	52 (57.8)	19 (21.1)	13 (14.4)	6 (6.7)
Total frequency	102 (56.7)	41 (22.8)	24 (13.3)	13 (7.2)

Values in brackets indicate percentage

- **Group 1:** Dyspepsia
- **Group 2:** Weigh loss, vomiting, regurgitation, dysphasia, iron deficiency anemia
- **Group 3:** History of Gastric Ulcer, Duodenal Ulcer, GI bleeding, gastric and esophageal cancer
- **Group 4:** Others

Endoscopy was normal in 21 patients (23.3%) of case group and 17 (18.9%) control group. The most frequent endoscopic diagnoses were gastritis, duodenitis, esophagitis or presence of GERD that were seen in 31(34.4%) and 39 (343.3%) patients in case and control group respectively. There was no significant differences in endoscopic diagnosis between the two groups ($p = 0.689$). no patients in the studied groups had sever hypoxia ($SaO_2 < 92\%$ for = 15"). Mild hypoxia ($SaO_2 < 94\%$ for <15") have found in 11 patients (12.3%) of cases and 12 (13.3%) in control group that was not significant between the two groups ($p = 0.823$). Patients were matched and distributed randomly among three expert gastroenterologists as an endoscopist and there was no significant relationship in distribution of patients among the three endoscopists ($p = 0.395$). Other measured indices in this study were measurement of SaO_2 before endoscopy, the lowest level of SaO_2 during endoscopy, the rate of SaO_2 decreasing and duration of endoscopy. As shown in Table 3, the rate of arterial oxygen saturation was in range of 97% among case and control groups before endoscopy which was not significant. Lowest arterial oxygen saturation during endoscopy was 95% in both studied groups in which the difference was not significant. Endoscopy time was 228 sec in the control group and about 217 sec in group which was not significantly different. Decrease in arterial blood oxygen saturation in the control and case groups was 1.9±2.2 and 1.7±1.7, respectively in which the difference was not significant. The indices had no significant differences between the two groups. There was no significant relationship between age and presence of hypoxia among different age blocks in this study. The mean dose of midazolam used was 3.2±1.1 (min. 1.5 mg and max. 7 mg). Calculating dose of drug based on body weight, mean dose was planned 0.02-0.05 mg kg^{-1} (min. 0.03 mg and max. 0.11 mg). As shown in Table 4, in 11 patients (12.2%) of 90 patients during endoscopy after receiving midazolam, decrease in arterial blood oxygen saturation levels were observed and from the rest of the patients, 79 (78.8%) had no changing in arterial blood oxygen saturation. Hypoxia was not observed between the doses of 0.07-0.089 mg kg^{-1}, whereas, 10 patients (11%) had hypoxia by doses of 0.03-0.069 mg kg^{-1}. In fact decrease in arterial blood oxygen saturation was not related to dose of midazolam. Therefore, there were no significant differences with regard to diagnostic and therapeutic interventions between the case and control group. We have found no difference in duration of endoscopy between the two groups, but there was a significant relationship between the endoscopy time among the three endoscopists. In spite of difference in duration of endoscopy among three endoscopists, there was no significant fall in arterial oxygen saturation statistically ($p = 0.374$). There were no significant differences between development of mild hypoxia and age and sex of patients, endoscopic diagnosis and mean age of patients or different age groups, height, weight, BMI, duration of endoscopy in the both groups. There was only a significant difference between the physician performing endoscopy and hypoxia in case group ($p = 0.044$). On the other hand, there was a relationship between the rate of SaO_2 before

Table 3: Mean and SD of Sao_2 and duration of endoscopy in the groups

Variables	Control (placebo)	Case (midazolam)	p-value
SaO_2 before endoscopy	97.4±1.2	96.7±1.3	0.415
Lowest SaO_2 during endoscopy	95.5±2.5	95.9±2.1	0.249
Rate of SaO_2 reduction	1.9±2.2	1.7±1.7	0.408
Duration of endoscopy	228.0±129	217.0±141	0.551

Table 4: Prevalence of hypoxia related to dosage of midazolam used in case group

Dose of midazolam (mg kg^{-1})	Mild hypoxia: Yes	No	Total
0.030-0.039	1 (1.1)	6 (6.7)	7 (7.8)
0.040-0.049	4 (4.4)	14 (15.6)	18 (20)
0.050-0.059	3 (3.3)	24 (25.7)	27 (30)
0.060-0.069	2 (2.2)	17 (18.9)	19 (21.1)
0.070-0.079	0 (0)	4 (4.4)	4 (4.4)
0.080-0.089	0 (0)	7 (7.8)	7 (7.8)
0.090-0.099	1 (1.1)	2 (2.2)	3 (3.3)
0.100-0.109	0 (0)	5 (3.3)	5 (5.6)
Total	11 (12.2)	79 (78.8)	90 (100)

Values in brackets indicate percentage

Table 5: Mean SaO_2 of patients in case and control groups before endoscopy

Group	Mild hypoxia (Mean±SD)	No hypoxia (Mean±SD)	p-value
Case	96.64 ±0.92	97.72±1.33	0.011
Control	96.67±0.88	97.55±1.22	0.018

endoscopy and occurrence of mild hypoxia, as the mean SaO_2 of patients with mild hypoxia was lower than the patients with no hypoxia in the both groups (Table 5).

DISCUSSION

The results of our study have confirmed that the rate of mild hypoxia was not significant between case and control groups and found no sever oxygen desaturation in both studied groups. There are significant differences between our results and the results reported by Wang *et al.* (2000). They assessed hypoxia and the effect of pre-oxygenation on oxygen saturation in patients attending for UGI endoscopy in two separate hospitals. Two-hundred patients were divided in 100 sedated and 100 nonsedated groups. They reported sever hypoxia (SaO_2 <92% for = 15") in 17% of case group and 6% of control group, whereas we didn't find sever hypoxia in our study. Mild hypoxia (SaO_2 <94% for <15") was seen in 47% and 12% of case and control group, respectively. They concluded that hypoxia is common in patients undergoing upper gastrointestinal endoscopy with and without sedation. Like our study, sedation significantly increased the incidence of hypoxia in their control group. In addition, the dose of sedation (5 mg for younger than 65 years and 2.5 mg for older than 65 years patients) was selected regardless to body weight of the patients. So, that, over sedation can play a role in occurrence of hypoxia. On the other hand, high risk patients to develop hypoxia (asthma, COPD, emergency endoscopy, obese and etc.) were not excluded that can explain the high prevalence of hypoxia in their study. Also, they performed the study at two different centers by two different groups of endoscopists.

In Pakistan, 27 patients underwent endoscopic assessment (ERCP, UGIE and colonoscopy) with intravenous midazolam 5-10 mg. in some cases pethidine 25-50 mg were used simultaneously. They have reported 20.2% of mild hypoxia in their patients that was greater than our results and sever hypoxia was seen in 11.5% of their patients that was unlike to this study. Also, there was no control group to compare sedative effects and high risk patients were not excluded. In addition, the dose of sedative used was greater than of the dose in this study that can be effective on high prevalence of hypoxia. Also, they had found a significant statistical relationship between therapeutic management and development of hypoxia. Whereas we have found no difference between diagnostic and therapeutic management and progress of hypoxia in this study. Of course, in present study, 2 patients in case and 3 patients in control group underwent therapeutic management during endoscopy. One of the 5 patients developed mild hypoxia that the small sample size may lead to this result (Sarwar *et al.*, 2006).

Banks *et al.* (2001) in England had studied three hundred and thirty patients attending for routine unsedated diagnostic gastroscopy and 154 sedated patients. SaO_2 levels were lower in sedated (2%) compared to unsedated patients (21%) ($p<0.0001$). Whereas we didn't find sever hypoxia in present study (SpO_2<92%). Although, a hypoxic criterion used by them was lower than our measure, the incidence of hypoxia was higher than our study. On the other hand, patients requested to be in control group by themselves that can influence on results of their study. Also, they had not excluded high risk patients from the study. Like banks *et al.* (2001) incidence of mild hypoxia in our both studied group were not related to patient sex, age and age blocks.

Mild hypoxia in patients aged more than 50 or 65 years old was reported in several studies. Unlike Dharial *et al.* (1992) that reported a relationship between BMI more than 28 and hypoxia during endoscopy, we didn't find relationship between mild hypoxia and height, weight and BMI in this study. Since, we excluded patients with BMI more than 30, the results are not global.

In our study, incidence of hypoxia was not significant related to endoscopy time, endoscopic diagnosis of the disease, indication of endoscopy, type of intervention (therapeutic or diagnostic with or without biopsy) in both case and control group. We identified only one significant relation between incidence of hypoxia and physician performing the procedure in case group. In spite of prolonged duration of endoscopy by third co-worker endoscopists, hypoxia was not reported in the patients underwent endoscopy procedure. Of course, the number of patients being endoscoped by third endoscopist was lesser than the patients of the two other endoscopists. This result was confirmed by Banks *et al.* (2001). Berg *et al.* (1991) studied didn't show correlation between physician performing the procedure and degree of desaturation. Another predictive factor of oxygen desaturation during upper gastrointestinal endoscopy is pre-endoscopy period oxygen saturation. It was considerable that pre-endoscopy mean arterial oxygen saturation was significantly lower in hypoxic patients in our study. Whereas Banks *et al.* (2001) had found no significant correlation between pre-endoscopy oxygen saturation level and incidence of hypoxia. However,

Alcain *et al.* (1998) had shown that SaO_2 <95% was a predictive factors of severe oxygen desaturation in patients undergoing endoscopy (odds ratio 67.7) (Banks *et al.*, 2001; Alcain *et al.*, 1998).

According to the results of present study, although several factors mentioned above can lead to hypoxia during UGI endoscopy, it seems that pre-endoscopy SaO_2 plays a certain role in this way. Since, we have observed no increase risk of hypoxia with appropriate level of sedation in our patients and sedation during UGI endoscopy can decrease time of the procedure and increases tolerance of patient, so that, it is recommended that sedative endoscopy performs for all patients undergo UGI endoscopy without risk factors leading to hypoxia (Al-Qorain *et al.*, 1993; Gross and Long, 1990). Patterson *et al.* (1995) in Ireland had confirmed that endoscopy with supplemental oxygen can reduce the risk of hypoxemia during endoscopy (Patterson *et al.*, 1995; Khiani *et al.*, 2009). Similar results were obtained by Wang *et al.* (2000), Reshef *et al.* (1996), Patterson *et al.* (1995), Holm *et al.* (1999), Javid *et al.* (1999), Yano *et al.* (1998) and Val Adán *et al.* (1996).

CONCLUSION

Using supplemental oxygen during endoscopy can decrease the rate of hypoxia especially in patients with pre-endoscopy low oxygen saturation level. With regard to the results of earlier studies, pulse-oximetry monitoring during UGI endoscopy is recommended in sedated high risk patients and nasal supplemental oxygen is valuable to reduce the rate of hypoxia during endoscopy.

REFERENCES

Al-Qorain, A., Y. Adu-Gyamfi, E.B. Larbi and F. Al-Shedokhi, 1993. The effect of supplemental oxygen in sedated and unsedated patients undergoing upper gastrointestinal endoscopy. J. Int. Med. Res., 21: 165-170.

Alcain, G., P. Guillen, A. Escolar, M. Moreno and C. Martin, 1998. Predictive factors of oxygen desaturation during upper gastrointestinal endoscopy in non sedated patients. Gastrointest Endosc., 48: 143-147.

Banks, M.R., P.J. Kumar and H.E. Mulcahy, 2001. Puls oximetry saturation levels during routine unsedated diagnostic upper gastrointestinal endoscopy. Scand. J. Gastroenterol., 36: 105-109.

Bell, G.V., 1990. Monitoring: The gastroentrologist's view. Scand. J. Gastroenterol., 79: 18-23.

Bell, G.V., 1991. Monitoring and safety in endoscopy. Balliers Clin. Gastroentrol., 5: 79-98.

Berg, J.C., R. Miller and E. Burkhalter, 1991. Clinical value of pulse oximetry during routine diagnostic and therapeutic endoscopic procedures. Endoscopy, 23: 328-330.

Bilotta, J.J., J.L. Floyd and J.D. Waye, 1990. Arterial oxygen desaturation during ambulatory colonoscopy: Predictability, incidence and clinical insignificance. Gastrointest. Endosc., 36: 5-8.

Dharival, A., J.V. Plevris, N.T. Lo, N.D. Finlayson, R.E. Heading and P.C. Hayes, 1992. Age, anemia and obesity associated oxygen desaturation during upper gastrointestinal endoscopy. Gastrointest. Endosc., 38: 684-688.

Fisher, N.C., S. Bailey and J.Y. Gibson, 1998. A prospective randomized controlled trial of sedation VS no sedation in out patient diagnostic upper gastrointestinal endoscopy. Endoscopy, 30: 21-24.

Freeman, M.L., 1994. Sedation and monitoring for gastrointestinal endoscopy. Gastroentrol. Endosc. Clin. North Am., 4: 475-499.

Freeman, M.L., 2003. Sedation and Monitoring for Gastrointestinal Endoscopy. In: Tadataka Yamada, Apers, D.H. and N. Kaplowitz (Ed.). 4th Edn., Lipponcot Williams and Wilkins, Philadelphia, pp: 2812-2824.

Gross, G.B. and W.B. Long, 1990. Nasal oxygen alleviates hypoxemia in colonoscopy patients sedated with midazolam and meperidine. Gastrointest. Endosc., 36: 26-29.

Holm, C., M. Christensen, S. Schulze and J. Rosenberg, 1999. Effect of oxygen on tachycardia and arterial oxygen saturation during colonoscopy. Eur. J. Surg., 165: 755-758.

Javid, G., B. Khan, M.M. Wani, A. Shah, G.M. Gulzar and B. Khan, 1999. Role of pulse oximetry during nonsedated upper gastrointestinal endoscopic procedures. Indian J. Gastroenterol., 18: 15-17.

Katz, A.S., E.L. Michelson, J. Stawicki and F.D. Holford, 1981. Cardiac arrhythmias: Frequency during fiberoptic bronchoscopy and correlation with hypoxemia. Arch. Intern. Med., 141: 603-606.

Khiani, V.S., W. Salah, S. Maimone, L. Cummings and A. Chak, 2009. Sedation during endoscopy for patients at risk of obstructive sleep apnea. Gastrointest. Endosc., 70: 1116-1120.

Lieberman, D.A., C.K. Wuerker and R.M. Katon, 1985. Cardiopulnonary risk of esophagogastroduodenoscopy. Role of endoscope diameter and systemic sedation. Gastroenterology, 88: 468-472.

Malbotra, H.S., S. Rana, L. Pal and D.J. Dastagupta, 1991. Electrocardiographic changes during upper gastrointestinal endoscopy in ambient hypoxia. J. Assoc. Phys. India, 39: 692-693.

O'Connor, K.W. and S. Jones, 1990. Oxygen desaturation is common and clinically underappreciated during elective endoscopic procedures. Gastrointest. Endosc., 36: 2-4.

Patterson, K.W., N. Noonan, N.W. Keeling, R. Kirkham and D.F. Hogan, 1995. Hypoxia during outpatient gastrointestinal endoscopy: The effect of sedation and supplemental oxygen. J. Clin. Anesth., 7: 136-140.

Reshef, R., M. Shiller, R. Kinberg, H. Rennert, G. Rennert, M. Herskortis and T. Loberan, 1996. A prospective study evaluating the usefulness of continuous supplemental oxygen in various endoscopic procedures. Isr. J. Med. Sci., 32: 736-740.

Rozen, P., D. Oppenheim, J. Ratan, S. Laniado and T. Gilat, 1979. Arterial oxygen tension changes in elderly patients undergoing upper gastrointestinal endoscopy. I. Possible causes. Scand. J. Gastroenterol., 14: 577-581.

Sarwar, S., A. Alanı and A.A. Khan, 2006. Puls oxymetry during gastrointestinal endoscopic procedures. J. Coll. Phys. Surg. Pak., 16: 97-100.

Thompson, D.G., J.E. Lennard-Jones, S.J. Evans, R.E. Cowan, R.S. Murray and J.T. Wright, 1980. Patients appreciate premedication for endoscopy. Lancet, 316: 469-470.

Val Adán, P., R.S. Félix, S.M. Royo, E.M. Murciano, B.L. Clau and M.M. Huguet, 1996. Pulse-oximetry monitoring during endoscopy of the upper digestive tract and chronic obstructive lung disease. Rev. Clin. Esp., 196: 455-457.

Wang, C.Y., L.C. Ling, M.S. Cardosa, A.K. Wong and N.W. Wong, 2000. Hypoxia during upper gastrointestinal endoscopy with and without sedation and the effect of pre-oxygenation on oxygen saturation. Anaesthesia, 55: 654-658.

Yano, H., H. Iishi, M. Tatsuta, N. Sakai, H. Narahara and M. Omori, 1998. Oxygen desaturation during sedation for colonoscopy in elderly patients. Hepatogastroenterology, 45: 2138-2141.

Yen, D., S.C. Hu, L.S. Chen, K. Liu and W.F. Kao *et al*., 1997. Arterial oxygen desaturation during emergent nonsedated upper gastrointestinal endoscopy in the emergency department. Am. J. Emerg. Med., 15: 644-647.