Electrocardiographic changes in elderly patients during endoscopic retrograde cholangiopancreatography

NG Kounis MD1, GM Zavras MD2, PJ Papadaki MD2, SN Kouni BS1, MBatsolaki PhD1, GV Gouvelou-Deligianni SRN1, C Markoglou MD2, JA Goudevenos MD3, CN Mallioris MD1, C Kokkinis MD2, K Kalokairinou MD2, N Grapsas MD4, GN Kounis5, CM Koutsojannis PhD3

BACKGROUND: Cardiorespiratory complications may occur during gastrointestinal endoscopy, and elderly people seem to be more vulnerable to these complications during endoscopic procedures involving the manipulation of abdominal viscera.

OBJECTIVES: To determine the incidence of cardiac arrhythmias, changes in oxygen saturation, heart rate and blood pressure during endoscopic retrograde cholangiopancreatography (ERCP) via Holter monitoring in elderly patients older than 70 years of age.

METHODS: Holter monitoring and 12-lead electrocardiograms were performed in 30 elderly patients undergoing ERCP and in 30 control subjects undergoing routine chest, abdomen, bone and upper gastrointestinal small bowel follow-through studies. A computerized nontriggered template system was used to analyze the electrocardiograms qualitatively and quantitatively. Arrhythmias, cardiac axis, conduction defects, pauses, ST segment changes, ectopic beats, oxygen desaturation and changes in blood pressure and rate-pressure product were evaluated.

RESULTS: Increased heart rate, ST segment changes resulting from myocardial ischemia, oxygen desaturation and transient atrial and ventricular ectopic beats were frequent during ERCP compared with the control group. In one patient, transient left bundle branch block developed and this was attributed to pre-existing hypertension with cardiomegaly. One patient developed ventricular tachycardia and one other sinus bradycardia, but this was attributed to sick sinus syndrome.

CONCLUSIONS: Transient myocardial ischemia and various cardiac arrhythmias are frequent in elderly patients undergoing ERCP. Appropriate noninvasive monitoring seems to be justified during this procedure.

Key Words: Cardiac arrhythmias; Cholangiopancreatography; Elderly; Holter monitoring

Les modifications électrocardiographiques chez les patients âgés pendant une cholangiopan créatographie rétrograde endoscopique

HISTORIQUE: Des complications cardiorespiratoires peuvent se manifester pendant une endoscopie gastro-intestinale, et les personnes âgées semblent plus vulnérables à ces complications pendant les interventions endoscopiques qui entraînent une manipulation des viscères abdominaux.

OBJECTIFS: Déterminer l'incidence des arythmies cardiaques, les modifications de la saturation en oxygène, le rythme cardiaque et la tension artérielle pendant une cholangiopancréatographie rétrograde endoscopique (CPRE) par la méthode de Holter chez des patients âgés de plus de 70 ans.

MÉTHODOLOGIE: La méthode de Holter et des électrocardiogrammes à 12 dérivations ont été utilisés chez 30 patients âgés subissant une CPRE et chez 30 sujets témoins subissant un bilan systématique du thorax, de l'abdomen, des os et de la partie supérieure de l'intestin grêle. Un système informatisé de matrice non déclenché a permis d'analyser les électrocardiogrammes de manière qualitative et quantitative. Les arythmies, l'axe du cœur, les anomalies de conduction, les pauses, les modifications du segment ST, les extrasystoles, la désaturation en oxygène, les modifications de la tension artérielle et le produit de tension artérielle ont été évalués.

RÉSULTATS: Une augmentation du rythme cardiaque, des modifications du segment ST causées par une ischémie du myocarde, une désaturation en oxygène et des extrasystoles auriculaires et ventriculaires transitaires étaient fréquentes pendant la CPRE par rapport aux occurrences au sein du groupe témoin. Chez un patient, un bloc de branche gauche transitoire s’est développé, attribuable à une hypertension préexistante accompagnée d’une cardiomégalie. Un patient a développé une tachycardie ventriculaire et un autre, une bradycardie sinusale, mais celle-ci était causée par une maladie du cœur.

CONCLUSIONS: L’ischémie myocardique transitoire et diverses arythmies cardiaques sont fréquentes chez les personnes âgées qui subissent une CPRE. Une surveillance non envahissante pertinente semble justifiée pendant cette intervention.
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Manipulation of various body structures during routine or specific diagnostic and therapeutic techniques have been reported to be associated with cardiac arrhythmias and other cardiorespiratory complications. Such changes have occurred during tracheal suctioning (1), rectal examination (2), distention of the abdominal viscera (3), intravenous urography (4), coronary angiography (5), gastroscopy (6), sigmoidoscopy (7), barium enema (8) or small bowel enema (9). These events may be transient and not hazardous, but in some occasions they have been fatal (10-16). Gastrointestinal endoscopy is a modern and valuable procedure and consistently gives useful diagnostic and therapeutic results. Although cardiac arrhythmias and ST segment depression occur during gastrointestinal endoscopy even in younger patients (13,14), the elderly population is more prone to silent myocardial ischemia which manifests either as electrocardiographic ischemic changes or as disturbances of cardiac rhythm.

We previously have reported electrocardiographic changes in a middle-aged (17) and in elderly (9) populations during small bowel enema. However, there are no reports on any cardiac events during endoscopic retrograde cholangiopancreatography (ERCP) in elderly (greater than 70 years of age) patients, who seem to be more vulnerable to such procedures. Consequently, we have undertaken the following study to determine the incidence of any cardiac arrhythmia, changes in oxygen saturation, heart rate and blood pressure, and to identify those elderly patients at risk during the procedure.

SUBJECTS AND METHODS

Subjects
Thirty patients scheduled to undergo ERCP were recruited to the study and were monitored electrocardiographically with Holter tape recorders. Written informed consent was obtained for data correction and storage on magnetic media. The patients included 18 women and 12 men of mean age 73 years (SD 2, range 71 to 79 years). Their mean weight was 66.5 kg (SD 18.3, range 44 to 100). All current medications were continued in the observation period. Premedication was not given until few minutes before ERCP. Diazepam and Buscopan (Boehringer Ingelheim, Canada) were given for sedation and distention is more prone to silent myocardial ischemia which manifests either as electrocardiographic ischemic changes or as disturbances of cardiac rhythm.

Methods
After the usual skin preparation, modified V5 and V6 electrocardiographic leads were recorded on two channel Circadian Recorders (Circadian Inc, USA). The lead of most significance (V6) was analyzed in detail. The positive electrode was placed in the V6 position and the negative electrode was placed in the right intracavitcular fossa. Because the procedure was elective, electrocardiographic recording usually was initiated 4 h before the procedure and was continued during the examination and 4 h after it. All patients were advised to record in a diary any symptoms of palpitations, shortness of breath or chest pain. Immediately before ERCP, a 12-lead electrocardiogram and resting rhythm strip was available during Valsalva maneuver and during its recovery time. Continuous arterial blood pressure and oximetry monitoring data were recorded throughout the procedure. When it was necessary, arterial blood pressure also was measured by cuff sphygmomanometer in supine position. During analysis the rate-pressure product was calculated by microcomputer for each of one minute recording. Two channel qualitative and quantitative electrocardiographic analysis was performed by a computerized nontriggered template system. Particular attention was paid to arrhythmias of any kind, change in cardiac axis, conduction defects, pauses, ST segment changes and extrasystoles. The following definitions were used. Myocardial ischemia: a depression or elevation in ST segment of 0.1 mV or more from baseline measured at 60 ms from the j point; episode hypoxemia: a sudden decrease in oxygen saturation of more than 4% from baseline (18); tachycardia: a heart rate above 100 beats/min; bradycardia: a heart rate below 50 beats/min; abnormal complexes: abnormal QRS-shaped complexes with a coupling interval of more than 4% from baseline; on echocardiogram.

Control subjects
Thirty elderly age- and disease-matched patients not receiving any premedication, served as controls. They were undergoing chest, abdomen, bone or upper gastrointestinal small bowel follow-up studies and they had 8 h of electrocardiographic monitoring covering the period before, during and after the examination. The clinical characteristics of the control subjects are shown in Table 1.

Statistical analysis
Absolute differences in the number of arrhythmias, heart rate and oxygen saturation were compared between the hour of the examination and the closest hour when monitoring findings were most reliable, using Wilcoxon’s paired t-test (statistical significance at P<0.05). Differences in the prevalence of arrhythmias and ST segment changes between baseline periods and the procedure were accessed by χ² test.

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RESULTS

Heart rate
Twenty nine patients (96%) had increased heart rate during and immediately after ERCP compared with the rate before the endoscopy (P<0.05), but the increased heart rate in the two patients receiving therapeutic β-blockers for ischemic heart disease and in the patient receiving digoxin was not statistically significant. However, the patients who underwent ERCP had a higher mean heart rate (98.3 beats/min; 95% CI 92.1 to 103.3), than the control subjects (70.1 beats/min; 95% CI 63.2 to 73.6); statistical significance at P<0.05 for patients and control subjects during and after the procedure (Figure 1). In 27 (90%) patients, sinus tachycardia developed with heart rate exceeding 100 beats/min. This tachycardia gradually subsided after the examination. In one (3%) patient, sinus bradycardia developed but this patient had suffered a previous myocardial infarction and had been diagnosed to have sick sinus syndrome.

Cardiac rhythm
The electrocardiograms before the procedure showed no cardiac rhythm disturbances in 20 (67%) patients. However, two (7%) patients had pre-existing atrial fibrillation, five (16%) patients had premature atrial complexes and three (10%) patients had premature ventricular complexes. During the procedure, premature atrial complexes appeared in 19 (63%) patients, premature ventricular complexes appeared in nine (30%) patients, a burst of supraventricular tachycardia developed in one (3%) patient, sinus bradycardia developed but this patient had suffered a previous myocardial infarction and had been diagnosed to have sick sinus syndrome.

ST segment
ST segment changes (depression or elevation) during ERCP, in comparison with the baseline electrocardiogram, were considered as sign of myocardial ischemia. Sixteen (53%) patients developed ST segment changes (15 ST depression and one ST elevation) during the procedure. In all patients the changes were asymptomatic. In all instances the ST segment changes disappeared when the endoscope was withdrawn. There were no significant ST segment changes in the control group during chest, bone, abdomen and small bowel through studies.

Laboratory
In all patients oxygen saturation decreased during ERCP from a mean baseline 91.4% to a minimum of 78.6% (P<0.05). Saturation recovered to the baseline level 30 min after the study. Linear regression analysis was performed for arterial oxygen saturation and ST segment in 16 patients. A significant correlation was found between oxygen saturation and ST segment changes (Figure 2).

TABLE 2
Clinical characteristics of 30 control subjects

| Characteristics          | n (%)          |
|--------------------------|----------------|
| Patients                 | 30 (100)       |
| Mean age (years)         | 73 (SD 1.5, range 70 – 80 yrs) |
| Men/Women                | 15/15 (50/50)  |

| Radiological procedure   | n (%)          |
|--------------------------|----------------|
| Chest                    | 10 (34)        |
| Plain abdomen            | 7 (23)         |
| Bone                     | 8 (27)         |
| Barium swallow           | 5 (16)         |

TABLE 3
Arrhythmias during endoscopic retrograde cholangiopancreatography (ERCP) compared with the baseline period

| Arrhythmias                  | Baseline | ERCP          | P    |
|------------------------------|----------|---------------|------|
|                              | n (%)    | 95% CI        | n (%)| 95% CI |      |
| Sinus tachycardia            | 0 (0)    | NA            | 27 (90)| 70–96 | –    |
| Sinus bradycardia            | 0 (0)    | NA            | 1 (3.3)| 1–22  | –    |
| Premature atrial complexes   | 5 (16.6)| 3–25          | 19 (63.3)| 45–95 | <0.05|
| Supraventricular tachycardia | 0 (0)    | NA            | 1 (3.3)| 1–20  | –    |
| Premature ventricular complexes| 3 (10)| 3–27          | 9 (10.2)| 47–90 | <0.05|
| Ventricular tachycardia      | 0 (0)    | NA            | 1 (3.3)| NA    | –    |

ERCP-induced electrocardiographic changes in the elderly

Figure 1) Heart rate (mean value, 95% CI) before, during and after procedure in 30 elderly patients undergoing ERCP and in 30 age- and disease-matched control patients.

TABLE 4
Clinical characteristics of 22 patients who had clinical, radiological and echocardiographic evidence of heart disease, unifocal ventricular extrasystoles developed in eight, multifocal ventricular extrasystoles developed in three, atrial extrasystoles developed in six and sinus tachycardia in 20.
TABLE 4
Prevalences of PACs, ST, and PVCs during Holter monitoring of patients with ERCP and in control subjects

| Control Subjects (n) | ERCP Patients (n) | P   |
|----------------------|------------------|-----|
| 5                    | 19               |     |
| 0                    | 27               |     |
| 3                    | 9                |     |

ERCP Endoscopic retrograde cholangiopancreatography; PACs Premature atrial complexes; PVCs Premature ventricular complexes; ST Sinus tachycardia;

![Figure 2](image.png)

**Figure 2** Linear regression shown significant correlation between oxygen saturation and ST segment depression. 95% confidence lines

**DISCUSSION**

The present study shows that arrhythmias of all kinds, conduction disturbances, electrocardiographic changes compatible with myocardial ischemia and oxygen desaturation are encountered in elderly patients undergoing ERCP. There are previous studies (18-20) using hemodynamic monitoring (heart rate, blood pressure, rate pressure product), pulse oxymetry and electrocardiographic monitoring during gastrointestinal endoscopic procedures which associate cardiac risk with changes observed in heart rate, asymptomatic arrhythmias, ST segment changes, oxygen desaturation and changes in blood pressure. Some studies (21,22) have suggested that patients with heart disease were at an increased risk during the above procedures. In one study (19) including 52 consecutive patients undergoing upper gastrointestinal endoscopy, arrhythmias during the procedure were common and tended to occur more frequently in the elderly and in persons with heart disease and chronic lung disease. In another study (23) patients with cardiac history, before esophageal dilation, were particularly prone to cardiorespiratory events. It was found that 90% of patients with pre-existing cardiac disease developed an event during the procedure.

Other studies (24-26) have shown that patients with increased age are particularly prone to low oxygen saturation, pain during the procedure and increased duration of the procedure.

The current study suggests also that electrocardiographic and laboratory changes during ERCP are frequent, especially in elderly patients with coexisting cardiac disease. These changes, however, seem to be asymptomatic. The abnormalities observed ranged from sinus tachycardia to innocent and transient atrial and ventricular premature beats as well as ST segment changes and oxygen desaturation. In one patient asymptomatic supraventricular tachycardia and in another patient a burst of ventricular tachycardia developed but these two patients had ischemic heart disease. The patient who developed sinus bradycardia during ERCP had suffered a previous myocardial infarction and had been diagnosed as having sick sinus syndrome. All patients had diminished blood oxygen saturation and 16 developed ST segment changes compatible with ischemic heart disease.

The mechanisms by which the cardiorespiratory and electrocardiographic changes occur during ERCP remain speculative. During upper gastrointestinal endoscopy airway obstruction (24), gastric or salivary aspiration, direct pressure on the diaphragm (26), air insufflation (22) and stress and anxiety triggering catecholamine release may contribute (9,22,27,28). During ERCP several factors tend to increase sympathetic activity. Neural impulses from higher centers in the brain may be transient risk factors (29). The distension and collapse of hollow abdominal viscera during the procedure might be another factor accounting for the electrocardiographic abnormalities (19). Indeed, ERCP is a method with many applications especially for patients suspected to have biliary and pancreatic problems. However, it involves the insertion of a side-viewing duodenoscope through the oesophagus to the stomach, pylorus, duodenal bulb and papilla. This cannulation involves special manipulations, angulations, air insufflation and sometimes becomes unpleasant to the patient. It has been suggested that the removal of the insufflated air before the removal of the endoscope may lower the risk of cardiovascular problems (19). The use of a narrow diameter endoscope has been suggested to cause less hypoxia than the standard diameter endoscope (30,31). The increased load of the endoscopic examination on the cardiovascular function may be caused by psychological stress before and during examination (32) as well as by the physical effects of the anticholinergic drugs (33). Indeed, all of our patients were receiving, as premedication, diazepam and Buscopan.

Buscopan increases heart rate because it has anticholinergic properties. Premedication with anticholinergic drugs tends to shift the balance of the autonomous nervous system towards sympathetic dominance which increases the cardiac work and heart rate. It has been suggested that patients with cardiac disease, anticholinergic drugs may increase the risk of cardiac complications during endoscopic examination and they should be avoided in such patients (33). These authors state that withholding anticholinergic premedication does not seriously affect the endoscopic examination (33). To confirm whether psychological stress could alter the cardiac vulnerability, the investigators (33) compared the heart rate in patients who had never undergone endoscopy with those who had. They found that the heart rate increased during endoscopy, but did not increase significantly in those who had previous endoscopy, indicating that psychological factors play an important role in the electrocardiographic changes during endoscopy. Neural inhibition of the diaphragm by viscerosomatic reflexes due to esophageal and gastric distension has been thought to be another possibility (34-36). Additionally an increase in vagal activity as a result of gastrointestinal manipulation may induce vasospasm and reduce coronary blood flow with consequent brochospasm, ventilation-perfusion mismatch, hypoxia and blood desaturation (36). These effects may be potentiated by benzodiazepines given as premedication sedatives (37). However endoscopy without sedation also causes significant
CONCLUSIONS

We believe that the encountered electrocardiographic abnormalities and myocardial ischemia during ERCP in elderly patients, are common and usually transient. Clinical evidence of prior heart disease seems to be predisposing factor for these abnormalities. The procedure requires careful evaluation of the risks especially in the elderly people with preexisting cardiac disease. A careful history especially of the cardiovascular system should be obtained in all patients. Non-invasive monitoring during the procedure and appropriate clinical observation by the cardiologist, endoscopist and radiologist will result in safer examination and seems to be justified.

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