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Review Article

Upper Gastrointestinal Endoscopy -Cardio-Pulmonary changes and Complications

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ABSTRACT

Upper gastrointestinal (GI) endoscopy or oesophago-gastro-duodenoscopy (EGD), also known as Gastroscopy, refers to examination of the oesophagus, stomach and upper duodenum by means of a flexible fibre-optic endoscope.Upper GI endoscopy is a commonly performed procedure used to investigate a wide range of symptoms and treat a variety of complaints. Endooscopy is commonly used for diagnostic evaluation for signs and symptoms suggestive of upper GI diseases like dyspepsia, dysphasia, non-cardiac chest pain and recurrent emesis. It is also used for surveillance for upper GI cancer in high risk settings like Barrett's oesophagus and polyposis syndromes and also used for Biopsy for known or suggested upper GI diseases like malabsorption syndromes, neoplasms and infections. Gastroduodenoscopy is also useful for therapeutic intervention in removal of foreign bodies, control of GI hemorrhage, dilatation or stenting of strictures, ablation of neoplasms and for gastrostomy placement. The relative safety of upper GI 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 frequency 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. This article describes the changes in oxygen saturation (SpO2), blood pressure (BP), heart rate (HR) and electrocardiogram (ECG) during various upper GI endoscopic procedures.

1. Introduction

Endoscopy of the upper GI tract using fibre optic instruments has taken an increasingly dominant role in diagnosis and therapy since the introduction of the first panendoscope by Hirschowitz in 1963 [1]. Although upper GI Endoscopy is a routine diagnostic method used widely around the world, it does carry some risk for all patients. It is generally accepted that patients who suffer from cardiac or pulmonary illness are at increased risk while undergoing this procedure. When carefully managed, endoscopy plays a vital role in diagnosis and therapy even in these elderly cardiac patients [2]. Outpatient upper GI endoscopy is a commonly performed procedure and is very safe. The complication rates quoted for upper GI endoscopy varies between 0.02% and 1.1% with a mortality rate of 0% -0.12%. In a recent review of guidelines for endoscopy, it was mentioned, even today cardio pulmonary complications account for about 50% of the potentially serious morbidity and approximately 50% of all the procedure related deaths associated with GI endoscopy [3].

Osinike BB et al studied 100 patients without cardiopulmonary disorders for important variables like age of the patient, sex and duration of the diagnostic procedure. They monitored oxygen saturation, blood pressure and pulse rate during endoscopy using pulse oximeter and automated BP monitor. ECG was recorded before, during and after endoscopy. Then they evaluated important variables in relation to these changes for age, gender, duration of the procedure and drugs used and had similar readings in all of them [4]. Arterial hypoxemia is well documented during

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endoscopy and may predispose patients to cardiovascular sequealae including arrhythmias and ECG changes. Patients at high risk for these complications include the elderly, those with pre existing coronary artery disease, valvular heart disease and chronic obstructive pulmonary disease. Since these patients constitute a majority of patients undergoing endoscopy, the problem of hypoxemia has increased [5].Continuous ECG monitoring has revealed ST-T changes and arrhythmias more frequently in cardiac patients during endoscopy than in others [6, 7]. But in another study, Sachdev et al however did not find more frequent changes in cardiac subjects [8]. Elderly subjects have more frequently demonstrated ECG changes during endoscopy. Over activity of the sympathetic system due to apprehension or stress of the procedure, distension of the stomach by air insufflations [9] and hypoxemia [7], resulting from the presence of the endoscope in the throat have all been blamed for the ECG changes. Diazepam as premedication has reduced the incidence of abnormal ECG during endoscopy [6]. Administration of 2 litres of oxygen during the procedure also proved to be beneficial.

Upper GI endoscopy is a procedure during which a small flexible endoscope is introduced through the mouth and advanced through the pharynx, oesophagus, stomach, and duodenum. Upper GI endoscopy is used for both diagnostic and therapeutic procedures. The gastroscope was first developed in 1952 by a Japanese team of a doctor and optical engineers. Mutsuo Sugiura, in association with Olympus Corporation, worked with Dr. Tatsuro Uji and his subordinate, Shoji Fukami, to develop what he first called a "gastro camera". It consisted of a tiny camera attached to a flexible tip with a light bulb. With it, they were able to photograph stomach ulcers that were undetectable by X-ray and find stomach cancers in early stage [10]. Then came new innovations like remotely operated surgical instruments contained within the endoscope itself. The investigations and management of patients with digestive problems was revolutionized, in the 1960s with the introduction of flexible endoscopes, based on fibreoptic light transmission. Their diagnostic potential became obvious with improved visualization, increased tip control and biopsy capability. Subsequent developments, such as video-endoscopy, and the proliferation of therapeutic applications moved endoscopy into the mainstream of gastroenterology, and led to its enormous expansion worldwide. So the history of endoscope can be divided into 3 periods:

1. The rigid endoscope (1868- 1932)
2. The semi-flexible endoscope (1932-1957)
3. The fibreoptic endoscope (1957-1983)

The recognition of the value of diagnostic endoscopy has resulted in a revolution in the ability to assess the gastrointestinal tract and allow direct visualization of and sampling the mucosa. From this experience, the technique of interventional endoscopy has developed with specialist therapeutic endoscopes. The introduction of modern solid-state devices has provided the next step in the development of flexible endoscopy and most recently capsule endoscopy. Fibreoptic endoscopy is still the standard method of assessing the upper gastrointestinal tract. Investigation of the small intestine or oesophagus with regular diagnostic facilities is very difficult. Wireless video capsule endoscopy was developed recently from an idea of an Israeli physician Gavriel Iddan. The capsule contains a miniature camera which can take pictures of the lining of the small intestine as well as oesophagus. It is very useful in identifying diseases of small intestine like Crohn's disease, celiac disease, reflux disease, tumors, Barret's oesophagus and esophagitis. Wireless capsule technology is superior to barium x rays in identifying polyps present in the small intestine [11].

Recent improvements include endoscopic ultrasonography, which allows looking beyond GI walls, like studying pancreatic tumors. New updates in technology are helping in the development of high resolution endoscopes, magnification endoscopes, chemo-endoscopes and confocal endomicroscopy. In the management of severe gastrointestinal bleeding, endoscopy has now become the first and primary therapeutic modality. To improve patient's outcome and to reduce morbidity and mortality from severe GI haemorrhage, endoscopists are using panendoscopy, push enteroscopy and colonoscopy. Recent improvements in endoscopic haemostatic techniques and imaging modalities using wireless capsule endoscopy suggest that diagnostic and therapeutic GI endoscopy will be even more important in determining patient outcomes in the future [12].

2. Complications of upper GI endoscopy

An endoscopic procedure is considered appropriate if the benefit for the patient exceeds the risks by a sufficiently wide margin. The complication rate of upper GI endoscopy is about 0.1% with cardiopulmonary events predominating, which account for 50% of all reported complications. Most complications of cardiopulmonary origin are as a consequence of hypoxemia, which may be related to the procedure itself or due to the effect of sedatives. According to ASGE survey, 46% of cardiopulmonary complications are related to sedation. Significant oxygen desaturation (<90%) has been found in many of them [3]. ST-T changes and arrythmias are also frequently reported in electrocardiogram's (ECG's) recorded during endoscopy. As more numbers of elderly and high risk patients are being subjected to this procedure, the incidence of cardiopulmonary complications is also increasing in proportion.

Endoscopists, while using drugs for sedation should recognize that any drug which depresses CNS has the potential to impair respiration, circulation or both. Most complications of endoscopy are cardiopulmonary. Sedation should be kept to a minimum required level for patient's comfort and safety particularly in the elderly. A retrospective analysis identified that cardiopulmonary incidents were noted in the immediate post procedure period. Aspiration pneumonia, embolism and myocardial infarction were noted in the later period. Supplemental oxygen administration has been shown to reduce the magnitude of oxygen desaturation when given during endoscopic procedures.

Continuous electrocardiogram (ECG) monitoring is warranted in high risk patients. Patients who may benefit from ECG monitoring include those who have history of significant cardiac or pulmonary disease, elderly patients and those on whom prolonged

procedures are anticipated. End- tidal Co2 monitoring is useful in cases which take time for the procedure especially so if associated with a compromised cardio respiratory status [13]. Still, Diagnostic upper GI endoscopy is a remarkably safe procedure. Although there are no recent high quality prospective studies of complications following diagnostic upper GI endoscopy, one large US study estimated an overall complication rate (including mucosal biopsy) of 0.13% and an associated mortality of 0.004% [14].

3. Cardio-pulmonary complications

Cardio-pulmonary complications account for about 50% of the potentially serious morbidity and approximately 50% of all the procedure-related deaths associated with GI Endoscopy. Complications range from minor changes in vital signs to arrhythmias; myocardial infarction, respiratory arrest, shock and death.Cardio-respiratory complications related to sedation and analgesia are the commonest complication of diagnostic upper GI endoscopy. In many cases these complications are a direct or indirect consequence of elderly, frail or at-risk patients being given unnecessarily high doses of IV sedation [15, 16]. Elderly patients and those with pre-existing cardiopulmonary disease are at increased risk. Hypoxia is particularly common when intravenous sedation is combined with intravenous analgesia.

The important cardio pulmonary complications are: [3]

1. Drug induced respiratory depression with hypoxia and CO_2 retention
2. Aspiration pneumonia
3. Cardiac arrhythmias
4. Hypertension, hypotension and/or vaso-vagal syncope

5 Angina and myocardial infarction

6. Stroke

3.1. Drug induced respiratory depression

Intravenous benzodiazepines (Midazolam and Diazepam) can cause respiratory depression as a result of the drug occupying brainstem benzodiazepine receptor sites which in turn may reduce respiratory drive. Intravenous opioids (Pethidine and Fentanyl) occupy opioid receptor sites within the brain and brainstem and can similarly cause respiratory depression with resulting falls in both tidal volume and respiratory rate. Drug induced hypoventilation may cause both hypoxemia and CO_2 retention which in extreme cases may progress to apnoea and even respiratory arrest. Pulse oximetry is a very useful indicator of oxygenation but not ventilation. However when supplemental oxygen is used, the fall in SpO_2 may be significantly delayed for between 30–90 seconds after the onset of severe drug induced respiratory depression/apnoea. It is for this reason that continuous capnography is recommended in patients being sedated with Propofol [17, 18]. As for over-sedation, loss of verbal contact due to reduced conscious level may be the first sign of impending respiratory depression. Reduction in SpO_2 on pulse oximetry is a good indicator but it can be a late sign of respiratory depression. Increased $paCO_2$ (where Capnography is available) is the most sensitive early warning of respiratory depression. Stimulate the patient to wake up and take deep breaths. Reverse agonist sedative effect with antagonist Flumazenil plus (if necessary naloxone). The airway may need to be protected with chin lift, jaw thrust, plus, if necessary, airway, laryngeal mask.

3.2. Aspiration Pneumonia

Aspiration of gastric contents into the lungs is common, causes pneumonia and may result in death [15, 16]. It is at particular risk of occurring in over-sedated patients as a result of an unprotected airway and where there is an increased propensity to vomit e.g. in patients with GI bleeding, gastric stasis, gastric outlet obstruction or those patients who have simply eaten or drunk fluid within the last 4 hours. It can also occur when a local anaesthetic spray such as Lignocaine is used in combination with IV sedation; there is some evidence of an increased risk of aspiration. Elderly patients have an increased tendency to aspirate and this may be further confounded by an already poor gag reflex. Aspiration is common in obtunded patients e.g. those with hepatic encephalopathy. Aspiration may be suspected when a patient starts coughing violently either during or soon after an endoscopic procedure and cyanosis may occur. Treatment includes Suction of fluids from oral cavity and throat, increasing the rate of supplemental oxygen, encouraging the patient to cough, chest X-ray, IV antibiotics and physiotherapy.

3.3. Cardiac Arrhythmias

Cardiac arrhythmias are frequently observed during GI endoscopic procedures. Fortunately, most are not clinically significant.Sinus tachycardia is caused by anxiety or is related to pain. It can occur as a compensatory mechanism in patients who are hypotensive as a result of either dehydration or blood loss. It is also seen following administration of IV anticholinergics such as Buscopan. Sinus bradycardia is most frequently seen in patients who are taking beta blockers either for hypertension or IHD. It can also be induced by vagal stimulation, which occurs at the time of intubation of the oesophagus.Each cycle commences with a P wave and the PR interval is normal. Therefore, rhythms are sinus-paced and differ only in rate: normal sinus rhythm, sinus bradycardia, or sinus tachycardia. In this ECG, it is sinus bradycardia, because the rate is <60.Other frequently observed cardiac arrhythmias include atrial and ventricular ectopic beats, atrial fibrillation and supraventricular tachycardia. Ventricular tachycardia and even cardiac arrest due to VF have been described but fortunately are rare [16]. In Supraventricular Tachycardia as ventricular conduction follows the normal pathways, the ECG will show heartbeats with a normal morphology QRS complex and T wave.So, continuous ECG monitoring is recommended for high risk patients with a relevant cardiac history.

3.4. Hypertension, hypotension and vaso-vagal syncope

Hypertension (systolic BP greater than 160 mm Hg) can occur due to background systemic hypertension, anxiety or pain. In some patients intubation of the oesophagus can cause a reflex pressor response raising blood pressure. Hypotension (systolic BP less than 90 mm of Hg) is due to a fall in either cardiac output or total peripheral resistance lowering the patient's mean arterial pressure. Sedation with benzodiazepines has a mild vaso-dilatory effect and usually produces only a slight fall in BP in normal sedative doses. Profound fall in BP is commonly seen in hypovolumic patients e.g. due to blood loss or dehydration. In endoscopic procedures using a benzodiazepine and opioid as sedatives can drop blood pressure profoundly. Bradycardia of any cause can cause hypotension. For prevention of hypotension, relevant medical and drug history must be taken before endoscopic procedure. Patient should also be enquired about use of antihypertensive, anti-anginal and anti-arrythmic drugs and particularly about timing of their last dose. Blood pressure and pulse should be recorded before, during and after any endoscopic procedure at frequent intervals.

3.5. Angina and myocardial infarction

Myocardial infarction occurs either during or in the few days after endoscopic procedures with or without sedation. A proportion of these are undoubtedly causally related to the endoscopic procedure [15, 16, 17]. Angina or myocardial infarction occurs due to increased myocardial oxygen need, because, both sedated and non-sedated endoscopic procedures cause an increase in the 'rate/pressure product' (mean arterial BP X Heart rate), which is an indirect measure of myocardial oxygen consumption. This can cause angina pectoris in patients with IHD or it may cause occult symptomless myocardial ischemia which is only apparent with sophisticated monitoring e.g. myocardial perfusion study [17]. Hypotension and/or bradycardia will reduce myocardial muscle perfusion, predisposing to angina.

3.6. Cerebrovascular Attacks

Both TIAs and fully completed strokes can occur during and following endoscopic procedures [15, 16, 17]. Possible mechanisms include, periods of hypotension or hypertension, cardiac arrythmias or as a consequence of a myocardial ischemia

4. Quality indicators for endoscopic procedures: [18]

It is important to have the assurance that high quality endoscopic procedure is performed. A high quality endoscopy ensures that the patient receives the indicated procedure, that correct and clinically relevant diagnoses are made or excluded, that therapy is properly performed and that all these things are accomplished with minimum risk. So quality indicators have been developed by the task force of ASGE (American Society for Gastrointestinal Endoscopy) and ACG (American College of Gastroenterology).

For any Endoscopic procedure, indicators were considered for 3 time periods: pre-procedure, intra procedure and post procedure. Important issues during pre-procedure period include proper indication, patient consent for the procedure, patient clinical status and risk assessment, steps to reduce risk such as through the use of prophylactic antibiotics, and maintaining time in the performance of the procedure. The intra-procedure period extends from the administration of sedative or insertion of endoscope to removal of endoscope. During sedated endoscopic procedure, the following parameters have to be monitored: oxygen saturation with pulse oximetry, pulse rate and blood pressure. Blood pressure and pulse rate should be recorded at intervals no greater than 5 minutes. The post-procedure period extends up to subsequent follow-up. Post-procedure activities include providing instructions to the patient, recognition and documentation of complications, follow-up of pathologic conditions, and assessing patient satisfaction.

3.5. Angina and myocardial infarction

Hypoxia is common in patients undergoing upper gastrointestinal endoscopy with or without sedation. Sedation significantly increases the incidence of desaturation and hypoxia. Supplementary nasal oxygen at 4 litres/minute in sedated patients abolishes desaturation and hypoxia. Wang Cy, Ling LC et al studied the incidence of arterial oxygen desaturation in sedated and unsedated patients breathing room air who underwent diagnostic upper GI endoscopy by using pulse oximetry. Hypoxia (SpO2 92% or less of at least 15 s duration) occurred in 17% of sedated patients and in 6% of nonsedated patients, respectively ($p < 0.03$). Mild desaturation (SpO2 94% or less and less than 15 s duration) occurred in 47% of sedated patients compared with 12% of nonsedated patients ($p < 0.001$). In a further Study, the effects of supplementary oxygen therapy and the effects of oxygenation on arterial oxygen saturation (SpO2) in sedated patients were studied using pulse oximetry. Group A received no supplementary oxygen while Group B received supplementary oxygen at 4 1 x min (-1) via nasal cannulae. Hypoxia occurred in 25% Group A and none in groups B ($p < 0.001$) [19].

In patients undergoing upper GI endoscopy, there are some predictive variables that always are associated with increased risk for oxygen desaturation. Alcain, Guillén P, Escolar A, Moreno M, Martín L studied 481 patients to identify factors related to the patient, the examination, and the monitoring data that would predict severe desaturation. Mild desaturation (SaO2 between 90% and 94%) was found in 23.7% of these patients, and severe desaturation (SaO2 < 90%) was found in 6.4%. The variables found to predict severe desaturation were basal SaO2 < 95% (odds ratio 67.7), respiratory disease (odds ratio 30.5), more than one attempt needed for intubation (odds ratio 39.4) and emergency procedure (odds ratio 14.9).The predictive variables analyzed in this study can be used to identify patients who are at increased risk for desaturation and possibility of going into respiratory depression. Such patients require very close monitoring (pulse oximetry monitoring at the minimum) [20].

6. Upper GI endoscopy without sedation

Diagnostic upper gastrointestinal endoscopy is a safe procedure and usually does not require sedation. But some degree of hypoxemia occurs even without sedation. MR Banks, PJ Kumar

and HE Mulcahy, have studied 330 non-sedated patients undergoing diagnostic upper GI endoscopy with the help of pulse oximetry to identify factors associated with oxygen desaturation (SpO_2). They also studied a further 154 patients undergoing upper GI endoscopy with sedation as controls. They found out that SpO_2 levels were lower in sedated compared to non-sedated patients ($p<0.0001$). Six non-sedated patients (2%) desaturated to 90% or less during endoscopy as compared to 32 sedated patients (21%) ($p<0.0001$). SpO_2 levels in non-sedated patients were not related to patient's sex, age, smoking or duration of endoscopy. They concluded that pulse oximetry is not a prerequisite to perform routine non-sedated diagnostic endoscopy [21].

In young patients diagnostic upper gastrointestinal endoscopy can be performed without sedation. Endoscopy without sedation reduces the risks of respiratory depression and reduces procedural recovery time. Assurance to the patient works like a premedication. In a thoughtful editorial, written in 1969, Berry said 'endoscopic premedication' should be regarded as an extension of psychological preparation, just as endoscopy should be regarded as an extension of the physical examination. Non-pharmacological methods, such as patient education and relaxation techniques, have been shown to improve the rate of endoscopy acceptance by the patient. It is commonly noticed that patients presenting for the first endoscopy are relaxed if their anxiety is reduced as a result of increasing their familiarity with the impending procedure. The important psychological preparation for endoscopy begins with the introduction of the patient to the endoscopist. The establishment of rapport and confidence may be achieved by simple expressions of cordiality and sincere interest in the patient and his problem. There should be at least a brief discussion between the endoscopist and patient. The endoscopist should explain the specific purpose of the procedure and what difficulties or lack of them may be expected by the patient. Obviously anxious individuals may need reassurance of the simple procedure and a promise of gentility. Ability to anticipate varying individual psychological needs in patient's preparation may be the best index of the astuteness of the endoscopist, and may represent the difference between success and failure in demonstrating a lesion in a difficult case [22].

Arterial hypoxemia, tachycardia and increased systolic blood pressure associated with upper GI endoscopy are due to activation of a classic endocrine stress response with elevated cortisol and catecholamine levels. 50% of endoscopic procedures may be associated with a degree of hypoxemia and this commonly occurs immediately after insertion of endoscope. In non-sedated patients, factors commonly found predisposing to hypoxemia are – basal oxygen saturation of less than 95%, pre-existing respiratory disease, multiple attempts at intubation, emergency procedure, operator's inexperience and longer procedural time. In these circumstances, sedation will exacerbate hypoxemia.

Upper gastrointestinal endoscopy has been associated with significant increase of cardiac stress (as measured by the myocardial rate pressure product) even in healthy non-sedated volunteers. So it is not surprising that patients with stable coronary disease have been found to experience asymptomatic, silent period of ischemia during endoscopy. In these patients, the incidence of ST segment depression was found to be reduced by the use of supplemental oxygen. In some patients having stable coronary artery disease, an excess of ventricular extra-systoles were noticed during endoscopy, but these didn't lead to sustained arrhythmias or morbidity. Supplemental oxygen can certainly correct the hypoxia observed during endoscopy. So in their anaesthesia book, Chandra M Kumar and Mark Bellamy concluded that all patients undergoing upper GI endoscopy should be assessed continuously during the procedure for level of consciousness, hemodynamic status and respiratory status. According to them, in addition to clinical observation, electronic blood pressure monitoring and pulse oximetry are must for patients with sedation, for patients with pre existing cardiac or respiratory disease. Capnography has been suggested to be superior to pulse oximetry in detecting early respiratory depression [23].

7. Sedation and upper GI endoscopy

Endoscopists should recognize that any drug which depresses CNS has the potential to impair respiration, circulation or both. Most complications of endoscopy with sedation are cardiopulmonary. Sedation should be kept to a minimum required level for patient's comfort and safety particularly in the elderly. A retrospective analysis has identified that cardiopulmonary incidents were noted in the immediate post procedure period. Aspiration pneumonia, embolism and myocardial infarction were noted in the later period. Supplemental oxygen administration has been shown to reduce the magnitude of oxygen desaturation when given during endoscopic procedures. Continuous electrocardiogram (ECG) monitoring is warranted in high risk patients. Patients who may benefit from ECG monitoring include those who have history of significant cardiac or pulmonary disease, elderly patients and those on whom prolonged procedures are anticipated. End tidal CO2 monitoring is useful in cases which take time for the procedure especially so if associated with a compromised cardio respiratory status. Recovery room observation and monitoring for any adverse effects from the procedure and sedation has to be done. The length of follow up observation is dependent on the perceived risk to the patient [13].

Sedation given with all necessary precautions is useful. Killic Mehmet et al have observed 200 patients undergoing upper gastrointestinal endoscopy to know whether endoscopy procedure itself or the sedation medication was responsible for the oxygen desaturation seen during endoscopy. In the endoscopy unit of Dice hospital, they divided these 200 patients into two groups. The first group of 100 patients underwent upper GI endoscopy without sedation. The second group of 100 patients underwent endoscopy with Midazolam sedation. For all these 200 patients, preoperative oxygen saturation, haemoglobin levels and heart rate per minute were recorded. Patients with initial oxygen saturation levels <90% were excluded. At the end of endoscopy, all the 100 patients who received premedication were administered Flumazenil. Oxygen saturation and heart rate monitored. Results showed mean age of all

patients is about 45 years. No difference was found between the 2 groups regarding Haemoglobin, basal maximum pulse rate, duration of endoscopy and minimum basal oxygen saturation. Smoking was found making significant contribution to the oxygen desaturation. So the researchers concluded that Midazolam premedication for upper gastrointestinal endoscopy is a reliable procedure and does not lead to additional risk [24].

When deep sedation is planned it is better to monitor the patients for desaturation. Twenty patients posted for upper GI endoscopy who required deep sedation due to prolonged endoscopic procedures were studied by W. Murray et al to assess the cardiovascular changes during endoscopy and to evaluate suitable monitoring techniques to detect critical events during sedation and endoscopy. In these 20 patients continuous recordings of heart rate, electrocardiograms and arterial oxygen saturation were made and arterial pressure was recorded at 1 min intervals. These patients were studied immediately before administration of sedatives, continued for the duration of procedure and for 1 hour following endoscopy. Oxygen saturation decreased in all patients during the examination to a mean of 82.9% (SD 11.9), and remained below baseline for the duration of the examination and into the recovery period. Statistically significant increases and reductions of systolic arterial pressure and rate-pressure product were found during the procedures compared with baseline values recorded before administration of sedatives. Sixteen of the 20 patients developed tachycardia during the examination. Ten patients developed ectopic foci which were supraventricular, ventricular or both in origins. Electrocardiogram changes resolved during the recovery period. Myocardial ischemia was assessed by ST segment depression and a significant correlation was found between ST segment depression and hypoxemia, although the magnitude of the ST depression was small and may not have been detected clinically. No correlation was found between ST segment depression and arterial pressure, heart rate or rate-pressure product. Regular and frequent assessments of arterial pressure and heart rate are desirable but the results confirm the importance of monitoring arterial oxygen saturation in addition to arterial pressure and the electrocardiogram [25].

8. Cardio - respiratory monitoring

Monitoring might be necessary in old people and with long procedures. BB Osinaike et al, have studied in detail 40 patients undergoing upper gastrointestinal endoscopy at Lautech teaching hospital, Osugbo during 2006. None of these had cardio-respiratory diseases. Their oxygen saturation blood pressure, pulse rate were measured using pulse oximeter and automated BP monitor. The recordings were done from baseline until 5 minutes after the procedure. In these 40 patients baseline mean oxygen saturation was 96.8± 1.55%. It decreased significantly to 94.53±3.30 %(p= 0.002) during insertion of probe. Mild to moderate hypoxia was found in 19 (47.5%) patients. Severe hypoxia was found in 5 (12.5%) patients. The variables that reached statistical significance for desaturation were age greater than 50 years and duration longer than 27 minutes. 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 14 (35%) patients developed transient hypertension. So they concluded that mild to moderate hypoxia is common during endoscopic procedures and of no serious consequence; severe hypoxia is less common. So they recommended non-invasive monitoring to be done in patients aged greater than 50 years and with procedures longer than 27 minutes [4].

When deep sedation is planned it is better to monitor the patients for desaturation. Statistically significant increases and reductions of systolic arterial pressure and rate-pressure product were found during the procedures compared with baseline values recorded before administration of sedatives. Regular and frequent assessments of arterial oxygen saturation in addition to arterial pressure and the electrocardiogram are desirable in endoscopic procedures with sedation [25].

For non-sedated upper GI endoscopy routine oxygen monitoring is not necessary according to HY Embu et al. In a study of 54 patients in Nigeria, mild to moderate hypoxia occurred in 18.5% of the patients while severe desaturation occurred in 12.9% of the patients. All these severe hypoxia lasted for less than 30 seconds and no supplementary oxygen was needed. So they concluded that routine oxygen monitoring may not be necessary in patients with non-sedated upper GI endoscopy [26].

9. Blood pressure changes in upper GI endoscopy

Blood pressure levels are more stable in sedated endoscopy patients than in non-sedated, but oxygen desaturation is also more marked in sedated. In a study out of 252 patients posted for upper GI endoscopy, 1/3 were given Diazepam, 1/3 were given Midazolam and others received placebo. Pulse rate, blood pressure, ECG and peripheral oxygen saturation (SpO2) were noted at baseline after premedication, during endoscopy and post endoscopy. They found no difference in the baseline record of the three groups. Significant fall in SpO2 was noted in all the age groups, more marked in the sedated group during endoscopy. Blood pressure remained more stable in the sedated group. ECG changes included atrial and ventricular premature contractions in all the three groups [27].

In a different study Mizuno Ju et al observed that blood pressure decreased significantly 2 minutes after Midazolam administration, but increased after insertion of endoscope; it was equal to control value. Heart rate increased significantly 1 and 3 minutes after the introduction of endoscope. They concluded that sedation with IV Midazolam during upper GI endoscopy is useful to control the cardiovascular responses and to obtain amnesia. But a decrease in

SpO_2 should be watched carefully [28]. In sedated patients, Bhalla V et al observed stable blood pressure, although SpO_2 showed significant fall [39]. Others also observed significant increase in blood pressure and heart rate during endoscopy. These changes occured during intubation time in young patients and later during the procedure in older patients. In a study by Ruth Ross et al observed maximum profound changes in systolic pressure in the sedated group (73 mm Hg) compared to those having Throat spray (43 mm Hg) [29].

10. ECG changes during upper GI endooscopy

Although endoscopy is usually considered to be a safe procedure, arrhythmias are known to occur frequently, especially in the elderly. The frequency of arrhythmias varies between 38.5% and 75% and increases especially in elderly patients with heart disease [30, 31]. Most of the cardiac arrhythmias during upper GI endoscopic procedure are not significant clinically. Sinus tachycardia and sinus bradycardia are commonly noticed. Cardiac irregularities of rhythm and ECG changes are more commonly seen with elderly patients when they are monitored. So it is stated that elderly patients should have nasal oxygen and cardiopulmonary monitoring during endoscopy [32]. But another study didn't support routine oxygen administration. Here 50% of the patients received oxygen at 2 litres/min and the others room air during endoscopy. A wide range of ECG abnormalities were recorded in both oxygen and air groups, of which ventricular and supraventricular ectopic beats were the most common. There were no significant differences in the rate of occurrence of any clinically important cardiac abnormalities either between the oxygen and air groups or between the 3 monitored periods –before, during and after gastroscopy [33]. Along with tachycardia, atrial and ventricular premature contractions were noticed by others [34].Electrocardiographic changes usually occur when the endoscope is in the stomach, although introduction of endoscope produced 20% of dysarrhythmias [35].

To know whether diagnostic endoscopy is safe in very old people, 37 patients above 80 years age who were undergoing upper gastrointestinal endoscopy were monitored for a period of 24 hours with the help of Holter recording and pulse oximetry. It was observed that the number of VES increased during the one hour period after endoscopy. No fatal complications occurred, so they concluded that it is a safe procedure [36]. Diagnostic upper GI endoscopy can be done even at hill places with no deleterious effects on heart as studied on 120 patients in Simla. Electrocardiographic (ECG) changes were studied. Increase in heart rate was seen in most of these patients, maximum in patients with heart disease. ST depression was seen in 14%, T wave inversion in 13%, supraventricular tachycardia in 6% and ventricular ectopic in 1.6%. All these changes reverted to normal within 9 to 10 minutes; so it is a safe procedure [37].

Twenty patients posted for upper GI endoscopy who required deep sedation due to prolonged endoscopic procedures were studied to assess the cardiovascular changes during endoscopy and to evaluate suitable monitoring techniques to detect critical events during sedation and endoscopy. Oxygen saturation decreased in all patients during the examination to a mean of 82.9% (SD 11.9), and remained below baseline for the duration of the examination and into the recovery period. Statistically significant increases and reductions of systolic arterial pressure and rate-pressure product were found during the procedures compared with baseline values recorded before administration of sedatives. Sixteen of the 20 patients developed tachycardia during the examination. Ten patients developed ectopic foci which were supraventricular, ventricular or both in origins. Electrocardiogram changes resolved during the recovery period. Myocardial ischemia was assessed by ST segment depression and a significant correlation was found between ST segment depression and hypoxemia, although the magnitude of the ST depression was small and may not have been detected clinically. No correlation was found between ST segment depression and arterial pressure, heart rate or rate-pressure product. Regular and frequent assessments of arterial pressure and heart rate are desirable but the results confirm the importance of monitoring arterial oxygen saturation in addition to arterial pressure and the electrocardiogram [30].

Patients suspected of ischemic heart disease should be carefully monitored during upper GI endoscopy. Sixty patients who were posted for endoscopy because of their dyspeptic symptoms at Dow Medical College Hospital, Karachi were studied to assess the effects of endoscopy on ischemic heart disease patients with special reference to oxygen saturation, blood pressure, cardiac rhythm. 30 patients were with symptoms of ischemic heart disease and 30 patients without IHD. Pre-endoscopic oxygen saturation, cardiac rhythm and blood pressure were noted and monitored during and after the procedure till the changes that have taken place were returned back. Oxygen saturation dropped in IHD patients (10%) and they developed cardiac rhythm changes-Tachycardia and ventricular premature contractions (6%) and ST segment elevation (3.3%). So cardiac events can occur in IHD patients during endoscopy and these patients should be monitored for oxygen saturation and supplementation [38].

11. Acknowledgement

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