Surgery in Patients with Coronary Artery Disease—Silent Ischaemia during Transurethral Resection of Tumors of Prostate or Bladder

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Summary

Background: Asymptomatic episodes of myocardial ischemia in clinically stable patients seem to occur frequently and may hint at a worse prognosis.

Hypothesis: This study was undertaken to determine whether surgical patients with coronary artery disease (CAD) have a higher risk of cardiac ischemia during the perioperative period compared with the late postoperative period and compared with patients without CAD.

Methods: In all, 14 patients with and 14 patients without CAD were examined by Holter monitoring during the perioperative and three days later during the postoperative periods for the presence of ST-segment depression as a marker of silent myocardial ischemia.

Results: While patients without CAD did not show ST-segment depression, patients with CAD were found to have had 143 episodes of ST-segment depression, 49% in the perioperative and 51% in postoperative recordings.

Conclusion: Though patients were asymptomatic with antianginal therapy, there were episodes of ST-segment depression indicating silent myocardial ischemia in patients with CAD. Surgical interventions such as transurethral resection of tumors of prostate or bladder did not produce an increase of ischemic burden registered by Holter monitoring.

Key words: ST-segment analysis, Holter electrocardiogram, silent myocardial ischemia, coronary artery disease and non-coronary surgery, transurethral resection

Introduction

As awareness that episodes of myocardial ischemia often are asymptomatic has grown, the importance of 24 h Holter electrocardiographic (ECG) monitoring in uncovering the total ischemic burden of patients with coronary artery disease (CAD) has increased.² Modern digital Holter ECG systems are reliable in detecting ST-segment depressions as markers of myocardial ischemia during daily life.^{3,4} Symptomatic as well as asymptomatic episodes of transient myocardial ischemia are detected.

The ST-segment analysis in 24 h Holter monitoring of patients with CAD is of clinical importance to the therapy and prognosis of this disease. The occurrence of both symptomatic and asymptomatic ("silent") myocardial ischemia has an unfavorable prognosis in comparison with healthy persons.⁵ This study was undertaken to determine whether there is a higher cardiac risk to surgical patients with CAD and, if there is, whether the diagnostic tools and therapy utilized in planning surgery in these patients are sufficient.

Materials and Methods

We examined 28 patients undergoing transurethral resection of a tumor of prostate or bladder with ST-segment analysis in 24 h Holter monitoring. Perioperative 24 h Holter monitoring was instituted on the day prior to surgery. The preoperative phase, time of surgery, and the first postoperative hours were recorded. On postoperative Day 3, an additional 24-h Holter recording was performed.

Fourteen patients with angiographically documented CAD, history of myocardial infarction (MI), and anti-ischemic drug therapy (Table I) were examined. A control group consisted of 14 patients with no history of CAD and under no anti-ischemic drug therapy. Patients with bundle-branch block, valve disease, cardiomyopathy, pacemaker or digitalis drug therapy were not included in this study. Normal serum potassium level (3.8–5.0 mmol/l) was required for inclusion in the study.

Mean age of all examined patients was 67.3 ± 7.8 years; in the group of patients with CAD, mean age was 71.1 ± 4.9 years versus 63.5 ± 8.4 years in the control group.

We used the Oxford-Medilog 4000-II Holter ECG system, which carries out a real-time analysis. All data were directly

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TABLE I Anti-ischemic drug therapy of the study group

Drugs	Patients with ST-segment depression	Patients without ST-segment depression
Beta blocker	—	—
Nitrates (%)	3 (21.4)	2 (14.3)
Calcium antagonist (%)	1 (7.1)	1 (7.1)
Nitrate + calcium antagonist (%)	5 (35.7)	1 (7.1)
Beta blocker + nitrate + calcium antagonist (%)	—	1 (7.1)

digitalized by the system recorder. The lead CM₅ was used for ST-segment analysis.

All ST-segment depressions were optically controlled and printed out at a paper speed of 25 mm/s. An abnormal episode was defined as ± 0.1 mV of horizontal and downsloping ST-segment depression lasting for at least 1 min. We used standardized records of the patients to decide whether ischemic episodes were symptomatic or asymptomatic.

An increase of the heart rate of more than 10 beats/min in the 3-min period before each ischemic episode was considered significant.

The ST-segment analysis included the frequency, value, duration, and circadian variation of significant ST-segment depressions, whether symptomatic or asymptomatic, and observation of heart rate changes during episodes of myocardial ischemia.

Results

The results are summarized in Table II.

Duration of Surgery

Surgery required a total of 2300 min (mean 82.1 ± 25.1 min) in the 28 patients recorded [1360 min (mean 92.1 ± 25.3 min) in the study group and 940 min (mean 72.1 ± 20.5 min) in the control group].

Frequency of ST-Segment Depression

Of the 14 patients in the study group, 9 (64.3%) showed ischemic episodes, 8 of these (57.1%) during perioperative Holter monitoring; 6 of those 8 (75%) also had significant ST-segment depression on Holter monitoring at postoperative Day 3. Only one patient (7.1%) showed episodes of transient myocardial ischemia on postoperative Holter monitoring. All episodes of ischemia were asymptomatic.

None of the 14 patients of the control group showed ST-segment depression as a marker of transient myocardial ischemia, either on perioperative or postoperative Holter monitoring.

TABLE II Results

ST-segment depression	Study group peri-/postoperative	Control group peri-/postoperative
Frequency	70/73	0/0
Duration (min)	425/426	0/0
Value (mV)	0.136/0.136	0/0

In total, 143 episodes of myocardial ischemia were found, 70 (49%) in the perioperative and 73 (51%) in the postoperative period. The mean frequency of episodes in the recording of patients who had ST-segment depression was 9.5 ± 9.6 episodes per recording. The number of episodes per recording varied from 1 to 31 episodes.

Duration of Ischemic Episodes

A total of 851 min of ischemic episodes were recorded, 425 (49.9%) perioperatively and 426 (50.1%) postoperatively. The mean duration of one episode was 5.95 ± 8.38 min. The shortest episodes lasted 1 min, the longest 62 min.

Value of ST-Segment Depression

The mean value of all 143 episodes was -0.136 ± 0.048 mV; of the 70 perioperative episodes, -0.136 ± 0.044 mV; and of the 73 postoperative episodes, -0.136 ± 0.051 mV. All ST-segment depressions appeared between -0.1 and -0.356 mV (Fig. 1).

Circadian Variation

We found two peaks in all recorded episodes of myocardial ischemia, one between 4 and 10 A.M. and one between 5 and 7 P.M. (Fig. 2).

FIG. 1 Frequency and value of ischemic episodes. ■ = Number, □ = percent.

FIG. 2 Circadian variation of ischemic episodes. ■ = Number, □ = percent.

Heart Rate during Ischemic Episodes

A significant increase of heart rate accompanied 87 (61.7%) of all ischemic episodes. Other episodes were accompanied by neither a significant increase nor decrease of heart rate.

Discussion

Technique of ST-Segment Analysis

Better filter techniques and digital data processing allow sufficient accuracy of modern amplitude-modulated Holter ECG monitoring systems for ST-segment analysis.⁶⁻⁸ In comparison with a standard ECG, Silber *et al.*⁹ found a sensitivity of 87% and a specificity of 95% for detection of ST-segment depression for the Oxford Medilog 4000-II, the system used for our study. For the Oxford Medilog 4500, Silber *et al.*⁸ found a correlation coefficient of $r = 0.97$ for the mean value of ST-segment depression with the standard ECG for lead CM₅. Other Holter ECG monitoring systems also showed good correlation with reference ECG.^{3,10,11} Several authors considered the lead CM₅, which we used, too sensitive and specific for ST-segment analysis.^{8,13,12}

Taking into account studies by several authors,^{5,6,10,11} we considered only downsloping ST-segment depressions as markers of transient ischemia. Other markers have been found to be of lower specificity.^{4,7,12,14-18,27,30}

Importance and Frequency of Asymptomatic Myocardial Ischemia in Patients with Coronary Artery Disease

Episodes of myocardial ischemia with pain as a warning sign in patients with CAD are rather rare: in patients with stable angina pectoris, Hausmann *et al.*¹⁹ found 5 (7.8%) with exclusively symptomatic episodes and 32 (50%) with exclusively asymptomatic episodes. Stern *et al.*²⁰ only found 17%

with exclusively symptomatic episodes. Of all documented ischemic episodes, 72.3% were found to be asymptomatic by Stern *et al.*,²⁰ 77.3% by Hausmann *et al.*,¹⁹ and 90% by Nademanee *et al.*²¹ Cohn *et al.*⁵ found exclusively asymptomatic ST-segment depressions in patients with positive exercise tests. Several authors examined patients with stable angina,¹⁹⁻²¹ and others examined patients with unstable angina.¹⁷ Cohn *et al.*⁵ examined totally asymptomatic patients. Most episodes of myocardial ischemia were asymptomatic in spite of different study designs and different patient selection. In our study, 64.3% of the patients with CAD had significant ST-segment depressions. All episodes were silent.

Rocco *et al.*²² found 10.5 episodes per recording, Nademanee *et al.*¹⁷ 6.0, Cecchi *et al.*²³ 5.3, Shea *et al.*²⁴ 3.9, and Cohn *et al.*⁵ 3.2. The result of our study was 9.4 ischemic episodes per recording. The data of Rocco *et al.*,²² Shea *et al.*,²⁴ and Cohn *et al.*⁵ are from ambulant patients, in whom the more frequent ischemic episodes could be seen as provoked by higher physical stress. The relatively high frequency of episodes per recording in our patients could possibly cohere with more physical stress before, during, and after surgery.²⁵ Another study in patients with a history of MI showed a mean frequency of 2.1 episodes per recording. These patients, however, did not undergo surgery,²⁶ and comparison of the number of episodes of myocardial ischemia is difficult.

Osterspey *et al.*⁶ and Deanfield *et al.*¹⁵ describe a high spontaneous variability of ST-segment depression in regard to frequency and duration.

In our patients, the minimum number of ischemic episodes per recording was 1 and the maximum was 31. Other authors saw a similar high spread between minimum and maximum (Shea *et al.*²⁴ with 1 and 34, Rocco *et al.*²² with 1 and 21, Cohn *et al.*⁵ with 1 and 17 and Hausmann *et al.*¹⁹ with 1 and 13).

Circadian Variation of ST-Segment Depression

Cohn *et al.*,² Hausmann *et al.*,¹⁹ Nademanee *et al.*,²¹ and Rocco *et al.*²² found predominance of ischemic episodes in the morning. Triposkiadis *et al.*²⁷ described three peaks, always 2-3 hours after meal. We saw a predominance of ST-segment depression in the morning, with a peak between 4 and 10 A.M. During this period 54.6% of all ischemic episodes were recorded. Rocco *et al.*²² found that 39% of all ischemic episodes occurred between 6 A.M. and 12 noon. In another study we found two peaks, one between 11 A.M. and 1 P.M., the other between 7 and 8 P.M.²⁶

Duration and Value of ST-Segment Depression

The duration of episodes of myocardial ischemia can vary greatly. Different authors have found mean durations between 4.12 and 13.2 min.^{19,22,23} The bibliographic data are not homogeneous regarding the comparison of symptomatic with asymptomatic episodes. Hausmann *et al.*¹⁹ saw a significantly longer duration of asymptomatic than symptomatic episodes. In a study of patients with symptomatic as well as asymptomatic episodes, symptomatic episodes were of longer dura-

tion. The same group saw no significant difference in a comparison of patients with exclusively symptomatic and exclusively asymptomatic episodes of myocardial ischemia. Our study design did not allow a comparison of symptomatic with asymptomatic episodes; in patients with only asymptomatic episodes we found a mean duration of 6.0 min.

Most episodes have been recorded with a value of between 0.1 and 0.2 mV,^{3, 14, 19, 20, 22, 26} which corresponds with our study. Hausmann *et al.*¹⁹ and Stern *et al.*²⁰ did not find a significant difference in regard to the value of symptomatic and asymptomatic episodes. In patients with symptomatic and asymptomatic episodes, only Cecchi *et al.*²³ saw a higher mean value for symptomatic episodes. Duration and value of ST-segment depression do not seem to correspond with pain; thus, silent ischemia does not have a better prognosis.

In a study similar to the present one, we found in 10 patients with CAD undergoing total hip replacement, 125 perioperative and 56 postoperative episodes of myocardial ischemia on Holter electrocardiographic monitoring.²⁵ In addition, in that study, the total duration of 2730 min of transient myocardial ischemia in the perioperative and 913 min in the postoperative recordings of the 10 patients was greater than the results found in this study. The mean value was also higher than in this study. This may be due to greater physical stress during total hip replacement in comparison with the very much shorter and less traumatic transurethral resection of tumor of prostate or bladder.

Heart Rate during Ischemic Episodes

Some authors^{23, 22, 28} have described an increase in heart rate during episodes of myocardial ischemia. Hausmann *et al.*¹⁹ found an increase in heart rate in 96.4% of all symptomatic and 94.5% of all asymptomatic episodes. Of our exclusively asymptomatic patients, 61.7% showed a significant increase in heart rate. Chiercia *et al.*²⁹ demonstrated the considerable therapeutical value of beta blockade for reducing the frequency of symptomatic as well as asymptomatic episodes of myocardial ischemia.

Conclusion

Asymptomatic episodes of myocardial ischemia in clinically stationary patients seem to occur frequently. In this study it is difficult to describe a correlation between the frequent occurrence of ischemic episodes and the physical stress of surgery in patients with CAD. Because our patients came to the hospital shortly before surgery, it was impossible to demonstrate the occurrence of ischemic episodes in these patients over a longer period. However, the occurrence of silent ischemia is an expression of an insufficient anti-ischemic drug therapy. In this study 70 (49%) episodes in the perioperative and 73 (51%) episodes in the postoperative recordings were seen. All episodes were asymptomatic and occurred under anti-ischemic drug therapy. The occurrence of silent ischemia under anti-ischemic drug therapy for angina pectoris has a

worse prognosis than does symptomatic ischemia because of the absence of pain as a warning sign. What constitutes optimal anti-ischemic drug therapy remains a subject of discussion. Perioperative drug therapy with nitroglycerin is also to be considered.¹ Holter electrocardiographic monitoring is very important for the registration of frequent asymptomatic episodes to reduce the risk of patients with coronary artery disease undergoing surgery.

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