

STUDY OF CARDIOPULMONARY CHANGES DURING UPPER GASTROINTESTINAL ENDOSCOPY

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ABSTRACT

BACKGROUND

This study was undertaken to determine the changes in oxygen saturation, blood pressure and heart rate during various endoscopic procedures and to find out the risk factors for these changes.

MATERIALS AND METHODS

560 patients without cardiorespiratory disorders were recruited. Oxygen saturation, blood pressure, pulse rate, ECG were monitored during endoscopy using pulse oximeter, automated blood pressure monitor, and portable RMS ECG machine. These were recorded from baseline until 5 minutes after the procedure. The important variables, which were evaluated in relation to these changes, included age, gender, duration of the procedure and drug/dosages.

RESULTS

Mild to moderate hypoxia was found in 158 (28.2%) patients. Severe hypoxia was found in 32 (5.8%) patients. Changes in pulse rate were significant post-sedation, during probe insertion, during scoping, at removal of probe and immediately post-procedure ($p < 0.02$). The mean change in systolic blood pressure was not significant throughout the procedure when compared to baseline, however 68 (12.14%) patients developed transient hypertension.

CONCLUSION

Mild to moderate hypoxia is common during endoscopic procedures and are of no serious consequence. However severe hypoxia is less common. We recommend a non-invasive monitoring in patients with age greater than 50 years.

KEYWORDS

Endoscopy, Oxygen Saturation, Heart Rate, Blood Pressure, ECG.

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BACKGROUND

Endoscopy of the upper gastrointestinal tract using fibre optic or video instruments has taken a dominant role in diagnosis and therapy since the introduction of the first pan endoscope by Hirschowitz in 1963.¹ Although upper gastrointestinal endoscopy is reasonably safe, it is not perfectly so. The complication rate of gastrointestinal endoscopy is about 0.1% for upper GI and 0.2% for lower GI procedures with cardio-pulmonary events predominating.^{2,3,4} Cardiopulmonary complications may account for over 50% of all reported complication. The majority of complications are due to aspiration, over sedation, hypoventilation, vasovagal episodes and airway

obstruction.⁵ All patients are observed for about 30 minutes for any possible complication. In view of above facts, it is proposed to study the changes in cardio-pulmonary parameters as mentioned above during and after the endoscopic procedures. The detailed data were collected and compared with that in available literature and conclusion be drawn.

Objectives of the Study

1. To determine the changes in oxygen saturation, blood pressure, heart rate and ECG changes during various endoscopic procedures and
2. To find out the risk factors for these changes.

MATERIALS AND METHODS

Study Design

This is a prospective study. Study population was selected after applying the following inclusion and exclusion criteria. The patients attending in endoscopy unit of M.K.C.G. Medical college hospital for diagnosis and therapeutic G.I. Endoscopy from July 2016 to July 2018 were included in study.

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Inclusion Criteria

All age and all sex patients.

Exclusion Criteria

Patient with cardiac ischemia, respiratory distress, baseline oxygen saturation less than 95%, haemodynamically unstable patient, uncorrected coagulopathy, unable to obtain informed consent, intubated or terminally ill patient.

Materials

A Pentax gastrointestinal video endoscope EPK1000 will be used for upper gastrointestinal endoscopy. A portable RMS ECG machine used for recording standard 12 lead ECG with long rhythm strip of lead II at a speed of 25 mm/second and 1mV tracing. These tracings recorded before, during and immediately after endoscopy. Another ECG taken 10 minutes after withdrawal of the endoscope. Pulse oximeter was used for oxygen saturation and pulse monitoring. Automated blood pressure apparatus monitored blood pressure continuously before, during and up to 5 minutes after the procedure.

Methods

After taking proper history and complete general and systemic examination, upper gastrointestinal endoscopic procedure was done. Each patient was explained about the procedure beforehand and informed consent obtained in all cases. Following routine was followed out in each case. The patient was not allowed to take anything orally within 6 hours prior to endoscopic procedure. All patients 4% lignocaine spray was used for topical anaesthesia. Prophylactically antibiotics to prevent infective endocarditis was given in selected cases. Patient in left lateral supine position, scope was introduced through a mouth guard which protect the scope from being bitten after lubricating with lignocaine gel. Scope was introduced under direct vision of monitor, into oesophagus, then stomach, and first part of duodenum finally visualizing second part of duodenum. Oxygen saturation, blood pressure, ECG and pulse rate was monitored during endoscopy using pulse oximeter and automated blood pressure monitor and portable RMS ECG machine. These were recorded from baseline until 5 minutes after the procedure. The important variables, which will be evaluated in relation to these changes, include age, gender, duration of the procedure and drug/dosages.

Tachycardia is defined as >100 bpm or increase of >20 bpm from base line. Bradycardia is defined as <60 bpm. Hypertension is defined as systolic BP greater than 160 mmHg and hypotension <90 mmHg. Mild to moderate oxygen desaturation is considered as between 94-90%. Severe desaturation is considered as <90%. Supplemental oxygen is to be given at 3-5 L/minute by nasal cannula if oxygen saturation remained <90% for longer than 3 minutes.

RESULTS

Age

Of the 560 patients, the youngest patient was 11 years and the oldest patient was aged 80 years. The mean age of the study population was 42.82 years.

Age Group	Number of Patients	Percentage
11-20 Years	30	5.4%
21-30 Years	128	22.9%
31-40 Years	90	16.1%
41-50 Years	98	17.5%
51-60 Years	108	19.2%
61-70 Years	84	15.0%
71-80 Years	22	3.9%

Table 1. Age Distribution

In this study, maximum number of patients was in the age group of 21 to 30 years (22.9%). Next commonest age is 51 to 60 years (19.2%).

Gender (Sex)

Of the total 560 patients, there are 387(69.1%) male patients and 173(30.9%) female patients.

Gender	Total	Percentage
Male	387	69.1%
Female	173	30.1%

Table 2. Distribution of Patients by Sex

In this study, 69.1% of cases were male and rest of 30.1% were female. The male preponderance with female is in the ratio of 2.3:1.

SpO₂ (Saturation of Peripheral Oxygen)

Pulse oximetry is a reliable non-invasive method in assessing arterial oxygen saturation and was used in monitoring these patients.

	Before Endoscopy Mean ± SD	During Endoscopy Mean ± SD	After Endoscopy Mean ± SD
Male	98.2 ± 1.32	94.47 ± 2.98	97.32 ± 2.22
Female	98.6 ± 1.21	94.82 ± 2.72	97.98 ± 1.62
Together	98.5 ± 1.26	94.7 ± 2.81	97.57 ± 2.08

Table 3. Statistical Measures at Before, During and After of Endoscopy SpO₂ By Male, Female and Together

Normal levels of SpO₂ reported for pulse oximetry are 95% to 100% for adult population. In our study group, before starting Upper gastrointestinal endoscopy, baseline SpO₂ levels were found to be around 98.5%.

Age Group (Years)	SpO2 (%)		
	Before Endoscopy	During Endoscopy	After Endoscopy
	Mean ± SD	Mean ± SD	Mean ± SD
11-20	99.2 ± 0.71	96.56 ± 2.92	98.38 ± 1.52
21-30	98.62 ± 1.23	95.55 ± 2.63	98.65 ± 1.22
31-40	99.33 ± 0.47	95.63 ± 1.76	98.21 ± 1.28
41-50	98.26 ± 1.52	95.12 ± 2.28	98.2 ± 1.72
51-60	97.21 ± 2.12	92.12 ± 2.82	95.58 ± 2.28
61-70	97.2 ± 2.58	91.8 ± 2.72	95.48 ± 2.13
71-80	95.5 ± 3.28	90.6 ± 2.99	93.8 ± 2.81

Table 4. SpO2 Level Before, During and After Endoscopy by Age

The chart indicates the drastic decline of SpO₂ during Upper gastrointestinal endoscopy. Oxygen desaturation between 94-90% was taken as moderate desaturation and <90% as severe desaturation. In our study, the average baseline mean oxygen saturation was 98.5%. It decreased to 94% during insertion of the endoscopy probe. Mild to moderate hypoxia was found in 28.2% (158) of patients. Severe hypoxia was found in 5.8% (32) of the patients, mostly in those people who are above 50 years age. Oxygen saturation improved after the procedure to 97.5% in all these people. There were 32 episodes of severe hypoxia; 21 of these occurred during insertion of the endoscope and 11 during procedure. 25 episodes of severe hypoxia occurred in patients above 50 years age group and 6 of these patients received supplemental Oxygen.

Heart Rate (Pulse)

The following heart rate recordings were noted from pulse oximetry of our 560 patients during various stages of upper gastrointestinal endoscopy.

	Heart Rate		
	Before Endoscopy	During Endoscopy	After Endoscopy
	Mean ± SD	Mean ± SD	Mean ± SD
Male	78.68 ± 12.72	96.21 ± 14.79	82.7 ± 14.2
Female	86.72 ± 14.72	106.32 ± 16.5	85.7 ± 14
Together	81.26 ± 13.62	99.7 ± 15.4	85.7 ± 14.27

Table 5. Statistical Measure at Before, During and After the Procedure on Heart Rate by Male, Female and Combined

Significant asymptomatic tachycardia was noted in 86.07% of the study group patients. It occurred in all the stages of the procedure but predominantly during scope insertion. Our study showed that sinus tachycardia starts with the introduction of endoscope into pharynx. Heart rate returned to normal within few minutes at the end of the procedure. The rise in heart rate was observed during all phases of Upper gastrointestinal endoscopy in all age groups of patients and of both the sexes of the study group. A heart rate of above 100 beats per minute was taken as tachycardia and a rate of less than 60 beats per minute was taken as bradycardia. None of the patients developed bradycardia.

Changes in Heart Rate versus Age of the Patient

Age Group (in Years)	Heart Rate		
	Before Endoscopy	During Endoscopy	After Endoscopy
	Mean ± SD	Mean ± SD	Mean ± SD
11-20	88.75 ± 19.74	103.32 ± 22.78	96.49 ± 17.78
21-30	85.37 ± 21.23	101.76 ± 18.23	86.38 ± 13.23
31-40	79.32 ± 12.32	96.21 ± 12.89	78.83 ± 11.82
41-50	78.27 ± 11.21	93.12 ± 17.81	80.21 ± 13.65
51-60	75.43 ± 10.87	94.28 ± 12.76	81.31 ± 9.33
61-70	74.47 ± 8.57	98.54 ± 14.83	88.39 ± 12.72
71-80	90.34 ± 15.74	108.83 ± 18.92	97.21 ± 12.84

Table 6. Statistical Measures on Heart Rate by Age

Age Group (Years)	Increase in HR-(n)				
	1 to 10	11 to 20	21 to 30	31 & above	Total
11-20	1	08	21	0	30
21-30	28	18	76	06	128
31-40	20	24	30	20	90
41-50	18	28	42	10	98
51-60	26	21	52	09	108
61-70	08	20	44	12	84
71-80	02	06	12	02	22

Table 7. Distribution of Cases by Age and Increase in Heart Rate

The average baseline pulse rate of the study group was 88.75, 85.37, 79.32 and 78.27 in the 10 to 20, 21 to 30, 31 to 40 and 41 to 50 age groups. In the older age groups, the baseline heart rate was 75.43 and 74.47 in the 51 to 60 and 61 to 70 age groups. In the oldest age group of 71 to 80 years, the baseline pulse rate was high at 90.34.

During the upper gastrointestinal endoscopy procedure, heart rate increased considerably in all age groups. In the 11 to 20 age group it raised to 103.32 from a mean of 88.75 in the 21 to 30, 31 to 40 and 41 to 50 age groups also, heart rate increased from mean of 85.37, 79.32 and 78.27 to 101.76, 96.21 and 93.12 during the procedure.

After completion of upper gastrointestinal endoscopy, the heart rates remained slightly high. In the age group of 11 to 20 years, post procedural mean heart rate was at 96.49 whereas baseline level was 88.75. In the 21 to 30, 31 to 40 and 41 to 50 age groups also, post endoscopy the pulse rates remained high for some more time; they were at 86.38, 78.83 and 80.21. Similarly, in the older age groups, they remained high at 81.31, 88.39 and 97.21 in the age groups of 51 to 60, 61 to 70 and 71 to 80 years.

Blood Pressure

Out of these 560 patients, blood pressure increased to hypertension levels in 68 patients (12.14%). (Hypertension is systolic BP more than 160 mm of hg; Hypotension is systolic BP less than 90 mm hg). None of these patients developed any cardiac symptoms during this hypertensive phase. In all these patients, blood pressure returned to

normal within few minutes after the procedure. Systolic blood pressure didn't change significantly.

Changes in Blood Pressure versus Gender

Sex	Blood Pressure (mm of Hg)			
		Before Endoscopy	During Endoscopy	After Endoscopy
		Mean ± SD	Mean ± SD	Mean ± SD
Male	Systolic	118.8 ± 8.2	134.2 ± 16.82	125.2 ± 10.6
	Diastolic	78.66 ± 7.3	87.3 ± 6.6	80 ± 8.2
Female	Systolic	116.7 ± 12.8	130 ± 12.42	123 ± 8.7
	Diastolic	77.7 ± 6.2	85.1 ± 6.9	77.3 ± 6.2
Together	Systolic	117.8 ± 10.8	134 ± 14	124 ± 11
	Diastolic	77.9 ± 7	86.2 ± 9.2	78.7 ± 5.2

Table 8. Statistical Measure at Before, During and After the Process on Blood Pressure by Male, Female and Combined

In the present study, the base line mean systolic pressure for all patients was 117.8 ± 10.8 before the procedure. For male, the baseline systolic pressure was 118.8 ± 8.2 mm of Hg and in female it was 116.7 ± 12.8. During endoscopy, it increased to 134.2 ± 16.82 in males and to 130 ± 12.42 in females. Immediately after completion of endoscopy, it came down to 125.2 ± 10.6 in males and to 123 ± 8.7 in women. The baseline diastolic blood pressure of the total study group was 77.9 ± 7 mm of hg. For male patients, the mean baseline diastolic pressure levels were 78.66 ± 7.3 mm oh hg. It rose to 87.3 ± 6.6 during endoscopy and has fallen back to 80 ± 8.2 after the procedure. In female patients, the mean diastolic pressure levels before endoscopy were 77.7 ± 6.2. They rose to 85.1 ± 6.9 during the procedure and fallen back to 77.3 ± 6.2 after endoscopy.

Changes in Blood Pressure versus Age

Age Group (Years)	Blood Pressure (mm of Hg)			
		Before Endoscopy	During Endoscopy	After Endoscopy
		Mean ± SD	Mean ± SD	Mean ± SD
10-20	Systolic	116.22 ± 10.50	125.78 ± 6.22	116.39 ± 6.39
	Diastolic	76.82 ± 5.28	81.28 ± 4.92	76.32 ± 5.32
21-30	Systolic	115.32 ± 8.43	130.45 ± 12.76	121.78 ± 8.12
	Diastolic	74.35 ± 6.72	82.78 ± 4.32	78.54 ± 4.23
31-40	Systolic	122.56 ± 8.46	136.64 ± 11.21	124.75 ± 8.77
	Diastolic	77.21 ± 6.47	84.86 ± 6.44	80.64 ± 7.34
41-50	Systolic	122.32 ± 8.88	138.65 ± 11.43	132.64 ± 8.64
	Diastolic	78.44 ± 5.64	86.54 ± 6.32	84.78 ± 6.34
51-60	Systolic	126.85 ± 11.43	138.94 ± 11.73	132.43 ± 10.24
	Diastolic	80.32 ± 10.32	86.32 ± 6.32	84.21 ± 5.32
61-70	Systolic	130.82 ± 14.32	142.32 ± 12.32	136.82 ± 10.20
	Diastolic	80.21 ± 8.32	86.46 ± 4.32	82.32 ± 8.84
71-80	Systolic	138.76 ± 8.24	162.76 ± 6.32	146.89 ± 7.32
	Diastolic	82.76 ± 4.76	94.46 ± 8.32	90.22 ± 5.32

Table 9. Statistical Measure at Before, During and After the Process on Blood Pressure by Patient's Age

Both systolic and diastolic blood pressures of all age groups raised during the procedure. Even though the baseline blood pressures were high in older age groups, they showed a dramatic rise immediately after the insertion of endoscope. The mean baseline systolic blood pressures were around 116 mm of Hg in the age groups of both 10 to 20 years and 21 to 30 years. In the age groups of 31 to 40, 41 to 50 and 51 to 60 the baseline systolic pressures were 122.56, 122.32 and 126.85 mm of hg. In the older age groups of 61 to 70 and 71 to 80, the baseline systolic pressures were 130.82 and 138.76. Immediately after the insertion of endoscope, systolic blood pressure rose and remained at higher levels throughout endoscopy. In the 10 to 20 age group it rose from 116 to 125.78, and in the age groups of 21 to 30, 31 to 40, 41 to 50 it rose from 116 to 130.45, 122.56 to 136.64 and 122.32 to 138.65 mm of hg. In the old patients, systolic BP rose from 130.82 to 142.32 and 138.76 to 162.76 mm in the 61 to 70 and 71 to 80 years age groups. In the youngest age group of 10 to 20 years, systolic BP returned to baseline immediately after

completion of the procedure. In other groups, although BP decreased, it remained slightly higher than baseline levels. In age group 21 to 30, it remained at 121.78 (baseline 116), 31 to 40 group at 124.75 (122), 41 to 50 age group 132.64 (122), 51 to 60 group at 132.43(126.52), 61 to 70 group 136.82 (130) and 71 to 80 age group 146.89(138) mm of Hg.

Electrocardiographic Changes

In the present study, sinus tachycardia was observed in 482(86.07%) of the total patients and S-T depression noticed in 42(7.5%) of these patients during upper gastrointestinal endoscopy. T-wave inversion was observed in 46(8.2%) of the patients. Supraventricular tachycardia seen in 8(1.4%) All these changes disappeared in the ECG's taken 10 minutes after endoscopy. The following ECG changes were observed in our 560 patients during various stages of endoscopy. These electrocardiographic changes were observed mostly in patients aged above 50 years. T wave inversion was more frequent in women patients. All

these changes reverted to normal within few minutes after the endoscopic procedure.

Sinus Tachycardia	482 (86.07%)
ST Depression	42 (7.5%)
T Wave Inversion	46 (8.2%)
Supra Ventricular Tachycardia	8 (1.4%)
Table 10. Electrocardiographic Changes During Various Stages of Endoscopy	

ECG Changes	Baseline	Probe Insertion	During Endoscopy	Post Endoscopy
Sinus Tachycardia	22%	78%	70%	30%
ST Depression	0	6%	4%	0
T wave Inversion	0	7%	5%	0
Supra Ventricular Tachycardia	0	1.1%	1.1%	0
Table 11. ECG Changes Observed During Endoscopy				

Changes in Electrocardiogram Versus Age and Gender

Most of these electrocardiographic changes occurred in patients showing arterial oxygen desaturation. There were no major differences between male and female patients regarding electrocardiographic changes and occurrence of arrhythmias. Only T wave inversion was slightly more in women patients. Heart rate increased in 86.07% of patients resulting in sinus arrhythmia and the maximum rise occurred in older patients and in those with history of cardiac disease. Other ECG abnormalities more frequently appeared in elderly people, in persons with chronic lung disease and in persons with previous heart disease. S-T depression occurred only in patients with previous cardiac disease. All these changes reverted to near normal ranges within half an hour.

DISCUSSION

Upper gastrointestinal endoscopy is a commonly performed procedure and has evolved into an essential diagnostic and therapeutic tool. upper gastrointestinal endoscopy and therapeutic procedures are performed properly with minimal complications to the patient.⁶ Diagnostic upper gastrointestinal endoscopy is an invasive procedure and has many adverse effects like cardiopulmonary complications, complications related to sedation, infectious complications, bleeding and perforation. 50% of the complications and 60% of deaths during upper gastrointestinal endoscopy were attributed to cardiopulmonary complications.⁷ A total number of 560 patients were studied and their ages ranged from 11 to 80 years. Of these 560 patients, 387 are male and 173 females. In a similar study in Saudi Arabia, of the 6386 patients followed, the male female ratio was 5.2:1.⁸

The common cardio pulmonary changes noticed in our patients during upper gastrointestinal endoscopy study were-

- I. Blood oxygen desaturation
- II. Tachycardia
- III. Hypertension
- IV. ECG changes like sinus tachycardia, ST depression and T wave inversion

I. SpO₂

Although upper gastrointestinal endoscopy is generally a safe procedure, it is known to be associated with arterial oxygen desaturation;⁹ in our study 28.2% developed mild desaturation and 5.8% developed severe oxygen desaturation. Factors leading to oxygen desaturation are patient’s age, history of cardio vascular and respiratory diseases and difficulty with intubation procedure. The occurrence of lowest oxygen saturation and increased systolic pressure during introduction of endoscope is suggestive of sympathetic overstimulation during this phase. Similar findings were reported by Sun Young et al.^{10,11}

In a study of 126 patients who underwent non-sedated gastroscopy, Javid G et al. found in Srinagar study, that baseline SpO₂ was 97.8% and it remained >95% in 60% of patients during the procedure; mild oxygen desaturation occurred in 24% and severe desaturation in 16% of their patients.¹²

II. Blood Pressure

Out of these 560 patients, blood pressure increased to hypertension levels in 68 patients (12.14%). Both systolic and diastolic blood pressures increased, mostly during the insertion of endoscopic tube. Ross Ruth et al. had similar findings in their study of 37 patients.¹³

In the present study, for the youngest age group of 10 to 20 years, systolic BP returned to baseline immediately after completion of the procedure. In other age groups, although BP came down, it remained slightly higher than baseline levels. In a similar study by Osinaike B. B. et al., they didn’t find significant changes in systolic blood pressure throughout the procedure except transient hypertension in 14% of their patients. They also observed slower return of blood pressure to normal levels in older patients.¹⁴

III. Heart Rate

Upper gastrointestinal endoscopy is thought to cause stress response (endocrine response) leading to tachycardia, and there by leading to myocardial ischemia.¹⁵ Tachycardia occurred in 86.07% of the total patients during upper gastrointestinal endoscopy. Tachycardia occurred in 89% of upper gastrointestinal endoscopy patients during a study by Mistry FP et al. and disappeared in all of them after endoscopy.¹⁶ The present study too demonstrated similar result during all phases of the procedure. In all these cases, the tachycardia disappeared spontaneously in the post-endoscopic phase within 30 minutes. None of our patients developed bradycardia.

In an Indian study, tachycardia during upper gastrointestinal endoscopy has been studied by Malhotra HS et al., in 120 patients in Shimla and found increased heart rate in 96.6% of their study group.¹⁷

Ulgen M. S. et al. used Holter monitor and found that 15% of their patients suffered with severe tachyarrhythmia and attributed this to fear, anxiety and catecholamine secretion.¹⁸ In the present study also 10 to 20 age group showed sudden rise of mean heart rate from 88 to 103 and this can also be attributed to fear and anxiety.

IV. Electrocardiographic and Cardiac Changes

In our study, increase in heart rate was found in 86.07% of the patients and S-T depression noticed in 7.5% of the patients. T wave inversion observed in 8.2% of the patients. All these changes lasted for a few minutes after endoscopy and disappeared. In a study by Malhotra H. S. et al. at Simla, 96.6% patients showed tachycardia, 14.2% had ST depression, 13.3% had T wave inversion, and 5.8% had supraventricular tachycardia.¹⁷

Murray A. W. et al. studied the effects of gastroscopy in sedated patients and found that 16 of the 20 patients developed tachycardia and 10 patients developed supraventricular and ventricular ectopic foci.¹⁹

Malhotra et al studied 120 patients undergoing gastroscopy at Shimla and found tachycardia in 96.6%, S-T depression in 14.2%, T wave inversion in 13.3% and supraventricular tachycardia in 5.8% of patients.¹⁷

CONCLUSION

During upper gastrointestinal endoscopy, transient cardio respiratory changes occur frequently. Our study of 560 patients revealed mild to moderate hypoxia, tachycardia, and hypertension to be common during gastroscopy. Most of these changes are transient in nature and did not lead to significant pathology. Still in elderly patients and in those with pre-existing cardiac/pulmonary diseases, it will be useful to monitor patients pulse rate, blood pressure and oxygen saturation. In selected cases, ECG monitoring is useful.

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