

A Study of Cardio Pulmonary Changes during Upper Gastrointestinal Endoscopy

Sharan Badiger, Prema T. Akkasaligar, P. Amith Kumar

Abstract—Upper gastrointestinal endoscopy is a commonly performed diagnostic and therapeutic procedure and has many adverse effects like cardiopulmonary complications, complications related to sedation, infectious complications, bleeding and perforation. So this study was undertaken to evaluate important variables like patient's age, gender and stage of the procedure in relation to the cardiopulmonary changes during diagnostic upper gastrointestinal endoscopy by monitoring oxygen saturation, blood pressure, heart rate and electrocardiogram. This is a prospective longitudinal hospital based study involving a total of 140 consecutive patients, at Sri. B. M. Patil Medical College, Hospital and Research Centre. Cardiopulmonary changes during upper gastrointestinal endoscopy are more common in the age groups of 51-60 years, with equal frequency in both male and female. Oxygen saturation levels decreased by about 4% in both sexes during introduction of endoscopy. Mild to moderate hypoxia was found in 32% of the study group. Severe hypoxia was found in 5% of the patients, mostly in those patients who are above 50 years of age. Tachycardia was noted in 88% of the study group patients. Blood pressure increased to hypertension levels in 22 patients (15.7%) which returned to normal within few minutes after the procedure. S-T depression was noticed in 4% of patients and T wave inversion in 8% of patients during upper gastrointestinal endoscopy. All these changes disappeared after 10 minutes after the endoscopy. Cardiopulmonary changes are common during upper gastrointestinal endoscopy. Maximum changes in oxygen saturation, heart rate and blood pressure occurred immediately after the introduction of endoscope. The cardiopulmonary changes did not manifest into any identifiable clinical symptoms. The rate of recovery was faster in younger age groups and women.

Keywords—Blood Pressure, Cardio-Pulmonary, Heart Rate, Oxygen Saturation, Upper Gastrointestinal Endoscopy.

I. INTRODUCTION

UPPER gastrointestinal (GI) endoscopy or esophago-gastro-duodeno-scopy (EGD), also known as Gastroscopy, refers to examination of the esophagus, stomach and upper duodenum by means of a flexible fibre-optic endoscope. Upper gastrointestinal endoscopy is a commonly performed procedure used to investigate a wide range of symptoms and treat a variety of complaints. Gastroscopy is commonly used for diagnostic evaluation for signs and

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symptoms suggestive of upper gastrointestinal diseases like dyspepsia, dysphasia, non cardiac chest pain and recurrent emesis. It is also used for surveillance for upper gastrointestinal cancer in high risk settings like Barrett's esophagus and polyposis syndromes and also used for Biopsy for known or suggested upper gastrointestinal diseases like malabsorption syndromes, neoplasms and infections. Gastroduodenoscopy is also useful for therapeutic intervention in removal of foreign bodies, control of gastrointestinal hemorrhage, dilatation or stenting of strictures, ablation of neoplasms and for gastrostomy placement. The relative safety of upper gastrointestinal endoscopy has encouraged its use even in elderly patients and those with significant co-morbidity. However it is an invasive procedure and carries with it a range of complications and a small but well recognized mortality. As some complications are inevitable during prolonged endoscopic procedures, knowledge of potential complications and their expected frequencies can lead to improved risk benefit analysis by physician as well as by the patient. Early recognition of complications and prompt intervention may minimize morbidity. The complications are cardiopulmonary problems, bleeding, perforation and infection which are responsible for major morbidity [1]. This study is undertaken to determine the changes in oxygen saturation (Spo₂), blood pressure (BP), heart rate (HR) and ECG during various upper gastrointestinal endoscopic procedures.

II. MATERIALS AND METHODS

A. Source of Data

One hundred and forty patients undergoing upper gastrointestinal endoscopy at Sri. B. M. Patil Medical College, Hospital and Research Centre were studied. No premedication or anesthesia was given.

Thorough cardiac and respiratory system assessment was done in all patients.

A Pentax video gastrointestinal fiberoptic endoscope EPK 1000 was used for upper gastrointestinal endoscopy.

A portable RMS ECG machine was used for recording standard 12 lead ECG with long rhythm strip of lead II at a speed of 25mm/second and 1mV tracing. These tracings were recorded before, during and immediately after endoscopy. Another ECG was taken 10 minutes after withdrawal of the endoscope

Along with the ECG recording, blood pressure recording, heart rate recording and Spo₂ monitoring was done

simultaneously before, during and immediately after the procedure and 10 minutes after the procedure.

B. Method of Collection of Data

Patients undergoing upper gastrointestinal endoscopy were studied with proper history taking, clinical examination and relevant investigations.

1. Inclusion Criteria

All patients undergoing upper gastrointestinal endoscopy

2. Exclusion Criteria

All patients undergoing emergency endoscopic procedures and patients with the following conditions are excluded from this study.

- Acute myocardial Infarction
- Heart failure
- Cardiogenic shock
- Arrhythmias
- Respiratory failure
- Respiratory distress
- Baseline oxygen saturation less than 90% and requiring oxygen therapy before the procedure.

3. Statistical method:

- Diagrammatic Representation
- Statistical analysis using Z test or Chi-Square test.

III. RESULTS AND OBSERVATIONS

The present study was undertaken after approval by the Hospital ethical committee. Patients attending endoscopy clinic were thoroughly examined and where ever necessary investigated. Initial 140 consecutive patients, after enforcing the exclusive criteria, were enrolled for this study.

A. Age

Of the 140 patients, the youngest patient was 11 years and the oldest patient was aged 80 years. The mean age of the study population was 43.46 years.

TABLE I
AGE DISTRIBUTION OF PATIENTS

Age group	Number of patients (n-140)	Percentage
11 – 20	9	6.4
21 – 30	37	26.4
31 – 40	25	17.8
41 – 50	17	12.1
51 – 60	27	19.2
61 – 70	22	15.7
71 – 80	2	1.42

In this study, maximum number of patients was in the age group of 21 to 30 years (26.4%). Next commonest age is 51 to 60 years (19.2%).

B. Gender (Sex)

Of the total 140 patients, there are 104 male patients and 36 female patients.

TABLE II
DISTRIBUTION OF PATIENTS BY SEX

Gender	Total	Percentage
Male	104	74.3
Female	36	25.7

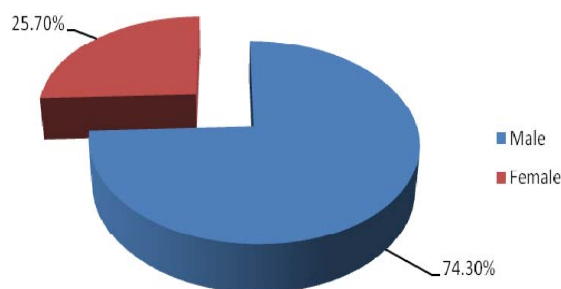


Fig. 1 Distribution of patients by sex

In this study, 74.3 % of cases were male and rest of 25.7% was female. The male preponderance with female is in the ratio of 3: 1.

C. Indications for Diagnostic Upper Gastrointestinal Endoscopy

All patients underwent diagnostic procedures. 82 patients were referred from Inpatient departments of the hospital and 58 were from outpatient departments.

The indications for upper gastrointestinal endoscopy in these patients were:

TABLE III
INDICATIONS FOR ENDOSCOPY

Indication	No: of Patients	Percentage
Dysphagia	28	20%
Upper GI bleed	37	27%
Persistent vomiting	7	5%
Dyspepsia	7	5%
Oesophageal varices	5	3%
Iron deficiency anemia	5	3%
Pain Epigastrium	4	3%

D. Diagnostic Yield of Endoscopy in Our Study Group

In the present study of 140 patients, upper gastrointestinal endoscopy was normal in 60(42.8%) patients. The lesions detected were: oesophagitis in 25 (17.85%) patients, Gastritis in 9(6.42%), oesophageal lesions like growths, ulcers and carcinoma in 16(11.42%) patients. Other lesions found include duodenitis, peptic ulcers, NSAID induced gastropathy, oesophageal varices and benign esophageal strictures.

TABLE IV
DISTRIBUTION OF PATIENTS BY DIAGNOSIS

Diagnosis	Male	Female
Normal Scopy	46	14
Oesophagitis	20	5
Gastritis	7	2
Oesophageal growths, ulcers and Carcinoma	11	5
Others	20	10

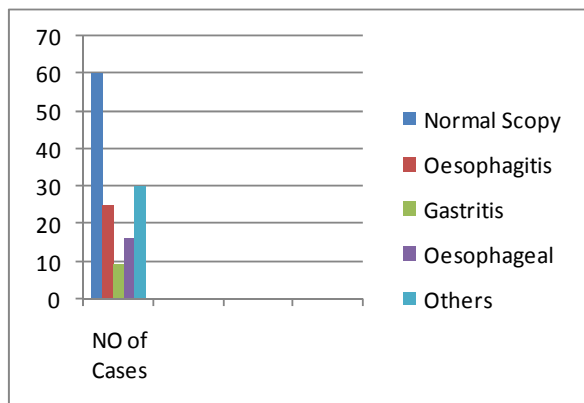


Fig. 2 Number of patients by diagnosis

All these 140 patients tolerated and successfully completed the diagnostic upper gastrointestinal endoscopy. The mean duration of upper gastrointestinal endoscopy was 8.46 minutes (range 6.1 to 12.4 minutes) for all age groups and both sexes.

Although sedation is known to increase the tolerance and reduces anxiety, Sedation was not used for any of these 140 patients. It is a known fact that sedation can't reduce the incidence of tachycardia and myocardial ischemia but can decrease the SPO2 levels.

E. Spo2 (Saturation of Peripheral Oxygen) Levels

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

TABLE V
STATISTICAL MEASURES AT BEFORE, DURING AND AFTER ENDOSCOPY ON SPO2 BY MALE, FEMALE AND TOGETHER

	Spo2 (%)		
	Before Endoscopy	During Endoscopy	After Endoscopy
	Mean± SD	Mean ± SD	Mean± SD
Male	98.54± 1.52	94.57± 2.99	97.32± 2.42
Female	98.6± 2.1	94.64± 2.67	97.94± 2.19
Together	98.54± 1.68	94.6± 2.91	97.5± 2.37

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%.

TABLE VI
SPO2 LEVEL BEFORE, DURING AND AFTER ENDOSCOPY BY AGE

Age Group	Spo2 (%)		
	Before Endoscopy	During Endoscopy	After Endoscopy
	Mean± SD	Mean± SD	Mean± SD
10 to 20	99.67± 0.71	96.56±2.92	99.22±1.3
21 to 30	98.82±1.74	95.55±2.63	98.05±2
31 to 40	99.33±0.87	95.63±1.76	98.42±0.88
41 to 50	99±0.89	95.44±1.5	98±1.32
51 to 60	97.75±1.53	93.21±3.22	96.57±2.74
61 to 70	97.77±2.14	92.68±2.73	96.05±2.95

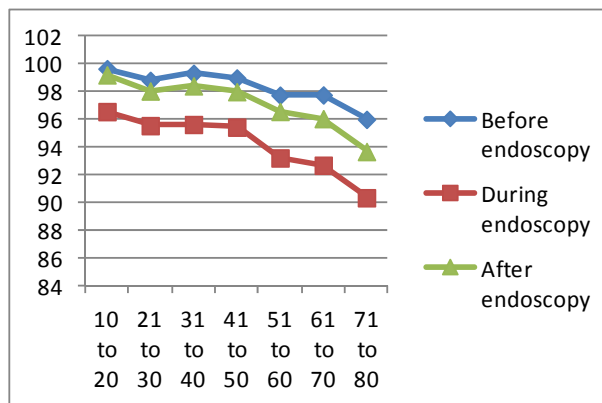


Fig. 3 Spo2 level at before, during and after endoscopy by age

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 %. It decreased to 94 % during insertion of the endoscopy probe. Mild to moderate hypoxia was found in 32% of patients. Severe hypoxia was found in 5% 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 6 episodes of severe hypoxia; 4 of these occurred during insertion of the endoscope and 2 during procedure. 5 episodes of severe hypoxia occurred in patients above 50 years age group and 2 of these patients received supplemental Oxygen.

F. Spo2 levels by Age and Gender

SPO2 levels decreased by about 4% in both sexes during introduction of endoscopy tube and continued at the lower levels during the diagnostic endoscopy procedure in both male and female; the oxygen desaturation was slightly more in male patients. Patients aged more than 60 years, having underlying chronic airway disease, history of smoking and severe anemic patients were related significantly to oxygen desaturation. Similarly the recovery of SPO2 was observed (by about 3%) immediately after the procedure in both the sexes. Base line levels were regained nearly 10 minutes after the procedure in all the patients. Two of the patients in the study group required supplemental Oxygen administration during the procedure.

Oxygen saturation was satisfactorily maintained above 95.5 in the younger age groups during the procedure. In the 10 to 20 age group it was about 96.56±2.92; In the 21 to 30 age group it remained at 95.55± 2.63 during the procedure. Even in the 31 to 40 age group and 41 to 50 age groups it stayed at 95.63± 1.76 and 95.44± 1.5 during the procedures.

But in the 51 to 60 age group, it has fallen to 93.21± 3.22 and in the 61 to 70 age group it fell more to 92.68 ± 2.73; In the oldest group of 71 to 80 years age group, it has fallen drastically to 90.33± 2.52. In this age group even the baseline

SPo2 was 96 ± 2 and it remained at 93.67 ± 2.52 even after the procedure.

The female patients in general showed slightly better SPo2 levels even at baseline. Before endoscopy, they maintained SPo2 levels of 98.6 ± 23.1 as against 98.54 ± 1.52 maintained my male group. During and post the procedures, they maintained 94.64 ± 2.67 and 97.94 ± 2.19 as against 94.57 ± 2.99 and 97.32 ± 2.42 seen in male patients.

G. Heart Rate (Pulse)

The following heart rate recordings were noted from pulse oximetry of our 140 patients during various stages of upper gastrointestinal endoscopy.

TABLE VII
STATISTICAL MEASURE AT BEFORE, DURING AND AFTER THE PROCEDURE ON HEART RATE BY MALE, FEMALE AND COMBINED

	Heart Rate		
	Before Endoscopy	During Endoscopy	After Endoscopy
	Mean± SD	Mean± SD	Mean± SD
Male	76.77±14.28	94.14±18.01	79.81±14.93
Female	86.7±16	101±16.5	88.66±15.3
Together	79±15	96±18	82±15

TABLE VIII
TEST OF SIGNIFICANCE BETWEEN HEART RATE LEVEL (BEFORE AND DURING ENDOSCOPY) [MALE AND FEMALE TOGETHER]

Statistical Measures	Before Endoscopy	During Endoscopy	t - value	p - value
Mean	79	96		
SD	15	18	8.62	P<0.00001
N	140	140		

TABLE IX
TEST OF SIGNIFICANCE BETWEEN HEART RATE LEVEL (BEFORE AND AFTER ENDOSCOPY) [MALE AND FEMALE TOGETHER]

Statistical Measures	Before Endoscopy	After Endoscopy	t - value	p - value
Mean	79	82		
SD	15	15	1.68	P=0.13
N	140	140		

Significant asymptomatic tachycardia was noted in 88% of the study group patients. It occurred in all the stages of the procedure but predominantly during blade 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 (pulse 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.

TABLE X
STATISTICAL MEASURES ON HEART RATE BY AGE

Age Group (in years)	Heart Rate		
	Before Endoscopy	During Endoscopy	After Endoscopy
	Mean±SD	Mean±SD	Mean±SD
12 to 20	85.89±17.57	105.33±17.87	91.67±16.72
21 to 30	82.05±19.05	96.66±22.32	84.39±20.03
31 to 40	76.25±13.49	95.96±16.3	78.08±12.34
41 to 50	78.5±15.31	95.25±18.77	80±15.16
51 to 60	76.75±10.67	91.82±12.78	81±9.75
61 to 70	77.05±13.28	94.64±16.11	79.27±13.81
71 to 80	94.33±12.74	108.67±9.29	98±9.64

H. Changes in Heart Rate versus Age of the Patient

The average baseline pulse rate of the study group was 85.89, 82.05, 76.25 and 78.5 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 76.75 and 77.05 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 94.33.

During the upper gastrointestinal endoscopy procedure, heart rate increased considerably in all age groups. In the 10 to 20 age group it raised to 105.33 from a mean of 85.89. In the 21 to 30, 31 to 40 and 41 to 50 age groups also, heart rate increased from mean of 82.05, 76.25 and 78.5 to 96.66, 95.96 and 95.25 during the procedure.

TABLE XI
DISTRIBUTION OF CASES BY AGE AND INCREASE IN HEART RATE BY (1-10, 11-20, 21-30, 31 AND ABOVE)

AGE Group (years)	Increase in HR - n (%)				Total
	1 to 10	11 to 20	21 to 30	31 and above	
10 - 20	0 (0%)	5 (55.56%)	4 (44.44%)	0 (0%)	9
21 - 30	10 (26.32%)	15 (39.47%)	11 (28.95%)	2 (5.26%)	38
31 - 40	5 (20.83%)	8 (33.33%)	6 (25%)	5 (20.83%)	24
41 - 50	5 (31.25%)	6 (37.5%)	1 (6.25%)	4 (25%)	16
51 - 60	7 (25%)	15 (53.57%)	6 (21.43%)	0 (0%)	28
61 - 70	7 (31.82%)	8 (36.36%)	5 (22.73%)	2 (9.09%)	22
71 - 80	1 (33.33%)	2 (66.67%)	0 (0%)	0 (0%)	3
					140

After completion of upper gastrointestinal endoscopy, the heart rates remained slightly high. In the age group of 10 to 20 years, post procedure, mean heart rate was at 91.67 where as baseline level was 85.89. 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 84.39, 78.08 and 80. Similarly in the older age groups, they remained high at 81, 79.27 and 98 in the age groups of 51 to 60, 61 to 70 and 71 to 80 years.

TABLE XII
TEST OF SIGNIFICANCE BETWEEN HEART RATE LEVEL (BEFORE AND DURING ENDOSCOPY) [MALE]

Statistical Measures	Before Endoscopy	During Endoscopy	t-value	p-value
Mean	76.77	94.14	9.23	p < 0.00001
SD	14.28	18.01		
N	104	104		

TABLE XIII
TEST OF SIGNIFICANCE BETWEEN HEART RATE LEVEL (DURING AND AFTER ENDOSCOPY) [MALE]

Statistical Measures	During Endoscopy	After Endoscopy	t-value	p-value
Mean	94.14	79.81	7.8	p < 0.00001
SD	18.01	14.06		
N	104	104		

TABLE XIV
TEST OF SIGNIFICANCE BETWEEN HEART RATE LEVEL (BEFORE AND DURING ENDOSCOPY) [FEMALE]

Statistical Measures	Before Endoscopy	During Endoscopy	t-value	p-value
Mean	86.7	101.2	7.92	p < 0.00001
SD	16	16.5		
N	36	36		

TABLE XV
TEST OF SIGNIFICANCE BETWEEN HEART RATE LEVEL (DURING AND AFTER ENDOSCOPY) [FEMALE]

Statistical Measures	During Endoscopy	After Endoscopy	t-value	p-value
Mean	101.2	88.66	3.858	p < 0.00001
SD	16.5	15.3		
N	36	36		

TABLE XVI
TACHYCARDIA (HEART RATE MORE THAN 100 DURING ENDOSCOPY)

Age Group (Years)	Tachycardia		
	Male	Female	Total
10 - 20	3 (50%)	3 (50%)	6 (100%)
21 - 30	12 (63%)	7 (37%)	19 (100%)
31 - 40	8 (66%)	4 (34%)	12 (100%)
41 - 50	6 (86%)	1 (14%)	7 (100%)
51 - 60	10 (100%)	0 (0%)	10 (100%)
61 - 70	5 (84%)	1 (16%)	6 (100%)
71 - 80	3 (100%)	0 (0%)	3 (100%)

I. Blood Pressure

Out of these 140 patients, blood pressure increased to hypertension levels in 22 patients (15.7%). (Hypertension is systolic BP more than 160mm of hg; Hypotension is systolic BP less than 90mm 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.

J. Changes in Blood Pressure versus Gender

TABLE XVII
STATISTICAL MEASURE AT BEFORE, DURING AND AFTER THE PROCESS ON BLOOD PRESSURE BY MALE, FEMALE AND COMBINED

Sex		Blood Pressure (mm of Hg)		
		Before Endoscopy	During Endoscopy	After Endoscopy
		Mean± SD	Mean± SD	Mean± SD
Male	Systolic	119.6±9.8	136.4±12.42	127±10.65
	Diastolic	76.65±7.35	85.75±8.53	81±7.52
Female	Systolic	118.33±8.30	131.33±10.65	123.39±8.77
	Diastolic	76.22±5.43	83.55±7.04	78.66±6.12
Together	Systolic	119.3±9.43	135.1±12.16	126±10.29
	Diastolic	76.54±6.89	85.19±8.20	80.4±7.24

In the present study, the base line mean systolic pressure for all patients was 119.3±9.43 before the procedure. For male, the baseline systolic pressure was 119.6±9.8 mm of Hg and in female it was 118.33±8.30. During endoscopy, it increased to 136.4±12.42 in males and to 131.33±10.65 in females. Immediately after completion of endoscopy, it came down to 127±10.65 in males and to 123.39±8.77 in women.

The baseline diastolic blood pressure of the total study group was 76.54±6.89mm of hg. For male patients, the mean baseline diastolic pressure levels were 76.65±7.35 mm oh hg. It rose to 85.75±8.53 during endoscopy and has fallen back to 81±7.52 after the procedure. In female patients, the mean diastolic pressure levels before endoscopy were 76.22±5.43. They rose to 83.55±7.04 during the procedure and fallen back to 78.66±6.12 after endoscopy.

K. Changes in Blood Pressure versus Age

TABLE XVIII
STATISTICAL MEASURE AT BEFORE, DURING AND AFTER THE PROCESS ON BLOOD PRESSURE BY PATIENT'S AGE

Age Group (Years)		Blood Pressure (mm of Hg)		
		Before Endoscopy	During Endoscopy	After Endoscopy
		Mean± SD	Mean± SD	Mean± SD
10- 20	Systolic	116.44 ±10.57	126.22±6.44	117.33±6.48
	Diastolic	76±5.57	82±6.16	77.56±5.98
21- 30	Systolic	116.05±6.53	130.74±10.68	123.32±8.65
	Diastolic	75.16±5.25	83.68±6.3	79.74±6.5
31 - 40	Systolic	120.17±9.19	137.33±11.03	126.5±9.55
	Diastolic	77.17±7.08	84.75±9.02	80.17±6.01
41- 50	Systolic	121.88±9.22	140.88±11.73	131.13±9.15
	Diastolic	77.63±8.77	88.25±8.51	82.25±7.76
51- 60	Systolic	120±11.1	134.79±12.69	125.86±11.51
	Diastolic	76.71±7.84	85.36±9.81	80.21±9.02
61- 70	Systolic	119.91±9.39	136.18±10.56	127.09±8.59
	Diastolic	76.73±7.16	85.45±7.28	80.27±6.39
71- 80	Systolic	136±3.46	162.67±4.62	150±0
	Diastolic	82±7.21	97.33±8.33	92±6.93

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 blade.

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 120,121.8 and 120 mm

of hg. In the older age groups of 61 to 70 and 71 to 80, the baseline systolic pressures were 120 and 136.

Immediately after the insertion of endoscopic blade, systolic blood pressure rose and remained at higher levels throughout endoscopy. In the 10 to 20 age group it rose from 116 to 126, and in the age groups of 21 to 30, 31 to 40, 41 to 50 it rose from 116 to 130, 120 to 137 and 121 to 140 mm of hg. In the old patients, systolic BP rose from 120 to 136 and 136 to 162 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 123 (baseline 116), 31 to 40 group at 126 (120), 41 to 50 age group 131 (121), 51 to 60 group at 125 (120), 61 to 70 group 127 (119) and 71 to 80 age group 150 (136) mm of Hg.

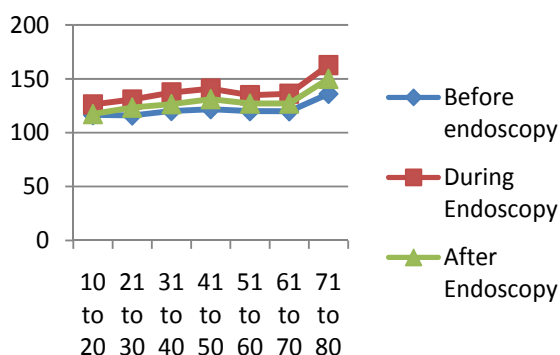


Fig. 4 Systolic BP level at before, during and after Endoscopy

Fig. 4 indicates that there is rise in systolic BP during endoscopy in all age groups and is more at older age.

TABLE XIX
TEST OF SIGNIFICANCE BETWEEN BLOOD PRESSURE LEVEL (BEFORE AND DURING ENDOSCOPY) [MALE]

Statistical Measures	Before Endoscopy	During Endoscopy	t-value	p-value
	Systolic	Systolic		
Mean	119.6	136.4	10.91	p < 0.00001
SD	9.8	12.42		
N	104	104		
	Diastolic	Diastolic		
Mean	76.65	85.75	8.34	p < 0.00001
SD	7.35	8.53		
N	104	104		

TABLE XX
TEST OF SIGNIFICANCE BETWEEN BLOOD PRESSURE LEVEL (DURING AND AFTER ENDOSCOPY) [MALE]

Statistical Measures	During Endoscopy	After Endoscopy	t-value	p-value
	Systolic	Systolic		
Mean	136.4	127	5.58	p < 0.01
SD	12.42	10.65		
N	104	104		
	Diastolic	Diastolic		
Mean	85.75	81	4.56	p < 0.00001
SD	8.53	7.52		
N	104	104		

TABLE XXI
TEST OF SIGNIFICANCE BETWEEN BLOOD PRESSURE LEVEL (BEFORE AND DURING ENDOSCOPY) [FEMALE]

Statistical Measures	Before Endoscopy	During Endoscopy	t-value	p-value
	Systolic	Systolic		
Mean	118.33	131.33	5.8	p < 0.00001
SD	8.3	10.65		
N	36	36		
	Diastolic	Diastolic		
Mean	76.22	83.55	5.72	p < 0.00001
SD	5.43	7.04		
N	36	36		

TABLE XXII
TEST OF SIGNIFICANCE BETWEEN BLOOD PRESSURE LEVEL (DURING AND AFTER ENDOSCOPY) [FEMALE]

Statistical Measures	During Endoscopy	After Endoscopy	t-value	p-value
	Systolic	Systolic		
Mean	131.33	123.39	3.46	p < 0.0001
SD	10.65	8.77		
N	36	36		
	Diastolic	Diastolic		
Mean	83.55	78.66	3.214	p < 0.00001
SD	7.04	6.12		
N	36	36		

L. Electrocardiographic Changes

In the present study, sinus tachycardia was observed in 88 % of the total patients and S-T depression noticed in 4% of these patients during upper gastrointestinal endoscopy.

T-wave inversion was observed in 3% of the patients. All these changes disappeared in the ECG's taken 10 minutes after endoscopy. The following ECG changes were observed in our 140 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.

TABLE XXIII
ELECTROCARDIOGRAPHIC CHANGES DURING VARIOUS STAGES OF
ENDOSCOPY

Sinus Tachycardia	88% of patients
ST depression	0%
T wave inversion	3%
Supra ventricular tachycardia	0%

TABLE XXIV
ELECTROCARDIOGRAPHIC CHANGES OBSERVED DURING ENDOSCOPY

ECG changes	Baseline	Probe insertion	During Endoscopy	Post Endoscopy
Sinus tachycardia	18%	82%	66%	34%
ST depression	0	7%	3%	0
T inversion	0	8%	2%	0
SV tachycardia	0	4%	1%	0

M. 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 88% 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 occurred in 12% of present study and were more frequently appeared in elderly people (68%), in persons with chronic lung disease (42%) and in persons with previous heart disease (28%). S-T depression occurred only in patients with previous cardiac disease. All these changes reverted to near normal ranges within half an hour.

IV. DISCUSSION

Upper gastrointestinal endoscopy is a commonly performed procedure and has evolved into an essential diagnostic and therapeutic tool. The assurance that high quality endoscopic procedures are performed has taken increased importance. A high quality endoscopy ensures that the patient receives an indicated procedure, that correct and clinically relevant diagnosis are made or excluded, upper gastrointestinal endoscopy and therapeutic procedures are performed properly with minimal complications to the patient [2].

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 [3].

So this study was undertaken to evaluate important variables like age of the patient, gender, duration of the procedure in relation to the cardiopulmonary changes during diagnostic endoscopy. For this purpose oxygen saturation, blood pressure, heart rate (pulse) and ECG recordings were monitored using pulse oximeter. A total number of 140 patients were studied and their ages ranged from 10 to 80 years. Of these 140 patients, 104 are male and 36 female. In a

similar study in Saudi Arabia, of the 6386 patients followed, the male female ratio was 5.2:1 [4].

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

1. Blood oxygen desaturation
2. Tachycardia
3. Hypertension
4. Tachypnoea
5. ECG changes like sinus tachycardia, ST depression and T wave inversion.

A. *SPo2*

Although upper gastrointestinal endoscopy is generally a safe procedure, it is known to be associated with arterial oxygen desaturation [5]; in our study 34% developed mild desaturation and 5 % 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.

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. Desaturation was severe in therapeutic endoscopies than diagnostic upper gastrointestinal endoscopies. They observed that oxygen desaturation was significantly related to patients aged more than 60 years ($p < 0.001$), hemoglobin < 10 gm/dl ($p < 0.001$) and history of smoking ($p < 0.001$) [6].

In our study of 140 patients, during endoscopy we found very mild oxygen desaturation (*SPo2* < 95%) in 34% of the patients, mild oxygen desaturation (*SPo2* 90-95%) in 10 % of the patients and severe desaturation (*SPo2* < 90%) in none of the patients. Similar findings were reported by Sun Young et al. [7].

In our study sedation was not used as it increases chances of oxygen desaturation. Rozario et al. in a prospective study of 389 patients compared two groups of patients who underwent Gastroscopy under sedation; one group received supplemental oxygen during gastroscopy while the other similar group didn't. They observed that patients receiving supplemental oxygen were 98% less likely to experience desaturation and recommended routine use of two litres/minute of supplemental O_2 during sedated endoscopic procedures [8].

Osinaike B. B. et al. studied 40 healthy patients to find out risk factors for cardiopulmonary changes during endoscopy. They concluded that mild to moderate hypoxia is common during endoscopic procedures and is of no serious consequence. Severe hypoxia is rare. They recommended non invasive monitoring in older patients and in endoscopic procedures longer than 27 minutes [9].

B. Blood Pressure

Out of these 140 patients, blood pressure increased to hypertension levels in 22 patients (15.7%). 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. They found that during upper gastrointestinal endoscopy there is large increase in blood pressure with maximum changes occurring during intubation in the youngest age group. In the older patients, they observed that blood pressure increased later in the procedure and was sustained for a long period. Systolic pressure was greater in sedated patients [10]. 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 [9].

Stress inducing procedures are supposed to cause an increase in blood pressure by catecholamine release. Tetsuya Saijyo et al. measured blood pressure by tonometry in 30 patients to determine the rationale behind the cardiac events during upper gastrointestinal endoscopy. They calculated CVbp and HFbp which are indicators of parasympathetic tone, and found that they increased in the early parts endoscopy but decreased significantly in the middle and late phases compared with the pre endoscopy values. Their conclusion was that gastrointestinal endoscopy induced an autonomic nervous abnormality which has contributed to these cardiac events [11]. In sedated patients, blood pressure remained stable although they were more prone to hypoxia [12]. As we didn't use sedation, all our patients showed some rise in systolic blood pressure.

C. Heart Rate

Upper gastrointestinal endoscopy is thought to cause stress response (endocrine response) leading to tachycardia, and there by leading to myocardial ischemia [13].

Tachycardia occurred in 88% of the total patients during upper gastrointestinal endoscopy. It was seen during all stages of the procedure but was higher during endoscope insertion. Introduction of endoscope into pharynx triggered severe tachycardia. In the present study, the rise in heart rate was more pronounced in women than men during the endoscopy procedure.

Rise in heart rate during endoscopy has been reported by many workers. 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 [14]. 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, although a few studies have reported 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. Maximum rise in heart rate was found in cardiac patients. All these changes reverted to normal within 10 minutes [15].

The frequency of tachyarrhythmia during gastroscopy studies were reported between 38.5% and 75%. So Ulgen M. S. et al. used Holter monitor to verify this and found that 15% of their patients suffered with severe tachyarrhythmia and attributed this to fear, anxiety and catecholamine secretion [16]. In the present study also 10 to 20 age group showed sudden rise of mean heart rate from 85 to 105 and this can also be attributed to fear and anxiety.

D. Electrocardiographic and Cardiac Changes

Ulgen M. S. et al studied 40 non cardiac patients of above 50 years age undergoing gastroscopy to know the safety of upper gastrointestinal endoscopy in the elderly candidates. They observed supraventricular tachycardia in 15% of patients without causing any symptoms. Two patients aged above 60 years had episodes of silent ischemia during endoscopy but their coronary angiograms at a later date showed normal coronary arteries. They concluded that gastroscopy does not cause serious cardiac complications in aged patients if they are properly screened to rule out cardiac disease [16].

In our study, increase in heart rate was found in 88 % of the patients and S-T depression noticed in 4% of the patients. T wave inversion observed in 8% 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 [15].

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. They assessed myocardial ischemia by ST segment depression and found that there is a significant correlation between ST segment depression and hypoxemia. They concluded that measuring arterial oxygen saturation is important to detect myocardial ischemia in addition to measuring BP and ECG recording [17].

Seinela Lauri et al. in a 24 hour Holter study of very old patients found that the number of ventricular ectopics was increased during the one hour period after upper gastrointestinal endoscopy, that too more commonly in known cardiac patients, although no fatalities occurred [18].

Hayashi Toru et al. in a study to determine the effect of autonomic imbalance on arrhythmia generation during endoscopy procedure found that high frequency spectral power, which reflect parasympathetic activity decreased during gastroscopy and advised measurement of this prior to

endoscopy can identify those with reduced power so that cardiovascular complications related to premedication and endoscopy can be prevented [19].

Possible predictive factors for patients undergoing upper gastrointestinal endoscopy are Basal SPO₂ of <95%, pre existing respiratory disease, more than one attempt at intubation and emergency gastroscopy. So these groups of patients require very close monitoring with pulse oximetry and endoscopist should be alert to the possibility of respiratory depression in these patients [20].

E. Arrhythmias

Other than sinus tachycardia, the present study group did not show significant arrhythmias. ST depression (4%), T wave inversion (8%) and supra ventricular tachycardia was noted in few patients.

Mathew et al noticed high incidence of cardiac arrhythmias in their study of 52 patients undergoing gastroscopy, including ventricular premature contractions in 19% of their study [21].

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. All these arrhythmias disappeared after endoscopy [15].

F. Effects of Age and Gender on Cardiopulmonary Changes

Blood pressure in the old people increased during later part of the procedure and lasted for a long period. In the younger age group, it occurred during entry of the endoscope. Heart rate changes were less significant in those who received throat spray. Similar findings were observed by Ross Ruth et al [10].

G. Need for Non Invasive Monitoring in the above 50 Years Age Group

In upper gastrointestinal endoscopy, the risk for cardiovascular and pulmonary complications is related to both the patients underlying condition and the endoscopic procedure being performed. Elderly patients with cardiac, pulmonary, renal or other problems are at increased risk, that too if sedation has to be used. Emergency therapeutic endoscopy is associated with more risk and in all these patients appropriate cardio respiratory monitoring will help to minimize complications. Continuous electrocardiographic monitoring is reasonable in elderly, in patients with significant cardiac or pulmonary disease and in whom prolonged procedure is anticipated. In these patients pulse oximetry measures oxygen saturation and helps to find out when patient needs supplemental oxygen administration. So in cardiovascular high risk patients and in long standing upper gastrointestinal therapeutic procedures, using pulse oximeter and monitoring the heart rhythm is indicated and administration of supplemental Oxygen can prevent many of the ventilation problems. Although electronic monitoring equipment facilitates assessment of patient's status, still it does not replace a well trained and vigilant assistant [22].

H. Cardiopulmonary Changes Found in This Study Group Include

Our study confirms that although upper gastrointestinal endoscopy (Gastroscopy) is a safe procedure, cardiopulmonary changes occur frequently. Elderly people need to be carefully monitored as they have higher chances of developing hypoxia and cardiac arrhythmias during the procedure.

Cardiopulmonary complications are due to vasovagal episodes, hypoventilation, aspiration, airway obstruction and oversedation. Risk factors for developing complications during upper gastrointestinal endoscopy include old age, obesity, severe anemia, pre-existing cardiopulmonary disorders and smoking. These risk factors should be identified before endoscopy. When these patients present for Upper gastrointestinal endoscopy, pulse oximetry monitoring along with ECG and blood pressure monitoring should be used.

V. CONCLUSION

During upper gastrointestinal endoscopy, transient cardio respiratory changes occur frequently. Our study of 140 patients revealed mild to moderate hypoxia, tachycardia, and hypertension are 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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REFERENCES

- [1] Sharan Badiger. Upper Gastrointestinal Endoscopy - Cardio-Pulmonary changes and Complications. International Journal of Current Scientific Research. 2012; 2, no.2: pp.350- 357.
- [2] Douglas O. Faigel, Irving M. Pike, Todd H. Baron, Amitabh Chak, Jonathan Cohen, Stephen E. Deal, Brenda Hoffman et al. Quality Indicators for Gastrointestinal Endoscopic Procedures: An Introduction. American Journal of Gastroenterology 2006; 101, pp. 866-872.
- [3] Bell G.D. Monitoring and safety in endoscopy. Baillière's Clinical Gastroenterology. 1991; 5, no.1: pp.79-98.
- [4] Laajam M. A., I. A. Al-Mofleh, F. Z. Al-Faleh, A. K. Al-Aska, K. Jessen, J. Hussain, and R. S. Al-Rashed. Upper gastrointestinal endoscopy in Saudi Arabia: analysis of 6386 procedures. The Quarterly Journal of Medicine. 1988; 66, no. 249: pp.21-25.
- [5] Dhariwal A, Plevris J. N, Lo N.T.C, Finlayson N.D.C, Heading R.C, Hayes, P.C., Age, anemia, and obesity-associated oxygen desaturation during upper gastrointestinal endoscopy, Gastrointestinal Endoscopy. 1992; 38, no: pp. 684-688.
- [6] Javid G, Khan B, Wani M. M, Shah A, Gulzar G. M. Role of pulse oximetry during non-sedated upper gastrointestinal endoscopic procedures. Indian journal of gastroenterology: official journal of the Indian Society of Gastroenterology. 1999; 18, no.1: pp.15-17.
- [7] Sun Young Yi, Arterial oxygen desaturation during non sedated diagnostic upper GI endoscopy. Korean Journal of Gastrointestinal Endoscopy.1996; 16: pp.25-29.
- [8] Rozario, Lorraine, Donna Sloper, and Michael J. Sheridan. Supplemental oxygen during moderate sedation and the occurrence of clinically

- significant desaturation during endoscopic procedures. *Gastroenterology Nursing*. 2008; 31, no. 4: pp.281-285.
- [9] Osinaik B. B., A Akere, T. O. Olajumoke, E. O. Oyebamiji. Cardiorespiratory changes during upper gastrointestinal Endoscopy. *Gastrointestinal Endoscopy*. 1992; 38, pp.684-9.
- [10] Ross Ruth, Julia L. Newton. Heart rate and blood pressure changes during gastroscopy in healthy older subjects. *Gerontology*. 2004; 50, no. 3: pp.182-186.
- [11] Saijyo Tetsuya, Masahiro Nomura, Yutaka Nakaya, Ken Saito, Yuki Kondo, Michiko Yukinaka, Ichiro Shimizu, and Susumu Ito. Assessment of autonomic nervous activity during gastrointestinal endoscopy: analysis of blood pressure variability by tonometry. *Journal of Gastroenterology and Hepatology*. 1998; 13, no. 8: pp.816-820.
- [12] Bhalla A, Sood A, Sachdeva, A, Duseja, Gupta V. Cardiorespiratory compromise under conscious sedation during upper gastrointestinal endoscopy. *J Coll Physicians Surg Pak*.2006; 16, no. 9: pp.585-589.
- [13] Yetkin G., S. Oba, M. Uludag, I. Paksoy, I. Akgün, and N. Eren. Effects of sedation during upper gastrointestinal endoscopy on endocrine response and cardiorespiratory function. *Brazilian Journal of Medical and Biological Research*. 2007; 40, no. 12: pp.1647-1652.
- [14] Mistry F.P., P. Abraham, and S. J. Bhatia. Oxygen desaturation and tachycardia during upper gastrointestinal endoscopy are transient and benign. *The Journal of the Association of Physicians of India*.1992; Aug; 40, no. 8: pp.524-527
- [15] Malhotra H. S., S. Rana, L. S. Pal, and D. J. Dasgupta. Electrocardiographic changes during upper gastrointestinal endoscopy in ambient hypoxia. *The Journal of the Association of Physicians of India*.1991; 39, no. 9: pp.692-693
- [16] Ulgen M.S, Y. Ates, Zeki Soyupacaci, and T. Keles. Effects of upper gastrointestinal endoscopy on the cardiovascular system of asymptomatic middle-aged and elderly patients without heart disease. *Turkish Journal of Gastroenterology*. 2001; 12, no. 3: pp.214-217
- [17] Murray A.W., C. G. Morran, G. N. C. Kenny, P. Macfarlane, and J. R. Anderson. Examination of cardiorespiratory changes during upper gastrointestinal endoscopy. *Anaesthesia*. 1991; 46, no. 3: pp.181-184.
- [18] Seinälä Lauri, Pekka Reinikainen, and Jari Ahvenainen. Effect of upper gastrointestinal endoscopy on cardiopulmonary changes in very old patients. *Archives of Gerontology and Geriatrics*. 2003; 37, no. 1: pp.25-32.
- [19] Hayashi Toru, Masahiro Nomura, Hirohito Honda, Kazuhiro Tezuka, Ryusuke Torisu, Yoshikazu Takeuchi, Yutaka Nakaya, and Susumu Ito. Evaluation of autonomic nervous function during upper gastrointestinal endoscopy using heart rate variability. *Journal of Gastroenterology*. 2000; 35, no. 11: pp.815-823.
- [20] Alcaín Guillermo, Pablo Guillén, Antonio Escolar, Miguel Moreno, and Leopoldo Martín. Predictive factors of oxygen desaturation during upper gastrointestinal endoscopy in non-sedated patients. *Gastrointestinal Endoscopy*. 1998; 48, no. 2: pp.143-147.
- [21] Mathew P.K., Ona F.V., Damevski K., Wallace W.A. Arrhythmias during upper gastrointestinal endoscopy. *Angiology*. 1979 Dec; 30, no.12: pp.834-840.
- [22] Patrick Waring J, Todd H Baron, William K Hirota, Jay L Goldstein, Brian C Jacobson, Jonathan A Leighton et al. Guidelines for conscious sedation and monitoring during gastrointestinal endoscopy. *Gastrointestinal Endoscopy*.2003; 58, no.3: pp. 317-322.

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